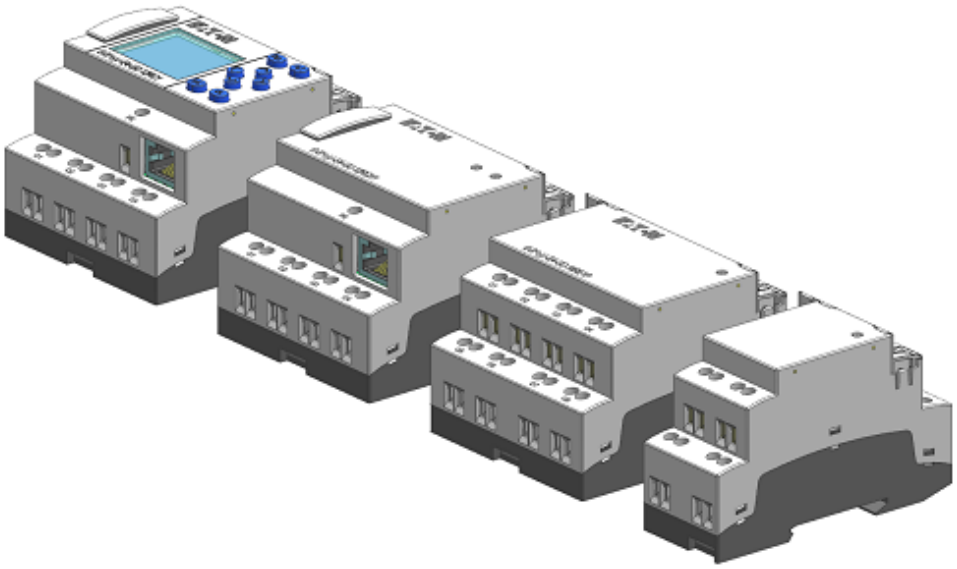
Manual

11/18 MN050009 EN

easyE4



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Original Operating Instructions

is the German-language edition of this document

Publication date

11/18 MN050009 EN 1st Edition, Build 007

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Subject to alteration.



DANGER!

Dangerous electrical voltage!

Before starting with the installation

- Installation requires qualified electrician
- Disconnect the power supply of the device.
- Secure against retriggering
- Verify isolation from the supply
- Ground and short-circuit
- Cover or enclose any neighboring live parts.
- Follow the engineering instructions (IL) 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 equipotential bonding. The system installer is responsible for implementing this connection.
- Connecting cables and signal lines should be installed so 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.
- Deviations of the mains voltage from the nominal value must not exceed the tolerance limits given in the specifications, otherwise this may result in malfunction and hazardous states.
- 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 result in an automatic restart.
- Built-in devices for enclosures or cabinets must only be run and operated in an installed state; desktop devices and portable devices only when the housing is closed.
- Measures should be taken to ensure the proper restarting of programs interrupted after a voltage dip or outage. This should not result in 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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0.1 About this manual

This manual contains all the information you will need in order to use the easyE4 safely and effectively.

The Manual easyE4 manual is considered an integral part of the devices and must always be readily available in the device's close proximity so that users have access to it.

As an integrated part, the easySoft 7 Help groups together the relevant sections in the easySoft 7.

This Manual describes all of the devices' lifecycle stages: transportation, installation, commissioning, operation, maintenance, storage, and disposal.
It assumes you have electrical engineering knowledge and skills.

Make sure to always use the latest documentation for your device.

 Manual easyE4 MN050009_EN

The latest version of this documentation, as well as additional references, is available for download on the Internet.

 http://www.eaton.eu/doc

Please send any comments, recommendations, or suggestions regarding this document to: AfterSalesEGBonn@eaton.com

0.1.1 List of revisions

The following significant amendments have been introduced since previous issues:

Publication date	Page	Keyword	New	Modification	Deleted
11/2018		New edition	✓		

0.1.2 Target group

This manual is intended for electricians and electrical engineers, as well as for the people who will be in charge of performing the electrical installation and people who will be using the control relays as operating and monitoring devices or as integrated operating and control devices in their own applications.

This manual is intended for people who:

- Want to use an easyE4 control relay
- Develop an application with easySoft 7.
- Want to test or commission a developed application

- Maintain an application with easySoft 7.
- Want to diagnose faults in an application

easyE4 devices must be installed and connected exclusively by electricians and people who are familiar with electrical installation work.



CAUTION

Installation requires qualified electrician



Follow the safety instructions for the easyE4!
The section on safety instructions must be read and understood by everyone who will be working with the easyE4 before the actual work is performed.



WARNING
Incomplete operator manual copies
Working with individual pages taken out from the operator manual may lead to bodily injury and property damage due to missing safety information.

▶ Always work with the latest and full document.

0.1.3 Legal disclaimer

All the information in this manual has been prepared to the best of our knowledge and in accordance with the state of the art. However, this does not exclude the possibility of there being errors or inaccuracies. We assume no liability for the correctness and completeness of this information. In particular, this information does not guarantee any particular properties.

Do not use the easyE4 before reading and understanding this manual.

It is assumed that the user of this manual is thoroughly familiar with the information found in the manuals for incorporating the control relay into automation processes.

Hazards posed by the control relay cannot be ruled out if the safety instructions are not observed – especially if the control relay is installed and commissioned by inadequately qualified personnel or if it is used improperly. Eaton assumes no liability for any damages resulting from cases such as these.

The use of sample programs and of the easySoft 7 programming software is subject to the following instructions and rules of use:

1. The program examples provided were created to the best of our knowledge and belief and in accordance with the current state-of-the-art. The program examples provided were created to the best of our knowledge and belief and in accordance with the current state-of-the-art. However, errors cannot be totally excluded, and the example programs do not cover all function blocks and applications that are available for the control relays.
2. Electrical engineering skills and know-how are required in order to be able to program and commission control relays. An incorrectly wired or incorrectly configured control relay will pose a property damage risk and an injury hazard when active components such as motors and pressure cylinders are being driven.
3. When using the provided sample programs and generating a program with SWDeasySoft 7, the user has the sole responsibility to observe the following:
   - All relevant rules and practices for preparing circuit diagrams for the circuit relays as specified in the latest documents for these relays.
   - All occupational health and safety and accident prevention directives, standards, and regulations applicable to the commissioning, circuit diagram creation for, and use of the control relays for your planned application, in particular those imposed by employers' liability insurance associations (Berufsgenossenschaften).
   - Acknowledged rule of technology and state of science.
   - All other general due diligence regarding the prevention of damages to life and physical condition of persons as well as material damage.
4. The manufacturer cannot accept any liability for any damages that are caused by customers not using the program examples provided in accordance with the conditions of use specified here under points 1 to 3.

0.1.4 Short designations

The following general terms are used throughout this manual:

Short designation	Explanation
easyE4	Entire series, used to refer to all the devices in the product family
EASY-E4-...	Used to refer to the devices in the series
EASY-E4-...-12...CX1	Base devices from the product family without a keypad
EASY-E4-...-12...C1	Base devices from the product family with an LCD display and a keypad
Expansions EASY-E4-...-...E1	All input and output expansions as devices in the product family

For the exact designation for your easyE4, please refer to the inscription on the device.

0.1 About this manual

0.1.5 Writing conventions

Table 1: Format conventions used throughout this manual

Award	Description
`Monospaced` Font	Used for displays, elements at the file level, source code command lines
Button	Used for the button labels on the device and in easySoft 7
Menu path\submenu\...\item	Used for paths to views and dialog boxes in easySoft 7
Menu/command	Used for commands found in the menu
<name>	Angle brackets are used to indicate variable values that you must replace with your own values
13:08	Flashing values on the display are shown in gray in this manual

0.1.5.1 Warning labels

Danger! Risk of personal injury.



DANGER

Warns of hazardous situations that result in serious injury or death.



WARNING

Warns of the possibility of hazardous situations that could result in serious injury or even death.



DANGER!

Dangerous Electrical Voltage!



CAUTION

Warns of the possibility of hazardous situations that can cause injury.

Property damage warning

NOTICE

Warns about the possibility of material damage.

Prohibited use



Prohibited uses, actions, etc.

Explanation

Bids



Bid

Explanation

Notes



▶ Indicates instructions to be followed

Additional information, background information, information worth knowing, useful additional information

0.1.5.2 Documents with additional information

Manuals, for example. These will be listed with the corresponding title and Eaton number after the icon.

Publication title — For identifying the Eaton publication code

External Internet addresses. They will be shown after the icon.

Destination address

0.1 About this manual

1. easyE4 control relays description

1.1 Use as intended

The easyE4 device is a programmable switching and controller device that is used to replace relay and contactor controls.

It is intended exclusively for monitoring, operating, and controlling machines and systems, as well as building and automation services for commercial buildings.

Any other use must be discussed and agreed upon with the manufacturer in advance.

The easyE4 are approved for use in closed spaces.



Bid

The easyE4 device must be used only in locations for which the device is approved. Make sure to read and follow the information and labels on the nameplate for the device, as well as section → "Approvals and declarations ", page 583 in the appendix.



Prohibited uses, actions, etc.

It is strictly prohibited to use the device to implement safety-relevant functions (in the sense of personal and machine protection) or safety-related controls (such as burner, emergency stop, and two-hand safety controls).

1.2 Function

The easyE4 device is an electronic control relay.

With their compact cover dimensions – and a heavy-duty, flat, anti-glare front – the base devices and expansions are ideal for industrial applications.

1.2.1 Features

- Logic gates
- Time and counter functions
- Time switch functions
- Arithmetic functions
- PID controllers
- Control relays with 16-character x 6-line LCD display (128 x 96 pixels) and keypad available.
- Function expansions can be implemented with insertable microSD cards
- Integrated operating system, can be loaded
- Built-in Ethernet interface
- Requires little space; can be used in an upright position as well
- Device construction for mounting rails
- Programming languages: Ladder diagram (LD), Function Block Diagram (FBD), Structured Text (ST), and easy Device Programming (EDP) on device and in easySoft 7

easyE4 base devices combine the functions of a control relay and an input device in one single unit

The Ethernet port makes it possible to integrate the base device into a network.

This allows the design of systems using high-speed controllers with decentralized intelligence.

There is ladder diagram language version called easy Device Programming (EDP) that you can use to put together a circuit diagram on the device.
In the case of devices with a display, you can enter the program as a circuit diagram directly on the device by using the corresponding buttons. You can also program it on your computer with the easySoft 7 programming software program (this option can also be used for base devices without a 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.
- ...

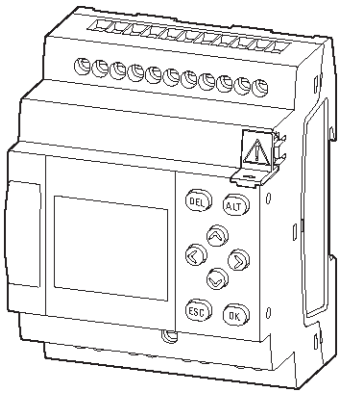
You can use the function blocks to run arithmetic functions, compare values, count up, count down, etc. All the function blocks available are provided in a list → Section "Function blocks", page 166

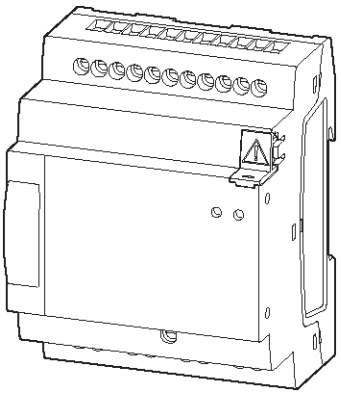
If you wish to wire a easyE4 device via your PC, i.e. create a circuit diagram, use the easySoft 7→ Section "Programming software easySoft 7", page 28.

1.3 Device models - versions and part nos.

1.3.1 Basic features

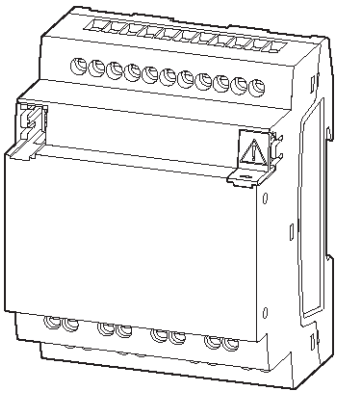
All base devices feature:

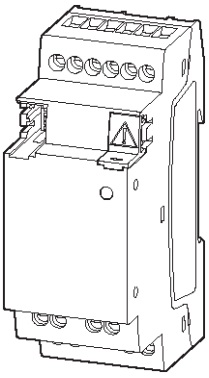




- An operating system (firmware)
- A microSD memory card slot.
- An Ethernet port (10/100 Mbps) that can be used as a communication or network interface

All expansions for the base devices are included in the operating system (firmware) as well.





1.3.2 Base device versions

The available base device versions are different from each other in terms of:

- The type of operating voltage
- The type of outputs
- The available controls

EASY-E4-...-12...C1

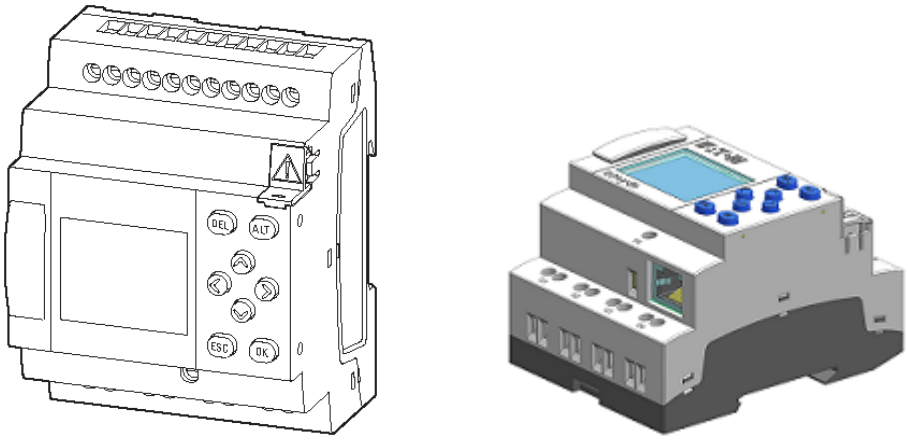


Figure 1: Devices with display and button controls

EASY-E4-...-12...CX1

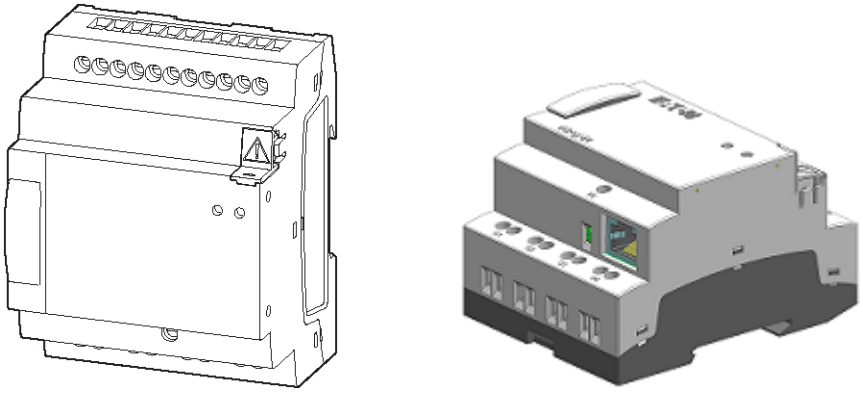


Figure 2: Devices with LED indicators used for diagnostics

1.3.3 I/O expansion versions EASY-E4-...-...E1

The available input and output expansion devices are different from each other in terms of:

- The type of operating voltage
- The type and number of inputs
- The type and number of outputs and
- in terms of width (space units SU).

EASY-E4-UC-16RE1, EASY-E4-DC-16TE1

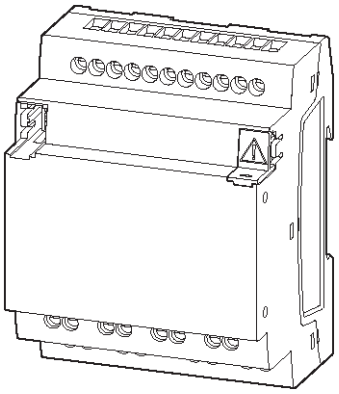


Figure 3: Device models in 4SU

EASY-E4-UC-8RE1, EASY-E4-DC-6AE1, EASY-E4-DC-8TE1

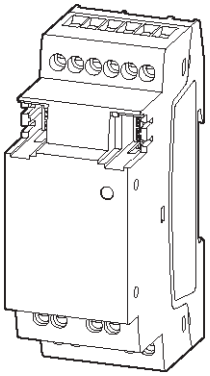


Figure 4: Device models in 2SU

1.4 Accessory devices

In addition to I/O expansions, there are additional accessories available for easyE4 base devices.

> *NOTICE*
> Only use original accessories.

Order accessories through your supplier or through the EATON online catalog
www.eaton.eu/ecat

Example:

article no.	Catalog Number
191087	MEMORY-SDU-A1 microSD 2 GB memory card with adapter, I Grade, without an operating system
197226	EASYSOFT-SWLIC software licence easySoft 7 Operating and programming software license
061360	ZB4-101-GF1 Device foot for screw mounting
197225	EASY-E4-CONNECT1 Spare parts package Three (3) connectors and three (3) end covers for the easyE4 series between the control relay and input/output expansions

1.5 What the different parts of the part number mean

The part number includes information that specifies the version and model of the specific device being used.

The Part number can be found at the front of the easyE4.

Table 2: Part number for screw terminal devices

easy-E4	-	.C	-	..	...	-	x1(P)
Power rating		Type of supply voltage		Number of input-s/outputs	Type of output R-Relay T-Transistor A-Analog		E-Expansion CX-Base device with LED diagnostics C-Base device with display and buttons 1-Version P-Model with push-in terminals instead of screw terminals

Make sure to take advantage of the EATON online catalog. Enter "easy" into the search box and the catalog will take you directly to the corresponding product group in the Automation, Control and visualization section.

http://www.eaton.eu/ecat

1.6 Nameplate

The device can be identified by checking the nameplate on its side.
This nameplate includes the following information:

- Manufacturer
- Operational voltage
- Heat dissipation information
- Type approval and certification marks and information
- Information relevant to UL listing

In addition to the device's part number and MAC address, the QR code in the front also contains additional information:

- Version
- Serial number
- Production Date
- Delivered operating system

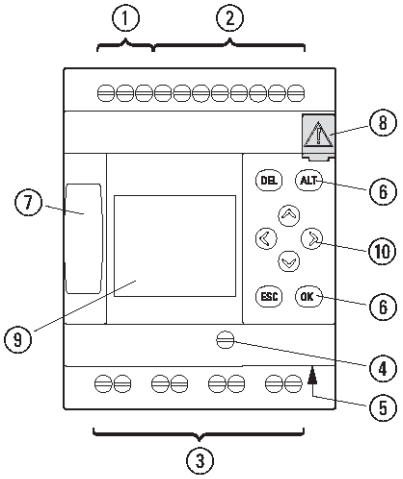
1.7 Support

To get fast and effective support, make sure to always provide Customer Service with the following information:

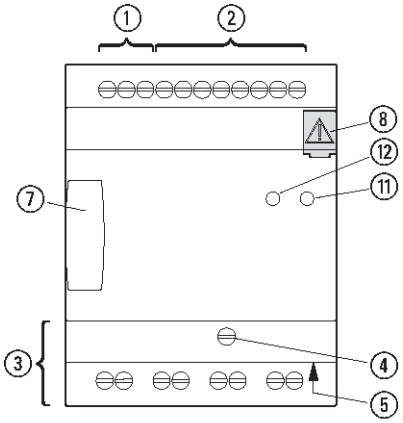
- Part number
- Information from the QR code
- Ambient conditions at the location of use
- Fuse or other protective element used to protect the device
- Supply voltage conditions
- If applicable, easySoft 7 build No., version

1.8 Overview of devices

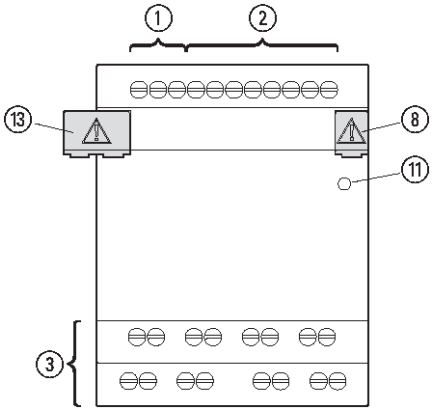
EASY-E4-...-12...C1

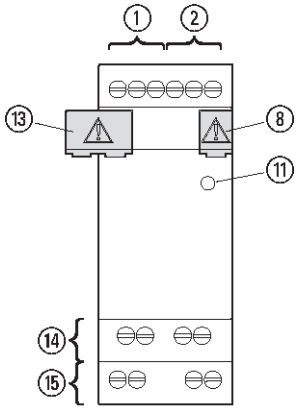


EASY-E4-...-12...CX1



Expansions





1	Power Supply	6	Pushbuttons	11	LED POW/RUN
2	Input points	7	Slot for microSD memory card	12	LED ETHERNET/NET
3	Outputs	8	Covering cap	13	Bus connector plug
4	Ethernet connection Functional earth	9	Display	14	Analog inputs
5	Ethernet socket	10	Cursor buttons	15	Analog outputs

1.9 Programming software easySoft 7

easyE4 control relays are designed to be programmed with the easySoft 7 programming software program. This program was developed specifically for this series of devices, and makes it possible to quickly, conveniently, and easily integrate available functions into a circuit diagram and use the result as a control program.
The program is available free of charge. However, you will need a software license in order to be able to use all of its functions.

easySoft 7 can also be used to:

- Test your circuit diagram by simulating the power flow (offline test).
- Transfer your circuit diagram to a connected and operational easyE4 base device.
- Monitor the power flow and view operand states after transferring the circuit diagram (online test)
- Print out your circuit diagram so that you can document it in detail

In addition, the program makes it possible for you to use a password to protect your projects and, accordingly, your know-how.

1.10 Safety regulations

1.10.1 Basics

The device has been designed according to the state of the art and all generally accepted safety rules and standards. However, this alone cannot eliminate all potential hazards, which is why it is necessary for you to be aware of all hazards and residual risks.

Do not run the device unless it is in perfect technical condition. Make sure to always operate it as specified in this document and for the intended purpose.



Follow the safety instructions for the easyE4!
The section on safety instructions must be read and understood by everyone who will be working with the easyE4 before the actual work is performed.

NOTICE
Pay attention to the hazard severity levels used throughout this documentation whenever a hazard is indicated. The hazard symbol and signal word used and the corresponding text will provide information regarding the specific hazard and how to avoid or prevent it.

1.10.2 Mandatory requirements, personnel requirements

1.10.2.1 Occupational safety

All generally accepted occupational health and safety rules and standards (internal and national) must be complied with, as must be all applicable laws and regulations in the relevant country.

1.10.2.2 Personnel qualifications

The personnel responsible for installation, operation, maintenance, and repairs must have the necessary qualifications for the work they will be performing. They must be appropriately trained and/or briefed and be informed of all hazards and risks associated with the device.

1.10.2.3 Device documentation

This manual is considered an integral part of the device and must always be readily available in the device's close proximity so that users have access to it.

Make sure that every person who will be working with the device, regardless of the life-cycle stage involved, has read and understood the relevant parts of the documentation for the device.

Additional parts of the documentation and information for the easyE4, including the installation instructions, can be found at the Eaton Download Center - Documentation and at the product pages on the Internet

http://www.eaton.eu/doc

http://www.eaton.eu/easy



WARNING

Incomplete operator manual copies

Working with individual pages taken out from the operator manual may lead to bodily injury and property damage due to missing safety information.

▶ Always work with the latest and full document.

1.10.2.4 Installation, maintenance, and disposal

Make sure that the device is connected, installed, serviced, and disposed of professionally and in line with all relevant standards and safety rules.



CAUTION

Installation requires qualified electrician



Important!

Dispose of recyclables as required by your local recycling regulations.

Devices no longer being used must be professionally disposed of as per local regulations. To learn more, please visit:

Eaton.com/recycling

1.10.2.5 Prerequisites for proper operation

In order for the device to be able to meet the contractually stipulated terms, the following must be observed:

- Only qualified personnel should be allowed to work with the device.
- The personnel working with the device must have read and understood all documents for the device and must follow all the instructions in them.
- The required ambient conditions must be met.
- Maintenance work must be carried out correctly.



Make sure to read the → "Legal disclaimer", page 14.

We assume no liability for damages, consequential damages, and/or accidents caused by the following:

- Failure to follow any applicable occupational health and safety rules, standards, and/or regulations
- Device failures or function disturbances
- Improper use and/or handling
- Not following the instructions or observing the information in the documentation for the device
- Alterations, changes, and repairs to the device

1.10.3 Device-specific hazards



CAUTION
DESTRUCTION
The easyE4 should only be opened by the manufacturer or by an authorized center. Operate the device until only with the enclosure fully closed and sealed.



CAUTION
ELECTROSTATIC DISCHARGE
Do not touch components (e.g., connector pins) that are electrostatic-sensitive.

- Discharge (by touching a grounded metal object) any static charge accumulated in your body before touching the device.

Electrostatic discharges may damage or ruin assembly parts. Because of this, it is necessary to take precautions whenever handling the cards. Please refer to the guidelines for electrostatic-sensitive components for more information (ESD guidelines).



CAUTION
INTERFERENCES
The values specified in the technical data, as well as the device's electromagnetic compatibility (EMC), cannot be guaranteed if the following are used: unsuitable cables, improperly assembled and terminated cables, and/or wiring that does not conform to the applicable standards.
Only use cables assembled and terminated by professionals.
The cables being used must be assembled and terminated as required by the port/interface description in this document.
When wiring the devices, follow all instructions regarding how to wire the corresponding port/interface.
All general Directives and standards must be complied with.



CAUTION
INTERFERENCES
Screw all plug-in connections or lock them into place in order to improve screening.
Signal cables must not be routed in the same cable duct with power cables.
Before putting the system into operation, check all cable connections to make sure that everything has been wired properly.
Make sure that all voltages and signals have the required values as specified in the technical data.



CAUTION
SAFELY DIVERTING ELECTRICAL INTERFERENCE CURRENTS

The devices must be connected to a central earth point with a conductor that is as short and has as low a resistance as possible.

- Ground connection characteristics:
  Wire cross-sectional area ≧ 1.5 mm², length ≦ 350 mm

The easyE4 needs to be connected to the conductive structure in, e.g., the control panel using the central earth point (earthing screw). This method of earthing is mandatory required for proper function.



DANGER
STRAY CURRENTS

Large equalizing currents between the functional earthing system and the ground system of different devices may result in fire or in malfunctions due to signal interference.

▶ If necessary, route an equipotential bonding conductor, with a cross-sectional area that is several times larger than that of the cable shielding, parallel to the cable.



CAUTION
DATA LOSS

If the SD card is being written to and a voltage drop occurs or the card is removed, data may be lost or the SD card may be ruined.

▶ Insert the SD card only when the easyE4 is de-energized.

Avoid writing to SD cards. Reasons:

- SD cards have a limited number of write cycles.
- If there is a voltage drop while a write operation is in progress, data loss is highly likely to occur.

▶ Remove the SD card only when the easyE4 is de-energized.
▶ Before switching off the device, make sure that there are no programs writing to the SD card.



CAUTION
SHORT-CIRCUIT HAZARD

If the device is or has been exposed to environmental fluctuations (ambient temperature, air humidity), condensation may form on or inside it. As long as this condensation is present, there will be a short-circuit hazard. Do not switch on the device when it has condensation in or on it.
If the device has condensation in or on it, or if the panel has been

exposed to environmental fluctuations, let the panel settle into the existing ambient temperature before switching it on.



CAUTION
UV LIGHT
Plastics will become brittle when exposed to UV light. This artificial aging will reduce the easyE4 unit's lifespan. Protect the device from direct sunlight and other sources of UV radiation.



CAUTION
POINTY, SHARP OBJECTS AND CORROSIVE LIQUIDS
When cleaning the device:

- Do not use any pointy or sharp objects (e.g., knives).
- Do not use aggressive or abrasive cleaning products or solvents.

Make sure that no liquids get into the device (short-circuit hazard) and that the device is not damaged in any way.



CAUTION
INSTALLATION CUT-OUT
The mounting cutout must be located in a position that will not defeat the purpose of stabilizing webs or other reinforcing elements in the control panel. If necessary, reinforcing elements must be installed/added.



WARNING
The device should only be run with safety extra-low voltage (functional extra-low voltage with protective separation).
The power transformer must conform to the relevant standards.



CAUTION
MECHANICAL FORCES ON THE ETHERNET PORT
Communications may be affected, and the connection's mechanical components may be damaged, if the Ethernet interface is subjected to strong vibrations or the RJ45 plug-in connection is subjected to pulling.

- Protect the RJ45 plug-in connection from strong vibrations.
- Protect the RJ45 plug-in connection from tensile forces at the socket.



CAUTION

Installation requires qualified electrician

2. Installation



CAUTION

Installation requires qualified electrician

easyE4 devices must be installed and wired exclusively by an electrician or a person who

is familiar with electrical installation rules and practices.

The devices are installed in the following order:

1. Mounting base device
2. Assemble the base device and expansion devices into a block (optional)
3. Connecting the power supply
4. Connecting inputs
5. Connect all outputs (optional)
6. Connect to Ethernet



DANGER OF ELECTRICAL SHOCK!

Dangerous Electrical Voltage!
All installation work must be carried out with the entire installation in a de-energized state.

Always comply with all applicable country-specific safety rules and regulations:

1. Switch off and isolate
2. Secure against retriggering
3. Verify isolation from the supply
4. Earthing and short-circuiting
5. Covering or providing barriers to adjacent live parts

What to do before turning the device back on

- Remove all tools and materials
- Leave the danger zone
- Remove the short-circuiting and grounding at the area where work was performed and then elsewhere
- Disconnect the ground wire from the system components first, then from the ground
- Do not touch system components or cables without a ground wire (if there was one previously) anymore
- Reinstall all safety covers, safety enclosures, safety labels, and safety signs

- Do not remove safety measures at switching points until you get the all-clear for the areas where work was performed
- If carrying out work that involves more than one worker, make absolutely sure that nobody is still in the danger zone

2.1 Prerequisites for the location of use

The device must be used exclusively in locations for which it has been approved/certified.

The supply voltage must be guaranteed and must conform to the relevant specifications-

→ Section "Nameplate", page 25and
refer to the specifications on the → Section "Technical data", page 584 of the individual devices, → page 584



CAUTION
INSTALLATION CUT-OUT
The mounting cutout must be located in a position that will not defeat the purpose of stabilizing webs or other reinforcing elements in the control panel. If necessary, reinforcing elements must be installed/added.

2.1.1 Installation position

easyE4 devices are intended to be flush mounted in control cabinets, control panels, service distribution boards, or control consoles from behind.

The following must be taken into account when selecting the installation position:

- The controls and connectors must remain accessible even after the device has been installed.
- easyE4 devices can be installed in a horizontal or vertical position.



The slot for the microSD memory card is located under a cover on the base device.
Please observe the clearance required in order to be able to remove the microSD and use the buttons.

2.1.1.1 Temperatures

Make sure that the device does not overheat.

Do not expose the device to direct sunlight or other sources of heat.
The minimum clearance to components that radiate heat, such as transformers under heavy loads, is 15 cm.



CAUTION
UV LIGHT
Plastics will become brittle when exposed to UV light. This artificial aging will reduce the easyE4 unit's lifespan. Protect the device from direct sunlight and other sources of UV radiation.

The environmental ambient conditions for operation must not exceed the specified values:

Ambient climatic conditions	
Air pressure (in operation)	795 - 1080 hPa
	max. 2000 m NHN
Temperature	
Operation	- 25 – +55 °C (-13 – +131 °F) The display is readable between ϑ -5°C (-23°F) ≦ T ≦ 50°C (122°F).
Storage / Transport	- 40 – +70 °C (-40 – +158 °F)
Humidity	Relative humidity 5 - 95 %
Condensation	Prevent condensation by means of suitable measures

2.1.1.2 Aeration and de-aeration

- The device uses natural convection-based passive cooling, i.e., it does not use fans.
- Make sure that there will be enough volume for air changes inside the control panel, etc.
  The specified clearance around the easyE4 is: a, b, c ≧ 30 mm (1.2")
- When installing the easyE4 in complex systems together with other assemblies, you must ensure that there will be enough air circulation in order to prevent overheating.
  Ambient temperature for natural convection for devices with a display: ϑ -25°C (-13°F) ≦ T ≦ 55°C (131°F)
  The display will be readable between ϑ -5°C (-23°F) ≦ T ≦ 50°C (122°F).
  The panel builder is responsible for the temperature rise calculation. Eaton will provide heat dissipation data for the easyE4 as necessary for design verification in accordance with IEC EN 61439.

2.2 Unpacking and checking the equipment supplied

- Check the easyE4's packaging for transit damage.
- Carefully remove the packaging in order to avoid damaging the device.
- Check the package contents for visible transit damage.
- Use the information in Installation instructions to make sure that the contents are complete.



Keep the original packaging so that you will be able to use it in the future if you need to transport or ship the device.
Make sure to also keep the documents enclosed with the device and/or to give them to the end customer.

The package for the easyE4 series comes with:

Table 3: Std. pack easyE4 control relays

Unit	Description
1 x	EASY-E4-...-12...C1 or EASY-E4-...-12...CX1
1 x	Installation instructions IL050020ZU

Unit	Description
1 x	EASY-E4-...-...E1
1 x	Bus connector plug EASY-E4-CONNECT1
1 x	Installation instructions IL050021ZU

The easyE4 is sturdily built, but the components inside it are sensitive to excessively strong vibrations and/or mechanical shock.

Accordingly, make sure to protect the easyE4 from mechanical loads that exceed the scope of the unit's intended use.

The device should only be transported in its original packaging after being packed properly.

Missing parts or damage

If you notice anything wrong, please contact your distributor or
Eaton Service +49 (0) 180 5 223822 (de,en)

2.3 Mounting

NOTICE
Arrange for a professional technician to mount the device.



CAUTION
INSTALLATION CUT-OUT
The mounting cutout must be located in a position that will not defeat the purpose of stabilizing webs or other reinforcing elements in the control panel. If necessary, reinforcing elements must be installed/added.

- Check to make sure that the installation clearances are being observed
  → Section " Installation position", page 38
- Make sure that the mounting cutout has the right size.

Mounting EASY-E4-...

Mounting on ICE/EN 60715 mounting rail OR

With screws and ZB4-101-GF1 mounting feet.

2.3.1 Mounting easyE4 control relays

Install a easyE4 control relays in an enclosure, switch cabinet or distribution board so that the power supply and terminal connections cannot be touched accidentally during operation.

The easyE4 control relays can be mounted either vertically or horizontally.

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

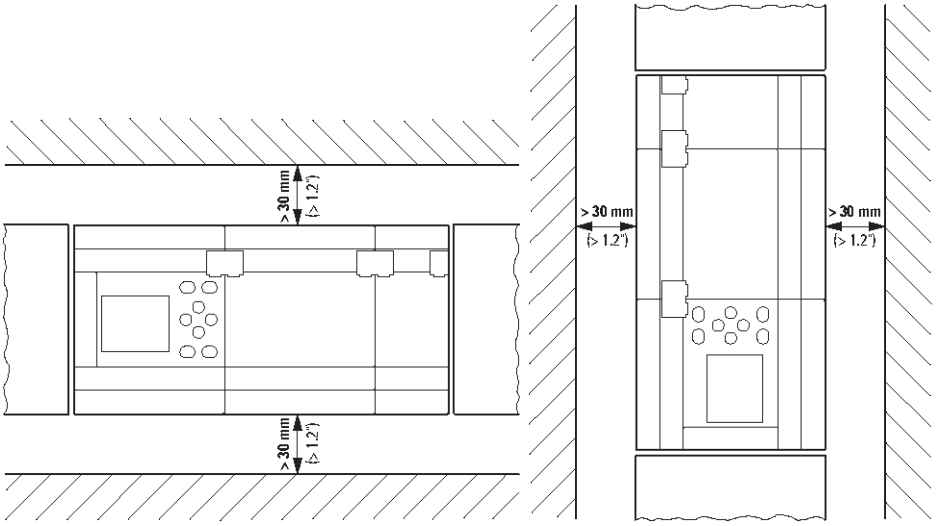


Figure 5: Mounting distance min. 3 cm

▶ Snap the base device and every expansion onto a mounting rail or mount every device using ZB4-101-GF1 device feet

Local expansion units are connected directly next to the basic unit.

You can use the EASY-E4-CONNECT1 connector to connect the easyE4 base device to up to 11 expansions and assemble them into a single device block.

Expansion devices come with an EASY-E4-CONNECT1 connector as standard.

You can use the expansion devices to:

- Increase the number of inputs/outputs
- Combine various voltages
- Process analog/digital signals

You can use all digital and analog expansion devices regardless of the corresponding operating voltage.

Each expansion needs to be mounted individually on the mounting rail or with screws and device feet, much like the base device. Once you are done mounting all the devices, use the connector to combine them into a single device block.

▶ Connect the base device to the expansion, and the expansions to each other, with the EASY-E4-CONNECT1 connector.

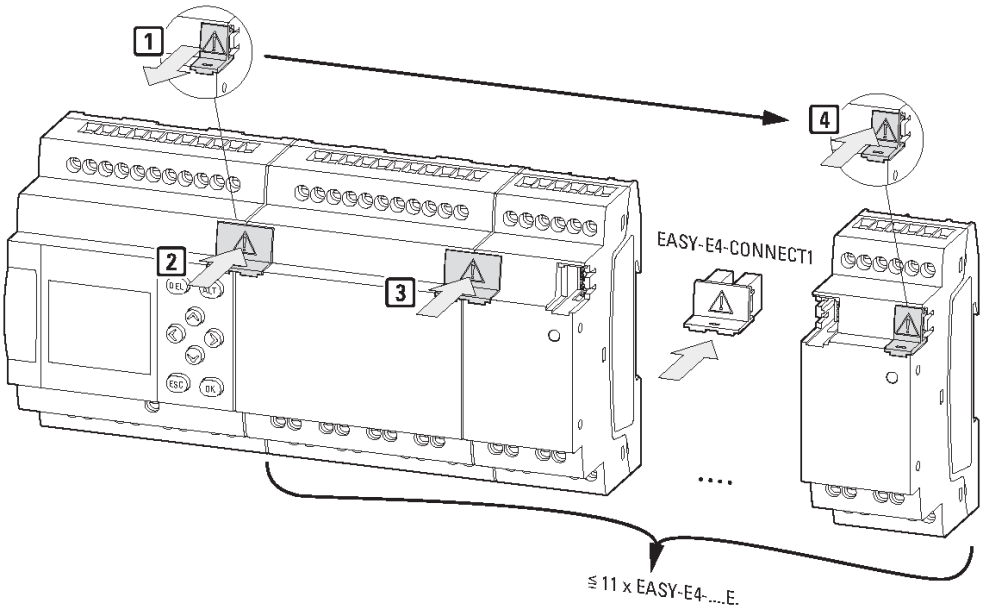


Figure 6: Assembling a base device with expansions

2.3.1.1 Installation on mounting rail

1. Position the base device against the mounting rail's upper lip in an inclined position.
2. Lightly push the device down and against the mounting rail until it snaps into place over the mounting rail's lower lip.

The device will clip into place automatically.

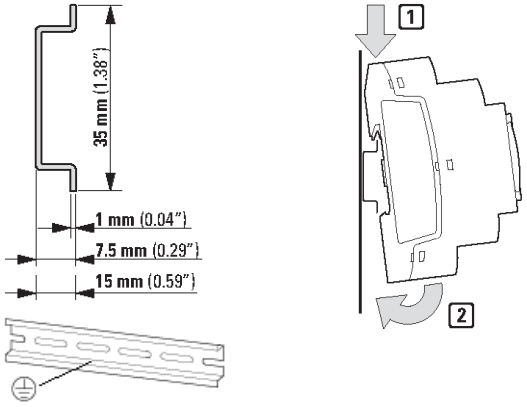


Figure 7: Installation on IEC/EN 60715 mounting rail

3. Check that the device is seated firmly.

The device is mounted vertically on a mounting rail in the same way.

Mounting the first expansion (optional)

1. Position the expansion device against the mounting rail's upper lip in an inclined position to the right of the base device.
2. Slide the expansion until it is resting flush against the base device.
3. Lightly push the device down and against the mounting rail until it snaps into place over the mounting rail's lower lip.
4. Remove the end cover from the base device and store it in a safe place.
5. Connect the base device to the expansion using the connector.

Mounting additional expansions (optional)

1. Position the expansion device against the mounting rail's upper lip in an inclined position to the right of the previous expansion.
2. Slide the expansion until it is resting flush against the previous expansion.
3. Lightly push the device down and against the mounting rail until it snaps into place over the mounting rail's lower lip.
4. Connect the expansions to each other using the connector.
5. Repeat for all additional expansions – up to 11 EASY-E4-...-...E1

Finishing up the process

1. Take the base device's end cover and install it on the right side of the last expansion.

There will be the following electrical isolation at the local expansion connection between the base device and the expansion device:

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

Basic device and expansion unit can be provided with different power supplies.

2.3.1.2 Screw mounting

Fixing brackets ZB4-101-GF1 that can be inserted on the rear of the easyE4 devices are required for screw fixing.
These feet are available as an accessory – please refer to → Section " Accessory devices", page 24.

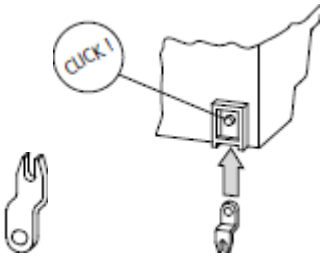


Figure 8: Inserting a fastening bracket.

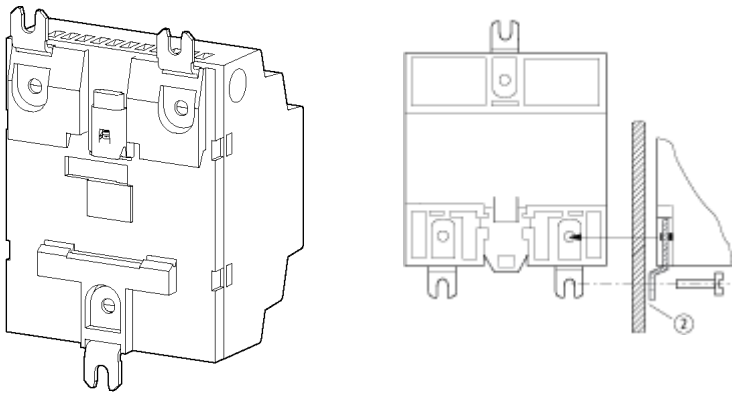


Figure 9: Screw mounting configuration for a device

The base devices and the EASY-E4-UC-16RE1 and EASY-E4-DC-16TE1(4SU) expansions require three feet each, while the EASY-E4-UC-8RE1, EASY-E4-DC-8TE1, and EASY-E4-DC-6AE1 expansions require two each.

2.3.1.3 Removing a device

- Disconnect all the connections and wires for the device
- If the device is a standalone base device, you can remove it directly
- If you are working with a block consisting of a base device and expansion devices, remove the EASY-E4-CONNECT1 connectors

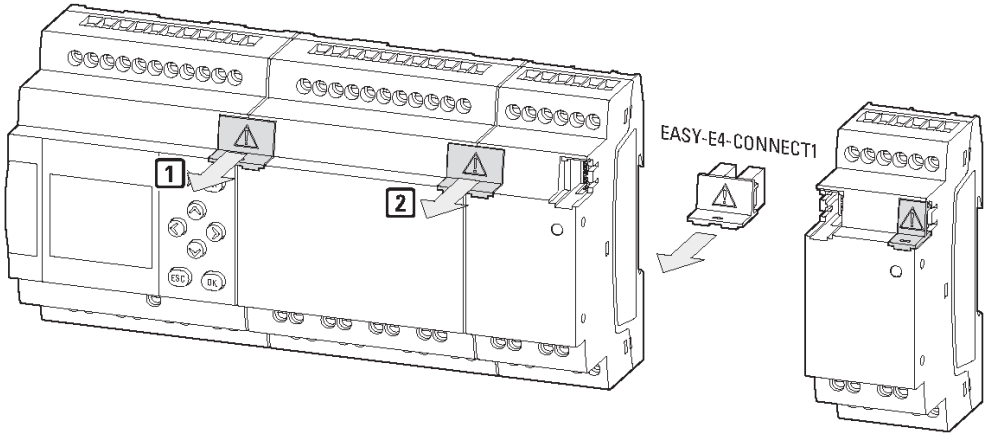


Figure 10: Remove adjacent connectors

- Remove the device from the mounting rail

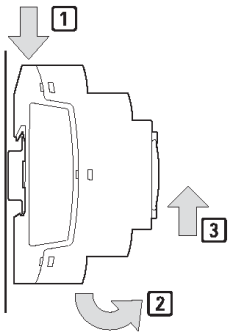


Figure 11: Dismantling

- Screw mounting option:
  Unscrew the screws on the device feet.

2.4 Connection terminals

Tool for all easyE4 devices:

Flat-blade screwdriver with a 3.5 x 0.6 mm blade

and for fastening on screw terminals (optional)

a tightening torque 0.5 - 0.7 Nm.

2.4.1 Cable cross-sections

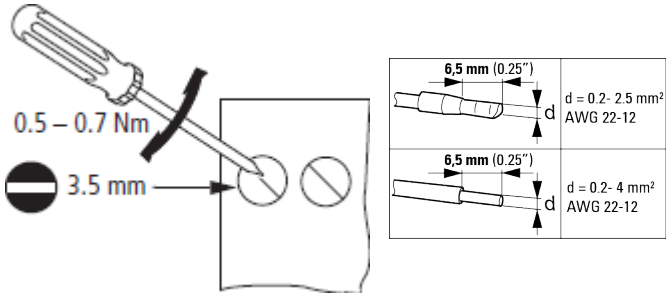


Figure 12: Screw length stripping length

	Terminal capacity in mm²
solid	0.2 to 4 (AWG 22 -12)
Flexible with ferrule	0.2 to 2.5

See also

→ Section "Connecting the Ethernet cable", page 65

2.4.2 Connecting the power supply

Cable protection

For all base devices, as well as for the expansion devices, connect an (F1) circuit protection device rated for at least 1 A (slow).

You can use a shared circuit protection device for the base device and expansion(s).

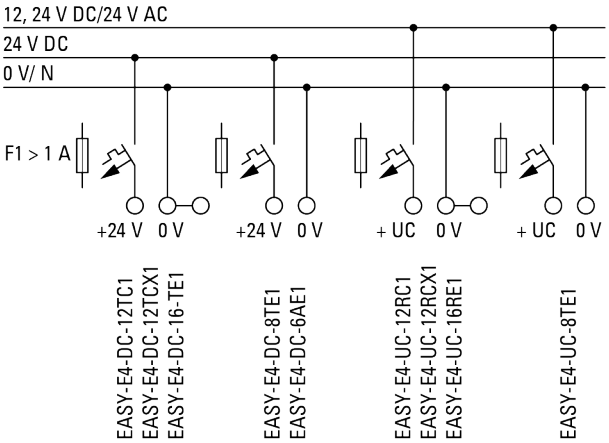


Figure 13: Connecting the power supply

System test

The devices run a system test after the supply voltage has been switched on.

The system test lasts 1 s for the base device. After this time elapses, the device will enter RUN or STOP mode depending on the specific device and configured settings.

NOTICE

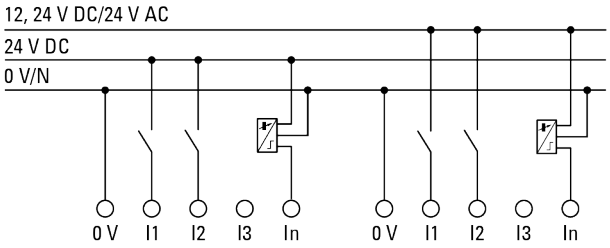
When the basic devices and expansion units are switched on, they behave like a capacitor, so that an inrush current higher than the rated input current is present. Take this inrush current into account when designing the electrical equipment by using slow fuses and suitable switches. Never use reed relay contacts to switch the power supply as these may burn or stick. When designing the DC power supply unit, bear the inrush current in mind.

You can find the required connection specifications for your device model from the corresponding data sheet, → Section "Technical data", page 584

2.4.3 Connect digital inputs

The inputs of the easyE4 devices switch electronically.
Once you have connected a contact via an input terminal, you can reuse it as a contact in your circuit diagram as often as you like.

Connect the contacts, for example buttons or switches, to the input terminals of the easyE4 device.



EASY-E4-DC-12TC1
EASY-E4-DC-12TCX1
EASY-E4-DC-8TE1
EASY-E4-DC-16TE1

EASY-E4-UC-12RC1
EASY-E4-UC-12RCX1
EASY-E4-UC-8RE1
EASY-E4-UC-16RE1

Figure 14: Connect digital inputs

As per the hardware characteristics, base devices have 8 digital inputs available (I1 – I8)
Meanwhile, expansion devices feature 4 (I1 – I4) or 8 (I1 – I8) inputs.

2.4.3.1 Connect digital counter inputs

Only possible on base devices.

Base devices with DC and UC voltage come with special counting and measuring functions on inputs I1 to I4.
These functions are connected directly to function blocks.

The following applies to EASY-E4-UC-...:
The voltage supplied to the EASY-E4-UC-... must be a DC voltage, since only DC signals will be processed.

You can process the following:

- 4 individual high-speed counter signals (one single counting direction), I1, I2, I3, I4
- 2 incremental counters, I1, I2 and I3, I4
- Frequencies I1, I2, I3, I4

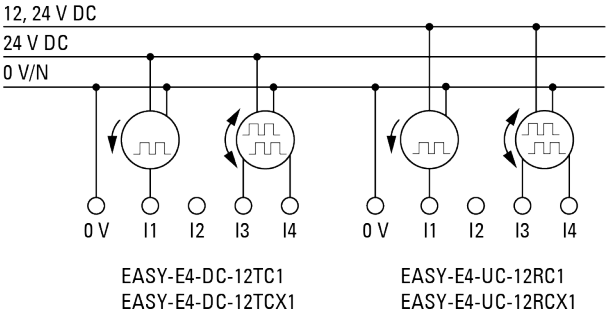


Figure 15: Connect digital counter inputs

Input cable length
Strong interference on long cables can result in inputs reaching their switching level. Please do not exceed the maximum cable lengths specified in the technical data for the connected sensors.

2.4.4 Connecting analog inputs

Only possible on base devices.

Base devices with DC and UC voltage can read analog voltages within a range of 0 to 10 V via inputs I5, I6, I7, and I8 on the EASY-E4-... base device.

The signal has a 12 bit resolution, value range 0 - 4 095.

The following applies:

- I5 = IA01
- I6 = IA02
- I7 = IA03
- I8 = IA04

The analog voltage inputs can also be used as digital inputs.

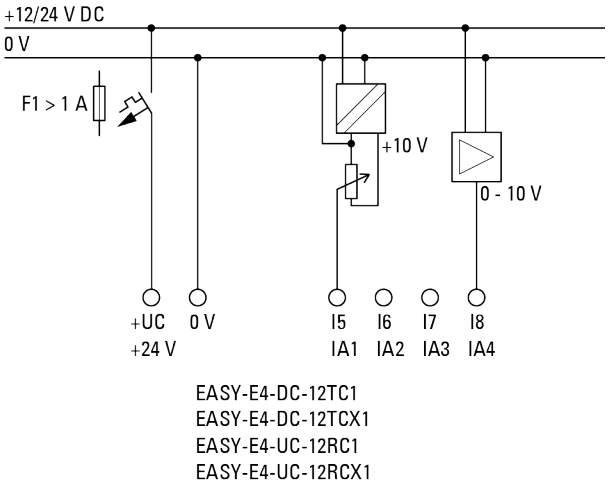


Figure 16: Connecting analog inputs

SETPOINT encoder:
Use a potentiometer with a resistance ≤ 1 kΩ, e.g., 1 kΩ, 0.25 W.

DANGER

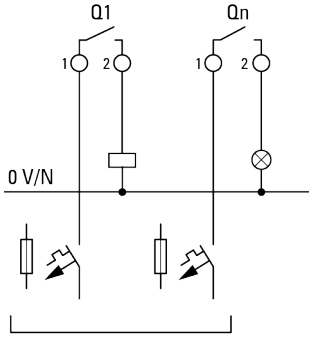
Analog signals are more sensitive to interference than digital signals. Consequently, greater care must be taken when laying and connecting the signal lines. The measures described below must be adhered to in order to prevent any deviations in analog values. An incorrect connection can lead to unwanted switching states.

Tips for analog signals

- Use shielded or twisted pair cables.
- Keep signal cables as short as possible and not longer than 10 m.
- With short cable lengths ground the shield of the signal cables at both ends with a large surface area connection.
  In the case of longer signal cables, the shield should only be terminated on one end, i.e., on the side of the EASY-E4-... devices.
  Otherwise compensation currents between both grounding points may flow, leading to the interference of analog signals.
- Lay signal cables separately from heavy current cables.
- Connect inductive loads that you are switching via the outputs of the EASY-E4-...-devices to a separate power supply or use a suppressor circuit for motors and valves.
  If loads such as motors, solenoid valves or contactors and EASY-E4-... devices are operated with the same power feed, switching may give rise to interference on the analog input signals.
- Make sure that the reference potential is galvanically connected.
- Do not run the EASY-E4-... devices on a non-grounded power supply.

2.4.5 Connecting relay outputs

The EASY-E4-UC-... base and expansion devices feature relay outputs.



EASY-E4-UC-12RC1
EASY-E4-UC-12RCX1
EASY-E4-UC-16RE1
EASY-E4-UC-8RE1

Figure 17: Connecting relay outputs

DANGER

Make sure to observe the technical data for the relays.
Do not exceed the upper voltage limit of 250 VAC 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.

2.4.6 Connecting transistor outputs

EASY-E4-DC-... devices feature transistor outputs.

A separate power supply feed must be provided for the base device transistor outputs.

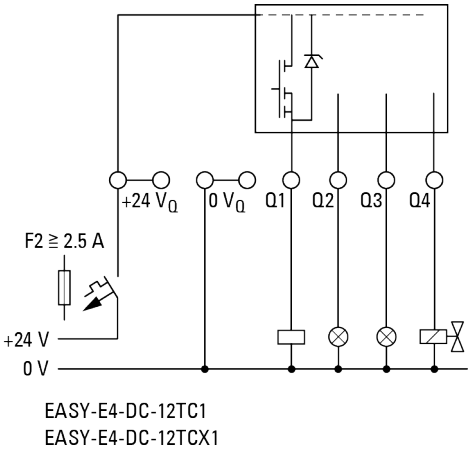


Figure 18: Connecting base device transistor outputs

Transistor outputs on easyE4 expansion devices are powered via the power supply for the expansion device. In other words, transistor outputs have the same potential as the expansion device's inputs.

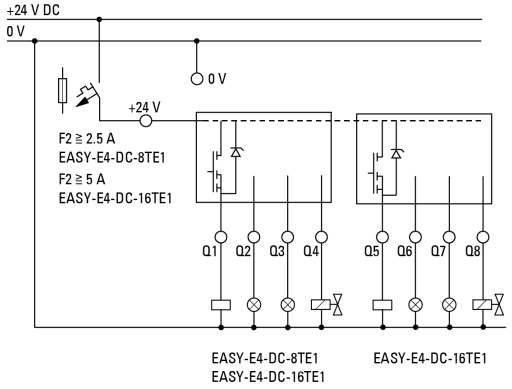


Figure 19: Connecting expansion device transistor outputs

→ Suppressor circuit for transistor outputs on EASY-E4-... devices.

Large currents may be produced when inductive loads are switched off. Because of this, transistor outputs should be protected with a suppressor circuit.
Use a suppressor circuit and observe the following:

Multiple inductive loads should not be switched off simultaneously, as this may result in the electronic components overheating in the worst-case scenario. If the +24 VDC power supply is switched off via a contact in the event of an emergency stop, and if

more than one driven output with an inductive load can be switched off, you must provide these inductive loads with a suppressor circuit.

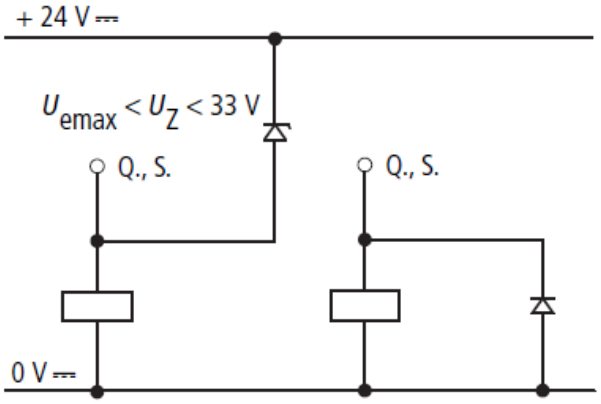


Figure 20: Inductive load with suppressor circuit

2.4.6.1 Transistor output behavior in the event of a short circuit/overload

The following applies to easyE4 devices with transistor outputs:

In the event of a short circuit or overload at a transistor output, this output will switch off and a general fault alarm ID (please refer to fault IDs) will be set to 1. 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 continues, the output will switch off and on until the fault is rectified or the power supply is switched off.

2.4.6.2 Connecting outputs in parallel

Only outputs of the same group (Q1 to Q4 or Q5 to Q8) can be connected in parallel; e.g. Q1 and Q3 or Q5, Q7 and Q8. Parallel switched outputs must be similtaneously energized.



DANGER

If the outputs are not switched on and off automatically, or if outputs from both groups are connected in parallel, this may result in malfunctions such as short circuits or the load not switching on

2.4.7 Analog I/O expansion device

The EASY-E4-DC-6AE1 features four analog inputs and two analog outputs. You can use easySoft 7 to set the operating mode for each analog input and analog output.

The following options are available:

Resolution, analog	Resolution, digital	value
0 – 10 V	12 bits	0 - 4095
4 – 20 mA	12 bits	820 - 4095
0 – 20 mA	12 bits	0 - 4095

For all analog inputs, you can configure noise suppression, averaging, and an update rate in easySoft 7.

Project view

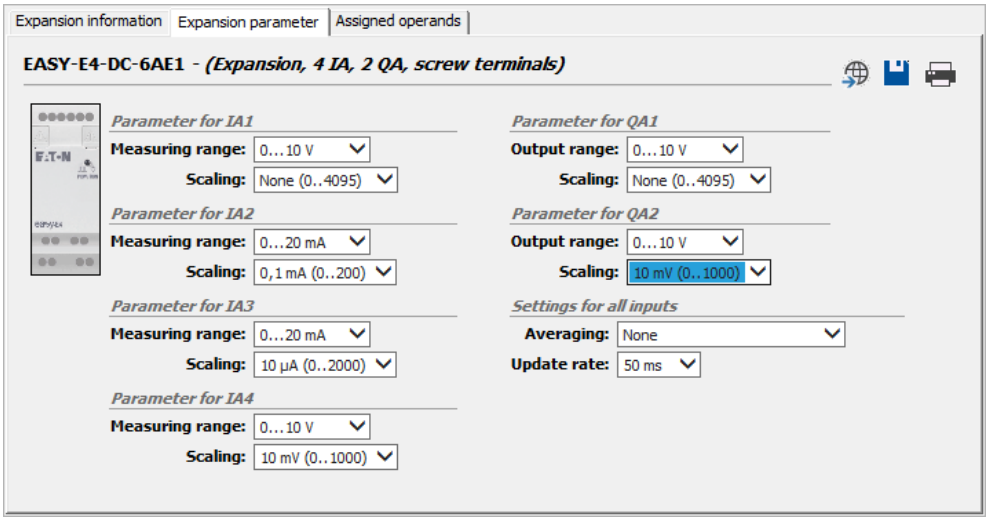


Figure 21: Device parameters tab

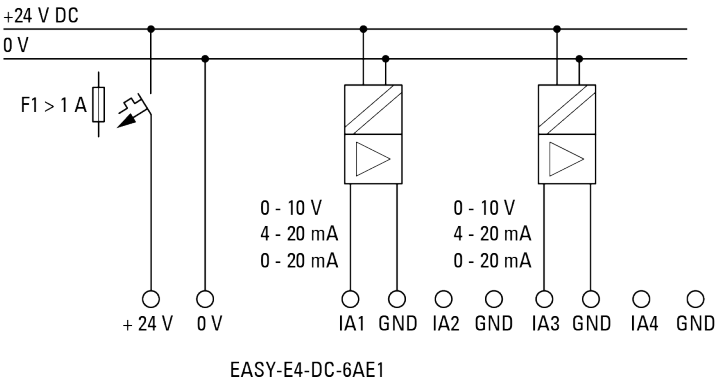


Figure 22: Connecting analog inputs EASY-E4-DC-6AE1

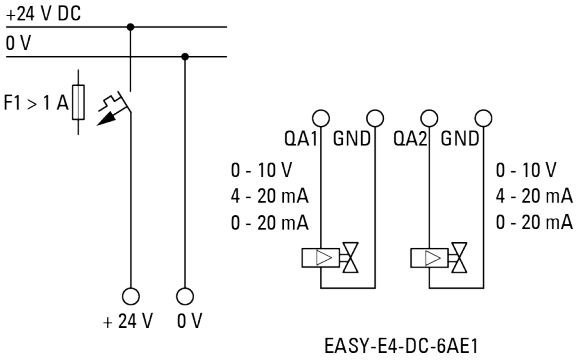


Figure 23: Connecting analog outputs EASY-E4-DC-6AE1

DANGER

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

The following measures must be adhered to in order to prevent any deviations in analog values.

→ Section "Tips for analog signals", page 53

2.4.8 Terminal configurations for individual devices

EASY-E4-UC-12RC1, EASY-E4-UC-12RCX1											
Power Supply	+UC	0V	0V								
Input				I1	I2	I3	I4	I5	I6	I7	I8
Output				Q1/1	Q1/2	Q2/1	Q2/2	Q3/1	Q3/2	Q4/1	Q4/2

EASY-E4-DC-12TC1, EASY-E4-DC-12TCX1											
Power Supply	+24V	0V	0V								
Input					I1	I2	I3	I4	I5	I6	I7	I8
Output power supply	+24VQ	+24VQ	0V	0V							
Output					Q1	Q2	Q3	Q4			

EASY-E4-UC-16RE1											
Power Supply	+UC	0V	0V								
Input				I1	I2	I3	I4	I5	I6	I7	I8
Output				Q1/1	Q1/2	Q2/1	Q2/2	Q3/1	Q3/2	Q4/1	Q4/2
Output				Q5/1	Q5/2	Q6/1	Q6/2	Q7/1	Q7/2	Q8/1	Q8/2

EASY-E4-UC-8RE1						
Power Supply	+UC	0V				
Input			I1	I2	I3	I4
Output			Q1/1	Q1/2	Q2/1	Q2/2
Output			Q3/1	Q3/2	Q4/1	Q4/2

EASY-E4-DC-16TE1											
Power Supply	+24V	0V	0V								
Input				I1	I2	I3	I4	I5	I6	I7	I8
Output				Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8

EASY-E4-DC-8TE1						
Power Supply	+24V	0V				
Input			I1	I2	I3	I4
Output			Q1	Q2	Q3	Q4

EASY-E4-DC-6AE1						
Power Supply	+24V	0V				
Input			IA1	GND	IA2	GND
Output			IA3	GND	IA4	GND
Output			QA1	GND	QA2	GND

2.5 External connections

With their ports, the base devices make it possible to connect a variety of peripheral devices and components.

2.5.1 External connection layouts

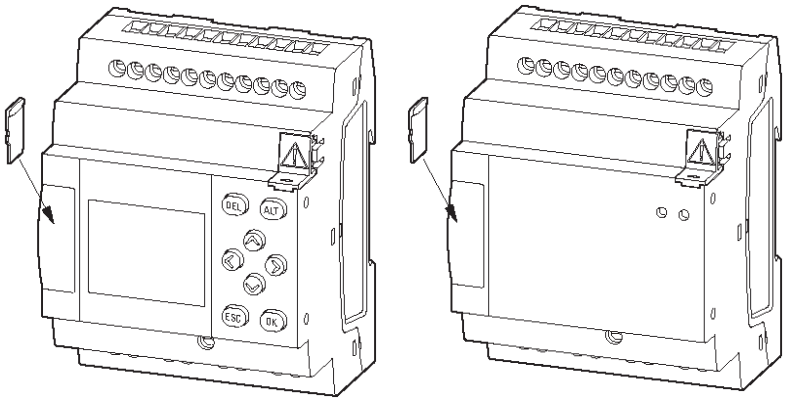


Figure 24: Slot for microSD

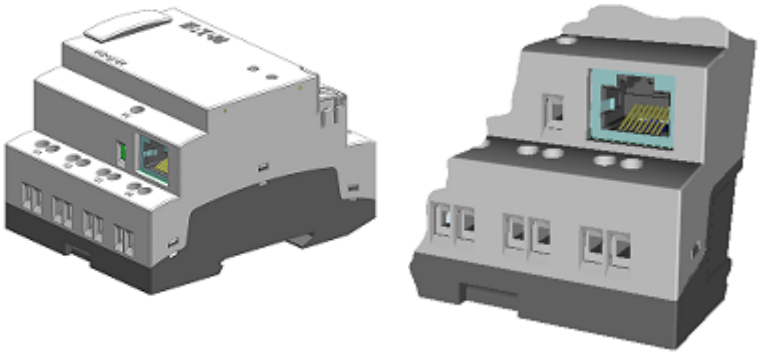


Figure 25: Ethernet port on base device

2.5.2 Memory card

The slot for the microSD is located at the front of the base device.

Inserting a microSD card

Memory cards cannot be inserted the wrong way around.
Do not use force when inserting the card.

- Pull out the slot.
- Push the microSD card into the slot until you feel it lock into place.
- Close the slot.

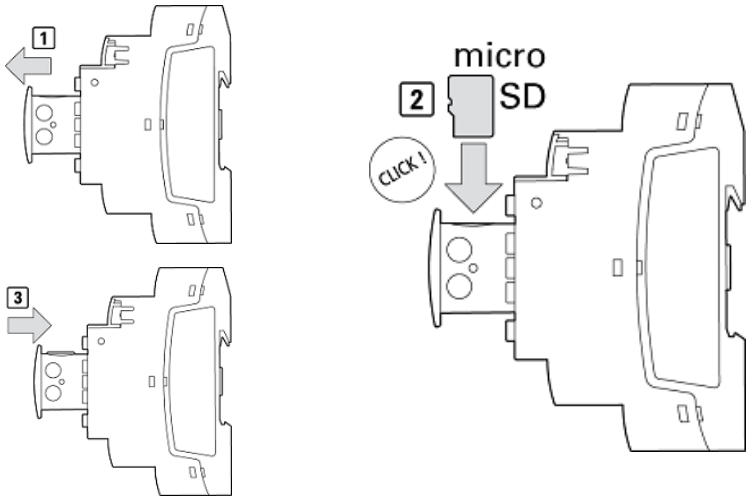


Figure 26: Inserting a memory card

Remove microSD

- Pull out the slot.
- Push the microSD card into the slot.

The memory card will be released and come out a bit

- Remove the memory card.
- Store the microSD in its case in order to protect it.
- Close the slot

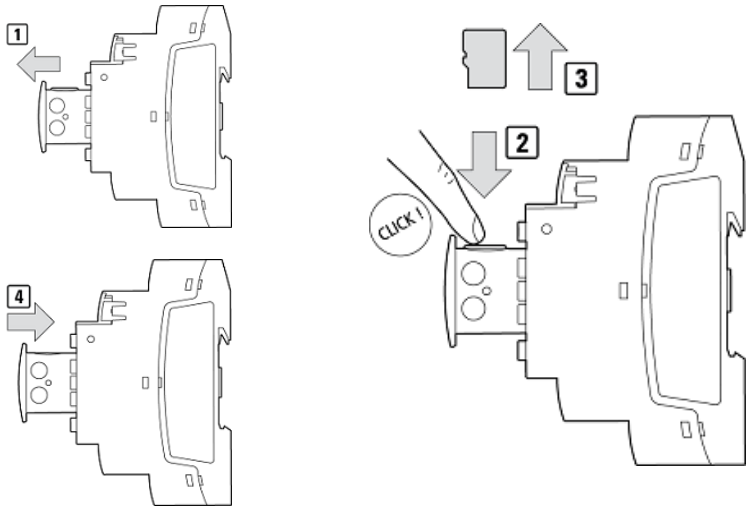


Figure 27: Removing the memory card

2.5.3 Ethernet

Every easyE4 base device features an Ethernet port.
This Ethernet port is a Cat 5 port.
Make sure to use compatible standard RJ45 Ethernet cables only.

The Ethernet port on the base device serves as a communication interface.

The Ethernet controllers support transfer rates of 10 Mbit/s and 100 Mbit/s.

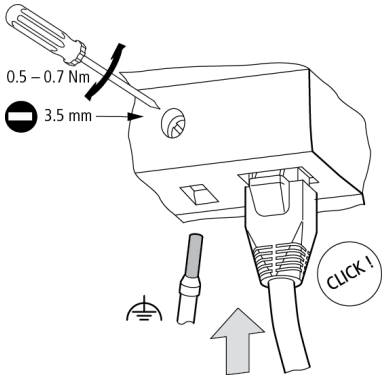


Figure 28: RJ-45 socket, 8-pole

If you integrate the EASY-E4-... into an Ethernet network, you will need to connect the functional earth to the corresponding terminal.

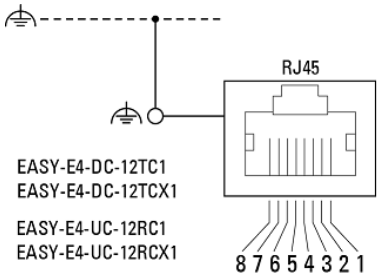
To commission the communications between the EASY-E4-... control relay and the device to which the Ethernet cable is connected, follow the description for the connected device.

2.5.3.1 Connecting the Ethernet cable



6,5 mm (0.25") d	d = 0.2- 2.5 mm² AWG 22-12
6,5 mm (0.25") d	d = 0.2- 4 mm² AWG 22-12

Figure 29: Connecting the Ethernet cable



PIN	Ethernet 10/100 MBit
1	Tx +
2	Tx –
3	Rx +
4	Rx –
5	—
6	—
7	Rx –
8	—

- Connect the functional earth
- Plug in the Ethernet cable

Removing the Ethernet cable

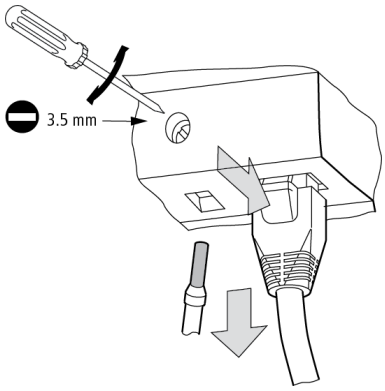


Figure 30: Removing the Ethernet cable

2.6 Programming software license

The programming software (version 7 and higher) is available for download.

Please note that easyE4 devices can only be programmed with easySoft 7.

The easySoft 7 programming software program is available for free. However, you will need to buy a software license in order to be able to use all of the software's functions.

You can order an easySoft 7 programming software license through your supplier or through the EATON online catalog EASYSOFT-SWLIC, article no. 197226.

http://www.eaton.eu/ecat

Once you purchase a software license, you will receive a license product certificate that you can then use to request a license key online. This license key can be used to unlock all of the software's functions.

Installation requirements

- An easySoft 7 version
- A PC that meets all system requirements and for which the person installing the software has administrator privileges
- A 24-digit license key

If a valid key is not entered during installation, the software will be installed in demo mode.
This means that the software will be fully installed, but with the following limitations:

- You will not be able to load any programs onto a connected device (no online function)
- There will not be any card manager functions available for the microSD memory card

However, you will still be able to simulate programs.
You can always add a license key later on.

System requirements

Hardware

- Recommended minimum resolution of 1280 x 1024 pixels
- Min. 250 MB of free space on the hard drive

Software

One of the following operating systems:

- Windows 7 (32 + 64 Bit) >= SP1,
- Windows 8/8.1 (32 + 64 Bit) or
- Windows 10 (32 + 64 Bit)

2.6.1 Licensing

When you purchase an EASYSOFT-SWLIC (order No. 197226), you will be purchasing a license product certificate for easySoft 7.
This license product certificate will include a 36-digit certificate number that you can use to request a 24-digit license key online.

During the installation process, you will be asked for the 24-digit license key for your easySoft 7. If you do not enter a license key, the program will be installed in demo mode.
You can add a license key at a later point if necessary.

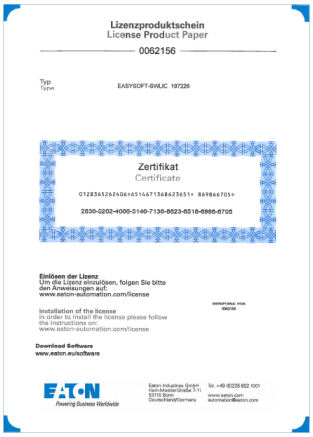


Figure 31: Figure: License product certificate

2.6.1.1 Getting a license key

To get a license key with your license product certificate, follow the instructions at:
http://www.eaton-automation.com/license

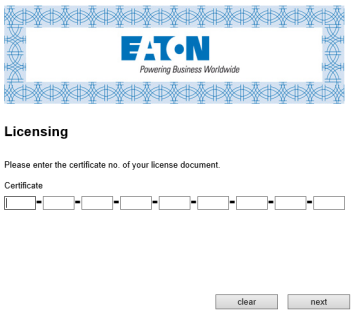


Figure 32: Input screen for the license product certificate No.

Once you enter the 36-digit certificate number from your license product certificate, a dialog box will appear. For your own security, enter the owner information into this dialog box.

Once you enter all your information, a 24-digit license key will be sent to the e-mail address you provided.

The e-mail will contain the following information:

- License type: SW-EASYSOFT
- License product certificate number: 7-digit number for your certificate
- License key: Automatically generated 24-digit code
- Information regarding the owner's registration

→ The 24-digit license key is requested during the installation process.

2.6.2 Adding a license key later on

If you installed the demo version of easySoft 7, you can add a valid license key later on in order to unlock the full version.

▶ Go to easySoft 7 the *? menu* and click on License.

A dialog box for entering the license key will appear.

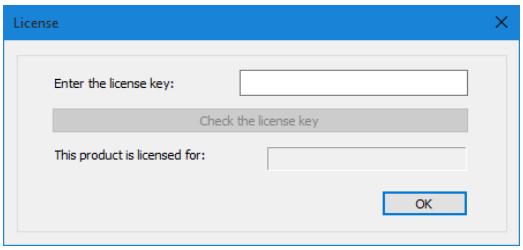


Figure 33: License dialog box

▶ Now enter the 24-digit license key that you received by e-mail.

2.6.3 Software updates and hardware changes

Once you have licensed the programming software, you can download the latest easySoft 7 version from the Eaton Download Center - Software and install it – the license information will remain.

▶ If you change hardware, use your license key and redeem it again.

easySoft 7 can check whether there are any updates for the version installed. This requires for the PC to have an active Internet connection.

Menu?

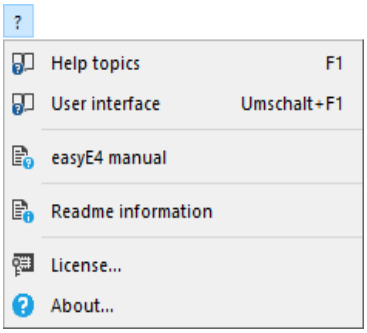


Figure 34: Options in ? menu

2.6.4 Installation instructions

Before starting with the installation, close all open applications.

To install easySoft 7, you will need to have local admin privileges for your system.

Download

- Download the full version of the easySoft 7 program from the Software Download Center.

Download Center - Software
http://www.eaton.eu/software

- Select the "Software" category, then the easySoft 7 software, then the product version, and finally your language.
- Click on the product version you want in order to download it.
- Save the installation package file on your PC.

Installation

During the installation process, you will be asked for the 24-digit license key for your easySoft 7. If you do not enter a license key, the program will be installed in demo mode.
You can add a license key later on if necessary.

- Follow the on screen instructions of the installation package.

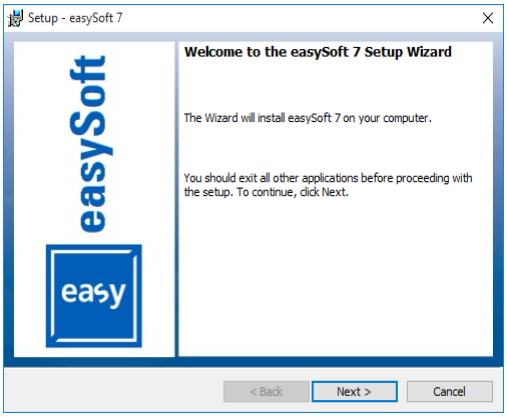


Figure 35: Step 1

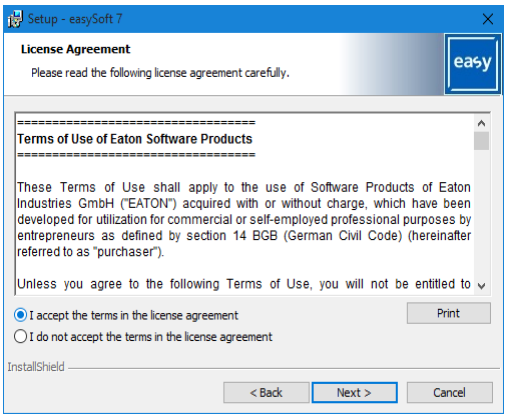


Figure 36: Step 2 License agreement

You can also print out the terms of use in their entirety.

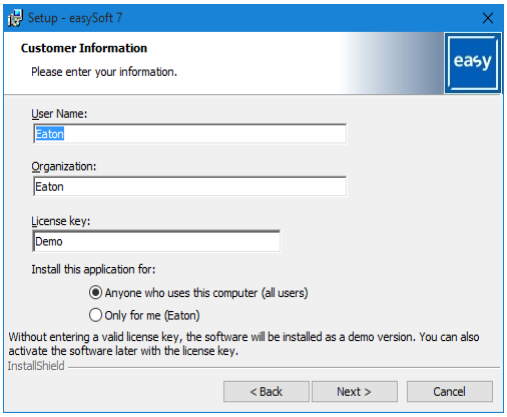


Figure 37: Step 3 License key

To install the full version of the software, enter your 24-digit license key here.

If a valid license key is not entered during installation, the software will be installed in demo mode.
You can add a license key later on – please refer to → Section "Adding a license key later on", page 69.

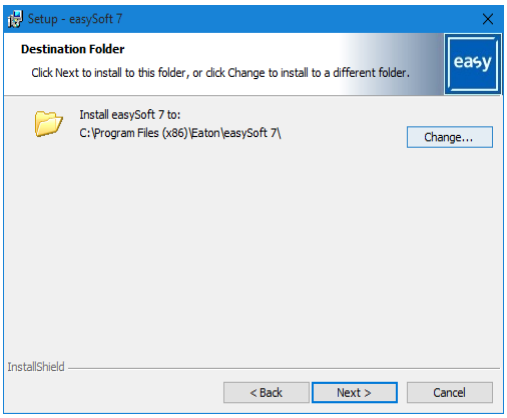


Figure 38: Step 4 Destination folder

Shows the path where the program files will be stored.

You can click on Browse... to set a different storage location where you want the easySoft 7 programming software program to be installed.

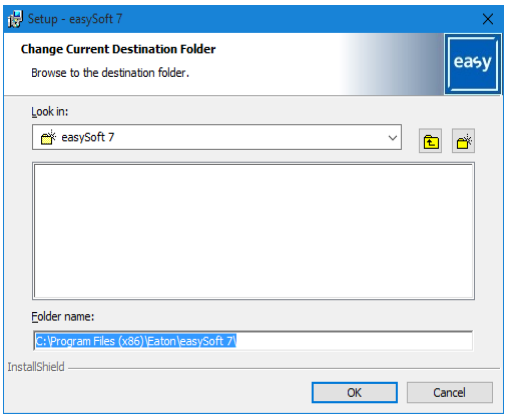


Figure 39: Step 4.1 Changing the destination folder

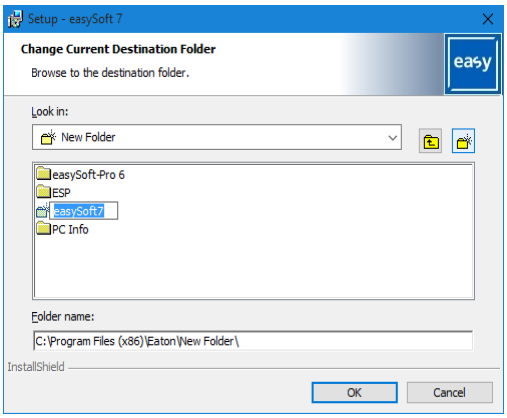


Figure 40: Step 4.2 Creating your own destination folder

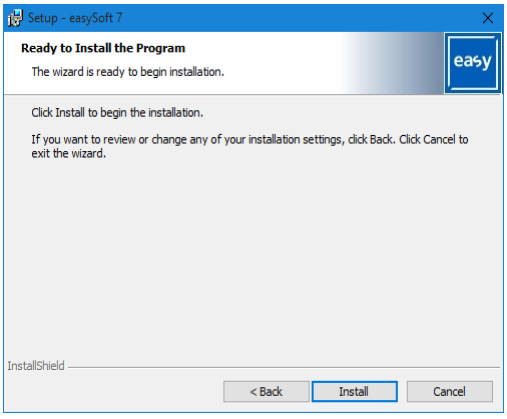


Figure 41: Step 6 Starting the installation

A confirmation prompt will appear.
The installation will start as soon as you confirm this prompt.

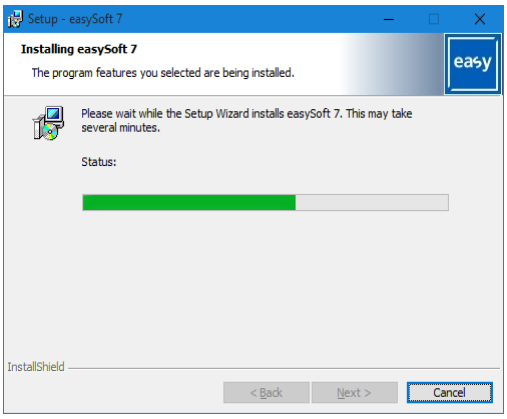


Figure 42: Step 7 Progress display

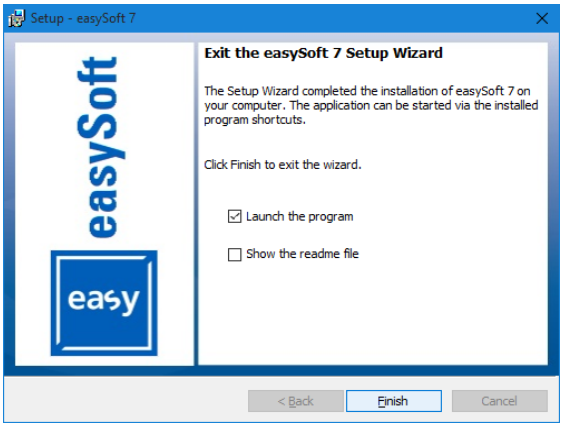


Figure 43: Step 8 Finishing

The easySoft 7 icon will be added to your Desktop during the installation process.

▶ Click on the easySoft 7 icon to open easySoft 7.



or

Figure 44: easySoft 7 icon depending on the screen resolution

3. Commissioning



CAUTION
SHORT-CIRCUIT HAZARD
If the device is or has been exposed to environmental fluctuations (ambient temperature, air humidity), condensation may form on or inside it. As long as this condensation is present, there will be a short-circuit hazard.
Do not switch on the device when it has condensation in or on it.
If the device has condensation in or on it, or if the panel has been exposed to environmental fluctuations, let the panel settle into the existing ambient temperature before switching it on.

The easyE4 devices with/without display and operator functions can be commissioned. However, a display and operating facility is required in order to follow all explanations in this chapter.

The following applies to devices without a display and controls: You can use easySoft 7 for the display and controls or use a remote display. To this end, the control relay offers a point-to-point Ethernet connection or a connection in a network via easySoft 7.

3.1 Initial commissioning

Carry out the following steps once:

- Configure the device's system settings as necessary, including the menu language.
  Please refer to→ Section "Switch languages", page 465
- Install the required software package easySoft 7.
- Transfer program to the easyE4 device

3.2 Daily operation

Once the easyE4 has been initially commissioned, it will run whenever it is connected to the supply voltage.

In other words, it does not have to be separately switched on and off.



Reducing the level of brightness will increase the display backlight's lifespan.
The corresponding setting can be adjusted in the operating system.



Follow the instructions in the following section if your basic device until will not boot up and/or if an error message appears:→ Section "Faults ", page 567

3.3 Switch on

Before switching the device on, check the power supplies, inputs, outputs, and any expansion devices and Ethernet connections to make sure that they are properly connected.

3.3.1 Startup behavior of easyE4 control relays with LED indicators

If there is no program, the control relay will start in STOP mode.

These devices without a display and controls feature 2 LEDs that indicate the state of the Ethernet port and the device status.

If there is an executable program on the easyE4 control relays, the device will start in RUN mode.

In addition to having a valid program on the control relay, please make sure that there are no peripheral faults that will lead to STOP mode.

Device models without a display feature LED indicators in the front:

- 1. POW/RUN
- 2. ETHERNET (base devices only)

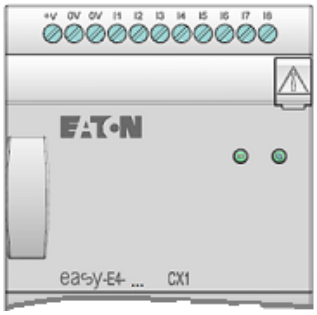


Figure 45: LED indicators on EASY-E4-...-12...CX1

LED POW/RUN base device

The POW/RUN LED indicates the state of the POW power supply as well as the STOP or RUN state.

Off	Malfunction or no supply voltage
Green, continuous light	Supply voltage OK, RUN mode
Green, Flashing, 1 Hz	Supply voltage OK, STOP mode
Green, Flashing, 4 Hz	Fault at one of the expansions, between the easyE4 device and the EASY-E4-CONNECT1 connector

LED ETHERNET/NET (base device only)

Off	No Ethernet cable connected; supply voltage off The port is not enabled; the easyE4 device does not have an IP address
Yellow, continuous light	Ethernet cable connected
Green, continuous light	There is an IP address, but the NET has not been configured
Red, continuous light	Ethernet conflict or error, e.g.: duplicate IP address, address collision
Green, flashing, 2 flashes, pause, etc.	NET data flow working; one or more NET stations missing
Green, flashing, 1 flash, pause, etc.	NET data flow working; all NET stations working

LED POW/RUN expansion unit

Off	Malfunction or no supply voltage
Green, continuous light	Supply voltage OK, address assigned, expansion bus working correctly
Green, Flashing, 1 Hz	Supply voltage OK, no data exchange with base device
Green, Flashing, 3 Hz	Supply voltage OK, no data exchange with base device, diagnostic bit will be set, device not working

3.3.2 Startup behavior of easyE4 control relays with a display and keypad

If there is no program, the control relay will start in STOP mode.

All the information on the display will be shown in English if the device is configured with its factory settings.

If there is an executable program on the easyE4 control relays, the device will start in RUN mode.

→ In addition to having a valid program on the control relay, please make sure that there are no peripheral faults that will lead to STOP mode.

→ easyE4 base device with integrated display

- If there is no splash screen on the memory card after being switched on, the easyE4 base device will show the Eaton logo and then the status display. This status display provides information on the device's status.
- If there is a splash screen on the memory card after being switched on, the easyE4 device will show the splash screen and then the status display. This status display provides information on the device's status.

If there is no executable program on the easyE4 control relays, the device will start in STOP mode.

All the information on the display will be shown in English if the device is configured with its factory settings. Once the device is ready for operation, the status display will appear.

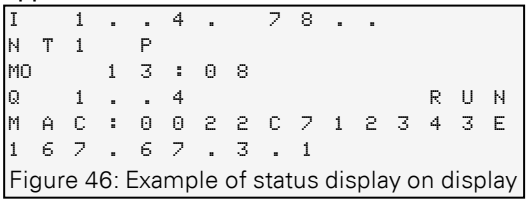


Figure 46: Example of status display on display

3.3.2.1 Changing the menu language

To change the menu language on the device, follow the steps below:

- Press the OK button.

The main menu will appear.

Main menu

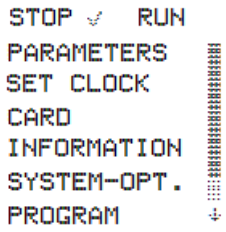


Figure 47: Main menu in English

- Use the cursor buttons to scroll to the SYSTEM OPT. menu option
- Press the OK button.

The SYSTEM OPTIONS menu will appear.

Main menu\System Options\Menu Language

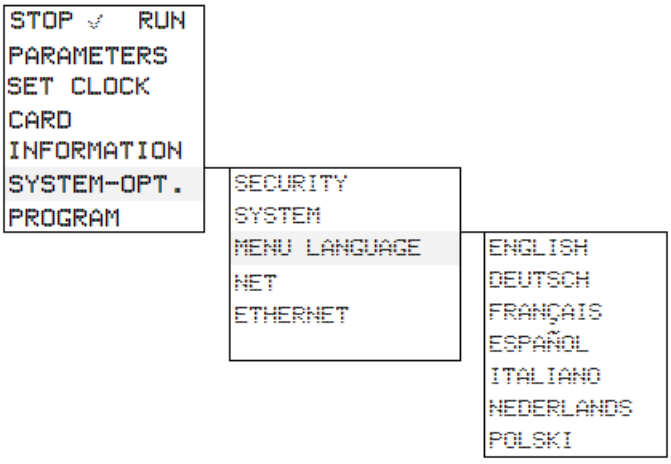


Figure 48: Menu path in English

- Use the cursor buttons to scroll to the MENU LANGUAGE menu option.
- Press the OK button.
- Use the cursor buttons to scroll to the language you want.
- Confirm with the OK button.
- Exit the menu with the ESC button.

The display will be switched to the language you selected.

3.3.3 Startup behavior of base devices with connected expansion devices

Make sure that all required expansion devices are connected to the expansion bus and to the base device.

- As far as possible, switch all easyE4 devices on at the same time.
- Check whether the program you want is found on the base device (display or easySoft 7)
- If there is no program on the base device, load the program you want (with the memory card or easySoft 7) onto the base device.
- Start the base device in RUN mode.
- Find out what the operating state of the base device and the expansions is.



All expansion devices must be selected in the program. The expansion devices must be connected in the same order in the program and in the physical block.

If a device is missing, or if a device different from the one in the program is being used, the easyE4 base device will remain in STOP mode. The easyE4 base device will also do this if you install more devices than the ones found in the program.



DANGER

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.

3.3.4 Status display on easyE4 control relays with display and keypad

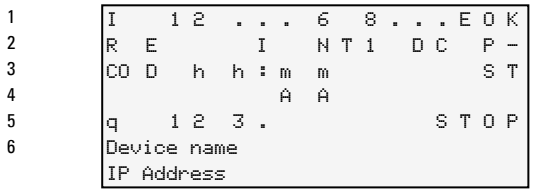
After being switched on, the easyE4 base device will start with the status display after the boot logo.

The status display has six lines, with each one containing 16 characters.

Press the Alt button to switch between displays.

- The first time you press ALT, the time will be replaced by the date.
- Pressing the ALT button again will switch to display 2

Status indicator 1



Status indicator 2

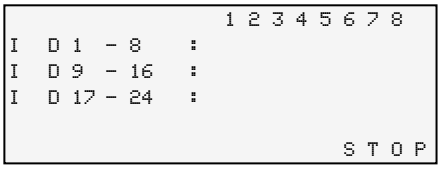


Figure 49: Start displays for easyE4 base device in English

Status indicator 1		
Line 1	The Ethernet status for the base device without LED indicators will be shown for diagnostic purposes	
	EOF	The Ethernet port is not enabled; no Ethernet cable connected; supply voltage off The port is not enabled; the easyE4 device does not have an IP address
	ECN	Ethernet cable connected
	EOK	There is an Ethernet IP address, but the NET has not been configured
	ENW	NET data flow working; all NET stations working
	ENM	NET data flow working; one or more NET stations missing
	EER	Ethernet conflict or error, e.g.: duplicate IP address, address collision

Line 2	Settings in current program	
	RE	Retention active
	I	Debounce active
	NT	NET stations with NET ID (1 this case)
	DC	Used to display the type of power used by the base device (AC or DC)
	P	P Buttons inactive (-) or active (+)

Line 3	Current device setting	
	WD	Weekday
	hh:mm	Device time
1xALT	DD-MM-YYY	Displays the device date with the configured format
	ST	Configured startup behavior for the device; nothing displayed – automatic starting is possible

Line 4		
	q	Outputs; the number will be shown during activity (1, 2, 3, etc.)
	RUN/STOP	Current device operating mode

Line 5	The device's MAC address or device name; displayed only if a name has been assigned
Line 6	IP address; displayed only if an address has been assigned

Status indicator 2	
	Displays set diagnostic bits ID1 through ID24: state display with "0" and "1" for each bit
Line 1	Bit number for each block
Line 2	ID 1 ... ID 8:
Line 3	ID 9 ... ID 16
Line 4	ID 17 ... ID 24
Line 5	Free
Line 6	Current device operating mode

▶ Press the ALT button.

Shows additional indicators.

```
I    1  .  .  4  .    7  8  .  .
N  T 1    P
MO      1  3  :  0  8
Q    1  .  .  4                    R  U  N
M  A  C  :  0  0  2  2  C  7  1  2  3  4  3  E
1  6  7  .  6  7  .  3  .  1
```

Figure 50: Example of status display on display

You can use the main menu from the status display in order to access the individual sub-menus.

▶ Press the OK button.

The main menu will appear.

Table 4: *Main menu*

```
STOP ✓ RUN
PARAMETERS
SET CLOCK
CARD
INFORMATION
SYSTEM-OPT.
PROGRAM
```

See also

→ chapter "3 Operation", page 87

3.3.5 Commissioning the Ethernet network

If you only want to communicate with one single easyE4, use an Ethernet cable to connect the easyE4 Ethernet port to your computer – please refer to → "Connecting the Ethernet cable", page 65

easySoft 7 communications make it possible to search for connected easyE4 that are switched on and establish communications with them.

3.3.5.1 Network operation

Install the Ethernet network as required by your network architecture (switch, router, firewall, VPN, etc.)

If you want to run the easyE4 with other devices on the Ethernet network and communicate through the Internet, you will need to incorporate network security measures outside of the easyE4.



Make sure that the network area in which you run the easyE4 devices is secure.
You can do this by using VPN connections or other network security measures such as a firewall, a VLAN without Internet access, etc.



WARNING
Make sure that it is absolutely impossible to have unauthorized access to your easyE4 devices through a network. Unauthorized access may result in property damage and/or, in the worst-case scenario, serious injury or death.

Eaton recommends implementing measures for protecting against cyberattacks.



Eaton cyber security
http://www.eaton.com/us/en-us/company/news-insights/cybersecurity.html



http://www.eaton.com/cybersecurity

See also

→ Section "Establish Ethernet connection", page 119

3.3.6 Remote operation

If you want to put the easyE4 device into operation without being present at the machine or system, make sure that you always know what exactly will happen when you do so.
Make absolutely sure that remote operation will not endanger anyone.

See also

→ Section "Setting up a web server", page 560
→ Section "Modbus TCP", page 545
→ Section "Setting up a NET", page 537

3.4 Overview of switch-on behavior

The following figure shows what happens when the device is turned on.

- RUN start
- Card start

As soon as the easyE4 device starts, the options will be read.

The easyE4 basic device will check whether a microSD has been inserted and whether there is a starting program on the microSD. The device will then switch to RUN or STOP mode depending on these parameters.

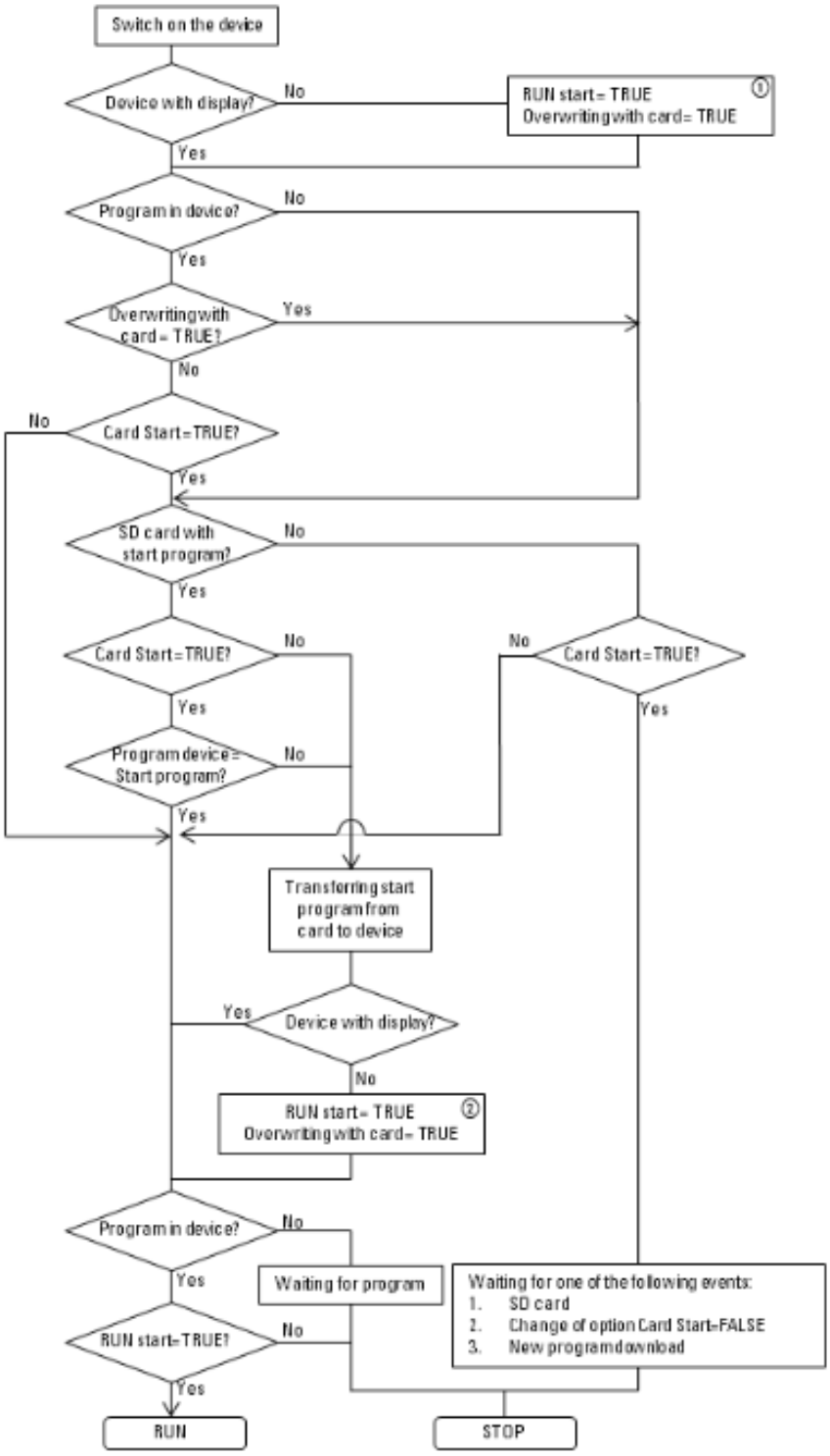


Figure 51: Startup procedure with device initialization

① RUN start: The device should be able to start without easySoft 7
Allow overwriting via card: If an SD card with a starting program has been inserted, the device should load from the card

② Options set again, since they could be overwritten by the loaded program

4. Operation

The way in which the various base devices are operated varies.
Only EASY-E4-...-12...C1 base devices with a display and buttons can be operated directly.
Meanwhile, EASY-E4-...-12...CX1 base devices with LED indicators used for diagnostic purposes, as well as all expansion devices, are limited to providing information via their LEDs' flashing patterns.

→ Section "Startup behavior of easyE4 control relays with LED indicators", page 76

4.1 Base device with display and buttons



Figure 52: Display and keypad on EASY-E4-...-12...C1

4.1.1 LCD Display

Monochrome device display with six lines, each with 16 characters (128 x 96 pixels).

```
I    1 . . 4 .   7 8 . .
N T 1    P
MO     1 3 : 0 8
Q    1 . . 4               R U N
M A C : 0 0 2 2 C 7 1 2 3 4 3 E
1 6 7 . 6 7 . 3 . 1
```

Figure 53: Example of status display on display

The display can show texts, values, parameters, and pseudographics.

Once the device is switched on, as well as during ongoing operation, the device will switch to sleep mode and display the status display after a configurable time without any operator activity.

4.1.1.1 Display color backlight

The display backlight can be illuminated white, red, or green or be switched off in order to signal specific device states.

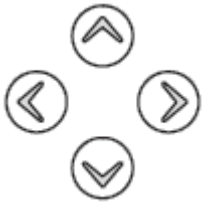
The backlight brightness has three different available levels.

▶ Press the OK button on the device in order to open the main menu from the status display.

Either the cursor position or the available action on the display will flash. A checkmark ✓ will be shown to indicate which option is currently selected. Please note that since the display has six lines only, you may need to use the ⌃⌄ cursor buttons to scroll to the remaining available lines on a screen.

The display's settings can be configured on the easyE4 device in the *SYSTEM OPTIONS\SYSTEM\DISPLAY* menu, → Section "View", page 461

4.1.2 Keyboard

DEL	Deleting in the circuit diagram
ALT	Special functions in circuit diagram, Status display
Cursor buttons 	Move cursor Select menu items, Change numbers, contacts and values
ESC	Back, Cancel
OK	Next menu level, Save your entry

Once the device is switched on, as well as during ongoing operation, the device will switch to sleep mode and display the status display after a configurable time without any operator activity.

▶ Press the OK button on the device in order to open the main menu from the status display.

▶ Use the ⌃⌄ cursor buttons to scroll through the individual menu options.

▶ To confirm a selection, press OK. to open the corresponding menu path.

▶ If necessary, use the ‹› cursor buttons while in a line to toggle between the right and left display areas.
If this option is available, the ◇ character will appear.

4.1.3 Selecting menus and entering values

2x ALT	Calling the System menu
ESC	Return to the previous menu level Cancel entries since last OK
OK	Move to the next menu level Call menu item Activate, change, save entries
Cursor buttons 	Change menu item, Change the value, Activate, change, save entries

How the P button functions are mapped to the cursor buttons:

	Input P1
	Input P2
	Input P3
	Input P4

- Press the OK button on the EASY-E4-... in order to open the menu from the status display.
- Use the  cursor buttons to scroll through the individual menu options.
- To confirm a selection, press OK. to open the corresponding menu path.
- If necessary, use the  cursor buttons while in a line to toggle between the right and left display areas.
  If this option is available, the ◇ character will appear.

4.1.4 Cursor display

The cursor buttons in the easyE4 program perform three functions:

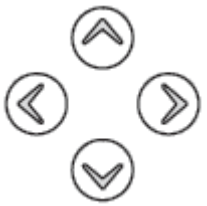
- Move
- Enter
- Connect

The current mode is indicated by the appearance of the flashing cursor.

Current selection flashes on the easyE4 display

▮	In Move mode, use to position the cursor on the circuit diagram in order to select a rung, a contact or a relay coil or the selection position of a coil function or a NET-ID.
I 01	Use the OK button to switch to Entry mode so that you can enter or change a value at the current cursor position. Press the ESC button in Entry mode to restore to the last changes of an entry.
↙	Press the ALT button to switch to Connect mode for wiring contacts and relays. Press the ALT button again to return to Move.
ESC	Press the ESC button to leave the program (circuit diagram and parameter display).

4.1.5 Entering of values



Used to select a position.

Use to select values and/or a setting

ESC Cancel, retain previous value

OK Store settings

4.2 Operating modes of the easyE4

A easyE4 device recognizes operating modes RUN, STOP and BUSY.

4.2.1 RUN mode

In RUN mode, the program stored on the device will be executed immediately

after the device is switched on and will continue to be executed until you select STOP, a system fault occurs, or the supply voltage is switched off.
The outputs will be driven based on the relevant switch logic. The parameter values will be retained in the event of a power failure, and all you will need to do is reset the real-time clock in the event that the backup time elapses.

In RUN operating mode:

- the process image of the inputs are read.
- The program is executed.
- The NET is run (Ethernet, web server, and Modbus TCP).
- the process image of the outputs is transferred to the physical outputs.

The easyE4 devices with a display do not start with RUN mode if you deactivate the RUN MODE startup behavior.

easyE4 devices with LED indicators have a different startup behavior. On them, the RUN START and CARD START functions will be enabled automatically, as manually starting the device is not possible.
For more information on the CARD START function, please refer to → Section "Setting the startup behavior", page 466

4.2.2 STOP mode

When the device is in STOP mode, the program will not be executed. In order to be able to do programming on the circuit diagram, modify system parameters, or configure communications, the device must be in this operating mode.
In addition, the program can be stored on the memory card or be loaded from it while the device is in this mode.



WARNING! AUTOMATIC STARTUP!
Configure your machine/plant so that the automatic starting of the easyE4 device never causes unintentional starting of the machine/plant concerned.
Create your program in such a way that a defined and safe startup procedure is always provided after the power supply is switched on.

The main menu on the display is used to switch between operating modes, i.e., from RUN to STOP and vice versa,→ Section "STOP RUN operating mode menu", page 95

If a program has not been stored on the easyE4, it will not be possible to switch to RUN mode.
It will not be possible to do configuration work either.

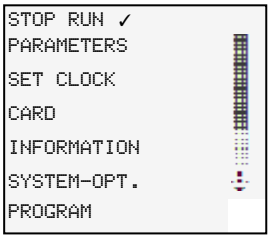
In order to configure it, the program must be stopped.

STOP ✓ RUN

Operating mode changes may be protected with a password.

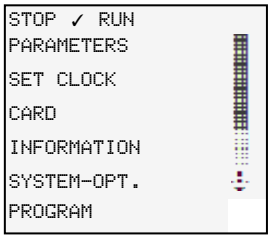
Ongoing operation

Table 5: *Main menu*



To work on the easyE4

Table 6: *Main menu*



4.3 Operation of the menu selection and value entry

4.3.1 How to navigate the device menus

OK	Select; confirm value
ESC	Cancel; go back
DEL	Delete
ALT	Depending on the starting point: - Toggle display - Jump to the start or end of the menu
	Go left
	Go right
	Go up; increment value
	Go down; decrement value

4.3.2 Operating principle in the circuit diagram and function block editor

Button	Effect
DEL	Delete rung, contact, relay or empty rung in the circuit diagram
ALT	Toggle between N/C and N/O contact, connect contacts, relays and rungs, add rungs
	Change value; move cursor up, down
	Change position; move cursor left, right
ESC	Undo setting from last OK, current display, leave menu
OK	Change contact / relay. Insert new; save settings
	P1 input when used as P button
	P2 input when used as P button
	P3 input when used as P button
	P4 input when used as P button

4.3.3 Selecting a device menu

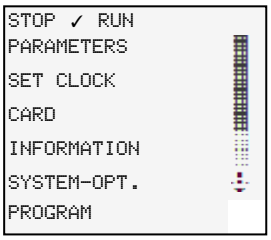
You can use the main menu from the status display in order to access the individual sub-menus.

▶ Press the OK button.

The main menu will appear.
The scrollbar on the right side will indicate whether there are additional menu options.

Please note that since the display has six lines only, you may need to use the cursor buttons to scroll to the remaining available lines on a screen

Table 7: *Main menu*



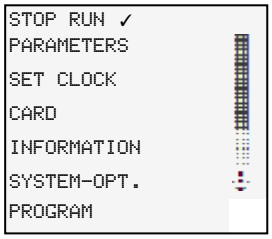
4.4 Overview of the menus on the device

Following is an overview of the menu structure and the various submenus that can be accessed from the main menu.

4.4.1 Main menu

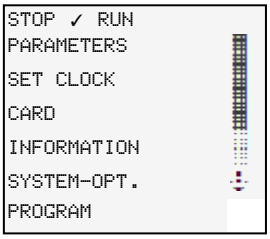
Ongoing operation

Table 8: *Main menu*



To work on the easyE4

Table 9: *Main menu*



4.4.2 STOP RUN operating mode menu

This submenu can be used to switch between operating modes.

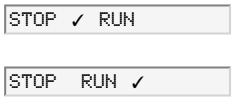


Table 10: *STOP*

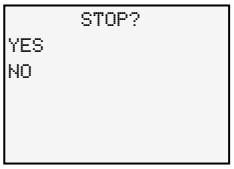
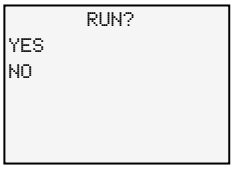


Table 11: *RUN*



See also

→ Section "Operating modes of the easyE4", page 91

4.4.3 Menu Parameter

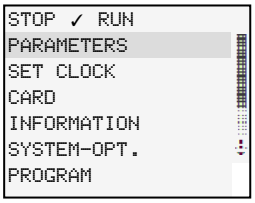
This submenu lists the function blocks that are being used in the current program. This makes it possible to change the values of constants in the program at runtime without having to stop or re-transfer the program.

When the password is activated and the +/- basic parameter for each function block is set, you can allow or deny the operator of the system the possibility to change the values.

Function blocks with basic parameters that you have set to + via the +/- character in the function block editor are displayed in the PARAMETERS menu and can be changed. It is only possible to change constants. Other operands cannot be changed. It is also possible to change parameters via the PARAMETERS menu if you have saved the program and therefore password protected the function block editor.

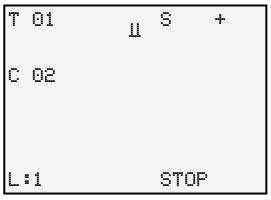
To immediately apply a change to the individual constants, press the OK button. Press the ESC button to cancel the change instead.

Table 12: *Parameter*



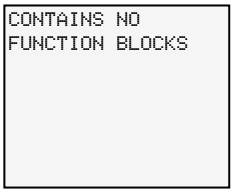
List of function blocks in the current program, e.g.,

Table 13: *Parameter*



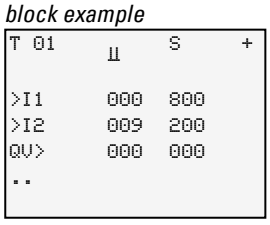
The current program does not use any function blocks

Table 14: *Parameter*



Pressing the OK button will show the parameters for the individual function blocks in an additional submenu that can be used to modify these parameters with the cursor buttons.

Table 15: *Time function block example*



4.4.4 Set clock menu

This submenu can be used to set the date and time, select the display format for the date, and adjust the daylight saving time and radio clock settings on the easyE4 device.

Opens additional menus

Table 16: *Set clock*

```
STOP ✓ RUN
PARAMETERS
SET CLOCK
CARD
INFORMATION
SYSTEM-OPT.
PROGRAM
```

Table 17: *Set clock*

```
SET CLOCK
DST
RADIO CLOCK
```

Table 18: *Set Clock-\Date&Time*

```
   DD-MM-YYYY
FR 13.08.2018
   12:03:04
```

Table 19: *Set clock\DST*

```
NONE                ✓
CEST
US
RULE
```

Table 20: *Set Clock\Radio Clock*

```
RADIO CLOCK
ACTIVE     : YES
INPUT      : I001
OFFSET     : +000'
```

See also

→ Section "Time and Date setting", page 482

4.4.5 Menu Card

This submenu will only be available if a memory card is detected in the slot.

Opens additional menus

Table 21: *Main menu*

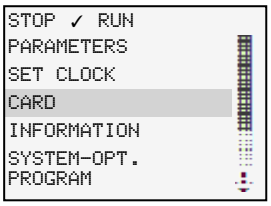


Table 22: *Card*

PROGRAM
LOG RECORDING
MANAGE SD CARD
INFORMATION

Table 23: *Cards\Program*

SET BOOT PROG.
DELETE PROGRAM
CARD -> DEVICE
DEVICE -> CARD

Table 24: *Cards\Log recording*

START NEW LOG
DELETE OLD LOG
DELETE ACT. LOG

Table 25: *Cards\Manage SD card*

FORMAT
RELEASE CARD

Table 26: *Cards\Information*

EXISTING:	YES
FORMATTED:	YES
SIZE:	xxxMB
FREE:	XXXMB

See also

→ Section "microSD memory card", page 487
→ Section "Transferring programs from and to a memory card", page 150
→ Section "Configuring the memory card and device ID", page 481

4.4.6 Menu Information

Shows the current status of the easyE4 device.

Opens additional menus,
The submenu is only available in English.

Table 27: *Main menu*

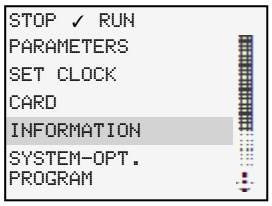
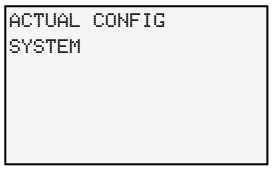
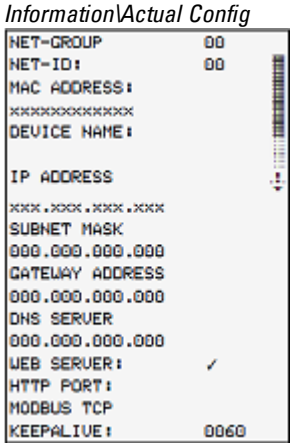


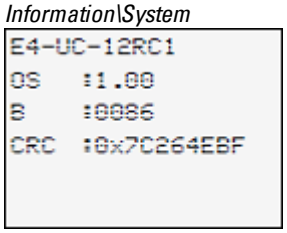
Table 28: *Information*



Information\Actual Config



Information\System



Shows the versions on the easyE4
Specification of the part number
OS: Operating system version
B: Firmware build version
CRC: Cyclic redundancy check result

For updating the operating system

→ Section "microSD memory card", page 487
→ Section "Device information", page 511

4.4.7 System options menu

This menu can be used to configure the basic settings for the system.

Opens additional menus

Table 29: *Main menu*

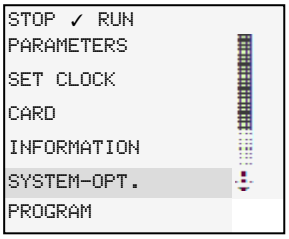


Table 30: *System options*

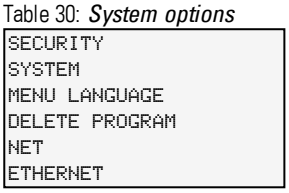


Table 31: *System-Options\Security*

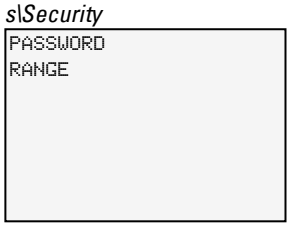


Table 32: *System options\System*

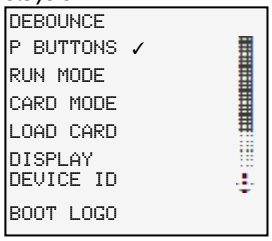
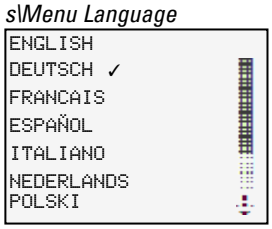
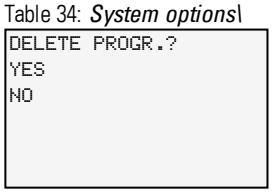


Table 33: *System Options\Menu Language*



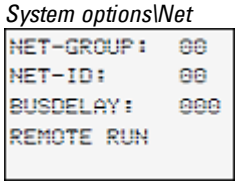
Deletes the program in the easyE4 device.

Table 34: *System options*



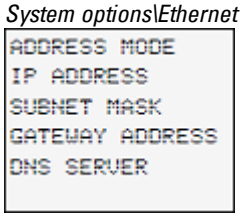
The submenu is only available in English.

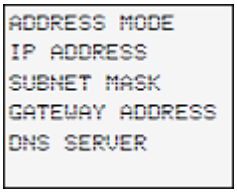
System options\Net



The submenu is only available in English.

System options\Ethernet





See also

→ Section "System settings", page 459
→ Section "Security – password protection", page 476
→ Section "Setting up a NET", page 537
→ Section "Setting up a web server", page 560
→ Section "Modbus TCP", page 545
→ Section "E-mail function", page 562

4.4.8 Program menu

This menu will only be available if the easyE4 is configured with its factory settings and/or when a program created with the EDP programming language has been stored on the easyE4 device.

You can use this menu to create a program with the EDP programming language directly on the easyE4 device.

Opens another menu

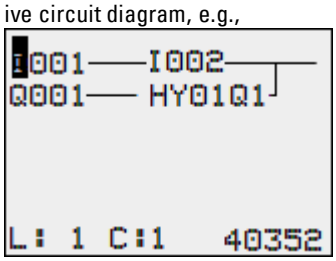
Table 35: *Main menu*

```
STOP ✓ RUN
PARAMETERS
SET CLOCK
CARD
INFORMATION
SYSTEM-OPT.
PROGRAM
```

Table 36: *Programs*

```
CIRCUIT DIAGRAM
FUNCTION BLOCKS
```

Used to display and edit the active circuit diagram, e.g.,



Pressing the OK button will show the parameters for the individual function blocks in an additional submenu that can be used to modify these parameters with the device's cursor buttons.

Table 37: *Programs\Function blocks*

```
T01          ⊔  S    +

C 02

L:1              STOP
```

Table 38: *Timer module example*

```
T01          ⊔  S    +

>I1     000   800
>I2     009   200
QV>     000   000
..
```

Menu options in the status line for work with the circuit diagram and the function blocks

When you complete your work on the circuit diagram and exit the menu with the ESC button, you will be able to select from the CANCEL, SEARCH, GO TO, and SAVE options by scrolling through them with the cursor buttons in the bottommost line.

After editing the function blocks, the CANCEL and SAVE options will be available.

Table 39: *Programs\Circuit diagram*

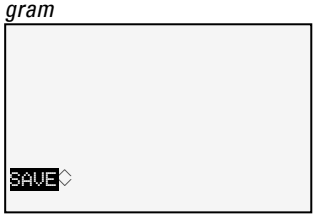


Table 40: *Programs\Function blocks*



4.5 Your first EDP program

This section is intended to guide you step-by-step through the process of creating your first program with the easy Device Programming (EDP) language in order to wire a circuit diagram. This should enable you to become familiar with all the relevant rules and use an easyE4 device for your own projects in no time. Just like with conventional wiring, you will be using contacts and relays in the program. This means that the easyE4 device makes it possible to eliminate the use of these components in a variety of ways, including the use of function blocks.

The easyE4 program will take care of the entire wiring for these components.

All you have to do is then connect to the easyE4any switches, sensors, lamps or contactors you wish to use.

→ Use easySoft 7 to create your own program

Opens another menu

Table 41: *Main menu*

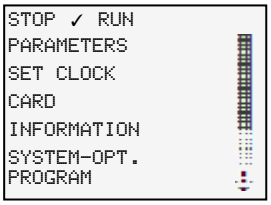
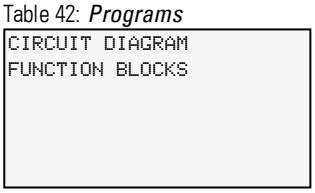


Table 42: *Programs*



Prerequisites for entering a circuit diagram

- The easyE4 device is in STOP operating mode.
- The display must be showing the status display.

▶ Press the OK button to get to the main menu from the status display.

▶ Use the ▲▼ buttons to scroll to the Program menu option.

▶ Open the menu option by pressing the OK button.

The *PROGRAM\CIRCUIT DIAGR.* menu option will now be selected on the easyE4 device.

In general, press the OK button to switch to the next menu level, and press the ESC button to move one level back.

▶ Press the OK button twice to enter the circuit diagram display via menu options <PROGRAM… ->CIRCUIT DIAGR.>. This is where you will create the circuit diagram.

Circuit diagram display

The content of the circuit diagram is displayed in the first 5 lines. This window can be moved over the circuit diagram. At the moment the circuit diagram is empty.
The cursor flashes at the top left, which is where you will start to wire your circuit diagram.

Circuit diagram display

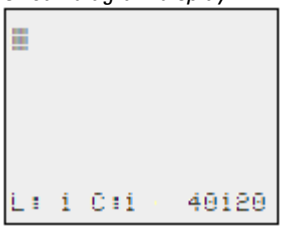


Figure 54: Empty circuit diagram

The last line shows the cursor's position:

- L: = Rung (Line).
- C: = Contact or coil field (Column).
- Amount of free memory in bytes.

4.5.1 Draw a wiring diagram

The circuit diagram supports four contacts and one coil in series. The display shows 6 fields of the circuit diagram.

Use the cursor buttons to move the cursor over the invisible circuit diagram grid.

Navigating in the circuit diagram

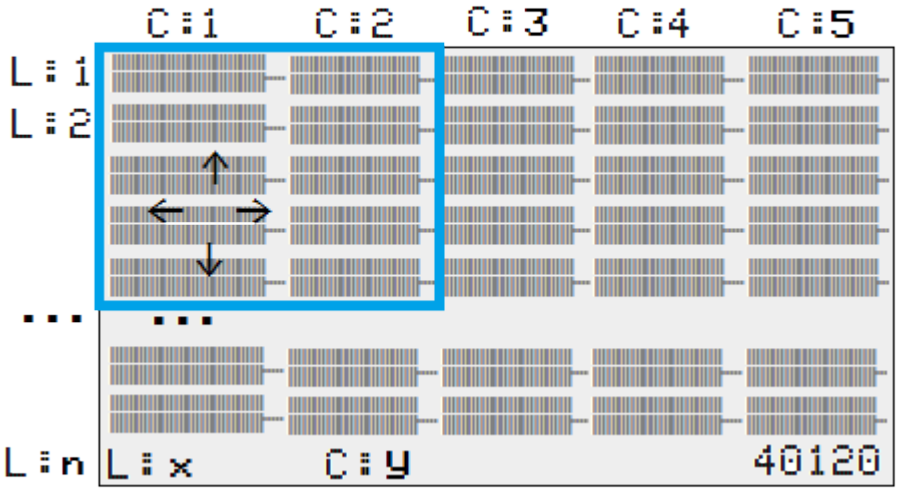


Figure 55: Fields in the circuit diagram

The first four columns are contact fields, the fifth column is a coil field. Each line is a circuit connection.
The easyE4 automatically connects the contact to the power supply.

The following example is provided for a lighting control. The easyE4 device takes on the wiring and the tasks of the circuit shown below.

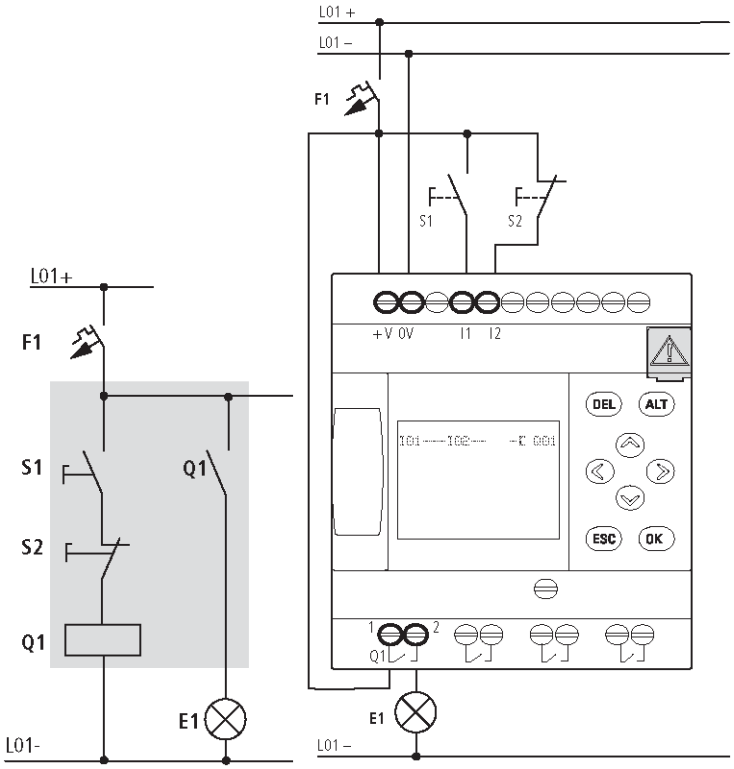


Figure 56: Lighting control circuit

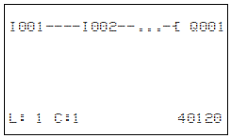


Figure 57: Circuit diagram with inputs I01, I02 and output Q1

▶ Now wire the circuit diagram as described below.

With this example the switches S1 and S2 are at the input. `I001` and `I002` are the switch contacts for the input terminals in the circuit diagram .

The relay Q1 is represented in the circuit diagram by the relay coil `-( Q001`.

The symbol `-(` identifies the coil's function, in this case a relay coil acting as a contactor. `Q001` is one of the easyE4device's outputs.

From the first contact to the output coil

With easyE4 devices wire from the input to the output. The first input contact is `I001`.

▶ Press the OK button.

easyE4 will insert the first contact, `I001`, at the cursor position.

The `I` flashes and can be changed,

for example, to a `P` for a button input by using the cursor buttons ▲ or ▼. However, nothing needs to be changed at this point.

▶ Press the OK button twice,
to move the cursor across the 001 to the second contact field.

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

▶ Press the OK button.

The easyE4 device will once again insert an I001 contact at the cursor position.

▶ Press the OK button so that the cursor will jump to the next position.

▶ Use the ▲ or ▼ cursor buttons to select the number 002.

→ Pressing DEL will delete the contact at the cursor position.

▶ Press the OK button 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

easyE4 device displays a small arrow ↙ in the circuit diagram when creating the wiring.

Press the ALT button to activate the arrow ↙ and press the cursor buttons ▲▼◀▶ to move it. Pressing the ALT button once more switches the cursor back to Move mode.

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

- In the left contact field, you can press the ALT button 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 easyE4 device automatically connects adjacent contacts up to the coil.

▶ Press the ALT to wire the cursor from I002 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 I002 will be connected up to the coil field.

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

▶ Press the cursor button once more.

The cursor will move to the coil field.

▶ Press the OK button.

The specified coil function -[and the output relay Q001 are correct and do not have to be changed.

Your result will look as follows: Your first wired and functional circuit diagram

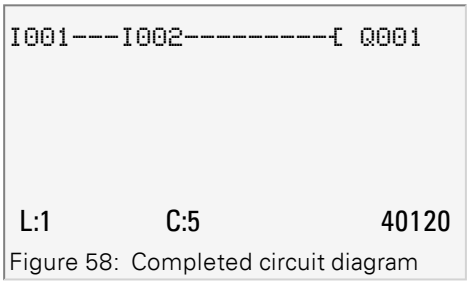


Figure 58: Completed circuit diagram

You can use the cursor buttons to access the part that is not visible.

▶ Press the ESC button to leave the circuit diagram display.

Line 6 will show the SAVE menu option.

Saving

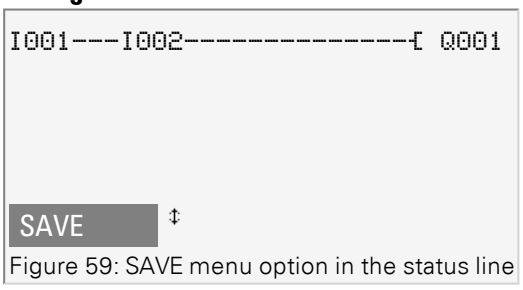


Figure 59: SAVE menu option in the status line

▶ Press the OK button to confirm.

The circuit diagram is stored.

▶ Press the ESC button twice to return to the main menu.

You can test the circuit diagram if the S1 and S2 buttons are connected.

4.5.2 Testing the circuit diagram

- Go back to the main menu.
- Select the STOP RUN menu option.

The current operating mode is indicated on the display of the easyE4 device by a tick ✓ at RUN or STOP stop. Pressing the OK button enables you to toggle between the modes.

- Press the OK pushbutton in order to change to RUN.

→ The Status display also shows the current mode set.

4.5.3 Control options in RUN mode

There are two control options in RUN mode. Control of:

1. Inputs and outputs with Status display
2. power flow with power flow display

Status display during RUN mode

▶ Change to the status display and press pushbutton S1.
Do not execute pushbutton S2.

The contacts for inputs I001 and I002 are activated and relay QS1 picks up, indicated by the highlighted numbers.

Test using the power flow display

▶ Change to the circuit diagram display and press pushbutton S1.

The relay picks up and the easyE4 displays the power flow with a double line.

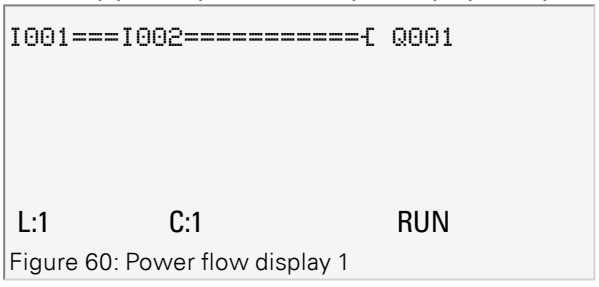


Figure 60: Power flow display 1

Power flow display: Inputs I001 and I002 are closed, relay Q1 has picked up

▶ Press pushbutton S2, that has been connected as a break contact.

The power flow is interrupted and relay Q1 drops out.

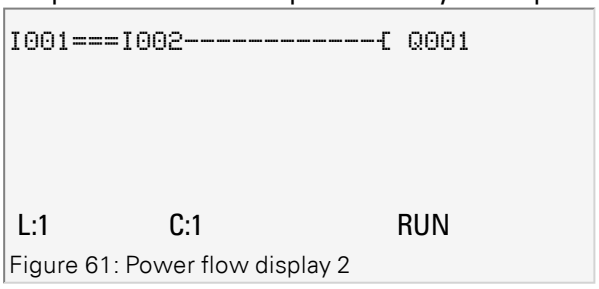


Figure 61: Power flow display 2

Power flow display: Input I001 is closed, input I002 is open,
relay Q1 has dropped out

▶ Press the ESC button to return to the Status display.

→ The circuit diagram does not have to be completed in its entirety so that it is possible to test parts of it. The easyE4 device simply ignores any incomplete wiring that is not yet working and only uses the finished wiring.

Power flow display with Zoom function

A reduced display of the circuit diagram is possible for a better overview. To do this, follow the steps below:

▶ Change to the circuit diagram display and press the ALT button.

The circuit diagram display is reduced.

▶ Press pushbutton S1.

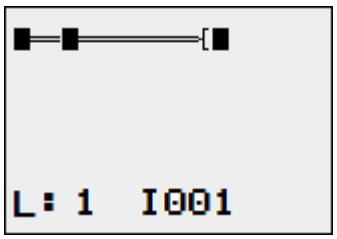


Figure 62: Current flow display with zoom

Power flow display in Zoom function: Input I001 and I002 are closed, relay Q1 picked up

■ Contact closed, coil is triggered.

□ Contact opened, coil not triggered.

▶ Press pushbutton S2, that has been connected as a break contact.

The power flow is interrupted and relay Q1 drops out.

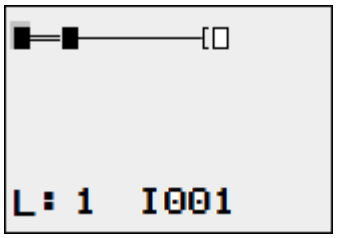


Figure 63: Current flow display with zoom

Use the ⌃⌄⌃⌄ cursor buttons to move from contact to contact or coil.

▶ Press the cursor button ⌄.

The cursor moves to the second contact.

Press the ALT button. The zoom function will be turned off and the display will switch to the display status with contact and/or coil designations.

Power flow display: Input I01 is closed, input I02 is open, relay Q1 has dropped out.

4.5.4 Delete program

The DELETE PROGRAM function not only deletes the circuit diagram but all elements of a program. These are as follows:

- Circuit diagram
- Function block list
- Function block diagram
- Screens

The system settings and operating parameters are reset to the default settings and also a possible NET parameterization.

Proceed as follows to delete the program in the easyE4 device:

easyE4 must be in STOP mode in order to extend, delete or modify the circuit diagram.

▶ Switch the easyE4 device to STOP mode.

▶ From the main menu, go to the SYSTEM OPTIONS menu.

Opens additional menus

Table 43: *Main menu*

STOP ✓ RUN
PARAMETERS
SET CLOCK
CARD
INFORMATION
SYSTEM-OPT.
PROGRAM

Table 44: *System options*

SECURITY
SYSTEM
MENU LANGUAGE
DELETE PROGRAM
NET
ETHERNET

Table 45: *System options*

DELETE PROGR.?
YES
NO

▶ Select DELETE PROGRAM.

The easyE4 device will show a confirmation prompt.

▶ Select YES.

▶ Press the OK button to delete the program

or

▶ Press the ESC button to cancel

Pressing the ESC button once more returns you to the previous menu level.

4.6 Transfer program to the easyE4 device

There are two options for directly transferring a finished .e70 program to an easyE4 device.

- With a microSD memory card
- With a direct Ethernet connection between the PC and easyE4

4.6.1 Transfer with a microSD memory card

Prerequisites

- You will temporarily need a suitable microSD memory card with a maximum storage capacity of 2 GB.
- A PC on which the easySoft 7 programming software is installed, → Section "Installation instructions", page 71

▶ Insert the microSD memory card into a drive on your PC (with a suitable adapter if necessary).

▶ Open the easySoft 7 programming software on your PC.

▶ Create an application program and save it

or

▶ Open a sample program.

If necessary, use the help in the ? menu by accessing the help topics with the F1 key or open the easyE4 manual.

Application examples
A number of applications are available for download from the product page at http://www.eaton.eu/easy.
These examples come with a description, the circuit diagram, and the easySoft 7 project (in the EDP and LD programming languages as of this writing).

The appendix contains a sample program that can be opened via a hyperlink, → Section "Sample Projects", page 588

Make sure to stay in the Project view, as the Project menu will only be available there.

▶ Click on the Project\Card... menu option.

easySoft 7 Project view

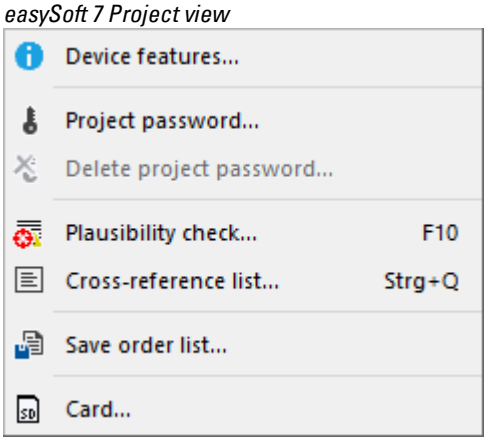
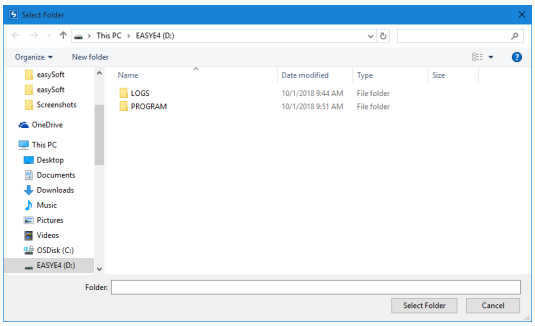


Figure 64: Sample program open

In the Select Folder dialog box that appears, select a folder where the LOGS and PROGRAM folders that easySoft 7 needs should be created.

▶ Select the drive where the memory card is located

Exit the dialog box by clicking on Select Folder.



The Card setup dialog box will appear.

easySoft 7 Project View\Project\Card...

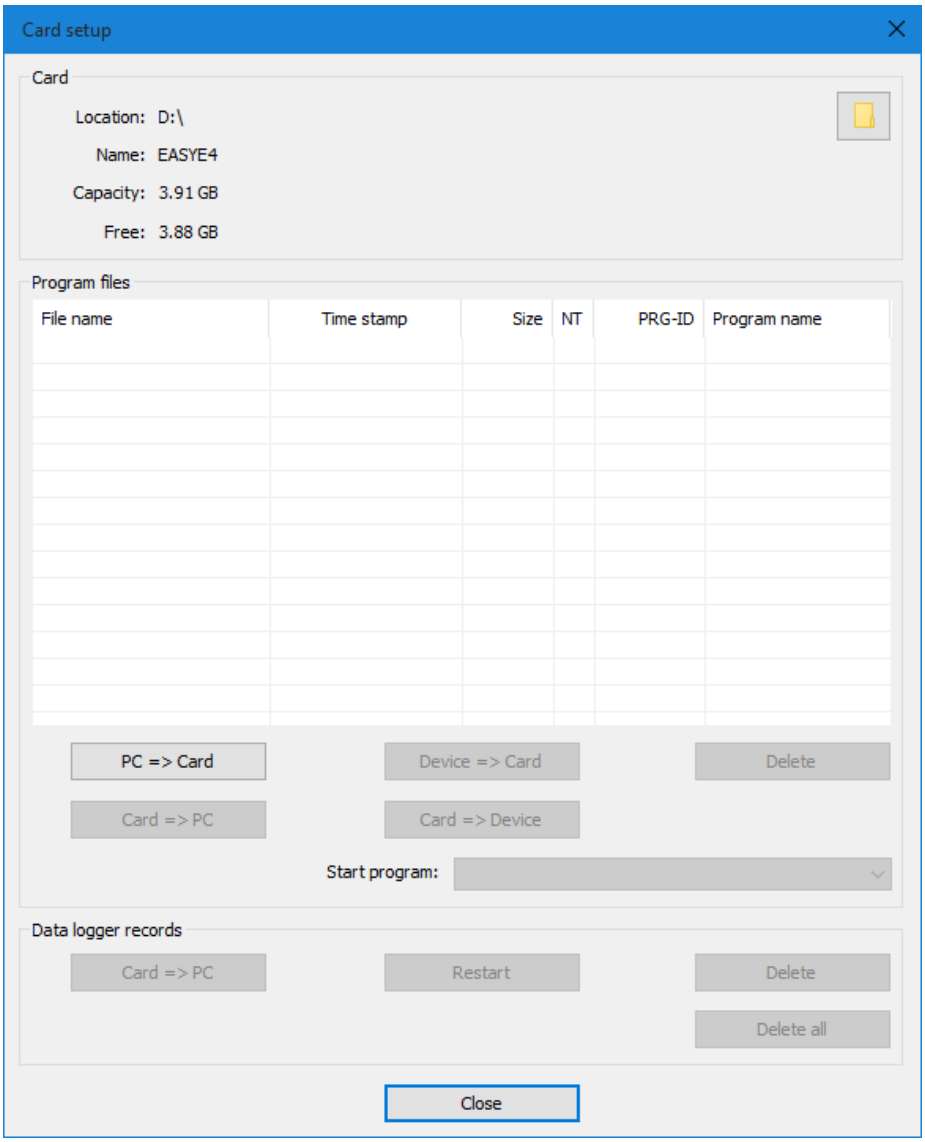
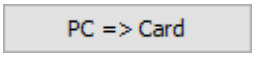


Figure 65: Card setup dialog box

You can use the Card section to specify the storage location, i.e., the drive, where the microSD memory card is located.
In addition, this section will show the available information about the memory card.

▶ Click on the PC => Card button to select the transfer option you want.



The File selection dialog box will appear.

Use this dialog box to enter the name that the program should have on the easyE4 device.
Please make sure that this name does not have more than 14 characters (only letters and numbers are permitted).

▶ Enter a new entry into the input field.

easySoft 7 Project View\Project\Card...

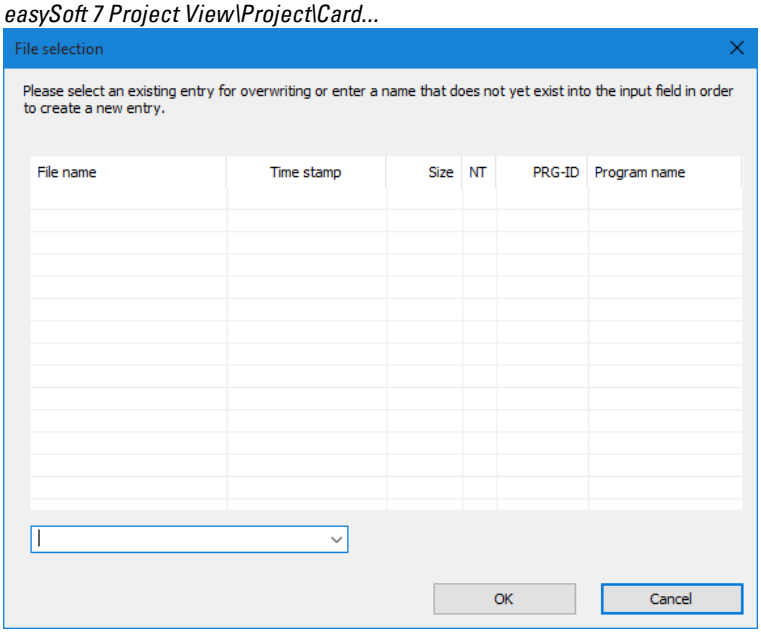


Figure 66: File selection dialog box

The following safety prompt will appear:
Do you want to enter the program as a start program on the card as well?

→ This prompt is intended for cases in which the easyE4 device will start running this program as soon as a supply voltage is applied. If you select the Yes option, please make sure to take into account the potential automatic startup and the settings configured in the program

▶ Click on Yes for the test with a sample program from this manual.

easySoft 7 Project View\Project\Card...

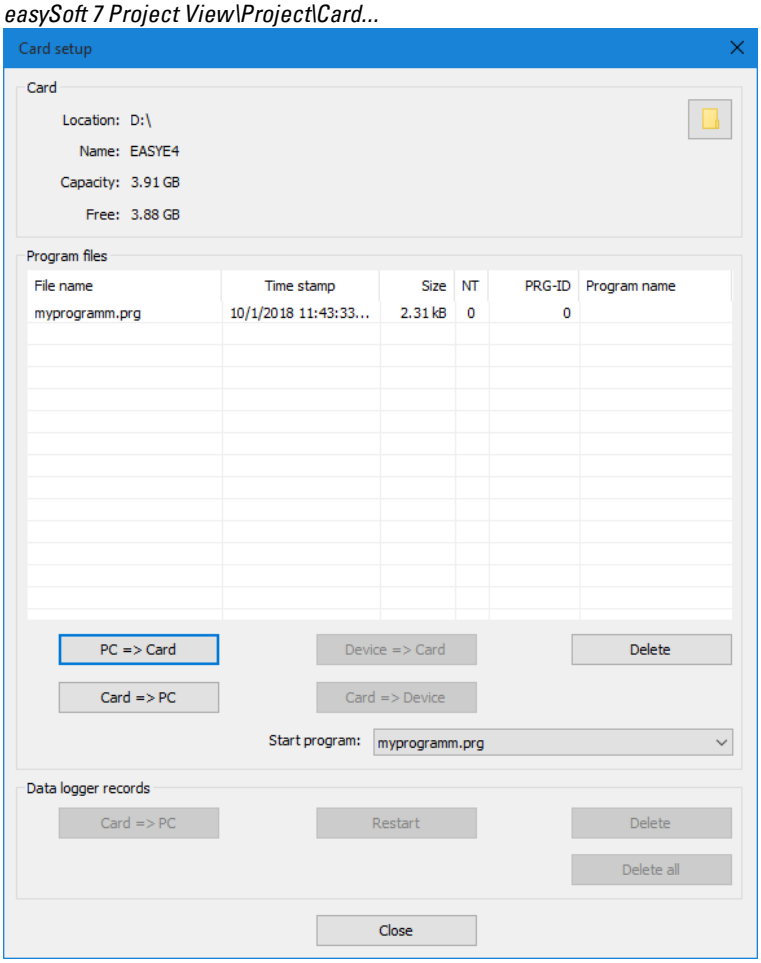


Figure 67: The program was transferred to the memory card.

- Close the window
- Remove the microSD memory card from the drive.
- Insert the microSD memory card into the slot on the easyE4 base device.
  → Section "Inserting a microSD card", page 62

The easyE4 device will be ready for operation.

- Apply the corresponding supply voltage while observing all relevant safety instructions.
- The easyE4 device will start running the program (depending on the operating mode).

or

- Transfer the program from the microSD memory card to the device if you did not define the program as the starting program.
  → page 150

4.6.2 Establish Ethernet connection

Establishing a connection between a PC and an easyE4 base device

In order to be able to establish a connection, your PC must first have the required Ethernet capability. This capability can be in the form of a local Ethernet port on the PC or a standard adapter (e.g., USB-to-Ethernet adapter).

The PC's and the easyE4 base device's IP addresses must fall within the same range, i.e., the addresses' first two or three numbers must be the same, while the last number must be different and not equal to 0.

- Check the easyE4 device's IP address.
- To do this, open the *INFORMATION\ACTUAL CONFIG* menu and scroll to IP ADDRESS.

Table 46: *Main menu*

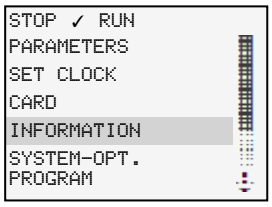


Table 47: *Information*

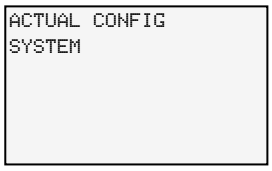
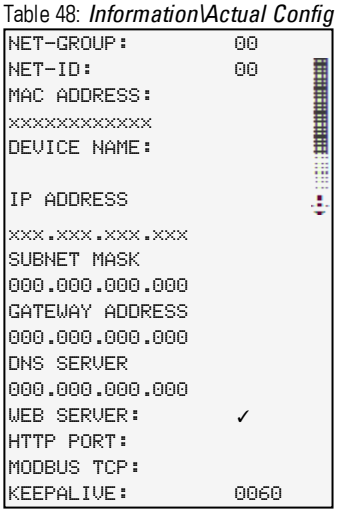


Table 48: *Information\Actual Config*



- If an IP address has not been assigned yet, enter one.
- To do this, open the *SYSTEM OPTIONS\ETHERNET\IP Address* menu.

Table 49: *Main menu*

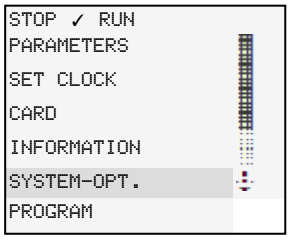


Table 50: *System options*

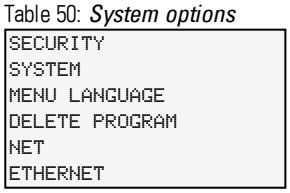


Table 51: *System options\Ethernet*

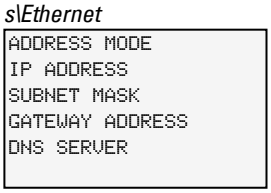
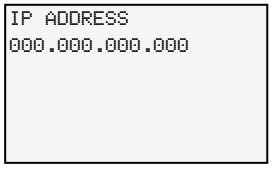


Table 52: *System Options\Ethernet\IP Address*



- Use the cursor buttons to enter the device's IP address.

Table 53: *System Options\Ethernet\Address mode*

AUTO IP ✓
DHCP
STATIC IP

▶ Select the network setting you want.

▶ Set up a new Ethernet connection on your PC's operating system.

To do this, go to Windows Network and Sharing Center and set up a LAN connection over Internet Protocol Version 4 (TCP/IPv4). Then enter an IP address in the same range you used for the device, but with a different device number.

Example using Windows

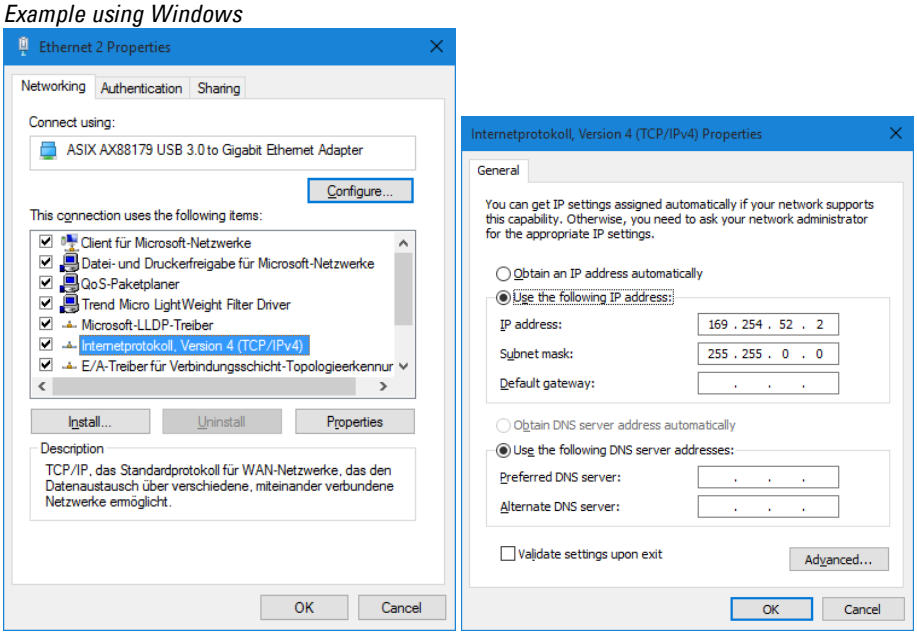


Figure 68: Ethernet connection on PC

You can now connect to your easySoft 7 device with the easySoft 7 programming software.

See also

→ Section "Establishing an Ethernet connection", page 532

5. Programming on the device

This chapter describes how to wire easyE4 contacts and coils with the display and keypad.

5.1 Program

An easyE4 program consists of the required system settings for the easyE4 device, NET, password, and operating parameters,
as well as the following:

- Circuit diagram (program on the easyE4)
- Function block list
- Function block diagram



Programs have file extension .e70. However, please note that this file extension will not be shown on the display.



The programs themselves can be created very easily with easySoft 7 and then transferred to the easyE4 device.
easySoft 7 Help provides corresponding support.

5.2 Circuit diagram display

The circuit diagram, i.e., the program with which the easyE4 works, can be displayed in the main menu under Program.

Programs/Circuit diagram

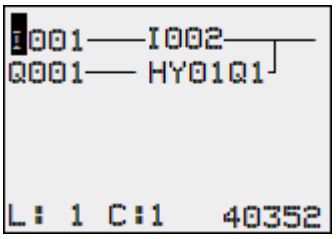


Figure 69: Circuit diagram display

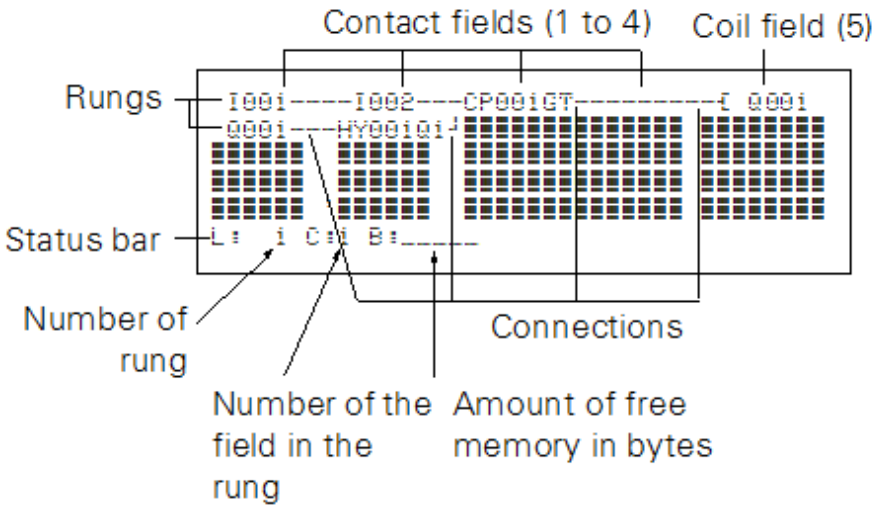
You wire contacts and coils of relays in the easyE4 circuit diagram from left to right, from the contact to the coil.
The circuit diagram is created on a hidden wiring grid containing contact fields, coil fields and rungs. It is then wired up with connections.

- Insert contacts in the four contact fields. The first contact field on the left is automatically connected to the voltage.
- The coil field can be used to enter the relay coil being driven together with the corresponding coil identifier and coil function. The coil identifier consists of a coil name, coil number, and, in the case of function blocks, the function identifier. The coil function defines the method of operation of the coil.

The cursor buttons can be used to change the contact fields. The number of the circuit connection and the contact are displayed in the lower status line.

There are 256 rungs available in the circuit diagram, for wiring contacts and coils.

For greater legibility the circuit diagram of the easyE4 device shows two contacts or one contact plus coil in a row on each rung. A total of 16 characters per circuit connection and five circuit connections plus the status line can be displayed simultaneously.



Program display on the display

- 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 recognize how much memory is available for the circuit diagram and function blocks.

The circuit diagram display has two functions:

- It is used to edit the circuit diagram in STOP mode.
- It is used in RUN mode to check the circuit diagram using the power flow display.

5.3 Circuit diagram elements

A circuit diagram is a series of commands that the easyE4 device processes cyclically in RUN operating mode.

Coils and contacts are interconnected in the circuit diagram. In RUN mode, a coil is switched on or off depending on the power flow and coil function set.

5.3.1 Function blocks

Function blocks are program elements with special functions. Examples: Timing relays, time switch, data block comparators. Function blocks are provided with or without contacts and coils. How a safety or standard function block is added to the safety or standard circuit diagram and parameterized is described in
→ Section "Working with function blocks", page 154

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

5.3.2 Relays

Relays are switching devices that are emulated in easyE4 device electronically, which activate their contacts according to the assigned function. A relay consists of at least one coil and contact.

5.3.3 Contacts

Contacts are used to change the power flow inside the easyE4 circuit diagram. Contacts such as N/O contacts are set to 1 when they are closed and 0 when they are opened. In the easyE4 circuit diagram you can wire contacts as make or break contacts. N/C contacts are indicated with a horizontal line above the operand concerned.

An easyE4 device operates with different contacts that you arrange in any order in the contact fields of the circuit diagram.

Table 54: Usable contacts

	Switching contact		Look
	N/O contact, i.e., normally open contact		I, Q, M, A, …
	N/C contact, i.e., normally closed contact		I, S, S, A, …

For a detailed list of all the contacts used in the circuit diagram, please refer to → Section "Function blocks", page 166

5.3.4 Coils

Coils are the actuating mechanisms of relays. The results of the wiring are transferred to the coils when the device is in RUN mode. These switch to the On (1) or Off (0) state according to these results. The options for setting output and marker relays are listed with the description of each coil function.

A easyE4 device is provided with different types of relays and function blocks which can be wired in a circuit diagram via their coils (inputs).

Coil functions

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



If you want to map coils from your circuit diagram to the easyE4 device, use the coils with a contactor function in your device!

The following coil functions are available for all coils:

Table 55: Coil function

Display	Coil function	Example	→ Page
-[	Contactor function	-[Q01, -[D02, -[S04, -[:01, -[M07,..	→ page 127
⌐	Impulse relay function	⌐Q03, ⌐M04, ⌐D08, ⌐S07, ⌐:01,..	→ page 127
S	Set	SQ08,SM02,SD03,SS04..	→ page 128
R	Reset	RQ04,RM05,RD07,RS03..	→ page 128
]-	Contactor function with negated result	]-Q04,]-M96..	→ page 129
⌐‾	Cycle pulse on rising edge	⌐‾M01..	→ page 129
‾⌐	Cycle pulse on falling edge	‾⌐M42..	→ page 130



With non-retentive coil functions such as -[(contactor),]- (negated contactor), ⌐‾ (rising) and ‾⌐ (falling edge evaluation): Each coil must only be used once. The last coil in the circuit diagram determines the state of the relay. Exception: When working with jumps, the same coil can be used twice.
Retentive coil functions such as
S, R, ⌐ can be used several times.

The available coil functions for the various function blocks are described in the relevant sections. Please refer to → Section "Working with function blocks", page 154

Coil with contactor function -[

The output signal follows the input signal directly, the relay operates as a contactor.

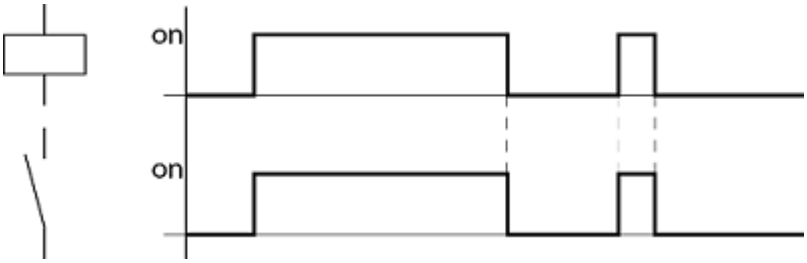


Figure 70: Contactor function signal diagram

Coil with the impulse relay function -⌐

The relay coil switches whenever the input signal changes from 0 to 1. The relay behaves like a bistable flip-flop.

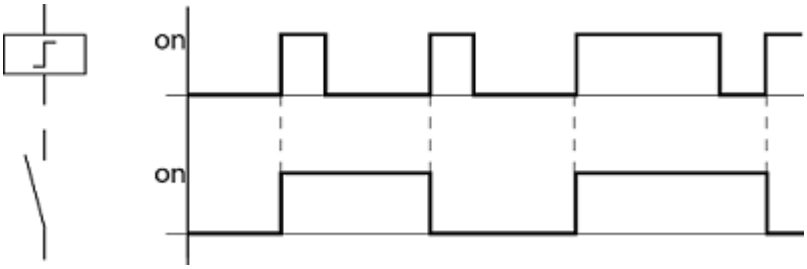


Figure 71: Impulse relay signal diagram

A coil is automatically switched off in the event of a power failure and in STOP mode. Exception: retentive coils retain the 1 state.

See also

→ Section "Retention function", page 473

"Set" ⊣ and "Reset" coil functions

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 power supply is switched off (C), the coil is not retentive.

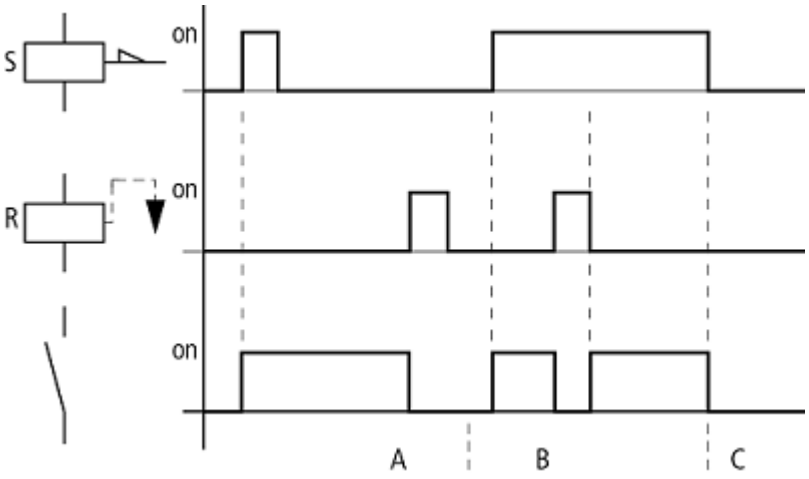


Figure 72: Set and Reset signal diagram

If both coils are triggered at the same time, priority is given to the coil further down in the circuit diagram. This is shown in the above signal diagram in section B. Has a higher rung number(The Reset coil in the example above.)

```
I 05--------------S Q 01
I 10--------------R Q 01
```

Figure 73: Simultaneous triggering of Q 01

The above example shows the Reset coil with priority when the Set and Reset coil are triggered at the same time.

Coil negation (inverse contactor function)]-

The output signal follows the inverted input signal, the relay works like a contactor with negated contacts. If the coil is set to 1, the coil will switch its make contacts to 0.

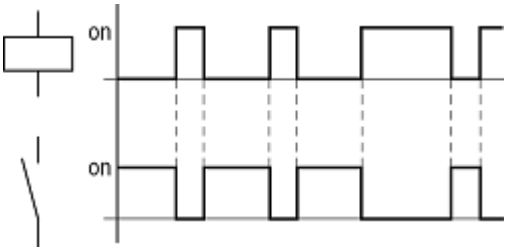


Figure 74: Inverse contactor function signal diagram

Evaluating a rising edge (cycle pulse) ⎍

This function is used if the coil is only meant to switch on a rising edge. When the coil status changes from 0 to 1, the coil switches its make contacts to 1 for one cycle.

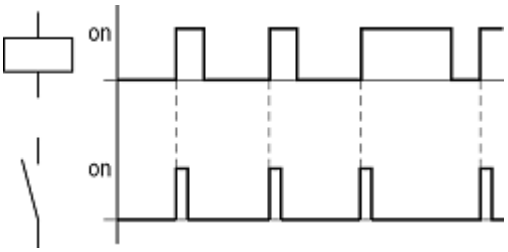


Figure 75: Signal diagram of cycle pulse with rising edge

Evaluating a falling edge (cycle pulse)

This function is used if the coil is only meant to switch on a falling edge. When the coil status drops out from 1 to 0, the coil switches its make contacts to 1 for one cycle.

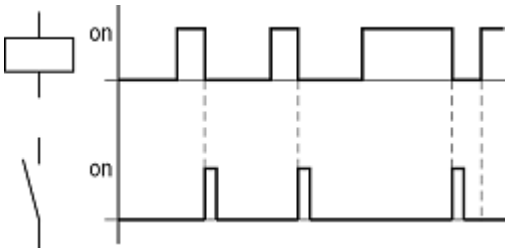


Figure 76: Signal diagram of cycle pulse with negative edge

A set coil is automatically switched off in the event of a power failure and in STOP mode.
Retentive coils keep their logic state.

5.3.5 Markers and analog operands

The term "marker" is used to represent marker bits (M). Marker bits (M) are used to store the Boolean states 0 or 1. A marker bit is also called an auxiliary relay.

easyE4 devices also manage the marker bits in marker bytes (MB), marker words (MW) and in marker double words (MD). A marker byte consists of 8 marker bits, a marker word of 16 marker bits and a marker double word of 32 marker bits.

You can use a specific bit and, accordingly, a specific byte to save a contact's state. For example, marker bit 9 is also found in market byte 2, marker word 1, and marker double word 1. You can use the following conversion table to figure out which word contains a bit or which bits encompass a specific double word.

Bear in mind that after the division, a rounding up to the next higher integer is necessary, even if the decimal number is below 0.5.

Table 56: Conversion table M, MB, MW, DW

Searched for	Given			
	Bit M n	Byte MB n	Word MW n	Double Word DW n
Bit (M)		8n-7 to 8n	16n-15 to 16n	32n-31 up to 32n
Byte (MB)	$\frac{n}{8}$		2n-1 to 2n	4n-3 to 4n
Word (MW)	$\frac{n}{16}$	$\frac{n}{2}$		2n-1 to 2n
Double word (DW)	$\frac{n}{32}$	$\frac{n}{4}$	$\frac{n}{2}$	

n = 1 to 96

Example 1: given Bit81 =M81; n=81;

- Byte(MB) = n/8 = 10.125 ≈ 11
- Word(MW) = n/16 = 5.0625 ≈ 6
- Double word(DW) = n/32=2.5313 ≈3

Bit81 is contained in MB11, MW6 and DW3.

Example 2: given Byte21=MB21; n=21;

- Bit(M) = 8n-7 to 8n = Bit161 to 168
- Word(MW) = n/2 = 10.5 ≈ 11
- Double word(DW) = n/4 = 5.25 ≈ 6

Byte21 contains the bits Bit161 to Bit168. Byte21 is contained in MW11 and DW6.

Marker bit (M), marker bytes (MB), marker words (MW) and marker double words (MD) are used in the circuit and function block diagram.

Avoid any accidental double assignment of markers. In this way, you can assign the available 96 or 128 marker bit contacts and also change the state of these marker bits

via the first 12 marker bytes (MB), 6 marker words or 3 marker double words. This will generate undefined states. When write accesses are made successively within an MD, such as to MD1, MW2, MB4 or M32, the last write operation is retained.

Observing the following wiring rules will prevent the double assignment of marker bits.

For easyE4 with the marker bits M01-M96 use
Marker bytes, starting at MB13
Marker words, starting at MW07
Marker double words, starting at MD04

Retentive markers

You can declare a freely definable contiguous range between marker bytes as retentive.

Device	Marker range that can be declared as retentive
easyE4	MB01 – MB400

For more information on how to configure retentive markers in order to save data in a non-volatile manner, please refer to → Section "Retention function", page 473

Numeric formats

The values of the data types marker byte (MB) and marker word (MB) are processed as unsigned. In order to store negative values, you must use a marker double word.

This fact must be particularly taken into account if the output of a function block can take on a negative value. You must temporarily store this value in a marker double word in order to transfer it to the input of a function block, otherwise the sign information will be lost.

The easyE4 device processes calculations with a signed 31-bit value.

The value range is: –2147483648 to +2147483647

In the case of a 31-bit value, the 32nd bit is the sign bit.

Bit 32 = status 0 -> positive number.

Bit 32 = status 1 -> negative number.

Example

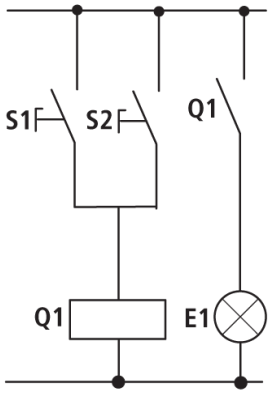
$00000000000000000000010000010010_{bin} = 412_{hex} = 1042_{dez}$

$11111110110111001111010001000111_{bin} = FEDCF447_{hex} = –19073977_{dez}$

5.4 Working with contacts and coils

Switches, pushbuttons and relays from a conventional hardwired circuit diagram are wired in the easyE4 circuit diagram via input contacts and relay coils.

Hardwired



Wired with an easyE4 device

easyE4 connection

Make contact S1 to input terminal I1
Make contact S2 to input terminal I2
Connect load E1 to easy output Q1

S1 or S2 switch on E1.

easyE4 circuit diagram:

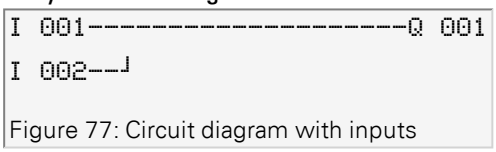


Figure 77: Circuit diagram with inputs

Circuit diagram with inputs I 001, I 002 and output Q 001

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.

The jump destination has a special position for the input contacts and the jump location for the output relays. These are used for structuring a circuit diagram → Section "Working with contacts and coils", page 133.

Following is a description of how to wire various contacts and coils for the various relay types and function blocks (inputs) in the circuit diagram.

5.4.1 Entering and modifying contacts

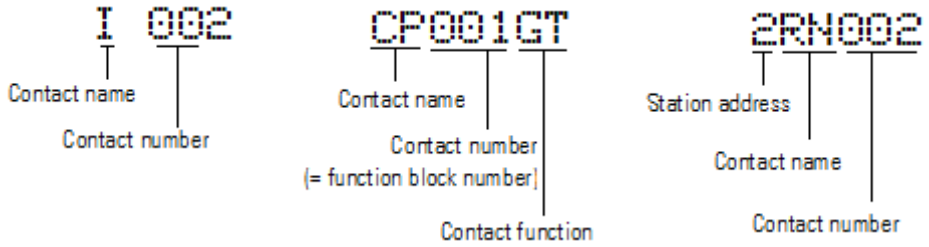


Figure 78: Contact legend

You choose an input contact in the easyE4 device by means of the contact name and the contact number.

Example: Base device input contact or function block contact consists of the abbreviated function block name, the number, and the contact function.

Example: Contact of "comparator" function block

For more information on how to add and configure a function block as a contact or coil in a circuit diagram, please refer to → Section "Working with contacts and coils", page 133 on → "Working with contacts and coils", page 133.

If a NET station's contact is used in a circuit diagram, the station's NET-ID (address) will be placed before the contact name, →"Wiring another NET station's contact or coil in a circuit diagram" section, page 121.

Example: Contact of a NET station

5.4.2 Changing an N/O contact to an N/C contact

DANGER

Persons, systems and machines may be put at risk if an N/C contact is misinterpreted. When using N/C contacts in the program always evaluate the PRSNT and DIAG diagnostic bits of this module.

You can define each contact in the circuit diagram as a N/O or N/C.

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

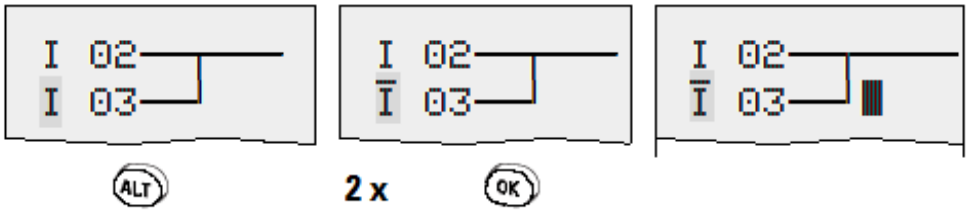


Figure 79: Change contact I 03 from N/O to N/C

Bear in mind that the active state of an N/C contact is 0. The 0 state of a contact may, however, be present if the station is missing or is operating incorrectly. The use of an N/C contact in the circuit diagram without evaluating the diagnostics bit may cause incorrect interpretations.

5.4.3 Entering and modifying coils

With a relay coil or a function block, you choose the coil function, coil name, coil number as well as the function block coil. With coils of an NET station, choose the address (NET ID) in front of the coil name.

→ The coil number in the figures on the left must be the same as the function block number!

Examples

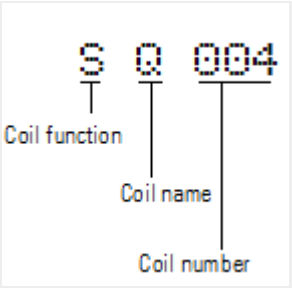


Figure 80: Relay coil "Output Q"

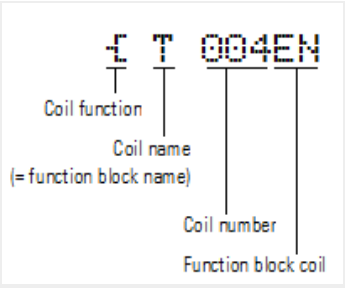


Figure 81: Relay coil for timing relay function block with control coil

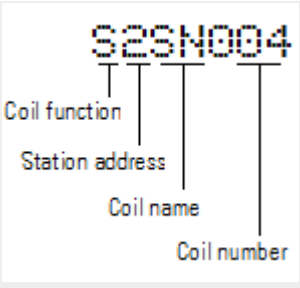


Figure 82: Relay coil of a NET station

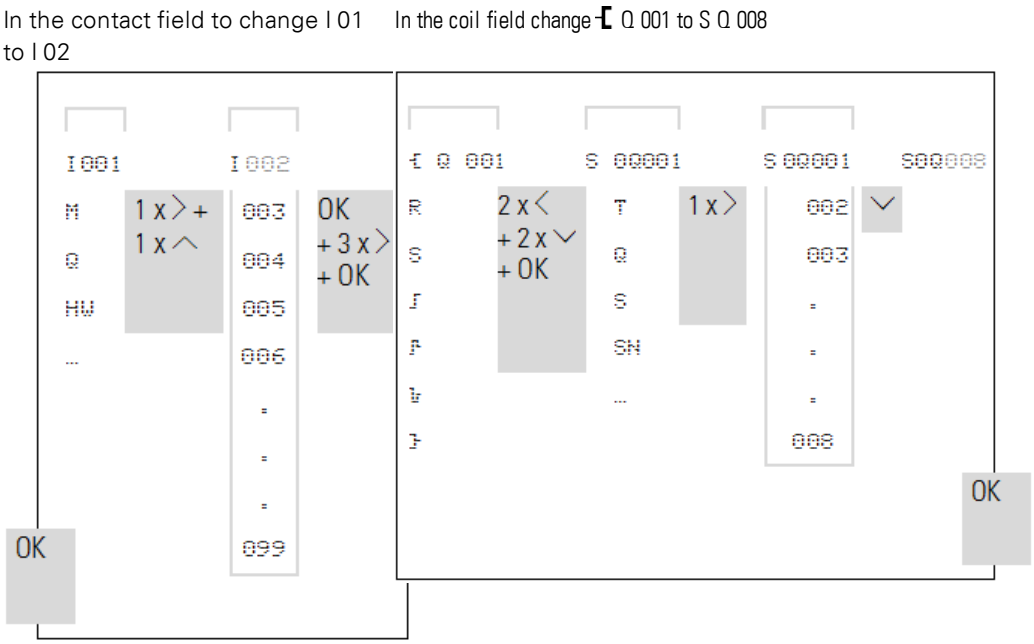
→ A complete list of all contacts and coils,
→ Section "Function blocks", page 166

The values for contact and coil fields can be changed in input mode.
The value that can be changed will flash.

I001 The easyE4 device proposes contact I 001 or the coil Q 001 for entry in an empty field.

- Use the ↑↓←→ buttons to move the cursor to a free contact or coil field.
- Press the OK button to switch to Entry mode.
- Use ←→ to select the position you wish to change and press the OK to move to the next position
  (a selected position is shown in light grey in the following figure).
- Use the ↑↓ cursor buttons to change the value at the position.

The easyE4 device will exit input mode as soon as you exit a contact or coil field with the ←→ cursor buttons or the OK button.



5.4.4 Deleting contacts and coils

- Use the buttons to move the cursor to a free contact or coil field.
- Press the DEL pushbutton.

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

5.4.5 Creating and modifying connections

Contacts and relay coils are connected with the wiring arrow in Connect mode. The easyE4 device displays the cursor in this mode as a wiring arrow.

- Use ↑↓←→ to move the cursor to the contact or coil field from which you wish to create a connection.

→ Do not position the cursor on the first contact field.
Here the ALT button has a different function (add rung).

- Press the ALT button to switch to Connect mode.
- Use the ←→ cursor buttons to move the arrow between the contact and coil fields and use the ↑↓ cursor buttons to move it between the rungs.
- Press the ALT button to leave Connect mode.

The easyE4 device closes the mode automatically as soon as you have moved the arrow to an occupied contact or coil field.

→ In a rung, the easyE4 device connects contacts and the connection to the relay coil automatically if no empty fields are between them.

Never wire backwards.

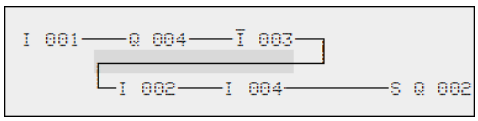


Figure 83: Circuit diagram with five contacts, invalid

When using more than four contacts in series, use one of the 96 M or 128 M markers.

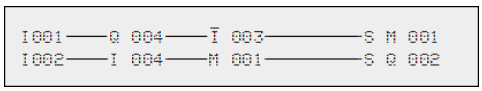


Figure 84: Circuit diagram with M marker relay

5.4.6 Deleting connections

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

The easyE4 device deletes a connection branch.
Closed adjacent connections will be retained.

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

5.4.7 Adding a rung

The circuit diagram display shows three of the 256 rungs at the same time. Rungs outside of the display, including empty rungs, are scrolled by easyE4 automatically in the circuit diagram display if you move the cursor beyond the top or bottom of the display.

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 the ALT button.

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

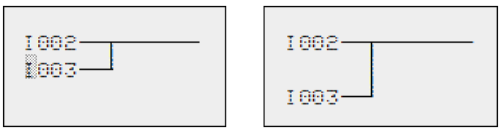


Figure 85: Inserting a new rung

5.4.8 Deleting a rung

The easyE4 device only removes empty rungs (without contacts or coils).

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

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

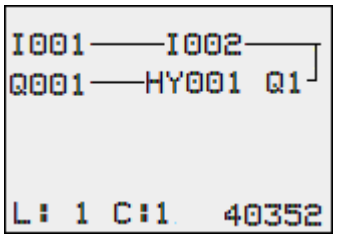
5.4.9 Got to a rung

The GO TO function can be used to go to a different rung.

- Press the ESC button.
- Use the cursor buttons to select the GO TO menu.
- Press the OK button.
- Use the cursor buttons to select the rung you want (L…).

Always the first contact of the rung is displayed.

- Press the OK button.



You can use the "GO TO" function to jump to any rung, up to the last wired rung.

5.4.10 Saving the circuit diagram

- Press the ESC button.

A menu will appear in the status line.

- Use the cursor buttons to switch to the SAVE menu.
- Press the OK button.

The entire program, circuit diagram and function blocks will be saved.

After saving, you will be returned to the previous menu from which you have opened the circuit diagram.

5.4.11 Exiting the circuit diagram without saving

- In order to exit a circuit diagram without saving, press ESC.

A menu will appear in the status line.

- Use the ⌃⌄ cursor buttons to switch to the CANCEL menu.
- Press the OK button.

The circuit diagram is closed without saving.

5.4.12 Searching for contacts and coils

Boolean operands or function blocks that are wired as contacts or coils can be found in the following way:

- Press the ESC button.
- Use the ⌃⌄ cursor buttons to switch to the SEARCH menu.
- Press the OK button.
- Use the cursor buttons ⌃⌄⌃⌄ to select a contact or coil as well as the required number.

For a function block you select the function block name and the number.

- Confirm the search with the OK pushbutton.

The search starts at the point where the search is activated, continues to the end of the circuit diagram. It applies only to this area.
If the required contact or coil is located above the point of calling, start the search at the beginning of the circuit diagram.
If the search is successful, you will automatically reach the required contact or coil field in the circuit diagram.

5.4.13 Switching with the cursor buttons

You can use the four cursor buttons on the easyE4 device as hardwired inputs in the circuit diagram.

The P buttons can be used for testing circuits or for manual operation. The button function is a useful addition for service and commissioning tasks.

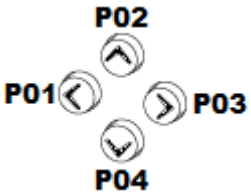


Figure 86: The cursor buttons are wired in the circuit diagram as contacts P 01 to P 04.

Requirement:

The P buttons must have been enabled in the system menu.

Example 1

This standard circuit diagram example enables a lamp at output Q1 to either be switched on or off via the inputs I1 and I2 or via the cursor buttons ∧∨.

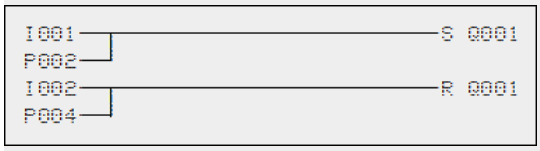


Figure 87: Switch Q1 via I1, I2, ∧, or ∨

Example 2

This circuit diagram example causes output Q1 to be actuated by input I1. I5 switches to cursor operation and disconnects the rung I 01 via M̄ 01.

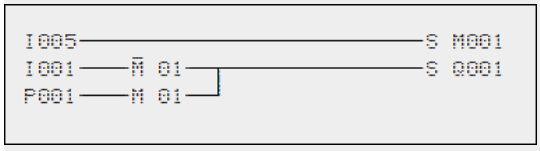


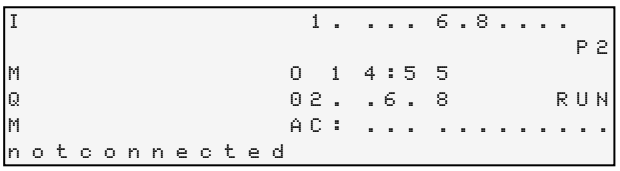
Figure 88: I5 switches to cursor buttons.

The easyE4 device only evaluates P button entries if the status display is shown.

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

Display in Status display:

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



5.4.14 Checking the circuit diagram

The easyE4 device features an integrated power flow display with which you can follow the switching states of contacts, relay and function block coils during operation. The circuit diagram display performs two functions depending on the mode:

- STOP: Create the circuit diagram.
- RUN: Power flow display.

▶ Create the small parallel circuit below and save it.

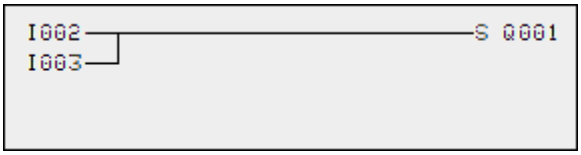


Figure 89: Paralleling link

▶ Switch easyE4 to RUN mode via the main menu.

▶ Switch back to the circuit diagram display.

You are now unable to edit the circuit diagram.

If you change to the circuit diagram display but cannot change a circuit diagram, first check whether the easyE4 device is in STOP mode.

▶ Switch on I3.

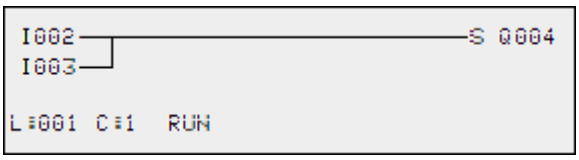


Figure 90: Power flow display

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 power flow display indicates at the bottom right the controller is in RUN mode.



The power flow display does not show signal changes in the millisecond range due to the inherent technical delay of LCD displays.

5.4.15 Jumps

Jumps can be used for structuring a circuit diagram. They can replace the function of a selector switch, for example, for Manual/Automatic mode or for different machine programs.

Jumps consist of a jump location and a jump destination (label). Jumps exist in the

- circuit diagram, for skipping rungs:
  Jump location and jump destination are located in the same circuit diagram
- Function block editor, for skipping function blocks:
  Jump location is located in the circuit diagram and jump destination in the function block editor
  The use of jumps in the function block diagram is explained in → "LB - Jump label", page 391 and → "JC - Conditional jump", page 386.

The easyE4 device allows the use of up to 32 jumps.

Circuit diagram elements for jumps in the circuit diagram

Contact (N/O1))	
Numbers	001 up to 032
Coils	
Numbers	001 up to 032
Coil function	
[1]can only be used as first leftmost contact	

Function of jumps

If the jump coil is triggered, the rungs after the jump coil are no longer processed. 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 left-hand contact position = Jump destination

The jump destination is always an N/O contact with the status 1.

Backward jumps cannot be executed due to the way in which easyE4 works. 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 is also skipped.
Multiple usage of the same jump coil and the same contact is possible as long as this is done in pairs, this means:
Coil -[:1/jumped area/contact :1,
Coil -[:1/jumped area/contact :1,
etc.

NOTICE
If rungs are skipped, the states of the coils are retained. The time of started timing relays continues to run.

Power flow display of skipped area

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 for jumps

A selector switch is used to select two different sequences.

Sequence 1: Switch on motor 1 immediately.

Sequence 2: Activate barrier 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

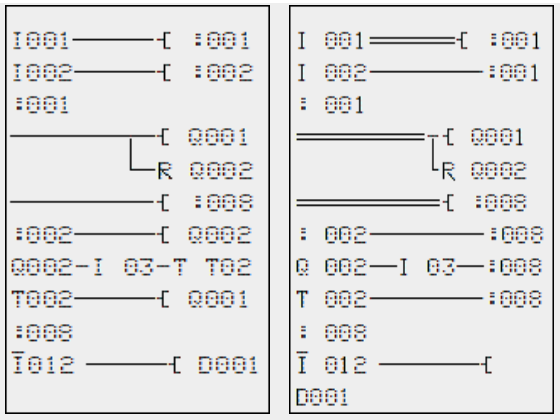
Q1 motor 1

Q2 guard 2

T 01 Wait time 30.00 s, on-delayed

D 01 Text “Motor protective circuit breaker tripped”

Circuit diagram: Power flow display: I001 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.

5.4.16 Wiring NET operands in the circuit diagram

A NET with several stations always allows the reading of all inputs and outputs. This is possible regardless of whether a circuit diagram is being processed or not on the NET station to be read. The inputs and outputs are addressed in the NET by using the preceding NET-ID of the station. The inputs and outputs of a NET station are identified with nI.. and nQ.

The permissible access by stations to the inputs and outputs of other stations depends on the operating mode of the devices on the NET, in which the following applications are possible:

Operating devices on the NET	Usable NET operands of data type…	
	Bit	32 Bit (DWord)
NET marker	nN.., NB.., NW.., ND...	–
All NET stations each process a circuit diagram.	nI.., nR.., nQ.., nS.., nRN.., nSN...	nPT.. and nGT...
Mixed operation of NET stations with and without a circuit diagram.	nI.., nR.., nQ.., nS.., nRN.., nSN...	nPT.. and nGT...
n = NET-ID		

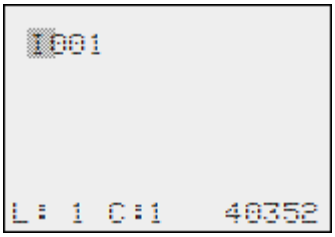
Wiring a contact or coil of another NET station in the circuit diagram

Prerequisites
You must have selected an I.., Q.., R.., RN.., or SN.. operand in the circuit diagram and be in input mode.

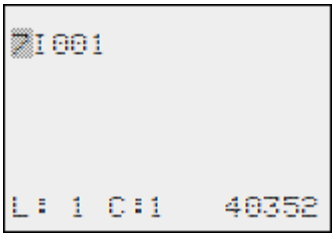
This mode is displayed by a flashing operand.

▶ Use the cursor button 〈 to move the cursor to the position to the left of the operand.

A flashing zero appears as the initial value.



- Use the ∧ or ∨ cursor buttons to select the NET-ID you want (NET-ID 7 in this example).
- Click on OK.



The local I.., or Q.. operand has been changed to a NET operand nI.., nR.., nQ.. and nS...

Several NET stations with their own circuit diagram

The relevant NET stations each process a circuit diagram.

- Every station has read access to all inputs and outputs of the other stations.
- The station only has write access to its local outputs and outputs of its local expansion unit.
  Example: Station 1 uses the state of Q1 of station 2 in its circuit diagram. Station 1, however, cannot set Q1 of station 2 to 1.
- Send NET (SN) and Receive NET(RN) is used for exchanging bits. These operands are always used in pairs.
- Put (PT) and Get (GT) are used in order to exchange double word operands via the NET.
  For more information on the manufacturer function blocks, please refer to: → Section "Working with function blocks", page 154
  → Section "Function blocks", page 166

SN-RN combination for bit exchange on the NET

- Writing via SN

The NET operand SN (Send NET) is used for sending bit data from one NET station to another. To do this you select the SN operand in a coil field.

- Reading using RN

The RN (Receive NET) NET operand is used to receive the bit data that another NET station has sent. To do this you select the RN operand in a contact field.

As the RN and SN must always be used in pairs, the following rule applies:

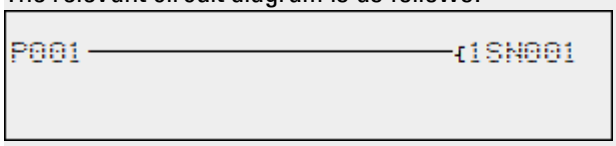
- on the sending station and receiving station use the same operand number for each SN/RN pair to be formed.
- in the circuit diagram of the sending station you set for the SN operand (coil) the station number (NET ID) of the receiving station.
- in the circuit diagram of the receiving station you set for the RN operand (contact) the station number (NET ID) of the sending station.

SN-RN example

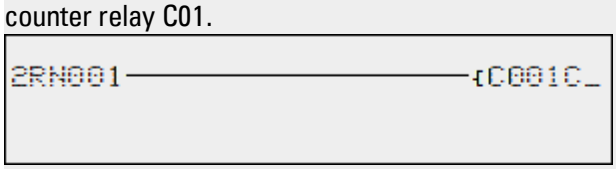
NET station 2 sends the status of the P button P01 via SN1 to NET station 1.



The relevant circuit diagram is as follows:



On NET station 1 the status of P1 is associated via RN01 as a count pulse for the counter relay C01.



NET operand GT.. (receive), PT.. (send) and SC.. (set date and time)

The function blocks are of data type 32-bit. They only function if the NET is operating correctly.

NET marker

n, N, MB, MW, MD

Every station that the NET marker describes can read any of the other stations.

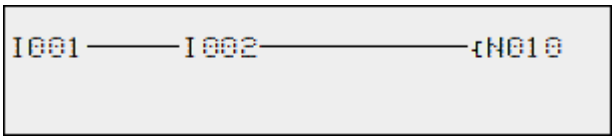


Figure 91: 1 slave

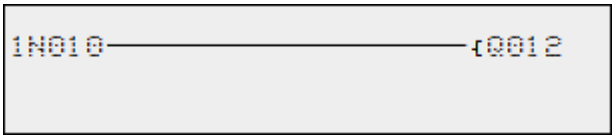


Figure 92: 2 slave

5.5 Transferring programs from and to a memory card

easyE4 base devices can be used with a microSD memory card.

For more information on the various ways in which this memory card can be used, please refer to: → Section "microSD memory card", page 487

Programs are normally transferred from easySoft 7 to the device so that they can be run on the device.
If the easyE4 base device has a microSD memory card, the program can also be stored on this memory card.→ Section "Automatic booting from the card", page 488

You can store multiple programs on a single memory card.
One of these programs can be set as the boot program, i.e., this boot program will be automatically transferred to the device and run as soon as there is a supply voltage present (the device is turned on) and there is no program on the device itself.

Programs can be transferred on the easyE4 device itself. They can also be transferred with easySoft 7 if the latter is connected to the easyE4.

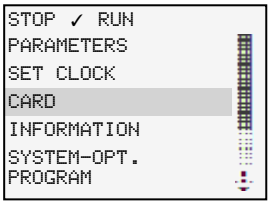
5.5.1 Configuration on base devices with a display

The program needs to be transferred using the Card menu option.

In order to be able to do this, the program must be in STOP mode. If it is not, the device will point this out.

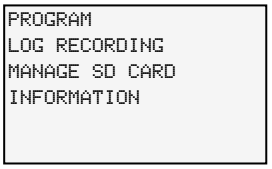
- Go to the main menu.
- Open the CARD menu option.

Table 57: *Main menu*



The device menu for the memory card will appear with additional menu options.

Table 58: *Card*



PROGRAM	Used to manage the programs on the device
LOGS	Data can be written to a binary file by using the DL (Data Logger) manufacturer function block. These logs can be managed here.
MANAGE CARD	Used to format and eject the card
INFORMATION	Provides information on the card size and the amount of free space left

5.5.1.1 PROGRAMS submenu

You can use this submenu to manage the programs on the easyE4.

The program transfer menu offers the following options:

Table 59: *Cards\Program*

SET BOOT PROG.
DELETE PROGRAM
CARD -> DEVICE
DEVICE -> CARD

START PROGRAM

If you select this submenu, a list with the names of all the programs stored on the memory card will appear.

Table 60: *Card\Program\Set boot program*

Name Program 1 ✓
Name Program 2
Name Program 3
...

The checkmark ✓ at the end of a line is used to indicate the program with which the easyE4 device will start as soon as there is a supply voltage.



If the display is empty, this means that no programs have been stored on the memory card.

▶ Select the starting program you want.

DELETE PROGRAM

If you select this submenu, a list with the names of all the programs stored on the memory card will appear.

The ✓ checkmark at the end of a line indicates which program is currently set as the starting program. Meanwhile, the program that is currently selected will flash.

▶ Select the program that you want to delete.

A confirmation prompt will appear. The program will not be deleted until you select Yes and press OK as a confirmation.

CARD -> DEVICE

If you select this submenu, a list with the names of all the programs stored on the memory card will appear.

The ✓ checkmark at the end of a line indicates which program is currently set as the program to be transferred to the device. Meanwhile, the program that is currently selected will flash.

- ▶ Select the program that you want to transfer to the device.
- ▶ Confirm your selection by clicking the OK button.

DEVICE -> CARD

The current program will be transferred from the device to the memory card.

After you select this submenu, another menu will be offered for selection.

SAVE PROG.	Overwrites the selected program with the program from the easyE4
SAVE AS	Makes it possible to save the current program on the easyE4 under a new name

See also

→ Section "microSD memory card", page 487
→ Section "Transferring programs from and to a memory card", page 150

5.6 Working with function blocks

Only the EDP programming language can be used on the device (if you want to program using the LD, FBD, or ST language instead, you will need to use easySoft 7). The rest of this section goes over the basics involved in working with function blocks on the device.

Function blocks are subdivided into manufacturer function blocks, interrupt function blocks, and user function blocks.

Manufacturer function blocks, which are function blocks provided by Eaton, can be used directly on the device in the circuit diagram. Meanwhile,
interrupt function blocks and user function blocks, which you can create yourself, will only be available when using the LD, FBD, or ST programming language and can only be used by using easySoft 7 to transfer the program to the device.

For a detailed description of all available function blocks, please refer to the "Function blocks" section.

The manufacturer function blocks are used to simulate some of the devices used in conventional open-loop and closed-loop control systems. You can first use the function block in the circuit diagram and then define the ACTUAL and Setpoint parameters for the inputs and outputs in the function block editor.
Or vice versa: you create the function block in the function block editor, define the parameters and use it then in the circuit diagram. With easyE4 devices you can insert up to 255 manufacturer function blocks in the function block list.



easyE4 devices will not limit this number automatically. This means that you must check the maximum number of manufacturer function blocks yourself in order to avoid a function block error.

5.6.1 Adding function blocks to the circuit diagram for the first time

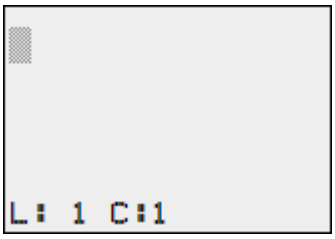
Prerequisites
In order to be able to select the *PROGRAM* menu option, one of the two following prerequisites must be met:

- The card must contain a compiled *.PRG program that uses the EDP programming language.
- The card must not contain a compiled *.PRG program.

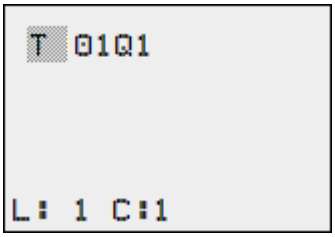
To add a function block to a circuit diagram for the first time, follow the steps below:

▶ Switch to the circuit diagram display by selecting
Main menu -> PROGRAMS -> CIRCUIT DIAGR..

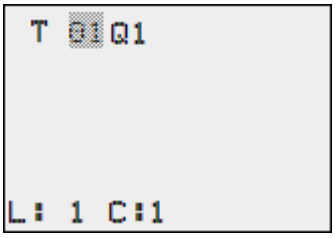
- Use the ▲▼◀▶ buttons to move the cursor to a free contact or coil field.
- Press the OK button to switch to Entry mode.



- Then use the ▲▼ cursor buttons to select the function block you want (e.g., a timing relay with the T identifier).

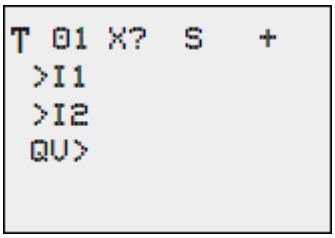


- While the function block identifier is flashing, press the OK button or the ▶ button to move to the function block number
- Press the OK button.



The display switches to the function block editor. Here you normally define all function block parameters. As you have reached the function block editor via the circuit diagram in this case, you can only set the basic parameters.

The figure on the left shows the function block editor of the Timing relay function block.



The basic parameters may vary according to the function block. All manufacturer function blocks have the basic parameter +/-. Through the +/- symbol you can switch the parameter display on and off in operating mode RUN to allow (+) or prevent (-) changes

to be made to reference points (constants). You must at least confirm the +/- character with the OK button.



Parameter sets can only be enabled or protected via the FUNCTION RELAYS menu, or via the circuit diagram with the "+" enable and with "–" inhibit parameter set characters.

- Use the cursor buttons ◀ ▶ to select the parameter to be changed, for example the time range "S".
- Use the cursor buttons ▲ ▼ to change the parameter value to a different time range such as M:S.
- Press the OK button to exit the parameter dialog if you wish to save the parameters or press the ESC button, if you do not wish to parameterize the function block and add it to the circuit diagram.

After saving or canceling, the cursor returns to the position in the circuit diagram where you last left it.

In order to finish configuring the manufacturer function block (e.g., by assigning a reference value), open the function block editor as follows:

- Press the ESC button in order to save the circuit diagram with the newly added function block.
- Answer the subsequent SAVE prompt with the OK button.

The circuit diagram is saved and the easyE4 device changes to the next higher menu level.

5.6.2 Function block list

The function block list can be used to access the function block editor.

- Go to
  Main menu -> PROGRAMS -> FUNCTION BLOCKS.

This lists all function blocks that were ever used in the circuit diagram, and also those that were already deleted in the circuit diagram.
If no function blocks are shown, the list is empty.

The function block list in the example below contains the AR, CP, and T manufacturer function blocks (the manufacturer function blocks are created in the order in which they were edited).

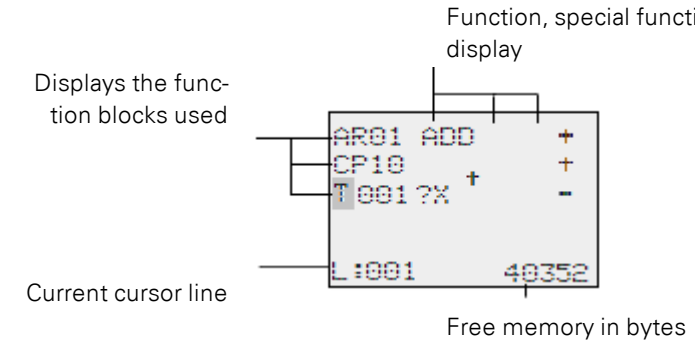
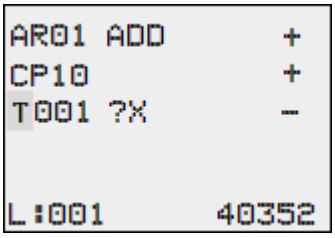


Figure 93: Explanation of the function block list

▶ Use the cursor buttons to select the required function block from the function block list, in this case timing relay T01.



▶ Confirm the selection by clicking the OK button.

The timing relay is displayed in the function block editor.

5.6.3 Configuring parameters in the function block editor

The function block can be fully parameterized in the function block editor.
This is accessed via the function block list.
Access is blocked if the program is password protected.

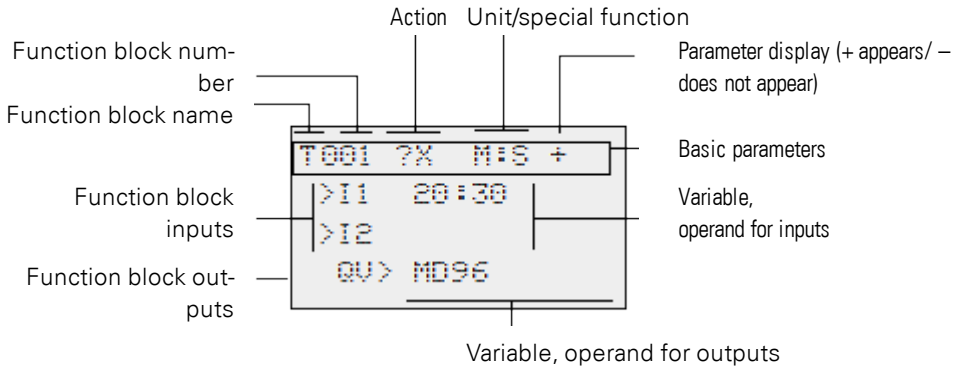
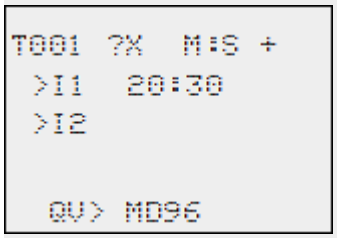


Figure 94: Manufacturer function block display in the function block editor

Example: Timing relay function block

Function block:	timing relay
Switch function:	On-delayed with random time
Time range:	M:S (Minute:Second)
Reference time >I1:	20 min 30 s
Actual time QV>:	Copied to MD96



Assigning operands at a manufacturer function block's input

The following operands can be assigned to the input of a manufacturer function block:

- Constants, e.g.: 42,
- Markers such as MD, MW, MB,
- Analog output QA,
- Analog inputs IA,
- The QV outputs of all manufacturer function blocks

You can set the parameters of the function block as follows:

▶ Use the ⌃⌄ cursor buttons to scroll through the function block inputs' constants.

▶ Change the values for a parameter set:

  ▶ OK button: Switches to input mode.

  ▶ Change whole number places with the ⟨⟩ cursor buttons.

  ▶ Use the ⌃⌄ cursor buttons to change the value of a whole number place.

▶ OK button: Saves the constant immediately

▶ Press the ESC button to leave the parameter display.

ESC button:
Keep the previous setting and exit the parameter display.

→ Ensure that the input of a function block is not assigned impermissible values during operation.

This risk exists if you apply negative values to an input even though the corresponding function block only accepts positive values.
If, for example, the T timing relay function block is driven with a negative time reference, it will no longer switch as expected.

You should therefore take care to exclude such situations, as the easyE4 device cannot foresee these when the parameters are assigned.

If, for example, you have set the output QV of the AR arithmetic function block at input I1 of the T manufacturer function block, you should connect a CP comparator in between in order to signal the occurrence of a negative value.

In most applications, a thorough simulation is enough to prevent any impermissible values at the function block input.

Assigning operands at a manufacturer function block's output

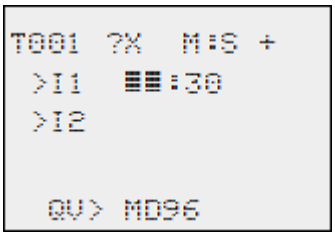
The following operands can be assigned to the output of a QV manufacturer function block:

- Markers such as MD, MW, MB,
- or the analog output QA.

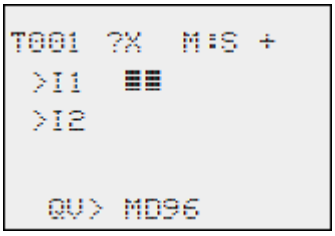
Deleting operands at function block inputs/outputs

Position the cursor on the required operand.

▶ Press the DEL pushbutton.



The operand is deleted.



Behavior of the function block editor with different operating modes

When working with the function block editor, the mode of the device is important.

1. STOP: You will be able to access all of the manufacturer function block's parameters.
2. RUN:
   - Only access to the basic parameters is possible.
   - It is only possible to change input values at manufacturer function blocks if they are constants. The modified constants are used directly for further pro-

cessing in the circuit diagram.

- You can toggle between reference values and actual values by pressing ALT.

Example

- >I1= Actual value, here from the output of the counter C 01
- >I2= constant 1095.
- QV> = Marker double word MD56.



Setpoints Actual Values

5.6.4 PARAMETERS menu

This menu item can only be activated in RUN mode.

Manufacturer function blocks with basic parameters that you have set to + via the +/- character in the function block editor are displayed in the PARAMETERS menu and can be changed. It is only possible to change constants. Other operands cannot be changed.

It is also possible to change parameters via the PARAMETERS menu if you have saved the program and therefore password protected the function block editor. This is the point of this menu. When the password is activated and the +/- basic parameter for each function block is set, you can allow or deny the operator of the system the possibility to change the values.

▶ Move from the Status display to the Parameters display by pressing OK -> PARAMETERS.

▶ Follow the operating steps described in → Section "Assigning operands at a manufacturer function block's input", page 158

5.6.5 Deleting function blocks

To remove a function block, you must remove it from the circuit diagram and from the function block list.

Requirement: The easyE4 device must be in STOP mode.

▶ Switch to the circuit diagram display by selecting *Main menu -> PROGRAMS -> CIRCUIT DIAGR.*.

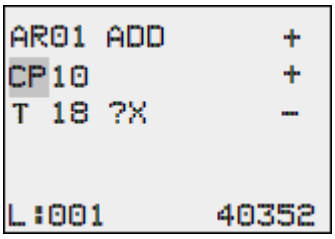
▶ Move the cursor in the circuit diagram to all the contact fields and the coil field in which the function block to be deleted is used and press the DEL button each time.

Deleting function blocks from the function block list

In order to prevent accidental deletion, a function block continues to be managed in the function block list, even if it was already removed in the circuit diagram. To delete the function block permanently and therefore to free up more memory, you must remove it from the function block list.

- Go to
  Main menu -> PROGRAMS -> FUNCTION BLOCKS.-> Function block list
- Select the function block to be deleted in the function block list, in this case CP10.
- Press the DEL pushbutton.

The function block is removed from the function block list.



- Press the ESC button in order to save the function block list with the deleted function block.
- Confirm with the OK button.
- In the function block list select the required function block.

  In this example, select the data block comparator AR01 in Adder mode.
- Press the OK button.

Depending on the display selected the function block is shown with the ACTUAL values and the result, or with the set operands and constants.

If you want to switch from the operand value display to the actual value display or vice versa while checking the manufacturer function block, press the ALT button.

- Press the ALT button again.

Here are some useful tips:

Tips for working with manufacturer function blocks

- Current ACTUAL values are deleted when you switch off the power supply or switch the easyE4 device to STOP mode.
  Exception: Retentive data keeps its state, → Section "Retention function", page 473.
  The most recent actual values are transferred to the operands every cycle. The data function block is an exception.
- If you want to prevent other people from modifying the parameters of the manufacturer function blocks, change the access enable symbol from + to – when cre-

ating the circuit diagram and setting parameters. You can then protect the circuit diagram with a password.

- Since every function block in the function block list takes up space even if it is no longer being used and has been deleted from the circuit diagram, you should clean up things every once in a while.
  Check the function block diagram for manufacturer function blocks that are no longer needed and delete them.
- The manufacturer function blocks are designed so that an output value of a function block can be assigned directly with an input of another function block. The 32-bit data format is used automatically. This also enables the transfer of negative values.



The following applies to RUN mode:
A easyE4 device processes the manufacturer function block after a pass through the circuit diagram. This takes the last status of the coils into account.

5.7 Organizing marker ranges

The easyE4 has 1024 bytes available for data storage.
With specific restrictions, the corresponding memory can be accessed using bytes, words, double words, and bits.

This means that four different operands with their own address can be used to access the exact same data range. Accordingly, it is extremely important to pay close attention to each operand's address in order to avoid accidental duplicate access.
Markers can be used to access data as follows (with the corresponding address range):

- M 1...512
- MB 1...512
- MW 1...512
- MD1...256



Avoid accidental double marker assignments.
Otherwise you might address the 512 bit markers simultaneously via the first 64 marker bytes, 32 marker words or 16 marker double words and thus produce uncontrollable states.

If you use:

- Marker bytes, starting at MB 65,
- Marker words, starting at MW513
  and
- marker double words starting at MD 127,

this will prevent duplicate assignments with bit markers that you may be using in the program.

The following table provides an overview.

Table 61: Available markers

Byte in memory	Bit access	Byte access	Word access	Double word access
	B	MB	MW	MD
1	8...1	1	1	1
2	16...9	2		
3	24...17	3	2	
4	32...25	4		
5	48...41	5	3	2
6	48...41	6		
7	56...49	7	4	
8	64...57	8		

Byte in memory	Bit access B	Byte access MB	Word access MW	Double word access MD
9	72...65	9	5	3
10	80...73	10		
....				
63	494...487	63	32	
64	512...495	64		
65	----------	65	33	17
66	----------	66		
....				
509	----------	509	255	128
510	----------	510		
511	----------	511	256	
512	----------	512		
513	----------	----------	257	129
514	----------	----------		
515	----------	----------	258	
516	----------	----------		
....				
1021	----------	----------	511	256
1022	----------	----------		
1023	----------	----------	512	
1024	----------	----------		

The first column shows the available memory in bytes.
The columns that follow show the various available access options (bit, byte, word, and double word).

The first 64 bytes can be accessed with all four access options.
Within this context, M41 is the least significant bit of byte 4, the least significant bit of MB5, the least significant bit of MW3, and the least significant bit of MD2.

Bit access ends at MB 64. After that point, access is only possible with bytes, words, and double words.

Byte access ends at MB 512. After that point, access is only possible with words and double words.

6. Function blocks

Function blocks offer pre-defined solutions for frequently occurring programming tasks. The programming language you select will determine which function blocks will be available.

Manufacturer function blocks

Manufacturer function blocks are available in easySoft 7 and directly on the device

Timer modules

- HW - Weekly timer (Hour Week) → page 168
- HY - Year time switch (Hora Year) → page 215
- OT - Operating hours counter → page 188
- RC - Real-time clock → page 192
- T - Timing relay → page 195
- WT - Weekly timer (WeekTable) → page 215
- YT - Year time switch (Year Table) → page 209

Counter function blocks

- C - Counter relay → page 218
- CF - Frequency counter → page 224
- CH - High-speed counter → page 230
- CI - Incremental counter → page 237

Arithmetic and analog function blocks

- A - Analog value comparator → page 244
- AR - Arithmetic → page 250
- CP – Comparator → page 255
- LS - Value scaling → page 259
- MM - Min-/Max function → page 264
- PW - Pulse width modulation → page 267

Open-loop and closed-loop function blocks

- DC - PID controller → page 272
- FT - PT1-Signal smoothing filter → page 279
- TC - Three step controller → page 297
- VC - Value limitation → page 302

Data and register function blocks

- BC - Block compare → page 306
- BT - Block transfer → page 311
- DB - Data function block → page 317
- MX - Data multiplexer → page 322
- SR - Shift register → page 326
- TB - Table function → page 334

PO - Pulse output → page 284
NET function blocks
GT - Get values from NET → page 339
PT - Put values to NET → page 342
SC - Synchronizing clock via NET → page 346
Other function blocks
AL - Alarm function block → page 349
BV - Boolean operation → page 353
D - Text display → page 357
D - Text display editor → page 366
DL - Data logger → page 380
JC - Conditional jump → page 386
MR - Master reset → page 393
NC - Numerical converter → page 397
ST - SET cycle time → page 403

Interrupt function blocks

Interrupt function blocks are available only in easySoft 7

IC - Counter-controlled interrupt function block → page 405
IE - Edge-controlled interrupt function block → page 418
IT - Time-controlled interrupt function block → page 424

User function blocks – used to create custom function blocks

User function blocks are only available in easySoft 7

UF - User function block → page 432

6.1 Manufacturer function blocks

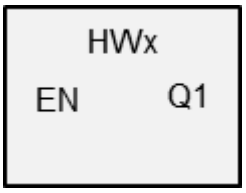
6.1.1 Timer modules

6.1.1.1 HW - Weekly timer (Hour Week)

easyE4 devices feature a real-time clock with a date and time functionality.
When combined with the WT, YT or HW, HY function blocks, this real-time clock makes it possible to implement the functionality of a time switch.

General

easyE4 base devices provide 32 weekly timer HW01…HW32 (Hour Week).
Each weekly timer provides 4 channels. These channels all act jointly on the function block output Q1 of the weekly timer.



Operating principle

Each of the 32 weekly timer, HW01 through HW32, features four channels that can each be configured with an ON event and an OFF event in the parameter configuration for the block. All channels act jointly on function block output Q1.

The following abbreviations are used for the individual days of the week:
Monday = Mon, Tuesday = Tue, Wednesday = Wed, Thursday = Thur, Fri = Fri, Saturday = Sat, Sunday = Sun.

The function block and its parameters

Function block inputs

	Description	Note
(Bit)		
EN	1: Activates the function block.	The checkbox for the ☑ Function block release by EN is necessary parameter must first be enabled

Assigning operands

You can assign the following operands to the function block inputs that are numeric inputs.

Operands	Value inputs
Constant, timer constant	x

Operands	Value inputs
MD, MW, MB - Markers	x
NB, NW, ND - NET markers	x
nNB, nND, nND- NET markers NET stations n	x
IA - Analog input	x
QA - Analog output	x
QV - QV - Numeric output of a FB	x

You can assign the following operands to the function block inputs that are bit inputs:

Operands	Bit inputs
Constant 0, constant 1	x
M – Markers	x
RN - Input bit via NET	x
SN - Output bit via NET (send)	x
N - Net marker bit	x
nN - NET marker bit NET station n	x
ID: Diagnostic alarm	x
LE - Output backlight	x
P buttons	x
I - Bit input	x
Q - Bit output	x
Q - Bit output of a FB	x

Function block outputs

	Description	Note
(Bit)		
Q1	1: if the on condition is fulfilled.	

Assigning operands

You can assign the following operands to the function block outputs that are numeric outputs:

Assigning operands	Outputs
Constant	x
Markers: MB, MD, MW	x
Analog inputs IA	x
Analog output QA	x
Numeric output from another QV FB	x

You can assign the following operands to the function block outputs that are bit outputs:

Assigning operands	Bit outputs
Constant 0, constant 1	x

Assigning operands	Bit outputs
M – Markers	x
SN - Output bit via NET (send)	x
N - Network marker bit	x
nN - NET station n marker	x
LE - Output backlight	x
Q - Bit output from another FB	x

Parameter set

	Description	Note
☑ Function block release by EN is necessary	If this checkbox is enabled, the state of function block input EN will be evaluated. If the checkbox is disabled instead, the function block will be enabled and function block input EN will not do anything.	This parameter ensures that when existing programs are copied, the functionality of the function blocks that are carried over will be retained. The parameter will be automatically set to 0 or 1 depending on the function block.
Channel A - D	A maximum of four channels can be configured (all four channels will act on output Q1). For each channel, you can set an ON time and an OFF time that are accurate to the second . In addition, you can select one or two days of the week when these times will apply.	Note: If the off time is earlier than the on time, the control relay will not switch off until the following day.
Parameter display + Call enabled	Function block parameters and constants can be edited on the device.	
Edit interrupt routine	Clicking on this button will open the interrupt routine	
Simulation possible		

Parameter definition at the function block

If + Call enabled is selected for the function block under *Function block diagram/Parameters/*, it will be possible to change the switching times in the PARAMETER menu on the device while in RUN / STOP mode.

The time to be entered must be between 00:00 and 23:59.

Table 62: Incomplete and automatic parameter definition at the function block

Day	Hour	Minute	Result
-	-	-	A switch point will not be set if you have not set the weekday or the time. Device display: -- --:--
DY1 e.g. Mo	-	-	If you only set the weekday for the On time, the programming software will automatically set the Hour and Minute values to 00. The contact remains active, if the Off Time has not been set. Device display example: Mo 00:00/-- --:--

Day	Hour	Minute	Result
DY2 e.g. Fr	-	-	If you only set the weekday for the Off time, the programming software will automatically set the Weekday for the On time to Sunday and Hour and Minute values to 00. Device display: Su 00:00/Fr --:--

DYx = Weekday

It is therefore not possible to enter the time only. If you delete the weekday (DEL button) whilst making an entry or during operation or simulation, the time will be deleted automatically. Entering the time automatically causes Sunday to be entered as the default weekday.

Other

Retention

The function block does not recognize retentive data.

Behavior in the event of a power failure

The time is backed up and refreshed in the event of a power supply failure. In this case, the time switches no longer switch and the contacts are kept open, Q1=0.
Information on the battery back-up time are provided on → Section "Real-time clock", page 586

The switching points are defined according to the parameters entered.



After being switched on, the control relay will always update its switching state based on all existing switching time settings and will switch Q1 accordingly.

Example 1: Daily on/off switching

(channel A ON - FR 10:00; OFF - SU 18:00)

If the function block output Q1 is to switch on and off daily for a certain number of weekdays, use one channel.

- For one channel define at DY1 the weekday and at ON the time for the initial on switching.
- Then in the same channel define at DY2 the weekday and at OFF the time for the last off switching.

The time switch is required to switch from 10:00 to 18:00 from Fridays to Sundays.

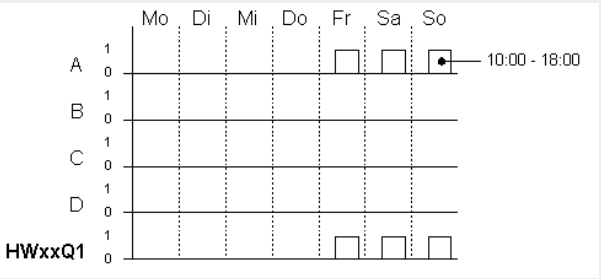


Figure 95: Signal diagram

The HW time switch must be assigned the following parameters:

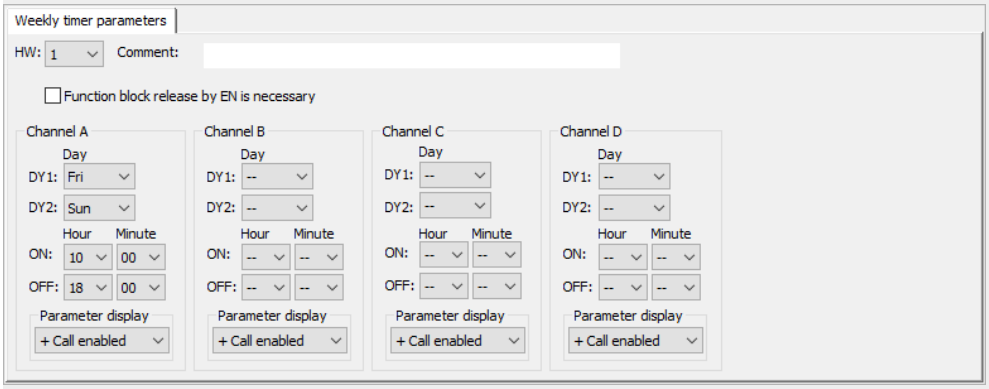


Figure 96: Figure: Tab with parameters in the Programming view

Example 2: Switching at specific times

The time switch is required to switch from Mondays to Fridays between 6:30 and 9:00 and between 17:00 and 22:30.

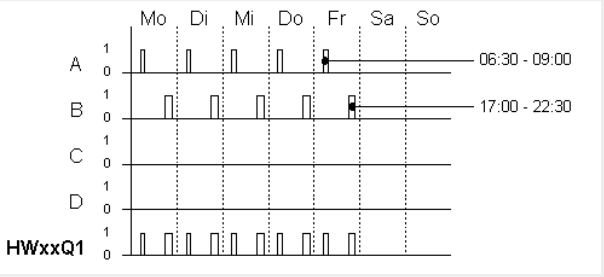


Figure 97: Signal diagram

The HW time switch must be assigned the following parameters:

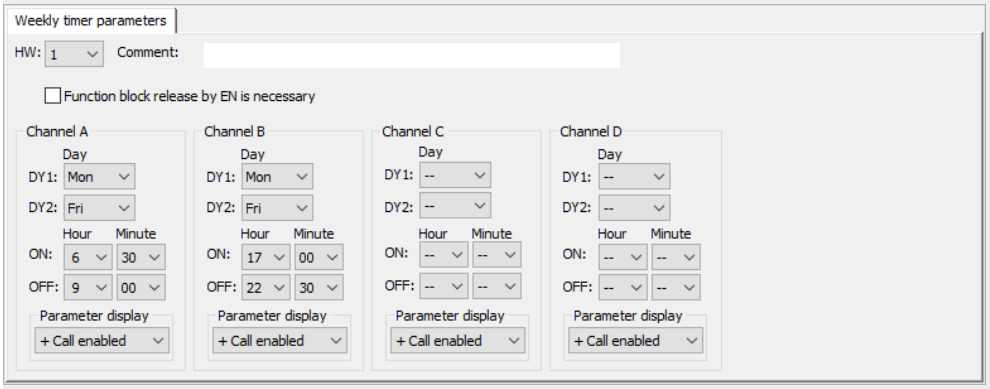


Figure 98: Figure: Tab with parameters in the Programming view

Example 3: Switching on one day and off switching on another day

If the contact Q1 is to remain switched on for a certain number of weekdays, use two channels.

- For one channel define at DY1 the weekday and at ON the time for the initial on switching. DY2 and OFF are left without any parameters for this first channel.
- Then in the next channel define at DY1 the weekday and at OFF the time for the switch-off. DY2 and ON are without any parameters for this second channel.

The time switch is required to switch on at 18:00 on Tuesdays and switch off at 6:00 on Saturdays.

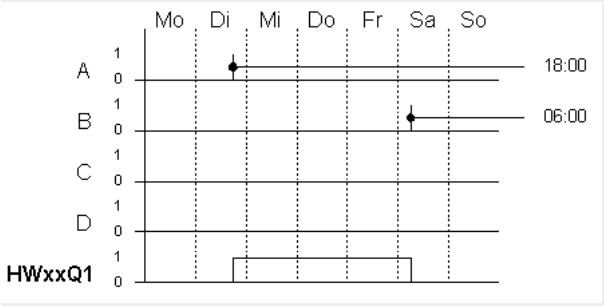


Figure 99: Signal diagram

The HW time switch must be assigned the following parameters:

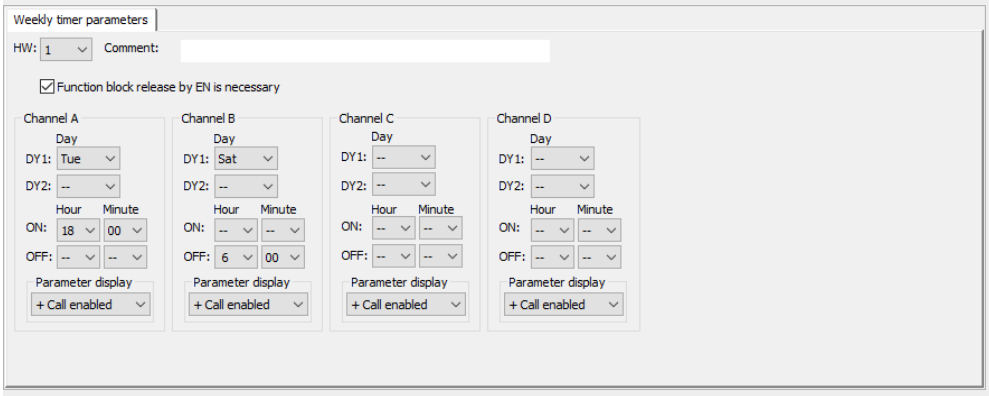


Figure 100: Figure: Tab with parameters in the Programming view

Example 4: Time overlap

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. The off time for Mondays to Wednesdays is 22:00.

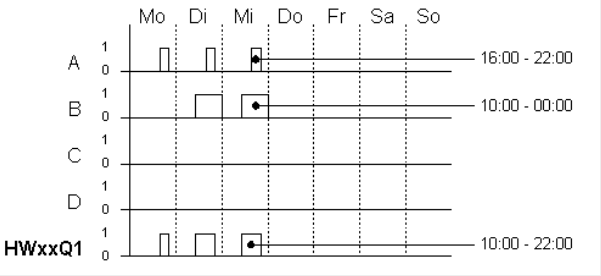


Figure 101: Signal diagram

The first on time at one of the four channels switches output Q1 to 1. The first off time of a channel switches output Q1 to 0. If the on time and off time are the same, the output Q1 is switched off.

The HW time switch must be assigned the following parameters:

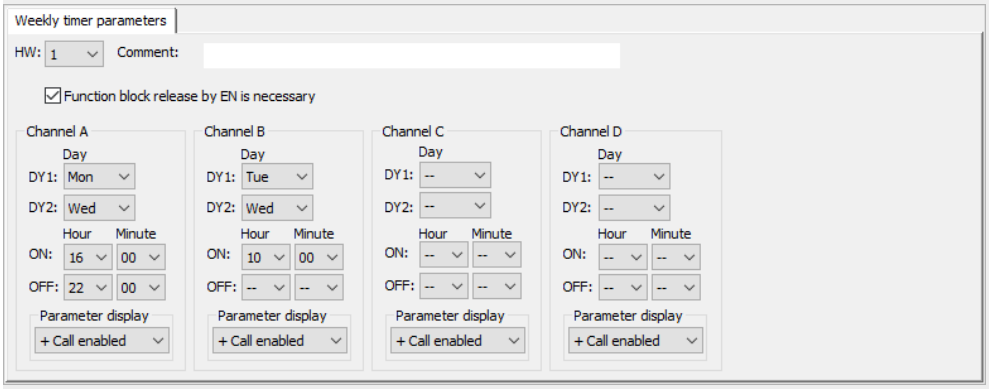


Figure 102: Figure: Tab with parameters in the Programming view

Example 5: 24 hours

The time switch is to switch for 24 hours. On time at 00:00 on Monday and off time at 00:00 on Tuesday.

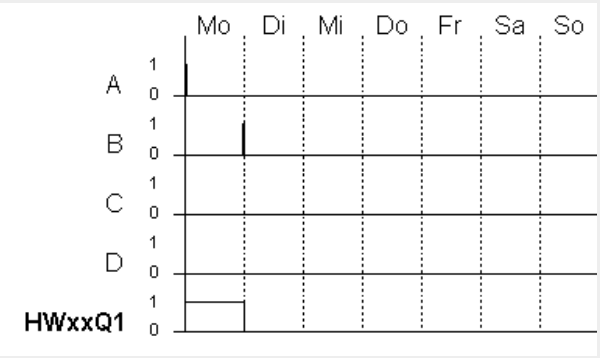


Figure 103: Signal diagram

The HW time switch must be assigned the following parameters:

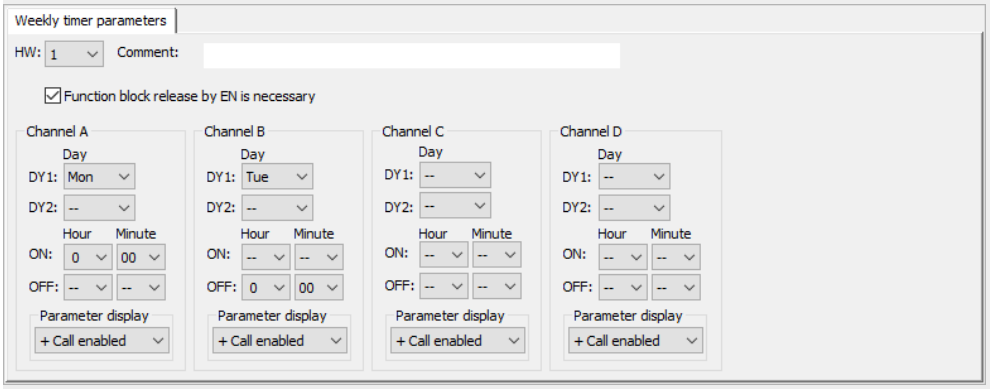


Figure 104: Tab with parameters in the Programming view

Example 6: Overnight switching

The time switch is set for one day, e.g. Mondays, for an on time of ON=22:00 and an off time of OFF=6:00.

The HW time switch must be assigned the following parameters:

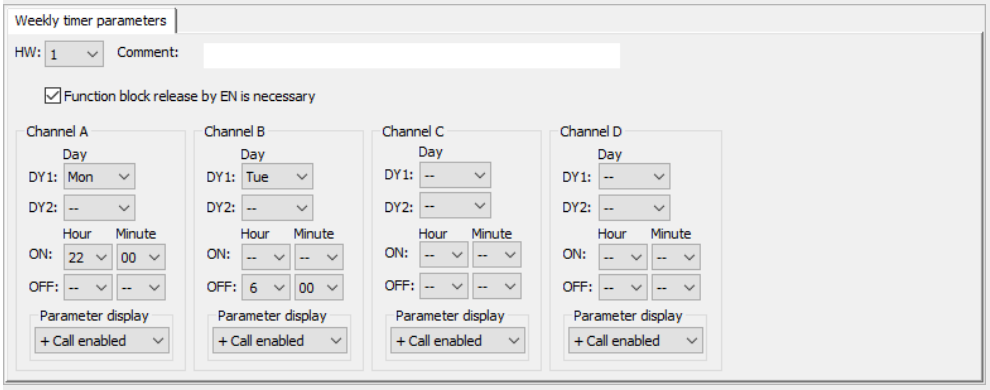


Figure 105: Tab with parameters in the Programming view

See also

→ Section "HY - Year time switch (Hora Year)", page 178
→ Section "OT - Operating hours counter ", page 188
→ Section "RC - Real-time clock", page 192
→ Section "T - Timing relay", page 195
→ Section "WT - Weekly timer (WeekTable)", page 215
→ Section "YT - Year time switch (Year Table)", page 209

6.1.1.2 HY - Year time switch (Hora Year)

easyE4 devices feature a real-time clock with a date and time functionality.
When combined with the WT, YT or HW, HY function blocks, this real-time clock makes it possible to implement the functionality of a time switch.

If you have to implement special on and off switching functions on public holidays, vacations, company holidays, school holidays and special events, these can be implemented easily with the year time switch.

The channels are set via the PARAMETER menu or via easySoft 7.

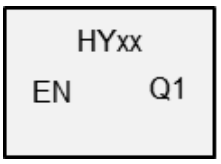
The year time switch can:

- Switch at recurring intervals by switching on and off for individual days, months, or years.
- Switch for continuous periods of time by remaining continuously switched on from the start of any user-defined day until the end of any user-defined day, month, or year.



The parameters for the switch-on and switch-off times for recurring intervals are configured in one single channel for each.
The parameters for the switch-on and switch-off times for a continuous period of time are configured in two neighbouring channels. If you enter the ON information on channel A, the OFF information must be entered on channel B; likewise, if the ON information is on channel B, the OFF information must be on channel C.

General



easyE4 base devices provide 32 year time switches HY01…HY32 (Hour Year). Accordingly, 128 switching times are available.
Each time switch is provided with four channels A, B, C and D.
You can choose an on and off switching time for every channel.
These channels all act jointly on function block output Q1 of the year time switch.

Operating principle

Each of the 32 year time switches, HY01 through HY32, features four channels that can each be configured with an ON event and an OFF event in the parameter configuration for the block. An ON time and an OFF time that are accurate to the day can be selected for each channel. All channels act jointly on function block output Q1.

Behavior in the event of a power failure

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. The contacts are kept open when de-energized. Information on the battery back-up time are provided on → Section "Real-time clock", page 586

.



Switching behavior with overlapping channel settings:
If the set ranges overlap, the year time switch activates the contact with the first detected ON signal irrespective of which channel is supplying this ON. In the same way, the year time switch switches the contact off with the first detected OFF, irrespective of whether another channel still supplies the ON signal.
Please note that the time switches can only be configured up to the year 2099.

The function block and its parameters

Function block inputs

	Description	Note
(Bit)		
EN	1: Activates the function block.	The checkbox for the ☑ Function block release by EN is necessary parameter must first be enabled

Assigning operands

You can assign the following operands to the function block inputs that are numeric inputs.

Operands	Value inputs
Constant, timer constant	x
MD, MW, MB - Markers	x
NB, NW, ND - NET markers	x
nNB, nND, nND- NET markers NET stations n	x
IA - Analog input	x
QA - Analog output	x
QV - QV - Numeric output of a FB	x

You can assign the following operands to the function block inputs that are bit inputs:

Operands	Bit inputs
Constant 0, constant 1	x
M – Markers	x
RN - Input bit via NET	x
SN - Output bit via NET (send)	x
N - Net marker bit	x
nN - NET marker bit NET station n	x
ID: Diagnostic alarm	x
LE - Output backlight	x
P buttons	x
I - Bit input	x
Q - Bit output	x
Q - Bit output of a FB	x

Function block outputs

	Description	Note
(Bit)		
Q1	1: if the on condition is fulfilled.	

Assigning operands

You can assign the following operands to the function block outputs that are numeric outputs:

Assigning operands	Outputs
Constant	x
Markers: MB, MD, MW	x
Analog inputs IA	x
Analog output QA	x
Numeric output from another QV FB	x

You can assign the following operands to the function block outputs that are bit outputs:

Assigning operands	Bit outputs
Constant 0, constant 1	x
M – Markers	x
SN - Output bit via NET (send)	x
N - Network marker bit	x
nN - NET station n marker	x
LE - Output backlight	x
Q - Bit output from another FB	x

Parameter set

Parameter set	Description	Note
☑ Function block release by EN is necessary	If this checkbox is enabled, the state of function block input EN will be evaluated. If the checkbox is disabled instead, the function block will be enabled and function block input EN will not do anything.	This parameter ensures that when existing programs are copied, the functionality of the function blocks that are carried over will be retained. The parameter will be automatically set to 0 or 1 depending on the function block.
Channel A - D	A maximum of four channels can be configured (all four channels will act on output Q1). There is an ON time and an OFF time that are accurate to the day for each channel.	
Parameter display + Call enabled	Function block parameters and constants can be edited on the device.	
Simulation possible		

Parameterization

If you select the function block in the easySoft 7 Programming view by clicking on it, a table with the various parameters will appear under the tab.

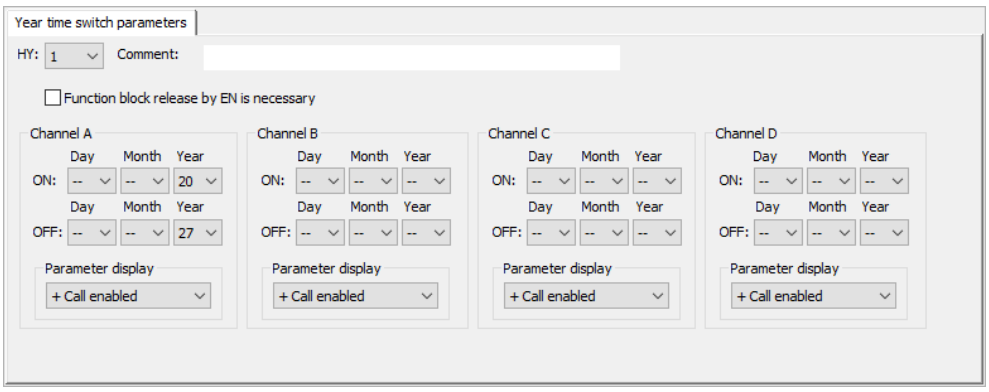


Figure 106: Year time switch parameters tab with and example in which a year range is being selected

Setting time range parameters

If + Call enabled is selected for the function block under *Function block diagram/Parameters/*, it will be possible to change the switching times in the PARAMETER menu on the device while in RUN / STOP mode.

Time ranges are defined by setting an ON and an OFF time.
The contact therefore always switches from ON to OFF, as shown in the following → "HY - Year time switch (Hora Year)", page 178.

Please note:
The year time switch only operates correctly if you observe the following rules:

- The On year must be before the Off year,
- ON and OFF times, the same time parameters must be defined.

Examples of correct time parameter configurations:

- ON = --/--/Year, OFF = --/--/Year,
- ON = --/Month/Year, OFF = --/Month/Year,
- ON = Day/Month/Year, OFF = Day/Month/Year

Setting time range parameters in which the on phase is from the beginning of the year to the end of the year (whole year(s)):

Channel A

ON: -- -- 22, OFF: -- -- 30 means:

The year time switch should switch on at 00:00 on day 01.01.2022 and switch off when the OFF year has elapsed at 00:00 on day 01.01.2031. The parameters are set in one channel. Refer to the → "HY - Year time switch (Hora Year)", page 178 below for this time range.

Setting time range parameters in which the on phase is from the beginning of the month to the end of the month (whole month(s)):

First channel ON: -- 04 --, OFF: -- 10 -- means:

This year time switch will switch on on April 1st at 00:00 and after the OFF month elapses will switch off on November 1st at 00:00. You would configure these settings in the same channel. Compare this to → "HY - Year time switch (Hora Year)", page 178 for this time range found below.

Setting time range parameters in which the on phase is from the beginning of the day to the end of the day for each month in each year (whole day(s)):

First channel ON: 02 -- --, OFF: 25 -- -- means:

The year time switch should switch on at 00:00 h on day 2 of each month, and switch off when the OFF day has elapsed at 00:00 h on day 26. The parameters are set in one channel. Refer to the → "HY - Year time switch (Hora Year)", page 178 below for this time range.

Setting time range parameters in which the on phase is from the beginning of the day to the end of the day for specified months and years year (day, month, year):

First channel ON: 02 04 25; OFF: 25 09 25 means:

The year time switch will switch on on 04/02/2015 at 00:00:01 and off on 09/26/2029 at 00:00:00. Outside of the configured time range, the time switch will remain off.

Setting overlapping time ranges:

Refer to the → "HY - Year time switch (Hora Year)", page 178 below for these time ranges.

In these cases, a time cannot be configured for switching, and switching will always occur for the entire day, from 00:00 to 24:00. This is a set configuration that cannot be modified at runtime.

Other

Retention

The function block does not recognize retentive data.

Examples HY - Year time switch in easySoft 7

Example 1: Select year range

The year time switch HY01 should switch on at 1 January 2020, 00:00 h, and remain switched on until 1 January 2028, 00:00 h.

The HY year time switch must be assigned the following parameters:

Programming view/HY01/Year time switch parameters tab

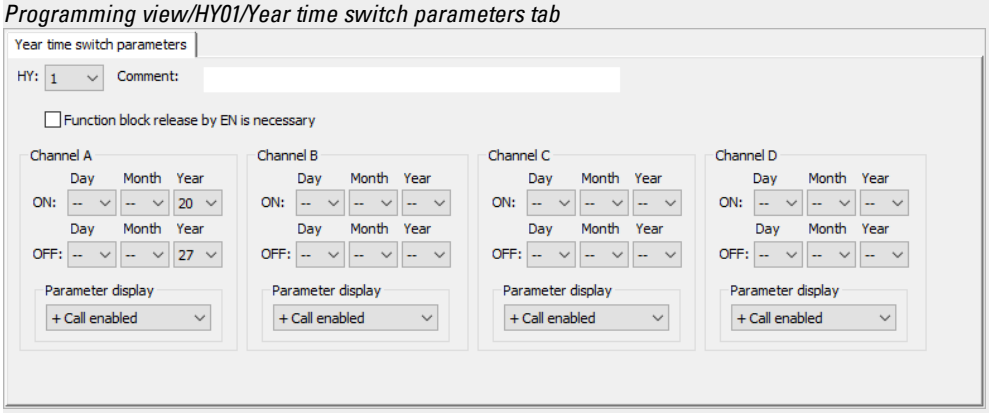


Figure 107: Figure: Entry screen in the programming software

Example 2: Select month ranges

The year time switch HY01 should switch on at 1 March , 00:00 h, and remain switched on until 1 November, 00:00 h.

The HY year time switch must be assigned the following parameters:

Programming view/HY01/Year time switch parameters tab

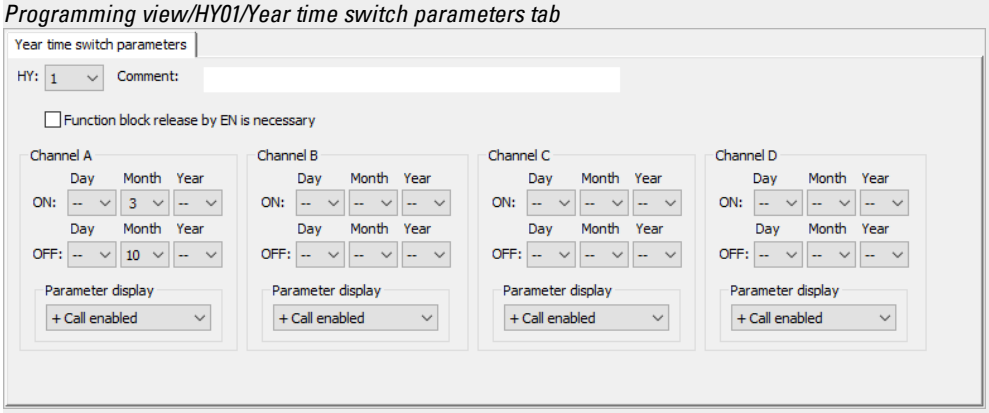


Figure 108: Figure: Entry screen in the programming software

Example 3: Select day ranges

The year time switch HY01 is required to switch on at 00:00 on day 1 of each month and switch off at 00:00 on day 29 of each month.

The HY year time switch must be assigned the following parameters:

Programming view/HY01/Year time switch parameters tab

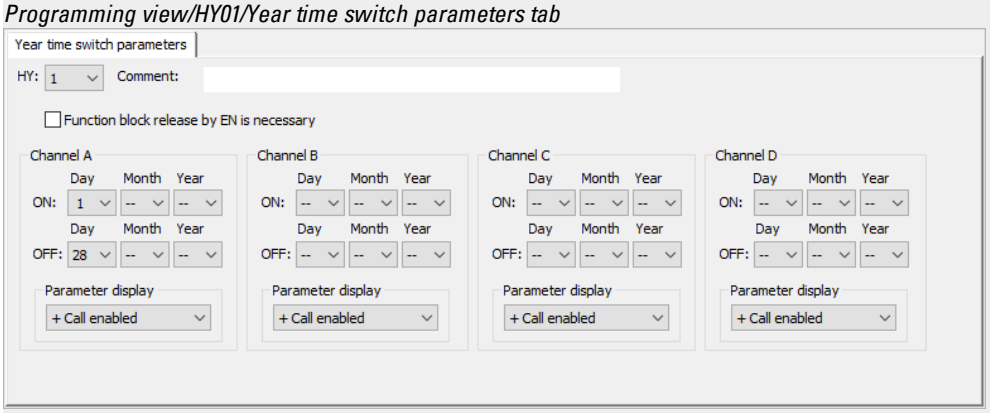


Figure 109: Figure: Entry screen in the programming software

Example 4: Select “public holidays"

The year time switch HY01 is required to switch on at 00:00 on day 5.12 of each year and switch off at 00:00 on day 28.12 of each year.

The HY year time switch must be assigned the following parameters:

Programming view/HY01/Year time switch parameters tab

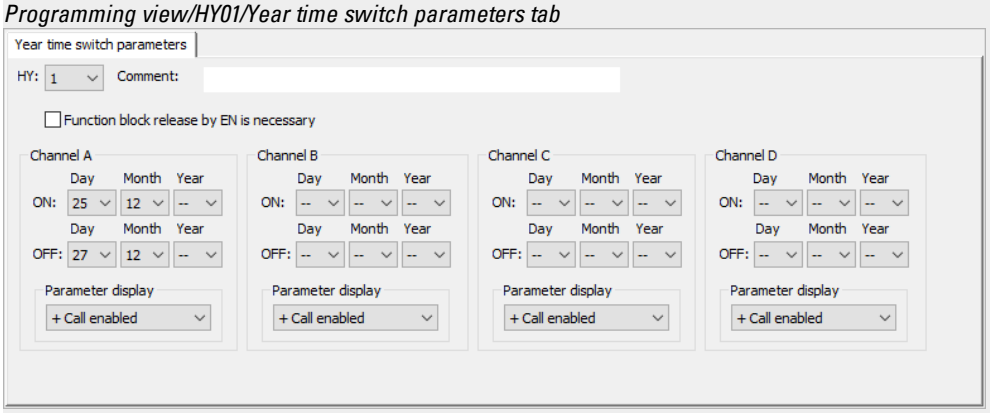


Figure 110: Figure: Entry screen in the programming software

Example 5: Select time range

The year time switch HY01 is required to switch on at 00:00 on day 01.05 of each year and stay on continuously until 00:00 on 2.11 of each year.

The HY year time switch must be assigned the following parameters:

Programming view/HY01/Year time switch parameters tab

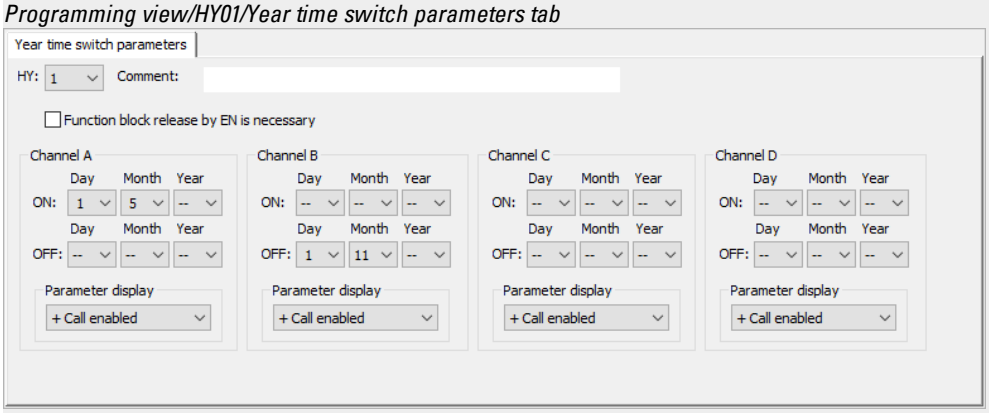


Figure 111: Figure: Entry screen in the programming software

Example 6: Specific days of specific months

The year time switch HY01 is required to switch on at 0:00 on day 9 of months 6, 7, 8, 9 and 10 of each year and switch off at 00:00 on day 17 of the month.

The HY year time switch must be assigned the following parameters:

Programming view/HY01/Year time switch parameters tab

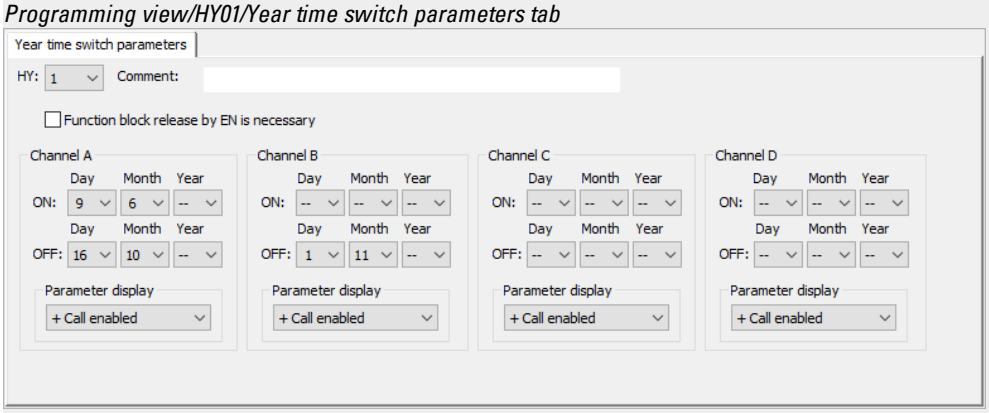


Figure 112: Figure: Entry screen in the programming software

Example 7: Overlapping ranges

Channel A of the year time switch HY01 switches on at 00:00 on day 3 of months 5, 6, 7, 8, 9, 10 and stays on until 00:00 on day 27 of the same months.

Channel B of the year time switch HY01 switches on at 00:00 on day 2 of months 6, 7, 8, 9, 10, 12 11 and stays on until 00:00 on day 19 of the same month.

The HY year time switch must be assigned the following parameters:

Programming view/HY01/Year time switch parameters tab

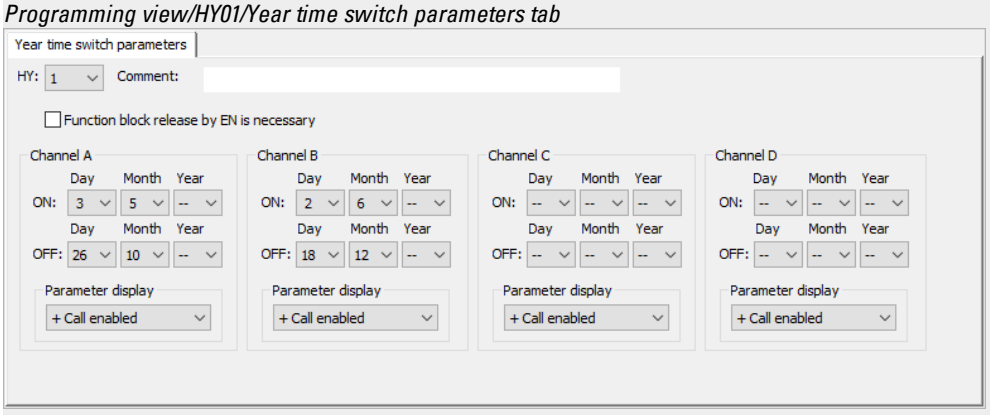


Figure 113: Figure: Entry screen in the programming software

Resulting behavior of contact HY01 Q1: The time switch comes on at 00:00 on day 3 and goes off at 00:00 on day 27. The time switch comes on at 00:00 on day 2 of the months June to December, and goes off at 00:00 on day 19 of the same months.

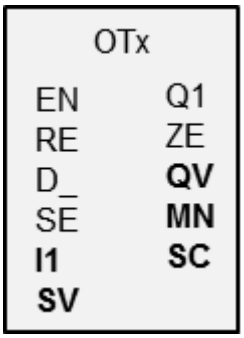
See also

→ Section "HW - Weekly timer (Hour Week)", page 168
→ Section "OT - Operating hours counter ", page 188
→ Section "RC - Real-time clock", page 192
→ Section "T - Timing relay", page 195
→ Section "WT - Weekly timer (WeekTable)", page 215
→ Section "YT - Year time switch (Year Table)", page 209

6.1.1.3 OT - Operating hours counter

General

easyE4 base devices provide 4 operating hours counter function blocks, OT01 through OT04. These function blocks output minutes and seconds in addition to hours. A comparison with a reference value that can be entered makes it possible, for instance, to signal when maintenance work is due.
The counter states are retained even when the device is switched off.



Operating principle

The operating hours counter will run as long as input EN has a state of 1. The operating hours counter's seconds will be output at SC, the minutes at MN, and the hours at QV. The second and minute values will run from 0 to 59, and the hour values will run from 0 to 596,523 h.

The operating hours counter features a comparison function. The corresponding reference value needs to be connected to I1. With every call, the value of the operating hours counter will be compared with the value at I1. The operating hours counter features a direction input, D_.

If the operating hours exceed the reference value at I1 when counting up, function block output Q1 will switch to 1 as long as the number of operating hours is greater than or equal to the reference value.
If, on the other hand, the operating hours fall below the reference value at I1 when counting down, function block output Q1 will switch to 1 until the number of operating hours is greater than the reference value.

The operating hours counter can be preset to any value you want. This value needs to be connected to SV and applied with a wising edge at SE.
The operating hours at QV will not be reset to zero unless reset input RE is activated.

An operating mode change between STOP/RUN, supply voltage ON/OFF, deleting the program, editing the program, loading a new program: None of these actions will clear the operating hours counter's actual value.
However, operating hours will not be added if the program is not running.
The actual value can only be cleared by using the reset input.

The function block and its parameters

Function block inputs

	Description	Note
(Bit)		
EN	1: Activates the function block.	
RE	Reset 1: Resets the actual counter value back to zero.	
D_	Count direction 1: down counting 0: up counting	Integer value range: 0…596 523
SE	When there is a rising edge at SE, the value at SV is applied as the operating hours value and appears at QV	
(DWord)		
I1	The value at I1 is the reference value. If this reference value is greater than the operating hours value, output Q1 will be set.	
SV	When there is a rising edge at SE, the value at SV is applied as the operating hours value	

Assigning operands

You can assign the following operands to the function block inputs that are numeric inputs.

Operands	Value inputs
Constant, timer constant	x
MD, MW, MB - Markers	x
NB, NW, ND - NET markers	x
nNB, nND, nND- NET markers NET stations n	x
IA - Analog input	x
QA - Analog output	x
QV - QV - Numeric output of a FB	x

You can assign the following operands to the function block inputs that are bit inputs:

Operands	Bit inputs
Constant 0, constant 1	x
M – Markers	x
RN - Input bit via NET	x
SN - Output bit via NET (send)	x
N - Net marker bit	x
nN - NET marker bit NET station n	x
ID: Diagnostic alarm	x
LE - Output backlight	x
P buttons	x

Operands	Bit inputs
I - Bit input	x
Q - Bit output	x
Q - Bit output of a FB	x

Function block outputs

	Description	Note
(Bit)		
Q1	1: If the operating hours counter reaches or falls below the reference value at I1 when counting down or reaches and exceeds it when counting up	
ZE	Zero 1: If operating hours counter = 0	
(DWord)		
QV	Actual operating hours counter value Displayed in hours	Integer Value range: 0…596 523
MN	minutes	Value range: 0…59
SC	seconds	Value range: 0…59

Assigning operands

You can assign the following operands to the function block outputs that are numeric outputs:

Assigning operands	Outputs
Constant	x
Markers: MB, MD, MW	x
Analog inputs IA	x
Analog output QA	x
Numeric output from another QV FB	x

You can assign the following operands to the function block outputs that are bit outputs:

Assigning operands	Bit outputs
Constant 0, constant 1	x
M – Markers	x
SN - Output bit via NET (send)	x
N - Network marker bit	x
nN - NET station n marker	x
LE - Output backlight	x
Q - Bit output from another FB	x

Parameter set

Configuration/time range	Description	Note
☑ Function block release by EN is necessary	If this checkbox is enabled, the state of function block input EN will be evaluated. If the checkbox is disabled instead, the function block will be enabled and function block input EN will not do anything.	This parameter ensures that when existing programs are copied, the functionality of the function blocks that are carried over will be retained. The parameter will be automatically set to 0 or 1 depending on the function block.
Parameter display + Call enabled	Function block parameters and constants can be edited on the device.	
Simulation possible		

Other

Retention

The function block does not recognize retentive data.

See also

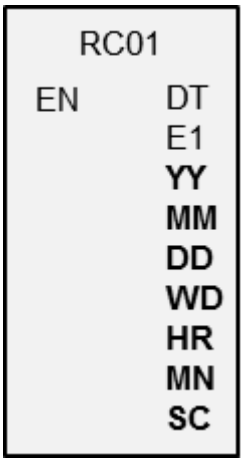
→ Section "HW - Weekly timer (Hour Week)", page 168
→ Section "HY - Year time switch (Hora Year)", page 178
→ Section "RC - Real-time clock", page 192
→ Section "T - Timing relay", page 195
→ Section "WT - Weekly timer (WeekTable)", page 215
→ Section "YT - Year time switch (Year Table)", page 209

6.1.1.4 RC - Real-time clock

General

easyE4 base devices provide exactly one real-time clock RC01.

This function block can be used to read the date and time value of the device's real-time clock. This value is output in seven individual parameters than can each be processed further individually. This makes it very easy to select recurring events with a downstream comparator function block.



Operating principle

If the function block is enabled, the date and time value from the device's real-time clock will be output at the function block outputs: YY (year), MM (month), DD (day), WD (day of the week), HR (hours), MN (minutes), SC (seconds).

Function block output DT signals whether the clock has been switched to daylight saving time.

The function block and its parameters

Function block inputs

	Description	Note
(Bit)		
EN	1: Activates the function block.	The checkbox for the ☑ Function block release by EN is necessary parameter must first be enabled

Assigning operands

You can assign the following operands to the function block inputs that are numeric inputs.

Operands	Value inputs
Constant, timer constant	x
MD, MW, MB - Markers	x
NB, NW, ND - NET markers	x
nNB, nND, nND- NET markers NET stations n	x

Operands	Value inputs
IA - Analog input	x
QA - Analog output	x
QV - QV - Numeric output of a FB	x

You can assign the following operands to the function block inputs that are bit inputs:

Operands	Bit inputs
Constant 0, constant 1	x
M – Markers	x
RN - Input bit via NET	x
SN - Output bit via NET (send)	x
N - Net marker bit	x
nN - NET marker bit NET station n	x
ID: Diagnostic alarm	x
LE - Output backlight	x
P buttons	x
I - Bit input	x
Q - Bit output	x
Q - Bit output of a FB	x

Function block outputs

	Description	Note
(Bit)		
DT	0: The output value is standard time 1: The output value is daylight saving time	
E1	Error 0: error-free operation 1: The value is invalid, since it is before the device's initial date	
(DWord)		
YY	Date: year	Range of 00 to 99
MM	Date: month	Range of 00 to 12
DD	Date: day	Range of 00 to 31
WD	Weekday	0= Su; 1=Mo, 2=Tu, 3=We, 4=Th, 5=Fr, 6=Sa, 7=Su
HR	Time: hour	Range of 00 to 23
MN	Time: minute	Range of 00 to 59
SC	Time: second	Range of 00 to 59

Assigning operands

You can assign the following operands to the function block outputs that are numeric outputs:

Assigning operands	Outputs
Constant	x

Assigning operands	Outputs
Markers: MB, MD, MW	x
Analog inputs IA	x
Analog output QA	x
Numeric output from another QV FB	x

You can assign the following operands to the function block outputs that are bit outputs:

Assigning operands	Bit outputs
Constant 0, constant 1	x
M – Markers	x
SN - Output bit via NET (send)	x
N - Network marker bit	x
nN - NET station n marker	x
LE - Output backlight	x
Q - Bit output from another FB	x

☑ Function block release by EN is necessary

Parameter set

	Description	Note
	If this checkbox is enabled, the state of function block input EN will be evaluated. If the checkbox is disabled instead, the function block will be enabled and function block input EN will not do anything.	This parameter ensures that when existing programs are copied, the functionality of the function blocks that are carried over will be retained. The parameter will be automatically set to 0 or 1 depending on the function block.
Parameter display + Call enabled	Function block parameters and constants can be edited on the device.	
Simulation possible		

Other

Retention

The function block does not recognize retentive data.

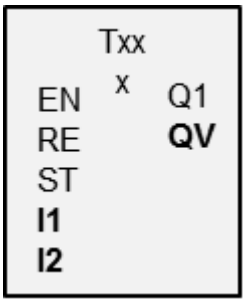
See also

→ Section "HW - Weekly timer (Hour Week)", page 168
→ Section "HY - Year time switch (Hora Year)", page 178
→ Section "OT - Operating hours counter ", page 188
→ Section "T - Timing relay", page 195
→ Section "WT - Weekly timer (WeekTable)", page 215
→ Section "YT - Year time switch (Year Table)", page 209

6.1.1.5 T - Timing relay

General

easyE4 base devices provide 32 timing relays (timer) T01…T32.



You can use a time relay to delay the switching duration and the ON and OFF times of a switch contact. The times can be set from a range of 5 ms to 99 h 59 min.
As reference values, you can use positive values, e.g., from analog inputs or actual values from counter and timing relays.
Minimum time setting: 0.005 s (5 ms).

Operating principle

Each one of the 32 timing relays is a multifunction relay with various operating modes. This operating mode is selected during configuration and cannot be changed at runtime.

In addition, the time range can be configured as well. Seconds, minutes, and hours are available.

The operands with the time reference values are connected to inputs I1, I2 and the switching state and the actual value of the running timing relay are signaled at the outputs.

The timing relay is started via the trigger coil T…EN and can be selectively reset via the reset coil T…RE. The third coil T..ST terminates the run down of the actual time.

The EN input is used to start and stop the timing relay.

→ Enabling the function block by disabling the Function block release by Enable is necessary option is not possible in this case.

The function block and its parameters

Function block inputs

	Description	Note
(Bit)		
EN	1: Activates the function block. Enable, the timing relay is started (Trigger coil) When a rising edge is detected, the timing relay (trigger) will be started at the same time. EN must be set to 1 without interruption until the time you want has elapsed. The only operating mode in which detecting a rising edge is enough is the Single pulse mode. In this case, the function block will be activated for one cycle and started for this mode.	
RE	Reset 1: Resets the timing relay to a value of zero (reset coil)	
ST	Stop coil 1: stops the timing relay. The started time will cease to time out whilst the ST is set to 1. The stopped time will continue to time out if the signal is reset to 0. If ST has a state of 1 when there is a rising edge at trigger coil EN, the assumption of the time reference value will be delayed while ST =1.	
(DWord)		
I1	Time setpoint 1	Integer value range: S: 1…999995 ms, resolution 5 ms M:S: 1… 5999 s, resolution 10 ms H:M: 1… 5999 min, resolution 1 Min.
I2	Time reference value 2 for an operating mode with two reference values, e.g., flashing. This input will be ignored in the case of operating modes with only one single reference value.	

Assigning operands

You can assign the following operands to the function block inputs that are numeric inputs.

Operands	Value inputs
Constant, timer constant	x
MD, MW, MB - Markers	x
NB, NW, ND - NET markers	x
nNB, nND, nND- NET markers NET stations n	x
IA - Analog input	x
QA - Analog output	x
QV - QV - Numeric output of a FB	x

You can assign the following operands to the function block inputs that are bit inputs:

Operands	Bit inputs
Constant 0, constant 1	x
M – Markers	x
RN - Input bit via NET	x
SN - Output bit via NET (send)	x
N - Net marker bit	x
nN - NET marker bit NET station n	x
ID: Diagnostic alarm	x
LE - Output backlight	x
P buttons	x
I - Bit input	x
Q - Bit output	x
Q - Bit output of a FB	x

Interpretation of variable operands for the time reference values at inputs I1 and I2

Variable time values

If you associate the function block inputs T ..I1 and T ..I2 with operands, you can use variable setpoints. The setpoints are transferred as follows, depending on the time range selected:

- S, value in milliseconds. The last digit is rounded up or down to 0 or 5, maximum value = 999995 ms.
- M:S, value in seconds, maximum value = 5999 s.
- H:M, value in minutes, maximum value = 5999 min.

Examples of time range S:

- Operand value 9504 -> time value is 9,500 s.
- Operand value 45507 -> 45,510 s.

Examples of time range M:S:

- Operand value 5999 -> Time value is 99 min, 59 s.

Example of time range H:M:

- Operand value 5999 -> Time value is 99 h, 59 min.

Operating mode

This parameter defines the switch function of the timing relay.

Device parameter	Control mode easySoft 7	Note
X	On-delayed	
?X	On-delayed with random time	
■	Off-delayed	
?■	Off-delayed with random time	

Device parameter	Control mode easySoft 7	Note
	On/off delayed	There are two time setpoints to be configured.
	On/off-delayed with random time	With random time, 2 time setpoints
	Single pulse	Normalizes input signals of different pulse lengths to a fixed pulse length at the switch contact of the timing relay.
	Flashing Time values: S1=Pulse time, S2= Pause time;	Time values Two time reference values need to be configured. I1=Pulse time, I2= Pause time; Synchronous flashing: I1 = I2 Mark-to-space ratio = 1:1 Asynchronous flashing: I1 ≠ I2 Mark-to-space ratio ≠ 1:1
	Off-delayed with retriggering	Retriggerable reference value
	Off-delayed with retriggering and random time	Retriggerable reference value

Function block outputs

	Description	Note
(Bit)		
Q1	Switching contact	
(DWord)		
QV	Elapsed actual time in RUN mode	Integer value range: 0 to max. 99990 in time range: seconds; milliseconds; hours depending on configured time range.

Parameter set

Configuration/time range	Description	Note
S	Seconds:Milliseconds Configurable as a constant: 00.005 to 999.995 (s.ms)	Resolution: 5 ms
M : S	Minutes:Seconds Configurable as a constant: 00:01 to 99:59 (min:s)	Resolution: 1 s
H : M	Hours:Minutes Configurable as a constant: 00:01 to 99:59 (h:min)	Resolution: 1 min
Parameter display + Call enabled	Function block parameters and constants can be edited on the device.	
Simulation possible		



Note on the minimum time setting:
If a time value is less than the program cycle time, the elapsed time will not be recognized until the next cycle. This may cause unforeseeable switching states.

Analog value and timing relay setpoint

If you wish to use variable values as a timing relay setpoint, such as an analog input, the following conversion rules apply, depending on the time base configured.

S time base

Equation: Time setpoint = (Variable value/10) in [ms]

Variable Value	Time setpoint in [s]	Time setpoint in [mm:ss]	Time setpoint in [hh:mm]
0 (Minimum)	00:000	00:00	00:00
100	00:108	01:04	01:04
300	00:308	05:00	05:00
500	00.507	08:02	10:06
4095 (Maximum)	04:099	68:15	68:15

M:S time base

Rule: Time setpoint = Variable value/60
Integer = Number of minutes,
Residual = Number of seconds

Time base H:M

Rule: Time setpoint = Variable value/60
Integer = Number of hours,
Residual = Number of minutes,



You can only use analog values as setpoints if the value of the analog input is stable. Fluctuating analog values impair a reproducible timing response.

Signal Diagrams

The fact that the function block features various operating modes means that it can work in more than one way as shown below.

How the timing relay works with the on-delayed operating mode with and without random times

Random switching

The contact of the timing relays switches randomly within the SETPOINT value range.

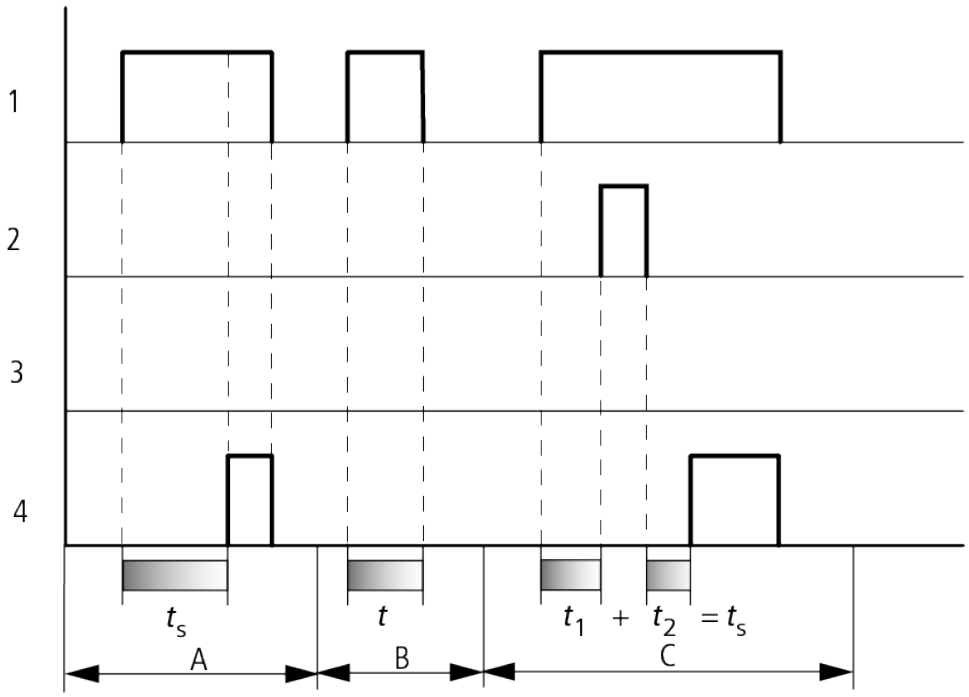


Figure 114: Signal diagram of timing relay, on-delayed (with and without random switching)

1: Trigger coil T…EN

2: Stop coil T…ST

3: Reset coil T…RE

4: Switching contact (N/O contact) T…Q1

ts: Setpoint time

Range A: The time runs down from the SET time value.

Range B: The time does not elapse because the trigger coil drops out prematurely.

Range C: The Stop coil stops the time from elapsing.

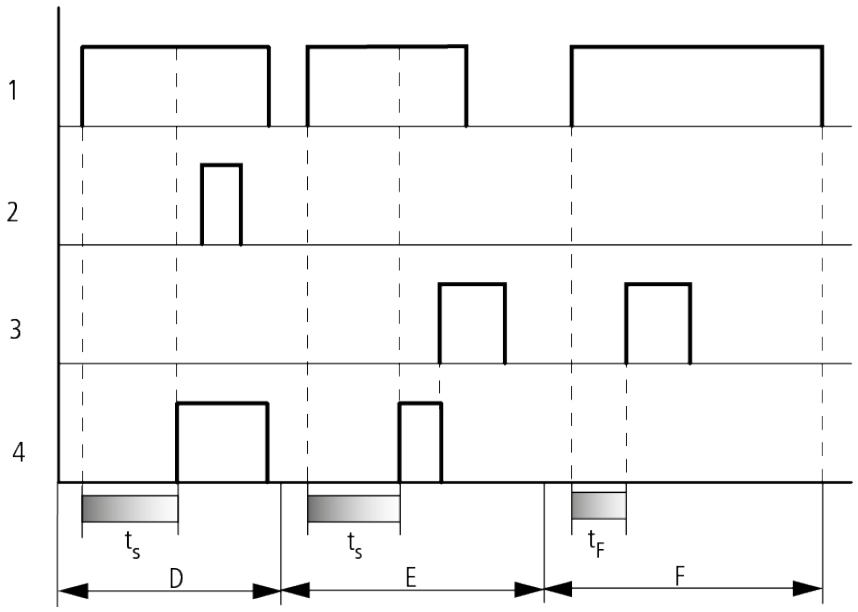


Figure 115: Signal diagram of timing relay, on-delayed (with and without random switching)

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: After the reset coil is activated, the switching contact is switched off and the internal time counter is reset. The function relay waits for a new trigger pulse.

How the timing relay works with the off-delayed operating mode with and without random times

Random switching, with and without retriggering

The contact of the timing relays 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.

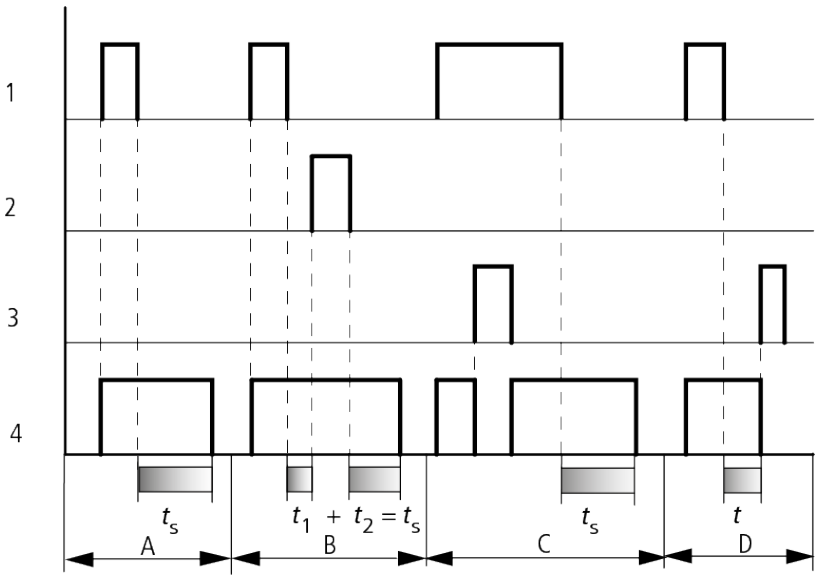


Figure 116: Signal diagram of timing relay, off-delayed

(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

ts: 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.

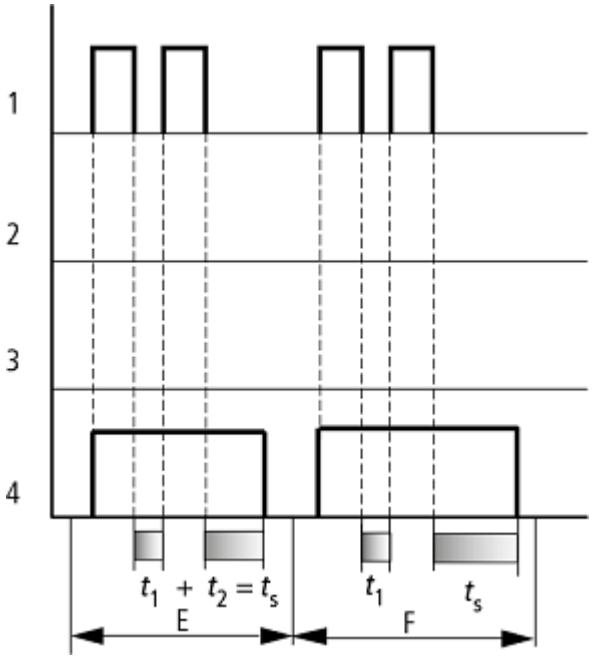


Figure 117: Signal diagram of timing relay, off-delayed

(with/without random switching, with/without retriggering)

Range E: The trigger coil drops out twice.

The SET time ts consists of t1 plus t2 (switch function not retriggerable).

Range F: The trigger coil drops out twice. The ACTUAL time t1 is cleared and the SET time ts elapses completely (retriggerable switch function).

How the timing relay works with the on/off-delayed operating mode with and without random times

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 range.

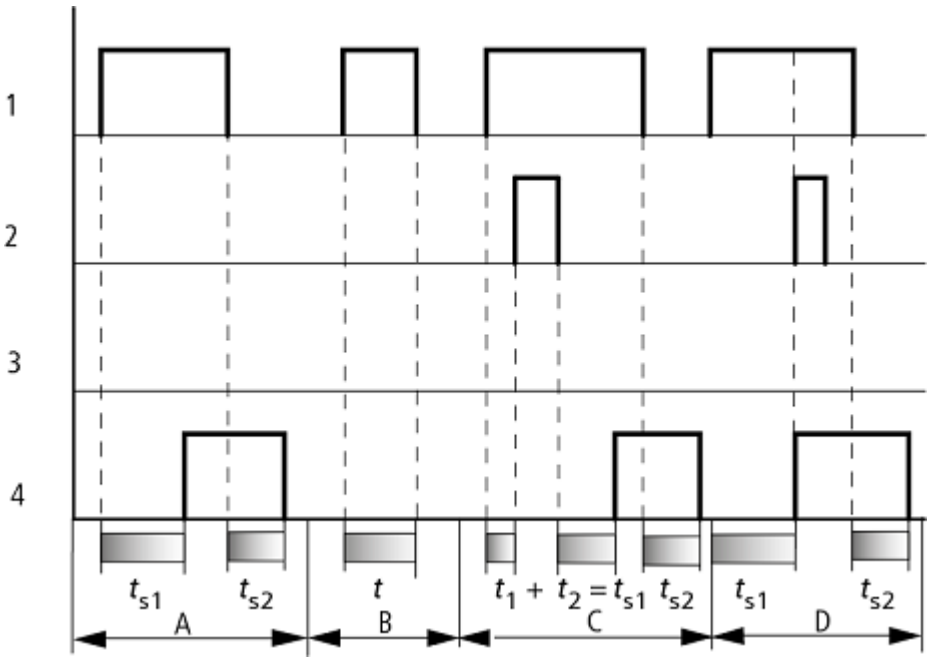


Figure 118: Operational diagrams timing relay, on and off delayed 1

1: Trigger coil T…EN

2: Stop coil T…ST

3: Reset coil T…RE

4: Switching contact (N/O contact) T…Q1

ts1: Pick-up time

ts2: 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.

How the timing relay works with the single pulse operating mode with and without random times

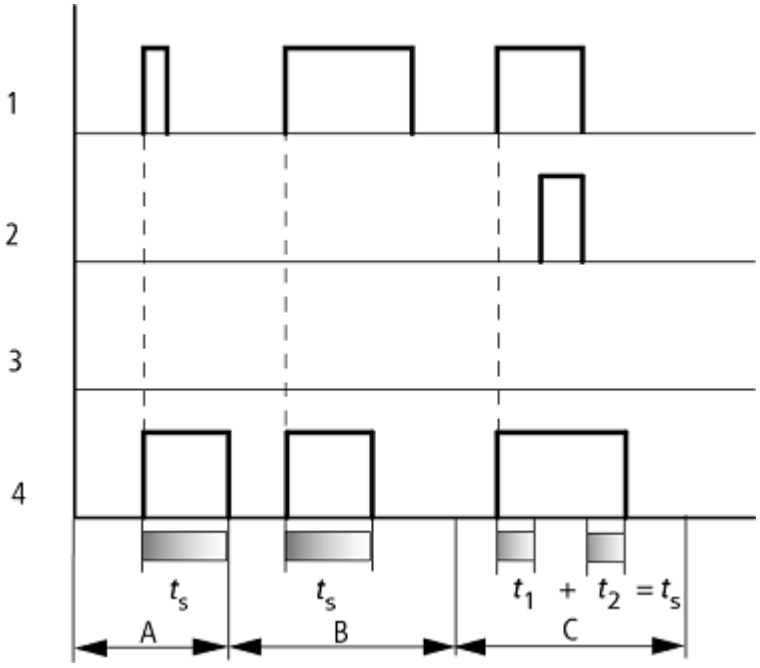


Figure 119: Signal diagram timing relay, single pulse 1

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.

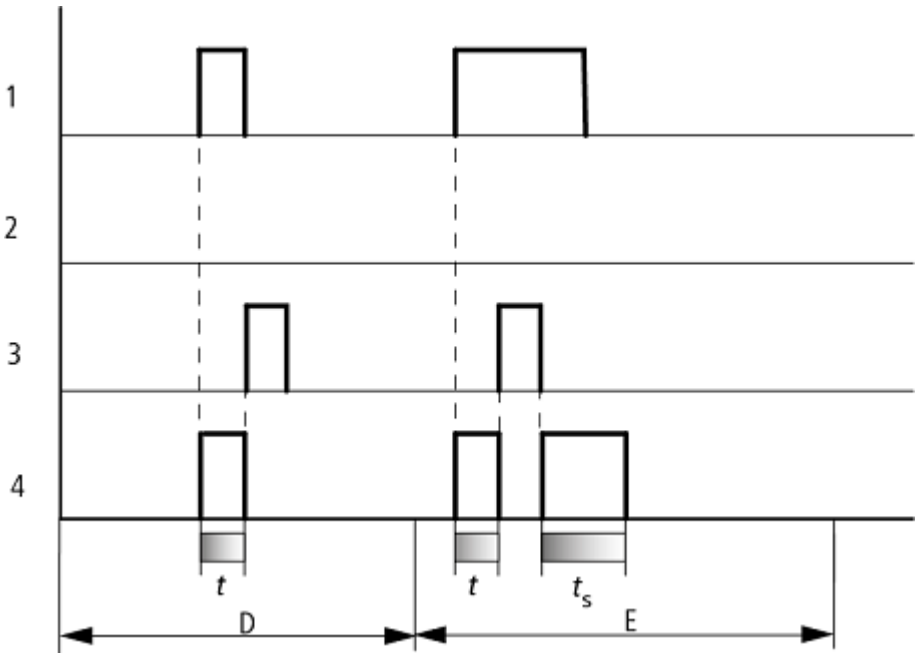


Figure 120: Signal diagram timing relay, single pulse 2

• Range D: The reset coil resets the timing relay.

• Range E: The reset coil resets the timing relay. The trigger coil is still energized after the reset coil is disconnected, whilst the delay time runs down..

How the timing relay works with the flashing operating mode, synchronous and asynchronous

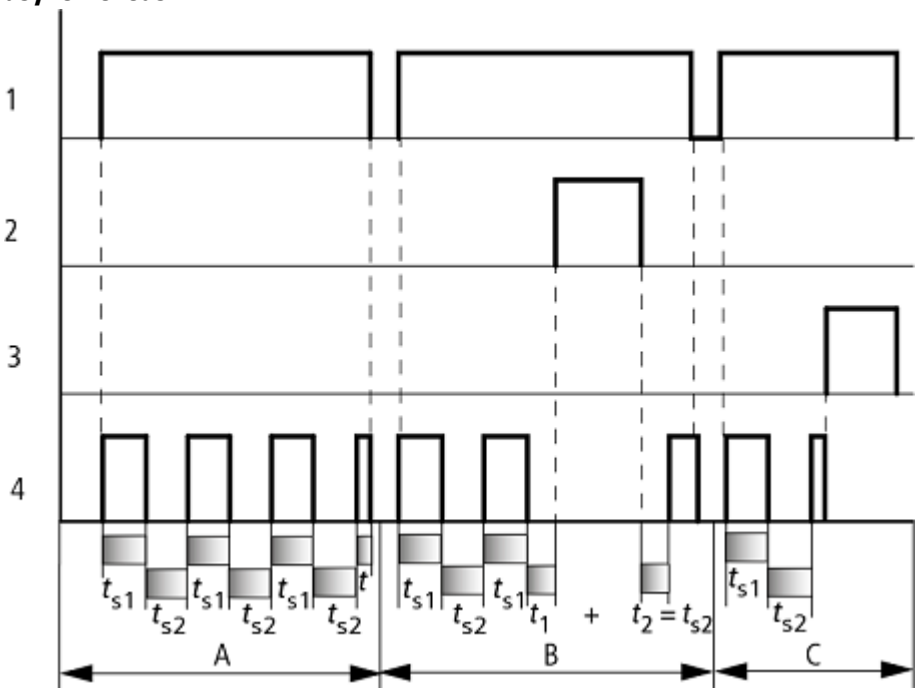


Figure 121: Signal diagram timing relay, single pulse 1

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 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.

Other

Retention

Selected timing relays can be run with retentive actual values. 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 the control relay is restarted in RUN mode, the timing relay continues with the retentively stored actual value.

In the Project view, go to the System settings tab and select the timing relays, out of T1 through T32, that should be run with retentive values. For more information, please refer to System settings tab. A retentive actual value requires 4 bytes of memory.

Operand	Description
Constant	0.. to 99:59 (time range: "M : S"/"H : M") or 0 - 99.99 (time range: "S")
C	Output of a counter relay (e.g. C3QV). If the counter actual value is greater than the maximum permissible setpoint of the configured time range, the setpoint will be limited to this maximum value. Example: You have configured the time range M: S and the counter actual value is 31333. The device limits the setpoint to 5999 min.
IA	Note the relationship described below between the permissible analog value and the timing relay setpoint.
T	Output of a timing relay (e.g. T4QV).

Example of a timing relay when using the EDP programming language

```
I 10----------------------------[ T 02EN

M 42----------------------------[ T 02RE

M 43----------------------------[ T 02ST
```

Figure 122: Wiring the function block coils

The trigger coil of the function block is connected here directly to the device inputs. A marker activates the reset coil, another marker activates the stop coil.

```
T 02Q1--------------------------[ Q 01
```

Figure 123: Wiring of the function block contact

The signal from the function block will go directly to the device output.

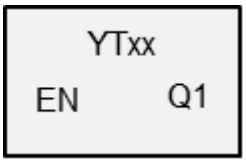
See also

→ Section "HW - Weekly timer (Hour Week)", page 168
→ Section "HY - Year time switch (Hora Year)", page 178
→ Section "OT - Operating hours counter ", page 188
→ Section "RC - Real-time clock", page 192
→ Section "WT - Weekly timer (WeekTable)", page 215
→ Section "YT - Year time switch (Year Table)", page 209

6.1.1.6 YT - Year time switch (Year Table)

easyE4 devices feature a real-time clock with a date and time functionality.
When combined with the WT, YT or HW, HY function blocks, this real-time clock makes it possible to implement the functionality of a time switch.

General



This function block is an enhanced version of the existing HY - year time switch function block.
easyE4 base devices provide 32 year time switches (new), YT01 through YT32.
Year time switches can be used to easily configure unique or recurring switching events.
The following operating modes are available within this context:

- Fixed date
- Fixed date for every year
- Weekday rule
- Easter rule

Variable holidays other than Easter cannot be selected.

Operating principle

Each of the 32 year time switches, YT01 through YT32, features eight channels that can each be configured with an ON event and an OFF event in the parameters for the function block. All channels act jointly on function block output Q1.

The function block and its parameters

Function block inputs

	Description	Note
(Bit)		
EN	1: Activates the function block.	The checkbox for the ☑ Function block release by EN is necessary parameter must first be enabled

Assigning operands

You can assign the following operands to the function block inputs that are numeric inputs.

Operands	Value inputs
Constant, timer constant	x
MD, MW, MB - Markers	x
NB, NW, ND - NET markers	x
nNB, nND, nND- NET markers NET stations n	x
IA - Analog input	x
QA - Analog output	x
QV - QV - Numeric output of a FB	x

You can assign the following operands to the function block inputs that are bit inputs:

Operands	Bit inputs
Constant 0, constant 1	x
M – Markers	x
RN - Input bit via NET	x
SN - Output bit via NET (send)	x
N - Net marker bit	x
nN - NET marker bit NET station n	x
ID: Diagnostic alarm	x
LE - Output backlight	x
P buttons	x
I - Bit input	x
Q - Bit output	x
Q - Bit output of a FB	x

Function block outputs

	Description	Note
(Bit)		
Q1	1: if the on condition is fulfilled.	Can be used to directly connect an output that implements the configured switching times

Assigning operands

You can assign the following operands to the function block outputs that are numeric outputs:

Assigning operands	Outputs
Constant	x
Markers: MB, MD, MW	x
Analog inputs IA	x
Analog output QA	x
Numeric output from another QV FB	x

You can assign the following operands to the function block outputs that are bit outputs:

Assigning operands	Bit outputs
Constant 0, constant 1	x
M – Markers	x
SN - Output bit via NET (send)	x
N - Network marker bit	x
nN - NET station n marker	x
LE - Output backlight	x
Q - Bit output from another FB	x

Parameter set

Parameter set	Description	Note
☑ Function block release by EN is necessary	If this checkbox is enabled, the state of function block input EN will be evaluated. If the checkbox is disabled instead, the function block will be enabled and function block input EN will not do anything.	This parameter ensures that when existing programs are copied, the functionality of the function blocks that are carried over will be retained. The parameter will be automatically set to 0 or 1 depending on the function block.
Channel A - D	A maximum of four channels can be configured (all four channels will act on output Q1). There is an ON time and an OFF time that are accurate to the day for each channel.	
Parameter display + Call enabled	Function block parameters and constants can be edited on the device.	
Simulation possible		

Parameterization

If you select the function block in the easySoft 7 Programming view by clicking on it, a table with the various parameters will appear under the tab.

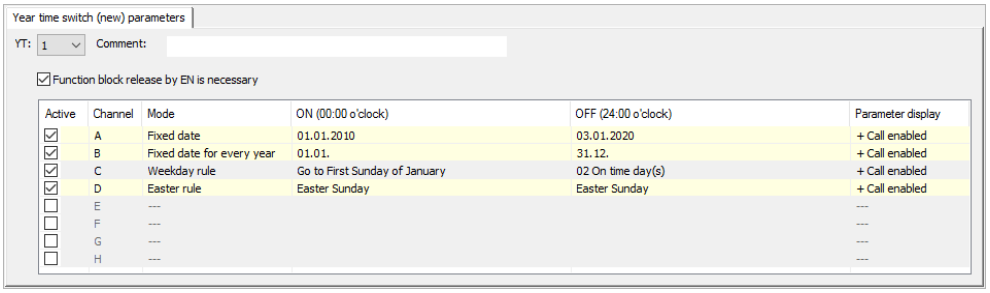


Figure 124: Year time switch (new) parameters tab for YT function block with example showing all four modes

If + Call enabled is selected for the function block under *Function block diagram/Parameters/*, it will be possible to change the switching times in the PARAMETER menu on the device while in RUN / STOP mode.

One of the following operating modes can be selected for each of the channels, A through H:

- Fixed date
  Will switch one; the ON and OFF times and specified with a number of years
- Fixed date for every year
  ON and OFF times with specified day and month but no year
- Weekday rule
  A cyclical switching operation that is carried out on a defined day of the week during a defined month. For example: the "first Sunday of January"
- Easter rule
  You can select an ON time and an OFF time that repeat annually and are relative to Easter. Easter does not have a fixed date, and is instead based on the lunar calendar. The selectable reference points for the ON and OFF times are Good Friday, Easter Sunday, Easter Monday, and day(s) before/after Easter Sunday.
  Reference points other than Easter cannot be selected.

In these cases, a time cannot be configured for switching, and switching will always occur for the entire day, from 00:00 to 24:00. This is a set configuration that cannot be modified at runtime.

This example uses all four available modes.

Other

Retention

The function block does not recognize retentive data.

Examples YT - Year time switch in easySoft 7

Example 1: Select year range

Year time switch YT01 should switch on on January 1st, 2020, at 00:00, and remain switched on until January 1st, 2028, 00:00.

The YT year time switch must be assigned the following parameters:

Programming view/YT01/Year time switch (new) parameters tab

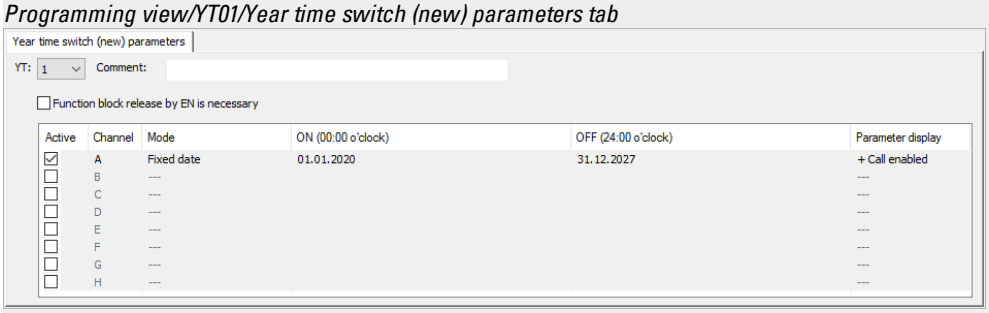


Figure 125: Figure: Entry screen in the programming software

Example 2: Select month ranges

Year time switch YT01 should switch on on March 1st, at 00:00, and remain switched on until November 1st, at 00:00.

The YT year time switch must be assigned the following parameters:

Programming view/YT01/Year time switch (new) parameters tab

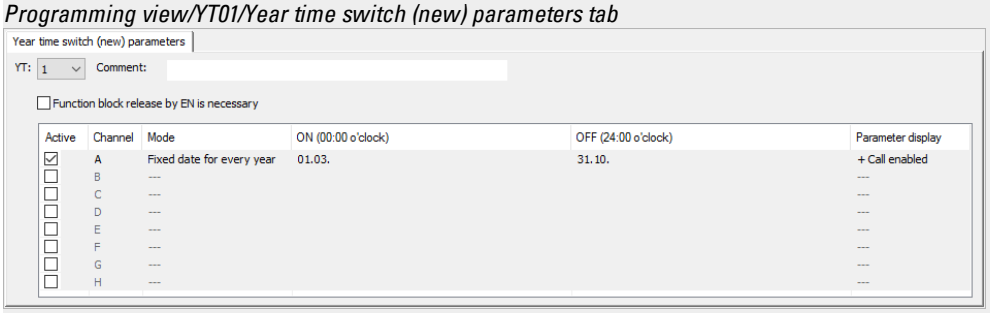


Figure 126: Figure: Entry screen in the programming software

Example 3: Select “public holidays"

Year time switch YT01 should switch on on 12/05 of every year at 00:00 and remain switched on until 12/28 of every year at 00:00.

The YT year time switch must be assigned the following parameters:

Programming view/YT01/Year time switch (new) parameters tab

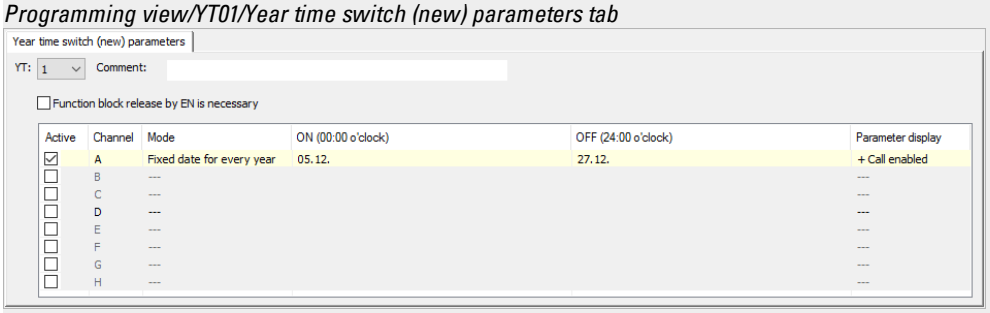


Figure 127: Figure: Entry screen in the programming software

Example 4: Select time range

Year time switch YT01 should switch on on 05/01 of every year at 00:00 and remain switched on until 11/02 of every year at 00:00.

The YT year time switch must be assigned the following parameters:

Programming view/YT01/Year time switch (new) parameters tab

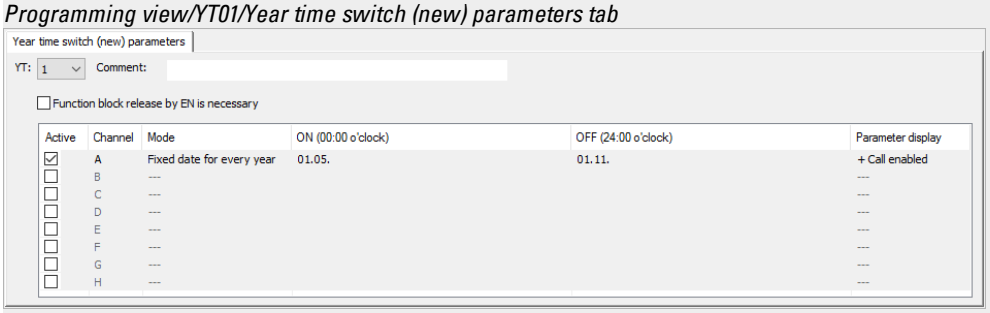


Figure 128: Figure: Entry screen in the programming software

Example 5: Specific days of specific months

Year time switch YT01 should switch on on the 9th of months 6, 7, 8, 9, and 10 every year at 00:00 and switch off on the 17th at 00:00.

The YT year time switch must be assigned the following parameters:

Programming view/YT01/Year time switch (new) parameters tab

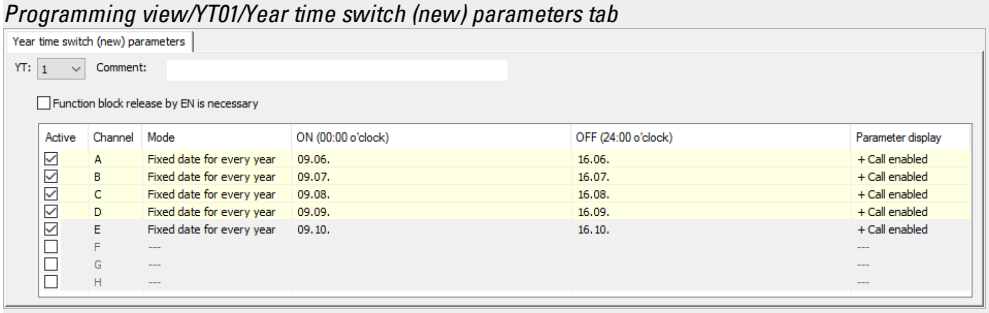


Figure 129: Figure: Entry screen in the programming software

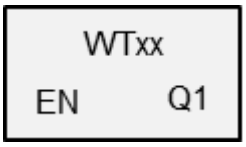
See also

→ Section "HW - Weekly timer (Hour Week)", page 168
→ Section "HY - Year time switch (Hora Year)", page 178
→ Section "OT - Operating hours counter ", page 188
→ Section "RC - Real-time clock", page 192
→ Section "T - Timing relay", page 195
→ Section "WT - Weekly timer (WeekTable)", page 215

6.1.1.7 WT - Weekly timer (WeekTable)

easyE4 devices feature a real-time clock with a date and time functionality.
When combined with the WT, YT or HW, HY function blocks, this real-time clock makes it possible to implement the functionality of a time switch.

General



This function block is an enhanced version of the existing HW - Weekly timer function block.
easyE4 base devices provide 32 weekly timers, WT01 through WT32. WT weekly timers can be used to easily configure recurring switching events. The function block was specifically designed for implementing switching events that occur at set weekly cycles.
It can also take into account different procedures for business days and weekends.

Operating principle

Each of the 32 weekly timers, WT01 through WT032, can be configured with eight switching events that will be executed at the same time and on any specified day of the week. The corresponding settings are accurate to the minute and cannot be modified at runtime, i.e., they must be viewed as a set configuration.

The function block and its parameters

Function block inputs

	Description	Note
(Bit)		
EN	1: Activates the function block.	The checkbox for the ☑ Function block release by EN is necessary parameter must first be enabled

Assigning operands

You can assign the following operands to the function block inputs that are numeric inputs.

Operands	Value inputs
Constant, timer constant	x
MD, MW, MB - Markers	x
NB, NW, ND - NET markers	x
nNB, nND, nND- NET markers NET stations n	x
IA - Analog input	x
QA - Analog output	x
QV - QV - Numeric output of a FB	x

You can assign the following operands to the function block inputs that are bit inputs:

Operands	Bit inputs
Constant 0, constant 1	x
M – Markers	x
RN - Input bit via NET	x
SN - Output bit via NET (send)	x
N - Net marker bit	x
nN - NET marker bit NET station n	x
ID: Diagnostic alarm	x
LE - Output backlight	x
P buttons	x
I - Bit input	x
Q - Bit output	x
Q - Bit output of a FB	x

Function block outputs

	Description	Note
(Bit)		
Q1	1: if the on condition is fulfilled.	Can be used to directly connect an output that implements the configured switching times

Assigning operands

You can assign the following operands to the function block outputs that are numeric outputs:

Assigning operands	Outputs
Constant	x
Markers: MB, MD, MW	x
Analog inputs IA	x
Analog output QA	x
Numeric output from another QV FB	x

You can assign the following operands to the function block outputs that are bit outputs:

Assigning operands	Bit outputs
Constant 0, constant 1	x
M – Markers	x
SN - Output bit via NET (send)	x
N - Network marker bit	x
nN - NET station n marker	x
LE - Output backlight	x
Q - Bit output from another FB	x

Parameter set

Parameter set	Description	Note
☑ Function block release by EN is necessary	If this checkbox is enabled, the state of function block input EN will be evaluated. If the checkbox is disabled instead, the function block will be enabled and function block input EN will not do anything.	This parameter ensures that when existing programs are copied, the functionality of the function blocks that are carried over will be retained. The parameter will be automatically set to 0 or 1 depending on the function block.
Channel A - D	A maximum of eight channels can be configured (all eight channels will act on output Q1). There is an ON time and an OFF time that are accurate to the day for each channel.	
Parameter display + Call enabled	Function block parameters and constants can be edited on the device.	
Simulation possible		

Parameterization

If you select the function block in the easySoft 7 Programming view by clicking on it, a table with the various parameters will appear under the tab.

Active	Channel	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Time	Status Q1	Parameter display
☑	A	√	√	√	√	√			12:00	ON	- Call disabled
☑	B	√	√	√	√	√			18:00	OFF	- Call disabled
☐	C								--:--	---	---
☐	D								--:--	---	---
☐	E								--:--	---	---
☐	F								--:--	---	---
☐	G								--:--	---	---
☐	H								--:--	---	---

Figure 130: Weekly timer (new) parameters tab with an example

If + Call enabled is selected for the function block under *Function block diagram/Parameters/*, it will be possible to change the switching times in the PARAMETER menu on the device while in RUN / STOP mode.

Channels A through H are available for an ON or OFF switching operation. The time to be entered must be between 00:00 and 23:59.

In the example, the ON time on business days is 12:00, and the OFF time is 18:00. A channel is required for each switching action. Channel A switches on every day of the week at 17:30, while channel B switches off at 20:00.

See also

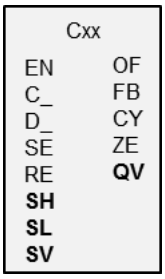
→ Section "HW - Weekly timer (Hour Week)", page 168
→ Section "HY - Year time switch (Hora Year)", page 178
→ Section "OT - Operating hours counter ", page 188
→ Section "RC - Real-time clock", page 192
→ Section "T - Timing relay", page 195
→ Section "YT - Year time switch (Year Table)", page 209

6.1.2 Counter function blocks

6.1.2.1 C - Counter relay

General

easyE4 base devices provide 32 counter relays, C01 through C32. Each counter relay can count up and down and functions as a double word counter.



Operating principle

You can enter upper and lower threshold values as reference values. The corresponding function block outputs will switch based on the determined actual value. You can set a starting value using input SV.

The counter relays C01…C32 are cycle time dependent.

The following applies to the EDP programming language:
The time for a single count pulse must be longer than twice the cycle time. For shorter pulses, use the CH high-speed counter function block.

NOTICE
Avoid unforeseeable switching states.
Switch C, CF, CH, CI function blocks only at one single point in the program.
Otherwise, previous counts will be overwritten.

The function block and its parameters

Function block inputs

	Description	Note
(Bit)		
EN	1: Activates the function block.	The checkbox for the ☑ Function block release by EN is necessary parameter must first be enabled
C_	Counter input, counts with every rising edge	
D_	Count direction 0: up counting 1: down counting	
SE	The starting value at SV is applied whenever there is a rising edge at this input	
RE	Reset 1: QV=0	Reset the counter to zero
(DWord)		
SH	Upper Threshold Value	Integer value range: -2,147,483,648 to +2,147,483,647
SL	Lower threshold value	
SV	Start value (Pre Set)	When there is a rising edge at SE, this value will be applied as the counter value. Integer value range: -2,147,483,648 to +2,147,483,647

Assigning operands

You can assign the following operands to the function block inputs that are numeric inputs.

Operands	Value inputs
Constant, timer constant	x
MD, MW, MB - Markers	x
NB, NW, ND - NET markers	x
nNB, nND, nND- NET markers NET stations n	x
IA - Analog input	x
QA - Analog output	x
QV - QV - Numeric output of a FB	x

You can assign the following operands to the function block inputs that are bit inputs:

Operands	Bit inputs
Constant 0, constant 1	x
M – Markers	x
RN - Input bit via NET	x
SN - Output bit via NET (send)	x

Operands	Bit inputs
N - Net marker bit	x
nN - NET marker bit NET station n	x
ID: Diagnostic alarm	x
LE - Output backlight	x
P buttons	x
I - Bit input	x
Q - Bit output	x
Q - Bit output of a FB	x

Function block outputs

	Description	Note
(Bit)		
OF	Overflow 1: if QV ≥ SH	OF=1, if the actual value QV is greater than or equal to the upper threshold value;
FB	Fall below 1: if QV ≤ SL	FB=1, if the actual value QV is less than or equal to the lower threshold value;
CY	Carry 1: if QV > value range	If the value range is exceeded, the switch contact switches to status 1 for one cycle per rising edge detected. The function block retains the value of the last valid operation before the contact CY is set.
ZE	Zero 1: if QV = 0	
(DWord)		
QV	Current counter value in RUN mode	Integer value range: -2,147,483,648 to +2,147,483,647

Assigning operands

You can assign the following operands to the function block outputs that are numeric outputs:

Assigning operands	Outputs
Constant	x
Markers: MB, MD, MW	x
Analog inputs IA	x
Analog output QA	x
Numeric output from another QV FB	x

You can assign the following operands to the function block outputs that are bit outputs:

Assigning operands	Bit outputs
Constant 0, constant 1	x
M – Markers	x

Assigning operands	Bit outputs
SN - Output bit via NET (send)	x
N - Network marker bit	x
nN - NET station n marker	x
LE - Output backlight	x
Q - Bit output from another FB	x

Parameter set

	Description	Note
Parameter set		
☑ Function block release by EN is necessary	If this checkbox is enabled, the state of function block input EN will be evaluated. If the checkbox is disabled instead, the function block will be enabled and function block input EN will not do anything.	This parameter ensures that when existing programs are copied, the functionality of the function blocks that are carried over will be retained. The parameter will be automatically set to 0 or 1 depending on the function block.
Parameter display + Call enabled	Function block parameters and constants can be edited on the device.	
Simulation possible		

Other

Signal diagrams

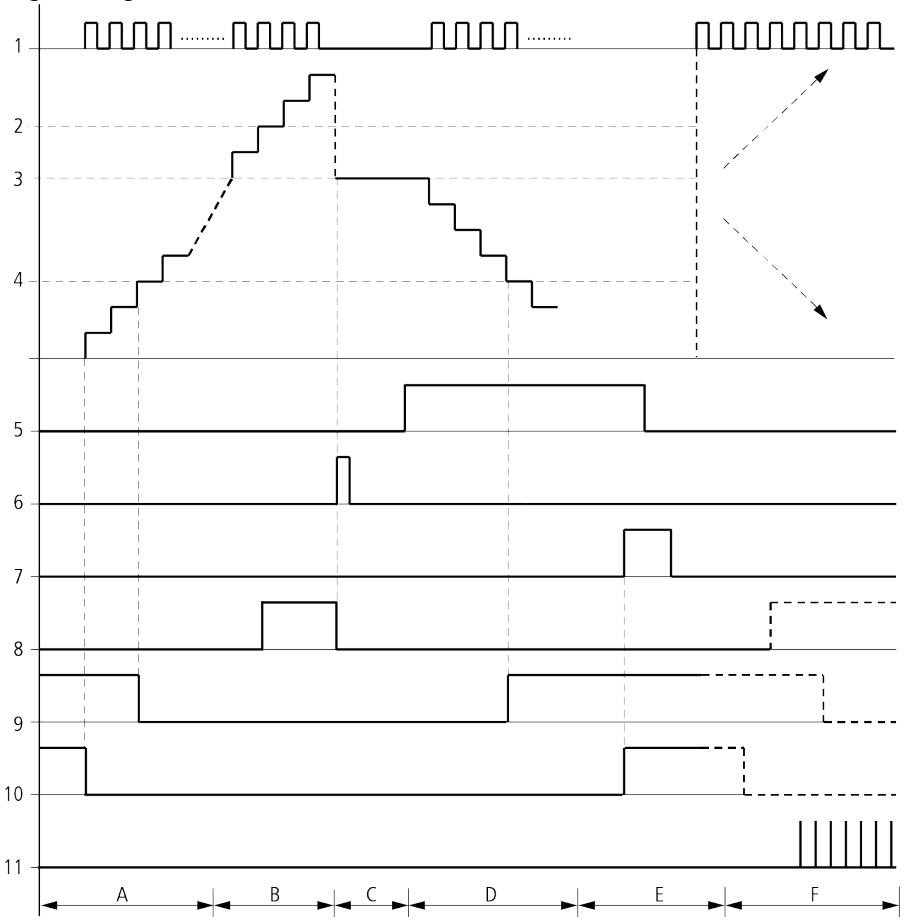


Figure 131: Signal diagram of counter relay

Legend for Figure

1: Counter input C..C_

2: Upper threshold value SH

3: Start value SV

4: Lower threshold value SL.

5: Counting direction, coil C..D

6: Transfer start value, coil C..SE.

7: Reset coil C..RE

8: Contact (N/O) C..OF: Upper limit threshold reached or exceeded.

9: Contact (N/O) C..FB: Lower threshold value reached or undershot.

10: C..ZE = 1, if actual value is zero

11: C..CY = 1, if the value is out of range.

• Range A:

– The counter range has the value zero.

– The contacts C..ZE (actual value equal to zero) and C..FB (lower threshold value undershot) are active.

– The counter receives pulses and increases the actual value.

– C..ZE drops out as well as C..FB after the lower threshold value is reached.

• Range B:

– The counter relay counts upwards and reaches the upper threshold 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 start value.

The contacts go to the respective position.

• Range D:

– The counting direction coil C..D_ is actuated. If counting pulses are present, downward counting is initiated.

If the lower threshold value is undershot, the contact C..FB becomes active.

• Range E:

– The reset coil C..RE is activated. The actual value will be set to zero.

– The contact C..ZE is active.

• Range F:

– The actual value goes outside the value range of the counter relay.

– The contacts OF, FB, ZE become active according to the direction of the values (positive or negative).

Retention

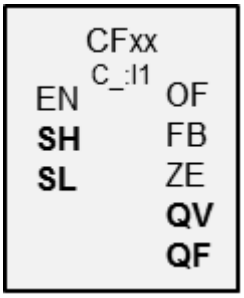
Counter relays can be operated with retentive actual values. You can select the number of retentive counter relays in *Project view/System settings tab*, please refer to System settings tab. The retentive ACTUAL value will require 4 bytes of memory space. If a counter relay is retentive, the actual value will be retained when the operating mode switches from RUN to STOP and when the power supply is switched off. If the device is started in RUN mode, the counter relay will continue to work with the non-volatile actual value.

See also

→ Section "CF - Frequency counter", page 224
→ Section "CH - High-speed counter", page 230
→ Section "CI - Incremental counter", page 237
→ Section "Timing and counter relay example", page 454

6.1.2.2 CF - Frequency counter

easyE4 base devices provide 4 frequency counters CF01…CF04. These high-speed frequency counters are internally connected with the digital inputs I01…I04 and operate independently of the cycle time. The contacts will switch according to the actual value.



Operating principle

For the entire configured measuring interval, the pulses at the input are counted independently of the cycle time and are then used to determine the frequency. The number of pulses counted within the measuring interval is then provided as a value at function block output QV. Finally, as a result, output QF delivers a value equal to ten times the frequency so that the measurement can be accurate to the decimal place despite the fact that the value range is of type integer.

This means that the frequency is the value at QF multiplied by 0.1.

F= QF*0,1

The CF01…CF04 frequency counters are not dependent on the cycle time.

The minimum counter frequency is 4 Hz.

The maximum counter frequency is 5 kHz.

Only square wave signals are permissible.

The mark-to-space ratio is 1:1.

The counter wiring must observe the following digital input assignment:

- I01 counter input for frequency counter CF01
- I02 counter input for counter CF02
- I03 counter input for counter CF03
- I04 counter input for counter CF04

NOTICE

Avoid unforeseeable switching states.

Switch C, CF, CH, CI function blocks only at one single point in the program.

Otherwise, previous counts will be overwritten.

The function block and its parameters

Function block inputs

	Description	Note
(Bit)		
EN	1: Activates the function block.	The checkbox for the ☑ Function block release by EN is necessary parameter must first be enabled
(DWord)		**(DWord)**
SH	Upper Threshold Value	Integer value range: -2,147,483,648 to +2,147,483,647
SL	Lower threshold value	

Assigning operands

You can assign the following operands to the function block inputs that are numeric inputs.

Operands	Value inputs
Constant, timer constant	x
MD, MW, MB - Markers	x
NB, NW, ND - NET markers	x
nNB, nND, nND- NET markers NET stations n	x
IA - Analog input	x
QA - Analog output	x
QV - QV - Numeric output of a FB	x

You can assign the following operands to the function block inputs that are bit inputs:

Operands	Bit inputs
Constant 0, constant 1	x
M – Markers	x
RN - Input bit via NET	x
SN - Output bit via NET (send)	x
N - Net marker bit	x
nN - NET marker bit NET station n	x
ID: Diagnostic alarm	x
LE - Output backlight	x
P buttons	x
I - Bit input	x
Q - Bit output	x
Q - Bit output of a FB	x

Function block outputs

	Description	Note
(Bit)		
OF	Overflow 1: if QV ≥ SH	
FB	Fall Below 1: if QV ≤ SL	
ZE	Zero 1: if QV = 0	
(DWord)		
QV	QV outputs the number of pulses detected per measuring interval	The function block operates in the integer value range from 0…50 000.
QF	QF outputs the measured frequency*10.	The function block operates in the integer value range from 4…50 000. The following formula applies: 10 000 = 1 kHz. The measurable frequency range is 0.4…5000 Hz.

Assigning operands

You can assign the following operands to the function block outputs that are numeric outputs:

Assigning operands	Outputs
Constant	x
Markers: MB, MD, MW	x
Analog inputs IA	x
Analog output QA	x
Numeric output from another QV FB	x

You can assign the following operands to the function block outputs that are bit outputs:

Assigning operands	Bit outputs
Constant 0, constant 1	x
M – Markers	x
SN - Output bit via NET (send)	x
N - Network marker bit	x
nN - NET station n marker	x
LE - Output backlight	x
Q - Bit output from another FB	x

Example with CF01 with 50 Hz at the input

There is a square wave signal with a frequency of 50 Hz at device input I01. Outputs QV and QF of function block CF01 will have the following values depending on the chosen measuring interval:

Measuring interval	QV	QF	f an I01
0.1s	5	500	50 Hz
0.5s	25	500	50 Hz
1.0s	50	500	50 Hz
2.0s	100	500	50 Hz
5.0s	250	500	50 Hz
10.0s	500	500	50 Hz

Parameter set

	Description	Note
☑ Function block release by EN is necessary	If this checkbox is enabled, the state of function block input EN will be evaluated. If the checkbox is disabled instead, the function block will be enabled and function block input EN will not do anything.	This parameter ensures that when existing programs are copied, the functionality of the function blocks that are carried over will be retained. The parameter will be automatically set to 0 or 1 depending on the function block.
Parameter display + Call enabled	Function block parameters and constants can be edited on the device.	
Measuring interval	Measuring interval / Maximum value at QV 0.1s — 500 0.5s — 2 500 1.0s — 5 000 2.0s — 10 000 5.0s — 25 000 10.0s — 50 000	The longer the measuring interval, the smaller the frequency being measured can be.
Simulation possible		

Other

Signal diagram

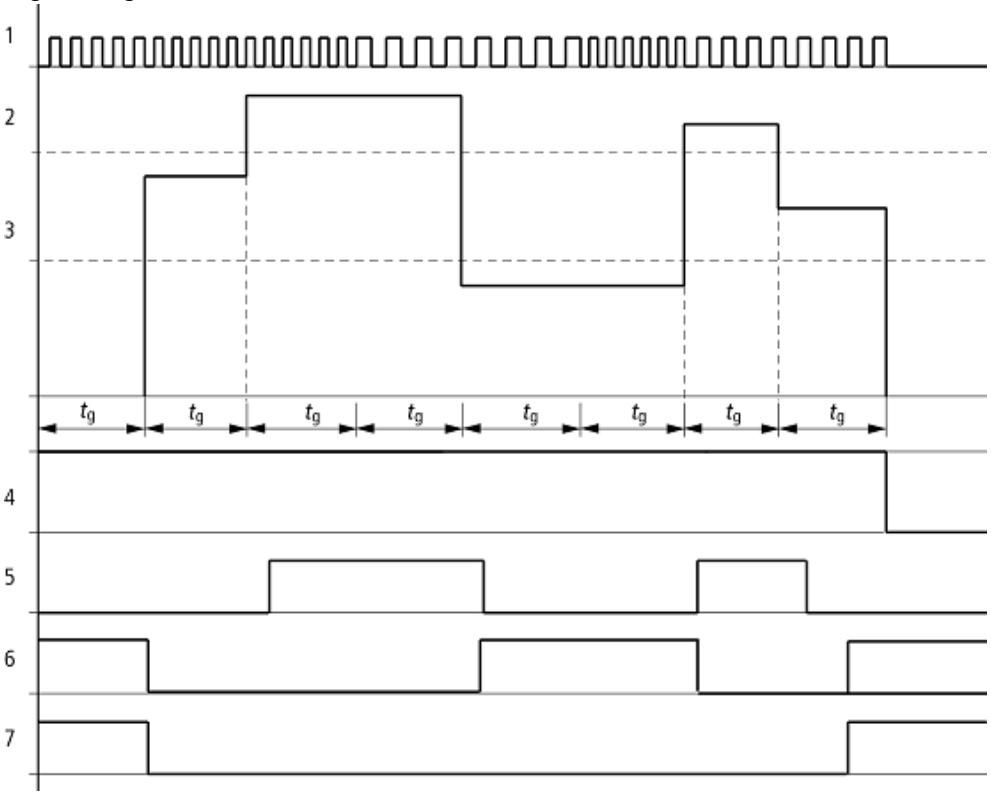


Figure 132: Signal diagram of frequency counter

1: One of the device inputs I01 to I04

2: Upper threshold value SH

3: Lower threshold value SL

4: Enable CF..EN

5: Contact (N/O) CF..OF: Upper threshold value exceeded

6: Contact (N/O) CF..FB: Lower threshold value undershot.

7: Actual value equal to zero CF..ZE

8. tg: gate time (= measuring interval) 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.

Retention

The frequency counter does not have any retentive actual values since the frequency is continuously remeasured.

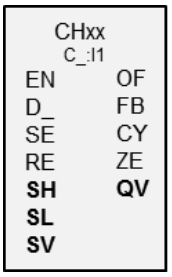
See also

→ Section "CF - Frequency counter", page 224
→ Section "CH - High-speed counter", page 230
→ Section "CI - Incremental counter", page 237
→ Section "Timing and counter relay example", page 454

6.1.2.3 CH - High-speed counter

General

easyE4 base devices provide 4 high-speed counters CH01…CH 04.
The high-speed up and down counters are internally hard-wired with the digital inputs I01...I04 and operate independently of the cycle time.



Operating principle

The contacts will switch according to the actual value. The appropriate function block outputs switch according to the actual value determined. The counter relays enable a preset start value to be defined at the SV input.

Only square wave signals are permissible.

The mark-to-space ratio is 1:1.

The counter wiring must observe the following digital input assignment:

- I01 Counter input for the CH01 counter relay
- I02 counter input for CH02 counter relay
- I03 counter input for CH03 counter relay
- I04 counter input for CH04 counter relay

NOTICE
Avoid unforeseeable switching states.
Switch C, CF, CH, CI function blocks only at one single point in the program.
Otherwise, previous counts will be overwritten.

The function block and its parameters

Function block inputs

	Description	Note
(Bit)		
EN	1: Activates the function block.	The checkbox for the ☑ Function block release by EN is necessary parameter must first be enabled
D_	Count direction 0: up counting 1: down counting	
SE	The starting value at SV is applied whenever there is a rising edge at this input	
RE	Reset 1: QV=0	
(DWord)		
SH	Upper Threshold Value	Integer value range: -2,147,483,648 to +2,147,483,647
SL	Lower threshold value	
SV	Start value (Pre Set)	

Assigning operands

You can assign the following operands to the function block inputs that are numeric inputs.

Operands	Value inputs
Constant, timer constant	x
MD, MW, MB - Markers	x
NB, NW, ND - NET markers	x
nNB, nND, nND- NET markers NET stations n	x
IA - Analog input	x
QA - Analog output	x
QV - QV - Numeric output of a FB	x

You can assign the following operands to the function block inputs that are bit inputs:

Operands	Bit inputs
Constant 0, constant 1	x
M – Markers	x
RN - Input bit via NET	x
SN - Output bit via NET (send)	x
N - Net marker bit	x
nN - NET marker bit NET station n	x
ID: Diagnostic alarm	x

Operands	Bit inputs
LE - Output backlight	x
P buttons	x
I - Bit input	x
Q - Bit output	x
Q - Bit output of a FB	x

Function block outputs

	Description	Note
(Bit)		
OF	Overflow 1: if QV ≥ SH	OF=1, if the actual value is greater than or equal to the upper threshold value;
FB	Fall below 1: if QV ≤ SL	FB=1, if the actual value is less than or equal to the lower threshold value;
CY	Carry 1: if QV > value range	If the value range is exceeded, the switch contact switches to status 1 for one cycle per rising edge detected. The function block retains the value of the last valid operation before the contact CY is set.
ZE	Zero 1: if QV = 0	
(DWord)		
QV	Current counter value in RUN mode	Integer value range: -2,147,483,648 to +2,147,483,647

Assigning operands

You can assign the following operands to the function block outputs that are numeric outputs:

Assigning operands	Outputs
Constant	x
Markers: MB, MD, MW	x
Analog inputs IA	x
Analog output QA	x
Numeric output from another QV FB	x

You can assign the following operands to the function block outputs that are bit outputs:

Assigning operands	Bit outputs
Constant 0, constant 1	x
M – Markers	x

Assigning operands	Bit outputs
SN - Output bit via NET (send)	x
N - Network marker bit	x
nN - NET station n marker	x
LE - Output backlight	x
Q - Bit output from another FB	x

Parameter set

	Description	Note
Parameter set		
☑ Function block release by EN is necessary	If this checkbox is enabled, the state of function block input EN will be evaluated. If the checkbox is disabled instead, the function block will be enabled and function block input EN will not do anything.	This parameter ensures that when existing programs are copied, the functionality of the function blocks that are carried over will be retained. The parameter will be automatically set to 0 or 1 depending on the function block.
Parameter display + Call enabled	Function block parameters and constants can be edited on the device.	
Simulation possible		

Other

Signal diagram

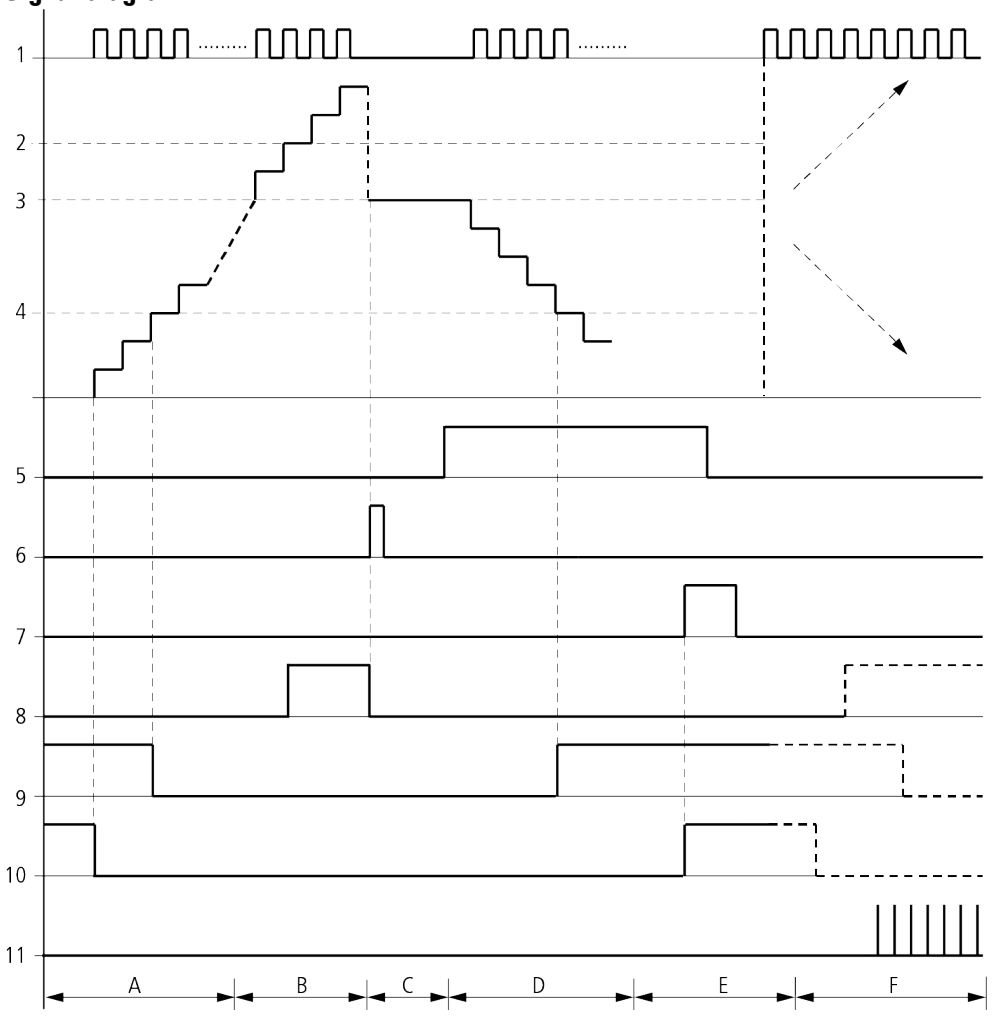


Figure 133: Signal diagram High-speed counter

Legend for Figure

1: One of the I01 through I04 device inputs

2: Upper threshold value SH.

3: Start value SV.

4: Lower threshold value SL.

5: Count direction, coil CH…D

6: Transfer start value, coil CH..SE.

7: Reset coil CH…RE

8: Contact (N/O) CH..OF: Upper limit threshold reached or exceeded.

9: Contact (N/O) CH..FB: Lower threshold value reached or undershot.

10: CH..ZE = 1, if actual value is zero.

11: CH..CY = 1, if the value is out of range

• Range A:

– The counter range has the value zero.

– The contacts CH..ZE (actual value equal to zero) and CH..FB (lower threshold value undershot) are active.

– The counter receives pulses and increases the actual value.

– CH..ZE drops out as well as CH..FB after the lower threshold value is reached.

• Range B:

– The counter relay counts upwards and reaches the upper threshold value.

The contact “upper threshold value” CH…OF becomes active.

• Range C:

– The coil CH..SE is briefly actuated and the actual value is set to the start value.

The contacts go to the respective position.

• Range D:

– The counting direction coil CH..D_ is actuated. If counting pulses are present, downward counting is initiated.

– If the lower threshold value is undershot, the contact CH..FB becomes active.

• Range E:

– The reset coil CH..RE is activated. The actual value will be set to zero.

– The contact CH…ZE is active.

• Range F:

– The actual value goes outside the value range of the counter relay.

– The contacts OF, FB, ZE become active according to the direction of the values (positive or negative).

Retention

Counter relays can be operated with retentive actual values. You can select the number of retentive counter relays in *Project view/System settings tab*, please refer to System settings tab. The retentive ACTUAL value will require 4 bytes of memory space. If a counter relay is retentive, the actual value will be retained when the operating mode switches from RUN to STOP and when the power supply is switched off. If the device is started in RUN mode, the counter relay will continue to work with the non-volatile

actual value.

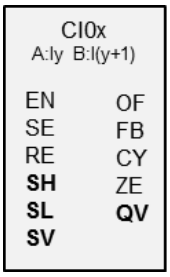
See also

→ "C - Counter relay", page 218
→ "CH - High-speed counter", page 230
→ "CI - Incremental counter", page 237
→ "Timing and counter relay example", page 454

6.1.2.4 CI - Incremental counter

General information

easyE4 base devices provide 2 high-speed incremental encoder counters, CI01 through CI02. The high-speed up and down counters are internally hardwired with the digital inputs I01...I02 or I03...I04 and operate independently of the cycle time.



Operating principle

Incremental counters interpret rising and falling edges in order to identify the count direction. The count will be in the direction of the rising and falling edges.

The counter wiring must observe the following digital device input assignment:

I01 Counter input for the counter CI01 channel A.

I02 Counter input for counter CI01 channel B

I03 Counter input for counter CI02 channel A

I04 Counter input for counter CI02 channel B

The contacts will switch according to the actual value. The appropriate function block outputs switch according to the actual value determined. The counter relays enable a preset start value to be defined at the SV input.

Only square wave signals are permissible.

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.

Positive count direction

If the rising edge at channel A is detected before the rising edge at channel B, the counter will count up. This means that the counter will be incremented by 1 after there is a rising edge at channel A followed by a rising edge at channel B. The same applies to the falling edges in sequence at channel A and channel B. The counter relay's result will be incremented and output at output QV.

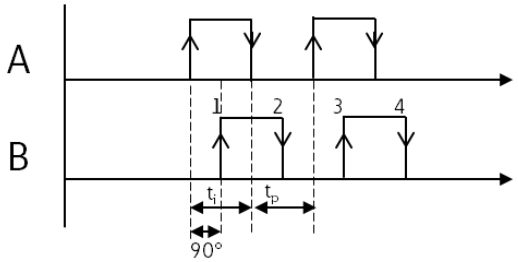


Figure 134: CI function block counting up; QV=QV+4

Negative count direction

If the rising edge at channel B is detected before the rising edge at channel A, the counter will count up. This means that the counter will be decremented by 1 after there is a rising edge at channel A followed by a rising edge at channel B. The counter relay's result will be decremented and output at output QV.

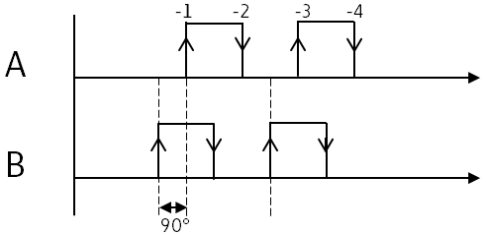


Figure 135: CI function block counting down; QV=QV-4

> *NOTICE*
> Avoid unforeseeable switching states.
> Switch C, CF, CH, CI function blocks only at one single point in the program.
> Otherwise, previous counts will be overwritten.

The function block and its parameters

Function block inputs

	Description	Note
(Bit)		
EN	1: Activates the function block.	The checkbox for the ☑ Function block release by EN is necessary parameter must first be enabled
SE	The starting value at SV is applied whenever there is a rising edge at this input	
RE	Reset 1: QV=0	
(DWord)		
SH	Upper Threshold Value	Integer value range: -2,147,483,648 to +2,147,483,647
SL	Lower threshold value	
SV	Start value (Pre Set)	

Assigning operands

You can assign the following operands to the function block inputs that are numeric inputs.

Operands	Value inputs
Constant, timer constant	x
MD, MW, MB - Markers	x

Operands	Value inputs
NB, NW, ND - NET markers	x
nNB, nND, nND- NET markers NET stations n	x
IA - Analog input	x
QA - Analog output	x
QV - QV - Numeric output of a FB	x

You can assign the following operands to the function block inputs that are bit inputs:

Operands	Bit inputs
Constant 0, constant 1	x
M – Markers	x
RN - Input bit via NET	x
SN - Output bit via NET (send)	x
N - Net marker bit	x
nN - NET marker bit NET station n	x
ID: Diagnostic alarm	x
LE - Output backlight	x
P buttons	x
I - Bit input	x
Q - Bit output	x
Q - Bit output of a FB	x

Function block outputs

	Description	Note
(Bit)		
OF	Overflow 1: if QV ≥ SH	OF=1, if the actual value is greater than or equal to the upper threshold value;
FB	Fall below 1: if QV ≤ SL	FB=1, if the actual value is less than or equal to the lower threshold value;
CY	Carry 1: if QV > value range	If the value range is exceeded, the switch contact switches to status 1 for one cycle per rising edge detected. The function block retains the value of the last valid operation before the contact CY is set.
ZE	Zero 1: if QV = 0	
(DWord)		
QV	Current counter value in RUN mode	The pulses at channel A and channel B are counted. 2 pulses are counted per counting period. Example: 2 pulses at channel A

	Description	Note
		and 2 pulses at channel B; value at CI..QV = 4

Assigning operands

You can assign the following operands to the function block outputs that are numeric outputs:

Assigning operands	Outputs
Constant	x
Markers: MB, MD, MW	x
Analog inputs IA	x
Analog output QA	x
Numeric output from another QV FB	x

You can assign the following operands to the function block outputs that are bit outputs:

Assigning operands	Bit outputs
Constant 0, constant 1	x
M – Markers	x
SN - Output bit via NET (send)	x
N - Network marker bit	x
nN - NET station n marker	x
LE - Output backlight	x
Q - Bit output from another FB	x

Parameter set

Parameter set	Description	Note
☑ Function block release by EN is necessary	If this checkbox is enabled, the state of function block input EN will be evaluated. If the checkbox is disabled instead, the function block will be enabled and function block input EN will not do anything.	This parameter ensures that when existing programs are copied, the functionality of the function blocks that are carried over will be retained. The parameter will be automatically set to 0 or 1 depending on the function block.
Parameter display + Call enabled	Function block parameters and constants can be edited on the device.	
Simulation possible		

Other

Signal diagram

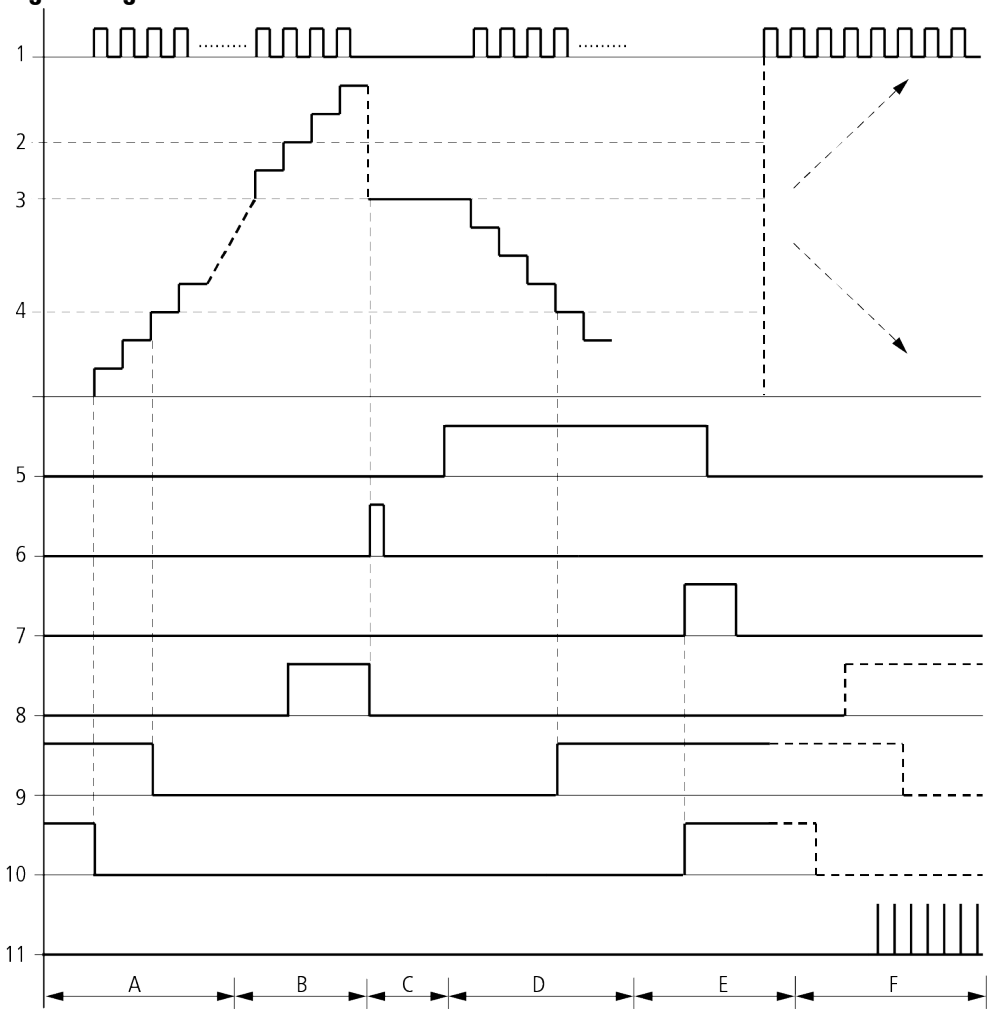


Figure 136: Signal diagram High-speed incremental value counter

Legend for Figure

1: One of the I01 through I04 device inputs

2: Upper threshold value SH

3: Start value SV

4: Lower threshold value SL

5: Transfer start value, coil CI..SE.

6: Reset coil CI…RE

7: Contact (N/O) CI..OF: Upper limit threshold reached or exceeded.

8: Contact (N/O) CI..FB: Lower threshold value reached or undershot.

9: CI..ZE = 1, if actual value is zero

10: CI..CY = 1, if the value is out of range.

• Range A:

– The counter range has the value zero.

– The contacts CI..ZE (actual value equal to zero) and CI..FB (lower threshold value undershot) are active.

– The counter relay receives pulses at I01 and I02 or at I03 and I04 and increments the actual value.

– CI..ZE drops out as well as CI..FB after the lower threshold value is reached.

• Range B:

– The counter relay counts upwards and reaches the upper threshold value.

The “upper setpoint value reached” contact CI..OF becomes active.

• Range C:

– The coil CI..SE is briefly actuated and the actual value is set to the start value.

The contacts go to the respective position.

• Range D:

– The counter relay receives pulses at I02 or I04 and decrements the actual value. The function block counts down.

– If the lower threshold value is undershot, the contact CI..FB becomes active.

• Range E:

– The reset coil CI..RE is activated. The actual value will be set to zero.

– The contact CI..ZE is active.

• Range F:

– The actual value goes outside the value range of the counter relay.

– The contacts OF, FB, ZE become active according to the direction of the values (positive or negative).

Retention

Counter relays can be operated with retentive actual values. You can select the number of retentive counter relays in *Project view/System settings tab*, please refer to System settings tab. The retentive ACTUAL value will require 4 bytes of memory space. If a counter relay is retentive, the actual value will be retained when the operating mode switches from RUN to STOP and when the power supply is switched off. If the device is started in RUN mode, the counter relay will continue to work with the non-volatile actual value.

See also

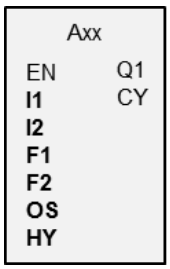
→ Section "CI - Incremental counter", page 237
→ Section "CF - Frequency counter", page 224
→ Section "CH - High-speed counter", page 230
→ Section "Timing and counter relay example", page 454

6.1.3 Arithmetic and analog function blocks

6.1.3.1 A - Analog value comparator

General

easyE4 base devices provide 32 analog comparators, A01 through A32.
Analog comparators can be used to compare analog input values with a reference value.



Operating principle

The following comparisons are available:
Function block input I1 greater than, equal to, or less than function block input I2.

Using the factors F1 and F2 as inputs enables you to amplify and adjust the values of the function block inputs.

Function block input OS can be used as an offset for input I1.

The HY function block input is used for the positive and negative switching hysteresis of the input I2.

The contact Q1 switches if the condition of the comparison mode you have selected is fulfilled.

The function block and its parameters

Function block inputs

	Description	Note
(Bit)		
EN	1: Activates the function block.	The check-box for the ☑ Function block release by EN is necessary parameter must first be enabled
(DWord)		
I1	Comparison value 1	Integer value range: -2,147,483,648 to +2,147,483,647
I2	Comparison value 2	
F1	Gain factor for I1 (I1 = F1 * value) Default value = 1	
F2	Gain factor for I2 (I2 = F2 * value) Default value = 1	
OS	Offset for the value at I1, $I1_{OS}$ = OS + actual value at I1;	
HY	Switching hysteresis for value at I2. To calculate the hysteresis band (dead band) limited by the upper and lower hysteresis threshold), the function block takes into account the value HY as well as positive and negative components. $I2_{HY}$ = Actual value at I2+ HY, $I2_{HY}$ = Actual value at I2 - HY);	

Assigning operands

You can assign the following operands to the function block inputs that are numeric inputs.

Operands	Value inputs
Constant, timer constant	x
MD, MW, MB - Markers	x
NB, NW, ND - NET markers	x
nNB, nND, nND- NET markers NET stations n	x
IA - Analog input	x
QA - Analog output	x
QV - QV - Numeric output of a FB	x

You can assign the following operands to the function block inputs that are bit inputs:

Operands	Bit inputs
Constant 0, constant 1	x
M – Markers	x
RN - Input bit via NET	x
SN - Output bit via NET (send)	x
N - Net marker bit	x
nN - NET marker bit NET station n	x
ID: Diagnostic alarm	x
LE - Output backlight	x
P buttons	x
I - Bit input	x
Q - Bit output	x
Q - Bit output of a FB	x

Operating modes

	Description	Note
LT: less than (I1 < I2)	Less than (I1 < I2)	
EQ: equal to (I1 = I2)	Equal to (I1 = I2)	
GT: greater than (I1 > I2)	Greater than (I1 > I2)	

Function block outputs

	Description	Note
(Bit)		
Q1	Status 1 if condition is fulfilled (e.g. I1 < I2 with LT mode active)	
CY	$-2^{31} \le I1 * F1 + OS \le (2^{31} - 1) \Rightarrow CY = 0$ $-2^{31} \le I2 * F2 + HY \le (2^{31} - 1) \Rightarrow CY = 0$ $-2^{31} \le I2 * F2 - HY \le (2^{31} - 1) \Rightarrow CY = 0$ Status 1 if the above permissible value range of the function block is exceeded.	If an out of range value is indicated with CY = 1, Q1 will remain 0.

Assigning operands

You can assign the following operands to the function block outputs that are numeric outputs:

Assigning operands	Outputs
Constant	x
Markers: MB, MD, MW	x
Analog inputs IA	x
Analog output QA	x
Numeric output from another QV FB	x

You can assign the following operands to the function block outputs that are bit outputs:

Assigning operands	Bit outputs
Constant 0, constant 1	x
M – Markers	x
SN - Output bit via NET (send)	x
N - Network marker bit	x
nN - NET station n marker	x
LE - Output backlight	x
Q - Bit output from another FB	x

Parameter set

	Description	Note
☑ Function block release by EN is necessary	If this checkbox is enabled, the state of function block input EN will be evaluated. If the checkbox is disabled instead, the function block will be enabled and function block input EN will not do anything.	This parameter ensures that when existing programs are copied, the functionality of the function blocks that are carried over will be retained. The parameter will be automatically set to 0 or 1 depending on the function block.
Parameter display + Call enabled	Function block parameters and constants can be edited on the device.	
Simulation possible		

Other

Signal diagrams

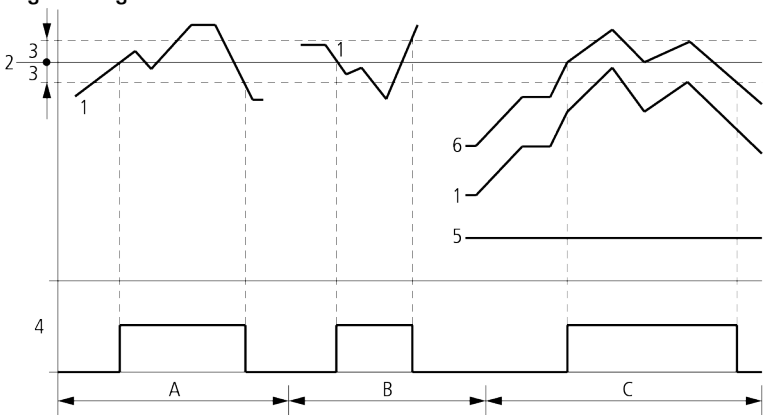


Figure 137: Analog comparator signal diagram

Legend for Figure

1: Actual value at I1

2: Setpoint value on I2

3: Hysteresis on HY

4: Switching contact Q1 (N/O contact)

5: Offset for value I1

6: Actual value plus offset

• Range A: Compare I1 greater than I2

– The actual value I1 increases.

– The contact switches when the actual reaches the setpoint value.

– The actual value changes and falls below the value of the setpoint value minus the hysteresis.

– The contact goes to the normal position.

• Range B: Compare I1 less than 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 I1 with Offset greater than I2

– This example behaves as described in Range A. The offset value is added to the actual value.

– Compare I1 equal to I2 The contact switches on.

– If I1 is equal to I2, i.e., if the actual value is equal to the reference value: The contact will switch off.

– If the hysteresis limit is exceeded with the actual value rising.

– If the hysteresis limit is undershot with the actual value decreasing.

• Range D: I1 with offset leaves the permissible value range. The contact CY closes. CY opens as soon as I1 with offset is once more within the value range.

Retention

The function block does not recognize retentive data.

Example of an analog comparator when using the EDP programming language

```
I01----A01Q1-----------------[ Q01
I02----A01CY-----------------S Q02
```

Example of an AR configuration on a device display

When using the function block in the circuit diagram for the first time, use OK to automatically enter the display of function blocks on the device display, as shown in the following figure.

```
A02 GT +
>I1
>F1
>I2
>F2
>OS
>HY
```

Figure 138: Parameters on the display

Enter the function block settings here. The display contains the following elements:

A02	Function block: Analog comparator, number 02
GT	Operating mode: Greater than
+	Parameter set can be called via the PARAMETERS menu
>I1	Comparison value 1, is compared with the comparison value 2 at >I2, Value range: -2147483648… +2147483647
>F1	Gain factor for >I1 (>I1 = >F1. Value) Value range: -2147483648… +2147483647
>I2	Comparison value 2 I1, Value range: -2147483648… +2147483647
>F2	Gain factor for >I2 (>I2 = >F2. Value) Value range: -2147483648 … +2147483647
>OS	Offset (zero point offset) for the value of >I1 Value range: -2147483648… +2147483647
>HY	Positive and negative switching hysteresis for comparison value I2, Value range: -2147483648… +2147483647

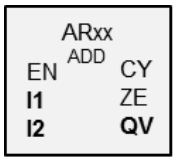
See also

→ Section "AR - Arithmetic", page 250
→ Section "CP – Comparator", page 255
→ Section "LS - Value scaling", page 259
→ Section "MM - Min-/Max function", page 264
→ Section "PW - Pulse width modulation", page 267

6.1.3.2 AR - Arithmetic

General

easyE4 base devices provide 32 arithmetic function blocks, AR01 through AR32. These function blocks can be used to carry out the four basic arithmetic operations: addition, subtraction, multiplication, and division.



Operating principle

The function block will apply the selected arithmetic operation to the values at function block inputs I1 and I2. If the calculation result exceeds the value range that can be represented, overflow signal contact CY will close and function block output QV will contain the value of the last valid operation. When the function block is called for the first time, the value at function block output QV will equal zero.

The function block and its parameters

Function block inputs

	Description	Note
(Bit)		
EN	1: Activates the function block.	The checkbox for the ☑ Function block release by EN is necessary parameter must first be enabled
(DWord)		
I1	Operand 1	Integer value range: -2,147,483,648 to +2,147,483,647
I2	Operand 2	

Assigning operands

You can assign the following operands to the function block inputs that are numeric inputs.

Operands	Value inputs
Constant, timer constant	x
MD, MW, MB - Markers	x
NB, NW, ND - NET markers	x
nNB, nND, nND- NET markers NET stations n	x
IA - Analog input	x
QA - Analog output	x
QV - QV - Numeric output of a FB	x

You can assign the following operands to the function block inputs that are bit inputs:

Operands	Bit inputs
Constant 0, constant 1	x
M – Markers	x
RN - Input bit via NET	x
SN - Output bit via NET (send)	x
N - Net marker bit	x
nN - NET marker bit NET station n	x
ID: Diagnostic alarm	x
LE - Output backlight	x
P buttons	x
I - Bit input	x
Q - Bit output	x
Q - Bit output of a FB	x

Operating modes

	Description	Note
ADD - Adder	Adding (I1 + I2 = QV)	2174483647 + 1 = QV contains the last permissible value as an overflow has occurred. The carry bit AR..CY is set to 1.
SUB - Subtracter	Subtracting (I1 - I2 = QV)	-2174483648 - 3 = QV contains the last permissible value as an overflow has occurred. The carry bit AR..CY is set to 1.
MUL - Multiplier	Multiplying (I1 * I2 = QV)	1000042 * 2401 = QV contains the last permissible value as an overflow has occurred. The carry bit AR..CY is set to 1.
DIV - Divider	Dividing (I1 : I2 = QV)	1024: 0 = QV contains the last permissible value as an overflow occurred. The carry bit AR..CY is set to 1. 10 : 100 = 0

Function block outputs

	Description	Note
(Bit)		
CY	Status 1 if the above value range is exceeded.	
ZE	Status 1 if the value of the function block output QV (the calculation result) equals zero	
(DWord)		
QV	Current counter value in RUN mode	Integer value range: -2,147,483,648 to +2,147,483,647

Assigning operands

You can assign the following operands to the function block outputs that are numeric outputs:

Assigning operands	Outputs
Constant	x
Markers: MB, MD, MW	x
Analog inputs IA	x
Analog output QA	x
Numeric output from another QV FB	x

You can assign the following operands to the function block outputs that are bit outputs:

Assigning operands	Bit outputs
Constant 0, constant 1	x
M – Markers	x
SN - Output bit via NET (send)	x
N - Network marker bit	x
nN - NET station n marker	x
LE - Output backlight	x
Q - Bit output from another FB	x

Parameter set

	Description	Note
Parameter set		
☑ Function block release by EN is necessary	If this checkbox is enabled, the state of function block input EN will be evaluated. If the checkbox is disabled instead, the function block will be enabled and function block input EN will not do anything.	This parameter ensures that when existing programs are copied, the functionality of the function blocks that are carried over will be retained. The parameter will be automatically set to 0 or 1 depending on the function block.
Parameter display + Call enabled	Function block parameters and constants can be edited on the device.	
Simulation possible		

Addition example

42 + 1000 = 1042

2147483647 + 1 = Last valid value before this arithmetic operation, due to overflow (Carry) AR..CY = 1

-2048 + 1000 = -1048

Subtraction example

1134 - 42 = 1092

-2147483648 - 3 = Last valid value before this arithmetic operation, due to overflow (Carry) AR..CY = 1

-4096 - 1000 = -5096

-4096 - (-1000) = -3096

Multiplication example

12 x 12 = 144

1000042 x 2401 = Last valid value of this arithmetic operation, due to overflow (Carry) correct value = 2401100842 AR..CY = 1

-1000 x 10 = -10000

Division example

1024 : 256 = 4

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

1024 : 0 = Last valid value before this arithmetic operation, due to overflow (Carry) (mathematically correct "Infinity") AR..CY = 1

-1000 : 10 = -100

1000 : (-10) = -100

-1000 : (-10) = 100

10 : 100 = 0

Example of an arithmetic function block when using the EDP programming language

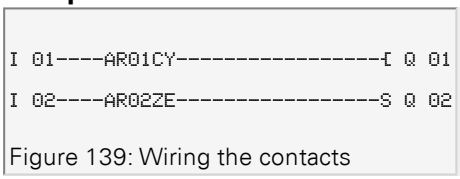


Figure 139: Wiring the contacts

Example of an AR configuration on a device display

When using the function block in the circuit diagram for the first time, use OK to automatically enter the display of function blocks on the device display, as shown in the following figure.

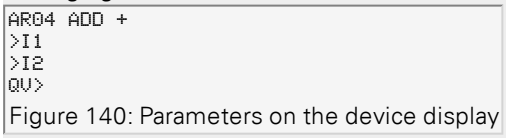


Figure 140: Parameters on the device display

Enter the function block settings here. The display contains the following elements:

AR04 arithmetic function block	Function block:Arithmetic
ADD +	Mode:Adder
+	Parameter set can be called via the PARAMETERS menu
>I1	First value is associated with the value at I2 via the arithmetic operation. Integer value range: -2,147,483,648 to +2,147,483,647

>I2	Second value; Integer value range: -2,147,483,648 to +2,147,483,647
>QV	Supplies the calculation result. Integer value range: -2,147,483,648 to +2,147,483,647

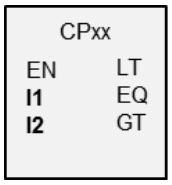
See also

→ Section "AR - Arithmetic", page 250
→ Section "CP – Comparator", page 255
→ Section "LS - Value scaling", page 259
→ Section "MM - Min-/Max function", page 264
→ Section "PW - Pulse width modulation", page 267

6.1.3.3 CP – Comparator

General

easyE4 base devices provide 32 comparator function blocks (Compare) CP01 to CP32.
Comparators are used to compare variables and constants with each other and output the relationship between them: Less than / Equal to / Greater than.



Operating principle

The function block compares values present at the inputs I1 and I2. The following contacts close depending on the comparison result:

- I1 greater than I2, GT contact closes.
- I1 equal to I2, EQ contact closes.
- I1 less than I2, LT contact closes.

The function block and its parameters

Function block inputs

	Description	Note
(Bit)		
EN	1: Activates the function block.	The checkbox for the ☑ Function block release by EN is necessary parameter must first be enabled
(DWord)		
I1	Comparison reference value	Integer value range: -2,147,483,648 to +2,147,483,647
I2	Comparison value	

Assigning operands

You can assign the following operands to the function block inputs that are numeric inputs.

Operands	Value inputs
Constant, timer constant	x
MD, MW, MB - Markers	x
NB, NW, ND - NET markers	x
nNB, nND, nND- NET markers NET stations n	x
IA - Analog input	x
QA - Analog output	x
QV - QV - Numeric output of a FB	x

You can assign the following operands to the function block inputs that are bit inputs:

Operands	Bit inputs
Constant 0, constant 1	x
M – Markers	x
RN - Input bit via NET	x
SN - Output bit via NET (send)	x
N - Net marker bit	x
nN - NET marker bit NET station n	x
ID: Diagnostic alarm	x
LE - Output backlight	x
P buttons	x
I - Bit input	x
Q - Bit output	x
Q - Bit output of a FB	x

Function block outputs

	Description	Note
(Bit)		
LT	Less Than 1: if I1 < I2	
EQ	Equal 1: if I1 = I2	
GT	Greater Than 1: if I1 > I2	

Assigning operands

You can assign the following operands to the function block outputs that are numeric outputs:

Assigning operands	Outputs
Constant	x
Markers: MB, MD, MW	x
Analog inputs IA	x
Analog output QA	x
Numeric output from another QV FB	x

You can assign the following operands to the function block outputs that are bit outputs:

Assigning operands	Bit outputs
Constant 0, constant 1	x
M – Markers	x
SN - Output bit via NET (send)	x
N - Network marker bit	x
nN - NET station n marker	x
LE - Output backlight	x
Q - Bit output from another FB	x

Parameter set

	Description	Note
Parameter set		
☑ Function block release by EN is necessary	If this checkbox is enabled, the state of function block input EN will be evaluated. If the checkbox is disabled instead, the function block will be enabled and function block input EN will not do anything.	This parameter ensures that when existing programs are copied, the functionality of the function blocks that are carried over will be retained. The parameter will be automatically set to 0 or 1 depending on the function block.
Parameter display + Call enabled	Function block parameters and constants can be edited on the device.	
Simulation possible		

Other

Retention

The function block does not recognize retentive data.

Example of a comparator function block when using the EDP programming language

The contact of the function block is sent to markers.

```
CP12LT----------------------[ M 21

CP12LT----------------------[ M 22

CP12GT----------------------┬ R M 21
                            └ R M 22
```

Figure 141: Wiring the contacts

Example of a CP configuration on a device display

When using the function block in the circuit diagram for the first time, use OK to automatically enter the display of function blocks on the device display, as shown in the following figure.

```
CP12 +
>I1
>I2
```

Figure 142: Parameters on the display

Enter the function block settings here. The display contains the following elements:

CP12 comparator	Function block: Value comparator, number 12
+	Parameter set can be called via the PARAMETERS menu
>I1	Reference value to which the comparison is made Integer value range:

	-2,147,483,648 to +2,147,483,647
>I2	Comparison value; I2 is compared with I1 Integer value range: -2,147,483,648 to +2,147,483,647

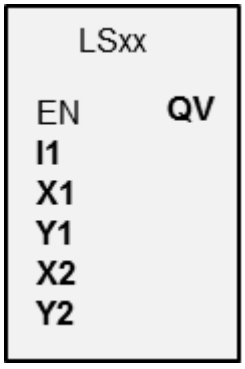
See also

→ Section "CP – Comparator", page 255
→ Section "AR - Arithmetic", page 250
→ Section "LS - Value scaling", page 259
→ Section "MM - Min-/Max function", page 264
→ Section "PW - Pulse width modulation", page 267

6.1.3.4 LS - Value scaling

General

easyE4 base devices provider 32 value scaling function blocks, LS01 through LS32.



These function blocks can be used to transfer values from one value range to another. More specifically, a value scaling function block will take one of the mathematical relationships you have specified and use it to scale the value at input LS..I1 in order to then output it, either as smaller value or larger value, at output LS..QV. The mathematical relationship is based on a straight line defined by the coordinate pairs X1, Y1 and X2, Y2 (see under “The mathematical relationship is:”).
A typical application is the conversion of values, such as 0…20 mA to 4…20 mA. An easy800 device is provided with 32 value scaling function blocks.

Operating principle

"EN = 1" starts the function block.
"EN = 0" initiates a reset in which the output **QV** is reset to 0.

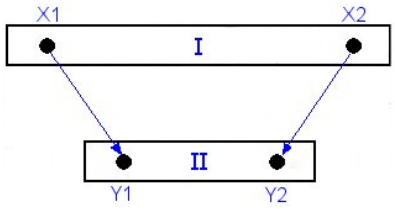


Figure 143: Figure: Scaling the input values - reducing

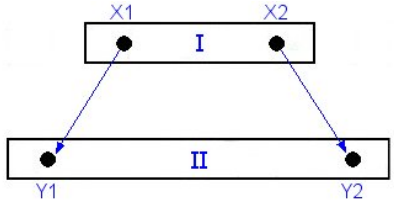


Figure 144: Figure: Scaling the input values - increasing

① Source range
② Destination range

The mathematical relationship is follows:

$$Y = m * X + Y0$$

$$m = \frac{Y2 - Y1}{X2 - X1} \qquad Y0 = \frac{X2 * Y1 - X1 * Y2}{X2 - X1}$$

m = Gradient

Y0 = Y offset when X = 0

X1, Y1 = First value pair

X2, Y2 = Second value pair

g = Straight line with positive gradient

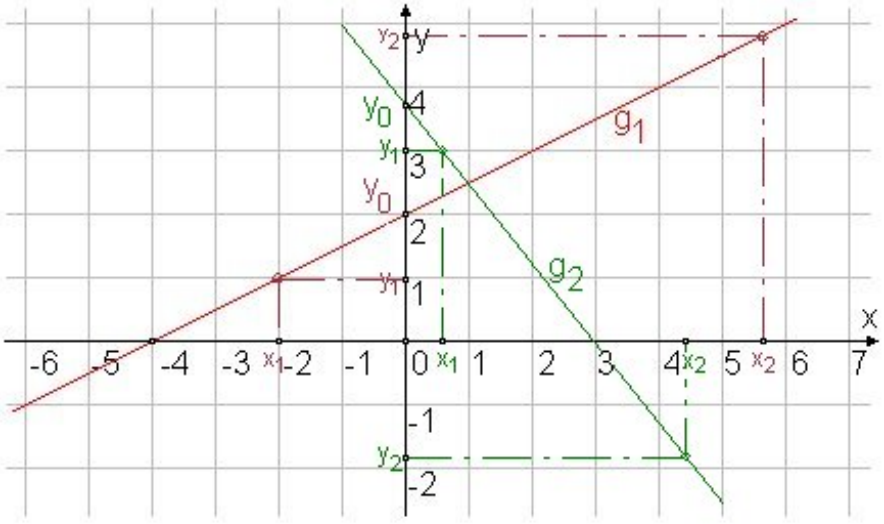


Figure 145: Figure: Mathematical interrelationship

The function block and its parameters

Function block inputs

	Description	Note
(Bit)		
EN	1: Activates the function block.	The checkbox for the ☑ Function block release by EN is necessary parameter must first be enabled
(DWord)		**(DWord)**
I1	Input value, value range: 32-bit	Integer value range: -2,147,483,648 to +2,147,483,647
X1	First scale; data point 1	Value range: 32 bits
Y1	First scale; data point 2	
X2	Second scale; data point 1	
Y2	Second scale; data point 2	

Assigning operands

You can assign the following operands to the function block inputs that are numeric inputs.

Operands	Value inputs
Constant, timer constant	x
MD, MW, MB - Markers	x
NB, NW, ND - NET markers	x
nNB, nND, nND- NET markers NET stations n	x

Operands	Value inputs
IA - Analog input	x
QA - Analog output	x
QV - QV - Numeric output of a FB	x

You can assign the following operands to the function block inputs that are bit inputs:

Operands	Bit inputs
Constant 0, constant 1	x
M – Markers	x
RN - Input bit via NET	x
SN - Output bit via NET (send)	x
N - Net marker bit	x
nN - NET marker bit NET station n	x
ID: Diagnostic alarm	x
LE - Output backlight	x
P buttons	x
I - Bit input	x
Q - Bit output	x
Q - Bit output of a FB	x

Function block outputs

	Description	Note
(DWord)		
QV	Delivers the scaled input value	Integer value range: -2,147,483,648 to +2,147,483,647

Assigning operands

You can assign the following operands to the function block outputs that are numeric outputs:

Assigning operands	Outputs
Constant	x
Markers: MB, MD, MW	x
Analog inputs IA	x
Analog output QA	x
Numeric output from another QV FB	x

You can assign the following operands to the function block outputs that are bit outputs:

Assigning operands	Bit outputs
Constant 0, constant 1	x
M – Markers	x
SN - Output bit via NET (send)	x

Assigning operands	Bit outputs
N - Network marker bit	x
nN - NET station n marker	x
LE - Output backlight	x
Q - Bit output from another FB	x

Parameter set

	Description	Note
☑ Function block release by EN is necessary	If this checkbox is enabled, the state of function block input EN will be evaluated. If the checkbox is disabled instead, the function block will be enabled and function block input EN will not do anything.	This parameter ensures that when existing programs are copied, the functionality of the function blocks that are carried over will be retained. The parameter will be automatically set to 0 or 1 depending on the function block.
Parameter display + Call enabled	Function block parameters and constants can be edited on the device.	
Interrupt source	Used to select device inputs I1 through I8 as a trigger for the interrupt	
Edit interrupt routine	Clicking on the button will open the interrupt routine in the Programming view	
Simulation possible		

Other

Retention

The function block does not recognize retentive data.

Application example LS

An analog pressure sensor I1 in a tank delivers a value ranging from 0 (empty) to 10000 (full). When the cylindrical, upright tank is completely full, it holds 600 liters. The purpose is for the current fill level to be converted to liters. The relationship between the pressure and the fill level, and accordingly the volume as well, is linear, meaning that an LS function block can be used.

The parameters would need to be configured as follows: X1=0, X2= 10000, Y1=0, Y2=600

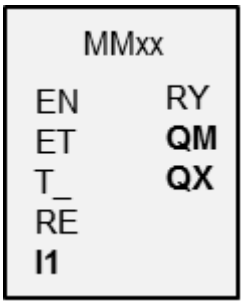
QV will then deliver the fill level in liters.

See also

→ Section "LS - Value scaling", page 259
→ Section "AR - Arithmetic", page 250
→ Section "CP – Comparator", page 255
→ Section "MM - Min-/Max function", page 264
→ Section "PW - Pulse width modulation", page 267

6.1.3.5 MM - Min-/Max function

General



easyE4 base devices provide 32 Min-/Max function blocks, MM01 through MM32.

These function blocks can be used to determine the maximum value and the minimum value of a changing analog value. This makes it, for example, easy to conveniently determine the magnitude of the pressure fluctuations inside a system.

Operating principle

If the function block is enabled, the current value at function block input I1 will be compared with the existing minimum value and maximum value. If the current value falls below or exceeds these values respectively, it will accordingly be set as the new minimum value or maximum value. Only one minimum value and one maximum value will be stored in the function block at any one time.

Both values will be zero when the measurement starts. Moreover, they can be reset to zero using the RE input.

You can run the calculation cyclically or only when there are rising edges at function block input T_. The typical application is monitoring a process value cyclically.

The function block and its parameters

Function block inputs

	Description	Note
(Bit)		
EN	1: Activates the function block.	
ET	Enable trigger 0: Calculates Min/Max every time the function block is called; trigger input T_ is deactivated 1: Calculates Min/Max only when there is a rising edge at T_; trigger input T_ is activated	Typically, an ET = 0 automatic trigger configuration is used
T_	Trigger input Min/Max are calculated when there is a rising edge at T_, provided that ET = 1	The fastest this can be done is every second cycle, since a switch from 0 to 1 is required at T_.
RE	1: Sets the internal Min/Max values to 0	
(DWord)		
I1	Analog value used for the Min/Max comparison	Integer value range: -2,147,483,648 to +2,147,483,647

Assigning operands

You can assign the following operands to the function block inputs that are numeric inputs.

Operands	Value inputs
Constant, timer constant	x
MD, MW, MB - Markers	x
NB, NW, ND - NET markers	x
nNB, nND, nND- NET markers NET stations n	x
IA - Analog input	x
QA - Analog output	x
QV - QV - Numeric output of a FB	x

You can assign the following operands to the function block inputs that are bit inputs:

Operands	Bit inputs
Constant 0, constant 1	x
M – Markers	x
RN - Input bit via NET	x
SN - Output bit via NET (send)	x
N - Net marker bit	x
nN - NET marker bit NET station n	x
ID: Diagnostic alarm	x
LE - Output backlight	x
P buttons	x
I - Bit input	x
Q - Bit output	x
Q - Bit output of a FB	x

Function block outputs

	Description	Note
(Bit)		
RY	Event message signaling that a new minimum or maximum value has been entered	This message will only be displayed for one cycle
(DWord)		
QM	Minimum value of I1 that was sampled during the active period	
QX	Maximum value of I1 that was sampled during the active period	

Assigning operands

You can assign the following operands to the function block outputs that are numeric outputs:

Assigning operands	Outputs
Constant	x
Markers: MB, MD, MW	x
Analog inputs IA	x
Analog output QA	x
Numeric output from another QV FB	x

You can assign the following operands to the function block outputs that are bit outputs:

Assigning operands	Bit outputs
Constant 0, constant 1	x
M – Markers	x
SN - Output bit via NET (send)	x
N - Network marker bit	x
nN - NET station n marker	x
LE - Output backlight	x
Q - Bit output from another FB	x

Parameter set

	Description	Note
☑ Function block release by EN is necessary	If this checkbox is enabled, the state of function block input EN will be evaluated. If the checkbox is disabled instead, the function block will be enabled and function block input EN will not do anything.	This parameter ensures that when existing programs are copied, the functionality of the function blocks that are carried over will be retained. The parameter will be automatically set to 0 or 1 depending on the function block.
Parameter display + Call enabled	Function block parameters and constants can be edited on the device.	
Simulation possible		

Other

Retention

The function block does not recognize retentive data.

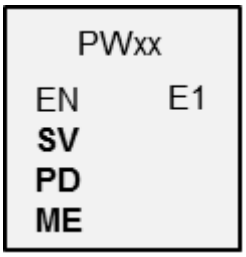
See also

→ Section "MM - Min-/Max function", page 264
→ Section "AR - Arithmetic", page 250
→ Section "CP – Comparator", page 255
→ Section "LS - Value scaling", page 259
→ Section "PW - Pulse width modulation", page 267

6.1.3.6 PW - Pulse width modulation

General

easyE4 base devices provide two function blocks for pulse width modulation PW01…PW02.
These function blocks generate a pulse train with a constant period. The main application for PW function blocks is when working with devices that feature transistor outputs.
However, PW function blocks can also be used with devices featuring relay outputs. Due to the relay's ON and OFF times, a long period duration and a long minimum ON duration are both possible with these devices.
Function block PW is used, among other things, to set up PID controllers with a pulse output for proportional actuators.
When doing this, the PW function block is used together with the DC (PID controller) function block.



Operating principle

The PW function block modulates the pulse duty factor of a square wave signal, and thus changes the mark to space ratio and pulse duration.
The period duration of the signal stays constant.

You define the period duration at the PD input. The on time or pulse duration is proportional to the manipulated variable at the SV input. You can also define the minimum on duration at the ME input.

A hardware output is assigned to each function block:

PW01 -> Q01, PW02 -> Q02

The function block causes the direct output of the calculated value at the hardware output.

If you use a PW function block with its permanently assigned Q1 or Q2 output, you cannot make any additional associations of these outputs in the program.
A status change at Q1 or Q2 that is caused by the circuit diagram is suppressed in favor of the higher priority status change caused by the function block.

DANGER
UNFORESEEABLE SWITCHING STATES AT OUTPUT
When using the PW function block, strictly observe the separate assignment of the outputs if other hardware-dependent function blocks are used, such as the PO function block.

If this is not observed, unforeseeable switching states may occur at the output concerned.

The function block and its parameters

Function block inputs

	Description	Note
(Bit)		
EN	1: Activates the function block. 0: Output Q1 or Q2 switches to a state of 0.	The checkbox for the ☑ Function block release by EN is necessary parameter must first be enabled
(DWord)		
SV	Manipulated variable Value range: 0 to 4095 (12 bit) of this value range corresponds to 0...100% of the period duration. Notes on the normalization of the manipulated variable are provided in the previous section Manipulated variable SV.	No signals are output at Q1 and Q2 if SV=0 or SV<ME, and the output concerned will stay at 0.
PD	Period duration [ms] When the value is 0, no pulses are output at Q1 and Q2. The minimum period duration for a device with transistor outputs is 5 ms. (the resulting max. frequency is 200 Hz).	Value range: 0…65535
ME	Minimum On duration [ms] The minimum on duration for devices with transistor outputs is 0.1 ms. This on duration applies if ME is not set or set to 0. If ME=1, the on duration is 1ms etc.. The minimum on duration possible essentially depends on the downstream electronics.	Value range: 0…65535

Manipulated variable SV

The value range from 0 to 4095 of the manipulated variable SV corresponds to 0 to 100% of the period duration.

If you wish to control the pulse duration with the DC.. PID controller, you can associate the DC..QV output directly with the input PW..SV. This kind of application does not require any normalization since the DC..QV covers the same value range between 0 and 4095.

If you wish to control the pulse duration via an analog input that has a value range between 0 and 1023, you will have to normalize this value first of all. If you require an integral normalization factor, in this case the factor of 4, only multiplication with the AR arithmetic function block is required.

If you wish to control the pulse duration with a signed value you will have to normalize this value first of all with an LS value scaling function block.

If the actual value specified via SV for the pulse duration is shorter than the minimum on duration, the output at Q1 or Q2 is accordingly 0. The status of the PW..E1 contact must be observed.

If the off duration of the pulse at the output is less than the minimum off duration, Q1 or Q2 are permanently on. The status of the PW..E1 contact must be observed.

Parameter limits for period duration and minimum ON duration

Table 63: Parameter limit values for period duration and minimum on duration

	Period duration [ms]	Minimum On duration [ms]	Note
Base device			
EASY-E4-UC-...	Min. zz Max. 65535	Min. zz Max. 65535	Period duration When the value is 0, no pulses are output at Q1 and Q2. minimum contact closing time Can be selected within the valid limits
EASY-E4-DC-...	Min. zz Max. 65535	Min. zz Max. 65535	
EASY-E4-AC-...	Min. zz Max. 65535	Min. zz Max. 65535	

Minimum period duration PD

The minimum period duration is 5 ms.

Minimum contact closing time ME

The minimum on duration is limited to zz (100) µs when a very low manipulated variable is set at input SV.

Minimum on duration = Minimum off duration

The above hardware restriction also applies to the minimum off duration if a very high manipulated variable at input SV generates a correspondingly long pulse duration. If a large mark-space ratio of this kind is almost as long as the period duration, the minimum off duration is 100 µs.

If the duration is below the set minimum on duration or minimum off duration, the Boolean control output E1 is set to 1. This control output E1 is used for monitoring during commissioning and does not have to be connected.

Period duration to minimum ON duration ratio

The ratio of the period duration/minimum on duration (P/M) determines which percentage of manipulated variables have no effect.
The minimum on duration must be set as low as possible so that P/M is as high as possible.

If, however, a very short on duration has no effect on the connected actuator, it is advisable to suppress these short on phases in order to reduce the load on the hardware. In this case, the period duration should not be set too low.

Assigning operands

You can assign the following operands to the function block inputs that are numeric inputs.

Operands	Value inputs
Constant, timer constant	x
MD, MW, MB - Markers	x
NB, NW, ND - NET markers	x
nNB, nND, nND- NET markers NET stations n	x
IA - Analog input	x
QA - Analog output	x
QV - QV - Numeric output of a FB	x

You can assign the following operands to the function block inputs that are bit inputs:

Operands	Bit inputs
Constant 0, constant 1	x
M – Markers	x
RN - Input bit via NET	x
SN - Output bit via NET (send)	x
N - Net marker bit	x
nN - NET marker bit NET station n	x
ID: Diagnostic alarm	x
LE - Output backlight	x
P buttons	x
I - Bit input	x
Q - Bit output	x
Q - Bit output of a FB	x

Function block outputs

	Description	Note
(Bit)		
E1	Error output 1: if the value is below the minimum on duration or minimum off duration.	The range limits are checked irrespective of the edge change on the Boolean EN input.

Assigning operands

You can assign the following operands to the function block outputs that are numeric outputs:

Assigning operands	Outputs
Constant	x
Markers: MB, MD, MW	x
Analog inputs IA	x
Analog output QA	x
Numeric output from another QV FB	x

You can assign the following operands to the function block outputs that are bit outputs:

Assigning operands	Bit outputs
Constant 0, constant 1	x
M – Markers	x
SN - Output bit via NET (send)	x
N - Network marker bit	x
nN - NET station n marker	x
LE - Output backlight	x
Q - Bit output from another FB	x

Parameter set

	Description	Note
Parameter set		
☑ Function block release by EN is necessary	If this checkbox is enabled, the state of function block input EN will be evaluated. If the checkbox is disabled instead, the function block will be enabled and function block input EN will not do anything.	This parameter ensures that when existing programs are copied, the functionality of the function blocks that are carried over will be retained. The parameter will be automatically set to 0 or 1 depending on the function block.
Parameter display + Call enabled	Function block parameters and constants can be edited on the device.	
Simulation not possible		

See also

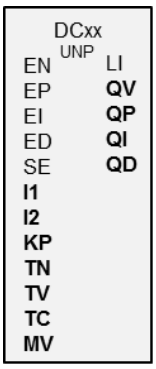
→ Section "PW - Pulse width modulation", page 267
→ Section "AR - Arithmetic", page 250
→ Section "CP – Comparator", page 255
→ Section "LS - Value scaling", page 259
→ Section "MM - Min-/Max function", page 264

6.1.4 Open-loop and closed-loop function blocks

6.1.4.1 DC - PID controller

General

easyE4 The base devices provide 32 PID controller function blocks DC01...DC32.



Operating principle

A closed-loop control circuit with a PID controller consists of the following components:

- Setpoint (reference variable),
- Actual value (controlled variable),
- System deviation = (setpoint–actual value),
- PID controller,
- Control system (e.g. PTn system),
- Disturbance variables.

The PID controller operates on the basis of the equation of the PID algorithm. According to this, the manipulated variable Y(t) is the result of the calculation of the proportional component, an integral component and a differential component.

PID controller equation:

$$Y(t) = YP(t) + YI(t) + YD(t)$$

Y(t)= calculated manipulated variable with scan time t
YP(t)= Value of the proportional component of the manipulated variable with scan time t
YI(t) = Value of the integral component of the manipulated variable with scan time t
YD(t)= Value of the differential component of the manipulated variable with scan time t

Proportional component

The proportional component YP is the product of the gain (Kp) and the control difference (e). The control difference is the difference between the setpoint (Xs) and the actual value (Xi) at a specified scan time. The equation used by the device for the proportional component is as follows:

$YP(t) = Kp * [Xs(t) - Xi(t)]$	Kp =	Proportional gain
	Xs(t) =	SETPOINT value at scan time t
	Xi(t) =	ACTUAL value at scan time t

Integral component

The integral component YI is proportional to the sum of the control difference over time. The equation used by the device for the integral component is as follows:

$$YI(t) = Kp * Tc / Tn * [Xs(t) - Xi(t)] + YI(t-1)]$$

K_p = Proportional gain
Tc = Scan time
Tn = Reset time (also known as integration time).
Xs(t) = Setpoint with scan time t
Xi(t) = Actual value with scan time t
YI(t—1)= Value of the integral component of the manipulated variable with scan time t – 1

Differential component

The differential component YD 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 behavior 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 by the following equation:

$$YD(t) = Kp \times Tv / Tc \times (Xi(t-1) - Xi(t))$$

K_p = Proportional gain
Tc = Scan time
Tv = Rate time of the control system (also called the differential time)
Xi(t) = Actual value with scan time t
Xi(t-1) = Actual value with scan time t - 1

In order for a PID controller to work, it must be enabled with DC_EN =1. The PID controller will provide manipulated variable QV as an output variable. If the DC..EN coil is not active, the entire PID controller will be disabled and reset. The manipulated variable at the QV output will assume a value of 0. Function block inputs DC_EP, DC_EI, and DC_ED all need to be active in order for the proportional term, integral term, and derivative term to be calculated.

Example: If only coils DC…EP and DC…EI are activated, the PID controller operates as a PI controller.

A deactivation of the I and D component is linked with a reset. The controller is assigned parameters with the standard variables Kp [%], TN [0.1 s] and TV [0.1 s].

The device calculates the manipulated variable every time the scan time TC has elapsed. If the scan time is zero, the manipulated variable is calculated every cycle.

The controller can also be run in UNP and BIP modes, and also controlled in Manual mode.

Manual mode of the PID controller

A value must be present at the MV function block input in order to set the manipulated variable directly. If the function block input 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. If DC..SE is no longer triggered, the control algorithm is active again.



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.

The function block and its parameters

Function block inputs

	Description	Note
(Bit)		
EN	1: Activates the function block.	
EP	1: Activates the proportional term	
EI	1: Activates the integral term	
DF	1: Activates the derivative term	
SE	1: Accept manual manipulated variable	
(DWord)		
I1	Setpoint	Value range: -32768 ... +32767
I2	Actual value	Value range: -32768 ... +32767
KP	Proportional gain Kp [%]	Value range: 0 ... 65535 The value 100 corresponds to a KP (factor) of 1.
TN	Reset time Tn [0.1 s]	Value range: 0 ... 65535
TV	Rate time Tv [0.1 s]	Value range: 0 ... 65535
TC	Scan time = Time between function block calls. Value range: 0.1 s - 6553.5 s. If the value 0 is specified, the scan time is determined by the program cycle time.	
MV	Manual manipulated variable Value range: -4096 ... +4095	When UNP mode is selected: and negative values are entered at MV, the function block returns a zero at output QV.

KP Proportional gain factor

The input KP is used to define a proportional gain factor.
The value <100> corresponds to a KP factor of 1, the value 50 corresponds to a KP of 0.5 etc.

Scan time Tc

The TC input defines the time between the function block calls. Values between 0.1s and 6553.5s can be defined.
If the TC scan time is set to 0, the program cycle time defines the time difference between the function block calls. This may cause irregularities in the control response as the program cycle time is not always constant. The ST (set cycle time) function block should be used to set a constant program cycle time, please refer to → "ST - SET cycle time", page 403.



A combination of two devices easyE4 is ideal for applications requiring lengthy calculations or visualizations such as PID closed-loop control tasks with the PID controller and also visualization functions at the same time.
In these kinds of applications, move the time consuming calculations to a second device, possibly without an integrated display, which you can connect via NET.

Assigning operands

You can assign the following operands to the function block inputs that are numeric inputs.

Operands	Value inputs
Constant, timer constant	x
MD, MW, MB - Markers	x
NB, NW, ND - NET markers	x
nNB, nND, nND- NET markers NET stations n	x
IA - Analog input	x
QA - Analog output	x
QV - QV - Numeric output of a FB	x

You can assign the following operands to the function block inputs that are bit inputs:

Operands	Bit inputs
Constant 0, constant 1	x
M – Markers	x
RN - Input bit via NET	x
SN - Output bit via NET (send)	x
N - Net marker bit	x
nN - NET marker bit NET station n	x
ID: Diagnostic alarm	x
LE - Output backlight	x
P buttons	x
I - Bit input	x
Q - Bit output	x
Q - Bit output of a FB	x

Operating mode

	Description	Note
Mode parameter		
UNP	The manipulated variable is output as a unipolar 12-bit value. .	Value range: 0 ... 4095
BIP	The manipulated variable is output as a bipolar 13-bit value.	Value range: -4096 ... +4095

Function block outputs

	Description	Note
(Bit)		
LI	1: if the value range of the medium-voltage is exceeded.	
(DWord)		
QV	Manipulated variable	Integer value range for operating mode UNP: 0...+4095 (12 Bit) for operating mode BIP: -4096...+4095 (13 Bit)
QP	Proportional component of the manipulated variable Can be used for diagnostic purposes	
QI	Integral component of the manipulated variable Can be used for diagnostic purposes	
QD	Differential component of the manipulated variable Can be used for diagnostic purposes	

Assigning operands

You can assign the following operands to the function block outputs that are numeric outputs:

Assigning operands	Outputs
Constant	x
Markers: MB, MD, MW	x
Analog inputs IA	x
Analog output QA	x
Numeric output from another QV FB	x

You can assign the following operands to the function block outputs that are bit outputs:

Assigning operands	Bit outputs
Constant 0, constant 1	x
M – Markers	x
SN - Output bit via NET (send)	x
N - Network marker bit	x
nN - NET station n marker	x
LE - Output backlight	x
Q - Bit output from another FB	x

Parameter set

	Description	Note
☑ Function block release by EN is necessary	If this checkbox is enabled, the state of function block input EN will be evaluated. If the checkbox is disabled instead, the function block will be enabled and function block input EN will not do anything.	This parameter ensures that when existing programs are copied, the functionality of the function blocks that are carried over will be retained. The parameter will be automatically set to 0 or 1 depending on the function block.
Parameter display + Call enabled	Function block parameters and constants can be edited on the device.	
Simulation possible		

Other

Retention

The function block does not recognize retentive data.

Example of a PID controller with the programming method EDP

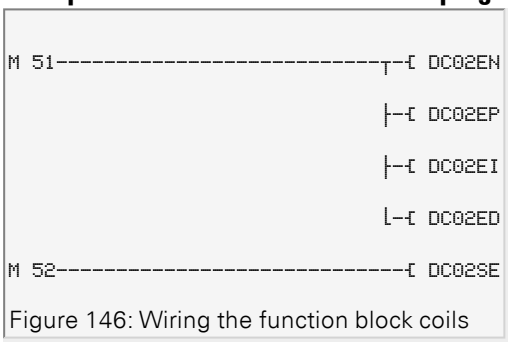


Figure 146: Wiring the function block coils

The function block coils are activated by markers.

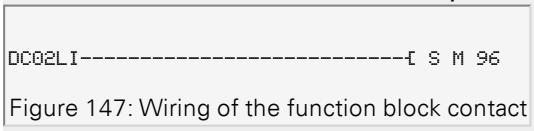


Figure 147: Wiring of the function block contact

The message of the function block is sent to a marker.

Example of a PID controller configuration on a device display

When using the function block in the circuit diagram for the first time, use OK to automatically enter the display of function blocks on the device display, as shown in the following figure.

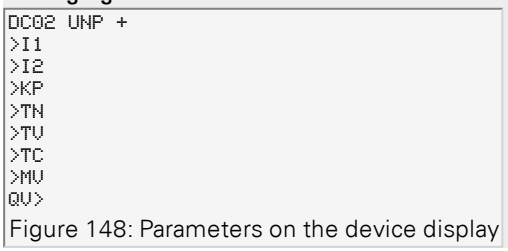


Figure 148: Parameters on the device display

Enter the function block settings here. The display contains the following elements:

DC02	Function block: PID controller, number 02
UNP	Operating mode: Unipolar
+	Parameter set can be called via the PARAMETERS menu
>I1	SETPOINT of the PID control: -32768…+32767
>I2	ACTUAL value of the PID control: -32768…+32767
>KP	Proportional gain Kp; 0…65535, in %; Example: The value 1500 is processed in the function block as 15.
>TN	Reset Time Tn: 0… 65535, in 100 ms; Example: The value 250 is processed in the function block as 25 s.
>TV	Rate time TV: 0…65535, in 100 ms; Example: The value 20 is processed in the function block as 2 s.
>TC	Scan Time Tc: 0…65535, in 100 ms
>MV	Manual manipulated variable: -4096… +4095
QV>	Manipulated variable: • unipolar: 0…4095 • bipolar: -4096…+4095

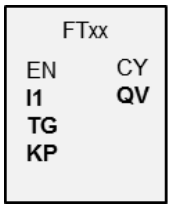
See also

→ Section "DC - PID controller", page 272
→ Section "FT - PT1-Signal smoothing filter ", page 279
→ Section "TC - Three step controller", page 297
→ Section "VC - Value limitation ", page 302
→ Section "BC - Block compare", page 306
→ Section "BV - Boolean operation", page 353
→ Section "PO - Pulse output", page 284

6.1.4.2 FT - PT1-Signal smoothing filter

General

easyE4 base devices provide 32 PT1 signal smoothing filter function blocks FT01...FT32.
The function block smoothes noisy signals such as analog input signals. It operates as a low pass filter.



Operating principle

The signal to be smoothed is added via input I1. The smoothed output value is transferred to QV.

EN=1 starts the function block. EN=0 initiates a reset in which the output QV is reset to 0.

You can use the TG input to set the recovery time. This recovery time is the time over which smoothing will be applied, and it should not be longer than necessary, as signals will be delayed more than is actually necessary for smoothing. Please note that delays are an unavoidable side effect of signal smoothing.

The input KP is used to define a proportional gain factor. The input signal I1 is multiplied with this factor. The value <100> corresponds to a KP of 1.

The PT1 delayed output value is provided at output QV.

If the function block is called for the first time when the device is started or after a reset, this will result in the delay value being initialized with the input value (the PT1 delay does not start with a value of zero). In other words, the output value at QV will equal the input value at I1 during the first processing cycle. This will speed up the PT1 starting behavior.

Step response of the function block

The step response of the FT-PT1 function is an e function. After a time t = Tg the normalized output value is 0.63 QV/QVmax.

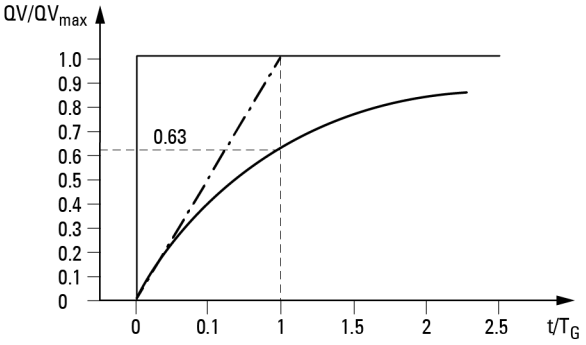


Figure 149: Response of the FT function block

——— Output value of the FT-PT1 signal smoothing filter function block, Tangent

— · — · Tangent

The output value is based on the following equation:

$$Y(t) = [T_A/T_G] \cdot [K_P \cdot (X(t)-Y(t-1))]$$

Y(t) = Calculated output value at time t
T_A =Scan time (calculated internally)
T_G = Recovery time
K_P = Proportional gain
X(t) = Actual value at time t
Y(t-1) = Calculated output value at time t-1

Scan time

Scan time T_A depends on the set recovery time value.

At recovery time T_G	Internal calculation of the scan time T_A
$T_G \leqq 1000$ ms	$T_A = 10$ ms
$T_G > 1000$ ms	$T_A = T_G/100$

Cycle time to scan time

The ratio of cycle time $_{cyc}$ to sampling time T_A should be such that the sampling time is much larger than the cycle time (by a factor of approximately 10): $T_A=10 \cdot t_{cyc}$. The sample time is set indirectly with the value for recovery time T_G (please refer to the table above).

The following therefore applies: $t_{cyc} << T_A$.

For applications in which this cannot be fulfilled, the cycle time should be set with the ST (set cycle time) function block so that the scan time is an integral multiple of the cycle time.

$$t_{cyc} \cdot n = T_A$$

mit n = 1,2,3, …

The function block always works with a scan time that is an integral multiple of the cycle time. This can cause the set recovery time to be lengthened.



In the case of time-consuming application scenarios in which, for instance, a signal smoothing filter and a PID controller are used and visualization tasks need to be executed simultaneously, the cycle time may be extended to an extent that may not be tolerable for controller tasks. In these kinds of applications, move the time-consuming calculations to a second device connected via easyNet – please refer to

The function block and its parameters

Function block inputs

	Description	Note
(Bit)		
EN	1: Activates the function block.	
(DWord)		
I1	Input value	Value range: -32768…+32767
TG	Recovery time TG [0.1 s]	Value range: 0…65535 The value 10 corresponds to a recovery time of 1000 ms.
KP	Proportional gain Kp [%] Value range: 0 ... 65535	Value range: 0…65535 The value 100 corresponds to a KP (factor) of 1. The value 50 corresponds to a KP of 0.5.

Assigning operands

You can assign the following operands to the function block inputs that are numeric inputs.

Operands	Value inputs
Constant, timer constant	x
MD, MW, MB - Markers	x
NB, NW, ND - NET markers	x
nNB, nND, nND- NET markers NET stations n	x
IA - Analog input	x
QA - Analog output	x
QV - QV - Numeric output of a FB	x

You can assign the following operands to the function block inputs that are bit inputs:

Operands	Bit inputs
Constant 0, constant 1	x
M – Markers	x
RN - Input bit via NET	x
SN - Output bit via NET (send)	x
N - Net marker bit	x
nN - NET marker bit NET station n	x
ID: Diagnostic alarm	x
LE - Output backlight	x
P buttons	x
I - Bit input	x
Q - Bit output	x
Q - Bit output of a FB	x

Function block outputs

	Description	Note
(Bit)		
CY	Carry 1: If output value QV falls outside the valid value range.	Value range: -32768…+32767
(DWord)		
QV	Delayed output value	Value range: -32768…+32767

Assigning operands

You can assign the following operands to the function block outputs that are numeric outputs:

Assigning operands	Outputs
Constant	x
Markers: MB, MD, MW	x
Analog inputs IA	x
Analog output QA	x
Numeric output from another QV FB	x

You can assign the following operands to the function block outputs that are bit outputs:

Assigning operands	Bit outputs
Constant 0, constant 1	x
M – Markers	x
SN - Output bit via NET (send)	x
N - Network marker bit	x
nN - NET station n marker	x
LE - Output backlight	x
Q - Bit output from another FB	x

Parameter set

	Description	Note
☑ Function block release by EN is necessary	If this checkbox is enabled, the state of function block input EN will be evaluated. If the checkbox is disabled instead, the function block will be enabled and function block input EN will not do anything.	This parameter ensures that when existing programs are copied, the functionality of the function blocks that are carried over will be retained. The parameter will be automatically set to 0 or 1 depending on the function block.
Parameter display + Call enabled	Function block parameters and constants can be edited on the device.	
Simulation possible		

Other

Retention

The function block does not recognize retentive data.

Example of an FT-PT1-signal smoothing filter when using the EDP programming language

```
M 40-----------------------------[ FT01EN
```

Figure 150: Wiring the function block coils

Example of an FT-PT1 signal smoothing filter configuration on a device display

When using the function block in the circuit diagram for the first time, use OK to automatically enter the general display of function block parameters, as shown in the figure on the left. Enter the function block settings here.

```
FT17 +
>I1
>TG
>KP
QV>
```

Figure 151: Parameters shown on display

The display contains the following elements:

FT17 signal smoothing filter	Function block: Signal smoothing, number 17
+	Parameter set can be called via the PARAMETERS menu
>I1	Input value: -32768… +32767
$>T_G$	Recovery time: 0… 65535 resolved in 100 ms Example: The value 250 is processed in the function block as 25 s.
$>K_P$	Proportional gain: 0… 65535 in %; Example: With KP=1500 the function block performs the calculation with K_p =15
QV>	Output value: -32768 … +32767, smoothed

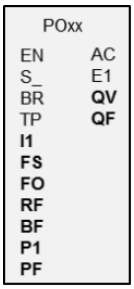
See also

→ Section "FT - PT1-Signal smoothing filter ", page 279
→ Section "TC - Three step controller", page 297
→ Section "VC - Value limitation ", page 302
→ Section "BC - Block compare", page 306
→ Section "BV - Boolean operation", page 353
→ Section "PO - Pulse output", page 284

6.1.4.3 PO - Pulse output

General

The DC versions of easyE4 base devices provide 2 pulse output function blocks, PO01 through PO02. These function blocks make it possibly to quickly output 24 V pulses in order to drive stepper motors. Pulse output PO01 is hardwired to device output Q1 and PO02 to device output Q2.





If you use a PO function block with its hardwired device output Q1 or Q2, do not not assign that device output again in the program. Doing so will not have any effect, as a state change by the function block has a higher priority.



WARNING
UNFORESEEABLE SWITCHING STATES AT OUTPUT
When using the PO function block, strictly observe the separate assignment of the outputs if other hardware-dependent function blocks are used, such as the PW function block.

If this is not observed, unforeseeable switching states may occur at the output concerned.

Operating principle

You can use the pulse output function block to generate a defined number of pulses at device output Q1 or Q2.. This series of pulses is called a pulse train. You can change the frequency within the pulse sequence. You can generate several pulse sequences in defined intervals. You can use these pulse trains to control a stepper motor in the three possible individual sequences: acceleration, operation, and deceleration. The function block also has Jog mode as well as normal mode.

Each function block is assigned a set device output for the fast pulses:

Function block PO01: -> device output Q01

Function block PO02: -> device output Q02

The device outputs Q01 and Q02 used must not be processed again in the circuit diagram. The reason for this is that the PO function blocks overwrite all other status changes at the device outputs Q01 and Q02.
A suitable power output stage that is compatible with the stepper motor being used is required in order to be able to drive the stepper motor.

You then feed the step and direction data to the input logic of the driver. The input logic for both signals should be optocoupled and process an input voltage of +24V.

The parameter definition for a stepper motor and therefore the function block largely depends on the rated load to be moved. This defines the framework for the maximum start and operating frequency.

The function block is active if the PO..EN coil is actuated. After you have parameterized the function block, you can actuate the coil PO..S_. This will start normal operation. Alternatively, you can also actuate the coil PO..TP and start the function block in Jog mode.

Operating modes

Jog mode

You can use the PO in jog mode for commissioning. You can either start a positioning job with a specified number of steps or a specified jog frequency.

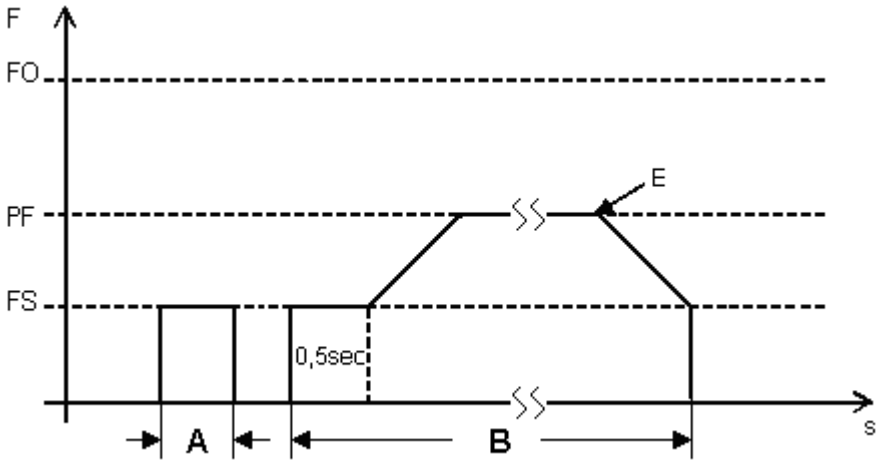


Figure 152: Signal diagram for jog mode

FO: operating frequency

PF: jog frequency

FS: start frequency

A: Distance with TP on time active for less than 0.5 sec

B: Distance with TP on time active for more than 0.5 s,
for the first 0.5 secs the distance is covered at the defined starting frequency.

E: Jog command completed for positioning at a specified jog frequency with TP = 0

Positioning with a specified number of steps P1 (defined distance)

When using this operating mode, set the distance using the number of steps – please refer to A → "Signal diagram for jog mode", page 286

- Define the input parameters as stated above.
- Switch input EN = 1.
- Switch the TP input to 1 for a duration < 0.5 seconds.

The motor is started at the starting frequency, moves the set number of steps and then stops automatically.

Positioning at a specified jog frequency PF (any positioning section at a defined maximum frequency)

When using this operating mode, control the distance manually with the duration of the state of 1 at function block input TP – please refer to B → "Signal diagram for jog mode", page 286 .

- Define the input parameters as stated above.
- Switch the EN input to 1.
- Switch the TP input to 1 for at least a duration ≥ 0.5 seconds.

The motor is set in motion with the starting frequency for 0.5 s and is then accelerated to jog frequency.
Motion will continue until you terminate jog mode with TP = 0 or another stop condition is active.

- End jog mode with TP = 0 – please refer to E → "Signal diagram for jog mode", page 286.

The PO function block then generates a braking phase (braking ramp) in which the step sequence frequency of the motor is continuously reduced from the jog frequency PF to the start frequency FS.

Normal mode

For normal mode, specify the number of pulses based on the distance that must be traversed.
In addition, configure the start frequency and the operating frequency as a function of the load torque and of the motor being used.
Set the slope for the starting and braking ramps by using the corresponding RF and BF frequency change inputs. The function block will interpret the frequency change parameter value as a change in mHz per step. For example RF = 2000 means that the frequency will increase 2 Hz per step during the acceleration phase.

- Define the input parameters as stated above.
- Switch input EN=1.
- Start a positioning job with a rising edge at bit input S_.
- Check the acceptance of the job at device output AC.

The function block and its parameters

Function block inputs

	Description	Note
(Bit)		
EN	1: Activates the function block.	The checkbox for the ☑ Function block release by EN is necessary parameter must first be enabled
EN	Enable of the function block on status 1. The operations **Start positioning job** (S_) or **Jog mode** (TP) can be executed when the function block is enabled. Disable the function block on status 0. The function block **Reset** is carried out when there is falling edge from 1 to 0.	**Caution!** In normal operation always stop a positioning job via the BR input. In this case, the step sequence frequency will be reduced according to the braking ramp and the motor will brake gently. A stop with EN= 0 would cause an abrupt stop of the motor and a possible loss of the reference point if this would be dragged further by the moved load.
S_	The positioning job will start when there is a rising edge. An active positioning job will be signaled with AC =1.	When a positioning job is activated, the acceleration, operating and braking phases are executed in succession. If a positioning job is already activated, a renewed rising edge 0 -> 1 at S_ will not cause a new job to be started.
BR	Aborts the ongoing positioning job when there is a rising edge.	After the positioning job is aborted, the function block now runs the braking phase, i.e. a delayed motor stop is executed. The bit output AC is only set to 0 when the braking phase has been completed.
TP	Activates the Jog mode on status 1 The on duration TP = 1 determines the type of Jog mode.	Two operating mode are available in Jog mode for diagnostics and testing. **1. Positioning with a preset number of steps** TP on duration < 0.5 seconds The motor moves by the number of steps defined at P1. **2. Positioning with a specified jog frequency - manual mode** TP on duration ≥ 0.5 seconds The motor will be accelerated to the jog frequency set at PF. The movement will be continued until the jog command is stopped with TP = 0.
(DWord)		
I1	Number of pulses	For number of pulses enter the total number pulses for the entire sequence, consisting of the three individual acceleration, operating and braking phases. Integer value range:

	Description	Note
		0…+2 147 483 647
FS	Start Frequency	Integer value range: 0…5000 Hz
FO	Operating frequency	Integer value range: 0…5000 Hz
RF	Frequency change in the acceleration phase [mHz/step]	Integer value range: 0…65 535 Value for changing the frequency during the acceleration in 0.001Hz per step. Example: f-REF = 0 - 10 V 0 = No frequency change 100 = Frequency increased by 0.1 Hz per step
BF	Frequency change in the braking phase [mHz/step]	Value for changing the frequency during braking in 0.001Hz per step. Example: f-REF = 0 - 10 V 1000 = Frequency reduction by 1 Hz per step Integer value range: 0…65 535
P1	Number of steps in jog mode	If you only define a very low number of steps, the start pulse at the TP function block input must likewise only be very short. Otherwise the function block will output several pulse sequences that will cause the distance A to be covered several times. In extreme cases generate short start pulses at TP using a T... timing relay. Integer value range: 0…65 535
PF	Frequency in Jog mode	Integer value range: 0…5000 Hz

Assigning operands

You can assign the following operands to the function block inputs that are numeric inputs.

Operands	Value inputs
Constant, timer constant	x
MD, MW, MB - Markers	x
NB, NW, ND - NET markers	x
nNB, nND, nND- NET markers NET stations n	x
IA - Analog input	x
QA - Analog output	x
QV - QV - Numeric output of a FB	x

You can assign the following operands to the function block inputs that are bit inputs:

Operands	Bit inputs
Constant 0, constant 1	x
M – Markers	x
RN - Input bit via NET	x
SN - Output bit via NET (send)	x
N - Net marker bit	x
nN - NET marker bit NET station n	x
ID: Diagnostic alarm	x
LE - Output backlight	x
P buttons	x
I - Bit input	x
Q - Bit output	x
Q - Bit output of a FB	x

Function block outputs

	Description	Note
(Bit)		
AC	1: Signals an ongoing positioning job Pulses are output at device output Q01 or Q02. also during jog mode or during the braking ramp and also after S_ is set to 0. 0: Signals that there is no ongoing positioning job.	
E1	Error output 1: in the event of incorrect parameters, such as: - FO<FS (operating frequency < start frequency) - PF<FS (jog frequency < start frequency)	No positioning commands if the function block detects incorrect parameters. If the function block detects an incorrect parameter change during an active positioning job, the step sequence frequency is reduced according to the braking ramp and the motor is gently braked to a stop.
(DWord)		
QV	Actual number of steps completed	Integer value range: 0…+2 147 483 647
QF	Actual output frequency	Integer value range: 0…5000 Hz

Assigning operands

You can assign the following operands to the function block outputs that are numeric outputs:

Assigning operands	Outputs
Constant	x
Markers: MB, MD, MW	x
Analog inputs IA	x
Analog output QA	x
Numeric output from another QV FB	x

You can assign the following operands to the function block outputs that are bit outputs:

Assigning operands	Bit outputs
Constant 0, constant 1	x
M – Markers	x
SN - Output bit via NET (send)	x
N - Network marker bit	x
nN - NET station n marker	x
LE - Output backlight	x
Q - Bit output from another FB	x

Parameter set

Parameter set	Description	Note
☑ Function block release by EN is necessary	If this checkbox is enabled, the state of function block input EN will be evaluated. If the checkbox is disabled instead, the function block will be enabled and function block input EN will not do anything.	This parameter ensures that when existing programs are copied, the functionality of the function blocks that are carried over will be retained. The parameter will be automatically set to 0 or 1 depending on the function block.
Parameter display + Call enabled	Function block parameters and constants can be edited on the device.	
Simulation not possible		

Other

Retention

The function block does not recognize retentive data.

Signal diagram normal operation

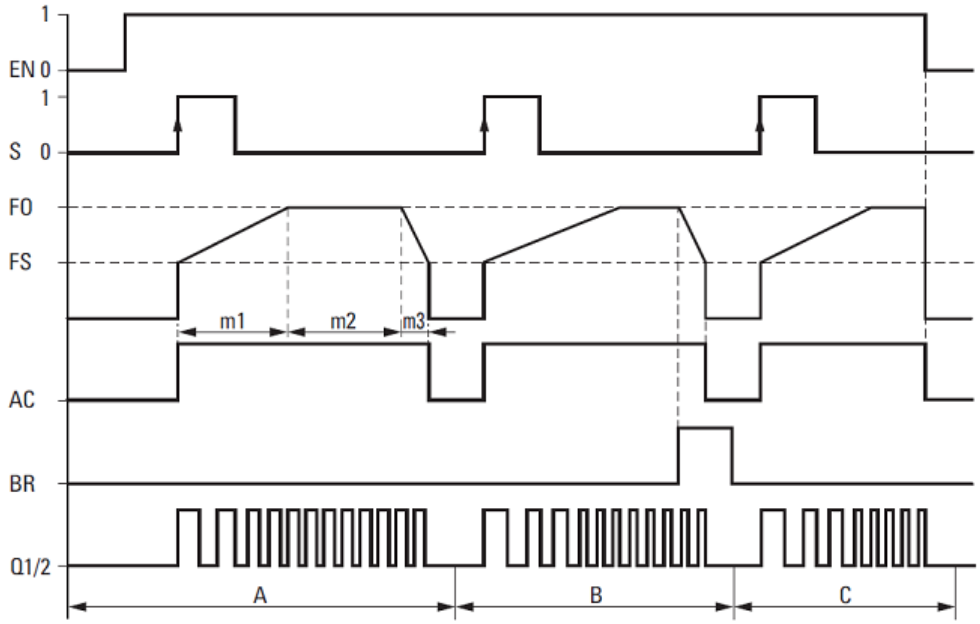


Figure 153: Signal diagram for PO pulse output - possible normal mode phases

EN: Enable coil

S: Start coil for pulse sequence

FO: Operating frequency,

FS = start frequency,

m1 = Acceleration phase, m2 = Operating phase, m3 = Braking phase

AC: Pulse sequence applied at device output, contact

BR: Stop coil for pulse sequence

Q1/2: Pulse sequence at the device output Q1 and/or Q2

• Range A: The pulse sequence is present at the device output until the number of pulses defined at I1 has been reached.

• Range B: Activating the coil PO..BR initiates the braking phase and reduces the frequency of the pulse sequence.

• Range C: A voltage drop at coil PO..EN immediately switches off the pulse sequence from the device output.

Signal diagram jog mode

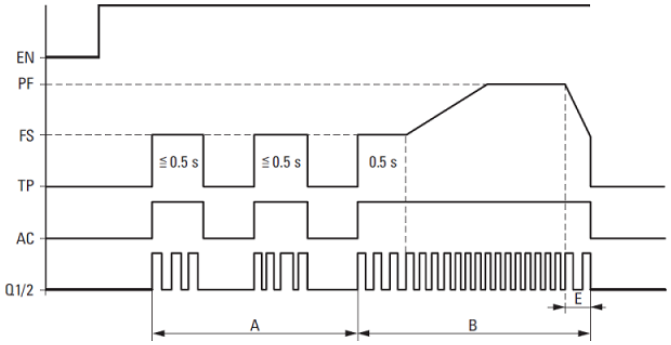


Figure 154: Signal diagram PO pulse output - jog mode

FS = Start frequency

PF = Jog frequency

A = Pulse number with

TP duty factor < 0.5 s

B = Number of pulses at TP duty factor > 0.5 s

E = Braking phase

Pulse profiles

The PO function block enables very simple pulse profiles to be generated in order to control a stepper motor with the sequences acceleration [1], operation [2] and braking [3]. In order to do this, a PO function block supplies a user-defined number of square wave pulses (50% relative ON duration) at the permanently assigned high-speed device output Q1 or Q2.

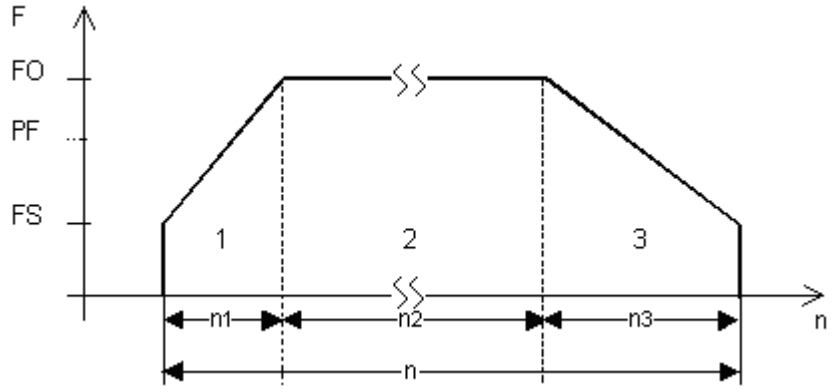


Figure 155: Typical pulse profile for a stepper motor with the acceleration [1], operation [2], and deceleration [3] sequences

F = frequency

1: Acceleration sequence

2: operating sequence

3: Deceleration sequence

FS: start frequency

FO: operating frequency

PF: jog frequency

t: time

Figure 156: n: Total number of pulses

n1 = Number of pulses for acceleration, n2 = Number of pulses for operation, n3 = Number of pulses for braking

Start frequency FS

The maximum start frequency that can be configured depends on the load torque. Enter a start frequency value that will enable the stepper motor to move the load even at low speeds. You will normally be able to find information on the maximum start frequency without taking the load torque into account in the technical data for the motor. When the

load torque is taken into account, the start frequency must only be high enough for the motor not to lose any pulses during acceleration and not to be driven by the load during deceleration.



If the value of FS is set too low, this may cause oscillations between the motor and the load. Jumps at the start or end of the positioning section may occur if FS is set too high.

Operating frequency FO

The maximum operating frequency also depends on the load torque.
The motor generally achieves its maximum power and torque at very low speeds. The higher the speed, the weaker the motor will be.

Jog frequency PF

The maximum frequency that the motor should be able to reach in jog mode.

Number of steps P1

The number of steps that the motor should be able to execute in jog mode.

Frequency change per step in the acceleration phase RF

During the acceleration phase [1], the motor's step sequence frequency is increased continuously from the start frequency to the operating frequency.
The frequency change per step is used to define the number of steps that the acceleration phase will take with the configured starting and operating frequencies.

Frequency change per step in the braking phase RF

During the deceleration phase [3], the motor's step sequence frequency is decreased continuously from the operating frequency to the start frequency.
The frequency change per step is used to define the number of steps that the deceleration phase will take with the configured starting and operating frequencies.

Number of pulses (total number of pulses) I1

The total number of pulses needs to be configured based on the distance being covered on the basis of the specified step angle per step.



In normal operation the function block will always move a distance specified by the Total number of pulses.

This value for the total number of pulses and the calculated number of pulses for the acceleration and braking sequence are used by the function block to calculate the number of pulses for the operating sequence [2].

Number of pulses for acceleration and braking

The PO function block automatically calculates the number of pulses required for acceleration and braking using the frequency change values FS->FO and FO->FS you have

set.
You can calculate the number of pulses for the acceleration and braking sequence using the following equations.

$$n_{RRF} = \frac{(FO - FS)}{RF} * 1000$$

$$n_{RBF} = \frac{(FO - FS)}{BF} * 1000$$

FO: Operating frequency [Hz]; FS: Start frequency [Hz],

n_{RRF} : Number of pulses in the acceleration sequence

n_{RBF} : Number of pulses in the braking sequence

RF: Frequency change in the acceleration phase [mHz/step]

BF: Frequency change in the braking phase [mHz/step]

Example

FS = 200 Hz, FO = 3000 Hz, RF = BF = 1000

Result: $n_{R..}$ = 2800

Connecting a pulse output function block

Prerequisites

- A control relay with 24 VDC must be selected for the project.

Parameters for normal operation

- Configure the following function block inputs as shown:
  - I1 - Number of pulses (0...+2147483647),
  - FS and FO - Start and operating frequency (0...5000 Hz),
  - RF and BF - Frequency change per step in the acceleration and braking phase.
- Connect function block inputs EN, S_, and BR to the corresponding contact suitable for activation.
  Adding a comment for the selected operand can make the program easier to understand.

Parameters for jog operation

- Define at inputs FS and FO the parameters for the start and operating frequency. The operating frequency is not for operation but is required for the plausibility check.
- To run at the specified jog frequency, configure the maximum frequency that the motor can reach in jog mode, and which must be greater than the start frequency, at function block input PF - jog frequency (0 to 5000 Hz).
- To run at the specified number of steps, configure the maximum number of steps that the motor should carry out in jog mode at function block input P1.
- Connect inputs EN and TP each to a contact suitable for activation.

Evaluation of a pulse output contact

You can use bit outputs AC (positioning job in progress) and E1 (error) to check whether a positioning or jog mode job has been activated. You can use error output E1 to check whether your parameters are correct.

Resetting a pulse output function block

▶ To reset (Reset) the pulse output function block, switch the EN bit input from 1 to 0

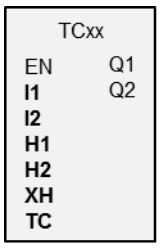
See also

→ Section "PO - Pulse output", page 284
→ Section "FT - PT1-Signal smoothing filter ", page 279
→ Section "TC - Three step controller", page 297
→ Section "VC - Value limitation ", page 302
→ Section "BC - Block compare", page 306
→ Section "BV - Boolean operation", page 353
→ Section "PO - Pulse output", page 284

6.1.4.4 TC - Three step controller

General

TC three-step controllers feature three states for the manipulated variable. These states are implemented with two function block outputs Q1, Q2, of which either none or only one can be closed. I1 is the setpoint and I2 is the actual value. X = I1 - I2 yields control deviation X, which is applied on the actual controller. The controller will then determine the manipulated variable for function block outputs Q1, Q2.



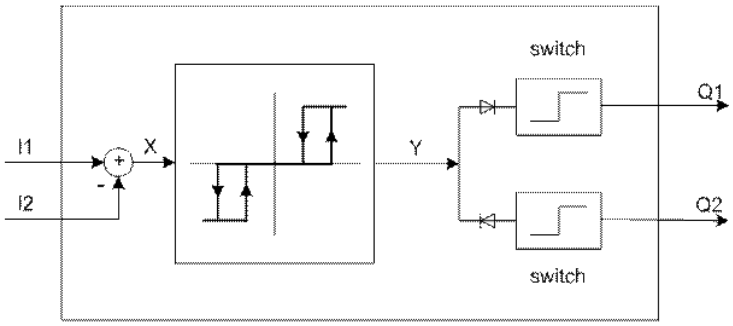


Figure 157: Three-step controller schematic diagram

I1: Setpoint

I2: Actual value

Operating principle

The following timing diagram shows how the three-step controller behaves.

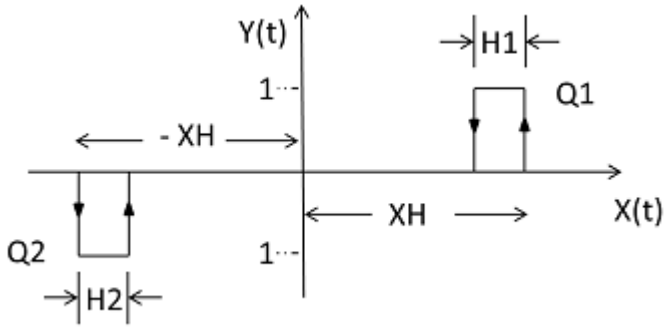


Figure 158: Timing diagram for three-step controller

XH/ -XH: Distance X from switching point

H1: Hysteresis 1 for XH

H2: Hysteresis 2 for -XH

Y(t): Operating points for Q1/ Q2

Q1: Switch output X = positive

Q2: Switch output X = negative

Operating ranges

- X > XH
  Q1 switches one to X < (XH – H1)
- X < –XH
  Q2 switches one to X > -XH + H2

If the switching conditions for Q1 and Q2 are not met, both outputs will be switched off to 0.



Only Q1, or Q1, or neither one can be switched on at any one time.

The function block and its parameters

Function block inputs

	Description	Note
(Bit)		
EN	1: Activates the function block.	
(DWord)		
I1	Setpoint	-32768…+32767
I2	Actual value	-32768…+32767
H1	Hysteresis value 1	0…32767
H2	Hysteresis value 2	0…32767
XH	Distance from switching point	0…32767 Contact distance
TC	Cycle time	0…65535 In 0.1 ms; value of 10 = 1 s. If the value = 0, the function block will go through every cycle.

Assigning operands

You can assign the following operands to the function block inputs that are numeric inputs.

Operands	Numeric inputs
	I1, I2, H1, H2, XH, TC
Constant	x
Markers MD, MW, MB	x
Analog inputs IA	x
Analog output QA	x
Numeric output from a different FB	x

You can assign the following operands to the function block inputs that are bit inputs:

Operands	Bit inputs
	EN
Constant 0, constant 1	x
M – Markers	x

Operands	Bit inputs
RN - Input bit via NET	x
SN _ Output bit via NET (send)	x
N - Network marker bit	x
nN - NET station n marker	x
ID: Diagnostic alarm	x
LE - Output backlight	x
I bit input	x
Q Bit output from another FB	x

Function block outputs

	Description
(Bit)	
Q1	Switch output 1
Q2	Switch output 2

Assigning operands

You can assign the following operands to the function block outputs that are bit outputs:

Operands	Bit outputs
	Q1, Q2
Constant 0, constant 1	x
M – Markers	x
RN - Input bit via NET	x
SN _ Output bit via NET (send)	x
N - Network marker bit	x
nN	x
ID: Diagnostic alarm	x
LE - display brightness indicators	x
I bit input	x
Q Bit output from another FB	x

Parameter set

	Description	Note
☑ Function block release by EN is necessary	If this checkbox is enabled, the state of function block input EN will be evaluated. If the checkbox is disabled instead, the function block will be enabled and function block input EN will not do anything.	This parameter ensures that when existing programs are copied, the functionality of the function blocks that are carried over will be retained. The parameter will be automatically set to 0 or 1 depending on the function block.
Parameter display + Call enabled	Function block parameters and constants can be edited on the device.	
Simulation possible		

Other

Retention

The function block does not recognize retentive data.

Heating and cooling

Actual value I1 (temperature) is higher than setpoint I2, meaning that cooling is required.

Function block output Q1 =1 switches the cooling system on as soon as (I1-I2) > XH.

Actual value I1 (temperature) is lower than setpoint I2, meaning that heating is required.

Function block output Q2 = 1 switches the heating system on as soon as (I1-I2) > XH

Hysteresis values H1 and H2 determine how long cooling or heating is required and, accordingly, the cooling/heating energy content.

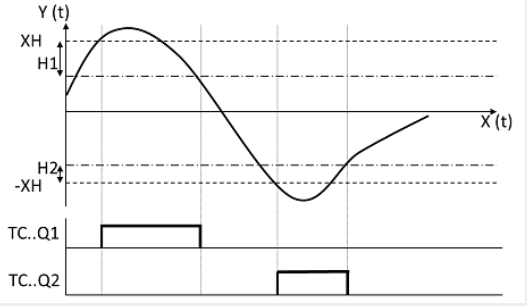


Figure 159: Signal diagram for three-step controller

Level control

The contents of a liquid tank must not fall below or exceed a specific liquid level.

The ACTUAL value (level) is higher than the SETPOINT, meaning that liquid needs to be drained. Function block output Q1 switches the drain valve on.

The ACTUAL value (level) is lower than the SETPOINT, meaning that liquid needs to be replenished. Function block output Q2 switches the supply valve on.

Hysteresis values H1 and H2 define how long liquid needs to be drained or replenished. This also means that they define the volume before draining and after replenishing.

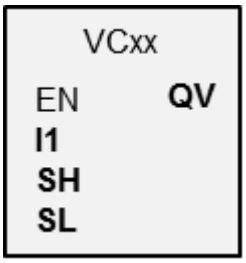
See also

→ Section "TC - Three step controller", page 297
→ Section "FT - PT1-Signal smoothing filter ", page 279
→ Section "VC - Value limitation ", page 302
→ Section "BC - Block compare", page 306
→ Section "BV - Boolean operation", page 353
→ Section "PO - Pulse output", page 284

6.1.4.5 VC - Value limitation

General

easyE4 base devices provide 32 value limitation function blocks, VC01 through VC32.
These function blocks can be used to output values within specific limits.



Operating principle

The lower and upper limits are set using function block inputs SL (Low) and SH (High). The value at function block output QV will follow the value at function block input I1 as long as the latter falls within the limits. Values outside of the range will be truncated accordingly.

EN = 0 will carry out a reset and function block output QV will be set to a value of 0.

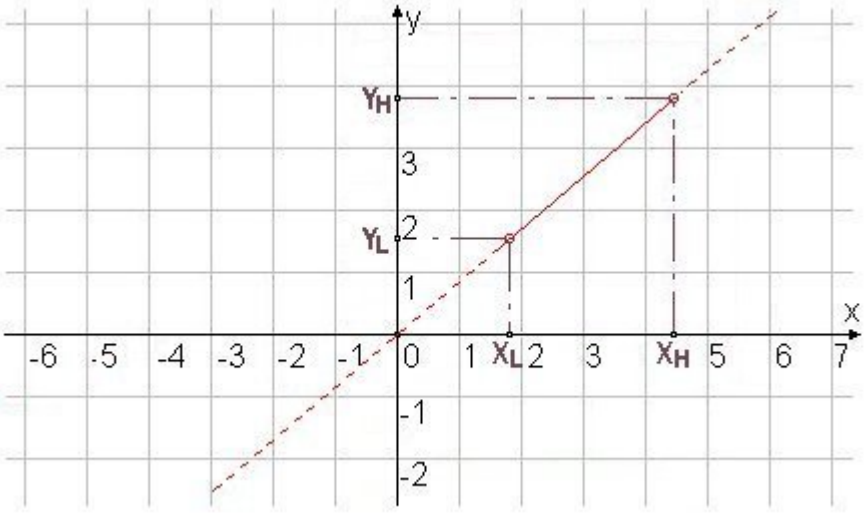


Figure 160: Figure: Restriction of the input values to the specified limits.

SL: Lower limit	I1: Input function at I1
SH: Upper limit	QV: Bounded output function at QV

The function block and its parameters

Function block inputs

	Description	Note
(Bit)		
EN	1: Activates the function block.	The checkbox for the ☑ Function block release by EN is

	Description	Note
		necessary parameter must first be enabled
(DWord)		
I1	Input value	Integer value range: -2,147,483,648 to +2,147,483,647
SH	Upper Threshold Value	
SL	Lower threshold value	

Assigning operands

You can assign the following operands to the function block inputs that are numeric inputs.

Operands	Value inputs
Constant, timer constant	x
MD, MW, MB - Markers	x
NB, NW, ND - NET markers	x
nNB, nND, nND- NET markers NET stations n	x
IA - Analog input	x
QA - Analog output	x
QV - QV - Numeric output of a FB	x

You can assign the following operands to the function block inputs that are bit inputs:

Operands	Bit inputs
Constant 0, constant 1	x
M – Markers	x
RN - Input bit via NET	x
SN - Output bit via NET (send)	x
N - Net marker bit	x
nN - NET marker bit NET station n	x
ID: Diagnostic alarm	x
LE - Output backlight	x
P buttons	x
I - Bit input	x
Q - Bit output	x
Q - Bit output of a FB	x

Function block outputs

	Description	Note
(DWord)		
QV	Outputs the value at input I1 within the set limits.	Integer value range: -2,147,483,648 to +2,147,483,647

Assigning operands

You can assign the following operands to the function block outputs that are numeric outputs:

Assigning operands	Outputs
Constant	x
Markers: MB, MD, MW	x
Analog inputs IA	x
Analog output QA	x
Numeric output from another QV FB	x

You can assign the following operands to the function block outputs that are bit outputs:

Assigning operands	Bit outputs
Constant 0, constant 1	x
M – Markers	x
SN - Output bit via NET (send)	x
N - Network marker bit	x
nN - NET station n marker	x
LE - Output backlight	x
Q - Bit output from another FB	x

Parameter set

Parameter set	Description	Note
☑ Function block release by EN is necessary	If this checkbox is enabled, the state of function block input EN will be evaluated. If the checkbox is disabled instead, the function block will be enabled and function block input EN will not do anything.	This parameter ensures that when existing programs are copied, the functionality of the function blocks that are carried over will be retained. The parameter will be automatically set to 0 or 1 depending on the function block.
Parameter display + Call enabled	Function block parameters and constants can be edited on the device.	
Simulation possible		

Other

Retention

The function block does not recognize retentive data.

See also

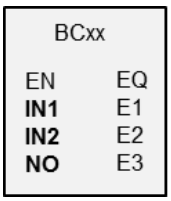
→ Section "DC - PID controller", page 272
→ Section "FT - PT1-Signal smoothing filter ", page 279
→ Section "TC - Three step controller", page 297
→ Section "BC - Block compare", page 306
→ Section "BV - Boolean operation", page 353
→ Section "PO - Pulse output", page 284

6.1.5 Data and register function blocks

6.1.5.1 BC - Block compare

General

easyE4 base devices provide 32 block comparison function blocks,
BC01 through BC32. This function block compares values from two contiguous marker ranges. Moreover, this comparison can be carried out within the entire marker range (1024 bytes).
Addresses are byte-based, including the range that can only be addressed with words or double words. (MB513 through MB1024) → Section "Organizing marker ranges", page 163



Operating principle

The reference data block starts at the source address specified at input I1. This data block will be compared with the data block that starts at the destination address specified at I2. You can use constants or operands, in which case the data value of the operand at runtime will be used as the corresponding address.

The NO input is used to specify the size of the data block (number of elements) in bytes.

If the comparison of two data blocks finds that there is no difference between them, the Boolean output EQ will be set to 1.

The following operands can be used:

- Constant NU
- ACTUAL value ..QV.. of a function block
- Analog input IA.. or analog output QA..
- Timer constant

Example value 0

A value <0> at input I1 means that the reference data block for the comparison starts at MB01. A value of <100> at I2 means that the target data block for the compare operation begins at MB101.

Marker byte example

You wish to compare the content of marker bytes MB11-MB14 with the content of marker bytes MB381-MB384 (MD96). A value <10> at input I1 means that the reference data block for the comparison starts at MB11. A value <380> at I2 means that the destination data block for the comparison starts at MB381.

→ Marker addresses are always specified using byte addresses.

→ easySoft 7 no longer supports addresses without an offset.

Update

After importing projects created with earlier versions of the programming software easySoft, check whether the "without offset" address type was used. If it was, you will need to reprogram the relevant parameters and replace the marker operands with constants.

Offset calculation for addressing marker words

Offset = MW (x-1)*2

Offset calculation for addressing marker double words

Offset = MD (x-1)*4

Parameter error due to incorrect number or offset definition

Bad parameter configurations will be output at program runtime via error outputs E1 through E3.
This type of parameter configuration error will occur, for example, when the number of elements exceeds the source or destination range or, due to an offset error, the source or destination range falls outside the available marker range.

Application example

Comparing marker data blocks

I1	MB23
I2	MB30
NO	NU 4

The function block and its parameters

Function block inputs

	Description	Note
(Bit)		
EN	1: Activates the function block.	The checkbox for the ☑ Function block release by EN is necessary parameter must first be enabled
(DWord)		
I1	Source range	First marker address (MB, MW, or MD) of the reference data block or offset added to marker byte MB01 when using one of the operands specified above.
I2	Destination range	First marker address (MB, MW or MD) of the destination data block or offset to marker byte MB01 when defining one of the operands stated in the table.
NO	Number of elements to be compared: max. 192 bytes	

Assigning operands

You can assign the following operands to the function block inputs that are numeric inputs.

Operands	Value inputs
Constant, timer constant	x
MD, MW, MB - Markers	x
NB, NW, ND - NET markers	x
nNB, nND, nND- NET markers NET stations n	x
IA - Analog input	x
QA - Analog output	x
QV - QV - Numeric output of a FB	x

You can assign the following operands to the function block inputs that are bit inputs:

Operands	Bit inputs
Constant 0, constant 1	x
M – Markers	x
RN - Input bit via NET	x
SN - Output bit via NET (send)	x
N - Net marker bit	x
nN - NET marker bit NET station n	x
ID: Diagnostic alarm	x
LE - Output backlight	x
P buttons	x
I - Bit input	x
Q - Bit output	x
Q - Bit output of a FB	x

Function block outputs

	Description	Note
(Bit)		
EQ	1: if the data ranges are identical. 0: if the data ranges are not identical.	
E1	Error output 1: if the number of elements exceeds the source or target range.	The range limits are checked irrespective of the edge change on the Boolean EN input.
E2	Error output 1: if the source and target range overlap.	The range limits are checked irrespective of the edge change on the Boolean EN input.
E3	Error output 1: if the source or destination range are outside of the available marker range (offset error, or input NO is not configured i.e. has the value 0.	The range limits are checked irrespective of the edge change on the Boolean EN input.
EQ	Equal 1: if the data ranges are identical. 0: if the data ranges are not identical.	

Assigning operands

You can assign the following operands to the function block outputs that are numeric outputs:

Assigning operands	Outputs
Constant	x
Markers: MB, MD, MW	x
Analog inputs IA	x
Analog output QA	x
Numeric output from another QV FB	x

You can assign the following operands to the function block outputs that are bit outputs:

Assigning operands	Bit outputs
Constant 0, constant 1	x
M – Markers	x
SN - Output bit via NET (send)	x
N - Network marker bit	x
nN - NET station n marker	x
LE - Output backlight	x
Q - Bit output from another FB	x

Parameter set

Parameter set	Description	Note
☑ Function block release by EN is necessary	If this checkbox is enabled, the state of function block input EN will be evaluated. If the checkbox is disabled instead, the function block will be enabled and function block input EN will not do anything.	This parameter ensures that when existing programs are copied, the functionality of the function blocks that are carried over will be retained. The parameter will be automatically set to 0 or 1 depending on the function block.
Parameter display + Call enabled	Function block parameters and constants can be edited on the device.	
Simulation possible		

Other

Retention

The function block does not recognize retentive data.

Example of a block comparison function block when using the EDP programming language

```
I 05----------------------------[ BC11EN
```

Figure 161: Wiring the enable coil

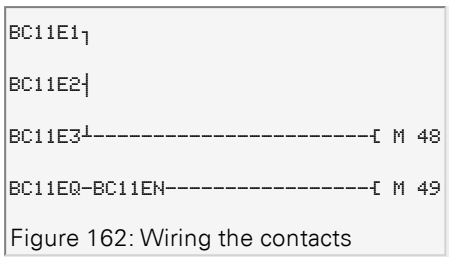


Figure 162: Wiring the contacts

Example of an AR configuration on a device display

When using the function block in the circuit diagram for the first time, use OK to automatically enter the display of function blocks on the device display, as shown in the following figure.



Figure 163: Parameters on the display

Enter the function block settings here. The display contains the following elements:

BC11 block compare	Function block: Data block comparator, number 11
+	Parameter set can be called via the PARAMETERS menu
>I1	Start of comparison range 1; the data block with the start address present at input I1 is compared with the data block with the start address present at input I2.
>I2	Start of comparison range 2
> NO	Number of elements to be compared in bytes per range, number: 1 - 383

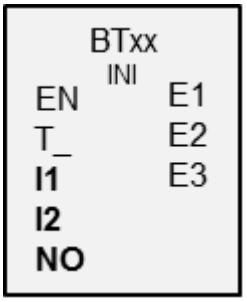
See also

→ Section "BC - Block compare", page 306
→ Section "FT - PT1-Signal smoothing filter ", page 279
→ Section "TC - Three step controller", page 297
→ Section "VC - Value limitation ", page 302
→ Section "BV - Boolean operation", page 353
→ Section "PO - Pulse output", page 284

6.1.5.2 BT - Block transfer

General

easyE4 base devices provide 32 Block Transfer function blocks BT01...BT32.
The block transfer function copies values from one marker range to a different, contiguous market range when the CPY (copy) operating mode is enabled.
When the INI (initialization) mode is enabled instead, the function block copies the content of a marker byte to a different, continuous marker range.
The transfer is carried out bytewise.



Operating principle

Data is transferred from the source address specified at function block input I1 to the destination address specified at function block input I2. The NO input is used to specify the size of the data block in bytes.

Transfer with offset

The source address for the copy or initialization is specified at function block input I1, while the destination address is specified at function block input I2. Within this context, the numeric value of the operand at runtime will be interpreted as the offset to be added to marker byte MB01.

Example with a value of "0"

A value 0 at input I1 means that the source data block for the transfer starts at MB01. A value 10 at I2 means that the destination data block for the transfer starts at MB11.

With the offset information you can address marker ranges (for example MB380), which you can not address when using marker operands (direct addressing).

Marker byte example

You wish to transfer the content of marker bytes MB1-MB4 with the content of marker bytes MB381-MB384 (MD96). A value 0 at input I1 means that the source data block for the transfer starts at MB01. A value 380 at I2 means that the destination address for the transfer starts at MB381.

Offset calculation for addressing marker words

Offset = MW (x-1)*2

Offset calculation for addressing marker double words

Offset = MD (x-1)*4

Parameter error due to incorrect number or offset definition

Incorrect parameters are indicated whilst the program is running via the E1 - E3 error outputs.
Parameter errors of this kind occur, for example, if the number of elements to be transferred exceeds the source or destination range, or when, due to an offset error, the source and destination range are outside of the available marker range.



Transfer function blocks always copy or initialize marker bytes, and never marker words or double words. This transfer behavior does not depend on the values at I1 and I2 (source address and destination address). You can copy a marker double word, e.g., MD 12 to MD 96, by copying 4 marker bytes with the function block.

The function block and its parameters

Function block inputs

	Description	Note
(Bit)		
EN	1: Activates the function block.	The checkbox for the ☑ Function block release by EN is necessary parameter must first be enabled
T_	Triggering the transfer on a rising edge	
(DWord)		
I1	Source address	Offset to marker byte MB01 when using for the definition one of the aforementioned operands
I2	Destination address	Offset to marker byte MB01 when using for the definition one of the operands stated in the table
NO	Number of elements to be initialized or copied.	Integer value range Operating mode INI: 1…+1024 Byte Operating mode CPY: 1…+1024 Byte

Assigning operands

You can assign the following operands to the function block inputs that are numeric inputs.

Operands	Value inputs
Constant, timer constant	x
MD, MW, MB - Markers	x
NB, NW, ND - NET markers	x
nNB, nND, nND- NET markers NET stations n	x
IA - Analog input	x
QA - Analog output	x
QV - QV - Numeric output of a FB	x

You can assign the following operands to the function block inputs that are bit inputs:

Operands	Bit inputs
Constant 0, constant 1	x
M – Markers	x
RN - Input bit via NET	x
SN - Output bit via NET (send)	x
N - Net marker bit	x
nN - NET marker bit NET station n	x
ID: Diagnostic alarm	x
LE - Output backlight	x
P buttons	x
I - Bit input	x
Q - Bit output	x
Q - Bit output of a FB	x

Operating modes

	Description	Note
INI	Initialize	Initializes the destination range with a byte value that is stored at the source address. The length of the source range is fixed at one byte. NO defines the length of the destination range.
CPY	Copy	Copies a data block from a source to a destination range. NO defines the size of the data block to be copied.

Copy mode, operating mode = CPY

In Copy mode, the function block copies the complete data range of the size specified at NO from the source range to the destination range. You specify the start of the source range and the destination range via I1 (source address) and I2 (destination address).

Example transfer with offset

Copying a marker data block (2 bytes) with a variable offset definition for the marker ranges.
The content of the marker bytes MB14 + MB15 are to be copied with a variable offset that is defined via the output QV of counter relay C3.

I1	NU14
I2	C 3
NO	NU 2

Initialization mode, operating mode = INI

In initialization mode, the function block takes a byte value that is stored at the source address (input I1) and copies it to a destination range. The destination range is specified

at input I2, and the length is defined by the value at input NO. The exact same source byte value (MB) is then copied to every single byte in the destination range.



If you select a type MD or MW marker operand as the source address, the function block always uses the content of the least significant byte for the initialization. If, for example, you assign MD 6 to I1, the function block initializes with the content of marker byte MB21.

Function block outputs

	Description	Note
(Bit)		
E1	Error output 1: if the number of elements exceeds the source or destination range.	The range limits are checked irrespective of the edge change on the Boolean T_ input. No data blocks are initialized or copied if an error occurs.
E2	Error output 1: if the source and destination range overlap.	The range limits are checked irrespective of the edge change on the Boolean _T input. No data blocks are initialized or copied if an error occurs.
E3	Error output 1: if the source or destination range are outside of the available marker range (offset error, or input NO is not configured i.e. has the value 0.	The range limits are checked irrespective of the edge change on the Boolean T_ input. No data blocks are initialized or copied if an error occurs.

Assigning operands

You can assign the following operands to the function block outputs that are numeric outputs:

Assigning operands	Outputs
Constant	x
Markers: MB, MD, MW	x
Analog inputs IA	x
Analog output QA	x
Numeric output from another QV FB	x

You can assign the following operands to the function block outputs that are bit outputs:

Assigning operands	Bit outputs
Constant 0, constant 1	x
M – Markers	x
SN - Output bit via NET (send)	x
N - Network marker bit	x
nN - NET station n marker	x
LE - Output backlight	x
Q - Bit output from another FB	x

Parameter set

	Description	Note
Parameter set		
☑ Function block release by EN is necessary	If this checkbox is enabled, the state of function block input EN will be evaluated. If the checkbox is disabled instead, the function block will be enabled and function block input EN will not do anything.	This parameter ensures that when existing programs are copied, the functionality of the function blocks that are carried over will be retained. The parameter will be automatically set to 0 or 1 depending on the function block.
Parameter display + Call enabled	Function block parameters and constants can be edited on the device.	
Simulation possible		

Other

Retention

The function block does not recognize retentive data.

Example of a configuration for a BT block transfer function block on the device display

When using the function block in the circuit diagram for the first time, use OK to automatically enter the display of function blocks on the device display, as shown in the following figure.

```
BT07 INI +
>I1
>I2
> NO
```

Figure 164: Parameters on the display

Enter the function block settings here. The display contains the following elements:

BT07 block transfer	Function block: block transfer, number 07
INI	Operating mode: INI - Initialize
+	Parameter set can be called via the PARAMETERS menu
>I1	Start address of source range or initialization markers (MB,MW,MD)
>I2	Start address destination range
> NO	Number of elements to be written in bytes per range, number: 1…383

Example of a block transfer function block when using the EDP programming language

The trigger coil is connected to a device input.

```
I 05-----------------------------[ BT07T_
```

Figure 165: Wiring the trigger coil

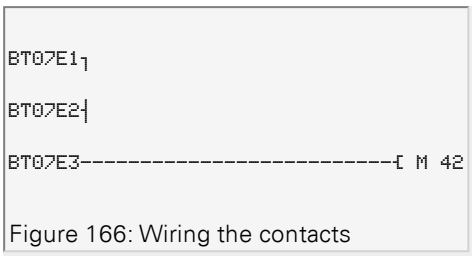


Figure 166: Wiring the contacts

The messages of the function block are sent as a group message to a marker M42.

See also

→ Section "BC - Block compare", page 306
→ Section "BT - Block transfer", page 311
→ Section "MX - Data multiplexer", page 322
→ Section "SR - Shift register", page 326
→ Section "TB - Table function", page 334
→ Section "Retention function", page 473
→ Section "Organizing marker ranges", page 163

6.1.5.3 DB - Data function block

General

easyE4 base devices provide 32 data function blocks DB01…DB32.
This function block makes it possible to copy bytes, words, or double words to an operand for only one cycle.



Operating principle

When there is a rising edge at function block input T_, the value at function block input I1 will be passed to an operand connected to function block output QV. The operand will keep that value until the next time it is overwritten,
meaning it can be used, for example, to save reference values for function blocks.

Note that the data function block only transfers the value in the program cycle in which it detects a rising edge. When the operand linked with output QV is overwritten by the program after the value is transferred, the value transferred with the data function block is lost.

The function block and its parameters

Function block inputs

	Description	Note
(Bit)		
EN	1: Activates the function block.	The checkbox for the ☑ Function block release by EN is necessary parameter must first be enabled
T_	A rising edge at this input will transfer the value of function block input I1 to the operand connected to QV.	
(DWord)		
I1	Value that is transferred to output QV when the function block is triggered.	Integer value range: -2,147,483,648 to +2,147,483,647

Assigning operands

You can assign the following operands to the function block inputs that are numeric inputs.

Operands	Value inputs
Constant, timer constant	x
MD, MW, MB - Markers	x
NB, NW, ND - NET markers	x
nNB, nND, nND- NET markers	x

Operands	Value inputs
NET stations n	
IA - Analog input	x
QA - Analog output	x
QV - QV - Numeric output of a FB	x

You can assign the following operands to the function block inputs that are bit inputs:

Operands	Bit inputs
Constant 0, constant 1	x
M – Markers	x
RN - Input bit via NET	x
SN - Output bit via NET (send)	x
N - Net marker bit	x
nN - NET marker bit NET station n	x
ID: Diagnostic alarm	x
LE - Output backlight	x
P buttons	x
I - Bit input	x
Q - Bit output	x
Q - Bit output of a FB	x

Function block outputs

	Description	Note
(Bit)		
Q1	1: transfer confirmation, if function block output T_ is 1.	
(DWord)		
QV	Passes the value at function block input I1 to the operand connected to QV during the program cycle in which a rising edge is detected at T_.	Integer value range: -2,147,483,648 to +2,147,483,647

Assigning operands

You can assign the following operands to the function block outputs that are numeric outputs:

Assigning operands	Outputs
Constant	x
Markers: MB, MD, MW	x
Analog inputs IA	x
Analog output QA	x
Numeric output from another QV FB	x

You can assign the following operands to the function block outputs that are bit outputs:

Assigning operands	Bit outputs
Constant 0, constant 1	x
M – Markers	x
SN - Output bit via NET (send)	x
N - Network marker bit	x
nN - NET station n marker	x
LE - Output backlight	x
Q - Bit output from another FB	x

Parameter set

	Description	Note
Parameter set		
☑ Function block release by EN is necessary	If this checkbox is enabled, the state of function block input EN will be evaluated. If the checkbox is disabled instead, the function block will be enabled and function block input EN will not do anything.	This parameter ensures that when existing programs are copied, the functionality of the function blocks that are carried over will be retained. The parameter will be automatically set to 0 or 1 depending on the function block.
☑ No edge evaluation of T bit input		
Parameter display + Call enabled	Function block parameters and constants can be edited on the device.	
Simulation possible		

Other

Retention

Data blocks can be operated with retentive actual values.
To select the number of data blocks, go to *Project view/System settings/Retention area*.
The retentive actual value will require 4 bytes of memory space. If a data block is retentive, the actual value will be retained when the operating mode changes from RUN to STOP and when the power supply is switched off. If the device is started in RUN mode, the data block will continue to work with the actual value stored in non-volatile memory.

Signal diagram

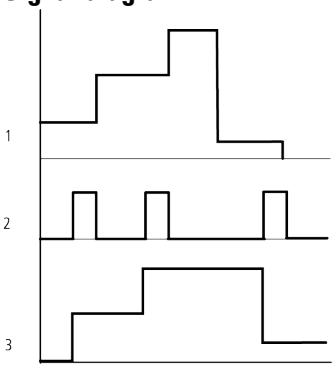


Figure 167: Signal diagram of data function block

Legend for Figure

1: Value at input DB..>I1

2: Trigger coil DB…T_

3: Value on DB…QV>

Example of a data function block with programming method EDP

The trigger coil is addressed via the network.

```
GT01Q1-------------------------[ DB16T
```

Figure 168: Wiring the trigger coil

The output of the data function block DB16Q1 is assigned to the input D02 EN of the text display function block.

```
DB16Q1-------------------------[ D 02EN
```

Figure 169: Wiring of the function block contact

Example of a DB configuration on a device display

When using the function block in the circuit diagram for the first time, use OK to automatically enter the display of function blocks on the device display, as shown in the following figure.

```
DB16 +
>I1
QV>
```

Figure 170: Parameters on the display

Enter the function block settings here. The display contains the following elements:

DB16 data function block	Function block: Data function block, number 16
+	Parameter set can be called via the PARAMETERS menu
>I1	Input value Integer value range: -2,147,483,648 to +2,147,483,647

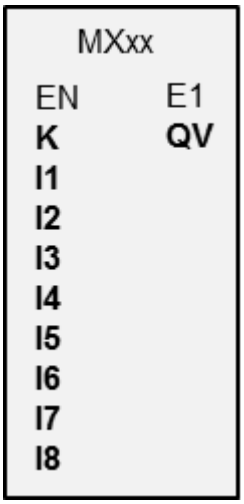
>I2	Outputs the value of DB..I1 when triggered. Integer value range: -2,147,483,648 to +2,147,483,647

See also

→ Section "BC - Block compare", page 306
→ Section "BT - Block transfer", page 311
→ Section "MX - Data multiplexer", page 322
→ Section "SR - Shift register", page 326
→ Section "TB - Table function", page 334
→ Section "Retention function", page 473
→ Section "Organizing marker ranges", page 163

6.1.5.4 MX - Data multiplexer

General



easyE4 base devices provide 32 data multiplexer function blocks, MX01 through MX32. You can use a data multiplexer to select a value from eight input values, I1 through I8. The function block will then provide this value at output QV for further processing.
Use input K (channel number) to specify which input will be connected through to the output. Channel number 0 will connect input I1 to QV, while channel number 7 will connect input I8 to QV.
The MX data multiplexer can be used for the sequential control of up eight to positioning sections that are transferred to the I1 input of the PO Pulse output function block.

Operating principle

If there is a signal state of 1 at the EN coil, the data value of the operand connected to input Ix will be connected through to output QV. In this case, the value at function block input K will reference input Ix.

You can change the channel number and accordingly connect a different input value through to QV even when the EN input is set.
If there is a signal state of "0" at the EN coil, output QV will be set to a signal state of "0". The function block will carry out a selection of one out of eight.

The function block and its parameters

Function block inputs

	Description	Note
(Bit)		
EN	1: Activates the function block.	The checkbox for the ☑ Function block release by EN is necessary parameter must first be enabled
(DWord)		
K	Channel number References the function block input you want (I1 through I8). channel — Function block input 0 — I1 1 — I2	Integer value range: 0…7

	Description		Note
	2	i3	
	3	I4	
	4	I5	
	5	I6	
	6	I7	
	7	I8	
I1…I8	Input value		Integer value range: -2,147,483,648 to +2,147,483,647

Assigning operands

You can assign the following operands to the function block inputs that are numeric inputs.

Operands	Value inputs
Constant, timer constant	x
MD, MW, MB - Markers	x
NB, NW, ND - NET markers	x
nNB, nND, nND- NET markers NET stations n	x
IA - Analog input	x
QA - Analog output	x
QV - QV - Numeric output of a FB	x

You can assign the following operands to the function block inputs that are bit inputs:

Operands	Bit inputs
Constant 0, constant 1	x
M – Markers	x
RN - Input bit via NET	x
SN - Output bit via NET (send)	x
N - Net marker bit	x
nN - NET marker bit NET station n	x
ID: Diagnostic alarm	x
LE - Output backlight	x
P buttons	x
I - Bit input	x
Q - Bit output	x
Q - Bit output of a FB	x

Function block outputs

	Description	Note
(Bit)		
E1	Error output 1: with incorrect parameters , if 0 > K or K > 7	Output QV is reset to 0 if there is a parameter error.
(DWord)		
QV	Output value of the selected channel	Integer value range: -2,147,483,648 to +2,147,483,647

Assigning operands

You can assign the following operands to the function block outputs that are numeric outputs:

Assigning operands	Outputs
Constant	x
Markers: MB, MD, MW	x
Analog inputs IA	x
Analog output QA	x
Numeric output from another QV FB	x

You can assign the following operands to the function block outputs that are bit outputs:

Assigning operands	Bit outputs
Constant 0, constant 1	x
M – Markers	x
SN - Output bit via NET (send)	x
N - Network marker bit	x
nN - NET station n marker	x
LE - Output backlight	x
Q - Bit output from another FB	x

Parameter set

	Description	Note
☑ Function block release by EN is necessary	If this checkbox is enabled, the state of function block input EN will be evaluated. If the checkbox is disabled instead, the function block will be enabled and function block input EN will not do anything.	This parameter ensures that when existing programs are copied, the functionality of the function blocks that are carried over will be retained. The parameter will be automatically set to 0 or 1 depending on the function block.
Parameter display + Call enabled	Function block parameters and constants can be edited on the device.	
Simulation possible		

Other

Retention

The function block does not recognize retentive data.

See also

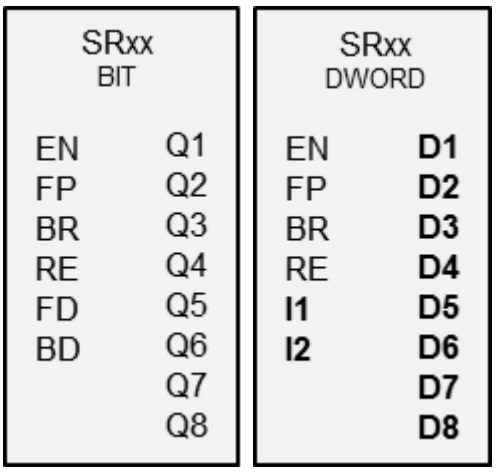
→ Section "BC - Block compare", page 306
→ Section "BT - Block transfer", page 311
→ Section "MX - Data multiplexer", page 322
→ Section "SR - Shift register", page 326
→ Section "TB - Table function", page 334
→ Section "Retention function", page 473
→ Section "Organizing marker ranges", page 163

6.1.5.5 SR - Shift register

General

easyE4 base devices provide 32 shift register function blocks, SR01 through SR32.

These function blocks can be used to shift bits or double words by one position with every clock pulse. You can select the BIT or DWORD operating mode with a parameter. To set the shift direction, you will need to activate either function block input FP (forward pulse) or function block input BP (backward pulse). The values to be accepted in the shift register are located at different inputs depending on the shift direction and operating mode.



The shift register has a linear structure. If, for example, a clock-pulsed bit operation adds a value is at one end of the register, another value is dropped at the other end.

Operating principle

SR function block - shift register (BIT)

A rising edge at FP (ForwardPulse) causes the bit value to be accepted at data input FD (ForwardData) into the first register field Q1. The original contents of the register fields are then moved by one field in the direction of the next higher field numbers.

A rising edge at the BP (BackwardPulse) transfers the bit value at the BD (BackwardData) data input to the last register field Q8. The original contents of the register fields are then moved by one field in the direction of the next lower field numbers.

Example: Shift register BIT mode, forward

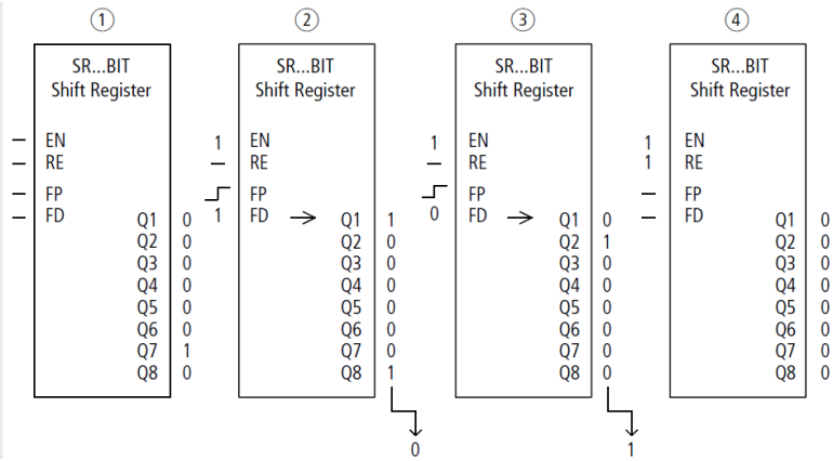


Figure 171: Shift register SR..: Forwards operation in BIT operating mode

1. Initial situation
   – SR..EN is not activated, the function block is not active.
   – SR..Q7 contains a data bit 1, a 0 is contained in the other register fields.
2. Transfer of a data bit
   – SR..EN is activated, the function block is active.
   – SR..FD has the value 1.
   – With the forwards pulse from SR..FP the register field SR..Q1 shifts the content of all register fields one place forwards and accepts the 1 from SR..FD.
3. Transfer of a data bit
   – SR..EN is activated, the function block is active.
   – SR..FD has the value 0.
   – With the forwards pulse from SR..FP the register field SR..Q1 shifts the content of all register fields one place forwards and accepts the 0 from SR..FD.
4. Reset of the register
   – SR..EN is activated, the function block is active.
   – Activating SR..RE clears the content of the register.

SR function block - shift register (DWORD)

A rising edge at FP (ForwardPulse) causes the double word value at data input I1 to be transferred to the first register field D1. The original contents of the register fields are then moved by one field in the direction of the next higher field numbers. A rising edge at the BP (BackwardPulse) transfers the double word value at data input I2 to the last register field D8. The original contents of the register fields are then moved by one field in the direction of the next lower field numbers.

Example: Shift register DW mode, backward

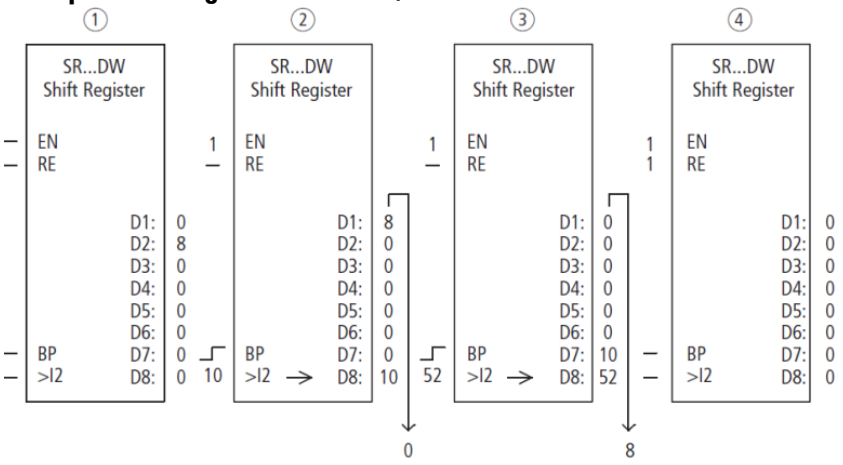


Figure 172: Shift register SR..: Backwards operation in DW operating mode

① Initial situation
– SR..EN is not activated, the function block is not active.
– SR..D2 contains the value 8, a 0 is contained in the other register fields.

② Transfer of value
– SR..EN is activated, the function block is active.
– SR..I2 has the value 10.
– With the backwards pulse from SR..BP the register field SR..D8 shifts the content of all register fields one place back and accepts the 10 from SR..I2.

③ Transfer of value
– SR..EN is activated, the function block is active.
– SR..I2 has the value 52.
– With the backwards pulse from SR..BP the register field SR..D8 shifts the content of all register fields one place back and accepts the 52 from SR..I2.

④ Reset of the register
– SR..EN is activated, the function block is active.
– Activating SR..RE clears the content of the register.

The function block and its parameters

Function block inputs

	Description	Note
(Bit)		
EN	1: Activates the function block.	The checkbox for the ☑ Function block release by EN is necessary parameter must first be enabled
FP	Forward Pulse Single Clock input, shift register forward	
BP	Backward Pulse Clock input, shift register backward	
RE	Reset 1 clears the entire output register Q1...Q8 and D1...D8.	

	Description	Note
FD	Bit data input, shift register forward	
BD	Bit data input, shift register backward	
(DWord)		
I1	Input value for shift direction forwards	Integer value range: -2,147,483,648 to +2,147,483,647
I2	Input value for shift direction backwards	

Assigning operands

You can assign the following operands to the function block inputs that are numeric inputs.

Operands	Value inputs
Constant, timer constant	x
MD, MW, MB - Markers	x
NB, NW, ND - NET markers	x
nNB, nND, nND- NET markers NET stations n	x
IA - Analog input	x
QA - Analog output	x
QV - QV - Numeric output of a FB	x

You can assign the following operands to the function block inputs that are bit inputs:

Operands	Bit inputs
Constant 0, constant 1	x
M – Markers	x
RN - Input bit via NET	x
SN - Output bit via NET (send)	x
N - Net marker bit	x
nN - NET marker bit NET station n	x
ID: Diagnostic alarm	x
LE - Output backlight	x
P buttons	x
I - Bit input	x
Q - Bit output	x
Q - Bit output of a FB	x

Operating modes

	Description	Note
BIT	Marker bit shift operation	
DW	Marker double word shift operation	

The factory setting of this parameter is BIT.

The operating mode is determined by selecting different function blocks:
SR - shift register (BIT) or
SR - shift register (DWORD)
and not with the parameters for the function block as is usually the case.

If the BIT operating mode is selected, the inputs I1, I2 and outputs D1-D8 are displayed. They have no function in BIT mode! If they are assigned operands, these will have no effect. The wiring of the SR function block (BIT) is carried out in the circuit diagram.

Function block outputs

	Description	Note
(Bit)		
Q1…Q8	Output of the bit register fields 1 - 8	
(DWord)		
D1…D8	Register values for the shift register 1 through 8	Integer value range: -2,147,483,648 to +2,147,483,647

Assigning operands

You can assign the following operands to the function block outputs that are numeric outputs:

Assigning operands	Outputs
Constant	x
Markers: MB, MD, MW	x
Analog inputs IA	x
Analog output QA	x
Numeric output from another QV FB	x

You can assign the following operands to the function block outputs that are bit outputs:

Assigning operands	Bit outputs
Constant 0, constant 1	x
M – Markers	x
SN - Output bit via NET (send)	x
N - Network marker bit	x
nN - NET station n marker	x
LE - Output backlight	x
Q - Bit output from another FB	x

Parameter set

	Description	Note
☑ Function block release by EN is necessary	If this checkbox is enabled, the state of function block input EN will be evaluated. If the checkbox is disabled instead, the function block will be enabled and function block input EN will not do anything.	This parameter ensures that when existing programs are copied, the functionality of the function blocks that are carried over will be retained. The parameter will be automatically set to 0 or 1 depending on the function block.
Parameter display + Call enabled	Function block parameters and constants can be edited on the device.	
Simulation possible		

Other

Retention

The function block does not recognize retentive data.

Application example

Different workpieces are moved along a production line with several machining stations. An operator determines the work required for the individual workpieces, creates a production code for it and writes it into a shift register. The workpieces reach the machining stations in this order. When the workpiece is changed, the stations read the required production steps from their permanently assigned register field. When workpiece 1 moves to the first station, the forwards pulse input coil SR01FP and the shift register SR01 receive production code 01 at input SR1I1 from the double word marker MD11. Production code 1 is now at the register field SR01D1 for the first machining station which reads it from double word marker MD01. The finished workpiece is then transferred to station 2. The shift register accepts the production code 2 for the next workpiece.

Production code 1 moves one place forwards, as does the remaining register content. It now stands at register output SR01D2. It reaches machining station 2 via double word marker MD02. The process is repeated for each further workpiece and for each further machining station until the finished workpieces leave the line.

When using the EDP programming language, the coils are connected in the circuit diagram:

The enable coil SR01EN is permanently active, the function block is not switched off.

Marker M09 switches the forwards pulse input coil SR01FP.

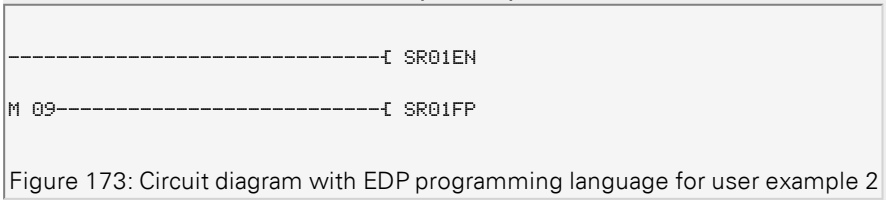


Figure 173: Circuit diagram with EDP programming language for user example 2

SR01 configuration on device display

When using the function block in the circuit diagram for the first time, use OK to automatically enter the display of function blocks on the device display, as shown in the following figure. After defining shift register number 01, you set here the following parameters:

- The DW operating mode for the double word marker format.
- The double word markers for receiving the production code.

```
SR01 DW +
>I1 MD11
>I2
D1> MD01
D2> MD02
D3> MD03
D4>
D5>
D6>
D7>
D8>
```

Figure 174: Parameters on the device display

Enter the function block settings here. The display contains the following elements:

SR01 shift register	Function block: SR shift register, number 01
DW	Operating mode: Double word
+	Parameter set can be called via the PARAMETERS menu
>I1	Input value DW forwards: Integer value range: -2,147,483,648 to +2,147,483,647
>I2	Input value DW backwards: Integer value range: -2,147,483,648 to +2,147,483,647
D1>	Register value 1 of the shift register, Integer value range: -2,147,483,648 to +2,147,483,647 for all registers
D2>	Register value 2
D3>	Register value 3
D4>	Register value 4
D5>	Register value 5
D6>	Register value 6
D7>	Register value 7
D8>	Register value 8

See also

→ Section "BC - Block compare", page 306
→ Section "BT - Block transfer", page 311
→ Section "SR - Shift register", page 326
→ Section "MX - Data multiplexer", page 322
→ Section "TB - Table function", page 334
→ Section "Retention function", page 473
→ Section "Organizing marker ranges", page 163

6.1.5.6 TB - Table function

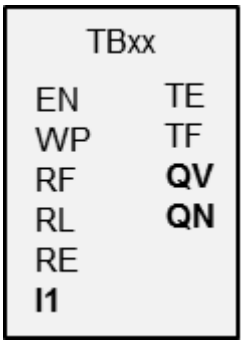
General

easyE4 base devices provide 32 table function function blocks, TB01 through TB32.

The table function block allows you to easily create and read table entries in the form of double words (32 bit).

You can select a LIFO or FIFO function for read operations.

A table can contain up to 16 double words.



Operating principle

Writing to a table

The function block is enabled when EN=1. When the function block is enabled and there is a rising edge at the function block input, the current value at function block input I1 will be added to the table. Every time there is an edge, a double word (32 bits) will be assigned a value.
It is permissible to simultaneously activate the EN coil and the WP coil with a rising edge.
Every new table entry will be appended after the last entry until the sixteenth entry is reached. At the same time, function block output QN will be incremented by 1. QN indicates the current number of entries. If I1 is added successfully, the input value that was just entered will be output at function block output QV.
Once the maximum number of 16 table entries is reached, no more data will be added to the table. If you want to keep making table entries in this scenario, you will first need to clear the entire table with a rising edge at function block input RE. Function block output QN will be set to 0 in this case.

Reading from the table

A table can be read from the table's beginning or end.
When there is a rising edge at the RF coil, the oldest value in the table will be read and output at output QV (FIFO function).
The read operation deletes this value from the table and the actual number of entries is decremented by 1 at the QN output.

A rising edge at the RL coil causes the most recent value entered in the table to be output at QV (LIFO function).
The read operation deletes this value from the table and the actual number of entries is decremented by 1 at the QN output.

The function block and its parameters

Function block inputs

	Description	Note
(Bit)		
EN	1: Activates the function block.	The checkbox for the ☑ Function block release by EN is necessary parameter must first be enabled
WP	Trigger coil Rising edge: The value at I1 will be added to the table and output at function block output QV. QN will be incremented by 1.	
RF	Trigger coil Rising edge: The oldest value in the table will be output at function block output QV (FIFO function). QN will be decremented by 1 with each read operation.	
RL	Trigger coil Rising edge: The most recent value in the table will be output at function block output QV (LIFO function). QN will be decremented by 1 with each read operation.	
RE	Reset Rising edge: The entire table will be cleared. Function block output QN will be set to 0.	
(DWord)		
I1	Input value to be transferred to the table.	Integer value range: -2,147,483,648 to +2,147,483,647

Assigning operands

You can assign the following operands to the function block inputs that are numeric inputs.

Operands	Value inputs
Constant, timer constant	x
MD, MW, MB - Markers	x
NB, NW, ND - NET markers	x
nNB, nND, nND- NET markers NET stations n	x
IA - Analog input	x
QA - Analog output	x
QV - QV - Numeric output of a FB	x

You can assign the following operands to the function block inputs that are bit inputs:

Operands	Bit inputs
Constant 0, constant 1	x

Operands	Bit inputs
M – Markers	x
RN - Input bit via NET	x
SN - Output bit via NET (send)	x
N - Net marker bit	x
nN - NET marker bit NET station n	x
ID: Diagnostic alarm	x
LE - Output backlight	x
P buttons	x
I - Bit input	x
Q - Bit output	x
Q - Bit output of a FB	x

The function block and its parameters

Function block outputs

	Description	Note
(Bit)		
TE	1: if the table is empty.	
TF	1: if the table is full.	
(DWord)		
QV	Read operation: The value read from the start or end of the table. Write operation: The input value just entered.	
QN	Current number of table entries	Integer value range: 0…16

Assigning operands

You can assign the following operands to the function block outputs that are numeric outputs:

Assigning operands	Outputs
Constant	x
Markers: MB, MD, MW	x
Analog inputs IA	x
Analog output QA	x
Numeric output from another QV FB	x

You can assign the following operands to the function block outputs that are bit outputs:

Assigning operands	Bit outputs
Constant 0, constant 1	x
M – Markers	x
SN - Output bit via NET (send)	x
N - Network marker bit	x

Assigning operands	Bit outputs
nN - NET station n marker	x
LE - Output backlight	x
Q - Bit output from another FB	x

Parameter set

Configuration/time range	Description	Note
☑ Function block release by EN is necessary	If this checkbox is enabled, the state of function block input EN will be evaluated. If the checkbox is disabled instead, the function block will be enabled and function block input EN will not do anything.	This parameter ensures that when existing programs are copied, the functionality of the function blocks that are carried over will be retained. The parameter will be automatically set to 0 or 1 depending on the function block.
Parameter display + Call enabled	Function block parameters and constants can be edited on the device.	
Simulation possible		

Other

Retention

The function block does not recognize retentive data.

Example of a table function when using the EDP programming language

While in the Programming view:

- Position a TB function block on a coil field in your circuit diagram.
- In the Properties field window select the required function block number on the circuit diagram element tab.
- Assign a numerical operand to the function block input I1 so that a numerical value can be transferred.
- Connect the coils TBxxEN, TBxxWP, TBxxRF etc. with the contact suitable for activation.
- If required, write a comment for the selected operand.

If you wish to check if a table is full or empty, you must also wire this function block as a contact.

- Position the function block on a contact field and select the same function block number in the circuit diagram element tab that you have assigned to the coil.
- If required, change the switch function of the contact from break to make contact.
- If necessary, position the function block on a contact field and associate TBxxTE (table empty) and TBxxTF (table full) with a Boolean operand suitable for evaluation tasks.

Whether you position the function relay first of all in a coil field or contact field or whether you make the entries in the Parameters tab of a coil or a contact is not important. It is only important that you have selected the same function block number if you also want to configure the same function block.

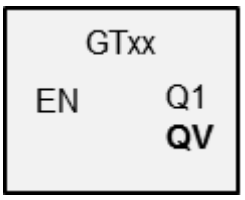
See also

→ Section "BC - Block compare", page 306
→ Section "BT - Block transfer", page 311
→ Section "TB - Table function", page 334
→ Section "MX - Data multiplexer", page 322
→ Section "SR - Shift register", page 326
→ Section "Retention function", page 473
→ Section "Organizing marker ranges", page 163

6.1.6 NET function blocks

6.1.6.1 GT - Get values from NET

General



easyE4 base devices provide 32 function blocks GT01…GT32 (GET).
The list of operands and function blocks will only include this function block if the project view features a NET consisting of at least two devices.

With function block GT you can poll a 32-bit value from the NET network. The function block automatically fetches the data designated for itself as soon as it is provided on the NET by another NET station using PUT function block PT.

Operating principle

The GET function block can be used to read a value from the NET. This value is sent beforehand by the corresponding PUT function block of another NET station. The sent value can be the content of a function block output, a marker byte, word or double word.

Each GET function block is assigned exactly one PUT function block in the parameters for the function block. At runtime, only one single EN enable signal is required, and the received value will be provided each cycle.

→ The SC function block only functions if the NET is running properly.

The function block and its parameters

Function block inputs

	Description	Note
(Bit)		
EN	1: Activates the function block.	

Assigning operands

You can assign the following operands to the function block inputs that are numeric inputs.

Operands	Value inputs
Constant, timer constant	x
MD, MW, MB - Markers	x
NB, NW, ND - NET markers	x
nNB, nND, nND- NET markers NET stations n	x

Operands	Value inputs
IA - Analog input	x
QA - Analog output	x
QV - QV - Numeric output of a FB	x

You can assign the following operands to the function block inputs that are bit inputs:

Operands	Bit inputs
Constant 0, constant 1	x
M – Markers	x
RN - Input bit via NET	x
SN - Output bit via NET (send)	x
N - Net marker bit	x
nN - NET marker bit NET station n	x
ID: Diagnostic alarm	x
LE - Output backlight	x
P buttons	x
I - Bit input	x
Q - Bit output	x
Q - Bit output of a FB	x

Function block outputs

	Description	Note
(Bit)		
Q1	1: if a new value transferred from the NET network is present. Only valid for one processing cycle	
(DWord)		
QV	Value received from NET	

Assigning operands

You can assign the following operands to the function block outputs that are numeric outputs:

Assigning operands	Outputs
Constant	x
Markers: MB, MD, MW	x
Analog inputs IA	x
Analog output QA	x
Numeric output from another QV FB	x

You can assign the following operands to the function block outputs that are bit outputs:

Assigning operands	Bit outputs
Constant 0, constant 1	x
M – Markers	x

Assigning operands	Bit outputs
SN - Output bit via NET (send)	x
N - Network marker bit	x
nN - NET station n marker	x
LE - Output backlight	x
Q - Bit output from another FB	x

Parameter set

	Description	Note
☑ Function block release by EN is necessary	If this checkbox is enabled, the state of function block input EN will be evaluated. If the checkbox is disabled instead, the function block will be enabled and function block input EN will not do anything.	This parameter ensures that when existing programs are copied, the functionality of the function blocks that are carried over will be retained. The parameter will be automatically set to 0 or 1 depending on the function block.
Parameter display + Call enabled	Function block parameters and constants can be edited on the device.	
Function block input	NET-ID: The number of the transmitting NET station.	Value range: 01…08
	PT: Number of the transmit function block (e.g. PT 20) by which the transmitting NET station puts a value onto the NET.	Possible function block numbers: 01...32
Simulation not possible		

To set parameters, follow the steps below:

- Uniquely define the sender providing the value for the GET function block. To do this, go to Programming view/Get value from the NET parameters tab /Function block input section/NET-ID and select the number of the transmitting NET station.
- Select also the number of the transmitting PUT function block from the PT drop-down menu.
- Connect the QV function block output to an operand to which you want to pass the received value.

Other

Retention

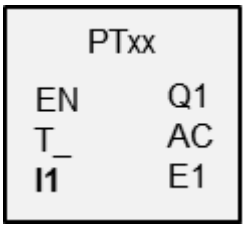
The function block does not recognize retentive data.

See also

→ Section "PT - Put values to NET", page 342
→ Section "GT - Get values from NET", page 339
→ Section "Setting up a NET", page 537

6.1.6.2 PT - Put values to NET

General



easyE4 base devices provide 32 function blocks PT01…PT32 (PUT).

The list of operands and function blocks will only include this function block if the project view features a NET consisting of at least two devices.

These function blocks can be used to pass an operand, which must not be longer than 32 bits, to the NET. The operand value is transferred and automatically read by the corresponding GET function block GT of another NET station.

Operating principle

The operand being transmitted needs to be connected to function block input I1. To do this, you can use the output from another function block, e.g., an arithmetic function block. Using a marker double word such as MD1 will make it possible to simultaneously transmit 32 marker bits, M01 through M32.

To transmit marker bits M01 through M96, you would need three PUT function blocks in order to transmit marker double words MD1, MD2, and MD3

You can trigger the transmission with a rising edge at function block input T_. In order for the function block to do another transmission, it would then need to detect another rising edge.

As an alternative, you can have the device do transmissions that depend on the cycle time, i.e., by specifying the number of cycles after which the transmission should occur. This makes it possible to optimize net loads and to transmit values that are not subject to change as frequently less often.

These options are selected in the parameters for the function block.

→ The SC function block only functions if the NET is running properly.

The function block and its parameters

Function block inputs

	Description	Note
(Bit)		
EN	1: Activates the function block.	
T_	Trigger coil When there is a rising edge, the function block will temporarily save the input value at I1 and pass it to the NET.	
(DWord)		

	Description	Note
I1	Input value that is to be put onto the NET.	Integer value range: -2,147,483,648 to +2,147,483,647

Assigning operands

You can assign the following operands to the function block inputs that are numeric inputs.

Operands	Value inputs
Constant, timer constant	x
MD, MW, MB - Markers	x
NB, NW, ND - NET markers	x
nNB, nND, nND- NET markers NET stations n	x
IA - Analog input	x
QA - Analog output	x
QV - QV - Numeric output of a FB	x

You can assign the following operands to the function block inputs that are bit inputs:

Operands	Bit inputs
Constant 0, constant 1	x
M – Markers	x
RN - Input bit via NET	x
SN - Output bit via NET (send)	x
N - Net marker bit	x
nN - NET marker bit NET station n	x
ID: Diagnostic alarm	x
LE - Output backlight	x
P buttons	x
I - Bit input	x
Q - Bit output	x
Q - Bit output of a FB	x

Function block outputs

	Description	Note
(Bit)		
Q1	1: if the status of the trigger coil PT..T_ is also 1.	
AC	1: As soon as a transmit job is activated, or as soon as one is aborted with an error message at output E1.	This bit output is used for checking whether the required value was transferred to the NET.
E1	Error - NET transmission error 1: If the value could not be sent and	

	Description	Note
	the previously set AC output changes from a state of 1 back to 0. The output will remain with a state of 1 until a new transmit job is activated.	

Assigning operands

You can assign the following operands to the function block outputs that are numeric outputs:

Assigning operands	Outputs
Constant	x
Markers: MB, MD, MW	x
Analog inputs IA	x
Analog output QA	x
Numeric output from another QV FB	x

You can assign the following operands to the function block outputs that are bit outputs:

Assigning operands	Bit outputs
Constant 0, constant 1	x
M – Markers	x
SN - Output bit via NET (send)	x
N - Network marker bit	x
nN - NET station n marker	x
LE - Output backlight	x
Q - Bit output from another FB	x

Parameter set

	Description	Note
☑ Function block release by EN is necessary	If this checkbox is enabled, the state of function block input EN will be evaluated. If the checkbox is disabled instead, the function block will be enabled and function block input EN will not do anything.	This parameter ensures that when existing programs are copied, the functionality of the function blocks that are carried over will be retained. The parameter will be automatically set to 0 or 1 depending on the function block.
☑ No edge evaluation of T bit input	When this checkbox is enabled, the data will be transmitted to the NET based on cycle times. It will be transmitted every nth cycle, where n can be defined in the parameters for the function block. If the checkbox is disabled, manual transmission triggering with an edge	

	Description	Note
	at function block input T_ will be required.	
Write data to NET after each … <n> cycle	Can only be selected if ☑ No edge evaluation of T bit input is enabled.	
Parameter display + Call enabled	Function block parameters and constants can be edited on the device.	
Simulation not possible		

Other

Retention

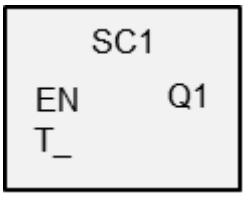
The function block does not recognize retentive data.

See also

→ Section "GT - Get values from NET", page 339
→ Section "PT - Put values to NET", page 342
→ Section "Setting up a NET", page 537

6.1.6.3 SC - Synchronizing clock via NET

General



easyE4 base devices provide exactly one function block SC01 (Send Clock).
This function block allows you to selectively place the date and time onto the network. All other NET stations accept the date and time of the transmitting station and set their device real-time clock accordingly.

Operating principle

If the function block's trigger coil is activated, the current date, day of the week, and time of the transmitting station will be sent to the NET network. The transmitting station will perform this operation as soon as the seconds counter of the device's real-time clock goes through zero to the next minute. The other stations accept this value. This process can be repeated as often as desired. In this case, the function block input trigger coil must be changed from a state of "0" to a state of "1" again.

Accuracy of time synchronization

The maximum time deviation between the functional stations is 5 s.

→ The SC function block only functions if the NET is running properly.

The function block and its parameters

Function block inputs

	Description	Note
(Bit)		
EN	1: Activates the function block.	
T_	Trigger coil When there is a rising edge, the function block will transmit the current date, day of the week, and time to the NET.	

Assigning operands

You can assign the following operands to the function block inputs that are numeric inputs.

Operands	Value inputs
Constant, timer constant	x
MD, MW, MB - Markers	x
NB, NW, ND - NET markers	x
nNB, nND, nND- NET markers NET stations n	x
IA - Analog input	x

Operands	Value inputs
QA - Analog output	x
QV - QV - Numeric output of a FB	x

You can assign the following operands to the function block inputs that are bit inputs:

Operands	Bit inputs
Constant 0, constant 1	x
M – Markers	x
RN - Input bit via NET	x
SN - Output bit via NET (send)	x
N - Net marker bit	x
nN - NET marker bit NET station n	x
ID: Diagnostic alarm	x
LE - Output backlight	x
P buttons	x
I - Bit input	x
Q - Bit output	x
Q - Bit output of a FB	x

Function block outputs

	Description	Note
(Bit)		
Q1	1: If the transmit job has been completed.	

Assigning operands

You can assign the following operands to the function block outputs that are numeric outputs:

Assigning operands	Outputs
Constant	x
Markers: MB, MD, MW	x
Analog inputs IA	x
Analog output QA	x
Numeric output from another QV FB	x

You can assign the following operands to the function block outputs that are bit outputs:

Assigning operands	Bit outputs
Constant 0, constant 1	x
M – Markers	x
SN - Output bit via NET (send)	x
N - Network marker bit	x
nN - NET station n marker	x
LE - Output backlight	x
Q - Bit output from another FB	x

Parameter set

	Description	Note
☑ Function block release by EN is necessary	If this checkbox is enabled, the state of function block input EN will be evaluated. If the checkbox is disabled instead, the function block will be enabled and function block input EN will not do anything.	This parameter ensures that when existing programs are copied, the functionality of the function blocks that are carried over will be retained. The parameter will be automatically set to 0 or 1 depending on the function block.
Parameter display + Call enabled	Function block parameters and constants can be edited on the device.	
Simulation not possible		

Other

Retention

The function block does not recognize retentive data.

User example

The trigger pulse is set at 03:32:21 (hh:mm:ss). The other stations are synchronized at 03:33:00. The time is accepted by all stations.

See also

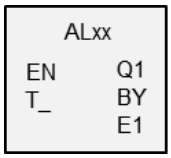
→ Section "GT - Get values from NET", page 339
→ Section "PT - Put values to NET", page 342
→ Section "Setting up a NET", page 537

6.1.7 Other function blocks

6.1.7.1 AL - Alarm function block

General

easyE4 base devices provide 32 alarm function blocks, AL01 through AL32. One e-mail with a defined subject and a defined 160-character message text can be sent with each function block.
This means that a maximum of 32 different messages can be sent to any recipient of your choice. The subject and the message text are both defined in the parameters for the AL function block.
The program triggers the actual sending.



Operating principle

In order for the e-mails to be sent, the LAN port on a suitable network must be configured and connected.

A rising edge at function block input T_ will cause the message to be sent. In order for this to work, however, function block output BY must equal to 0.
Message sending starts after each rising edge at T. A maximum of three send attempts will be made per trigger.
If the e-mail is sent successfully, there will be corresponding feedback signals at BY and E1. Otherwise, the job will be aborted, also with corresponding feedback signals at BY and E1.
Deactivating the function block will not result in e-mail sending operation being aborted.

BY will have a state of 1 as long as the job is in progress, preventing any new send jobs from being accepted. If the send job is not completed successfully, an error will be signaled at function block output E1 with E1 = 1.

The recipients and the e-mail server settings need to be set in the hardware configuration.
To do this, a base device needs to be selected in the Project view and the relevant parameters must be configured under the E-Mail tab.
For more information on this topic, please refer to → "E-mail function", page 562.

The function block and its parameters

Function block inputs

	Description	Note
(Bit)		

	Description	Note
EN	1: Activates the function block.	The checkbox for the ☑ Function block release by EN is necessary parameter must first be enabled
T_	A rising edge will start the communication job.	

Assigning operands

You can assign the following operands to the function block inputs that are numeric inputs.

Operands	Value inputs
Constant, timer constant	x
MD, MW, MB - Markers	x
NB, NW, ND - NET markers	x
nNB, nND, nND- NET markers NET stations n	x
IA - Analog input	x
QA - Analog output	x
QV - QV - Numeric output of a FB	x

You can assign the following operands to the function block inputs that are bit inputs:

Operands	Bit inputs
Constant 0, constant 1	x
M – Markers	x
RN - Input bit via NET	x
SN - Output bit via NET (send)	x
N - Net marker bit	x
nN - NET marker bit NET station n	x
ID: Diagnostic alarm	x
LE - Output backlight	x
P buttons	x
I - Bit input	x
Q - Bit output	x
Q - Bit output of a FB	x

Function block outputs

	Description	Note
(Bit)		
Q1	1: If function block input EN = 1.	
E1	Error output The send job could not be completed successfully after three attempts. Cleared if the job is completed without errors or if the EN input is set to "0".	
BY	BUSY	

	Description	Note
	1: The most recent send job is still in progress. 0: The most recent send job has been completed.	

Assigning operands

You can assign the following operands to the function block outputs that are numeric outputs:

Assigning operands	Outputs
Constant	x
Markers: MB, MD, MW	x
Analog inputs IA	x
Analog output QA	x
Numeric output from another QV FB	x

You can assign the following operands to the function block outputs that are bit outputs:

Assigning operands	Bit outputs
Constant 0, constant 1	x
M – Markers	x
SN - Output bit via NET (send)	x
N - Network marker bit	x
nN - NET station n marker	x
LE - Output backlight	x
Q - Bit output from another FB	x

Parameter set

Parameter set	Description	Note
☑ Function block release by EN is necessary	If this checkbox is enabled, the state of function block input EN will be evaluated. If the checkbox is disabled instead, the function block will be enabled and function block input EN will not do anything.	This parameter ensures that when existing programs are copied, the functionality of the function blocks that are carried over will be retained. The parameter will be automatically set to 0 or 1 depending on the function block.
☑ Web server active as long as there is a state of 1 at input EN	The web server will be selectively turned on and off based on AL_EN. In order for this to work, the web server must not be permanently enabled; go to → "Webserver tab", page 1.	Turning off the web server saves processing time
Parameter display + Call enabled	Function block parameters and constants can be edited on the device.	
Type of information transmission	E-Mail; there are no other options as of this writing	
Recipient assignment	Used to select one of the three possible recipient groups. Each recipient group	Each recipient group needs to be set up in the hardware con-

Parameter set	Description	Note
	contains all the detailed information required in order to send an e-mail. 1 recipient group; there are no other options as of this writing	figuration. To do this, click on "Project" – select a base device – click on the "E-Mail" tab. You can then configure the e-mail server and one or more e-mail recipients for each of the three available groups.
Subject	The e-mail's subject	
Message text	The text must not exceed 160 characters.	
Simulation possible		

Other

Retention

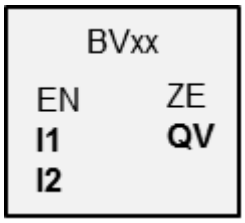
The function block does not recognize retentive data.

See also

→ Section "E-mail function", page 562
→ Section "BV - Boolean operation", page 353
→ Section "D - Text display", page 357
→ Section "D - Text display editor", page 366
→ Section "DL - Data logger", page 380
→ Section "JC - Conditional jump", page 386
→ Section "LB - Jump label", page 391
→ Section "MR - Master reset ", page 393
→ Section "NC - Numerical converter", page 397
→ Section "ST - SET cycle time", page 403

6.1.7.2 BV - Boolean operation

General



easyE4 base devices provide 32 (Boolean operation) function blocks, BV01 through BV32. This means that the values at function block inputs BV…I1 and BV…I2 will be connected with a Boolean operator. This function block can be used to mask specific bits from values, detect bit patterns, or change bit patterns.

Operating principle

This function block makes it possible to apply Boolean operators to bit groups (bytes, words, or even double words). The size of the parameters at I1 and I2 must be the same, in which case a bitwise AND, OR, XOR, or NOT operator will be applied to them, with the result being output at QV.

The function block and its parameters

Function block inputs

	Description	Note
(Bit)		
EN	1: Activates the function block.	The checkbox for the ☑ Function block release by EN is necessary parameter must first be enabled
(DWord)		
I1	First value	If one operand assumes a negative value, such as -10 (dec) the processing unit forms the two's complement of the amount. **Example**
I2	Second value	-10 (dec) = 10000000 00000000 00000000 00001010 (bin) Two's complement = 11111111 11111111 11111111 11110110 (bin) = FFFFFFF6 (hex) Bit 32 is retained at 1 as a sign bit.

Assigning operands

You can assign the following operands to the function block inputs that are numeric inputs.

Operands	Value inputs
Constant, timer constant	x
MD, MW, MB - Markers	x
NB, NW, ND - NET markers	x
nNB, nND, nND- NET markers NET stations n	x

Operands	Value inputs
IA - Analog input	x
QA - Analog output	x
QV - QV - Numeric output of a FB	x

You can assign the following operands to the function block inputs that are bit inputs:

Operands	Bit inputs
Constant 0, constant 1	x
M – Markers	x
RN - Input bit via NET	x
SN - Output bit via NET (send)	x
N - Net marker bit	x
nN - NET marker bit NET station n	x
ID: Diagnostic alarm	x
LE - Output backlight	x
P buttons	x
I - Bit input	x
Q - Bit output	x
Q - Bit output of a FB	x

Operating modes

	Description	Note
AND	AND operation	
OR	OR operation	
XOR	Exclusive OR operation (XOR eXclusive OR - exclusive OR, either or)	
NOT	Inverts the individual bits of the value at I1. The inverted value is shown as a signed decimal value.	

Function block outputs

	Description	Note
(Bit)		
ZE	Zero 1: if the value of the function block output QV (the operation result) equals zero	
(DWord)		
QV	Result of the operation	

Assigning operands

You can assign the following operands to the function block outputs that are numeric outputs:

Assigning operands	Outputs
Constant	x
Markers: MB, MD, MW	x
Analog inputs IA	x
Analog output QA	x
Numeric output from another QV FB	x

You can assign the following operands to the function block outputs that are bit outputs:

Assigning operands	Bit outputs
Constant 0, constant 1	x
M – Markers	x
SN - Output bit via NET (send)	x
N - Network marker bit	x
nN - NET station n marker	x
LE - Output backlight	x
Q - Bit output from another FB	x

Parameter set

	Description	Note
☑ Function block release by EN is necessary	If this checkbox is enabled, the state of function block input EN will be evaluated. If the checkbox is disabled instead, the function block will be enabled and function block input EN will not do anything.	This parameter ensures that when existing programs are copied, the functionality of the function blocks that are carried over will be retained. The parameter will be automatically set to 0 or 1 depending on the function block.
Parameter display + Call enabled	Function block parameters and constants can be edited on the device.	
Simulation possible		

Other

Retention

The function block does not recognize retentive data.

Example I1 AND I2 = QV

	decimal	binary
I1	13 219	0000 0000 0000 0000 0011 0011 1010 0011
I2	57 193	0000 0000 0000 0000 1101 1111 0110 1001
QV	65 515	0000 0000 0000 0000 0001 0011 0010 0001

Example I1 OR I2 = QV

	decimal	binary
I1	13 219	0000 0000 0000 0000 0011 0011 1010 0011
I2	57 193	0000 0000 0000 0000 1101 1111 0110 1001
QV	65 515	0000 0000 0000 0000 1111 1111 1110 1011

Example I1 XOR I2 = QV

	decimal	binary
I1	13 219	0000 0000 0000 0000 0011 0011 1010 0011
I2	57 193	0000 0000 0000 0000 1101 1111 0110 1001
QV	60 618	0000 0000 0000 0000 1110 1100 1100 1010

Example NOT I1 = QV

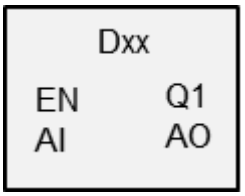
	decimal	binary
I1	13 219	0000 0000 0000 0000 0011 0011 1010 0011
I2	–	
QV	-13 220	1111 1111 1111 1111 1100 1100 0101 1100

See also

→ Section "AL - Alarm function block", page 349
→ Section "D - Text display", page 357
→ Section "D - Text display editor", page 366
→ Section "DL - Data logger", page 380
→ Section "JC - Conditional jump", page 386
→ Section "LB - Jump label", page 391
→ Section "MR - Master reset ", page 393
→ Section "NC - Numerical converter", page 397
→ Section "BV - Boolean operation", page 353

6.1.7.3 D - Text display

General



easyE4 base devices provide 32 text display function blocks, D01 through D32. Each of these function blocks can be used to output a custom text display on the easyE4 display or on another external display device and to allow custom input using the device's P buttons.

- Output options
  Each text display consists of 6 lines, with 16 characters each. In other words, 96 characters. These displays are created using a text editor in easySoft 7, and can be used to add graphic macros, texts, value displays, bar graphs, running texts, message texts, date and time entries, etc. on the work pane.
- Input options
  These can be used to enable operators to enter value input and use input buttons. Specific device P buttons can be used to implement user controls within this context.

Various character sets, such as Cyrillic, are available, as if the ability to switch between various user languages. The EN function block input is used to call the function block in the program, and enables the text display.

Operating principle

Only one text display function block instance (i.e., only one of the maximum 32) can be displayed at any one time. This must be implemented with the programming, i.e., only one of the text displays should be enabled with the EN input at any one time. If multiple function blocks are enabled instead, the display priority and rolling time will be used to determine which one is displayed. In this case, the program will follow the defined priorities to change from one enabled function block to the next every time after the set rolling time elapses.

The function block and its parameters

Function block inputs

	Description	Note
(Bit)		
EN	1: Activates the function block.	The text page for the relevant function block instance will be shown.
AI	1: Acknowledges an alarm message	A rising edge will acknowledge an alarm only as long as the function block is still visible

Assigning operands

You can assign the following operands to the function block inputs that are numeric inputs.

Operands	Value inputs
Constant, timer constant	x
MD, MW, MB - Markers	x
NB, NW, ND - NET markers	x
nNB, nND, nND- NET markers NET stations n	x
IA - Analog input	x
QA - Analog output	x
QV - QV - Numeric output of a FB	x

You can assign the following operands to the function block inputs that are bit inputs:

Operands	Bit inputs
Constant 0, constant 1	x
M – Markers	x
RN - Input bit via NET	x
SN - Output bit via NET (send)	x
N - Net marker bit	x
nN - NET marker bit NET station n	x
ID: Diagnostic alarm	x
LE - Output backlight	x
P buttons	x
I - Bit input	x
Q - Bit output	x
Q - Bit output of a FB	x

Function block outputs

	Description	Note
(Bit)		
Q1	Returns the state of input EN.	
AO	Acknowledgement pulse for an alarm reset	Only as long as the function block is still visible

Assigning operands

You can assign the following operands to the function block outputs that are numeric outputs:

Assigning operands	Outputs
Constant	x
Markers: MB, MD, MW	x
Analog inputs IA	x
Analog output QA	x
Numeric output from another QV FB	x

You can assign the following operands to the function block outputs that are bit outputs:

Assigning operands	Bit outputs
Constant 0, constant 1	x
M – Markers	x
SN - Output bit via NET (send)	x
N - Network marker bit	x
nN - NET station n marker	x
LE - Output backlight	x
Q - Bit output from another FB	x

Parameter set

	Description	Note
Display priority	001…032	001: highest priority 032 lowest priority
Rolling time [s]	001…030	Text display time when the priority is the same
☑ alarm	Highest priority; takes precedence over all other function blocks	The text display will remain on the device display until it is acknowledged via a rising edge at AI.

Text display tab

The parameters for the text display function block can be configured in the Text display parameters tab. Before you can configure a specific function block (e.g., D02), you will need to select it in the Programming view. If it is the first time you are configuring the function block, the configuration dialog box will show an empty text display consisting of 6 lines with 16 characters each.

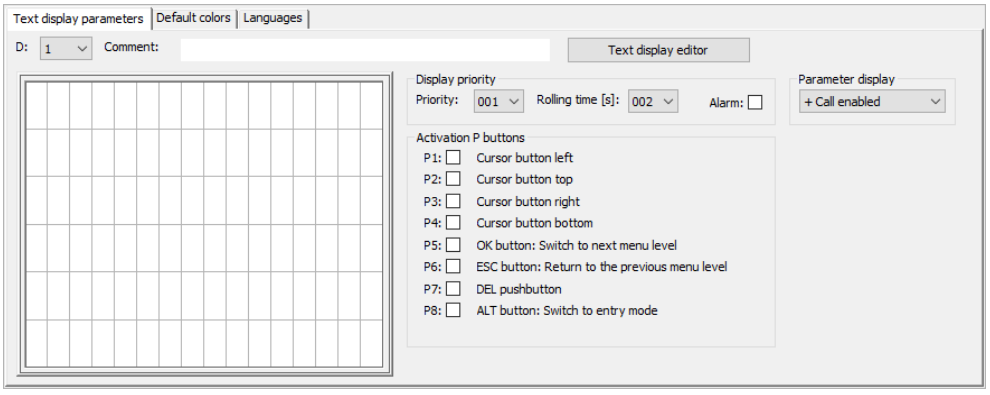


Figure 175: Text display parameters tab for text display function block in the Programming view

Display priority

If multiple text displays from D01 through D32 are enabled simultaneously, the display priority will be used to determine the order in which they will be displayed on the easyE4 device display. The text display with display priority 001 will have the highest priority, while the text display with 032 will have the lowest priority. The text display with the highest priority will be displayed as long as it is enabled (EN=1). The text display with the next highest priority will not be displayed until the function block input of the previous text display is disabled (EN=0). If multiple text function blocks with the same priority are enabled, the corresponding texts will be displayed in a rolling pattern based on the rolling time. Moreover, when a text display with an alarm becomes enabled, it will be displayed on the device display immediately. (Please refer to the Alarm parameter as well.)

Rolling time [s]

The rolling time parameter is used to specify how long text displays that have the exact same display priority will be displayed on the device display. In order for this parameter to do something, multiple text displays must be enabled simultaneously (EN=1). Please note that the rolling time is specified in seconds. Moreover, when a text display with an alarm becomes enabled, it will be displayed on the device display immediately. (Please refer to the Alarm parameter as well.)

☑ **Alarm**

If this checkbox is enabled, the corresponding text display will be displayed with absolute priority until the device operator acknowledges the alarm via a rising edge at input AI. This function is only effective for visible function blocks

If multiple text displays with an alarm are enabled simultaneously, the first one that was enabled will remain on the device display until it is acknowledged by a rising edge at input AI. The next text display will be shown then. Once all the text displays with an alarm have been acknowledged by a rising edge at input AI, the text display with the highest priority will be displayed on the device display.

It is important to keep in mind that the alarm acknowledgement function at function block input AI always expects a rising edge. In other words, the AI function block input does not need to be acknowledged immediately, but it does, however, need to be acknowledged by the next alarm reset at the latest.

Activation P buttons

The P buttons on the easyE4 device can be used for input and menu control purposes at runtime. You can use these parameters to individually define which buttons should be enabled, and the specific button configuration can be different for each individual text display. Please note that the buttons are required only if you need the operator to enter input or switch screens.

In order for the P buttons to work, they must be enabled with an enabled checkbox next to *Project view/System settings tab/P buttons* – please refer to System settings: → Section "P buttons", page 471 as well.

Default colors tab

The easyE4 device display is a monochrome display. Accordingly, the only device display setting that can be changed under the Default colors tab in this case is the backlight color:

- White
- Green
- Red

If you are using an external display device or are showing the device display via a web server, you will be able to configure additional color settings under the Default colors tab. To do this, you can select the predefined colors from the color table.

Left-click inside the color table to select the text color you want.

Right-click inside the color table to select the background color you want.

Please note that you can use the text display editor to configure additional color settings for each element. The color settings you configure in the editor will overwrite any settings you configure here.

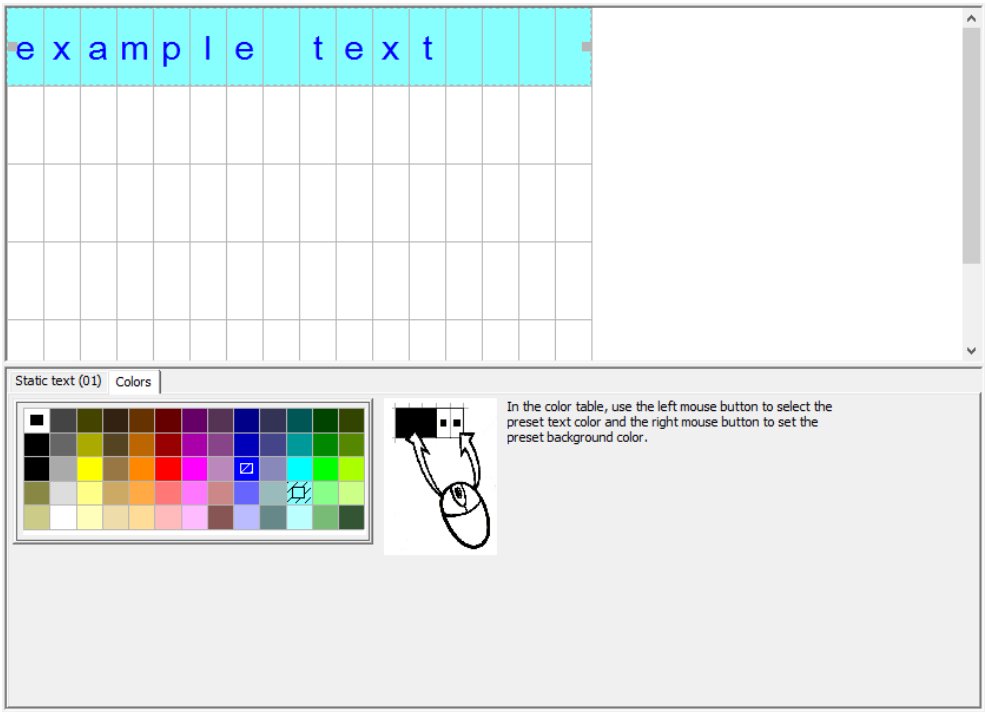


Figure 176: Default colors tab for text display

These will be the default color settings used in the text display editor.

Languages tab

You can configure the text display in such a way that the device operator will be able to

change the language on the device display or on other external device displays. To do this, you will need to configure the appropriate settings under the Languages tab.

You can assign each language any name of your choice in the Language table column. After doing so, you will need to open the text display editor and enter the text in each language for each text element being used.

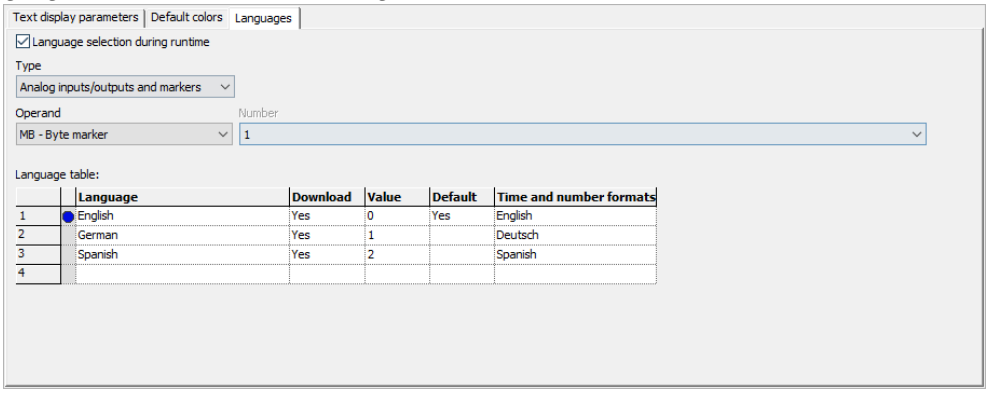


Figure 177: Text display function block, language tab

Language selection during runtime

Allows device operators to switch language at runtime.

Type and operand

User to select an operand that will be used to select the target language. You can use analog inputs or outputs from function blocks, marker bytes, marker words, marker double words, analog outputs, or analog inputs as an operand.

MB1 is selected in the following example. Look at the "Value" column, which is filled out by the system. When MB1 is assigned a value of 1 in the program, the language will be switched to English.

Language table

Column	Description
Language	In the language table, you can assign any name of your choice to each language in the project.
Download	Selecting <Yes> in the **Download** column will make the texts for the corresponding language be loaded onto the device. You can enter these texts for each language in the **text display editor** under the tab for the selected display and entry element.
Value	If the assigned operand assumes this value at runtime, the display will switch to the corresponding language.
Default	You can select a language as the default language. Selecting <Yes> in the **Default** column will make the corresponding language be selected whenever the current value of the operand cannot be found in the Value column. In other words, the default language will be used when a specific language is not selected.
Time and number formats	The **time and number formats** for each language will be taken from the formats specified in the corresponding column. Every text that is configured will then need to be entered in each of the defined languages when defining the text element in the text editor.

Other

Signal diagram for text displays with different priorities

The following signal diagram shows four different text displays with different priorities. The text display with the highest priority, D01, is displayed first. As soon as D01_EN=0, other enabled text displays are output – D02 in this example. And as soon as a text display with an alarm is enabled, e.g., D06_EN=1, the text display will be displayed and remain until the alarm is acknowledged with D06_AI=1. After the alarm is acknowledged, the enable text display with the highest priority or with an alarm will be displayed instead. In this example, D07 will be displayed until it is acknowledged with D07_AI=1, after which the display will switch to D02, i.e., the only remaining text display.

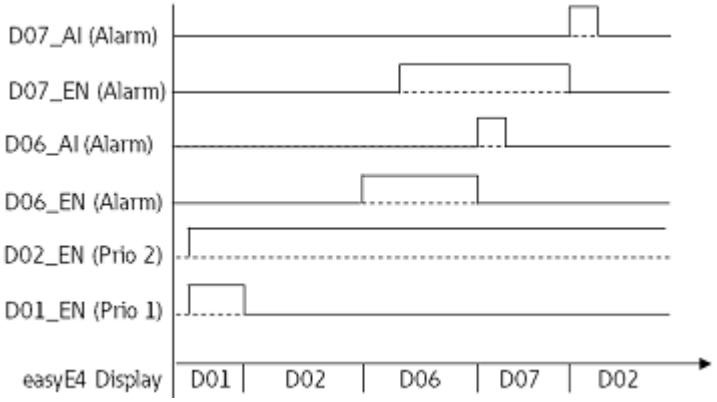


Figure 178: Signal diagram Text display

Signal diagram for text displays with identical priorities

Text displays D03, D04, and D05 all have the same priority of 3. They will accordingly be displayed according to their configured rolling time as soon as no other text displays with a higher priority are enabled. In other words, D01_EN must be 0 and D02_EN must be 0 for this to happen in the example below. D03, D04, and D05 will be displayed in alternating order until a text display with a higher priority is enabled, e.g., D02_EN=1.

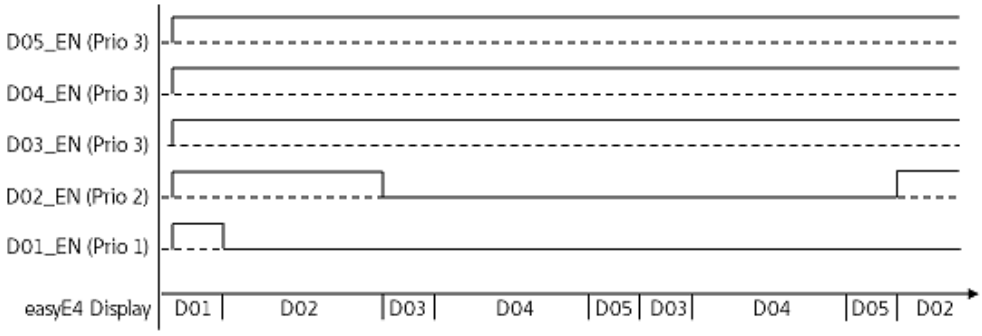


Figure 179: Signal diagram for text display with text function blocks with an identical priority of 3

Rolling time: D03 = 1s; D04 = 3s; D05 = 1s

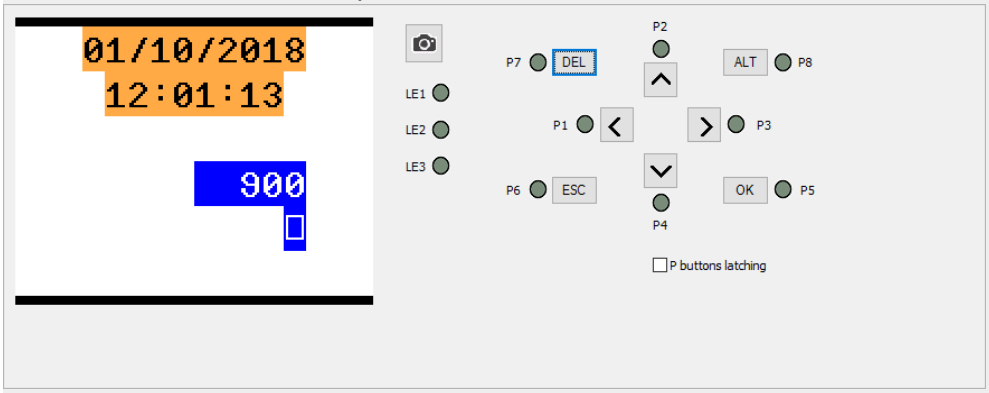
Retention

The function block does not recognize retentive data.

Example

Entering data on the display via a D text function block

If an easyE4 with a display is used with the text function block and the cursor buttons are enabled in the configuration, operators will be able to enter data using these buttons. To do this, the input mode needs to be accessed by pressing the ALT button. You can also simulate this with easySoft.



The input fields will then be highlighted in color or be shown with inverse colors.

To select an input field and enter data, the operator will need to use the arrow buttons. The currently active cursor position will flash.

UP: The numeric value at the current cursor position will be incremented

DOWN: The numeric value at the current cursor position will be decremented

RIGHT: The next smaller decimal place will be selected or the input value to the right or underneath will be selected

LEFT: The next larger decimal place will be selected or the input value to the left or above will be selected

In the example above, there are three input values on the screen: a value entry, a latching button, and a message text selection.

The value entry [with a value of 900 in the screenshot] consists of three decimal numbers in which the value for each number is entered individually. The latching button [the checkbox with the checkmark] is activated. The question marks show the 16-character area for the message text selection, in which the UP/DOWN buttons can be used to select one of the configured texts.

Once a new value is entered, it can be confirmed with OK. This will exit input mode.

See also

→ Section "AL - Alarm function block", page 349
→ Section "BV - Boolean operation", page 353
→ Section "D - Text display editor", page 366
→ Section "DL - Data logger", page 380
→ Section "JC - Conditional jump", page 386
→ Section "LB - Jump label", page 391
→ Section "MR - Master reset ", page 393
→ Section "NC - Numerical converter", page 397
→ Section "D - Text display", page 357

6.1.7.4 D - Text display editor

easySoft 7 features a text display editor that can be used to design text displays. In order to be able to access it, there must first be a text display function block in the Programming view work pane and the you must have clicked on the function block. Open the Text display parameters tab and click on the Text display editor button. The text display editor will be opened in a separate window.

Properties Text display editorText display editor

Text displays are put together with a text display editor that makes input with free text and actual values from various function blocks possible.
This editor features the following properties:

- 6 lines x 16 characters - 96 elements
- Texts can be positioned freely within the text display
- Analog value, timer value, and time value processing
- Message texts, times, dates, and checkboxes as input and output elements
- Simple value entry and controls
- User-controlled acknowledgements
- Ticker text with variable speeds
- Variable display times
- Prioritization by the user
- Multi-language capabilities
- Can also be used in user function blocks

Working with the text display editor

In order to position a display or input element, follow the steps below:

- ▶ Select the display or input element you want from the list, e.g., Static text.
- ▶ While holding down the left mouse button, drag the element to the work pane and drop it where you want it to be positioned.
- ▶ Move your cursor over one of the element handles and drag the handle until the display or input element has the size you want.
- ▶ Configure the parameters using the tabs below. For example:*Static text (01) tab/Text field*<Sample text>.

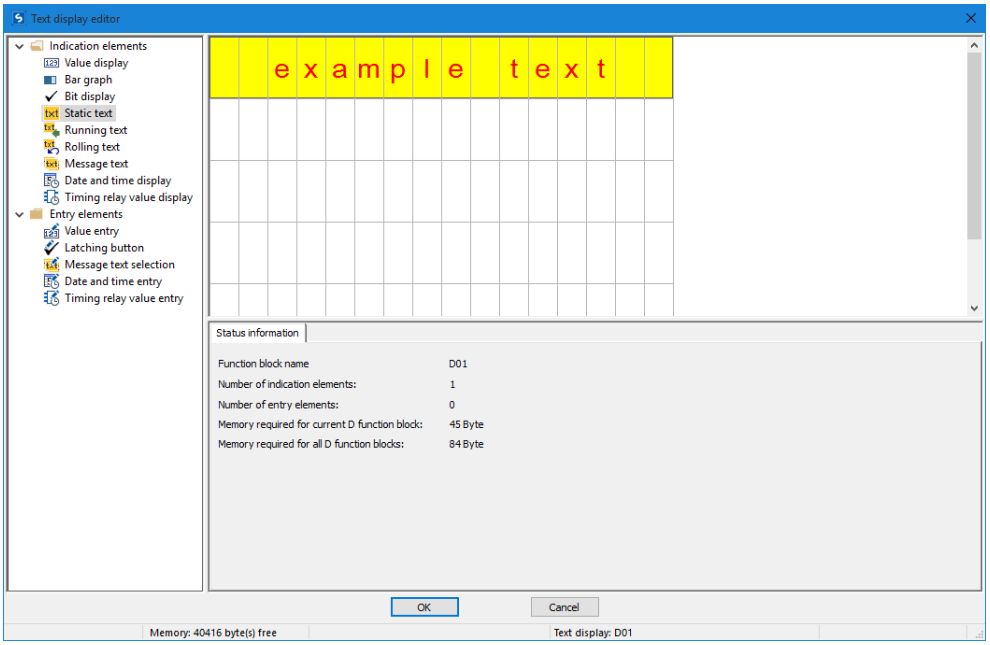


Figure 180: Text display editor with static text in the first line

1 List with display and input elements

2 Work pane with text display elements that have already been configured

3 Status information tab with parameters for the display and input elements

Color management in the display text editor

Each element will get its own text color and background color as parameters.

If you use the inverse display mode, the colors will be swapped.
If you enter 0 as a color, the function block instance "default color" will be used.

Insert special characters

In addition to the characters on your keyboard, you can also enter special characters . To do so, use the CTRL+C/CTRL+V shortcuts.

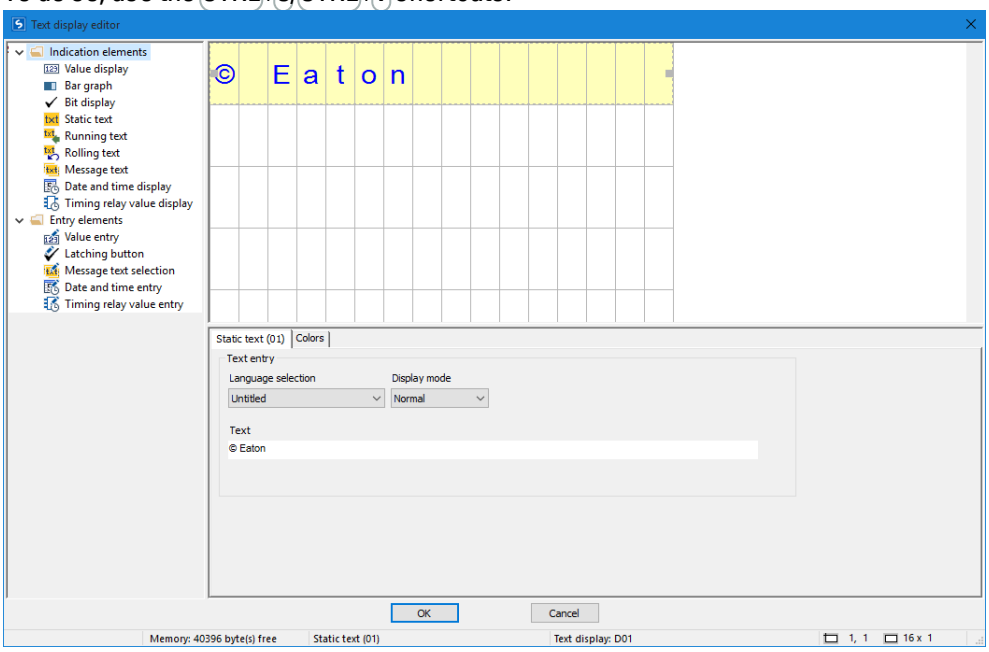
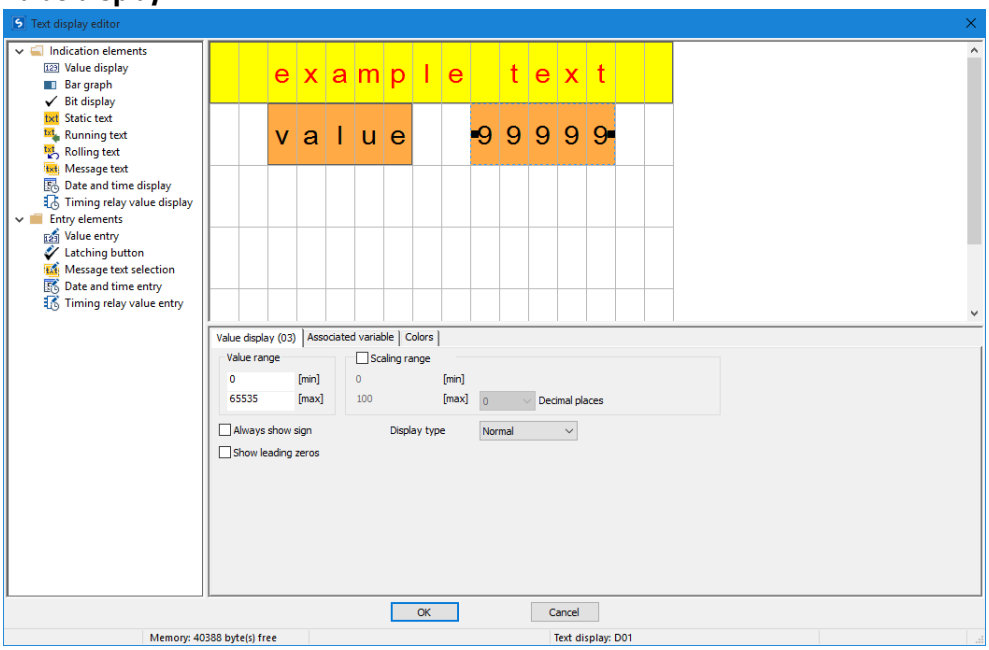


Figure 181: Character table Special characters

Display and input elements

Value display



Value displays can be very effectively combined with a static text. In the example above, the value display element has been placed to the right of the "Value" text in the preview pane. The display in the example is intended to have five digits, which is why

the number of characters has been configured accordingly. (The number 9 symbolizes value displays.)

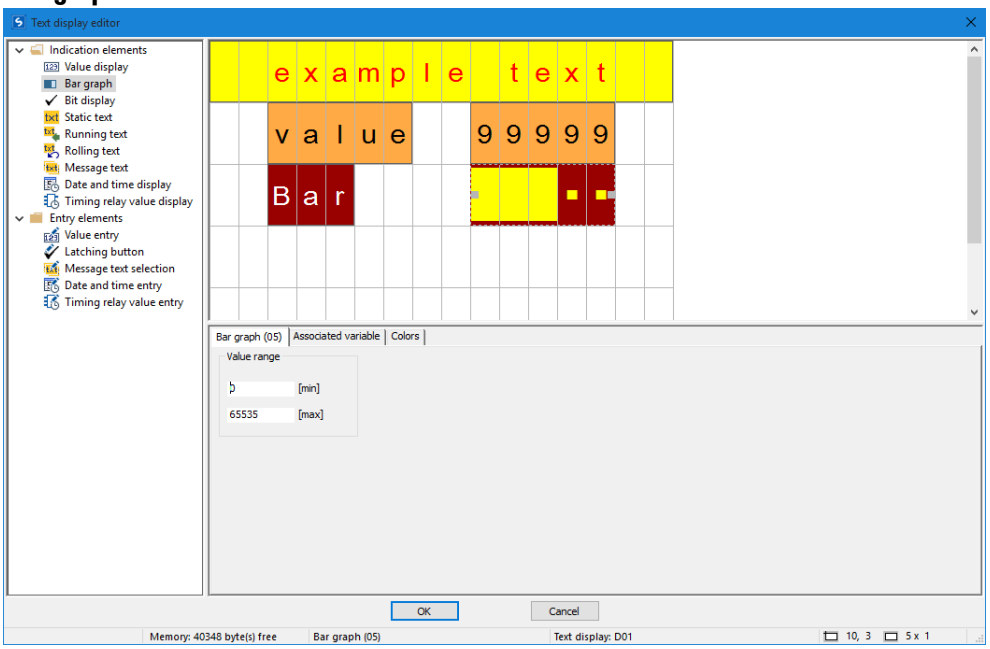
Value range: The default value range is 0-65535. If you want to make it smaller, you can enter the corresponding limits in this section. If the actual value falls outside the configured value range, the display will instead show the nearest value that still falls within the value range.

Scaling range: If you want the value to be scaled for display, enable the "Scaling range" option. Then enter the minimum and maximum values for the scaling.

Displays can be customized with a sign and/or leading zeros.

"Associated variable" tab: The settings in this tab can be used to select a byte, word, or double word value from the operand resources and the function block inputs and outputs so that it can be displayed.

Bar graph



Bar graphs can be very effectively combined with a static text. In the example above, the bar graph element has been placed to the right of the "Bar" text in the preview pane. The display in the example is intended to have five digits, which is why the number of characters has been configured accordingly.

Value range: The default value range is 0-65535. If you want to make it smaller, you can enter the corresponding limits in this section. If the actual value falls outside the configured value range, the display will instead show the nearest value that still falls within the value range.

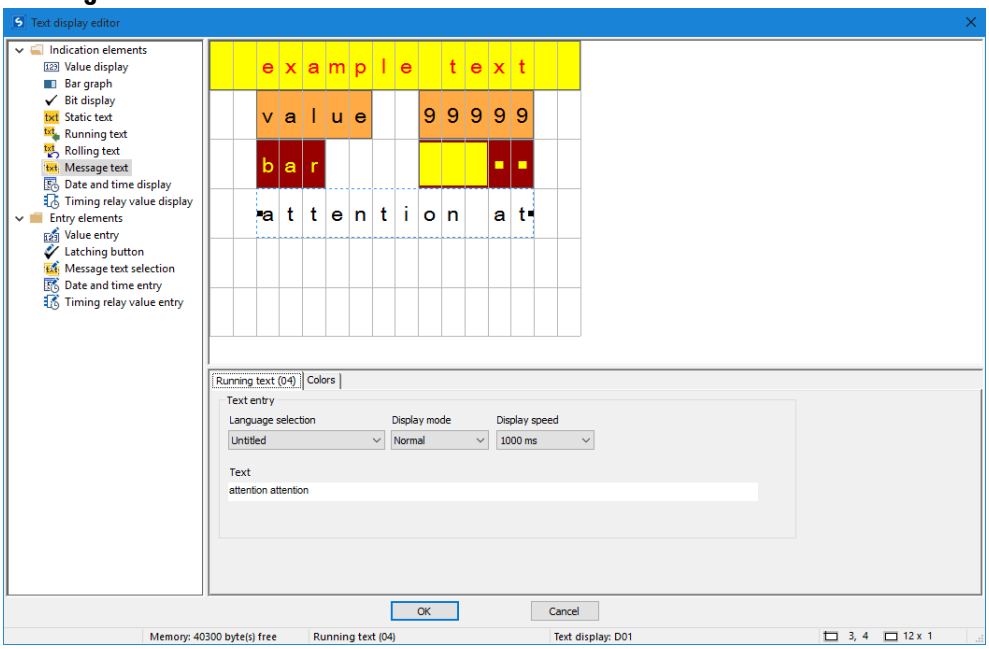
Associated variable tab: The settings in this tab can be used to select a byte, word, or double word value from the operand resources and the function block inputs and outputs so that it can be displayed.

Static text

To place a static text in the first line, follow the steps below:

- Select the Static text option from the list, hold down the left mouse button and drag the display element to the work pane, then drop it in the line where you want it.
- Enter the text you want into the *Static text (01) tab/Text field*, e.g., <Sample Text>.
- Move your cursor over one of the element handles and drag the handle until the static text element has the size you want.

Running text:

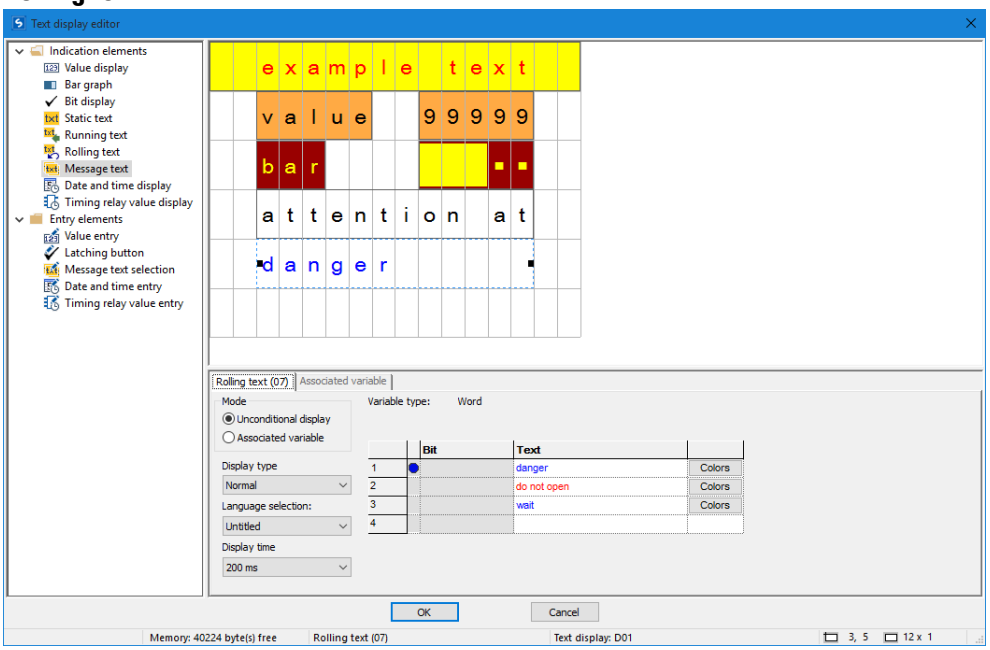


If you want to display a text that is longer than 16 characters, you can use the rolling text display element. This option can come in particularly handy when you want to draw the machine operator's attention to a text.

Simply select the running text display element from the list, hold down the left mouse button, and drag the element to the work pane. You can then move your cursor over one of the element handles and drag the handle until the running text element has the size you want.

You can use the settings in the corresponding tabs to enter the actual text and set the language, the display mode, and the display speed.

Rolling text:



Rolling texts can be used to display various texts in succession in a single line. This can come in handy, for instance, for operating or maintenance procedures in which the display needs to ask the operator or maintenance technician to carry out a step, then another step, then another, etc. In this case, the text can be changed every time the operator or maintenance technician performs the requested action (shift register).

The required texts need to be entered into the table under the Rolling text tab, where you can also select the corresponding colors and the display type.

Unconditional display:

When this operating mode is selected, the texts will be displayed in succession at the specified interval. This interval can be defined using the Display time parameter.

Associated variable

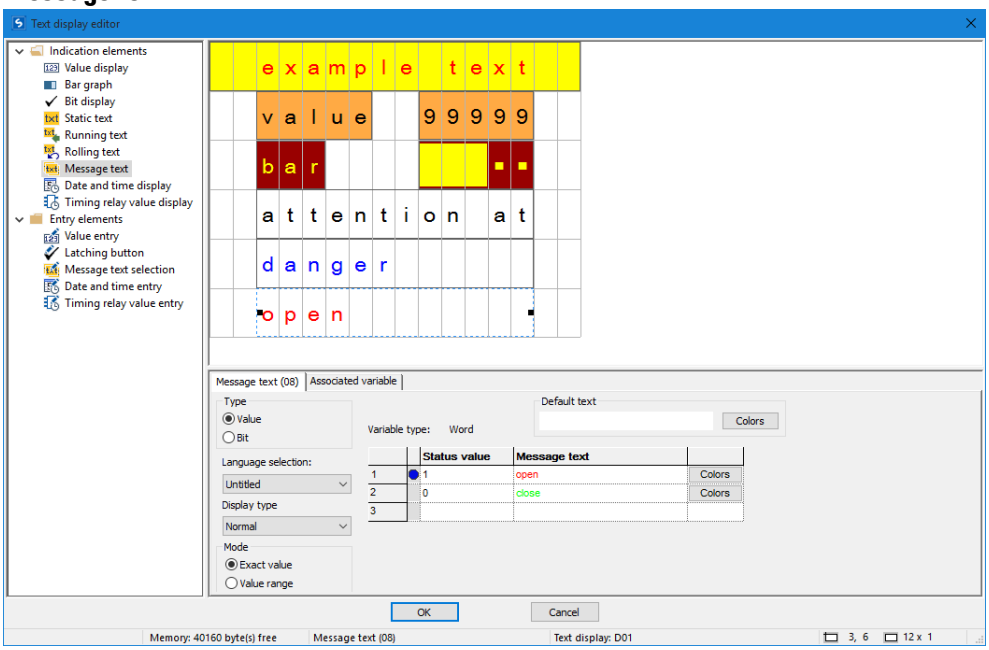
When this operating mode is selected, the text selection will depend on the application program. More specifically, an operand that can be selected under the Associated variable tab will be used to control how the texts are displayed. You can select local or network operands of type byte, word, or double word. Each text will then be automatically linked to a bit from the selected operand as you enter it.

- Text 1 will be assigned bit 1
- Text 2 will be assigned bit 2
- Text 3 will be assigned bit 3
- etc.

If bit 2 is set in the program at runtime, for example, text 2 will be displayed. If multiple bits in the operand are set simultaneously, the corresponding texts will be displayed in

succession. In this case, the interval at which they are displayed will correspond to the value configured with the Display time parameter.

Message text:



Message texts are very similar to rolling texts.
The difference is that in message texts, a decimal value (status value) is stored, while exactly one bit from the associated variable is assigned in the case of rolling texts.

Message texts can be used to display various texts in succession in a single line. This can come in handy, for instance, for operating or maintenance procedures in which the display needs to ask the operator or maintenance technician to carry out a step, then another step, then another, etc. In this case, the text can be changed every time the operator or maintenance technician performs the requested action (increment/decrement).

The required texts need to be entered into the table under the Message text tab, where you can also select the corresponding colors and the display type. To do this, you need to specify a status value for each system text. This status value (bit or decimal value) will then be used to call the corresponding message text in the user program (if you are using more than two texts, please make sure to select the "Value" type). An operand that can be selected under the Associated variable tab will be used to control how the texts are displayed. You can select local or network operands of type byte, word, or double word.

Mode: You can select either the "Exact value" mode or the "Value range" mode. If you select the exact value mode, a text will only be displayed if the value is exactly equal to the configured value. If you select the value range mode instead, texts will be displayed if the operand's value falls within a configured range.

This can come in handy, for instance, when trying to abstract analog values – please refer to the description for a fill level in the following example:

Example

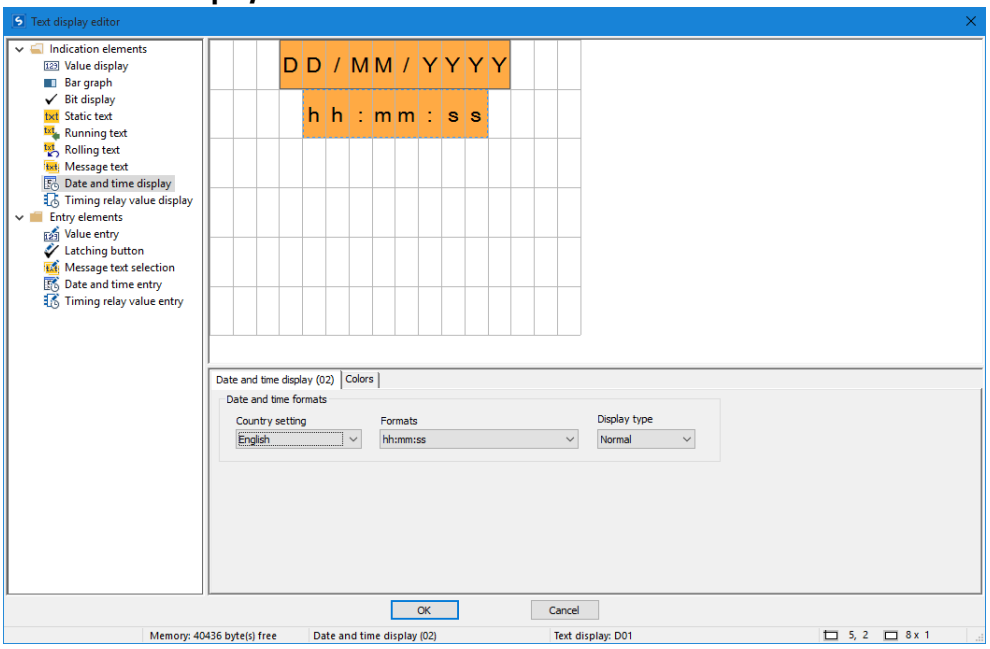
0-33 : Reserve

34-66 : Half full

67-90 : Pretty full

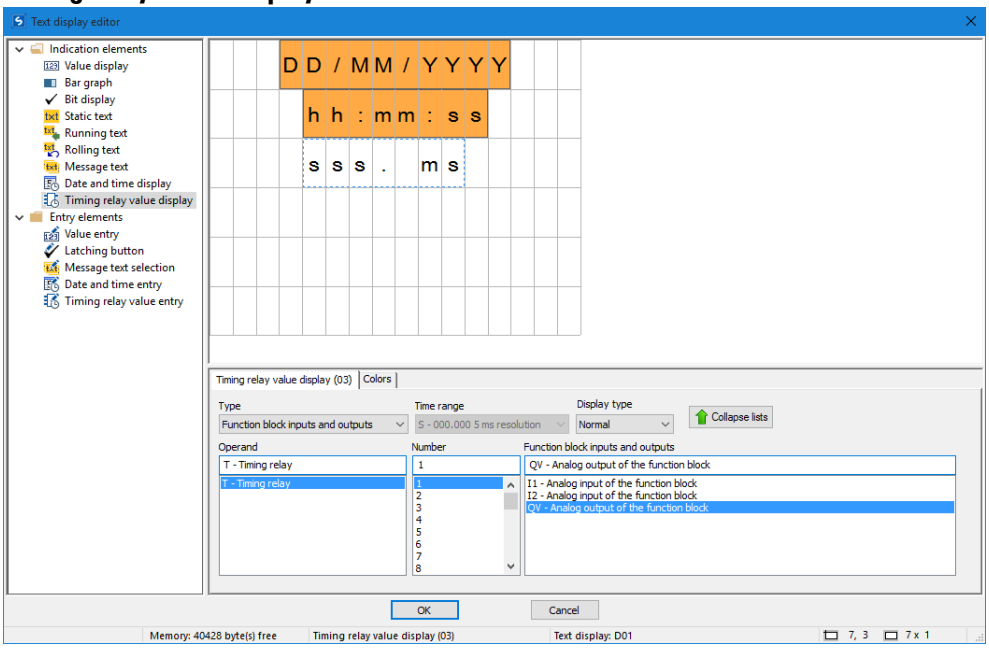
91-100 : Completely full

Date and time display



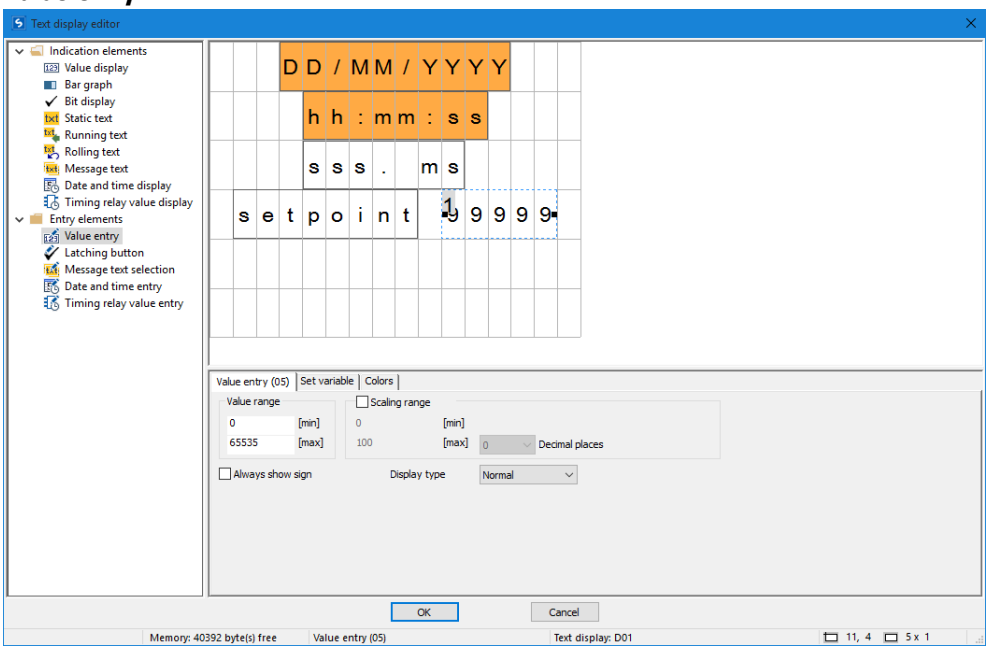
Date and time elements are available in various display formats. Drag a date and time display element to the screen and then select the format you want. The example above contains two data and time display elements configured with the same background color.

Timing relay value display



Time functions can be implemented using the timing relay value display elements. You can conveniently display the reference value or the running time value in its own display element. Please note that the number of characters, and the size of the display element accordingly, is fixed. To configure the element, you will need to select the timing relay function block number you want and configure the parameters you want. You can also reference operands such as markers directly as a source for the display, in which case you will need to make sure that the data format used in the operand is the format for a timer value.

Value entry



You can also use the display and the keyboard on the easyE4 to enable operators to enter input. To do this, drag a <value entry> element onto the screen. The value entry element is indicated with <99999>, with the superscript <1> indicating that the element is meant for value input. The <Setpoint> text in the example above is a separate display element of type static text and is used to describe the function of the value being entered.

After being entered, the value will be written to a "set variable" that can be selected under the corresponding tab. Moreover, this element can be configured with scaling, which can be activated by enabling the "Scaling range" option.

You can define the valid value range for the value written to the set variable in the "Value range" section. In this particular example, the full value range of 0 to 65535 that is allowed with a word width has been selected. In order to make things easier for operator, however, the value entered will fall within a range of 0 to 100 instead (this is a good idea, for example, when entering a container fill level for which the fill level percentage is sufficient in terms of accuracy). Accordingly, the scaling range is set at 0 to 100 in the example.

Example: If the operator enters a value of 40, a value of 65535*0.4=26214 will be written to the set variable.

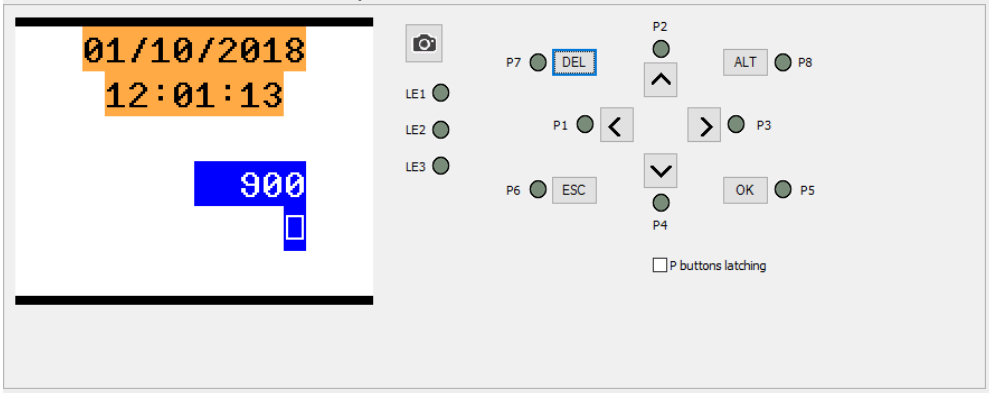
☑ Scaling range

Enabling the checkbox will allow you to configure the scaling range for the value entry element. If you, for example, enter a value of <1000> into the [max] field, the value input will be limited to 4 digits, <9999>.

Example

Entering data on the display via a D text function block

If an easyE4 with a display is used with the text function block and the cursor buttons are enabled in the configuration, operators will be able to enter data using these buttons. To do this, the input mode needs to be accessed by pressing the ALT button. You can also simulate this with easySoft.



The input fields will then be highlighted in color or be shown with inverse colors.

To select an input field and enter data, the operator will need to use the arrow buttons. The currently active cursor position will flash.

UP: The numeric value at the current cursor position will be incremented

DOWN: The numeric value at the current cursor position will be decremented

RIGHT: The next smaller decimal place will be selected or the input value to the right or underneath will be selected

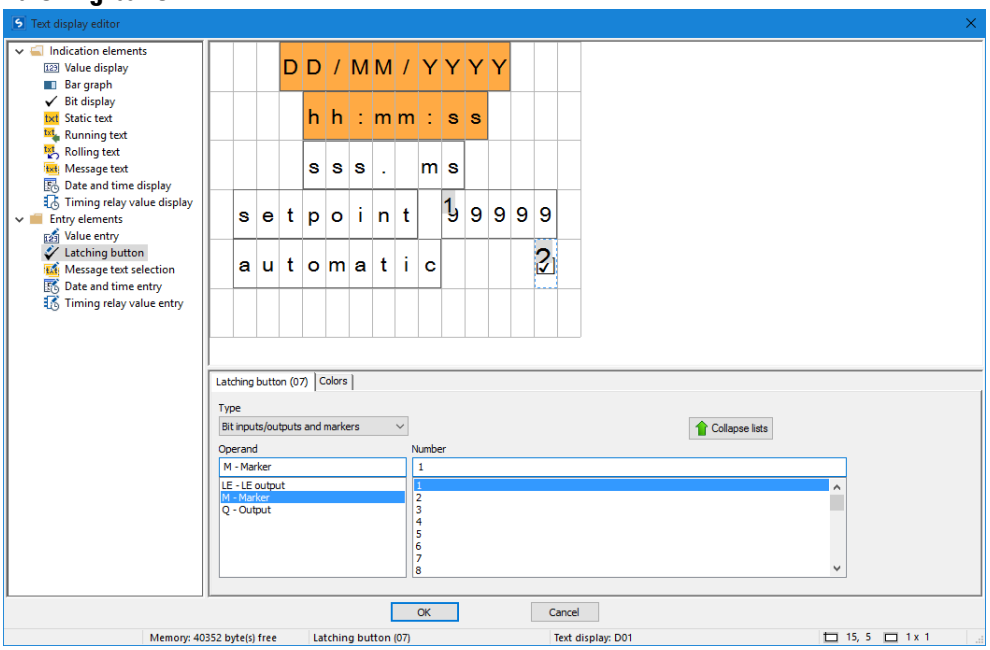
LEFT: The next larger decimal place will be selected or the input value to the left or above will be selected

In the example above, there are three input values on the screen: a value entry, a latching button, and a message text selection.

The value entry [with a value of 900 in the screenshot] consists of three decimal numbers in which the value for each number is entered individually. The latching button [the checkbox with the checkmark] is activated. The question marks show the 16-character area for the message text selection, in which the UP/DOWN buttons can be used to select one of the configured texts.

Once a new value is entered, it can be confirmed with OK. This will exit input mode.

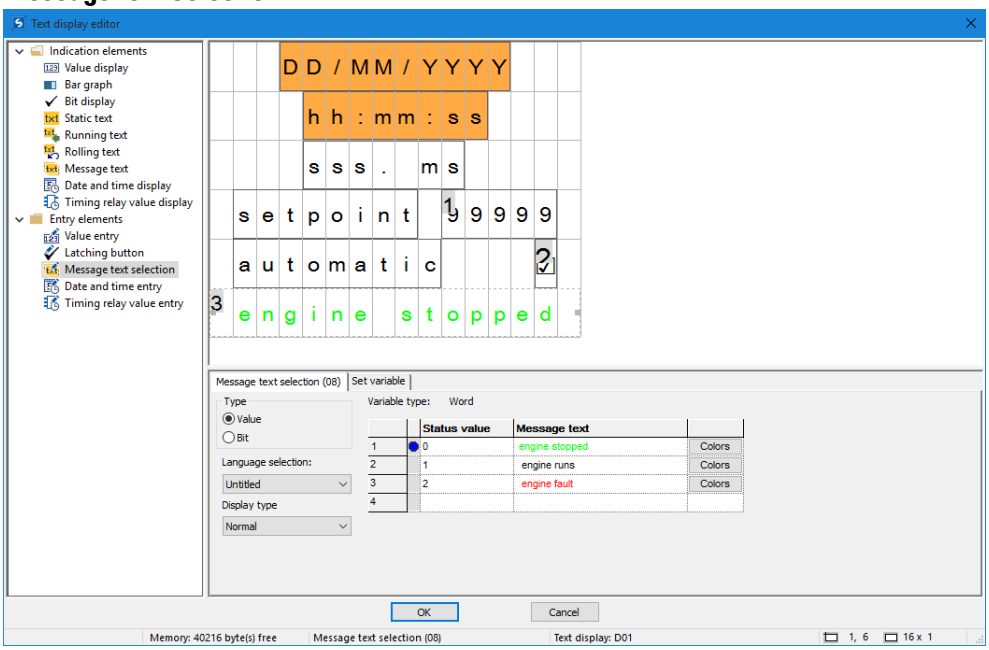
Latching button



Latching button input elements can be used to visualize and enter binary values with the use of a checkbox and checkmark . Two different colors can be used based on a Boolean value. To configure this type of element, you will need to select a bit operand (marker bit 1 in the example above).

The superscript ^{2} on the ☑ indicates that it is the second parameter on the page that can be modified by input – please refer to → Section "Entering data on the display via a D text function block", page 376.

Message text selection



Normally, message texts are activated by the program on the easy. However, it is also possible to have operators call message texts as "input" for the program on the easy (when selecting operating modes, for example). One example is a scenario in which a machine can produce various colors and the operator needs to select one: black socks, brown socks, blue socks.

This element is configured exactly the same way as a message text – please refer to → Section "D - Text display editor", page 366.

The only difference is that the message text selection element allows for operator input – please refer to → Section "Entering data on the display via a D text function block", page 376.

Date and time entry

This element is configured exactly the same way as a date and time display – please refer to → Section "Entering data on the display via a D text function block", page 376

The only difference is that the element allows for operator input.

Timing relay value entry

This element is configured exactly the same way as a timing relay value display – please refer to → Section "Entering data on the display via a D text function block", page 376

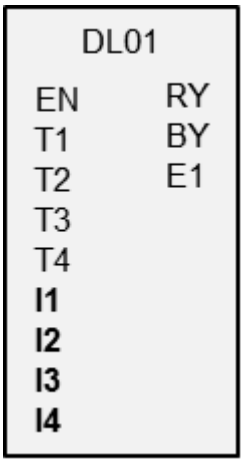
The only difference is that the element allows for operator input.

See also

→ Section "AL - Alarm function block", page 349
→ Section "BV - Boolean operation", page 353
→ Section "D - Text display", page 357
→ Section "DL - Data logger", page 380
→ Section "JC - Conditional jump", page 386
→ Section "LB - Jump label", page 391
→ Section "MR - Master reset ", page 393
→ Section "NC - Numerical converter", page 397
→ Section "D - Text display editor", page 366

6.1.7.5 DL - Data logger

General



easyE4 base devices provide exactly one data logger function block DL01.
You can use the data logger function block to write operating data with a timestamp to a log file on a memory card in the easyE4 base device. In order for this function block to work, a memory card must always be inserted in the device. You can select a filename for the log file when configuring the function block.
Digital function block inputs T1 through T4 and analog function block inputs I1 through I4 are always logged for each data set. In addition, the log will indicate which input triggered the logging operation.

Operating principle

Logging can be triggered with a rising edge at one of the trigger inputs T1 through T4 or a change at analog function block inputs I1 through I4. You can use the Delta ΔI parameter for each function block input (I1 through I4) to specify the data change magnitude starting from which logging will be triggered.

There are two storage modes available for selection:

1. All events will be saved in a single file [ring buffer], meaning that the file will grow with every save operation. Once the maximum number of data sets is reached, the entries at the beginning will be overwritten.
2. A new file will be created for each save operation until the number of log files is reached.

Any byte, word, or double word operand can be connected to analog inputs I1 through I4.

The function block and its parameters

Function block inputs

	Description	Note
(Bit)		
EN	1: Activates the function block.	
T1	1: Logging data set.	
T2	1: Logging data set.	
T3	1: Logging data set.	
T4	1: Logging data set.	
(DWord)		
I1	Analog value 1 for storage	

	Description	Note
I2	Analog value 2 for storage	
I3	Analog value 3 for storage	
I4	Analog value 4 for storage	



If too many log entries are made in a short amount of time, some of the entries may be lost. An important factor to consider within this context is the speed of the memory card being used. If logging is triggered via function block inputs T1 through T4, this problem can be avoided by only having one save operation be triggered if the function block is not in the "logging disabled" state.

Assigning operands

You can assign the following operands to the function block inputs that are numeric inputs.

Operands	Value inputs
Constant, timer constant	x
MD, MW, MB - Markers	x
NB, NW, ND - NET markers	x
nNB, nND, nND- NET markers NET stations n	x
IA - Analog input	x
QA - Analog output	x
QV - QV - Numeric output of a FB	x

You can assign the following operands to the function block inputs that are bit inputs:

Operands	Bit inputs
Constant 0, constant 1	x
M – Markers	x
RN - Input bit via NET	x
SN - Output bit via NET (send)	x
N - Net marker bit	x
nN - NET marker bit NET station n	x
ID: Diagnostic alarm	x
LE - Output backlight	x
P buttons	x
I - Bit input	x
Q - Bit output	x
Q - Bit output of a FB	x

Function block outputs

	Description	Note
(Bit)		
RY	Ready 0: Logging is enabled (in the case of ring buffers, RY = 0 always) 1: Logging inactive	Logging can be disabled because: • n log files have been written • The memory card is full • No memory card inserted • Memory card faulty
BY	Busy 1: Logging not possible	Possible causes: • The card is currently being written to • The temporary internal buffer is full
E1	Error output 1: Data loss	Possible causes: • No memory card inserted • The memory card does not have enough space for another log file • Memory card faulty • Temporary internal buffer overflow by at least one record

Assigning operands

You can assign the following operands to the function block outputs that are numeric outputs:

Assigning operands	Outputs
Constant	x
Markers: MB, MD, MW	x
Analog inputs IA	x
Analog output QA	x
Numeric output from another QV FB	x

You can assign the following operands to the function block outputs that are bit outputs:

Assigning operands	Bit outputs
Constant 0, constant 1	x
M – Markers	x
SN - Output bit via NET (send)	x
N - Network marker bit	x
nN - NET station n marker	x
LE - Output backlight	x
Q - Bit output from another FB	x

Parameter set

	Description	Note
Directory name of log session	Used to enter the name for the log file, e.g., <MYLOG>. A maximum of 8 characters are allowed, and they must conform to Microsoft DOS conventions. The default name will be <EASYLOG>.	
Storage mode	Ring buffer Until number of log files is reached	
Number of files per log session	A log session contains n log files	Integer value range for n: 0…1000
Number of data sets per log file	A log file contains n data sets	Integer value range for n: 0…60 000
Log when input values change	If the changes at DL_I are greater than or equal to ΔI, a data set will be logged.	Integer value range for ΔI: 0…65 535
☑ Function block release by EN is necessary	If this checkbox is enabled, the state of function block input EN will be evaluated. If the checkbox is disabled instead, the function block will be enabled and function block input EN will not do anything.	This parameter ensures that when existing programs are copied, the functionality of the function blocks that are carried over will be retained. The parameter will be automatically set to 0 or 1 depending on the function block.
Parameter display + Call enabled	Function block parameters and constants can be edited on the device.	
Simulation possible		

Storage mode

You can select between Ring buffer and Until number of log files is reached :

Ring buffer

If you select the ring buffer mode, the older values will be overwritten after a certain amount of time. If you select this option, you will be able to look at past values up to a certain limit, as old data will be lost at some point.

Until number of log files is reached
Up to n log files will be created in succession in a single folder. The name of the files will be <number>.log, where <number> will be an eight-digit number that is counted up starting from 00000001.log.

Number of files per log session

You can define the number of files you want to be logged per log session by using the Number of files per log session parameter. The maximum number is 1000. When this maximum number is reached, logging will stop (i.e., the log session will be terminated) and output RY will be set to 1. In order to start over, the log files must first be deleted from the storage device.

Number of data sets per log file

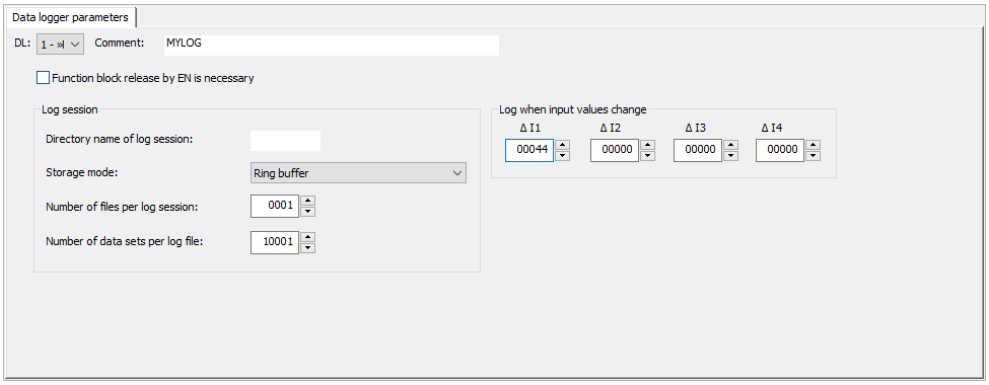
You can use this parameter to define the number of data sets you want to be logged per log file. The maximum number is 60,000. In this mode, logging will always be running, i.e., the log session will not be terminated automatically.

Make sure that the number of data sets you select is only as large as necessary so that the the time for logging will be kept as short as possible.

Log when input values change

You can use the delta values in this section in order to specify the magnitude of change in the actual value (when compared to the most recently logged value) at which a new save operation should start. You can set a delta (ΔI1 through ΔI4) for the four analog values at DL_I1 through DL_I4. Please note that all data will always be logged with each log operation.

Path



Other

Retention

The function block does not recognize retentive data.

Reading log files

The data in the file is binary-encoded and cannot be read with standard Windows PC tools. You can instead read it in easySoft 7, where you can see the logs and export them to Excel. To do this, click on *Project menu/Card.../Data logger logs/*Card => PC button.

Sample log file

The following information will be saved for each data set in the log file:

- Counters
- Date stamp
- Time stamp hh:mm:ss
- Time stamp ms

- States of function block trigger inputs T1 through T4 (DL01T1 through DL01T4 in this example)
- Values at analog function block inputs I1 through I4 (DL01I1 through DL01I4 in this example)

Counter	Date	Time	Time (ms)	DL01T1	DL01T2	DL01T3	DL01T4	DL01I1	DL01I2	DL01I3	DL01I4
0	2018-07-26	12:08:40	365	1	0	0	0	1480	2321	0	0
1	2018-07-26	12:08:40	968	1	1	0	0	1480	2322	0	0
2	2018-07-26	12:08:42	965	1	0	0	0	1479	2321	0	0
3	2018-07-26	12:08:43	677	0	1	0	0	1479	2322	0	0
4	2018-07-26	12:08:45	579	1	0	0	0	1480	2322	0	0
5	2018-07-26	12:08:46	908	0	1	0	0	1480	2321	0	0
6	2018-07-26	12:08:51	529	1	0	0	0	1480	2321	0	0
7	2018-07-26	12:08:52	332	0	1	0	0	1477	2322	0	0
8	2018-07-26	12:08:53	367	1	0	0	0	1480	2319	0	0
9	2018-07-26	12:08:54	151	0	1	0	0	1479	2322	0	0
10	2018-07-26	12:08:54	729	1	0	0	0	1480	2322	0	0
11	2018-07-26	12:08:55	155	1	1	0	0	1480	2322	0	0
12	2018-07-26	12:08:56	675	1	0	0	0	1480	2322	0	0
13	2018-07-26	12:08:56	677	1	1	0	0	1480	2322	0	0
14	2018-07-26	12:08:57	598	1	0	0	0	1480	2321	0	0
15	2018-07-26	12:08:57	607	1	1	0	0	1480	2321	0	0
16	2018-07-26	12:08:58	493	0	1	0	0	1480	2322	0	0
17	2018-07-26	12:08:58	494	1	1	0	0	1480	2322	0	0
18	2018-07-26	12:08:59	355	1	1	0	0	1481	2321	0	0
19	2018-07-26	12:09:00	198	0	1	0	0	1481	2322	0	0
20	2018-07-26	12:09:00	201	1	1	0	0	1481	2322	0	0
21	2018-07-26	12:09:01	56	0	1	0	0	1481	2322	0	0
22	2018-07-26	12:09:01	60	1	1	0	0	1481	2322	0	0
23	2018-07-26	12:09:02	523	1	0	0	0	1481	2322	0	0
24	2018-07-26	12:09:02	525	1	1	0	0	1481	2322	0	0
25	2018-07-26	12:09:03	445	0	1	0	0	1480	2321	0	0
26	2018-07-26	12:09:03	447	1	1	0	0	1480	2321	0	0

There are 26 data sets logged in this log file. The logging for all the data sets was triggered by a rising edge at one of the digital inputs, e.g., data sets 0 through 2 by a DL01T01=1 trigger and data set 3 by a DL01T04=1 trigger. Log files do not include any information regarding the operating mode.

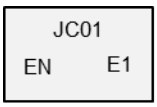
See also

→ Section "AL - Alarm function block", page 349
→ Section "BV - Boolean operation", page 353
→ Section "D - Text display", page 357
→ Section "D - Text display editor", page 366
→ Section "JC - Conditional jump", page 386
→ Section "LB - Jump label", page 391
→ Section "MR - Master reset ", page 393
→ Section "NC - Numerical converter", page 397
→ Section "DL - Data logger", page 380

6.1.7.6 JC - Conditional jump

General

This function block is only available when using the EDP (easy Device Programming) programming language.
easyE4 base devices provide 32 conditional jump function blocks, JC01 through JC32. You can use JC function blocks to branch off forward to an LB jump label function block within the function block diagram and skip several function blocks while doing so.
The JC function block is used in the circuit diagram, while the LB function block is used in the function block diagram. You can use this approach to structure a program.



Operating principle

In order for a jump to be executed, function block input EN must have a state of 1.
The jump target is defined using an LB jump label function block.

JC.. and LB.. must always be used in pairs.

When EN = 1, the program jumps forward over one or several function blocks. The next function block to be processed by the program is the first one following the jump label LB.. in the function block diagram.

When EN = 0, the next function block that the program processes is the one that you have added behind JC.. in the function block diagram.

If the associated jump label is not present for an activated jump or is positioned in front of the jump label (backward jump), the program jumps to the end of the function block diagram.

In both cases, the function block output will be set to state E1 = 1.



Please note that if there is a timing relay function block that has been started in the circuit diagram, the time will keep counting up even if the timing relay is skipped in the function block diagram with JC..

Display of function blocks in the function block diagram

Active function blocks

During simulation, the function block status display shows a red frame around an activated function block that is being processed in the program.
An inactive function block that is not being processed, for example, because the enable coil is set to 0, is shown in a black frame.

The following figure shows the function block JC.. as an example of an active function block. This functions here as the active jump label.

Skipped function blocks

Function blocks, in the function block diagram change the intensity of their color due to an active » Conditional Jump « JC...

With a skipped function block:

- The red in a frame of an active function block turns to pink and
- the black in the frame of an inactive function block turns to grey.
- The last internal states and values are frozen, e.g. the calculation result of an arithmetic function block, that was calculated before a JC..- function block was activated.

Based on these intermediate states, a function block starts

- its recalculation as soon as it is no longer skipped,
- a bit input can be activated in the circuit diagram and
- a green dot can also be displayed in the simulation,

however, the function block does not change its internal states and values. It consequently does not also change the state of its outputs.

Positioning in the function block diagram

Drag the conditional jump function block JC.. into the function block diagram and select in the Properties field window the required function block number between 1 and 32 on the Parameters tab.

The conditional jump function block JC.. is now shown at the end of the function block diagram.

Position the conditional jump function block JCxx in the function block diagram in front of the function block(s) to be skipped. To do this, activate the context menu of the JC.. function block and use the Move function block function.

Use of the conditional jump function block also requires the placement of a jump label (LABEL:xx) function block in the function block diagram.

Association in the circuit diagram

Drag the conditional jump function block JC.. onto a coil field of the circuit diagram and in the Properties Field window select the function block number already used in the positioning. Connect the JC..EN coil with an appropriate contact for activation.



For greater clarity, position the conditional jump function block JC.. in the circuit diagram if possible directly in front of the function block(s) to be skipped.

If the error output is to be evaluated, position the function block in the circuit diagram again. This time use it as a contact and associate JC..E1 with a suitable Boolean operand.

The function block and its parameters

Function block inputs

	Description	Note
(Bit)		
EN	1: Activates the function block.	The checkbox for the ☑ Function block release by EN is necessary parameter must first be enabled

Assigning operands

You can assign the following operands to the function block inputs that are numeric inputs.

Operands	Value inputs
Constant, timer constant	x
MD, MW, MB - Markers	x
NB, NW, ND - NET markers	x
nNB, nND, nND- NET markers NET stations n	x
IA - Analog input	x
QA - Analog output	x
QV - QV - Numeric output of a FB	x

You can assign the following operands to the function block inputs that are bit inputs:

Operands	Bit inputs
Constant 0, constant 1	x
M – Markers	x
RN - Input bit via NET	x
SN - Output bit via NET (send)	x
N - Net marker bit	x
nN - NET marker bit NET station n	x
ID: Diagnostic alarm	x
LE - Output backlight	x
P buttons	x
I - Bit input	x
Q - Bit output	x
Q - Bit output of a FB	x

Function block outputs

	Description	Note
(Bit)		
E1	Error 1: if no associated jump label LB is present or is located in front of the jump location (backward jump)	

Assigning operands

You can assign the following operands to the function block outputs that are numeric outputs:

Assigning operands	Outputs
Constant	x
Markers: MB, MD, MW	x
Analog inputs IA	x
Analog output QA	x
Numeric output from another QV FB	x

You can assign the following operands to the function block outputs that are bit outputs:

Assigning operands	Bit outputs
Constant 0, constant 1	x
M – Markers	x
SN - Output bit via NET (send)	x
N - Network marker bit	x
nN - NET station n marker	x
LE - Output backlight	x
Q - Bit output from another FB	x

Parameter set

Parameter set	Description	Note
☑ Function block release by EN is necessary	If this checkbox is enabled, the state of function block input EN will be evaluated. If the checkbox is disabled instead, the function block will be enabled and function block input EN will not do anything.	This parameter ensures that when existing programs are copied, the functionality of the function blocks that are carried over will be retained. The parameter will be automatically set to 0 or 1 depending on the function block.
Parameter display + Call enabled	Function block parameters and constants can be edited on the device.	
Simulation possible		

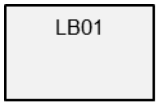
See also

→ Section "AL - Alarm function block", page 349
→ Section "BV - Boolean operation", page 353
→ Section "D - Text display", page 357
→ Section "D - Text display editor", page 366
→ Section "DL - Data logger", page 380
→ Section "LB - Jump label", page 391
→ Section "MR - Master reset ", page 393
→ Section "NC - Numerical converter", page 397
→ Section "ST - SET cycle time", page 403

6.1.7.7 LB - Jump label

General

This function block is only available when using the EDP (easy Device Programming) programming language.
easyE4base devices provide 32 jump label function blocks, LB01 through LB32.
Within a function block diagram, an LB jump label is used as a jump target for a conditional jump implemented with the JC function block.
JC.. and LB.. must always be used in pairs.



Operating principle

The jump label function block does not have to be linked or assigned parameters. It only has to be placed at the appropriate position in the function block diagram.

A corresponding JC.. function block (conditional jump) must exist for every LB.. function block. Conditional jump JC01, for example, is always associated with jump label LB01.

Seen from the corresponding conditional jump function block, the jump label must always be downstream. In other words, it must be closer to the end of the function block diagram.

If the jump label is located upstream of the jump location (backward jump), the program will branch off to the end of the function block diagram. In this case, the conditional jump function block output will be set to state E1 = 1.

Other

Linking and parameter setting

In the function block diagram view, drag the function block to the position you want. Then go to the Jump label parameters tab and select the same function block number you originally assigned to the corresponding conditional jump function block.

You can also move this function block later on. To do so, right-click on the function block you want to move and then select the *Move...* option.

See also

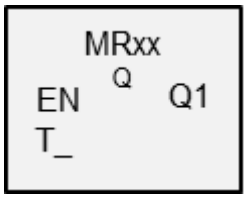
→ Section "AL - Alarm function block", page 349
→ Section "BV - Boolean operation", page 353
→ Section "D - Text display", page 357
→ Section "D - Text display editor", page 366
→ Section "DL - Data logger", page 380
→ Section "JC - Conditional jump", page 386
→ Section "MR - Master reset ", page 393
→ Section "NC - Numerical converter", page 397
→ Section "ST - SET cycle time", page 403

6.1.7.8 MR - Master reset

General

easyE4 base devices provide 32 master reset function blocks MR01 to MR32.

These function blocks can be used to set the markers and all device outputs to a state of 0.



Operating principle

Depending on the operating mode set, it is possible to reset either the outputs only, the markers only or both.

To ensure that all data ranges are reliably cleared, the master reset function block must be the last function block executed in your program. Otherwise subsequent function blocks may overwrite the data ranges again.

The function block and its parameters

Function block inputs

	Description	Note
(Bit)		
EN	1: Activates the function block.	
T_	Trigger: The reset will be carried out when there is a rising edge.	

Assigning operands

You can assign the following operands to the function block inputs that are numeric inputs.

Operands	Value inputs
Constant, timer constant	x
MD, MW, MB - Markers	x
NB, NW, ND - NET markers	x
nNB, nND, nND- NET markers NET stations n	x
IA - Analog input	x
QA - Analog output	x
QV - QV - Numeric output of a FB	x

You can assign the following operands to the function block inputs that are bit inputs:

Operands	Bit inputs
Constant 0, constant 1	x
M – Markers	x

Operands	Bit inputs
RN - Input bit via NET	x
SN - Output bit via NET (send)	x
N - Net marker bit	x
nN - NET marker bit NET station n	x
ID: Diagnostic alarm	x
LE - Output backlight	x
P buttons	x
I - Bit input	x
Q - Bit output	x
Q - Bit output of a FB	x

Operating mode

	Description	Note
Mode parameter		
Q = Reset outputs	Device outputs Q.., and QA..., as well as outputs LE.., SN.., will be reset to a state of 0.	Default settings
M = Reset marker	The following markers are reset to 0: • Marker range MD01...MD256 • ND01..ND16 • Internal markers of existing function blocks UF, IC, IE and IT	
ALL = Reset both	Has an effect on the operands set at Q and M.	

Function block outputs

	Description	Note
(Bit)		
Q1	1: If input T_ has a state of 1.	

Assigning operands

You can assign the following operands to the function block outputs that are numeric outputs:

Assigning operands	Outputs
Constant	x
Markers: MB, MD, MW	x
Analog inputs IA	x
Analog output QA	x
Numeric output from another QV FB	x

You can assign the following operands to the function block outputs that are bit outputs:

Assigning operands	Bit outputs
Constant 0, constant 1	x
M – Markers	x
SN - Output bit via NET (send)	x
N - Network marker bit	x
nN - NET station n marker	x
LE - Output backlight	x
Q - Bit output from another FB	x

Parameter set

	Description	Note
☑ Function block release by EN is necessary	If this checkbox is enabled, the state of function block input EN will be evaluated. If the checkbox is disabled instead, the function block will be enabled and function block input EN will not do anything.	This parameter ensures that when existing programs are copied, the functionality of the function blocks that are carried over will be retained. The parameter will be automatically set to 0 or 1 depending on the function block.
Parameter display + Call enabled	Function block parameters and constants can be edited on the device.	
Simulation possible		

Other

Retention

The function block does not recognize retentive data.

Example of a master reset function block with the programming method EDP

```
I 05--------------------------[ MR07T_
```

Figure 182: Wiring the function block coils

The trigger coil is connected to a device input.

```
MR07Q1-----------------------[ S M42
```

Figure 183: Wiring of the function block contact

The message of the function block is sent to a marker.

Example of a master reset function block configuration on a device display

When using the function block in the circuit diagram for the first time, use OK to automatically enter the display of function blocks on the device display, as shown in the following figure.

```
MR16 Q +
```

Figure 184: Parameters on the device display

Enter the function block settings here. The display contains the following elements:

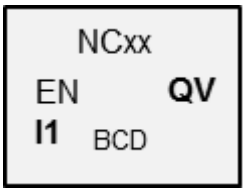
MR16 master reset	Function block: Master reset, number 16
Q	Operating mode: Reset outputs
+	Parameter set can be called via the PARAMETERS menu

See also

→ Section "AL - Alarm function block", page 349
→ Section "BV - Boolean operation", page 353
→ Section "D - Text display", page 357
→ Section "D - Text display editor", page 366
→ Section "DL - Data logger", page 380
→ Section "JC - Conditional jump", page 386
→ Section "LB - Jump label", page 391
→ Section "NC - Numerical converter", page 397
→ Section "ST - SET cycle time", page 403

6.1.7.9 NC - Numerical converter

General



easyE4base devices provide 32 numerical conversion function blocks NC01...NC32.
A decimal number can be represented either as being binary-coded or BCD-coded. Depending on the operating mode you select, this function block will convert BCD-coded numbers to binary-coded numbers (BCD mode) or vice verse, i.e., binary-coded numbers to BCD-coded numbers (BIN mode).

Operating principle

EN=1 enables the function block so that the number conversion will be carried out every cycle. The following applies when using LD, FBD, ST: As soon as there is a changed value at I1, the new conversion value will appear at output QV. When using EDP, the converted value will be provided until the next cycle.

The maximum data size that can be connected to the inputs/outputs is a double word (32 bits). A BCD-coded number requires four bits (a nibble). This means that the biggest BCD-coded numbers that can be converted are 7-digit BCD-coded numbers, since the most significant nibble is used for the sign.

0000 means +

1111 means –

EN=0 initiates a reset in which the output QV is reset to 0.

The function block and its parameters

Function block inputs

	Description	Note
(Bit)		
EN	1: Activates the function block.	
(DWord)		
I1	Operand to be converted	Integer value range, decimal not all the way due to BCD limitation BCD: -9 999 999 … +9 999 999 Decimal: -161 061 273 … +161 061 273

Assigning operands

You can assign the following operands to the function block inputs that are numeric inputs.

Operands	Value inputs
Constant, timer constant	x
MD, MW, MB - Markers	x
NB, NW, ND - NET markers	x
nNB, nND, nND- NET markers NET stations n	x
IA - Analog input	x
QA - Analog output	x
QV - QV - Numeric output of a FB	x

You can assign the following operands to the function block inputs that are bit inputs:

Operands	Bit inputs
Constant 0, constant 1	x
M – Markers	x
RN - Input bit via NET	x
SN - Output bit via NET (send)	x
N - Net marker bit	x
nN - NET marker bit NET station n	x
ID: Diagnostic alarm	x
LE - Output backlight	x
P buttons	x
I - Bit input	x
Q - Bit output	x
Q - Bit output of a FB	x

Operating mode

BCD mode

The BCD value at I1 will be converted to a binary value and output at output QV. The binary value is displayed as a decimal value.

BIN mode

The binary value present at input I1 is converted to a BCD value and supplied at the output QV. The binary value is displayed as a decimal value.

	Description	Note
BCD	Converts a BCD value to a binary value.	
BIN	Converts a binary value to a BCD value.	

Function block outputs

	Description	Note
(DWord)		
QV	Supplies the converted value.	Integer value range Decimal: -161 061 273…+161 061 273 BCD: -9 999 999… +9 999 999

Assigning operands

You can assign the following operands to the function block outputs that are numeric outputs:

Assigning operands	Outputs
Constant	x
Markers: MB, MD, MW	x
Analog inputs IA	x
Analog output QA	x
Numeric output from another QV FB	x

You can assign the following operands to the function block outputs that are bit outputs:

Assigning operands	Bit outputs
Constant 0, constant 1	x
M – Markers	x
SN - Output bit via NET (send)	x
N - Network marker bit	x
nN - NET station n marker	x
LE - Output backlight	x
Q - Bit output from another FB	x

Parameter set

Configuration/time range	Description	Note
☑ Function block release by EN is necessary	If this checkbox is enabled, the state of function block input EN will be evaluated. If the checkbox is disabled instead, the function block will be enabled and function block input EN will not do anything.	This parameter ensures that when existing programs are copied, the functionality of the function blocks that are carried over will be retained. The parameter will be automatically set to 0 or 1 depending on the function block.
Parameter display + Call enabled	Function block parameters and constants can be edited on the device.	
Simulation possible		

Other

Retention

The function block does not recognize retentive data.

Example for BIN operating mode

For simulation purposes in easySoft 7, function block input I1 can be connected to a marker double word instead of to a binary source. The value of this marker double word can be entered in hexadecimal or decimal format. It will always be interpreted as binary at function block input I1.

MD value (dec)	MD value (hex)	I1 BIN		BCD	QV (dec)
		→	NC	→	
9	9	0000 1001		0000 1001	9
23	17	0001 0111		0010 0011	35
37	25	0010 0101		0011 0111	55
9 999 999	00 989 67F	0000 0000 1001 1000 1001 0110 0111 1111		0000 1001 1001 1001 1001 1001 1001 1001	161 061 273
-9 999 999	FF 676 981	1111 1111 0110 0111 0110 1001 1000 0001		1111 0110 0110 0110 0110 0110 0110 0111	-161 061 273
	-10 000 000	1001 0000 0000 0000 0000 0000 0000 0000	Value range exceeded	1001 1001 1001 1001 1001 1001 1001 1001	-161 061 273

The most significant nibble determines the sign.
For negative numbers, the two's complement will be calculated.

Since each decimal value is represented with four bytes or eight nibbles and each nibble in the BCD code can assume a value of 9, the largest number that can be represented is 9999999. The smallest number that can be represented is -9,999,999.

However, since a BCD source cannot represent negative numbers, a negative numeric conversion at QV is simply a theoretical case.

Values greater than 9999999 are output as 161061273.
Values less than –9999999 are output as –161061273.
The working range of the function block has been exceeded.

Example for BCD operating mode

For simulation purposes in easySoft 7, function block input I1 can be connected to a marker double word instead of to a BCD source. The value of this marker double word can be entered in hexadecimal or decimal format. It will always be interpreted as BCD at function block input I1.

MD value (dec)	MD value (hex)	I1 BCD →	NC	→ BIN	QV (dec)
9	9	0000 1001		0000 1001	9
23	17	0001 0111		0001 0001	17
37	25	0010 0101		0001 1001	25
18 585	4 899	0000 0000 0000 0000 0100 1000 1001 1001		0000 0000 0000 0000 0001 0011 0010 0011	4 899
161 061 273	9 999 999	0000 1001 1001 1001 1001 1001 1001 1001		0000 0000 1001 1000 1001 0110 0111 1111	9 999 999
-161 061 273	F6 666 667	1111 0110 1001 1001 1001 1001 1001 1001		1111 1111 0110 0111 0110 1001 1000 0001	-9 999 999
161 061 274		1001 1001 1001 1001 1001 1001 1001 1001	Value range exceeded	1001 1001 1001 1001 1001 1001 1001 1001	9 999 999

→ The most significant nibble determines the sign. For negative numbers, the two's complement will be calculated.

→ Since each decimal value is represented with four bytes or eight nibbles and each nibble in the BCD code can assume a value of 9, the largest number that can be represented is 9999999. The smallest number that can be represented is -9,999,999.

However, since a BCD source cannot five a negative number at I1, a negative numeric conversion at QV is simply a theoretical case.

→ Values greater than 161061273 are output as 9999999.
Values less than –161061273 are output as –9999999.
The working range of the function block has been exceeded.

Example of a numerical converter function block when using the EDP programming language

Function block input NC..EN is connected directly to device terminal I5

```
I 05-----------------------------[ NC01EN
```

Figure 185: Wiring the function block coils

```
NC02 BCD +
>I1
QV>
```

Figure 186: Parameter configuration on the device

See also

→ Section "AL - Alarm function block", page 349
→ Section "BV - Boolean operation", page 353
→ Section "D - Text display", page 357
→ Section "D - Text display editor", page 366
→ Section "DL - Data logger", page 380
→ Section "JC - Conditional jump", page 386
→ Section "LB - Jump label", page 391
→ Section "MR - Master reset ", page 393
→ Section "ST - SET cycle time", page 403

6.1.7.10 ST - SET cycle time

General



easyE4 base devices provide 32 SET cycle time function blocks, ST01 through ST32.

This function block allows a SET cycle time to be defined.
This cycle time is adjusted automatically if the maximum cycle time used in the program is less than this specified value.
The maximum possible set cycle time is 1000 ms.

The set cycle time cannot be implemented if the cycle time of the program is longer than it.

The function block and its parameters

Function block inputs

	Description	Note
(Bit)		
EN	1: Activates the function block.	The checkbox for the ☑ Function block release by EN is necessary parameter must first be enabled
(DWord)		
I1	Required cycle time in ms	Integer value range: 0…1000

Assigning operands

You can assign the following operands to the function block inputs that are numeric inputs.

Operands	Value inputs
Constant, timer constant	x
MD, MW, MB - Markers	x
NB, NW, ND - NET markers	x
nNB, nND, nND- NET markers NET stations n	x
IA - Analog input	x
QA - Analog output	x
QV - QV - Numeric output of a FB	x

You can assign the following operands to the function block inputs that are bit inputs:

Operands	Bit inputs
Constant 0, constant 1	x
M – Markers	x

Operands	Bit inputs
RN - Input bit via NET	x
SN - Output bit via NET (send)	x
N - Net marker bit	x
nN - NET marker bit NET station n	x
ID: Diagnostic alarm	x
LE - Output backlight	x
P buttons	x
I - Bit input	x
Q - Bit output	x
Q - Bit output of a FB	x

Parameter set

	Description	Note
☑ Function block release by EN is necessary	If this checkbox is enabled, the state of function block input EN will be evaluated. If the checkbox is disabled instead, the function block will be enabled and function block input EN will not do anything.	This parameter ensures that when existing programs are copied, the functionality of the function blocks that are carried over will be retained. The parameter will be automatically set to 0 or 1 depending on the function block.
Parameter display + Call enabled	Function block parameters and constants can be edited on the device.	
Simulation NOT possible		

Other

Retention

The function block does not recognize retentive data.

Application example

A program consisting of the bit circuit diagram and function block generates a mean cycle time of approx. 12 ms. Setting the set cycle time to 30 ms will ensure that the cycle times are kept constant at this value.

See also

→ Section "AL - Alarm function block", page 349
→ Section "BV - Boolean operation", page 353
→ Section "D - Text display", page 357
→ Section "D - Text display editor", page 366
→ Section "DL - Data logger", page 380
→ Section "JC - Conditional jump", page 386
→ Section "LB - Jump label", page 391
→ Section "MR - Master reset ", page 393
→ Section "NC - Numerical converter", page 397

6.2 Interrupt function blocks

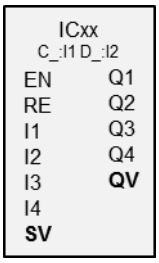
6.2.1 IC - Counter-controlled interrupt function block

Only possible with easySoft 7.

6.2.1.1 General

easyE4 base devices provide 8 counter-controlled interrupt function blocks, IC01 through IC08. This does not apply to the EDP programming language.
easyE4 makes it possible to quickly respond to various events. This makes it possible, for instance, to switch outputs on or off outside of the main program's routine. Only bit operators are allowed within an interrupt program.
The following events can trigger an interrupt:

- Reaching counter reference values, two-channel, device inputs I1 through I8, function blocks IC1 through IC8
- Frequency measurement, reference value exceeded or fallen below, device inputs I1 through I8, function blocks IC1 through IC8



Execution time for an interrupt
The time between the moment the event is detected and the moment there is a response at a device output is < 1 ms. To this end, the base device's QP physical output must be set.
If multiple interrupts are executed simultaneously, the times add up.

NOTICE
Use each device input from I1 to I8 only once in each interrupt function block. Otherwise, an error message will be output during the plausibility check and it will not be possible to load the program onto the device.

In total, no more than 8 interrupt sources are allowed to be processed in a single program. The valid interrupt sources are the IC, IE, IT interrupt function blocks and the CF, CH, and CI high-speed counters that are directly connected to the device inputs.

If there are multiple interrupt requests present simultaneously, the first detected interrupt program will be executed, after which the remaining ones will be executed based on the corresponding order.

While the interrupt program is being processed, any other incoming interrupts at the function block inputs of the same instance will not be detected.

6.2.1.2 Operating principle

A reference value is set at function block input SV. Depending on the operating mode, the function block will be assigned one or two of device inputs I1 through I8 in the corresponding parameters (at least one of them will be set as a counter input in the parameters). If the counter input reaches the reference value, the interrupt will be triggered. The system will switch from the main program to the interrupt program and the latter will be processed.

Interaction between main program and interrupt program

The states of function block inputs IC_I1 through IC_04 are passed to the interrupt program, where they can be processed further as I01 through I04.

Function block outputs IC_Q1 through IC_Q4 can be set from the interrupt program. The corresponding interrupt program outputs are Q01 through Q04.

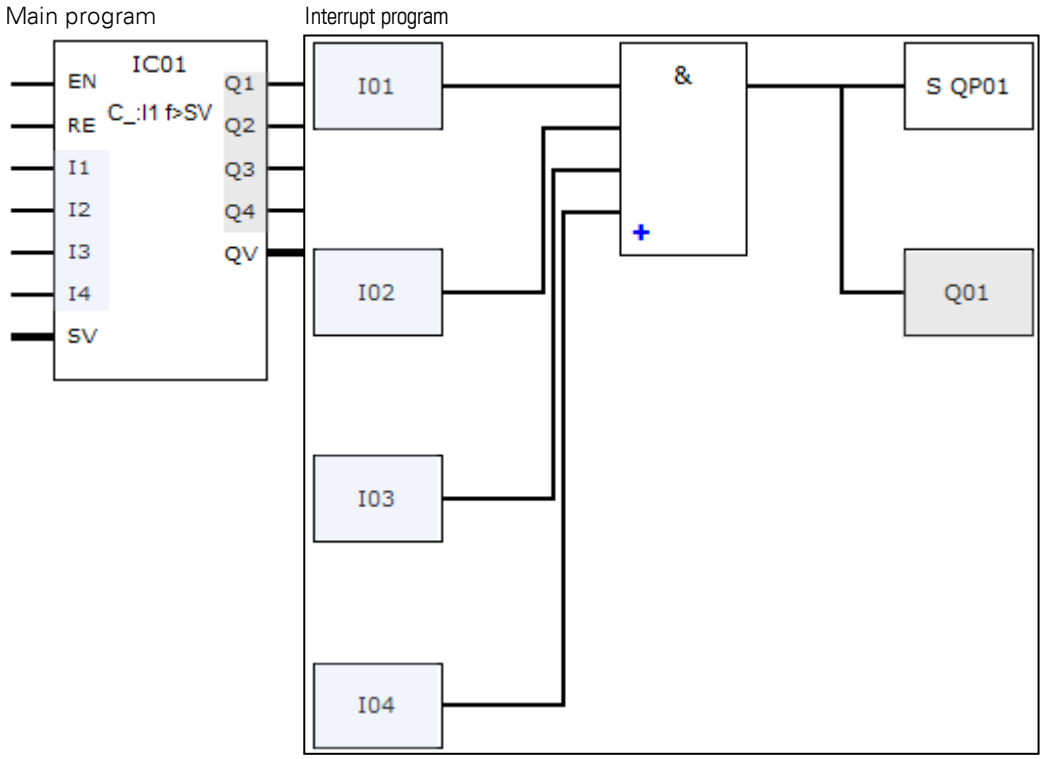


Figure 187: Input and output states being passed between the main program and interrupt program

If an output is defined as a physical output on base device in the parameters for the interrupt program, the output will be assigned an identifier of QP01 – QP04 and will act directly on device output Q1 – Q4.

Zur Verarbeitung des Interrupt-Programmes hat der Funktionsbaustein einen eigenen Merkerbereich von 32 Merker-Bits.

Available functions within an interrupt program

Interrupt programs are not available when using the EDP programming language.

Action	KOP	FBS	ST
New network	√	√	√
Input/output inverter	√	√	√
Contacts	Make, Break, Constant 1, Constant 0		
Coils	Contactor, Negated contactor, Set, Reset		
Jump functions	Jump if 1, Jump if 0, Return if 1, Return if 0		
Logic gates	AND, AND NOT, OR, OR NOT, XOR, XNOR		
Conditional statement	–	–	√
Simple alternative	–	–	√
Multiple alternatives	–	–	√

6.2.1.3 The function block and its parameters

Function block inputs

	Description	Note
(Bit)		
EN	1: Activates the function block.	The checkbox for the ☑ Function block release by EN is necessary parameter must first be enabled
RE	1: Sets the actual counter value to zero	
I1	The states of the bit inputs from the main program will be provided to the interrupt program	
I2		
I3		
I4		
(DWord)		
SV	Setpoint	Integer value range: -2,147,483,648 to +2,147,483,647

Assigning operands

You can assign the following operands to the function block inputs that are numeric inputs.

Operands	Value inputs
Constant, timer constant	x
MD, MW, MB - Markers	x
NB, NW, ND - NET markers	x
nNB, nND, nND- NET markers	x

Operands	Value inputs
NET stations n	
IA - Analog input	x
QA - Analog output	x
QV - QV - Numeric output of a FB	x

You can assign the following operands to the function block inputs that are bit inputs:

Operands	Bit inputs
Constant 0, constant 1	x
M – Markers	x
RN - Input bit via NET	x
SN - Output bit via NET (send)	x
N - Net marker bit	x
nN - NET marker bit NET station n	x
ID: Diagnostic alarm	x
LE - Output backlight	x
P buttons	x
I - Bit input	x
Q - Bit output	x
Q - Bit output of a FB	x

Operating modes

(Bit)	Description	Note
Counter with external direction control	Pulse at device input I1 – I8, which is defined as a counter input in the parameters. Duration signal at device input I1 – I8, which specifies the counting direction. 0: up counting 1: down counting	Maximum frequency 5kHz
Counter with 2 counter inputs	Pulse at device input I1 – I8 counts up. Pulse at device input I1 – I8 counts down.	
incremental counter	X2 With automatic up/down counting direction detection, two counter inputs I1…I8, counter input channel A, pulse I1…I8, counter input channel B, pulse When there is a complete channel A and B period (e.g., first channel A edge to next channel A edge), the value at IC..QV is incremented or decremented by 2 depending on the	

(Bit)	Description	Note
	counting direction.	
Frequency counter; f > SV	I1…I8, timeout of the frequency reference Measuring interval 0.01s, 500 Hz - 5000 Hz Measuring interval 0.1 s, 50 Hz - 5000 Hz Measuring interval 1.0 s 5 Hz - 5000 Hz	
Frequency counter; f < SV	I1 – I8, Frequency reference fallen below Measuring interval 0.01s, 500 Hz - 5000 Hz Measuring interval 0.1 s, 50 Hz - 5000 Hz Measuring interval 1.0 s 5 Hz - 5000 Hz	



In the case of pulse counter with external direction control, device inputs I1 through I4 must be used as pulse inputs and device inputs I5 through I8 must be used as direction inputs.
In the case of counters with 2 counter inputs, I1 through I4 should be used with first priority.
In the case of incremental encounters, I1 through I4 should be used with first priority.



In the case of incremental counters, channel A and channel B must deliver pulses with an offset of 90°.

IC function block with incremental counter operating mode, up or down count; X2

Function block outputs

	Description	Note
(Bit)		
Q1	Bit output used to provide operand states from the interrupt program to the main program.	
Q2		
Q3		
Q4		
(DWord)		
QV	Current count	Integer value range: -2,147,483,648 to +2,147,483,647

Assigning operands

You can assign the following operands to the function block outputs that are numeric outputs:

Assigning operands	Outputs
Constant	x
Markers: MB, MD, MW	x
Analog inputs IA	x
Analog output QA	x
Numeric output from another QV FB	x

You can assign the following operands to the function block outputs that are bit outputs:

Assigning operands	Bit outputs
Constant 0, constant 1	x
M – Markers	x
SN - Output bit via NET (send)	x
N - Network marker bit	x
nN - NET station n marker	x
LE - Output backlight	x
Q - Bit output from another FB	x

Parameter set

	Description	Note
☑ Function block release by EN is necessary	If this checkbox is enabled, the state of function block input EN will be evaluated. If the checkbox is disabled instead, the function block will be enabled and function block input EN will not do anything.	This parameter ensures that when existing programs are copied, the functionality of the function blocks that are carried over will be retained. The parameter will be automatically set to 0 or 1 depending on the function block.
Parameter display + Call enabled	Function block parameters and constants can be edited on the device.	
Edit interrupt routine	Clicking on the button will open the interrupt routine	
Simulation possible		

6.2.1.4 Other

Retention

The function block does not recognize retentive data.

The interrupt program does not have any retentive data.

Monitoring the interrupt load

In total, no more than 8 interrupt sources are allowed to be processed in a single program. The valid interrupt sources are the IC, IE, IT interrupt function blocks and the CF, CH, and CI high-speed counters that are directly connected to the device inputs. For more information, please refer to → "CF - Frequency counter", page 224, → "CH - High-speed counter", page 230 , → "CI - Incremental counter", page 237 as well.

For function blocks IE01 – IE08 and IC01 – IC08, device inputs I01 – I08 can be assigned freely.

For function blocks IT01 – IT08, an interrupt that is not yet in use is assigned in easySoft 7. The interrupt sources used by the CF, CH, and CI high-speed counters are also considered to be in use within this context.

Each device input and each interrupt source can only be used once.

Exceptions:

- For CI01, the instance of I02 can be used by an IT interrupt function block.
- For CI02, the instance of I04 can be used by an IT interrupt function block.
- For each interrupt function block IC, the instance of the second input of an IT function block can be used if the Counter with 2 counter inputs mode has not been selected.

These exceptions are taken into account by the plausibility check and by the program compilation routine in easySoft 7. The maximum number of 8 interrupts is also taken into account within this context.

	Device inputs							
	I01	**I02**	**I03**	**I04**	**I05**	**I06**	**I07**	**I08**
Interrupt source								
CF01 frequency counter	x							
CF02 frequency counter		x						
CF03 frequency counter			x					
CF04 frequency counter				x				
CH01 high-speed meter	x							
CH02 high-speed meter		x						
CH03 high-speed meter			x					
CH04 high-speed meter				x				
CI01 incremental counter	x	x						
CI02 incremental counter			x	x				
IE01…IE08	One input, I01 – I08 can be assigned freely (max. 8, none can be assigned more than once)							
IC01 – IC08	Two inputs, I01 – I08 can be assigned freely (max. 8, none can be assigned more than once)							
IT01…IT08	Automatically assigns the user interrupts 1 to 8 that are still available (only for instances of I01 – I08 that are not in use by other function blocks)							

The time between the moment the triggering signal is detected and the moment there is a response at an output is < 1 ms. If multiple interrupts are executed simultaneously, the times add up.

Measuring the interrupt load

The runtime for each interrupt source is measured in µs. All measured times are added over a period of 100 ms. After each 100 ms, the total of all times is evaluated and the time measurement is cleared. If the interrupts used up more than 50% of the computing time, the application will be stopped.

The <System_CPU_overload> diagnostic message will be generated and ID19 will be set to 1.

For more information on how diagnostic messages can be called and processed, please refer to Processing diagnostic messages

Available fixes for high interrupt loads

If the interrupt load becomes too heavy, the following steps can be taken to reduce it:

- Reduce the number of function blocks
- Keep the interrupt routine as short as possible
- Reduce frequencies when using counters

Example of a pulse counter with external direction control in easySoft 7

Device input I1: Counter input C_

Device input I5: Counting direction D_

If the setpoint of <1750> is reached at device input I1, the system will jump to the interrupt program. Inside the interrupt program, QP04 will be used to set device output Q4 to 1 directly. Q01 will be used to set function block output Q1 to 1. The system will then jump back to the main program.

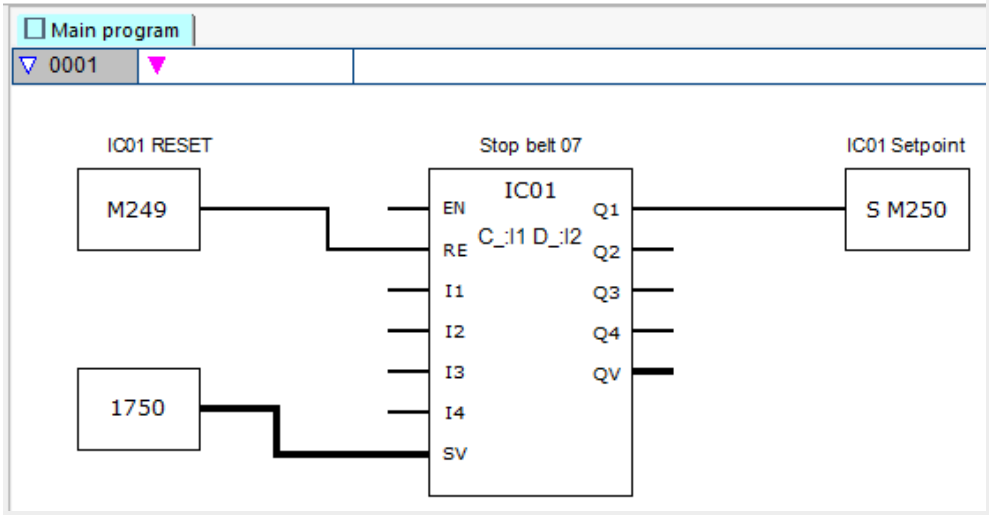


Figure 188: easySoft 7 main program

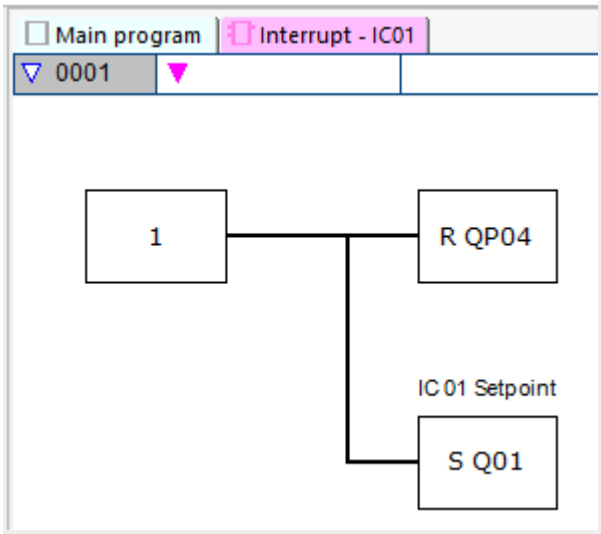


Figure 189: easySoft 7 interrupt program

Example with two counter inputs in easySoft 7

Device input I1: Up counter input C+

Device input I2: Down counter input C-

If the actual value reaches the function block's setpoint, the interrupt will be triggered. The interrupt program will then set device output Q1 back to 0. In addition, Q01=1 will be used to set function block output Q1 to 1 and main program marker M250 to 1. This way, the container status will be signaled.

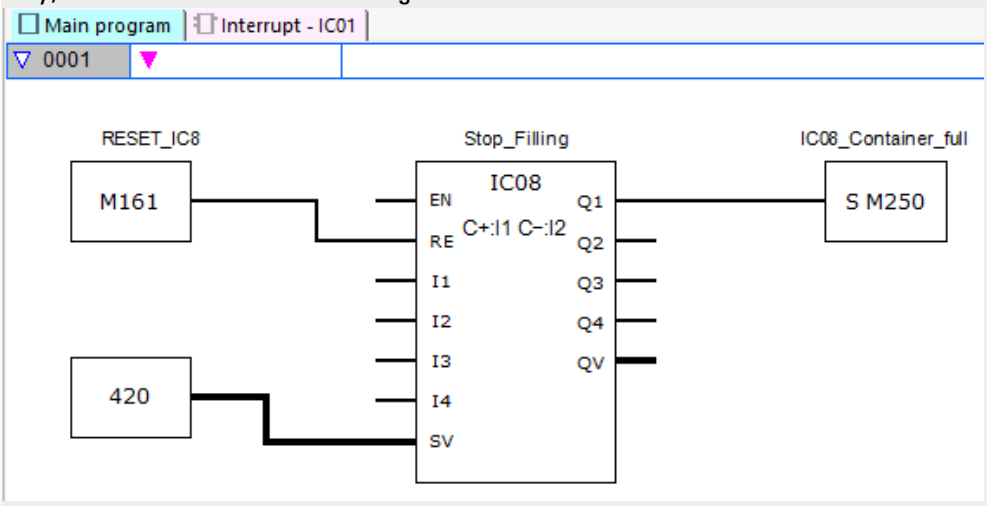


Figure 190: easySoft 7 main program

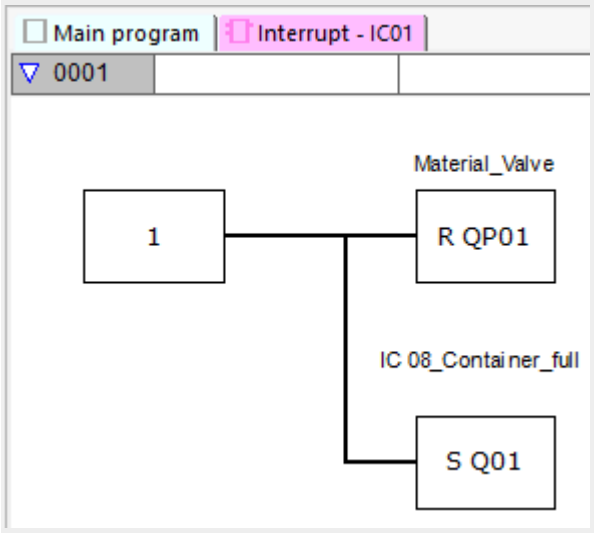


Figure 191: easySoft 7 interrupt program

Example of an incremental counter in easySoft 7

Palletizing system with home positioning

The gripper must set the material down every time the target position with marker word MW512 is reached in the up direction. When Q01 is set in the interrupt program, marker M511 is set in the main program so that it can be used to move back to the home position.

Device input I3: channel A

Device input I4: channel B

The target position is specified on marker MW512.

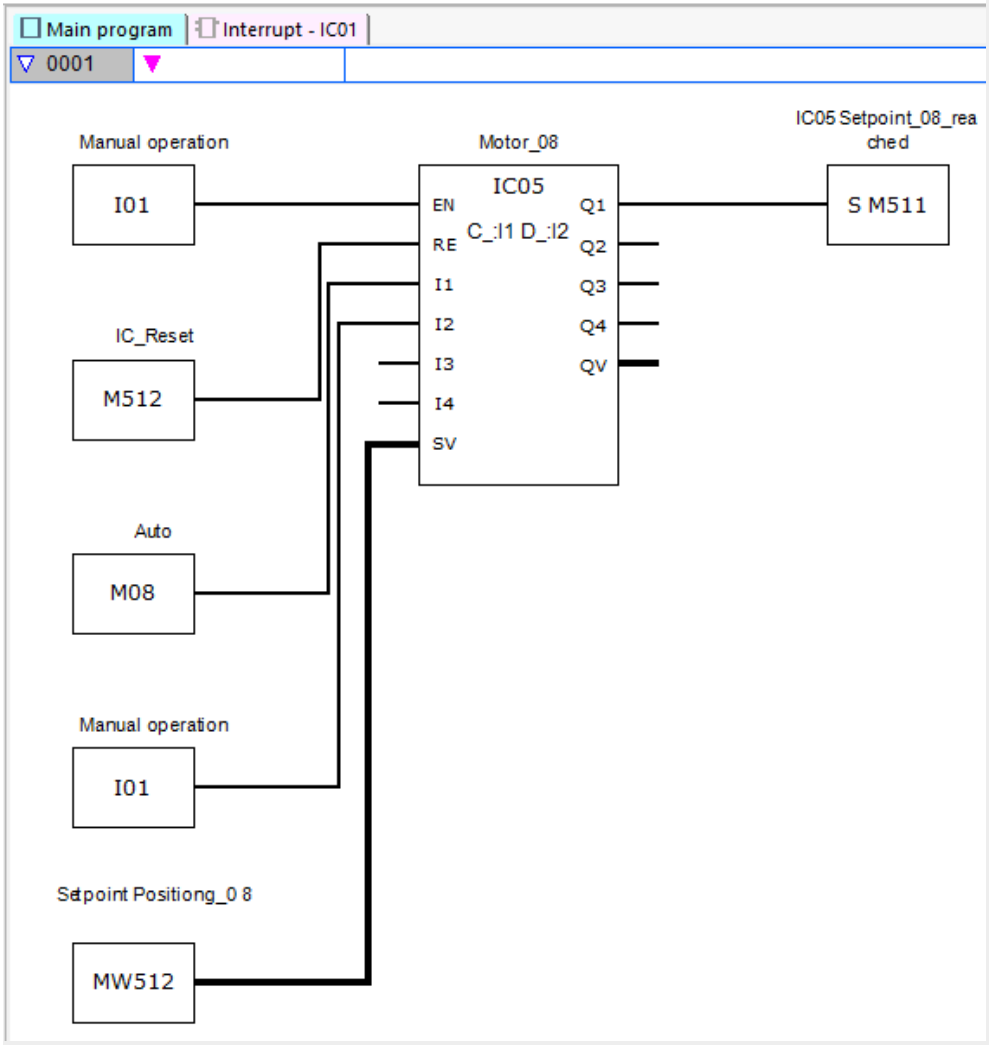


Figure 192: easySoft 7 main program

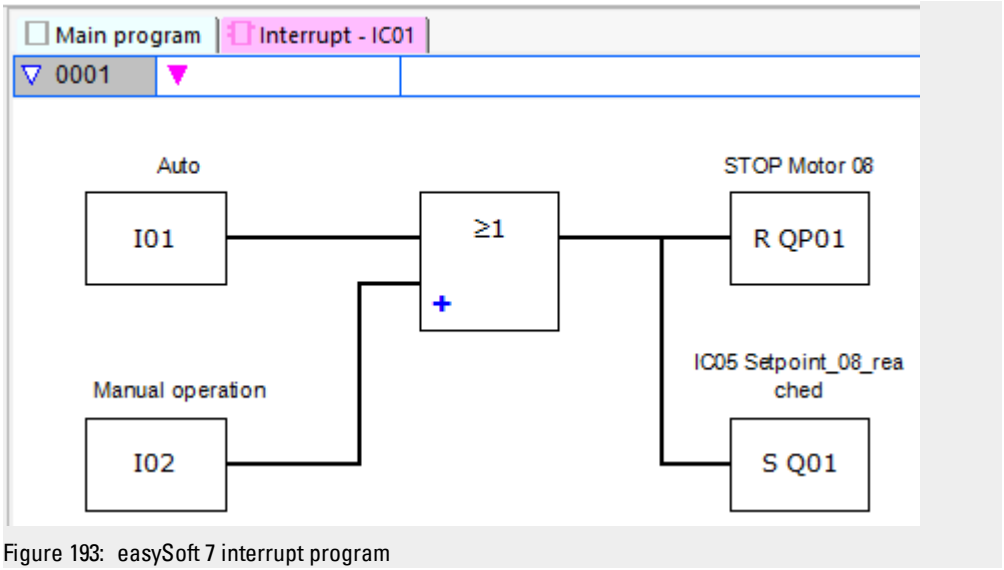


Figure 193: easySoft 7 interrupt program

Example frequency measurement in easySoft 7

Device input I1 is a measuring input.

If the frequency at device input I1 reaches the frequency of 1030 Hz, the interrupt is triggered. The interrupt program uses QP02 to reset device output Q2 and SQ01 to set marker M31 at function block output Q1. Marker 31 signals that the frequency has been reached.

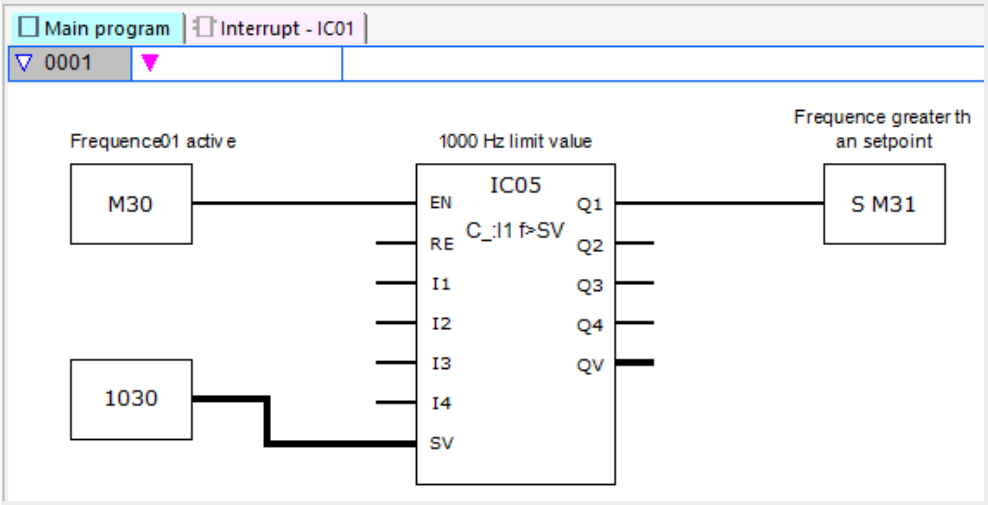


Figure 194: easySoft 7 main program

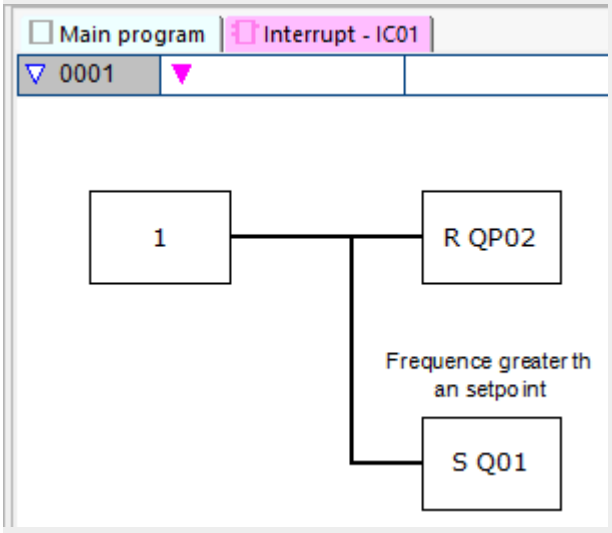


Figure 195: easySoft 7 interrupt program

See also

→ Section "IE - Edge-controlled interrupt function block", page 418
→ Section "IT - Time-controlled interrupt function block", page 424

6.2.2 IE - Edge-controlled interrupt function block

Only possible with easySoft 7.

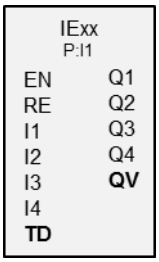
6.2.2.1 General

easyE4 base devices provide 8 edge-controlled interrupt function blocks, IE01 through IE08. This does not apply to the EDP programming language. easyE4 makes it possible to quickly respond to various events. This makes it possible, for instance, to switch outputs on or off outside of the main program's routine. Only bit operators are allowed within an interrupt program.
The following events can trigger an interrupt:

- Rising, falling, rising, and falling edges at device inputs I1 through I8, function block IE01 through IE08.

Execution time for an interrupt
The time between the moment the event is detected and the moment there is a response at a device output is < 1 ms. To this end, the base device's QP physical output must be set.
If multiple interrupts are executed simultaneously, the times add up.

NOTICE
Use each device input from I1 to I8 only once in each interrupt function block. Otherwise, an error message will be output during the plausibility check and it will not be possible to load the program onto the device.



In total, no more than 8 interrupt sources are allowed to be processed in a single program. The valid interrupt sources are the IC, IE, IT interrupt function blocks and the CF, CH, and CI high-speed counters that are directly connected to the device inputs.

If there are multiple interrupt requests present simultaneously, the first detected interrupt program will be executed, after which the remaining ones will be executed based on the corresponding order.

While the interrupt program is being processed and during a configured delay, any other incoming interrupts at the function block inputs of the same instance will not be detected.

6.2.2.2 Operating principle

You can use function block input TD to set a reference value for a delay you want. You will need to assign one of device inputs I1 through I8 to the function block as an interrupt source. The first edge at the assigned device input will trigger the interrupt directly if you did not configure a delay. Otherwise, the interrupt will be triggered after the configured delay elapses. The system will switch from the main program to the interrupt program and the latter will be processed.

Interaction between main program and interrupt program

The states of function block inputs IE_I1 through IE_04 are passed to the interrupt program, where they can be processed further as I01 through I04.

Function block outputs IE_Q1 through IE_Q4 can be set from the interrupt program. The corresponding interrupt program outputs are Q01 through Q04.

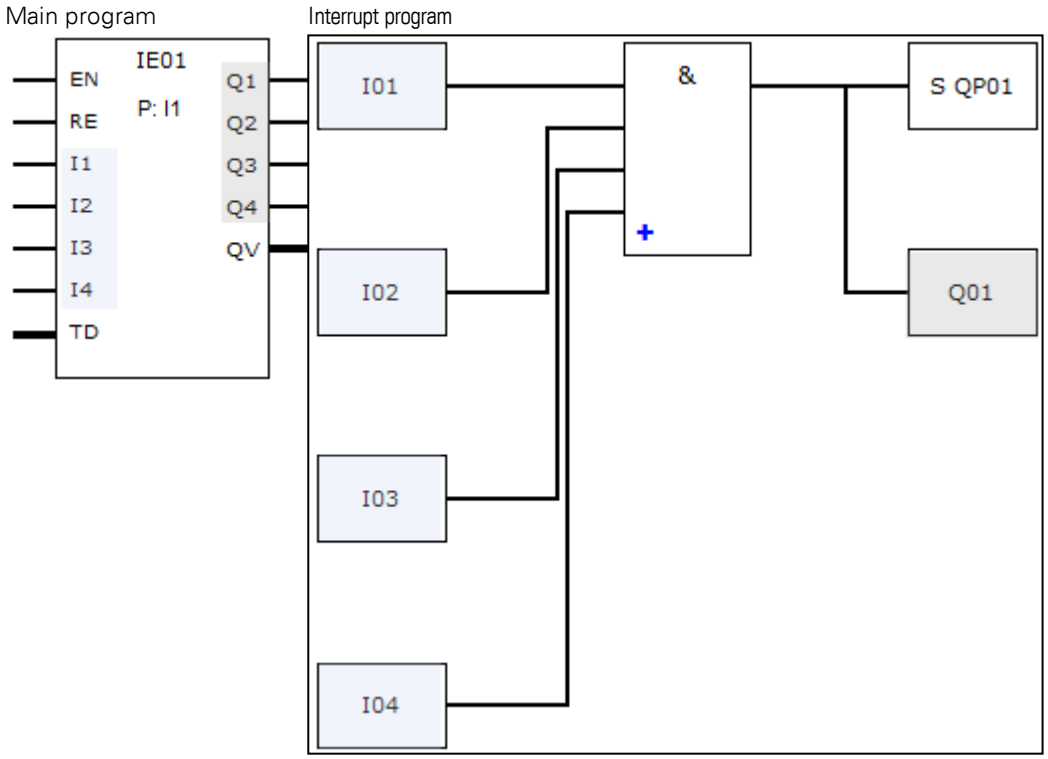


Figure 196: Input and output states being passed between the main program and interrupt program

If an output is defined as a physical output on base device in the parameters for the interrupt program, the output will be assigned an identifier of QP01 – QP04 and will act directly on device output Q1 – Q4.

Zur Verarbeitung des Interrupt-Programmes hat der Funktionsbaustein einen eigenen Merkerbereich von 32 Merker-Bits.

Available functions within an interrupt program

Interrupt programs are not available when using the EDP programming language.

Action	KOP	FBS	ST
New network	√	√	√
Input/output inverter	√	√	√
Contacts	Make, Break, Constant 1, Constant 0		
Coils	Contactor, Negated contactor, Set, Reset		
Jump functions	Jump if 1, Jump if 0, Return if 1, Return if 0		
Logic gates	AND, AND NOT, OR, OR NOT, XOR, XNOR		
Conditional statement	–	–	√
Simple alternative	–	–	√
Multiple alternatives	–	–	√

6.2.2.3 The function block and its parameters

Function block inputs

	Description	Note
(Bit)		
EN	1: Activates the function block.	The checkbox for the ☑ Function block release by EN is necessary parameter must first be enabled
RE	1: Sets the function block's internal counter for the delay back to the value at TD.	
I1	Bit input used to provide operand states from the main program to the interrupt program	
I2		
I3		
I4		
(DWord)		
TD	Delay until the interrupt program is started	Value range: 20 ms …999 990 ms Resolution: 10 ms

Assigning operands

You can assign the following operands to the function block inputs that are numeric inputs.

Operands	Value inputs
Constant, timer constant	x
MD, MW, MB - Markers	x
NB, NW, ND - NET markers	x
nNB, nND, nND- NET markers NET stations n	x
IA - Analog input	x
QA - Analog output	x
QV - QV - Numeric output of a FB	x

You can assign the following operands to the function block inputs that are bit inputs:

Operands	Bit inputs
Constant 0, constant 1	x
M – Markers	x
RN - Input bit via NET	x
SN - Output bit via NET (send)	x
N - Net marker bit	x
nN - NET marker bit NET station n	x
ID: Diagnostic alarm	x
LE - Output backlight	x
P buttons	x
I - Bit input	x
Q - Bit output	x
Q - Bit output of a FB	x

Operating modes

	Description	Note
Rising edge	Rising edge: Runs the interrupt program once after delay TD.	
Falling edge	Falling edge: Runs the interrupt program once after delay TD.	
Both edges	Rising edge and falling edge at input: Runs the interrupt program after delay TD each time.	

Function block outputs

	Description	Note
(Bit)		
Q1	Bit output used to provide operand states from the interrupt program to the main program.	
Q2		
Q3		
Q4		
(DWord)		
QV	Actual elapsed delay (TD) time	

Assigning operands

You can assign the following operands to the function block outputs that are numeric outputs:

Assigning operands	Outputs
Constant	x
Markers: MB, MD, MW	x
Analog inputs IA	x
Analog output QA	x
Numeric output from another QV FB	x

You can assign the following operands to the function block outputs that are bit outputs:

Assigning operands	Bit outputs
Constant 0, constant 1	x
M – Markers	x
SN - Output bit via NET (send)	x
N - Network marker bit	x
nN - NET station n marker	x
LE - Output backlight	x
Q - Bit output from another FB	x

Parameter set

	Description	Note
☑ Function block release by EN is necessary	If this checkbox is enabled, the state of function block input EN will be evaluated. If the checkbox is disabled instead, the function block will be enabled and function block input EN will not do anything.	This parameter ensures that when existing programs are copied, the functionality of the function blocks that are carried over will be retained. The parameter will be automatically set to 0 or 1 depending on the function block.
Parameter display + Call enabled	Function block parameters and constants can be edited on the device.	
Interrupt source	Used to select device inputs I1 through I8 as a trigger for the interrupt	
Edit interrupt routine	Clicking on the button will open the interrupt routine in the Programming view	
Simulation possible		

6.2.2.4 Other

Retention

The function block does not recognize retentive data.

The interrupt program does not have any retentive data.

Example slope in easySoft 7

Rising edge operating mode

Cutting device at station 2. The interrupt is triggered with a pulse at function block input I1. Device output Q1 is set in the interrupt program and the product is cut. Device output Q2 is reset. The interrupt program Q01 passes marker 211 to the main program with Q1 and signals that the cutting device is active.

Once the product has been cut at station 2, there is a rising edge at input I1 of the base device. Processing must be initiated.

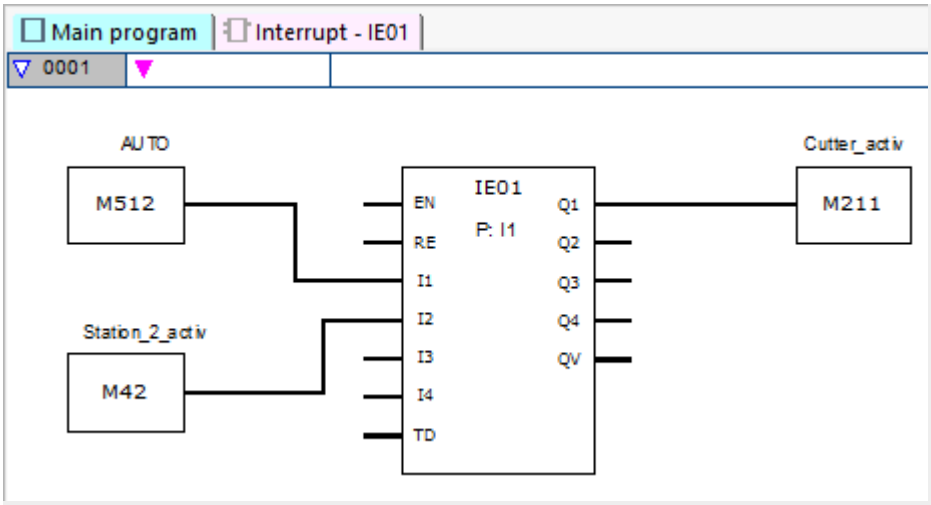


Figure 197: easySoft 7 main program

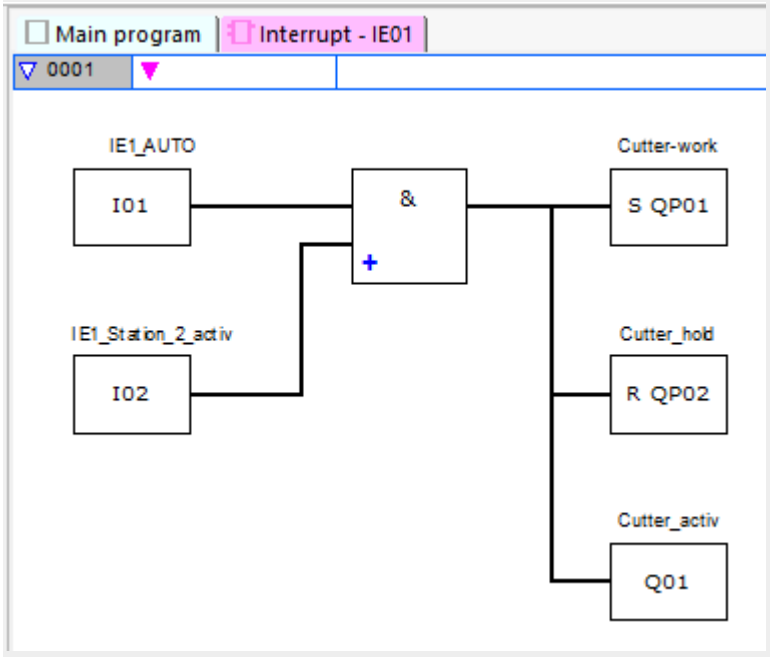


Figure 198: easySoft 7 interrupt program

See also

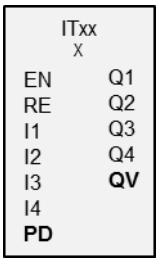
→ Section "IE - Edge-controlled interrupt function block", page 418
→ Section "IT - Time-controlled interrupt function block", page 424

6.2.3 IT - Time-controlled interrupt function block

Only possible with easySoft 7.

6.2.3.1 General

easyE4 base devices provide 8 time-controlled interrupt function blocks, IT01 through IT08. This does not apply to the EDP programming language.
easyE4 makes it possible to quickly respond to various events. This makes it possible, for instance, to switch outputs on or off outside of the main program's routine. Only bit operators are allowed within an interrupt program.
Time-controlled interrupt function blocks can be used in on-delayed mode or interval mode.



Execution time for an interrupt
The time between the moment the event is detected and the moment there is a response at a device output is < 1 ms. Accordingly, QP - Physical output on base device must be set in the interrupt program. If multiple interrupts are executed simultaneously, the times add up.

In total, no more than 8 interrupt sources are allowed to be processed in a single program. The valid interrupt sources are the IC, IE, IT interrupt function blocks and the CF, CH, and CI high-speed counters that are directly connected to the device inputs.

If there are multiple interrupt requests present simultaneously, the first detected interrupt program will be executed, after which the remaining ones will be executed based on the corresponding order.

6.2.3.2 Operating principle

A reference value is set at function block input PD. As soon as function block input EN is set to 1, the time measurement starts. Depending on the operating mode being used, the system will jump to the interrupt program once or repeatedly as soon as the specified time at function block input PD is reached.

Interaction between main program and interrupt program

The states of function block inputs IT_I1 through IC_04 are passed to the interrupt program, where they can be processed further as I01 through I04.

Function block outputs IT_Q1 through IC_Q4 can be set from the interrupt program. The corresponding interrupt program outputs are Q01 through Q04.

Main program Interrupt program

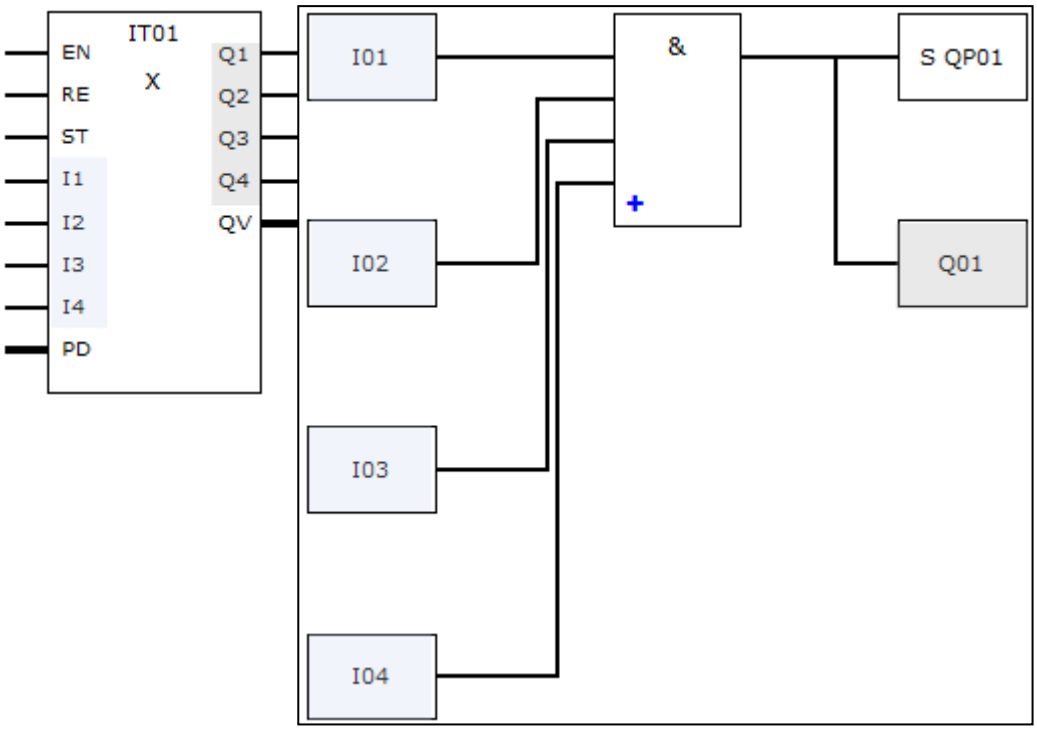


Figure 199: Input and output states being passed between the main program and interrupt program

If an output is defined as a physical output on base device in the parameters for the interrupt program, the output will be assigned an identifier of QP01 – QP04 and will act directly on device output Q1 – Q4.

Zur Verarbeitung des Interrupt-Programmes hat der Funktionsbaustein einen eigenen Merkerbereich von 32 Merker-Bits.

Available functions within an interrupt program

Interrupt programs are not available when using the EDP programming language.

Action	KOP	FBS	ST
New network	√	√	√
Input/output inverter	√	√	√
Contacts	Make, Break, Constant 1, Constant 0		
Coils	Contactor, Negated contactor, Set, Reset		
Jump functions	Jump if 1, Jump if 0, Return if 1, Return if 0		
Logic gates	AND, AND NOT, OR, OR NOT, XOR, XNOR		
Conditional statement	–	–	√
Simple alternative	–	–	√
Multiple alternatives	–	–	√

6.2.3.3 The function block and its parameters

Function block inputs

	Description	Note
(Bit)		
EN	1: Activates the function block.	
RE	1: Sets the actual time of the interrupt function block back to the time at PD.	
ST	1: Stops the interrupt function block's time measurement. 0: The interrupt function block's time measurement will continue.	
I1	The states of the bit inputs from the main program are provided to the interrupt program.	
I2		
I3		
I4		
(DWord)		
PD	Pulse pause time: Value of the delay that must elapse before the interrupt program is started.	Integer value range: 20…999 990 ms, resolution 10 ms

Assigning operands

You can assign the following operands to the function block inputs that are numeric inputs.

Operands	Value inputs
Constant, timer constant	x
MD, MW, MB - Markers	x
NB, NW, ND - NET markers	x
nNB, nND, nND- NET markers NET stations n	x
IA - Analog input	x
QA - Analog output	x
QV - QV - Numeric output of a FB	x

You can assign the following operands to the function block inputs that are bit inputs:

Operands	Bit inputs
Constant 0, constant 1	x
M – Markers	x
RN - Input bit via NET	x
SN - Output bit via NET (send)	x
N - Net marker bit	x

Operands	Bit inputs
nN - NET marker bit NET station n	x
ID: Diagnostic alarm	x
LE - Output backlight	x
P buttons	x
I - Bit input	x
Q - Bit output	x
Q - Bit output of a FB	x

Operating modes

	Description	Note
On-delayed	If the time set at function block input PD is reached, the system will jump to the interrupt program once	
Interval	If the time set at function block input PD is reached, the system will jump to the interrupt program. The time measurement will start again and, after it elapses, the system will jump to the interrupt program again. This will keep happening as long as function block input EN = 1.	

IT interrupt function blocks feature two operating modes that work as described below:

- On-delayed
  The interrupt function block is enabled via function block input EN. The pulse/pause time at function block input PD starts to count down. When the pulse/pause time at function block input PD elapses, the interrupt is triggered immediately and the interrupt program is processed.
- Interval
  The interrupt function block is enabled via function block input EN. The pulse time at function block input PD starts to count down. When the pulse time at function block input PD elapses, the interrupt is triggered immediately and the interrupt program is processed. After this, the pause time at function block input PD starts to count down. When the pause time at function block input PD elapses, the interrupt is triggered immediately and the interrupt program is processed. This means that the interrupt is triggered twice: once at the end of the pulse and once at the end of the pause.

Function block outputs

	Description	Note
(Bit)		
Q1	Bit output used to provide operand states from the interrupt program to the main program.	
Q2		
Q3		
Q4		

	Description	Note
(DWord)		
QV	Elapsed actual time of delay set at PD	

Assigning operands

You can assign the following operands to the function block outputs that are numeric outputs:

Assigning operands	Outputs
Constant	x
Markers: MB, MD, MW	x
Analog inputs IA	x
Analog output QA	x
Numeric output from another QV FB	x

You can assign the following operands to the function block outputs that are bit outputs:

Assigning operands	Bit outputs
Constant 0, constant 1	x
M – Markers	x
SN - Output bit via NET (send)	x
N - Network marker bit	x
nN - NET station n marker	x
LE - Output backlight	x
Q - Bit output from another FB	x

Parameter set

	Description	Note
Parameter display + Call enabled	Function block parameters and constants can be edited on the device.	
Edit interrupt routine	Clicking on the button will open the interrupt routine	
Simulation possible		

6.2.3.4 Other

Retention

The function block does not recognize retentive data.

The interrupt program does not have any retentive data.

Monitoring the interrupt load

In total, no more than 8 interrupt sources are allowed to be processed in a single program. The valid interrupt sources are the IC, IE, IT interrupt function blocks and the CF, CH, and CI high-speed counters that are directly connected to the device inputs. For more information, please refer to → "CF - Frequency counter", page 224, → "CH - High-speed counter", page 230 , → "CI - Incremental counter", page 237 as well.

For function blocks IE01 – IE08 and IC01 – IC08, device inputs I01 – I08 can be assigned freely.

For function blocks IT01 – IT08, an interrupt that is not yet in use is assigned in easySoft 7. The interrupt sources used by the CF, CH, and CI high-speed counters are also considered to be in use within this context.

Each device input and each interrupt source can only be used once.

Exceptions:

- For CI01, the instance of I02 can be used by an IT interrupt function block.
- For CI02, the instance of I04 can be used by an IT interrupt function block.
- For each interrupt function block IC, the instance of the second input of an IT function block can be used if the Counter with 2 counter inputs mode has not been selected.

These exceptions are taken into account by the plausibility check and by the program compilation routine in easySoft 7. The maximum number of 8 interrupts is also taken into account within this context.

	Device inputs							
	I01	**I02**	**I03**	**I04**	**I05**	**I06**	**I07**	**I08**
Interrupt source								
CF01 frequency counter	x							
CF02 frequency counter		x						
CF03 frequency counter			x					
CF04 frequency counter				x				
CH01 high-speed meter	x							
CH02 high-speed meter		x						
CH03 high-speed meter			x					
CH04 high-speed meter				x				
CI01 incremental counter	x	x						
CI02 incremental counter			x	x				
IE01…IE08	One input, I01 – I08 can be assigned freely (max. 8, none can be assigned more than once)							
IC01 – IC08	Two inputs, I01 – I08 can be assigned freely (max. 8, none can be assigned more than once)							
IT01…IT08	Automatically assigns the user interrupts 1 to 8 that are still available (only for instances of I01 – I08 that are not in use by other function blocks)							

The time between the moment the triggering signal is detected and the moment there is a response at an output is < 1 ms. If multiple interrupts are executed simultaneously, the times add up.

Measuring the interrupt load

The runtime for each interrupt source is measured in µs. All measured times are added over a period of 100 ms. After each 100 ms, the total of all times is evaluated and the time measurement is cleared. If the interrupts used up more than 50% of the computing time, the application will be stopped.

The <System_CPU_overload> diagnostic message will be generated and ID19 will be set to 1.

For more information on how diagnostic messages can be called and processed, please refer to Processing diagnostic messages

Available fixes for high interrupt loads

If the interrupt load becomes too heavy, the following steps can be taken to reduce it:

- Reduce the number of function blocks
- Keep the interrupt routine as short as possible
- Reduce frequencies when using counters

Example of a time-controlled interrupt function block in easySoft 7

Output Q4 needs to be reset after a specific time. This time should be independent from the main program's cycle time so that the switch-off point in time is always the same.

Operating mode: On-delayed

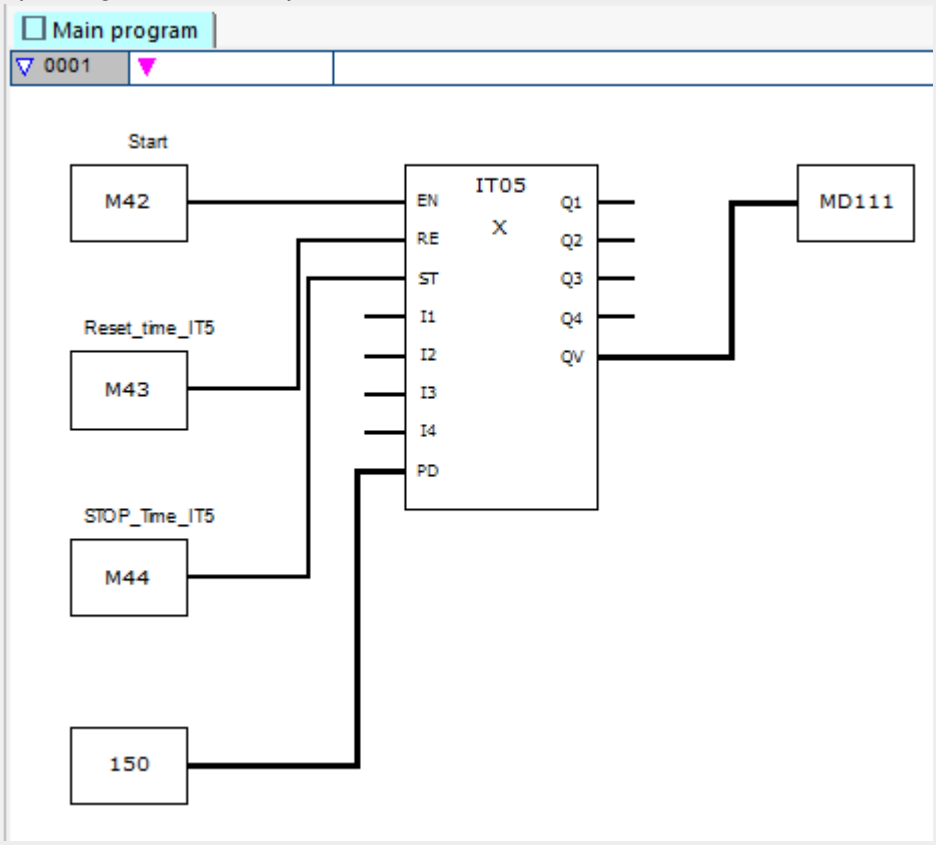


Figure 200: easySoft 7 main program

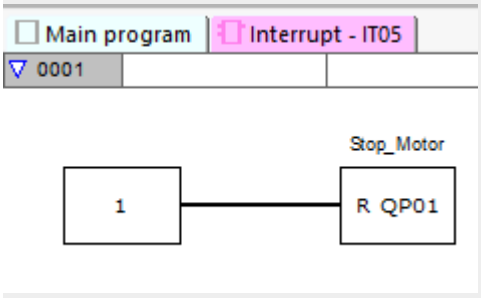


Figure 201: easySoft 7 interrupt program

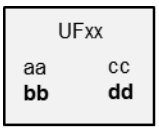
See also

→ Section "IT - Time-controlled interrupt function block", page 424
→ Section "IE - Edge-controlled interrupt function block", page 418

6.3 UF - User function block

Only possible with easySoft 7.

6.3.1 General



easyE4 base devices provide 127 user function blocks, UF01 through UF127.
You can configure these function blocks yourself and then use them in the main program the same way as manufacturer function blocks.

User function blocks are used whenever a recurring functionality needs to be programmed with various parameters. For example, when similar machines need to be controlled, the actual control program for them can be written in a user function block and then called multiple times – separately for each machine. User function blocks also feature inputs and outputs that can be used to pass custom parameters for each call.

The programming language used in each user function block is independent from the programming language used for the corresponding main program. In other words, you can use user function blocks written in ST in an FBD or LD main program, for instance.
User function blocks have their own data range. In fact, there are 64 bytes, which can be used as bits, bytes, words, or double words, available for each instance (call) of a user function block. This means, for example, that marker M01 in the main program is not the same marker M01 in a user function block.
Parts of the markers can be declared as being retentive. In this case, it is important to keep in mind that the total number of retentive markers cannot exceed 400 bytes, and that this total includes the retentive markers from the main program and the retentive markers from all user function block instances.
Just like a main program, a user function block is made up of FBD/LD networks or ST source code. This means that a user function block can be created the same way as a main program, with the only differences consisting of the available operands (please refer to → Section "Configuring a user function block", page 435.

The maximum number of user function blocks that can be called in a single main program is 127.

6.3.1.1 General information on user function blocks

The operand comments for a user function block are managed separately from the operand comments from the main program. This means, for example, that I1 ("Otto") in the user function block can have a comment different from I1 ("Emil") in the main program.

The markers and function blocks used in a user function block have their own self-contained data range. This precludes any conflicts with data from other user function blocks or data from the main program. Likewise, the standard function blocks used in a user function block, as well as their parameter sets, are managed separately in the firmware for each function block instance.

The number of instances of a manufacturer function block that can be used in a user function block is the same as the number that can be used in the main program. The program is limited only by the available program memory.

When a main program is loaded onto an easyE4 device or into the current project, all the user function blocks used in the main program will be loaded as well.

6.3.2 Creating a user function block

Once you have created a project and selected a programming language, you can create a user function block.

▶ Click on the *Program/ Create user function block...* menu option
or
click on the  button in the toolbar.

The Create user function block dialog box will appear

Program/ Create user function block... menu option

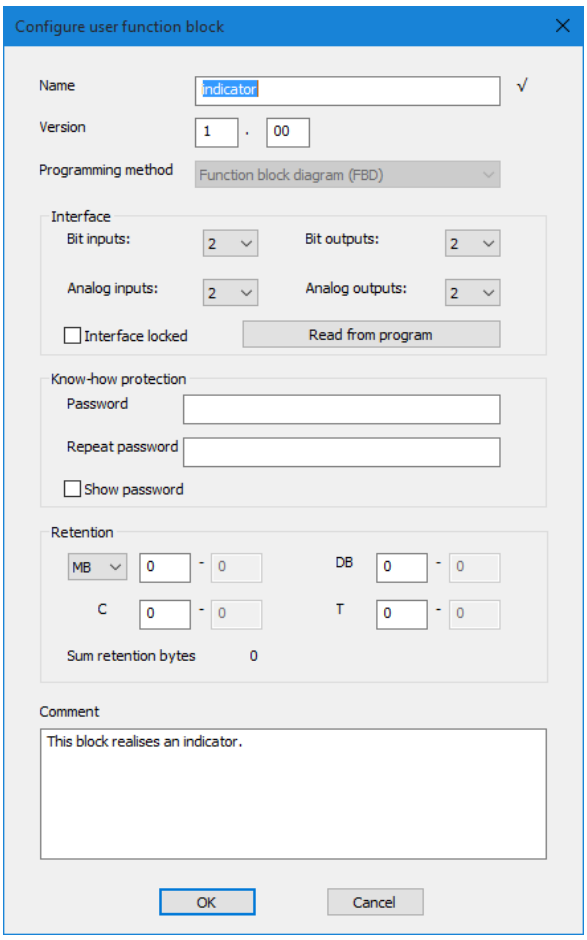


Figure 202: Configure user function block

You must at least enter a name and version and select a programming method before creating the user function block. However, in order to be able to use the user function block effectively, it is also a good idea to configure the options in the Interface section. In short, this section is used to specify how big the number of parameters passed from the main program should be.

You can choose to configure all the other options later on if you want. The "Configuring a user function block" section goes into them in greater detail.

Name and Version

The name you choose for the user function block should not exceed a maximum of 10 characters. The following characters are allowed:

- Uppercase and lowercase letters
- Numbers
- Special characters # $ % & ` ( ) + , - ; = @ [ ] ^ _ ' { } ~

Spaces and the \ / . : * ? < > | special characters are not allowed. The name is not case-sensitive. If you enter a name that meets all requirements, a black checkmark will appear to the right of the Name field. If the name needs to be corrected instead, a red exclamation mark will appear. A new user function block will automatically be assigned version 1.00. You can enter any version number between 0.00 and 99.99.

Programming method

You can use this drop-down menu to select the programming language (LD, FBD, ST) for the user function block. The default is FBD. The programming language you select here will be independent from the programming language used for the main program. However, please note that once you create a user function block, you will no longer be able to change its programming language.

▶ Clicking on OK to close the "Create user function block" dialog box will create and save the new user function block.

Once you click on OK, the empty programming unit for the user function block will be opened and the Programming view work pane will show an additional tab with the same name as the user function block, e.g., <UF – Blinker1V1.00>.

If you switch to the Main program tab, the user function block will appear in the list of operands and function blocks, in the "User function blocks" folder.

6.3.3 Configuring a user function block

In order to configure a user function block, click on the tab with the same name as the user function block inside the work pane, e.g., <UF – Blinker1V1.00>, and use one of the following methods:

▶ Click on the *Program/ Configure user function block...* menu option.

▶ Inside the pane, click on the tab with the same name as the user function block, e.g., <UF – Blinker1V1.00>, and then click on the "Configure user function block" button in the toolbar.

▶ Right-click on the tab for the user function block in the work pane and select the Configure... option.

Or

- In the work pane, click on the <Main program> tab.
- Go to the *list of operands and function blocks / User function blocks folder* , right-click on the function block, and then select the Configure... option.

The Configure user function block dialog box will appear.

- Enter all parameters.
- Confirm your input and close the dialog box by clicking on OK or pressing the <Return> key.

The changes will be applied to the user function block.

The Name, Version, and Programming method fields have already been described in the "Creating a user function block" field. Please note that, although the "Configure user function block" dialog box will show the programming language you originally selected, it will no longer be possible to change it.

Program/ Create user function block... menu option

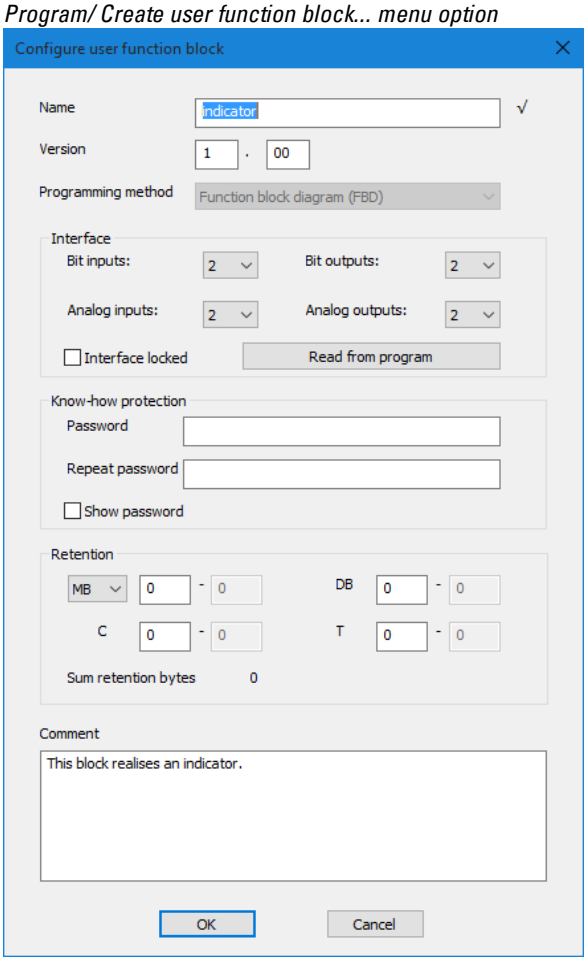


Figure 203: Configure user function block

Interface section

You can use the options in this dialog box to define the number of digital and analog inputs and outputs for your user function block. These inputs and outputs will then form the interface between the user function block and the main program. You can configure a maximum of 12 digital bit inputs/outputs and a maximum of 8 analog inputs/outputs. Please note, however, that the total number of all inputs and outputs cannot exceed 12.

When the user function block is called in the main program, the inputs and outputs defined in the Interface section will be shown and you will be able to configure them.

Read from program

If the program for the user function block has already been written and it uses inputs and outputs, you can click on the "Read from program" button to have the system automatically determine the interface parameters. The highest input/output index used will be the one copied over, and any gaps in the circuit will be ignored. Please note that this button will not be available if:

- The inputs and outputs are configured correctly in conformity with the program for the user function block.
- The user function block has already been used in a main program in the project.



easySoft 7 will not check whether the inputs/outputs used in the user function block program are defined in the Interface section as well.

Know-how protection section

You can set a password in order to prevent a user function block from being viewed or edited. This password must not be longer than 32 Unicode characters. If the password entered into both fields matches, a black checkmark will appear and the OK button will be enabled again.

Retention section

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 until the next time the ACTUAL value is overwritten.

There are two input fields (for the start and end values of the retention range) each for markers and for the following function blocks.

Project view/ System settings tab



Figure 204: Screenshot of Retention section that can be found in the System settings tab in the Project view (including sample values)

Value range for the function blocks, instances that can be stored retentively:

- C - Counter relay : 01…32
- CH - High-speed counter : 01…04
- CI - Incremental counter : 01…02
- DB - Data function block : 01…32
- T - Timing relay : 01…32

For more information, please refer to the description for the relevant function block.

Marker value ranges:

- MB : 1 …512
- MW : 1…512
- MD : 1…256

The values from the input field will be automatically converted to MB marker bytes.

Retention bytes

The entire retentive marker range for an easyE4 must not exceed 400 bytes. The total of the retention bytes for the main program and user function blocks (UF) will be displayed in the Project view, in the System settings tab. If the retentive marker range exceeds 400 bytes, a red negative number will be shown in the Free field in order to indicate this.

Retain retention during transfer

Retentive actual values on the device are deleted:

- By any program change in the circuit diagram or function block diagram followed by its transfer to the device.
- When the program is deleted via Communication View, Program, Delete.
- By any change of the retentive range via the Project view, System settings, Retention.
- By any changes to the parameters for the remote markers of a visualization device.
- When the program is deleted with the Communication -> Delete device button

The following exception applies to retentive markers:

☑ Marker contents

If this option is enabled, the contents of the existing retentive market range will be retained when the project is transferred. In order for this to work, however, the marker range defined as being retentive must remain unchanged .

☑ Function block contents

If this option is enabled, the contents of the existing retentive operand range will be retained when the project is transferred. In order for this to work, however, the function block defined as being retentive must remain unchanged .

The marker actual values are retained when you have selected the option Retain Markers During Transfer.

Comment section

This box can be used to enter an optional comment, e.g., in order to distinguish between various versions of a user function block.

6.3.4 Programming a user function block

Once you have created a user function block, the view will automatically switch to the Programming view for the user function block. Moreover, a tab with the user function block's name and version will appear next to the Main program tab in the work pane.

User function blocks are programmed exactly the same way as a main program. The only difference is that there are slightly fewer operands available (the list of available operands and function blocks will automatically change to reflect this).

You should be in the Programming view for the user function block. Following is a screenshot showing an example in which a timing relay is programmed with the flashing operating mode.

Programming view for UF Blinker1 tab

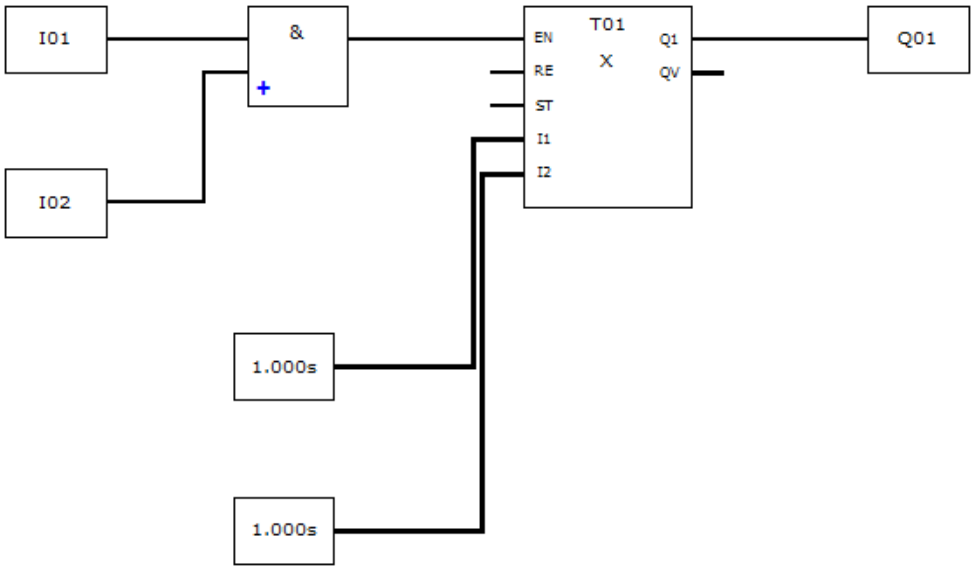


Figure 205: Programming view for UF Blinker1 user function block

- Run a plausibility check first.
- Save the user function block and switch to the Programming view for the main program.

The user function block will appear in the list of operands and function blocks with a green icon that means that it is not being used in the project yet.

6.3.5 Calling a user function block in the main program

User function blocks can be called in the main program the same way manufacturer function blocks are called.

User function block in and FBD main program

In order to call a user function block in a main program that uses the FBD programming language, drag the function block like a normal function block to the work pane in the Programming view.

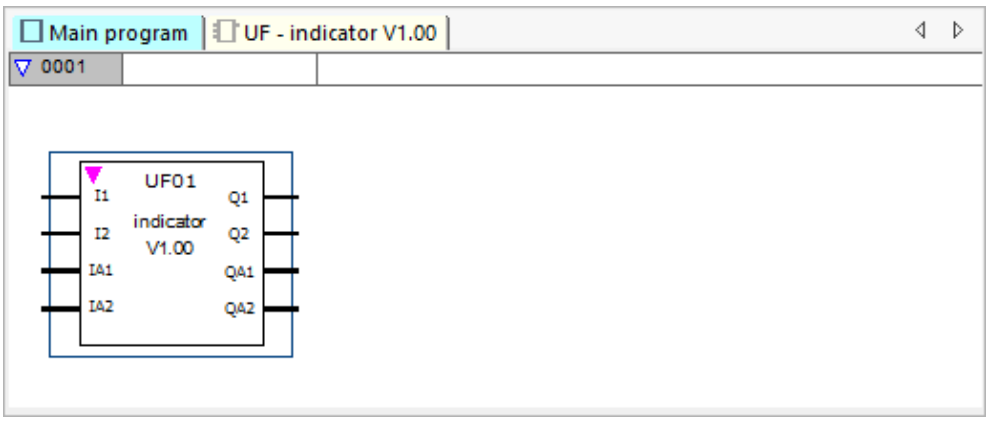


Figure 206: UF Blinker1 user function block used in the main program

The function block will be shown with its name, version, and configured inputs/outputs. The function block type will be "UF", followed by the instance number (01 to 127).

Once you have dragged it, the user function block will be shown with a brown icon, which means that is being used in the project.

Inputs/outputs wiring

The digital and analog inputs and outputs can be connected the same way as for any other function block. In the example below, the user function block's Q1 output is connected to a counter relay's C input.

Programming view

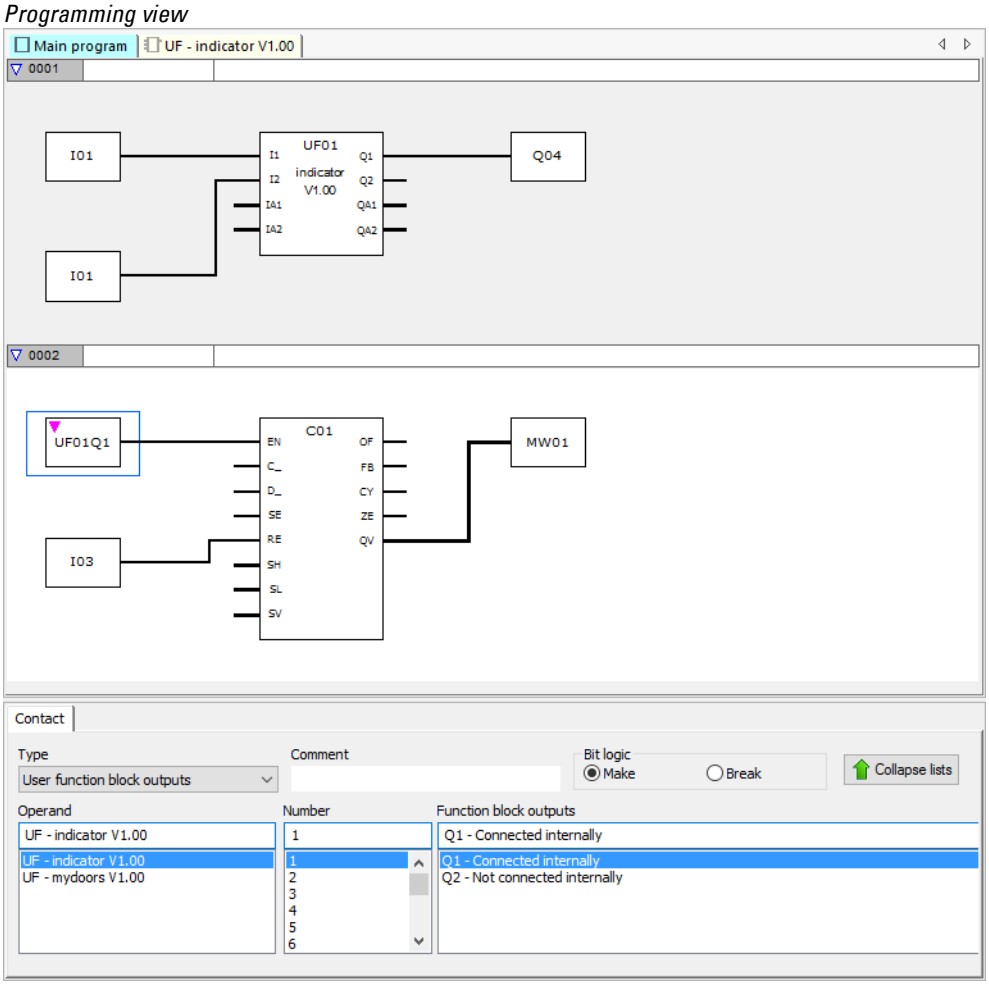


Figure 207: Inputs/outputs wiring

User function block inputs and outputs can be copied in the main program and pasted the same way as those from any other operand.

If a user function block call is copied and pasted, the new call will be assigned the next free instance number.

All the user function blocks used in a project's main programs will be part of the project file and will be saved together with the project.

If there are any user function blocks, the tabs will change accordingly:

Programming view

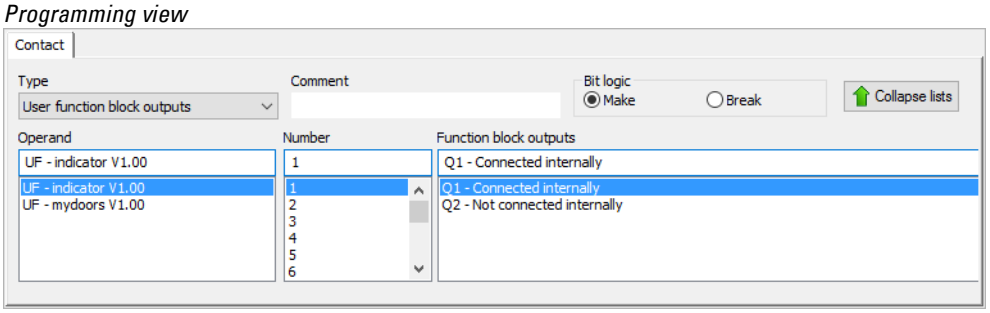


Figure 208: Contact tab

Programming view

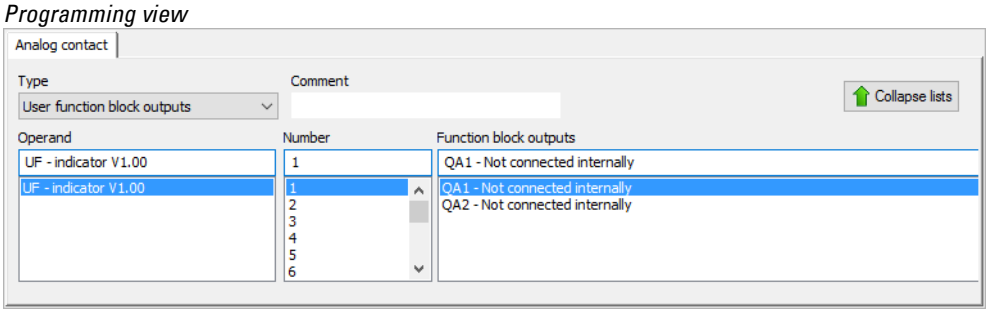


Figure 209: Analog contact tab

If there are any user function blocks with bit and/or analog outputs available, you will be able to select the "User function block outputs" option in the "Type" drop-down menu.

Meanwhile, the "Operand" drop-down menu will contain all registered user function blocks that have bit and/or analog outputs.

The "Number" drop-down menu will contain all available function block numbers within a range of 1 to 127, as well as the comment entered for the corresponding number. Please note that any instance numbers that have already been assigned to other types of user function blocks will not be available for selection.

Finally, the "Function block outputs" drop-down menu will list the various individual outputs, together with information specifying whether the contact is connected internally.

In addition, you will be able to select the bit logic for digital outputs.

Programming view

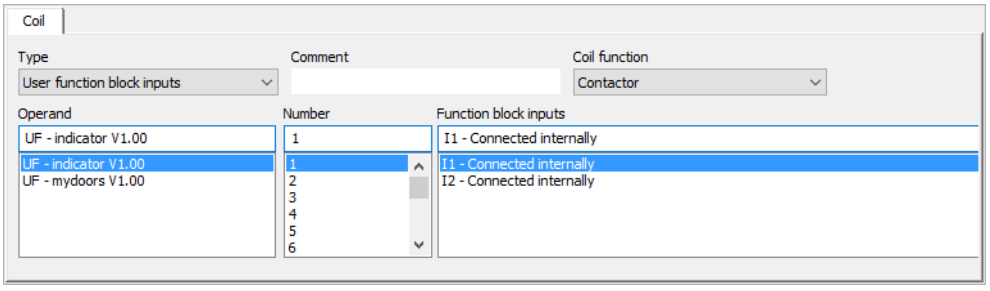


Figure 210: Coil tab

Programming view

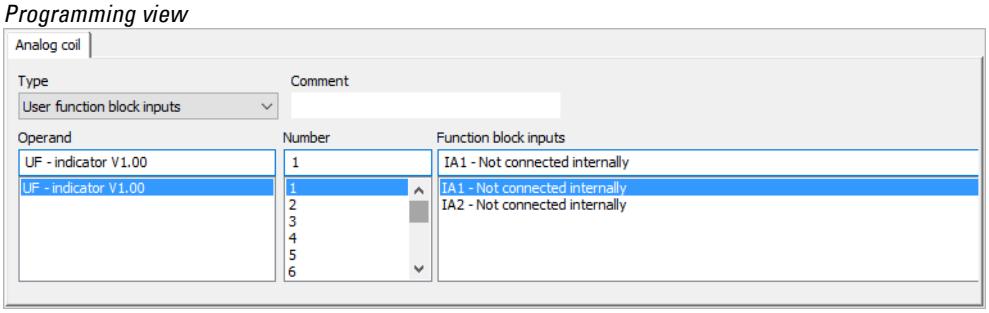


Figure 211: Analog coil tab

If there are any user function blocks with bit and/or analog inputs available, you will be able to select the "User function block inputs" option in the "Type" drop-down menu.

Meanwhile, the "Operand" drop-down menu will contain all registered user function blocks that have bit and/or analog inputs.

The "Number" drop-down menu will contain all available function block numbers within a range of 1 to 127, as well as the comment entered for the corresponding number. Please note that any instance numbers that have already been assigned to other types of user function blocks will not be available for selection.

Finally, the "Function block inputs" drop-down menu will list the various individual inputs, together with information specifying whether the coil is connected internally.

In addition, you will be able to select the coil function (Contactor, Set, Reset, etc.) for digital inputs.

6.3.5.1 User function blocks in an ST main program

A user function block created with the FBD language can also be called in an ST main program and vice versa.

In this case, a template based on the user function block's parameters (as defined in the Interface section) will be generated in the ST program if the function block is dragged onto the program. You will be able to connect the inputs and outputs the same way as with manufacturer function blocks.

The NAME and VERSION you entered originally will be used to define the user function block's type and version. These two pseudo inputs cannot remain unconnected and are not allowed to be mapped outside of the function block call.

Example

```
;UF01 (
    NAME := "indicator",
    VERSION := "V1.00",
    I1 := I01,
    I2 := I02,
    IA1 := ,
    IA2 := ,
    Q1 => ,
    Q2 => ,
    QA1 => ,
    QA2 =>
 );
 C01 (
    EN := ,
    C_ := UF01Q1,
    D_ := ,
    SE := ,
    RE := I03,
    SH := ,
    SL := ,
    SV := ,
    OF => ,
    FB => ,
    CY => ,
    ZE => ,
    QV => MW01
 );
```

The example shows the user function block's Q1 output being connected to a counter relay's C input.

6.3.6 Saving a user function block

You can close an open user function block at any time. Likewise, you can save changes to the user function block at any time. Please note that if you close a modified user function block, the system will ask whether you want to save or discard the changes.

The "Program->Close" menu option and the "Close" button will be available if the user function block is open and either the user function block view is open or the user function block is selected in the main program view.

The "Program->Save user function block" and the "Save user function block" button will be available if the user function block is open and has been modified and either the user function block view is open or the user function block is selected in the main program view.

Operands available for user function blocks

When a user function block is selected, the list of operands and function blocks will show the operands that are available. The number of manufacturer function blocks will be smaller.

All operands within a user function block refer to a separate local memory area. Supported (local) operands:

Operand	Maximum number
I	12
IA	8
Q	12
QA	8
M	480
MB	64
MW	32
MD	16

These numbers specify the maximum possible number for I, IA, Q, and QA. However, the following restrictions apply:

- The total number of inputs (bit and analog) must not exceed 12
- The total number of outputs (bit and analog) must not exceed 12
- A maximum of 12 bit inputs and outputs can be used
- A maximum of 8 analog inputs and outputs can be used

Device-specific operands (ID, LE, P) and NET operands (N, NB, NW, ND, RN, SN) are not supported for user function blocks.

Supported manufacturer function blocks:

All standard function blocks can be used in a user function block, with the exception of function blocks that have a hardware interface or firmware reference (i.e., OT, CF, CH, CI, PW, PO, GT, PT, SC, AL, D, DL, and ST). Function blocks BC, BT, and MR can be used, but will only act on the user function block's local data arrays.

- The Copy, Cut, and Paste functions are supported the same way as in the main program. However, they can only be used between user function blocks.
- Just like in the main program, the keyboard can be used to enter the I, Q, IA, QA, M, MB, MW, and MD operands as contacts and coils.
- In addition, and just like in the main program, the keyboard can be used to create contacts and coils corresponding to the supported function blocks, inputs, and outputs. This applies both to entering an operand completely and to changing the index number for an operand.
- As soon as a change is made to a user function block, the Save user function block option in the main menu and the Save user function block button in the toolbar will become available.

6.3.6.1 Programming view tabs

The tabs in the Programming view are intended to help you keep your project more manageable.

When applicable, tabs for user function blocks and interrupt function blocks will be found next to the tab for the main program. Different colors and icons will be used to differentiate between them:

Color	Registers
Blue	Main program
Green	User function block that is not being used
Yellow	User function block that is being used
Magenta	Interrupt function block

Inactive tabs will be shown with a brighter color. A total of 11 tabs can be displayed.

6.3.7 Exporting a user function block

User function blocks can be saved in a separate folder as a uf7 file. The "Export user function block..." menu option will become available if a user function block call is selected or the Programming view for a user function block is open.

Before the user function block is exported, it will be subjected to a plausibility check. Please note that it will only be possible to export the function block if it does not contain any errors. Finally, if the function block is protected with a password and is not open, a prompt asking you to enter the password will appear.

A dialog box will appear and ask if you want to edit the user function block's name, version, password, and/or comment before exporting it.

Yes— Yes: The "Edit user function block settings" dialog box will appear. Please note that if a password was previously set for the user function block, you will need to enter it first. If you do not enter the password, a prompt will appear asking whether you still want to export the user function block.

No: No: The "Select user function block folder" dialog box will appear. You can then select the folder where you want the user function block's uf7 file to be saved.



If the selected folder contains any items (files, folders, archives) with the exact same name as the user function block being exported, you will not be able to notice this in the "Select user function block folder" dialog box. Accordingly, make sure to first check whether the selected folder is suitable for saving the file.

Clicking on the "Select Folder" button may result in any of the following scenarios if there is a problem:

In the five cases below, you will be able to select a different folder:

1. The selected drive is not ready or is write-protected
2. The selected drive does not have enough free memory
3. The selected folder cannot be accessed
4. The selected folder is write-protected
5. The selected folder already contains a folder named UserFB_V1_01.uf7

In the first three cases, you will be asked whether you want to overwrite the file or select a different folder.

1. The selected folder already contains an archive named UserFB_V1_01.uf7
2. The selected folder already contains a user function block named UserFB_V1_01.uf7
3. The selected folder contains a write-protected user function block named UserFB_V1_01.uf7.

If the aforementioned checks are all completed successfully, the user function block will be saved and the user interface will be refreshed in the Programming view and in the list of operands and function blocks if applicable.

6.3.7.1 Plausibility check

When exporting a user function block, a user function block check that determines whether the user function block can be executed in the easyE4 device's current state will be triggered. This is especially necessary for user function blocks programmed using ST, as entering impermissible operands is possible in these cases.

The export function will generate a uf7 file only if the user function block is executable. In this case, the file will contain not only the actual user function block, but also all required management data.

This check can be run at any time on user function blocks that are in use or that are not in use in the project. The sole exception consists of password-protected user function blocks in use.

A user-function-block-specific plausibility check will not be run when copying and pasting between user function blocks. All checks are identical to those run on the main program.

Within the context of the plausibility check for a device, the system will check whether the total number of user function blocks per device is less than or equal to 127. If the plausibility check for a device outputs an error / warning for a user function block in the "Report output" dialog box and the view for the user function block is not active or open in the Programming view, double-clicking on the error / warning will activate, or, if applicable, open the Programming view for the user function block and show exactly where the error or warning is found.

Depending on the corresponding results, the following messages may appear after a plausibility check:

- FB input / FB output %2 is not part of the user function block's interface
- The number for an FB input / FB output was not assigned without gaps
- FB input %2 exceeds the maximum number of a total of 12 bit and analog inputs
- FB output %2 exceeds the maximum number of a total of 12 bit and analog outputs
- Operand %2 is not supported in user function blocks!
- The number for operand %2 falls outside the permissible value range for user function blocks.

6.3.8 Importing a user function block

The import function makes it possible to load user function blocks (uf7 files) from a folder. This function is available in the Programming view.



In order to be able to import user function blocks, all open user function blocks must be unmodified.
If they are not, the following message will be output: If open user function blocks are modified, an import will not be possible. Please save all modified user function blocks first..

▶ Select a uf7 file and click on "Open"

The selected user function block will be added to the user function block management group only if it meets certain criteria.

The following messages can occur:

- User function block is already found in easySoft 7.
  You do not need to import it. Do you want to select a different file?
- A user function block with different content is already found in easySoft 7. Since it is used in the project and the function block interfaces are different, the import is not allowed. Do you want to select a different file?

- A user function block with different content is already found in easySoft 7. This user function block is open for editing, meaning that an import is not possible. Do you want to select a different file?

The following applies to these three scenarios:

No:	The import will be aborted
Yes—	You will be able to select a different file

- A user function block with different content is already found in easySoft 7. Do you want to replace this user function block with the function block being imported?

No:	You will be able to select a different file
Yes—	The existing function block will be replaced with the imported function block

If the aforementioned checks are all completed successfully, the imported user function block will be added to the group of user function blocks in easySoft 7.

6.3.9 Replacing a user function block

This function makes it possible to replace a user function block that is being used in the project with a different user function block with an identical "Interface" configuration.

In order for this menu option to be available, a user function block call must be selected and the user function block must not be open for editing.

If there are any user function blocks with an "Interface" configuration that matches that of the selected function block and the latter is not open for editing, the "Replace user function block" dialog box will appear and the user function blocks that can be selected as replacements will be shown as a list in a pane.

You can then use the "Replace area" section to specify which user function block calls should be replaced:

- The selected user function block only
- All instances of the selected user function block in the current program
- All instances of the user function block in all programs

Clicking on the "Replace" button will replace the original user function block instance(s), i.e., the calls, contacts, and coils for the original user function block will be replaced with the selected user function block.

If there are no user function blocks with an "Interface" configuration that matches that of the selected function block available, or if they are open for editing, the following message will appear:

"There are no user function blocks that are suitable as a replacement, or they are currently open for editing."

6.3.10 Deleting a user function block

This function can be used to delete user function blocks from easySoft 7. Please note that you will only be able to delete user function blocks that are not being used in the project and that are not open for editing. If there are no user function blocks that can be deleted, the *Program/Delete user function blocks...* menu option will not be available.

The following options are available for deregistering / deleting a user function block:

1. *Program/Delete user function blocks… menu option*
2. *User function blocks folder in list of operands and function blocks/Delete user function blocks… context menu option*
3. *List of operands and function blocks <name>/Delete context menu option*

The following dialog box will appear if you use one of the first two options:

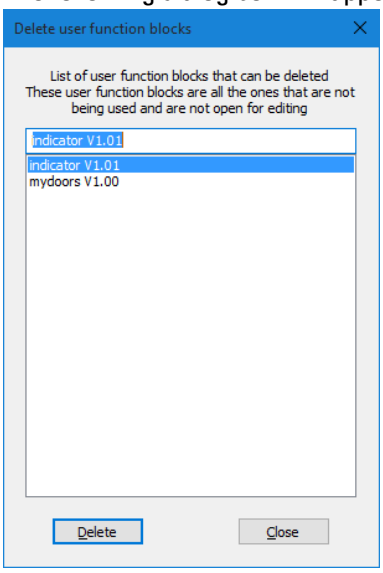


Figure 212: Delete user function blocks dialog box

You will get a list of all user function blocks that can be deleted, and can select any individual user function blocks you want. Once you select a function block and click on the Delete button, the function block will be deleted. After this, the user function block will no longer be part of easySoft 7 and will no longer be available in the *list of operands and function blocks/User function blocks folder*.

If you use the third option, the user function block you selected will be deleted and removed from the *list of operands and function blocks/User function blocks folder*.

6.3.11 Comparing user function blocks

The "Compare user function blocks..." menu option will be enabled as soon as you select a user function block. If the selected user function block is password-protected, you will have to enter the password.

Please note that you can only compare user function blocks that use the same programming language.

You can select whether you want to compare the user function block with a user function block registered in easySoft 7 or to one from a uf7 file (i.e., a user function block that has been previously exported). Accordingly, the following dialog box will appear:

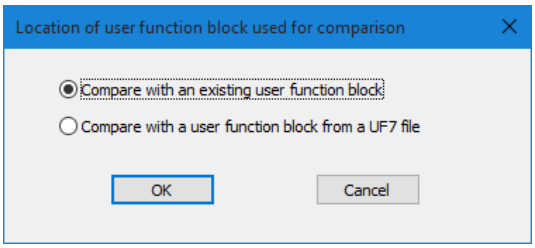


Figure 213: Location of user function block user for comparison dialog box

If you choose to compare the selected user function block with an existing user function block, a dialog box showing all available user function blocks with the same programming language will appear.

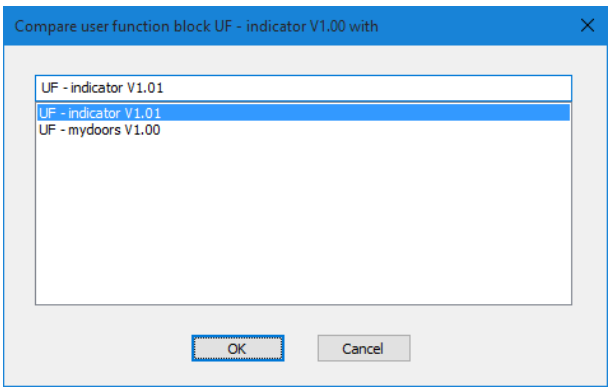


Figure 214: UF user function block

If you instead choose to compare the selected user function block with a previously exported user function block, the "Import user function block" dialog box will appear so that you can select a uf7 file.

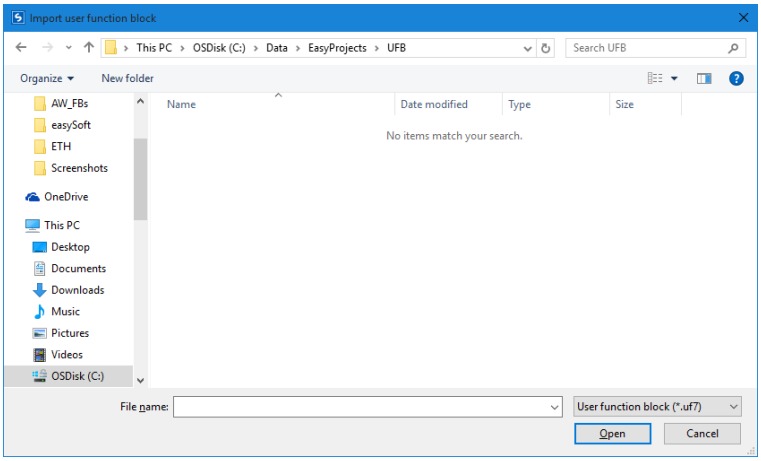


Figure 215: Import user function block

If a user function block is identical to the one being compared, or
if you are attempting to compare user function blocks that use different programming languages, you will get a message to this effect, after which you can select a different function block.

The comparison uses a text-based line-to-line comparison as a basis. The function units for each network will be grouped together in order to make the comparison easier to follow. The comparison itself will be visualized in a simplified ASCII character image. Moreover, the gates and parallel branches in each network will be assigned a three-digit order number in ascending order based on where they are located in the network. You can use these numbers is order to identify how the gates/parallel branches are related to each other.

After the comparison, the results will be shown on your default HTML browser and saved to an output file. This output file will have the same name as the opened user function block and the HTML extension.

6.3.12 Printing a user function block

You can print both user function blocks that are being used in the project and user function blocks that are not being used in the project.

When you print out a user function block, the printout will contain all the parameters from the configuration dialog box, the program in the programming language used, and a list of cross references for the operands used.

This function comes with the option of viewing a page preview first.

6.4 Timing and counter relay example

A warning light flashes when the counter reaches 10. In this example the function blocks C01 and T01 are wired in the standard circuit diagram and their inputs and outputs are defined.

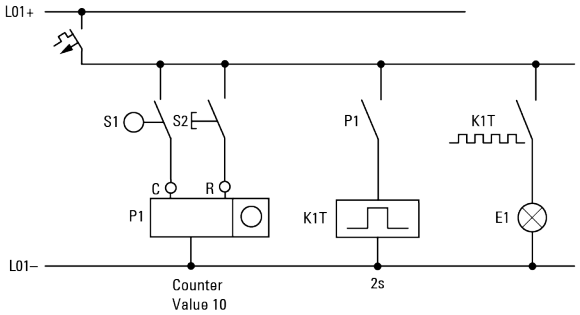


Figure 216: Hardwiring with relays

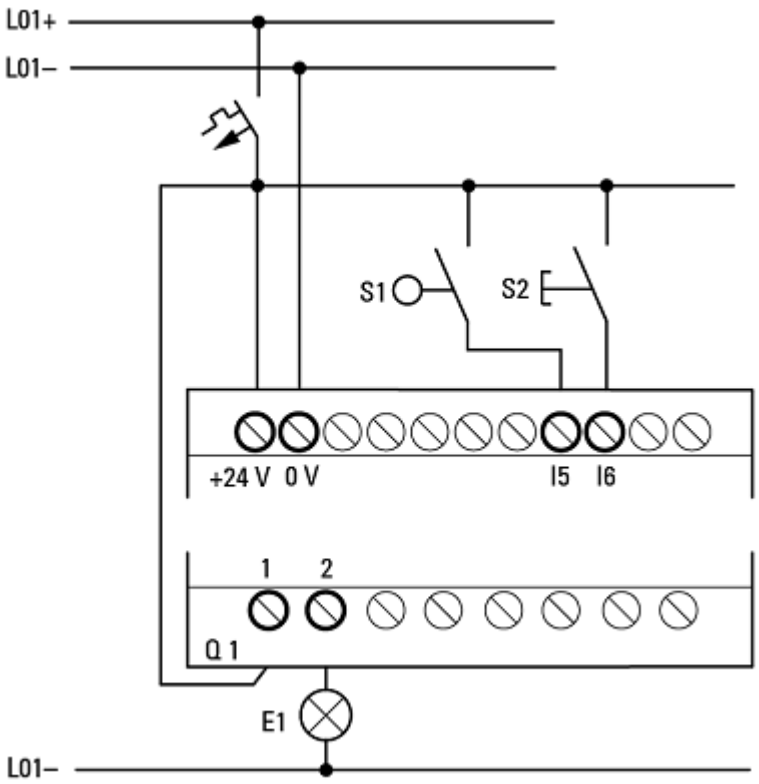


Figure 217: Wiring with easyE4

Enter circuit diagram

▶ Enter the following circuit diagram while using the EDP programming language.

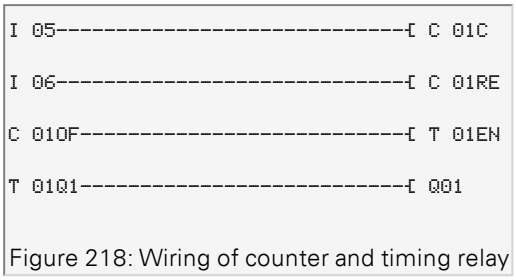


Figure 218: Wiring of counter and timing relay

Entering function block parameters

If you enter the coils or contacts of a function block, the inputs/outputs of the function block are displayed that you can parameterize. The parameters can be entered via the function blocks menu.

The meaning of these parameters is explained under each function block type.

Entry:

The first part of the parameter set of a counter C01 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 the ↑ and ↓ buttons to change the value of the digit.
- Press OK to save the value and ESC to return to the circuit diagram.

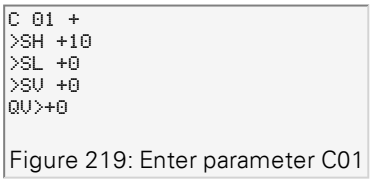


Figure 219: Enter parameter C01

Configuring the parameter for T01:

The timing relay works like a flashing relay. 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 you enter the same setpoint value at I1 and I2, the timing relay operates 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 entry.

```
T 01  n  S +
>I1 002,000
>I2 002,000
QV>
```

Figure 220: Enter ParameterT01

Testing the circuit diagram:

- Switch easyE4 to RUN operating mode and return to the program.

You can display every parameter set via the function relays menu.

- Move the cursor onto C 01 and press OK.

The parameter set for the counter is displayed with actual and setpoint values.

- Move the cursor ↓ downwards until you see the value QV.
- Switch input IS05. The ACTUAL value changes.

```
C 01 +
>SH +10
>SL +0
>SV +0
QV>+0
```

Figure 221: Testing the circuit diagram

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.

```
C 01 +
>SH +10
>SL +0
>SV +0
QV>+10
```

Figure 222: Testing the circuit diagram

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.

```
T 01  n  S +
>I1 002,000
>I2 002,000
QV> 0.550
```

Figure 223: Doubling the flashing frequency

If the setpoint is a constant, it can also be modified via the PARAMETERS menu.

→ The actual value is only shown in RUN mode.

See also

→ Section "Timing and counter relay example", page 454
→ Section "CF - Frequency counter", page 224
→ Section "CH - High-speed counter", page 230
→ Section "CI - Incremental counter", page 237

7. System settings

The "System settings" section groups together the various basic settings for the device, and accordingly can be used as a reference guide.

It is important to note where the relevant system setting can be configured, i.e., with the display on the EASY-E4-...-12...C1 under SYSTEM OPTIONS and/or only in easySoft 7 after selecting the device. Programming and integrating the easyE4 device into a group are also important within this context.

The following settings can only be configured with easySoft 7 as of this writing:

Connection to other devices

Setting up a NET	→ page 537
Modbus TCP	→ page 545
Setting up a web server	→ page 560
E-mail function	→ page 562

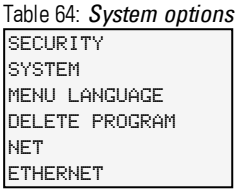
Configuration

Download comments	→ page 470
Define program name	→ page 472
Retention function	→ page 473
Configuring the memory card and device ID	→ page 481

7.1 System options - Base device with display and buttons

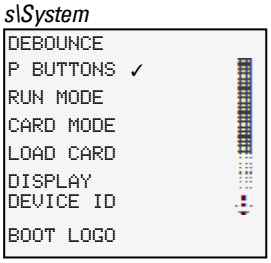
The system options that can be configured on EASY-E4-...-12...C1 base devices include:

Table 64: *System options*



Security	Access to the area used to assign a password and define password-protected areas → Section "Security – password protection", page 476
System	Accessing the system settings: **Debounce**, → Section "Debounce", page 469 **P Buttons**, → Section "P buttons", page 471 **RUN Start**, **Card Start**, → Section "Setting the startup behavior", page 466 **Load Card**, → Section "Configuring the memory card and device ID", page 481 **Display**, Display settings, → Section "View", page 461 **Device ID**, Device IDs, → Section "Device ID", page 461 **Splash Screen**, Used to set the display duration on the display, provided that a boot.bmp file has been stored on the memory card. → Section "Boot logo", page 462
Menu language	Used to set the device menu language, → Section "Switch languages", page 465
DELETE PROGRAM	Deletes the program on the easyE4 from the device memory
NET	Used to configure a **NET GROUP** as a group of multiple devices, → Section "Setting up a NET", page 537 The submenu is only provided in English
ETHERNET	Used to configure the Ethernet settings on the device, → Section "Ethernet", page 464 The submenu is only provided in English

Table 65: *System options\System*



7.2 View

This menu can be used to configure the settings for the display.

Table 66: *System Options\System\Display*

LIGHTING1	100
LIGHTING2	50
TIMEOUT:	10m
COLOR:	0

BRIGHTNESS1	Display brightness when the device is being operated Default value: 100, can be changed in increments of 10
BRIGHTNESS2	Brightness for sleep mode Default value: 50, can be changed in increments of 10 Value: 0 will cause the display to be switched off in sleep mode
TIMEOUT	Used to set the time in minutes or seconds after which the display will go to sleep if the easyE4 is not being actively operated
PAINT	Relevant to easyE4 remote operation Color value of 0 – 15, This setting will affect the way the device is displayed, e.g., in easySoft 7 or on the web server

7.3 Device ID

Used to set / enter the individual device IDs for transferring programs.

Table 67: *SYSTEM OPTIONS\DEVICE ID*

DEVICE ID
xxx xxx xxx

Entering a device ID of <000 000 000> will disable the device ID check and the program ID check. If you do this, it will be possible to transfer all program types to the base device through a microSD memory card or through easySoft 7 regardless of whether an ID has been set in the program itself.

7.4 Boot logo

Once an boot.bmp image is stored on the microSD memory card, this setting can be used to specify how long the image will be displayed, in seconds, before the status display is shown.

Table 68: *System Options\Boot Logo*

DISPL. DURATION
3 s

7.4.1 Image as on the display

You can create your own custom monochromatic image externally in any program. Simply make sure that the image is in BMP format and is named boot.bmp.

The size is set at 128 x 96 pixels (width x height) or, alternatively, 128 x 64 pixels. You can use two colors, which will be shown as shades of gray.

Make sure that the file always keeps the name boot.bmp!

Splash screen



Figure 224: boot.bmp

- Transfer the image to the microSD memory card.
- Store the boot.bmp file directly on the memory card.

microSD memory card on the PC

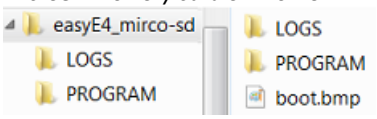


Figure 225: Storing the boot.bmp file

As soon as the easyE4 device is switched on,
the boot.bmp will be shown as a splash screen for the defined duration.

In order for the splash screen to keep working, the microSD memory card must remain in the device.

7.5 NET

This submenu can be used to configure the NET addresses for the easyE4 device.

The other stations, i.e., easyE4 devices, must also be configured accordingly in order for it to be possible to establish a connection.

The item in the last line on the status display 1 will indicate whether there is an active NET connection.

The submenu is only available in English.

Table 69: *System options\Net*

```
NET-GROUP:      00
NET-ID:         00
BUSDELAY:       000
REMOTE RUN
```

NET group

Used to select the group for the selected base device.

0	Base device running in standalone mode with the relevant I/O expansions (if any), no NET group
1-10	Available NET group numbers

NET-ID

Used to assign a group device number to the selected base device.

0	Base device running in standalone mode with the relevant I/O expansions (if any)
1-8	Available device IDs in the NET group

Bus delay

The bus delay is used to define the time after which a station on the NET will send its data to other stations.

This bus delay needs to be adjusted as appropriate for the number of stations and the values being transmitted. Please note than an excessively short bus delay will result in data collisions.

The permissible value range for the bus delay is 10 ms to 255 ms.

Cyclical data will be sent every 10 ms or when there is a data change, but not before the bus delay has elapsed. Using the default value of 60 ms will normally be sufficient to prevent transmission overloads.

Remote RUN

If this field is enabled, the NET stations of a group with NET-IDs 02 through 08 will take their current RUN or STOP operating mode from the NET station with NET-ID 1.

See also

→ Section "Setting up a NET", page 537

7.6 Ethernet

This submenu can be used to configure the addresses for the easyE4 device.

The other station must also be configured accordingly in order for it to be possible to establish a connection.

The last line on the status display will indicate whether there is an active connection.

New easyE4 base devices will come with the Auto IP setting configured by default. In order to configure the settings differently on the EASY-E4-...-12...C1, use the menu structure and go to *System Options\Ethernet*

The submenu is only available in English.

Table 70: Ethernet configuration on device

Table 71: *Main menu*

STOP ✓ RUN
PARAMETERS
SET CLOCK
CARD
INFORMATION
SYSTEM-OPT.
PROGRAM

Table 72: *System options*

SECURITY
SYSTEM
MENU LANGUAGE
DELETE PROGRAM
NET
ETHERNET

Table 73: *System options\Ethernet*

ADDRESS MODE
IP ADDRESS
SUBNET MASK
GATEWAY ADDRESS
DNS SERVER

▶ Use the cursor buttons to enter the device's IP address.

Table 74: *System Options\Ethernet\IP Address*

IP ADDRESS
000.000.000.000

▶ Select the network setting you want.

Table 75: *System Options\Ethernet\Address mode*

AUTO IP	✓
DHCP	
STATIC IP	

See also

→ Section "Establishing an Ethernet connection", page 532

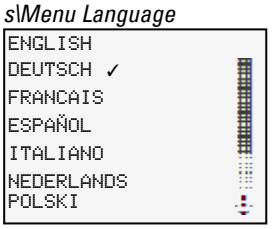
7.7 Switch languages

The menus are available in several languages.

7.7.1 Selecting a menu language on a base device with a display

- Go to the main menu.
- Go to SYSTEM OPTIONS\MENU LANGUAGE.
- Select one of the available languages.
- Confirm with the OK button.
- Exit the menu with the ESC button.

Table 76: *System Options\Menu Language*



The language will change when you exit the menu.

7.7.2 Setting the menu language in the easySoft 7

You can change the user interface language in easySoft 7.

- Click on the Options menu.
- Select the Languages menu option.
- Click on the language you want.

Before the change can be applied, the software will need to be closed and restarted.

7.8 Setting the startup behavior

The startup mode defines how the control relay will respond when the operating voltage is applied.

EASY-E4-...-12...CX1

Devices without a display can only be started in RUN mode.
After power up, the easyE4 device switches directly to RUN mode if it contains a valid program (circuit diagram). If, on the other hand, there is no circuit diagram in the device, it will remain in STOP mode.

If the device is connected via Ethernet, it can be configured.

EASY-E4-...-12...C1

The startup behavior of devices with a display can be set.

The selected startup mode is passed on with the program.

Startup behavior

The startup behavior is an important aid during the commissioning phase.
The circuit diagram which EASY-E4-...-12...C1 contains is not yet fully wired up or the system or machine is in a state which EASY-E4-... is not permitted to control.

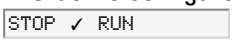
If voltage is applied to the easyE4 device in this case, it should not be possible to drive the outputs, i.e., it is not allowed for the outputs to be set immediately when the easyE4 is switched on.

7.8.1 Enabling / disabling the RUN START option

Only possible on base devices with a display.

7.8.1.1 Configuration on a base device with a display

In order to configure it, the program must be stopped.



Operating mode changes may be protected with a password.

- Go to the main menu.
- Go to SYSTEM OPTIONS\SYSTEM.
- Select the RUN START menu option.
- Press the OK button to enable and disable the option.

Display	Status	
RUN START ✓	Active	The program will start as soon as the device is switched on (the device will switch to RUN mode).
RUN MODE	Disabled	The program will need to be started separately (the device will remain in STOP mode).

The RUN START option will be enabled by default on the EASY-E4-..., as well as after a factory reset.

What will happen if the program is deleted

The startup mode setting is a device function and will be retained even if the circuit diagram is deleted.

Upload/download to memory card or PLC

The setting will be retained when a valid program is transferred.

7.8.2 Enabling / disabling the CARD START option

The mode for starting up with a memory card is intended for applications in which it is necessary for it to be possible to change programs easily and quickly by changing the memory card.

If the program on the memory card is different to the program in the easyE4 device, the program from the card will be loaded on power up first of all and then started in RUN mode. If the programs only contain different function block SETPOINT values (constants), the program on the memory card is not loaded.
The program is retained in the device and is started. If there is no circuit diagram on the memory card the device will remain in STOP mode.

Default setting CARD START inactive

7.8.2.1 Configuration on a base device with a display

In order to be able to configure this option, the program must be in STOP mode. If it is not, the device will point this out.

- Go to the main menu.
- Go to SYSTEM OPTIONS\SYSTEM.
- Select the CARD START menu option.
- Press the OK button to enable and disable the option.

If there is a checkmark ✓ next to the menu option, the program will be loaded from the memory card and applied as soon as the easyE4 device is switched on.
If there is no check mark, the current program will be kept.

7.8.2.2 Configuring the easySoft 7

You can enable and disable this option in easySoft 7.

- Select the device you want from the catalog in the Project view
- Click on the System settings tab.

Go to the Memory card / device ID section and find the checkbox for Card start.

- ☑ To turn on, enable the checkbox by clicking on it.
- ☐ To turn off, disable the checkbox by clicking on it.

See also

→ Section "Configuring the memory card and device ID", page 481

7.9 Debounce

easyE4 is factory set to evaluate input signals with an input delay, the so-called debounce function. This ensures that any contact bouncing of switches and push-buttons is masked out.

There are certain applications in which detecting very brief input signals is necessary. In order to ensure that this will happen in those cases, you can disable the input delay if necessary.

7.9.1 Configuring input debouncing on a base device with a display

- Go to the main menu.
- Go to SYSTEM OPTIONS\SYSTEM.
- Select the DEBOUNCE menu option.
- Press the OK button to enable and disable the option.

If there is a checkmark ✓ next to the menu option, input debouncing will be enabled. If there is no check mark, it will be disabled instead.

7.9.2 Configuring input debouncing in easySoft 7

You can enable and disable the input delay in easySoft 7.

- Select the device you want from the catalog in the Project view
- Click on the System settings tab.

Go to the System settings section and look for the Debounce checkbox.

- ☑ To turn on, enable the checkbox by clicking on it.
- ☐ To turn off, disable the checkbox by clicking on it.

7.10 Download comments

Only possible with easySoft 7.

All the comments created in easySoft 7 can be loaded onto the device together with the project.

- Select the device you want from the catalog in the Project view
- Click on the System settings tab.

Go to the Comments section and look for the Download comments checkbox.

- ☑ To turn on, enable the checkbox by clicking on it.
- ☐ To turn off, disable the checkbox by clicking on it.

7.11 P buttons

"P buttons" are the cursor buttons on easyE4 devices with a display and keypad.

When working with EASY-E4-...-12...C1 devices, you can use the buttons as a contact in your circuit diagram.



In order to prevent accidental operation, the buttons will not be automatically enabled.

7.11.1 Configuring the P buttons on a base device with a display

In order to configure it, the program must be stopped.



Operating mode changes may be protected with a password.

- Go to the main menu.
- Go to SYSTEM OPTIONS\SYSTEM.
- Select the P BUTTON menu option.
- Press the OK button to enable and disable the option.

If there is a checkmark ✓ next to the menu option, input debouncing will be enabled. If there is no check mark, it will be disabled instead.

7.11.2 Configuring the P buttons in easySoft 7

You can enable and disable the P buttons in easySoft 7.

- Select the device you want from the catalog in the Project view
- Click on the System settings tab.

Go to the System settings section and look for the checkbox for P buttons and an input field.

- ☑ To turn on, enable the checkbox by clicking on it.
- ☐ To turn off, disable the checkbox by clicking on it.

Max. cycle time [ms]

This setting can be used to define the maximum cycle time you want. The default setting is 1000 ms, and the value range is 0 to 1000 ms. The device will switch to STOP mode as soon as a program cycle exceeds the configured maximum cycle time.

- Enter the maximum cycle time in [ms] into the input field.

If you do not enter a value into the input field, the default setting will be used instead.

7.12 Define program name

Only possible with easySoft 7.

You can name your program in easySoft 7.

- Select the device you want from the catalog in the Project view
- Click on the System settings tab.

Go to the Program name section and look for the input field.

- Enter the name you want into the text field so that it will be applied to the program.

7.13 Retention function

Only possible with easySoft 7.

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 until the next time the ACTUAL value is overwritten.

There are two input fields (for the start and end values of the retention range) each for markers and for the following function blocks.

Project view/ System settings tab



Figure 226: Screenshot of Retention section that can be found in the System settings tab in the Project view (including sample values)

Value range for the function blocks, instances that can be stored retentively:

- C - Counter relay : 01…32
- CH - High-speed counter : 01…04
- CI - Incremental counter : 01…02
- DB - Data function block : 01…32
- T - Timing relay : 01…32

For more information, please refer to the description for the relevant function block.

Marker value ranges:

- MB : 1 …512
- MW : 1…512
- MD : 1…256

The values from the input field will be automatically converted to MB marker bytes.

Retention bytes

The entire retentive marker range for an easyE4 must not exceed 400 bytes. The total of the retention bytes for the main program and user function blocks (UF) will be displayed in the Project view, in the System settings tab. If the retentive marker range exceeds 400 bytes, a red negative number will be shown in the Free field in order to indicate this.

Retain retention during transfer

Retentive actual values on the device are deleted:

- By any program change in the circuit diagram or function block diagram followed by its transfer to the device.
- When the program is deleted via Communication View, Program, Delete.
- By any change of the retentive range via the Project view, System settings, Retention.
- By any changes to the parameters for the remote markers of a visualization device.
- When the program is deleted with the Communication -> Delete device button

The following exception applies to retentive markers:

☑ Marker contents

If this option is enabled, the contents of the existing retentive market range will be retained when the project is transferred. In order for this to work, however, the marker range defined as being retentive must remain unchanged .

☑ Function block contents

If this option is enabled, the contents of the existing retentive operand range will be retained when the project is transferred. In order for this to work, however, the function block defined as being retentive must remain unchanged .

The marker actual values are retained when you have selected the option Retain Markers During Transfer.

7.13.1 Retention in the easySoft 7

You can configure the retention function both for markers and for function block contents in easySoft 7.

▶ Select the device you want from the catalog in the Project view

▶ Click on the System settings tab.

Go to the

- Retain retention during transfer
  section and look for the checkbox for Marker contents and the checkbox for Function block contents
- Retention
- Retention bytes

▶ ☑ To turn on, enable the checkbox by clicking on it.

▶ ☐ To turn off, disable the checkbox by clicking on it.

To configure the corresponding retention as necessary, enable the Marker contents and/or Function block contents checkbox.

Define the ranges that should remain retentive by selecting them and entering the corresponding values.



These ranges should be used exclusively for values that are required in order to be able to start the system back up after a restart. Please keep potential unforeseen and/or undesirable consequences in mind!

Retention bytes will show the amount of memory needed as you enter the values you want.

▶ Check whether there is enough memory.

7.14 Security – password protection

Configuring password settings and password-protected areas is only possible on easyE4 devices with a display or must alternatively be configured in easySoft 7.

Password protection can be used to lock access to various areas.

→ At least one area must be protected.
In the default setting the circuit diagram is selected.

7.14.1 Configuring the password on a base device with a display

Defining password-protected areas

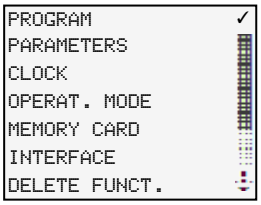
To define the areas that should be protected with a password, follow the steps below:

- Go to the main menu.
- Go to SYSTEM OPTIONS\SECURITY\AREA.
- Select the desired range
- Press the OK button to enable and disable the option.

If there is a checkmark ✓ for the area next to the scrollbar, this means that access to the corresponding area will be protected with a password prompt.

If there is no checkmark, it will be possible to access the area freely.

Table 77:
System options\Security\Area



The submenu shows the device areas that can be protected.

PROGRAM	The password is applied to the PROGRAMS as well as function blocks that are not enabled. This area also prevents the transfer of a circuit diagram from and to the memory card.
PARAMETER	The PARAMETERS menu is protected.
CLOCK	Date and time are protected with the password.
OPERATING MODE	It is not possible to change the operating mode from RUN to STOP and vice versa using the operating buttons of the device.
MEMORY CARD	Access to the microSD memory card will be protected.

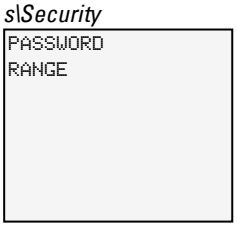
INTERFACE	Protects against access to the Ethernet interface of this device. Data exchange via the net is not affected. → Take into account the restricting effect of a protected interface if you have to reset the easyE4 device.
DELETE FUNCTION	When this function is not activated, the question "DELETE PROG?" will appear if the password entry is entered incorrectly four times. This question does not appear if you protect the this area. However, it is no longer possible to make changes in protected areas if you forget the password.

→ At least one of the following areas must be protected: Program, Parameters, Clock, Operating Mode, or Memory Card.
If you do not select any of these areas, "Program" will be selected automatically.
The PROGRAM area will be selected by default when using the device's factory settings.

Assigning a password

- Go to the main menu.
- Go to *SYSTEM OPTIONS\SECURITY*.
- Select the PASSWORD menu option.

Table 78: *System-Options\Security*



You can use any numbers or letters for the six-character password. Special characters and umlauts are not permitted.

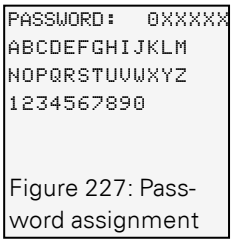


Figure 227: Password assignment

The first password character will flash.

- Select the first letter or number for the password.
- Confirm the entry with the OK pushbutton.
- Repeat these steps for the remaining characters in the password.

You can cancel at any time with the ESC button.

Enabling the password:

- Place the cursor anywhere inside the password.
- Press the OK button.

The password submenu will be displayed.

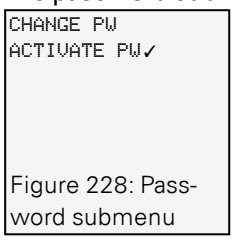


Figure 228: Password submenu

- Select the ACTIVATE PW menu option.
- Confirm the password with the OK pushbutton.

The password will be enabled in order to → Section "Defining password-protected areas", page 476.

Changing a password

- Press the OK button on the easyE4 to open the main menu.
- Go to SYSTEM OPTIONS\SECURITY\PASSWORD.

If a password has been assigned, the submenu for the password will be displayed.

- Select the CHANGE PW menu option.
- Enter the password.

The submenu for changing the password will be displayed.

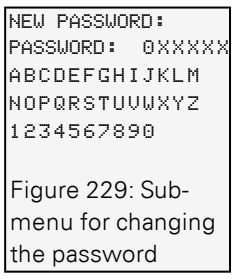


Figure 229: Submenu for changing the password

To assign a new password, follow the same steps outlined in → Section "Assigning a password", page 477

Removing password protection

To disable password protection, assign a password of <000000> .

7.14.1.1 What happens if you forget your password or enter the wrong password?

When you enter the wrong password, there will be a short period during which you will be locked out. You can try and enter the password again once this period elapses.

If the DELETE FUNCTION area is password-protected, you will be able to enter a password as many times as you want.

Starting from the fifth wrong attempt, the base device will display a delete prompt.

- ESC button: Abort, circuit diagram, data or password are not deleted.
- OK button: Circuit diagram, data and password are deleted.

If you no longer know the exact password, you can press OK to unlock the protected easyE4 device.
The saved program and all function relay parameters will be lost.

7.14.2 Configuring the password in easySoft 7

When working on a project, you can set a password for the <program>.e70 and select the areas you want to protect in easySoft 7.

- Select the device you want from the catalog in the project view
- Click on the Register Security.

Go to the Password entry section. This section will feature a checkbox for each area that can be protected with the password, as well as an input field for the password.

Project view\Security

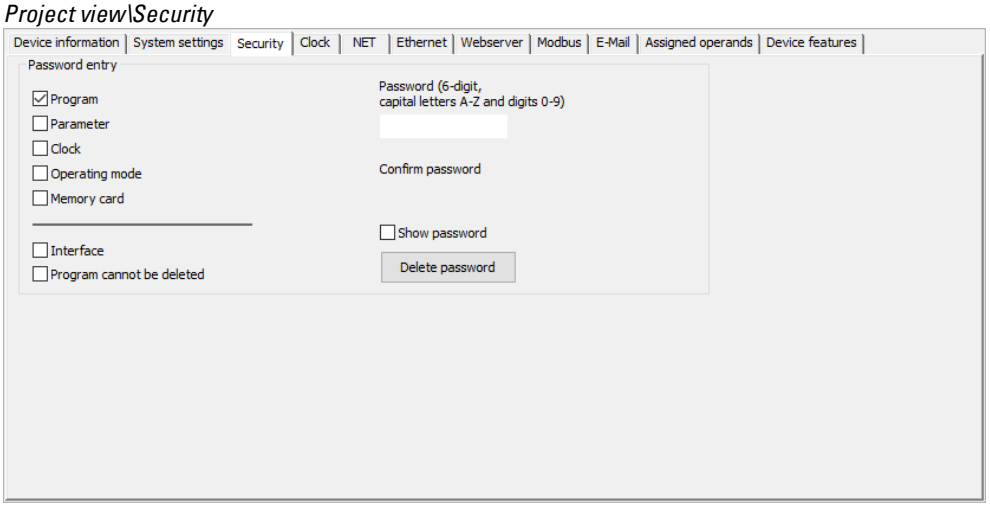


Figure 230: Assigning a program password

- To turn on, enable the checkbox by clicking on it.
- To turn off, disable the checkbox by clicking on it.

You can use any numbers or letters for the six-character password. Special characters and umlauts are not permitted.

- Enter the password into the input field.
- Confirm the password by entering it again.

If you enable ☑ the checkbox, the password will be shown in cleartext.

When you save the project, the password will be enabled for the <program>.e70.

The Delete password button will reset the password

See also

→ Section "Protect project with password", page 1

7.15 Configuring the memory card and device ID

Only possible with easySoft 7.

- Select the device you want from the catalog in the Project view
- Click on the System settings tab.

Go to the Memory card / device ID section and look for the Card start checkbox, the Allow overwriting via card checkbox, and the numeric input field.

- ☑ To turn on, enable the checkbox by clicking on it.
- ☐ To turn off, disable the checkbox by clicking on it.

If ☑ Card start, the device will access the memory card when it is switched on.

If ☑ Allow overwriting via card, it will be possible for the program that is found on the memory card to overwrite the program stored on the easyE4.

You can enter a six-digit number as a Program/device ID into the input field.



This ID ensures that a program will be overwritten on the easyE4 device only if the IDs match.

See also

→ Section "Transferring programs from and to a memory card", page 150
→ chapter "7 microSD memory card", page 487

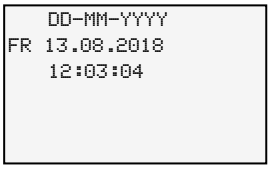
7.16 Time and Date setting

easyE4 devices feature a real-time clock with a date and time functionality.
When combined with the HW, HY or WT, YT function blocks, this real-time clock makes it possible to implement the functionality of a weekly timer and year time switch.

7.16.1 Time and date on a base device with a display

- Go to the main menu.
- Go to SET CLOCK.
- Select the DATE & TIME menu option.

Table 79: *Set Clock-\Date&Time*



Select the display format you want in the first line.

- Use the ⊙ cursor buttons to scroll through the available formats.
- Select the format you want.

DD-MM-YYYY DD/MM/YYYY DD.MM.YYYY	Day.Month.Year
MM/DD/.YYYY	Month.Day.Year
YYYY-MM-DD YYYY.MM.DD	Year.Month.Day

The display will change accordingly.

- Use the ⊙ cursor buttons to jump to the individual input positions in the date and time format.
- Set the values by means of the cursor keys ⊙.
- Confirm the entry with the OK pushbutton.

There are additional configuration options available in the SET CLOCK menu.

DST setting DST

- Go to the main menu.
- Go to SET CLOCK.
- Select the DST menu option.

Table 80: *Set clock\DST*

NONE ✓
CEST
US
RULE

The following will be available for selection: None, CEST,US, and Rule. A checkmark ✓ will indicate which setting is currently selected.

If you select "None," no daylight saving time schedule will be applied. "CEST" will apply the Central European Summer Time schedule, while "US" will apply the daylight saving time schedule used in the United States. Finally, selecting "Rule" will enable you to define your own custom schedule.

Table 81: *Set Clock\Daylight Saving\Rule*

SUMMERTIME START
SUMMERTIME END

- In "Rule,"
  select when you want daylight saving time to start and when you want it to end. The easyE4 will apply your settings and will automatically change the clock on the dates you selected.

Setting radio clock

Alternatively, you can also have the system synchronize its clock with a radio time signal.

- Go to the main menu.
- Go to SET CLOCK.
- Select the RADIO CLOCK menu option.
- To enable it, use the cursor buttons to select the YES option.
- Use the cursor buttons to select the input you want.
- Use the cursor buttons to define the value you want.
- If you want to set an offset for the time, follow the same steps.

Table 82: *Set Clock\Radio Clock*

RADIO CLOCK
ACTIVE : YES
INPUT : I001
OFFSET : +000'

7.16.2 Setting time and date in the easySoft 7

You can enable and disable the time in easySoft 7.

- Select the device you want from the catalog in the project view
- Click on the Register Clock.

Go to the SNTP synchronization section and look for the checkbox for Synchronize clock via SNTP.

- ☑ To turn on, enable the checkbox by clicking on it.
- ☐ To turn off, disable the checkbox by clicking on it.
- Select whether you want to enter a URL or the IP address for the SNTP server.
- Enter the address into the corresponding field.

Alternatively, you can synchronize the clock with a radio time signal.

Go to the Radio clock synchronization section and look for the Synchronize clock via radio (DCF77) checkbox.

- ☑ To turn on, enable the checkbox by clicking on it.
- ☐ To turn off, disable the checkbox by clicking on it.
- Use the drop-down menus to select the input you want to use and the time offset, in [min], at the location where the easyE4 is being used.

Finally, you can use the Daylight saving time section to configure the corresponding settings as needed.

- ◉ Enable the
  None, CEST, US setting
  or
  The Rule setting if you want to define your own custom schedule.
- Click on the Modify time zone... button to specify the time zone where you are located.

Go to the Time zone section to select the time zone corresponding to the location where the easyE4 device is being used.

Clicking on the Modify time zone... button will open the Time zone and geographic coordinates dialog box.

Use the City drop-down menu to select one of the available cities.

You can click on the New button to add a new option based on geographic coordinates. The new option will be saved on the local system.

NET-GROUP

If you are using a NET GROUP, you can select a easyE4 device from the group that will serve as the time reference for all the other devices in the NET GROUP.

Go to the NET synchronization section and look for the checkbox for Synchronize clock via NET.

- ☑ To turn on, enable the checkbox by clicking on it.
- ☐ To turn off, disable the checkbox by clicking on it.
- Select the NET-ID (station number) corresponding to the device in the NET GROUP that will serve as the time reference for the other devices.

application

Say that only one easyE4 device in the NET group features a radio clock and that you want this device to serve as the time reference for all the other devices in the group. In this case, you would enter the NET-ID of the device here.

See also

Timer modules

→ "HW - Weekly timer (Hour Week)", page 168
→ "HY - Year time switch (Hora Year)", page 178
→ "WT - Weekly timer (WeekTable)", page 215
→ "YT - Year time switch (Year Table)", page 209

8. microSD memory card

easyE4 base devices can be used with a microSD memory card.

The easyE4 device supports 128 MB to 32 GB microSD memory cards (SD and SDHC, FAT12/16/32, Class 2 or 4).

Moreover, using a memory card makes it possible to use the following functions:

1. Automatic booting from the memory card
   The easyE4 can load and run a starting program from the memory card.
2. Resetting to factory settings
3. Loading new operating system (firmware)
4. Setting a splash screen for the EASY-E4-...-12...C1 display
   You can store a boot.bmp file on the memory card so that it will be shown on the display when starting the easyE4 and when inserting the card
5. Transferring user programs, Storing multiple programs
6. Logging data
   → Section "DL - Data logger", page 380

In order to be able to transfer programs or use the data logger function, the microSD memory card must be formatted accordingly.
The actual transfer is carried out in easySoft 7, in the Project view.
The DL - Data logger function block can be used for logging data and states.

8.1 Automatic booting from the card

You can boot an easyE4 base device from the memory card.

To be able to do this, the following prerequisites must be met:

- The microSD memory card must contain at least one compiled PRG program.
- One of the programs must have been set as the starting program, i.e., the microSD memory card must contain a BOOT.TXT file.
- If there is a program on the base device already, the Allow overwriting via card option must be enabled in the program.

If all these prerequisites are met, the device will boot from the card as follows:

- Insert the memory card while the device is de-energized.
- Switch on the supply voltage.
- Since the RUN start option is enabled by default, the device will automatically switch to RUN mode.

As soon as the easyE4 device switches to RUN mode, it will check whether there is a program in its internal memory. If there are none, the following step will be skipped. If there is one, the device will check whether the following option is enabled in *Project view/System settings tab/Memory card / device ID section/Program/device ID*: ☑ Allow overwriting via card – please refer to → "System settings tab" as well.

If this option is enabled, the starting program specified in the BOOT.TXT file will be copied from the card to the internal device memory and run.

The steps carried out when the device is turned on are shown in detail in the corresponding flowchart – please refer to → "Overview of switch-on behavior", page 85.

Meeting the applicable prerequisites

There are three different ways to prepare a microSD memory card for booting. Following is a description:

1. Preparing the card in the PC for booting with easySoft 7
   The microSD memory card must be inserted into a slot on the PC and written to from there.
2. Preparing the card in the device for booting with easySoft 7
   The microSD memory card is already in the device and is written to from the PC.
3. Preparing the card for booting on the device itself
   The microSD memory card is already in the device and is prepared for booting on the device itself. easySoft 7 is not needed in this case.

8.1.1 Preparing the card in the PC for booting with easySoft 7

Only possible with easySoft 7.

Prerequisites

- Licensed easySoft 7 version on the PC

▶ Insert the microSD memory card into a card reader/writer on your PC.
▶ Open easySoft 7 and open the project you want to transfer, e.g., <test.e70>.
▶ If you want the starting program on the card to overwrite the current program on the device again later on, make sure to enable the Allow overwriting via card option in *Project view/System settings tab*.
▶ Start setting up the card by clicking on the *Project/Card...* menu option.
If this is the first time you click on this menu option, make sure to select the drive corresponding to the microSD card.

The Card setup dialog box will appear.

Transfer program

Menu bar/Project/Card...

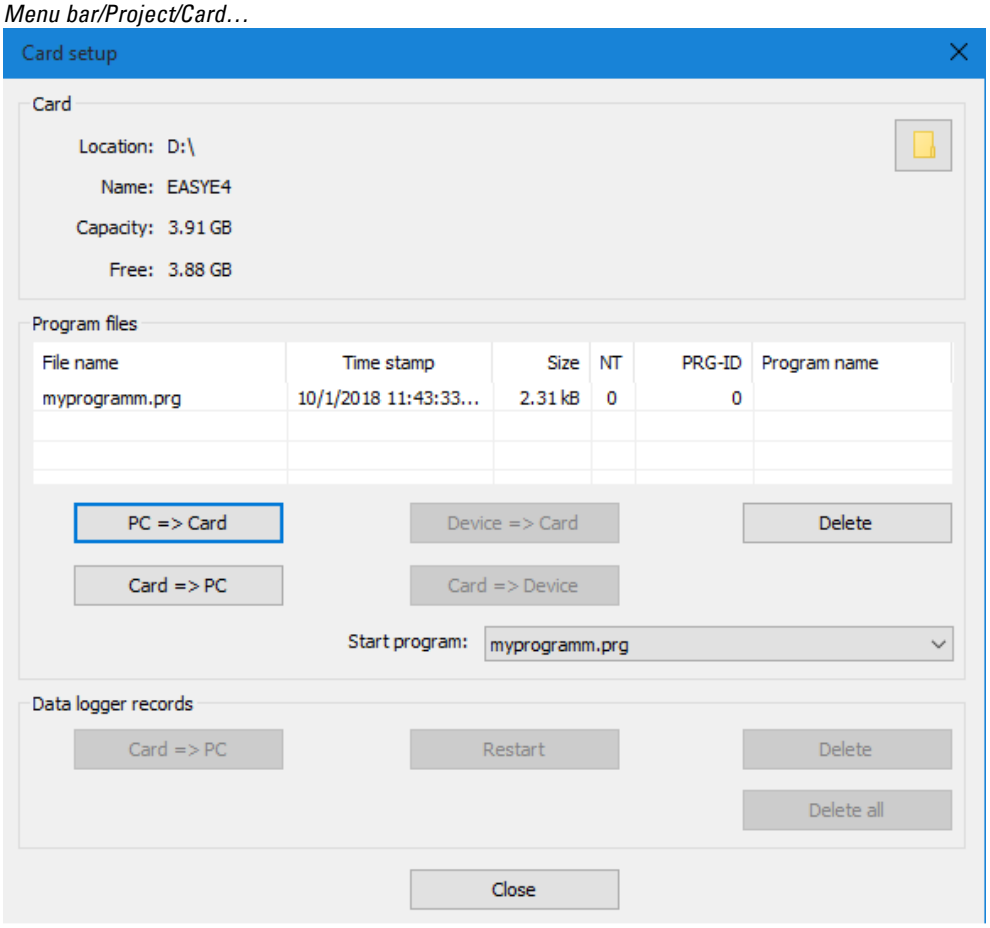
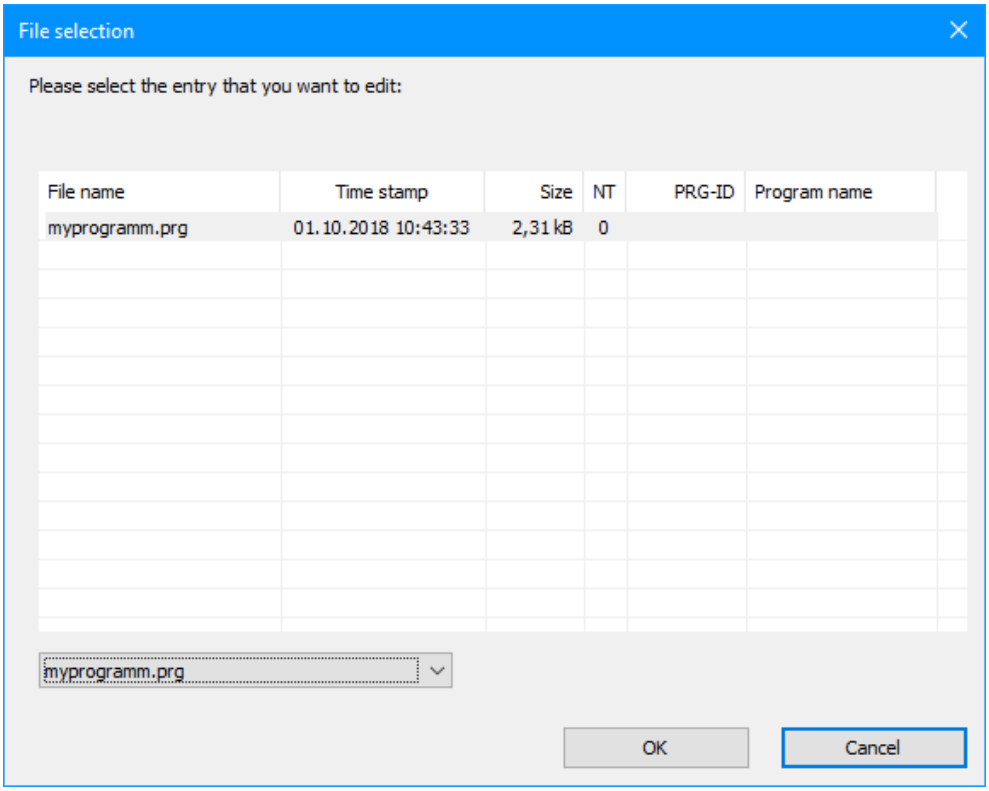


Figure 231: Offline User dialog memory card

▶ Click the PC -> Card button.

The "File selection" window opens.



- If the list does not show any files, this means that there are no programs on the card.
  Enter the name you want for the program into the drop-down menu, e.g., <test>. This name can be different from the *.e70 file's name. You can also select a name from the menu.
- Confirm your selection with OK. This will transfer the program for the device selected in the Project view to the card.

If the project is a NET application, the "Selection of NET station" dialog box will appear.

- Select the NET station with the program that you want to transfer to the microSD memory card, e.g., <NET station NT1>.

A plausibility check will then be run – please refer to → "Running a plausibility check," page 1. If this plausibility check is completed successfully, the following prompt will appear.

Setting a program as the starting program

"Do you want to enter the program as a start program on the card as well?"

- If you confirm by clicking on YES, the program will be set as a starting program for booting. Accordingly, a BOOT.TXT file that contains the name of the starting program will be generated. In addition, the name of the starting program will appear in the "Card setup" dialog box, in the Start program drop-down menu.

The .e70 program will be compiled into a .PRG program and shown in the list.

Optional: Checking the microSD memory card

You can use Explorer to check the contents of the microSD memory card. It should now contain both the transferred program and the BOOT.TXT file.

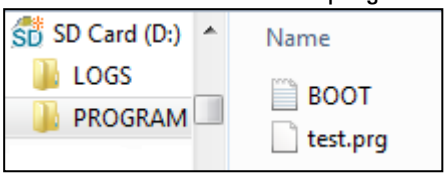


Figure 232: microSD memory card drive with PROGRAM folder contains BOOT.TXT and compiled test.prg program

The card is now prepared with all the prerequisites for booting. You can now use automatic booting from the card – please refer to → "", page 488.

8.1.2 Preparing the card in the easyE4 device for booting with easySoft 7

Prerequisites

- Licensed easySoft 7 version on the PC

- Insert the card into the device while the latter is de-energized.
- Switch on the supply voltage.
- Open easySoft 7 and open the project you want to transfer, e.g., <myProgram.e70>.
- If you want the starting program on the card to overwrite the current program on the device again later on, make sure to enable the Allow overwriting via card option in *Project view/System settings tab*.
- Establish online communications between the PC and the device – please refer to → "Establish a connection to the device", page 522
- If there is a program on the device already, make sure that the Allow overwriting via card option is enabled in the program. To do so, enable the Allow overwriting via card option in *Project view/System settings*.
- Go to the *Communication view/Program/Configuration* section and click on the Card… button.

The "Card setup" dialog box will appear.

Menu bar/Project/Card…

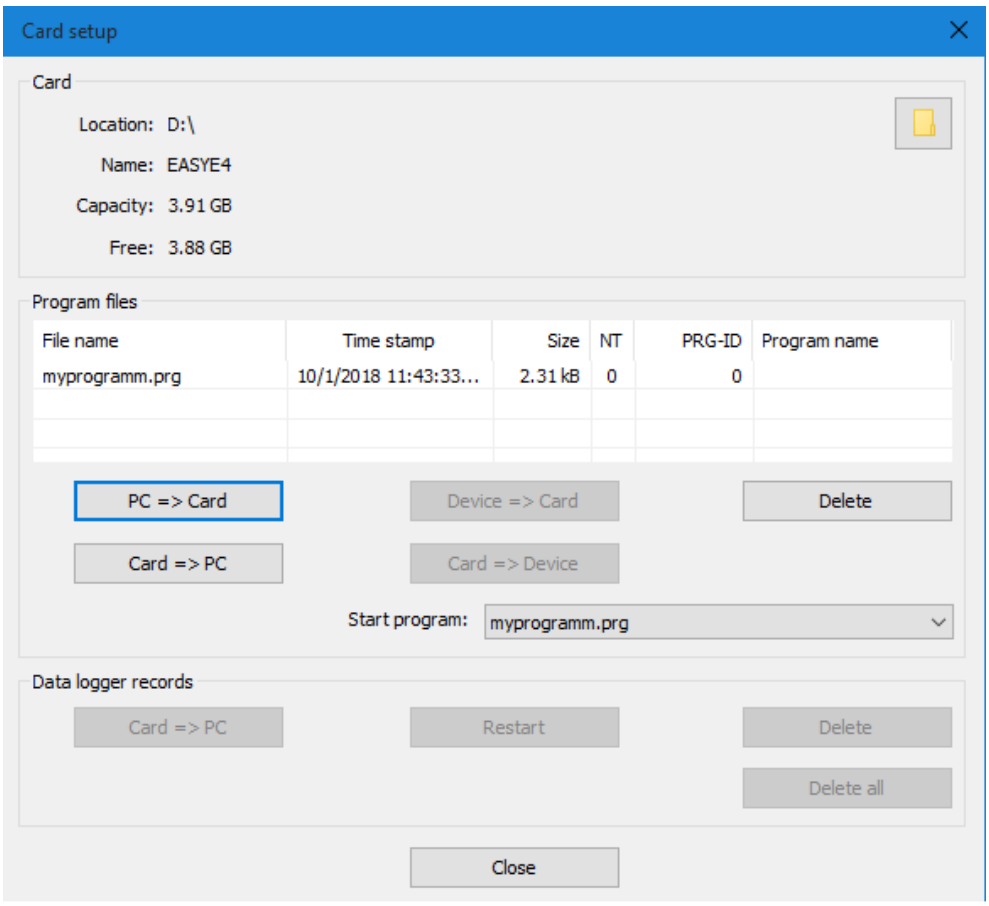
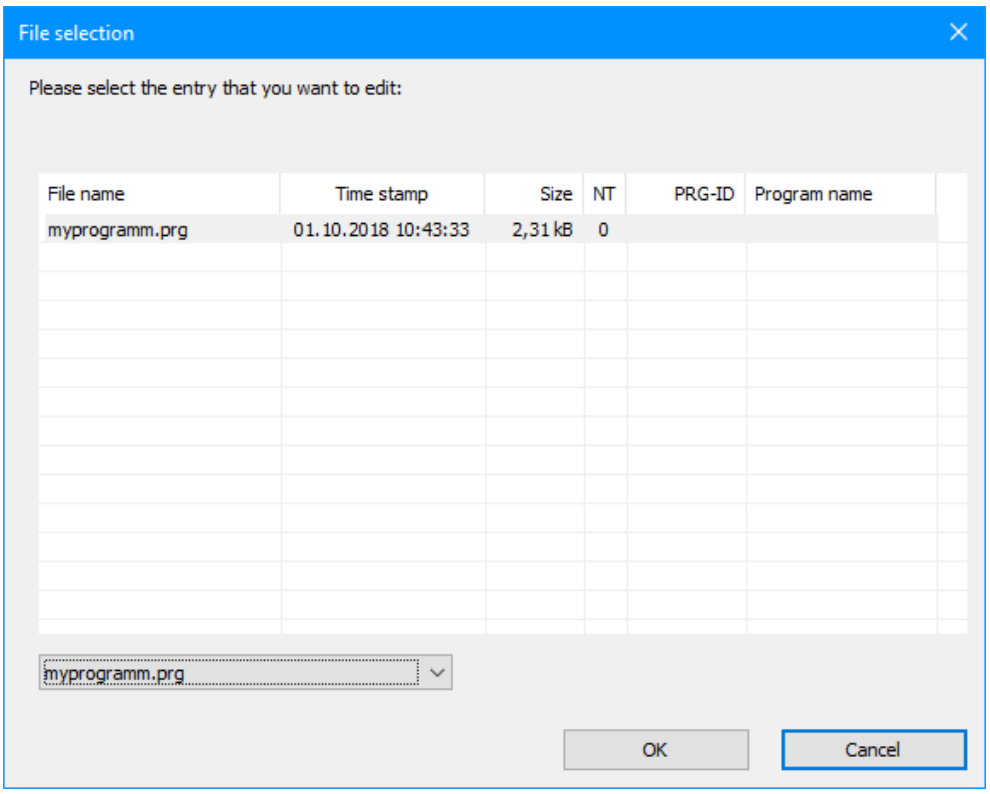


Figure 233: Offline User dialog memory card

Transfer program

▶ Click the PC -> Card button.

The "File selection" dialog box will appear.



- If the list does not show any files, this means that there are no programs on the card.
  Enter the name you want for the program into the drop-down menu, e.g., <test>. This name can be different from the *.e70 file's name in easySoft 7. You can also select a name from the menu.
- Confirm your selection with OK. This will transfer the program for the device selected in the Project view to the card.

If the project is a NET application, the "Selection of NET station" dialog box will appear.

- Select the NET station with the program that you want to transfer to the microSD memory card, e.g., <NET station NT1>.

A plausibility check will then be run – please refer to → "Plausibility check", page 448. If the plausibility check is completed successfully, the following prompt will appear.

Setting a program as the starting program

"Do you want to enter the program as a start program on the card as well?"

- If you confirm by clicking on YES, the program will be set as a starting program for booting. Accordingly, a BOOT.TXT file that contains the name of the starting program will be generated. In addition, the name of the starting program will appear in the "Card setup" dialog box, in the Start program drop-down menu.

The .e70 program will be compiled into a .PRG program and shown in the list.

Optional: Checking the microSD memory card

You can use Explorer to check the contents of the microSD memory card. It should now contain both the transferred program and the BOOT.TXT file.

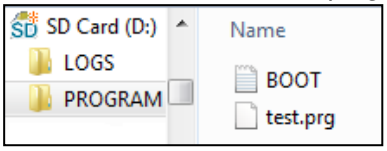


Figure 234: microSD memory card drive with PROGRAM folder contains BOOT.TXT and compiled test.-prg program

The card is now prepared with all the prerequisites for booting. You can now use automatic booting from the card – please refer to → "", page 488.

8.1.3 Preparing the card for booting on the easyE4 device itself

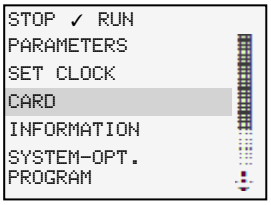
Prerequisites

- The microSD memory card must contain at least one compiled PRG program.

The easyE4 device must be in STOP mode before it can be configured. If it is not, the device will point this out.

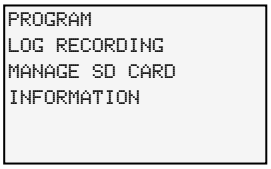
- Insert the memory card while the device is de-energized.
- Switch on the supply voltage.
- Go to the main menu.
- Go to CARD.

Table 83: *Main menu*



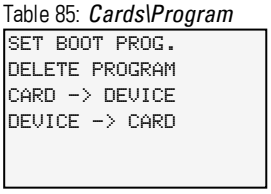
- Go to PROGRAM

Table 84: *Card*



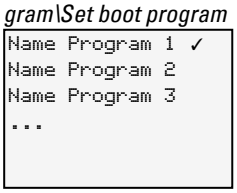
- Go to START PROGRAM

Table 85: *Cards\Program*



- Select the starting program from the list containing the names of all the programs stored on the memory card.
  The ✓ checkmark at the end of a line indicates the program with which the easyE4 device will start as soon as RUN mode is active.

Table 86: *Card\Program\Set boot program*





If the display is blank, this means that there are no programs on the memory card.

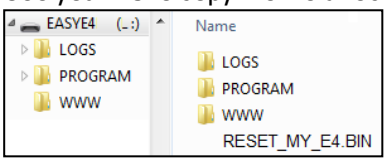
▶ Switch off the power supply.

The card is now prepared with all the prerequisites for booting. You can now use automatic booting from the card – please refer to → "", page 488.

8.2 Reset – resetting the device to factory settings

To carry out a reset, follow the steps below:

- Create an empty file on the PC (with a text editor, for example) and rename it RESET_MY_E4.BIN.
- Use your PC to copy the file directly to the root of the microSD memory card.



- Switch off the easyE4 base device.
- Insert the microSD memory card.
- Switch on the easyE4 base device.
- Now turn off the easyE4 base device and remove the microSD memory card.

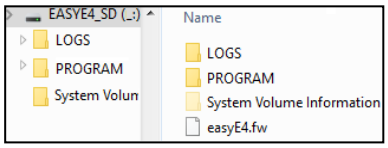
The easyE4 base device will be reset.
The program, password, and all settings will be deleted, and the network interface will work with auto-IP.

8.3 Loading new operating system

easyE4 base devices can be updated to a newer operating system.

This operating system is provided for download by Eaton Industries GmbH, Bonn through its online Download Center – Software.

- ▶ Download the operating system you want on your computer.
- ▶ Connect an empty microSD memory card (Format FAT 12, 16, 32) to your computer.
- ▶ Use your PC to unpack the downloaded operating system to the ROOT of the microSD memory card.



The unpacked operating system file will be named "EASYE4.FW."

- ▶ Switch off the easyE4 base device.

If there is a program on the base device, the program will be left unchanged when the operating system is updated. Retentive data will remain unchanged as well.

If the operating system on the device and the card match, the operating system will always be run from the card.

- ▶ Insert the microSD memory card with the new operating system into the microSD card holder and slide the holder into the device

→ Make sure that the power is stable and that the device is not turned off while the operating system is being updated. If it is, the operating system may be corrupted. Then run the operating system update again.

- ▶ Switch on the easyE4.

- The POW/RUN LED will flash very quickly in order to indicate the status of the bootloader that searches for the operating system on the card.
- The POW/RUN LED will flash with an "ON for 2 seconds / OFF for 2 seconds" cycle
- The POW/RUN LED will flash normally (POW)

or

- The POW/ RUN will show a solid light, meaning that the base device has started the existing program.

The operating system update has now been completed successfully.

→ You can go to *INFORMATION\SYSTEM* to see what the current operating system version is.

- Switch off the supply voltage.
- Remove the microSD memory card with the operating system from the device.

If you do not remove the microSD memory card, the program will not start (when turning on the device) until after the operating system is transferred again from the microSD card.

Releasing the microSD memory card

As an alternative to removing the memory card from the device, you can release it with easySoft 7.

There are two ways to do this:

Method 1

- In easySoft 7, go to *Communication view/Program/Configuration*.
- Click the Card... button.
- In the Card setup dialog box, click on the Release button.

Method 2

- In easySoft 7, go to *Communication view/Display/Display + buttons*.
- Press OK to exit the display.
- Make sure that the device is in STOP mode.
- Use the P buttons to select the CARD menu option and confirm your selection with OK.
- Use the P buttons to select the MANAGE SD CARD menu option and confirm your selection with OK.
- Use the P buttons to select the RELEASE CARD menu option and confirm your selection with OK.

After this, the microSD memory card will no longer be accessible.

8.4 Setting a splash screen for the EASY-E4-...-12...C1 display

You can create your own custom monochromatic image externally in any program. Simply make sure that the image is in BMP format and is named boot.bmp.

The size is set at 128 x 96 pixels (width x height) or, alternatively, 128 x 64 pixels. You can use two colors, which will be shown as shades of gray.
Make sure that the file always keeps the name boot.bmp!

Splash screen



Figure 235: boot.bmp

- Transfer the image to the microSD memory card.
- Store the boot.bmp file directly on the memory card.

microSD memory card on the PC

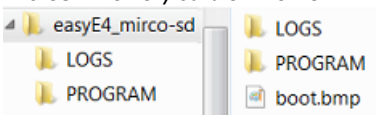


Figure 236: Storing the boot.bmp file

As soon as the easyE4 device is switched on,
the boot.bmp will be shown as a splash screen for the defined duration.

In order for the splash screen to keep working, the microSD memory card must remain in the device.

See also

→ Section "Transfer program to the easyE4 device", page 114
→ Section "Transferring programs from and to a memory card", page 150
→ Section "Overview of switch-on behavior", page 85
→ Section "DL - Data logger", page 380

9. easyE4 inside

9.1 Program execution

When using the LD or FBD programming language, the program will be executed as follows:

- The program will start by reading the hardware's input states and writing them to the image table register. After this, it will run through network 01 in its entirety and not only process all function blocks and logic circuitry, but also write the state of all mapping assignments (Q, M, etc., and function blocks) to the image table register. It will then run through the next network (if any networks are jumped over, they will not be run through). Once the last network has been run through, the resulting output states will be transmitted to the hardware and the cycle will start again.

In the Programming language ST

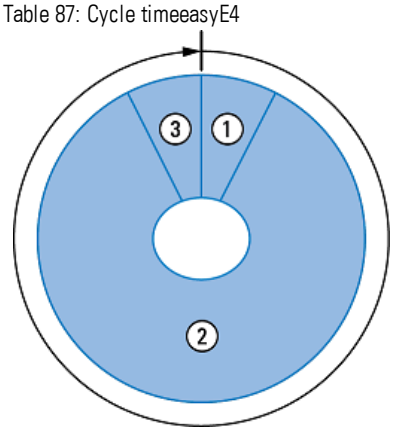
- The program will start by reading the hardware's input states and writing them to the image table register. After this, it will execute the statement and instruction list from top to bottom and modify the image table register every time there is a mapping assignment (if any statements or instructions are jumped over, they will not be executed). The cycle will then start again.

When using the EDP (easy Device Programming) programming language

- This programming language is the same one that can be use for programming directly on the base device. The way in which this program will be executed is identical to the way programs are executed on the easy500, easy700, and easy800 devices.

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.

Table 87: Cycle timeeasyE4



① Read process image	② Process circuit diagram and function block diagram	③ Write process image
Local inputs Function block inputs Markers Diagnostics information		Local outputs Function block outputs Markers NET stations out-

puts

NET sta-
tions
inputs

During this time, the easyE4 device passes through six segments in succession.

If the operands of the inputs and outputs are addressed in the easyE4, the signal states of the digital inputs/outputs are not scanned but a memory range in the device system memory is accessed. This memory range is called the process image. The process image is divided into two sections: the process image for the inputs and the process image for the outputs.

Segment 1 - 4

The easyE4 device evaluates the contact fields within the first four segments. The evaluation starts in the first segment in circuit diagram line 1 and continues from top to bottom until circuit diagram line n is reached.

The easyE4 device then moves to the next contact segment and continues to evaluate from top to bottom until it has reached the last contact in the fourth segment. During this process it checks whether contacts are switched in parallel or in series and saves the switching states of all contact fields.

Segment 5

In the fifth segment the easyE4 device assigns all coils in one pass, from the circuit diagram line 1 - n, with the new switch states from the process image of the outputs.

Segment 6

In the sixth segment which is outside of the circuit diagram, the function blocks present in the function block list are evaluated.

The easyE4 device uses this sixth segment in order to:

- process the existing function blocks. The output data of a function block is immediately up-to-date after it has been processed. The function blocks are processed by the easyE4 device in the order of the function block list (→ *FUNCTION BLOCKS menu*).

The following requirements must be fulfilled when using particular function blocks:

- Contact the "outside world"
  Output relays Q 01 to Q… are switched and inputs I 1 to I… are re-read.
- to exchange NET data if this easyE4 device receives new read data or provides new send data (on).
- to copy all new switching states to the process image.

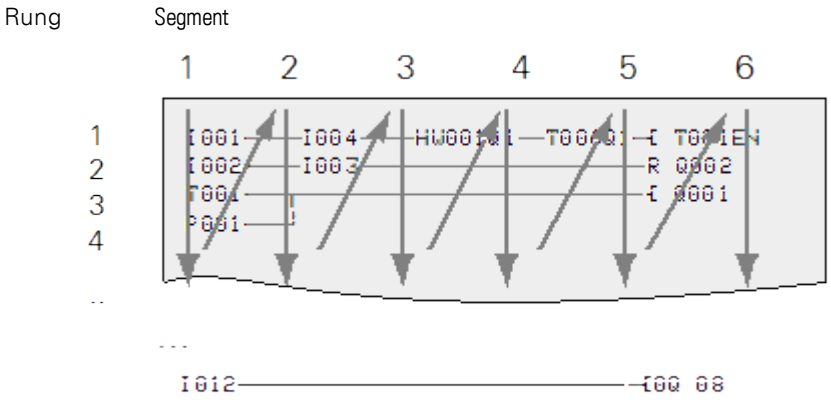


Figure 237: How the EDP evaluates circuit diagrams and function blocks

9.2 Transfering an existing circuit diagram

Existing easy.e60 programs can be imported with easySoft 7.

When importing existing programs / projects, you will be able to select either the EDP or LD programming language:

EDP programs will be imported in their entirety, and their flow structure will be compatible with previous devices.

If the program / project is instead imported into LD, the first mapping assignment will be to an intermediate marker. Once the last mapping assignment to an intermediate marker is completed, the intermediate markers will be mapped to the actual M, Q, etc. function block operands. This ensures that the program will keep the same flow structure as the previous devices.

easySoft 7 will output an import log that specifies how the inputs, outputs, and markers have been rewired.



If a project featuring an easyE4 features MFD-CP8/10 stations as well, the MFD devices will be shown as "other" NET stations.
easySoft 7 will use the previous devices and the operands used as a basis in order to optimize the easyE4 hardware and the new xyz.e70 program.

9.3 Timing characteristics of expansion devices

When the outputs and inputs on expansion devices are written to and read respectively via easyConnect, the corresponding process will not be synchronized with the program cycle. In fact, if the easyConnect cycle is more than twice as fast as the program cycle, the inputs and outputs will be refreshed with every program cycle.

If, on the other hand, the easyConnect cycle is slower than half the program cycle, the inputs and outputs may be refreshed after two program cycles instead.

Digital expansions

- The time it takes to write data to the outputs on a digital expansion and read its inputs is typically 0.6 ms.
- Eleven digital expansion devices typically require 6 ms in order for all outputs to be written and all inputs to be read.

Analog expansions

- The data for an analog device with four inputs and two outputs will typically be refreshed in 1.5 ms.

As for mixes of digital and analog devices, the following example is meant to illustrate the corresponding time response: With two digital expansion devices and two analog expansion devices, the easyConnect cycle would be 4.1 ms.

9.4 Time behavior of the inputs and outputs

The reaction time, which is measured from the reading in of a digital input signal to the setting of the associated output, is determined by the timing characteristics of the device inputs and outputs as well as the size and design of the circuit diagram.

Input delay (debounce)

The time required to switch the inputs and outputs in the circuit diagram can be increased on the easyE4 base device using an input delay, the so-called DEBOUNCE→ Section "Debounce", page 469

This function is useful, for example, in order to ensure a clean switching signal despite contact bounce.

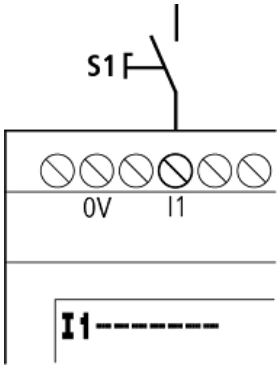


Figure 238: easyE4 input assigned a switch

EASY-E4-DC-... devices and EASY-E4-AC-... devices operate with physically different input voltages and therefore differ in the length and evaluation of debounce times.

9.4.1 Delay time on EASY-E4-DC-... devices

9.4.1.1 Delay time with DEBOUNCE activated

When DEBOUNCE is activated, the delay time for DC signals is 20 ms.

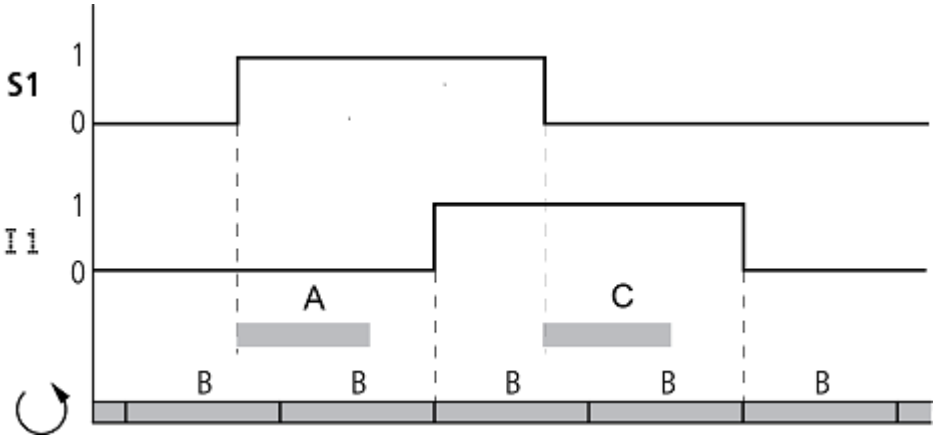


Figure 239: Delay times for evaluating an DC input signal and an activated DEBOUNCE

An input signal S1 must therefore be > 15 V on the input terminal for at least 20 ms before the switch contact will change from 0 to 1 (A). If applicable, this time must also include the cycle time (B) since a easyE4 device does not detect the signal until the start of a cycle.

When the DC voltage signal drops out from 1 to 0 and DEBOUNCE is active, the same delay time (C) of 20 ms is applied before the signal is transferred to the next circuit diagram cycle. For this the input signal S1 must be < 5 V at the input terminal.

9.4.1.2 Delay time with DEBOUNCE deactivated

When DEBOUNCE is deactivated, the typical delay time for DC signals on the input for easyE4 base devices caused by the hardware lies between 0.025 ms and 0.25 ms (A).

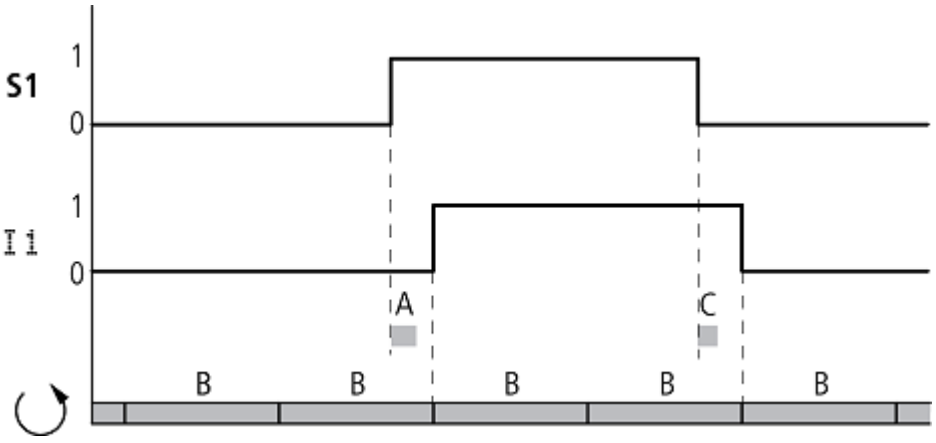


Figure 240: Switching behavior with DEBOUNCE deactivated

Typical delay times with DEBOUNCE deactivated are:

- On-delay for:
  - I1 to I4 easyE4 default: 0.025 ms
  - I1 to I4 EASY806-DC-SWD: 0.02 ms
  - I5 to I12: 0.25 ms
- Off delay for:
  - I1 to I4 easyE4 default: 0.025 ms
  - I1 to I4: 0.02 ms
  - I5, to I8: 0.4 ms

When using high-speed counter function blocks, the delay time for the input signals must not exceed 0.025 ms. DEBOUNCE must therefore be deactivated.

When DEBOUNCE is deactivated ensure that input signals are free of noise. The easyE4 device responds to very short signals.

To allow reliable recognition and processing of the input signal, it must be applied stably for a certain duration, the length of which depends on the circuit diagram processing cycle time.

9.4.2 Delay time on EASY-E4-UC-... devices

With AC inputs the easyE4 device scans the input signal in long or short scan cycles t_{SC1} depending on whether DEBOUNCE is activated/deactivated. The scan cycle also depends on the frequency of the supply network.

9.4.2.1 Delay time with DEBOUNCE activated

If the DEBOUNCE function is activated, the easyE4 device checks whether a positive half-wave is present at an input terminal during two successive scan cycles t_{SC1} (1st and 2nd scan pulse at A). If the easyE4 device registers two positive half waves in succession, it switches the appropriate input (contact) internally from 0 to 1.

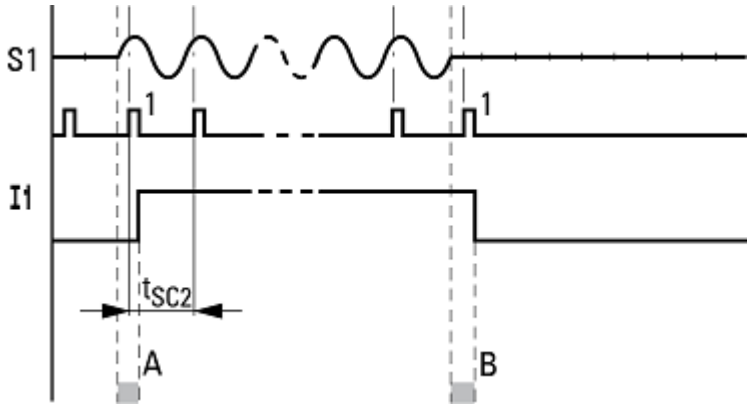


Figure 241: Delay times for evaluating an AC input signal and an activated DEBOUNCE

The typical input delay caused by the DEBOUNCE is therefore at least 80 ms. The cycle time must be added to this since an easyE4 does not transfer the signal into the circuit diagram until the start of a cycle. Conversely, the input is switched off if the easyE4 device does not detect any half-cycles twice in succession (1st and 2nd pulse at B).

t_{SC1} (50 Hz) = 40 ms, tSC (60 Hz) = 33.3 ms

- Switch-on delay (normally):
  - I1…I12: 80 ms (66.7)
- Off-delay (normally):
  - I1…I12: 80 ms (66.7)

The corresponding values for 60 Hz are given in brackets.

9.4.2.2 Additional delay time due to bouncing pushbuttons

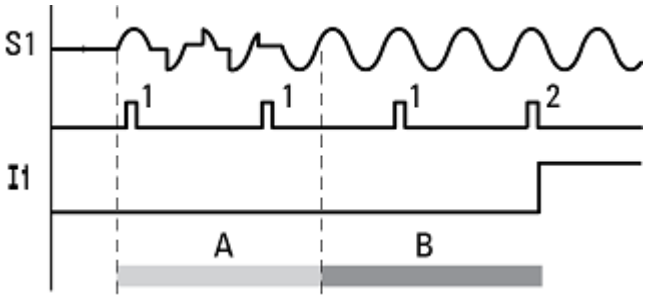


Figure 242: Pushbutton with bounce

If a button or switch bounces (A), the delay time may be extended by 20 ms (16.7 ms) (A).

Delay time with DEBOUNCE deactivated

When DEBOUNCE is deactivated, the delay time is reduced so that the easyE4 device switches in shorter scan cycles t_{SC2} the appropriate input (contact) internally from 0 to 1 (A) when a positive half wave is detected.

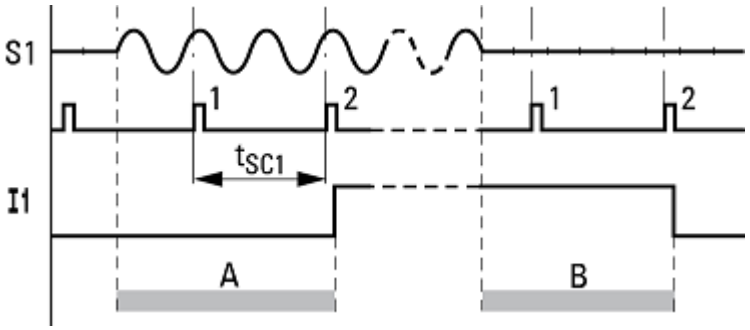


Figure 243: Switching behavior with DEBOUNCE deactivated

If a positive half-cycle is not detected the easyE4 switches off the contact (B).

t_{SC2} (50 Hz) = 20 ms, tSC (60 Hz) = 16.7 ms

- Switch-on delay (normally):
  - I1…I12: 20 ms (16.7)
- Off-delay (normally):
  - I1…I12: 20 ms (16.7)

The appropriate values for 60 Hz are given in brackets.

The procedure for changing the delay times is described in:
→ Section "Time behavior of the inputs and outputs", page 506

9.5 Device information

Device information is provided in the

Information menu both for service purposes and in order to make it possible to identify the device's performance characteristics.

Following data is displayed:

The submenu is only available in English.

ACTUAL CONFIG - Shows the device configuration

- NET GROUP: The NET group number, on a single line, e.g., 00
- NET-ID: The device's station number, on a single line, e.g., 00
- MAC ADDRESS: (MAC address of the device), two display lines
  e.g. 0022C712343E
- DEVICE NAME: E.g.: EASYE4-12UC1 DNS device name
- IP-ADDRESS: xxx.xxx.xxx.xxx
- SUBNET MASK: xxx.xxx.xxx.xxx
- GATEWAY ADDRESS: xxx.xxx.xxx.xxx
- DNS SERVER: xxx.xxx.xxx.xxx
- WEB SERVER (Enabled / Disabled)
- HTTP PORT
- MODBUS TCP (Enabled / Disabled)

SYSTEM - Shows the operating system version

- E4- : Part number
- B : 0068(build version)
- OS : 1.00(Version)
- CRC : 60268(checksum)

9.6 Operating states

easyE4 devices feature various operating states.

Switched off- no supply voltage available

Powered up

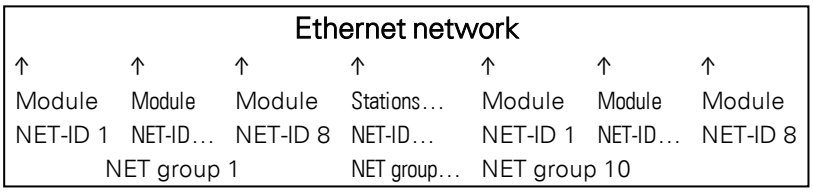
- If there is no program on the base device, the base device will remain in the STOP operating mode and it will not be possible to execute any programs.
- If there is a program on the device, the base device will remain in the STOP operating mode until it switches to RUN. When the base device is in STOP mode, the program will not be executed. Connected expansion devices will communicate with the base device as long as there are no configuration errors, and all the outputs on all devices will have a state of 0 (OFF). In addition, it will be possible to communicate with easySoft 7 via Ethernet.
- The base device can be switched to the RUN operating mode with the menu or through easySoft. In this case, the program will be executed and the outputs will be switched on and off as per the program logic. Existing communication services such as NET, Modbus, web servers, etc. will be running, and it will be possible to use them.

9.7 NET network

The NET functionality via Ethernet was created in order to simplify communications between easyE4 base devices while simultaneously ensuring that it would be possible to import existing easy800 projects.

A NET group can be made up of up to eight easyE4 base devices. Within the group, the easyE4 base devices can communicate with each other. If, however, you want devices to be able to communicate across groups, you will need to use a coordinator device that allows the easyE4 base devices from the various groups to communicate with each other via Modbus.

Ten NET groups (groups 1 through 10) can be run on a single Ethernet network at one time (this is the equivalent of 80 easyE4 base devices).



The following list shows the operands that can be used within a group by every device:

- (n = NET-ID 1 .. 8)
- n SN 01 - 32 [Bit]
- n RN 01 - 32 [Bit]
- PT 01 - 32 (PUT) [double word]
- GT 01 – 32 (GET) double word]
- n N 01 - 512[Bit]
- n NB 01 - 64 [Byte]
- n NW 01 - 32 [Byte]
- n ND 01 - 16 [double word]
- Synchronize clock (settings)

Examples

Station 1 sending a bit to station 2

NET-ID1		NET-ID 2
2 SN 15	→	1 RN 015

Station 3 sending a double word to station 8 via PT16

NET-ID1		NET-ID 2
PT16	→	GT 01 Parameter NET-ID 1 PT 16

Station 4 sending a network marker [bit and word] to all stations.

NET-ID4		NET-ID 2	NET-ID 5	NET-ID 7
N 125	→	4 N 125	4 N 125	4 N 125
NW30	→	4 NW 30	4 NW 30	4 NW 30

This basic principle applies to all network markers in all data formats:



Network markers overlap in the various data formats

N1-8	N9-16	N17-24	N25-32	N33-40	N41-48	N49-56	N57-64
NB1	NB2	NB3	NB4	NB5	NB6	NB7	NB8
NW1		NW2		NW3		NW4	
ND1				ND2			
N65-72	N73-80	N81-88	N89-96	N97-104	N105-112	N113-120	N121-128
NB9	NB10	NB11	NB12	NB13	NB14	NB15	NB16
NW5		NW6		NW7		NW8	
ND3				ND4			

etc.

Life signs NET stations

In order to make it possible for all NET stations within a group to be able to know whether NET stations important to them are still communicating, each station cyclically sends a heartbeat every second (1 s). If a heartbeat is not received, the corresponding error bit ID01 – 08 will be set to "1" until a heartbeat is detected.

Remote Run

If this flag is set, the NET stations in a group with NET-ID 02 through 08 will follow the current operating mode of the NET station with NET-ID 1 (RUN or STOP).

Bus Delay

The bus delay defines the delay that a station on the NET will use when sending its data to other stations.

This bus delay must be adjusted in line with the number of stations and the values being transmitted. If it is too short, there will be data collisions and the Ethernet will be limited to transmitting NET communications exclusively.

The value range for the bus delay is 10 ms to 255 ms.

The following rule of thumb applies:

- Case A: When using PUT/GET and network markers:
  - Bus delay in ms = (number of NET stations - 1) * 4 * 2 + 6
- Case B: If only network markers are being used:
  - Bus delay in ms = (number of NET stations - 1) * 2 * 2 + 6

The following table can be used as a convenient guide for configuring the setting:

Number of modules:	Delay with put/get ms	Delay without put/get ms
2	14	10
3	22	14
4	30	18
5	38	22
6	46	26
7	54	30
8	62	34



If you are no longer able to connect to the NET stations via Ethernet with easySoft 7, set the bus delay as high as possible for your application. To do this, you will need to disconnect each device from the Ethernet and use easySoft 7 to change the bus delay point by point.

10. Diagnostics messages of the operating system

Diagnostic operands are used in order to obtain information regarding operating states in the program (this functionality can only be used when the base device is in RUN mode). If the described event has occurred, the operands will have a state of **1**.

Operand	Event
ID01	There are more than two devices in this NET group and the NET is active. The following NET station is not present: 1
ID02	There are more than two devices in this NET group and the NET is active. The following NET station is not present: 2
ID03	There are more than two devices in this NET group and the NET is active. The following NET station is not present: 3
ID04	There are more than two devices in this NET group and the NET is active. The following NET station is not present: 4
ID05	There are more than two devices in this NET group and the NET is active. The following NET station is not present: 5
ID06	There are more than two devices in this NET group and the NET is active. The following NET station is not present: 6
ID07	There are more than two devices in this NET group and the NET is active. The following NET station is not present: 7
ID08	There are more than two devices in this NET group and the NET is active. The following NET station is not present: 8
ID09	The DCF77 radio time signal has been enabled in the program. A radio signal is not being detected at the selected input.
ID10	This diagnostic bit is set if one of the following time synchronization operations could not be completed successfully: • "Synchronize clock via NET" • "SNTP synchronisation" • Date and time • DCF77 radio clock Using the SC function block will not result in this error message or in it being cleared.
ID11	If the device cannot communicate via Ethernet.
ID12	Arithmetic blocks have their own error output that is used to signal whether there is a numeric underflow/overflow, e.g., as a result of attempting to divide by zero. When using the ST programming language, this diagnostic operand will additionally be set if such an error occurs.
ID13	If the base device is being operated with one or more expansion devices, this diagnostic operand will indicate whether required devices are disconnected from the easyConnect bus or are not being detected, e.g., in the event of a power failure on an expansion device.
ID14	Transistor outputs in the base device are experiencing an overload or a short circuit; the outputs will be switched off and then checked again after 30 seconds.
ID15	–
ID16	–
ID17	–
ID18	–
ID19	There is an interrupt overload. One or more interrupt function blocks are being used, and the interrupt

Operand	Event
	function block sequence is overloading the easy4's controller. Not all interrupt function blocks can be run correctly.

Additional diagnostic messages for the expansion devices can be assigned to diagnostic operands ID25 through ID96 based on the relevant device characteristics.

Example Transistor outputs

Transistor outputs in EASY-E4-DC-8TE1, EASY-E4-DC-16TE1 expansion devices

When there is a short circuit or overload at an output, the DIAG diagnostic message can be applied to a diagnostic operand. This means that when the event occurs, the operands will assume a state of **1**.

Example Analog expansion device

Name on device	Event
DIAG	General diagnostic indicating that a diagnostic event is present
DIAG 1	Current input overloaded (current greater than 23 mA), excessive voltage
DIAG 2	Analog output overloaded, excessive current, load too small Open wire at at least one current input (I < 4 mA)
DIAG 3	The measuring range has been physically exceeded at an input
DIAG 4	The measuring range has been physically fallen below at an input, e.g., the current is < 4 mA for a measuring range of 4–20 mA.

10.1 Transistor outputs (overload / short circuit)

The base and expansion devices' transistor outputs are thermally protected against overloads and short circuits. If the temperature inside the four transistor modules is too high, the outputs will be switched off. If the temperature returns to the operating range and the outputs are driven, the transistors will switch back on.

The overload / short circuit fault scenario can be detected for the base device with operand ID14.

ID14 = **1**, error

Expansion devices feature a "DIAG" output that you can assign to operands ID25 through ID96 for each device.

Example

EASY-E4-DC-8TE1 DIAG equals ID25

EASY-E4-DC-16TE1 DIAG equals ID26

10.2 Diagnostics buffer

Only possible with easySoft 7.

During online operation, the diagnostic buffer will be shown in the Communication view. Additional information on this in the easySoft 7 Help

11. Connection to other devices

New easyE4 base devices will come with the Auto IP setting configured by default. In order to configure the settings differently on the EASY-E4-...-12...C1, use the menu structure and go to *System Options\Ethernet*

Table 88: Ethernet addresses on the device

Table 89: *Main menu*

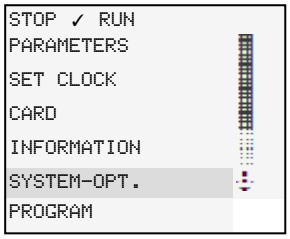


Table 90: *System options*

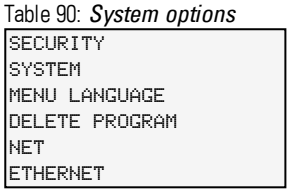


Table 91: *System options\Ethernet*

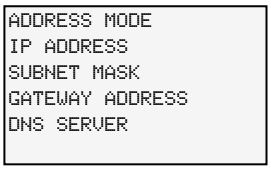
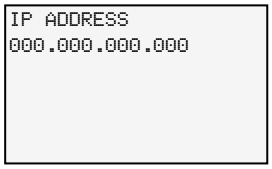
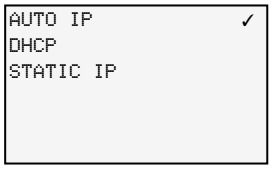


Table 92: *System Options\Ethernet\IP Address*



▶ Use the cursor buttons to enter the device's IP address.

Table 93: *System Options\Ethernet\Address mode*



▶ Select the network setting you want.

Prerequisites that must be met in order to be able to access an easyE4 control relays:

- The PC must have an Ethernet port that is free and has been configured
- The PC's Ethernet port must be configured for auto-IP.
- The easyE4 control relays must be connected to the PC with a standard Ethernet cable featuring an RJ45 connector

CAUTION
INTERFERENCES

The values specified in the technical data, as well as the device's electromagnetic compatibility (EMC), cannot be guaranteed if the following are used: unsuitable cables, improperly assembled and terminated cables, and/or wiring that does not conform to the applicable standards.
Only use cables assembled and terminated by professionals.
The cables being used must be assembled and terminated as required by the port/interface description in this document.
When wiring the devices, follow all instructions regarding how to wire the corresponding port/interface.
All general Directives and standards must be complied with.

11.1 Functions offline

Only possible with easySoft 7.

Offline mode should be used for the following tasks:

- Search...
  Searches for easyE4 control relays that are connected to the Ethernet → Section "Establishing a connection to the device", page 1
- Edit...
  All Ethernet connections found in the IP profiles pane
  can be edited, and you can add new ones as well.
- X
  Deletes the selected connection
- +
  Adds a connection that you can configure manually
  Select the connection you want and give it a name,
  e.g., Drill_42

Timeout times... Used to set the time within which a device should respond in order for an error message not to appear.

Establish a connection to the device

Only possible with easySoft 7.

Prerequisites that must be met in order to be able to access an easyE4 control relays:

- The PC must have an Ethernet port that is free and has been configured
- The PC's Ethernet port must be configured for auto-IP.

▶ Open easySoft 7 and click on the Communication button.

▶ Now expand the Connection section in order to show the corresponding buttons.

The software should have an offline connection status for the device

▶ Click the Search button.

A new dialog box with search options will appear.
(The search dialog box can be used for three different actions: Searching for devices with the New search button, configuring Ethernet and NET settings on devices with =>Device, and taking the Ethernet and NET configuration from an open project and assigning it to devices with <= Project)

▶ Use the drop-down menu at the top right to select your PC's interface (Ethernet)

▶ Select the "all" search filter option in the NET group drop-down menu and the "all" search filter option in the NET-ID drop-down menu (additional filter categories: 1 – 10 or none (0) for the NET group filter; NT1 – NT8 or none (0) for the NET-ID filter)

▶ Click on New search

Your PC interface will search for all reachable easyE4 control relays

Any devices that are found will be shown in the table together with the following:

First column: "?" = Inconsistent entries on the device; "!" = There are at least duplicated NET IDs; "x" = The device cannot be configured, since the "Enable configuration via network" option is disabled.

The MAC address (static)

Device type (static)

NET group (if any)

NET ID (if any)

IP address (as per the device's Ethernet settings)

Device name (if any)

State (RUN / STOP)

Required NET stations (if the device has a program and is being operated in a NET group or the devices already have the relevant NET settings configured)

- Select the row with the device to which you want to establish a connection
- Click on the "Save as IP profile" button (the IP address will appear under "Connection" / "Interface" and will be saved)
- Click on Close to close the dialog box
- Select the IP address in the Interface drop-down menu.
- Select the "Local" option in the Device drop-down menu
  (new devices will not have a program, and accordingly will not have a NET ID either)
- Click on the Online button

To terminate the online connection, click on the Offline button



If a device is locked with a password, the Password dialog box will appear so that you can unlock it. Simply enter the corresponding password and confirm it.

If the password is correct, the connection to the device will be established.

The following services and commands will become available:

Configuring Ethernet and NET settings without a program

- Search for device → Section "Establish a connection to the device", page 522
- Select the device you want from the list of devices found
- Use the fields underneath the list to configure all the parameters you want for the device
  (the system settings for Ethernet and NET; please refer to → Section "System settings", page 459)
- Click on the => Device button

Repeat these steps for every device that you want to configure

Project view

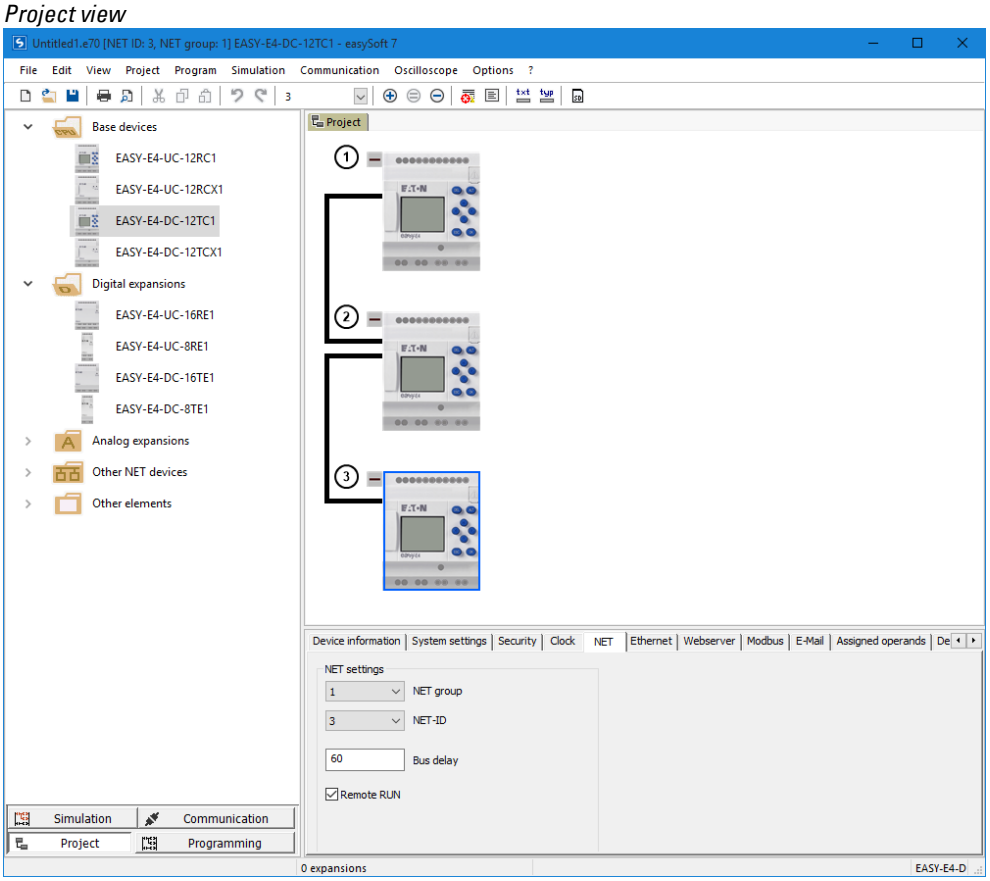


Figure 244: NET configuration without a program

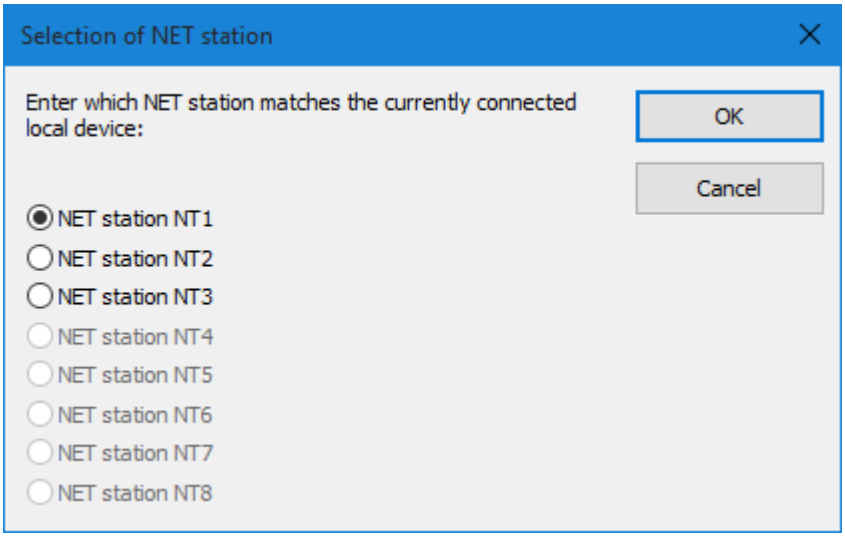


Figure 245: Selection of NET station

Configuring Ethernet and NET settings based on an opened project

- Search for device → Section "Establish a connection to the device", page 522
- Select the device you want from the list of devices found
- Click the <= Project button.
- A selection dialog box will appear. Select the NET station you want.
- Confirm your selection with OK.

Repeat these steps for every device that you want to configure

Program/Configuration

Program

The device must be connected online in order for you to be able to use the functions described below. With the following two exceptions, all the functions can be run with one single mouse click:

1.Configure – Card:

- Click the Card... button.
- If the device is in RUN mode, you will need to switch it to STOP mode (dialog box).
- The Card setup window appears.
- Release –
  Stops the card so that it can be removed from the device.
- Format
  Formats the card.
  Important: This will delete any easyE4 files found on the card!

2.NET…:

- ▶ Tap on the NET... button.
- ▶ Select the "all" search filter option in the NET group drop-down menu and the "all" search filter option in the NET-ID drop-down menu
- ▶ Click on New search
- ▶ A list with all the easyE4 devices connected via Ethernet will appear. This dialog box will have the exact same settings that it has when offline.

- ▶ Click on Program / Configuration

The following buttons will be enabled:

- PC => Device (if a program is open in easySoft 7)

Writes the program for the selected device in easySoft 7 to the device

- Device => PC

easySoft 7 will import the program from the device

- PC = Device? (if a program is open in easySoft 7)

The program on the device will be compared with the selected program in easySoft 7

- Delete device
  Deletes the program on the device
- RUN (if the device is in STOP mode)
  Starts RUN mode
- STOP (if the device is in RUN mode)
  Starts STOP mode
- In addition, the toolbar has the ▶ (RUN) and ■ (STOP) buttons

Configure

- Card... (used to configure an inserted microSD memory card)
- Click the Card... button.
- If the device is in RUN mode, you will need to switch it to STOP mode (dialog box).
- The Card setup window appears.
- Release – Stops the card so that it can be removed from the device.
- Format – Formats the card.
  Important: This will delete any easyE4 files found on the card!

Program files

- Table program files – All the easy programs found on the card will be listed in the table.
- PC => Card – Writes a program selected in the project in easySoft 7 to the card.
- Device => Card – Writes a program found on the device to the card.
- Card => PC – Imports a selected program on the card into an easySoft project.
- Card => Device – Writes a selected program from the list to the device.

- Delete – Deletes a selected program in the list from the card.
- Start program selection box – Used to define the starting program. A starting program is the program on the memory card that the device (regardless of whether there is a program available or not) will automatically load the next time it is switched on and the card is inserted. Please note that any programs already on the device will be overwritten. Select the starting program you want from the list of programs and then select the "Start program" option in order to set it as the starting program.

Data logger records

Card => PC Saves the selected log file as a CSV file on the PC. After doing so, you will be able to read and process the file with Excel or a similar program.

Example

Counter	Date	Time	Time (ms)	DL01T-1	DL01T-2	DL01T-3	DL01T-4	DL01I-1	DL01I-2	DL01I-3	DL01I-4
0	2018-04-12	16:14:42	370	1	0	0	0	3	0	0	0
1	2018-04-12	16:14:50	634	1	0	0	0	3789	0	0	0

Restart – Clicking on this button will create a new directory, on the memory card, for a new data logger file. The new log file will immediately be located in this folder on the memory card.

Delete – Deletes the selected log file from the memory card.

Delete all – Deletes all log files on the drive.

- NET.. (used to search for all NET devices found on the Ethernet network)
- Tap on the NET... button.
- Select the "all" search filter option in the NET group drop-down menu and the "all" search filter option in the NET-ID drop-down menu
- Click on New search
- A list with all the easyE4 devices connected via Ethernet will appear. This dialog box will have the exact same settings that it has when offline.

ACTUAL configuration

- Device => PC
- Imports the device configurations (base and expansion devices, as well as NET settings) found after all the devices are switched on.

NOTICE
Make sure that all the devices you want are on and communicating with the base device so that they will be detected. Otherwise, you will not be able to import the actual configuration you want into your easySoft project.

System settings

All system settings can be configured on devices with a display, as well as in the System settings tab in the Project view.

The language device setting can be accessed with easySoft 7 for any device.

See also

→ Section " Changing the menu language", page 79
→ Section "System settings", page 459

Clock

You can use these settings to set the device date and time. All other settings are system settings that can be configured under Clock in the project and transferred with the program (please refer to the System settings section as well).

To set the date and time, click inside the corresponding field and use your keyboard to enter it. You can also use the ˅ calendar display to select the date you want. Moreover, you can also use the ▲▼ arrow buttons and the hours, minutes, seconds selection to set the time you want.

You can test system settings such as the display format, radio clock, and daylight saving time in real-time online. As soon as you change a setting, simply click on the => Device button to write it to the device.

Display

11.1.1 Circuit diagram window in communication view

The window shows you:

The online status display shows the state of the rungs / blocks / function blocks in the circuit diagram, including the connected operands in a network.

In addition, you can use the oscilloscope function to plot and analyze the response of the operands you select (please refer to the Oscilloscope section).

The following buttons are found in the toolbar:

▶ Status Display On and ■ Status Display Off buttons

Wiring test (only in STOP mode)

Group diagnostics (shows all diagnostic alarms)

Oscilloscope (hides and shows the oscilloscope)

Oscilloscope recording on

Oscilloscope recording off

▶ To view the current states for operands, click on the Status Display On button and select the network / rung you want.

To stop the display, simply click on Status Display Off.

Online status display

The device must be in RUN mode

You can use the online status display to check the energized connections in a program. This is displayed in the same way as in Simulation mode.

The description for the offline status display in the Simulation view is otherwise the same for the online status display.



Please make sure that no program changes are made directly on the device while the online status display for the circuit diagram is enabled. For example, if an operator switches the device to stop mode, adds a contact or coil for a function block that has not yet been added, and then starts the device back up, the programming software will not be able to detect this. After this type of misuse, you will need to stop and restart the status display.

Online constant changes



WARNING

With the connection Online the functions Online Forcing of markers, marker bytes, marker words or marker double words and Online Constants, Modification at standard function block inputs act directly on the device. Depending on your program, this may cause uncontrolled switching states during commissioning in the machine or system concerned. Serious damage may occur.

Constants that you have assigned to the input of a function relay or function block can be changed permanently in the Online display. The new value is transferred automatically to the corresponding device.



If you want to permanently apply a modified constant value to the program and save it on the PC, you will need to change the value in the circuit diagram view (offline state) or have the program be uploaded from the device.

Display

You can use the display functions to carry out the following work online:

- Display + buttons
  Shows the device display (including for devices without a physical display) and

makes it possible to control the device with software buttons like the ones that would be found on the physical device.

- Device information
  You must be in the Configuration tab, seeing the devices.
  Select the device you want (click on one of the devices displayed)
  The corresponding device information will be displayed in real time. Depending on the specific tab you select, you will be able to view current real-time information such as:
  - Device information
  - Diagnostic alarms
  - Diagnostic buffer (what was stored during the current online easySoft session in terms of diagnostic messages)
  - HW (device hardware information)
  - Device features (operands, function blocks)
- I Digital input (digital input states)
- Q Digital output (digital output states)
- IA Analog input (analog input states)
- QA Analog output (analog output states)
- M Marker (marker bit states)
- MB Byte marker (marker byte states)
- MW Word marker (marker word states)
- MD Double word marker (marker double word states)
- ↔ Assigned operands (if there is a program on the device; which operands have been mapped to the various devices' inputs/outputs)
- Operand window + oscilloscope (same as described for the Simulation view, but online with the connected device)

Status display

There are various functions available for the status display.

11.1.2 Status display on

The base device must be connected to easySoft ONLINE and be in RUN mode.

▶ Either click on the Status display on option in the Communication menu or click on the Status Display On button in the toolbar.

The program's first network will be displayed. A red line stands for "1", while a black line stands for "0".

▶ Select the program network that you want to monitor.

To exit the status display, click on Status display off

11.1.3 Wiring test

The base device must be connected to easySoft online and be in STOP mode.

The status display must be on.

- Either click on the Wiring test on/off option in the Communication menu or click on the Wiring test button in the toolbar.
- Select the device for which you want to run the wiring test (base device or expansion device)

The input states will be displayed and, for each output, there will be a switch that you can use to switch the output on and off.



WARNING! AUTOMATIC STARTUP!

If you are running a wiring test with the outputs, make sure that this does not result in the system or machine assuming a dangerous state.
Do not, under any circumstance, leave your programming device without first turning off the wiring test.
Use the wiring test only if you are sure that you will always know what the response will be when switching outputs on and that this will not endanger any people or property.
Do NOT use the wiring test with outputs remotely through a network.
Make absolutely sure than your actions do not put people or property at risk.

- Either click on the Wiring test on/off option in the Communication menu or click on the Wiring test button in the toolbar to turn the test off.

All outputs are switched off.

Terminating communications with the base device will also switch off all outputs.

- Make sure that the wiring test is off and that all outputs have a state of "OFF."

11.1.4 Group diagnostic alarms

- Either click on the Group diagnostics option in the Communication menu or click on the Group diagnostics button in the toolbar.

You will get a log message containing all the diagnostic alarms in the device.

11.2 Establishing an Ethernet connection

In order to make it easier to access the easyE4 base device, you can establish an Ethernet connection.

Physical connection

Ethernet uses point-to-point connections, meaning that whenever more than two devices are connected, there needs to be a switch with a port for each device. It is recommended to use appropriate industrial switches that have been developed for use in industrial environments. You can use any standard switch and Ethernet cable with RJ45 connectors.
You can also use an Ethernet connection to program the individual devices.

See also

→ Section "Connecting the Ethernet cable", page 65
→ Section "Establish Ethernet connection", page 119

Prerequisites that must be met in order to be able to access an easyE4 control relays:

- The PC must have an Ethernet port that is free and has been configured
- The PC's Ethernet port must be configured for auto-IP.
- The easyE4 control relays must be connected to the PC with a standard Ethernet cable featuring an RJ45 connector
- An Ethernet address must have been assigned to the easyE4 device

▶ Write down the IP address for the easyE4 device. To find this address, open the *INFORMATION\ACTUAL CONFIG* menu on the device and scroll to the IP ADDRESS option.

▶ Open the Communication view in the easySoft 7 programming software.

Searching for the device

Communication\Connection view

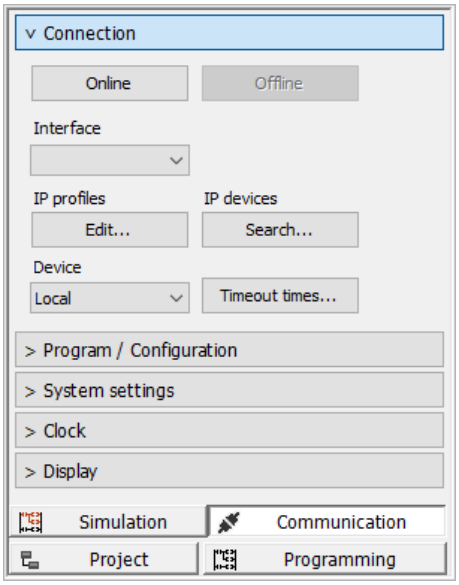


Figure 246: Establish Ethernet connection

- Click on Connection/IP profiles/Search... to open the Search for devices dialog box.
- Start a New search.

Search for devices dialog box

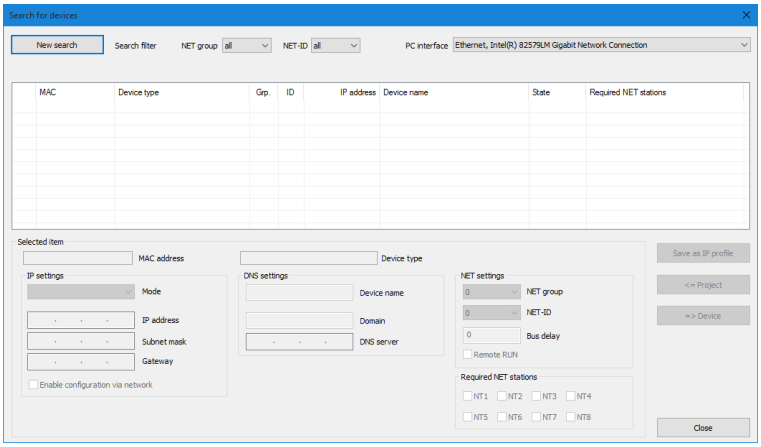


Figure 247: Search for devices with an IP address

If there is an Ethernet connection, the easyE4 base device will be found and listed in the table with the corresponding parameters.

Click on the Save as IP profile button to save the IP profile for the found easyE4 base device.

Search for devices dialog box

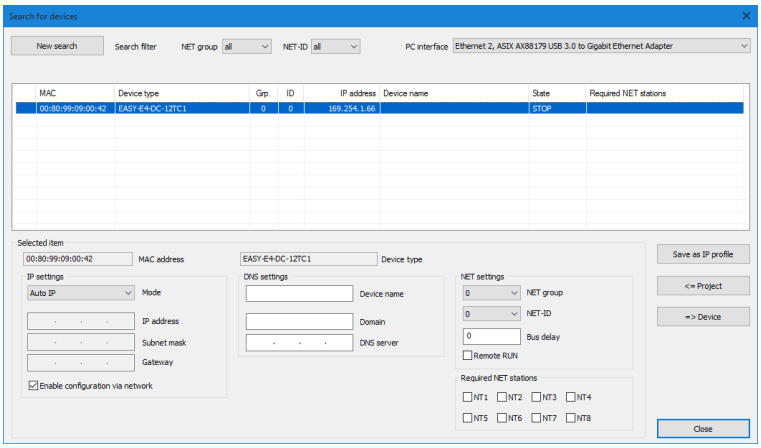


Figure 248: Saving the found device's IP profile

A message saying that the IP address of the easyE4 device has been created as a new profile will appear.

▶ Close the Search for devices dialog box.

The easyE4 device's IP address will be found under Interface.

If a connection has already been established to multiple easyE4 devices, there will be more options available. In this case, select the IP address of the easyE4 device you want under Interface.

Communication\Connection view

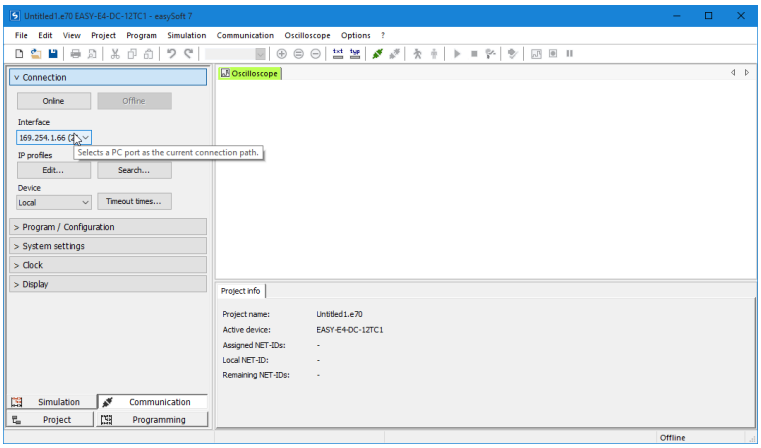


Figure 249: Selecting the easyE4 device's IP address

▶ Click on the Online button to establish a connection between your PC and the easyE4 device.

→ If the easyE4 device is protected with a password, a corresponding prompt will appear and ask you to enter the password before you can access the device.

If the password is correct, the connection to the device will be established.

Communication\Connection view

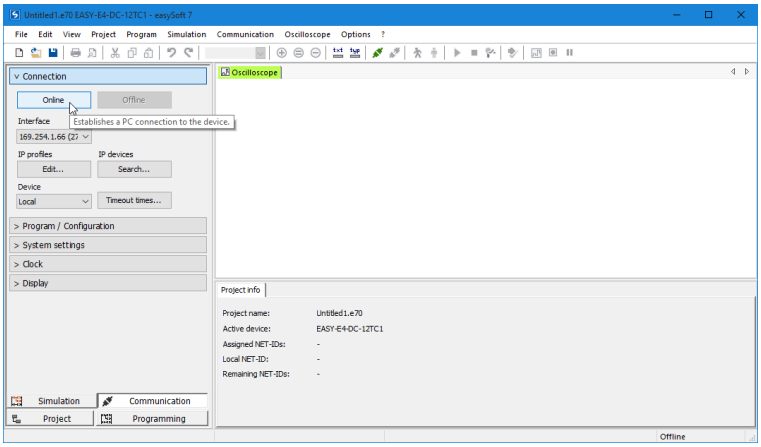


Figure 250: Establish PC connection to easyE4 device

As soon as the connection is established, the easyE4 device will appear in the work pane

Communication\Connection view

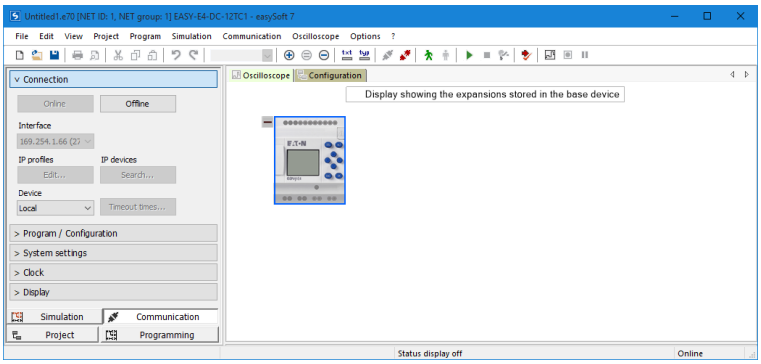


Figure 251: Connection to easyE4 device established

- Transfer your .e70 program by clicking on the PC => Device button in the Program / Configuration section.

Communication\Connection view

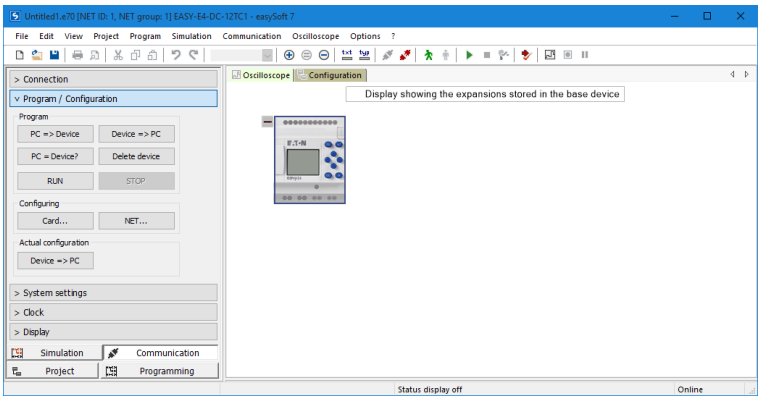


Figure 252: Transferring the current program to the easyE4 device

For additional help working with easySoft 7, read the various help topics in the easySoft 7 Help. To access it, press the F1 key on your keyboard.

11.3 Setting up a NET

NET - a group

A NET is a group that is made up of up to eight stations and that uses a special protocol for the device series in order to allow for communications via Ethernet connections.

The name "NET" refers to Ethernet/UDP-based communications between the easyE4 devices. It was designed specifically with the needs of straightforward transfers between easyE4 devices in mind. Within a NET, every device has read access to the NET operands of any other device in its group. In addition to this, data can be transferred both cyclically and acyclically.

Please note that nodes from different groups cannot communicate directly with each other.

Between groups

If, however, you want devices to be able to communicate across groups, you will need to use a coordinator device that controls the corresponding communication with Modbus TCP.

A total of ten NET groups (groups 1 through 10) can be run on a single Ethernet network at one time.

Ethernet network						
↑	↑	↑	↑	↑	↑	↑
Module	Module	Module	Stations…	Module	Module	Module
NET-ID 1	NET-ID…	NET-ID 8	NET-ID…	NET-ID 1	NET-ID…	NET-ID 8
NET group 1			NET group…	NET group 10		

NET uses UDP protocols that send unconfirmed broadcast frames; accordingly, the devices in the NET group must be located on the same subnet. Connections through a router are not allowed, as broadcast frames will normally be unable to pass through a router.

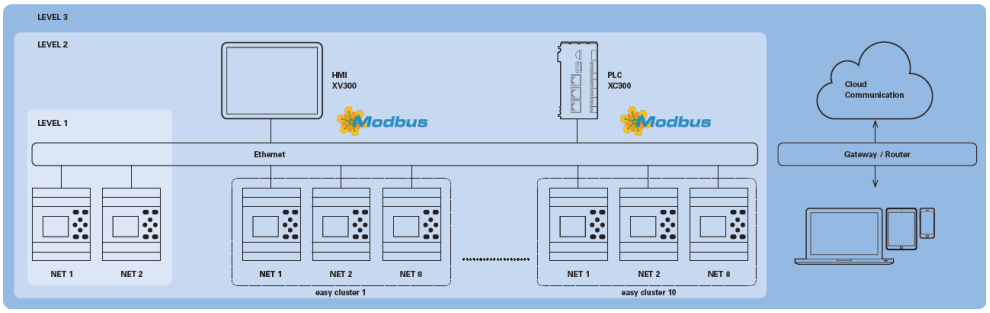


Figure 253: NET diagram

All easyE4 base devices feature an Ethernet port that can be simultaneously used for all communications, e.g., web server, Modbus TCP, e-mail, and programming the easyE4.

In order to be able to run a NET group, there must be an Ethernet connection between the devices or device and PC.

11.3.1 Access on the NET

There can be a max. of 8 easyE4 devices in a single NET group.

Access is based on various NET operands and function blocks.

1. Network markers (N, NB, NW, ND) (cyclical access)
   Every single device in the group is allowed read access to the network markers of the other devices in the group. In addition, each device has write and read access to its own network markers. This makes it possible for each device to provide up to 512 bits of data to the other stations in the group.
2. RN and SN bit markers (cyclical access)
   The RN and SN operands make it possible to directly access the state of the operands of another device on the NET. These operands are used to send and receive Boolean values. Each station in the group has 32 RN (Receive NET) and 32 SN (Sent NET) bit markers available.
3. Transmitting double words with function blocks (acyclical access)
   Each easyE4 device in the group has 32 PUT (PT) manufacturer function blocks and 32 GET (GT) function blocks available for sending and receiving analog values in an event-driven manner.
4. NET synchronization
   The device blocks in the NET group can be synchronized – please refer to
   → Section "Time and Date setting", page 482

Compatibility with easyNET

The easyNET devices in the easy800 series use their own custom CAN-specific transmission. Accordingly, devices from the easy800 and easyE4 series cannot be physically connected to each other.

Existing .e60 programs can be migrated to .e70 programs for the easyE4 series. When you do this, the easy800, devices that are used with the Remote I/O operating mode will be converted to local expansions.

11.3.2 Communication via NET

A NET group can be made up of up to eight easyE4 base devices.
Within the group, the easyE4 base devices can communicate with each other.

If, however, you want devices to be able to communicate across groups, you will need to use a coordinator device that controls the corresponding communication with Modbus TCP.

A total of ten NET groups (groups 1 through 10) can be run on a single Ethernet network at one time. This is the equivalent of a maximum of 80 easyE4 base devices that can communicate with each other.

The following list shows the operands that can be used within a group by every device:

- (n = NET-ID 1 .. 8)
- n SN 01 - 32 [Bit]
- n RN 01 - 32 [Bit]
- PT 01 - 32 (PUT) [double word]
- GT 01 – 32 (GET) double word]
- n N 01 - 512[Bit]
- n NB 01 - 64 [Byte]
- n NW 01 - 32 [Byte]
- n ND 01 - 16 [double word]
- Synchronize clock (settings)

Examples

Station 1 sending a bit to station 2

NET-ID1		NET-ID 2
2 SN 15	→	1 RN 015

Station 3 sending a double word to station 8 via PT16

NET-ID1		NET-ID 2
pt16	→	GT 01 Parameter NET-ID 1 PT 16

Station 4 sending a network marker [bit and word] to all stations.

NET-ID4		NET-ID 2	NET-ID 5	NET-ID 7
N 125	→	4 N 125	4 N 125	4 N 125
NW30	→	4 NW 30	4 NW 30	4 NW 30

This basic principle applies to all network markers in all data formats



Network markers overlap in the various data formats

N1-8	N9-16	N17-24	N25-32	N33-40	N41-48	N49-56	N57-64
NB1	NB2	NB3	NB4	NB5	NB6	NB7	NB8
NW1		NW2		NW3		NW4	
ND1				ND2			
N65-72	N73-80	N81-88	N89-96	N97-104	N105-112	N113-120	N121-128
NB9	NB10	NB11	NB12	NB13	NB14	NB15	NB16
NW5		NW6		NW7		NW8	
ND3				ND4			

etc.

NET station heartbeat

In order to make it possible for all NET stations within a group to be able to know whether NET stations important to them are still communicating, each station cyclically sends a heartbeat every second (1 s).
If a heartbeat is not received, the corresponding error bit ID01 – 08 will be set to "1" until a heartbeat is detected.

11.3.3 NET settings

Prerequisites
The Ethernet settings must have already been configured.
In offline mode, setting up the configuration in easySoft 7 under the Ethernet tab is enough, → Section "Establishing an Ethernet connection", page 532

A NET ID needs to be assigned to every easyE4 base device and to every station added to the project as an other NET station.

Project view

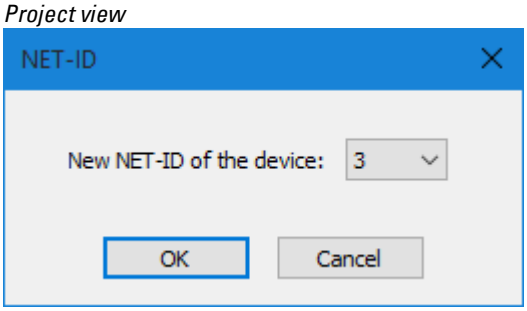


Figure 254: NET-ID dialog box used to assign a NET ID when adding a new base device

→ After you add a new station to the project, you will need to download all easyE4 programs for the NET group again.

Loading programs onto multiple NET stations

To conveniently load programs for multiple stations on the NET with a single operation, follow the steps below:

Prerequisites
- All the devices must be in the group physically.
- Every single device must have an assigned NET ID.

▶ If the project that is open features multiple NET stations, establish online communications with the NET-ID1 NET station.
▶ Make sure that <Device NT1> is selected instead of the usual <local> in the Communication view/Connection section/Device drop-down menu.
▶ Click on the PC -> Device button.

The Selection of NET stations dialog box will appear.

- Enable all the NET stations for which you want the new program to be loaded.
- Confirm your selection with OK.

The programs for all the selected NET stations will be loaded onto the devices.



Project view

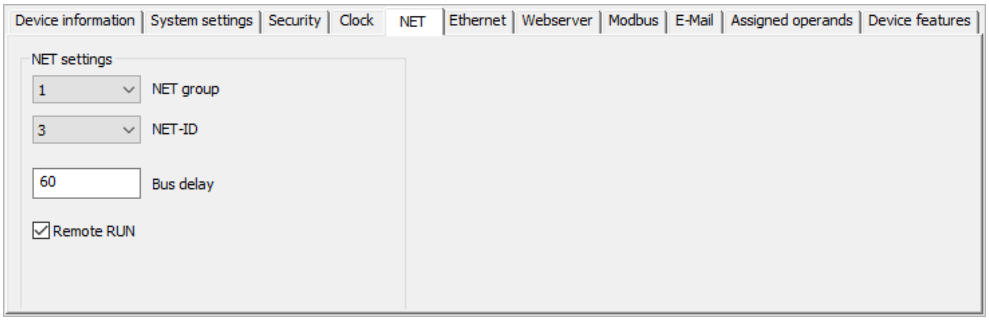


Figure 255: NET tab for the selected base device in the NET group

NET group

Used to select the group for the selected base device.

0	Base device running in standalone mode with the relevant I/O expansions (if any), no NET group
1-10	Available NET group numbers

NET-ID

Used to assign a group device number to the selected base device.

0	Base device running in standalone mode with the relevant I/O expansions (if any)
1-8	Available device IDs in the NET group

Remote RUN

If this field is enabled, the NET stations of a group with NET-IDs 02 through 08 will take their current RUN or STOP operating mode from the NET station with NET-ID 1.

Bus delay

The bus delay is used to define the time after which a station on the NET will send its data to other stations.

This bus delay needs to be adjusted as appropriate for the number of stations and the values being transmitted. Please note than an excessively short bus delay will result in data collisions.

The permissible value range for the bus delay is 10 ms to 255 ms.

Cyclical data will be sent every 10 ms or when there is a data change, but not before the bus delay has elapsed. Using the default value of 60 ms will normally be sufficient to prevent transmission overloads.

You can use the following formula:

- Case A: When using PUT/GET and network markers:
  Bus delay in ms = (number of NET stations - 1) * 4 * 2 + 6
- Case B: When using network markers exclusively:
  Bus delay in ms = (number of NET stations - 1) * 2 * 2 + 6

The following table can be used as a convenient guide for configuring the setting:

Number of modules:	Delay with PUT/GET in ms	Delay without PUT/GET in ms
2	14	10
3	22	14
4	30	18
5	38	22
6	46	26
7	54	30
8	62	34



If you are no longer able to connect to the NET stations via Ethernet with easySoft 7, set the bus delay as high as possible for your application.
To do this, you will need to disconnect each device from the Ethernet and use easySoft 7 to change the bus delay point by point.

See also

→ Section "GT - Get values from NET", page 339
→ Section "PT - Put values to NET", page 342
→ Section "SC - Synchronizing clock via NET", page 346
→ Section "Establishing an Ethernet connection", page 532
easySoft 7 Help

11.4 Modbus TCP

Only possible with easySoft 7.

11.4.1 General

Modbus TCP is a simple communication protocol that uses a client-server architecture in order to make it possible for measuring and control systems (server) to communicate with higher-level control systems (client) and vice versa. Since the protocol is based on TCP/IP and Ethernet, any device that supports the Internet protocol suite and features an Ethernet port can implement it.

During communications, data is written as a payload in TCP/IP packets and transmitted this way.

Please note that the easyE4 will only assume the functionality of a lower-level Modbus TCP server, and not the higher-level client functionality.

Modbus TCP ensures communications with devices:

- That do not necessarily have to be part of the easyE4 family of products
- That are not found in a NET group
  or
- That do not implement NET

The most important functions include, but are not limited to:

- Communications at the control level
- Transmitting analog and digital values to higher-level control systems
- Platform-independent communication
- Communication with devices that are not part of the easyE4 series

11.4.2 Programming communication with Modbus TCP

In order to program these communications, you will need at least one system that fulfills the functionality of a Modbus TCP client and that is able to send commands to the lower-level server.

Since the easyE4 control relays can work with various Modbus TCP clients available on the market, only standard-compliant Modbus TCP functions are supported.
In other words, functions that are defined in a standardized manner in the Modbus standard and are accordingly implemented at the protocol level in a standardized manner by all Modbus TCP stations. For more information, please refer to the MODBUS MESSAGING ON TCP/IP IMPLEMENTATION GUIDE V1.0b published by the Modbus Organization.

Connection:

In order for the Modbus TCP server to work, the following ports must be opened:

- Modbus TCP: Service—Port 502

Port 502 is normally set by default. If it is not, make sure to set it when establishing a connection.

Ports that may need to be opened depending on the functionality being used:

- DNS: UDP/TCP port 53 (only if using DNS)
- DHCP: UDP port 67 for server / UDP Port 68 for clients (only if using DHCP)

The Modbus TCP server implementation on the easyE4 will provide the following standard functions:

Function description		Function Code
Read Coils	Used to read outputs	0x01
Read Discrete Inputs	Used to read inputs	0x02
Read Holding Registers	Used to read output registers	0x03
Read Input Registers	Used to read input registers	0x04
Write Single Registers	Used to write to a register	0x06
Write Multiple Registers	Used to write to multiple registers	0x10

There are two basic protocol data units (PDUs) for each of the function descriptions above:

1. Request PDU (the Modbus TCP server must receive this PDU)
   a. Byte 0 contains the function code, which is used to identify the function that is desired
   b. The remaining bytes are function-specific
2. Response PDU (the Modbus TCP server must send this PDU)

a. Byte 0 contains the request's function code
b. The remaining bytes are function-specific

If an error occurs, the Modbus TCP server will send an error message

- Error-Frame
  a. Byte 0 always contains the request's error code (0x80 + function code)
  b. Byte 1 contains the exception code (error-specific)

Following is a description of the request & response function codes for each of the function descriptions in the table above:

11.4.2.1 Read Coils 0x01:

This function reads the entered number of bit outputs starting from a specified starting address and then returns the result in bytes (8 outputs per byte)

Table 94: Request-PDU

Function Code	1 byte	0x01 ;Read Coils
Start address	2 byte	Must always be 1 less than the starting output you want (zero-based)
Number of outputs	2 byte	1 to 2000 (0x7D0)

Response to the request being received

1. The starting address is analyzed (distributed among bytes 1 and 2)
   a. Byte 1 = Hi; Byte 2 = Lo
2. The number of outputs is analyzed (distributed among bytes 3 and 4)
   a. Byte 3 = Hi; Byte 4 = Lo
3. The output states are read
   a. From the start of the (starting address) to (starting address + number of outputs)

Table 95: Response-PDU

Function Code	1 byte	0x01 ;Read Coils
Bye Count	1 byte	N
Output values	n * 1 byte	value

n= Number of outputs read / 8

Preparation for sending the response

1. The read bits are encoded in bytes

(1 but per output state; 1=ON, 0=OFF)

2. The LSB of the first byte, i.e., bit 0, contains the state of the output that is addressed first in the request. The other outputs follow in ascending order.

3. If a byte is not used fully, the unused bits will be padded with 0's.

Once the response is encoded, it is sent.

11.4.2.2 Read Discrete Inputs 0x02:

This function reads a specified number of bit inputs starting from a specified starting address and then returns the result in bytes (8 inputs per byte)

Table 96: Request-PDU

Function Code	1 byte	0x02 ;Read Discrete Inputs
Start address	2 byte	Must always be 1 less than the starting input you want (zero-based)
Number of outputs	2 byte	1 to 2000 (0x7D0)

Response to the request being received

1. The starting address is analyzed (distributed among bytes 1 and 2)
   a. Byte 1 = Hi; Byte 2 = Lo
2. The number of inputs is analyzed (distributed among bytes 3 and 4)
   a. Byte 3 = Hi; Byte 4 = Lo
3. The bit input states are read
   a. From the start of the (starting address) to (starting address + number of bit inputs)

Table 97: Response-PDU

Function Code	1 byte	0x02 ;Read Discrete Inputs
Bye Count	1 byte	N
Output values	n* 1 Byte	value

n= Number of inputs read / 8

Preparation for sending the response

1. The read bits are encoded in bytes
   Bit per input state; 1=ON, 0=OFF)
2. The LSB of the first byte, i.e., bit 0, contains the state of the input that is addressed first in the request. The other inputs follow in ascending order.
3. If a byte is not used fully, the unused bits will be padded with 0's.

Once the response is encoded, it is sent.

11.4.2.3 Read Holding Registers 0x03:

Function 0x03 reads internal registers (e.g., marker words in the easyE4) word by word.

Table 98: Request-PDU

Function Code	1 byte	0x03 ;Read Holding Registers
Start address	2 byte	Must always be 1 less than the starting input you want (zero-based)
Number of registers	2 byte	1 to 125 (0x7D)

Response to the request being received

1. The starting address is analyzed (distributed among bytes 1 and 2)
   a. Byte 1 = Hi; Byte 2 = Lo
2. The number of registers is analyzed (distributed among bytes 3 and 4)
   a. Byte 3 = Hi; Byte 4 = Lo
3. The data words are read from the start of the (starting address) to (starting address + number of registers)
   A register corresponds, e.g., to one marker word

Table 99: Response-PDU

Function Code	1 byte	0x03 ;Read Holding Registers
Bye Count	1 byte	A value of = 2 * n must always be entered here
Register values	n* 2 byte	value

n= Number of registers read

Preparation for sending the response

1. The registers read (marker words) are mapped to two bytes per register
2. There are a high byte and a low byte for each register (marker word)

Example

- Register word Hi0x02
- Register word Lo0x2B
- Content of marker word 0x022B

3. The LSB within the byte is bit 0

Once the response is encoded, it is sent.

11.4.2.4 Read Input Registers 0x04:

Function 0x04 reads the analog inputs' registers word by word.

The Modbus client treats two bytes as one input register.

This means that in order to read an analog input with 32 bits, two consecutive input registers must be read.

Table 100: Request-PDU

Function Code	1 byte	0x04 ;Read Input Registers
Start address	2 byte	Must always be 1 less than the starting input you want (zero-based)
Number of input registers	2 byte	1 to 125 (0x7D)

Response to the request being received

1. The starting address is analyzed (distributed among bytes 1 and 2)
   b. Byte 1 = Hi; Byte 2 = Lo
2. The number of registers is analyzed (distributed among bytes 3 and 4)
   b. Byte 3 = Hi; Byte 4 = Lo
3. The input registers are read from the start of the (starting address) to (starting address + number of input registers)
   (An input register corresponds to two bytes)

Table 101: Response-PDU

Function Code	1 byte	0x04 ;Read Input Registers
Bye Count	1 byte	A value of = 2 * N must always be entered here
Register values	n* 2 byte	value

n= Number of input registers read

Preparation for sending the response

1. The input registers read are mapped to two bytes per input register
2. There are a high byte and a low byte for each input register
   a. The first byte = Hi; the second byte = Lo
   b. Example:
      - Register word Hi0x00
      - Register word Lo0x0A
      - Content of marker word 0x000A
3. The LSB within the byte is bit 0

Once the response is encoded, it is sent.

11.4.2.5 Write Single Registers 0x06:

This function writes 16 bites to a register ((NET) marker word in the easy)

Table 102: Request-PDU

Function Code	1 byte	0x06 ;Write single Registers
Target address	2 byte	Must always be 1 less than the MW being written to (if you want MW1 to be written to, there must be a 0 here)
Register value	2 byte	Value to be written

Response to the request being received

1. The target address is analyzed (distributed among bytes 1 and 2)
   a. Byte 1 = Hi; Byte 2 = Lo
2. The value being written is analyzed (distributed among bytes 3 and 4)
   a. Byte 3 = Hi; Byte 4 = Lo
3. The value is written to the target register ((NET) marker word)

Response-PDU

If the value is written successfully, the request will be echoed once as a response (→ Section "Write Single Registers 0x06:", page 550 Request PDU)

In other words, the response is identical to the corresponding request and is used for confirmation purposes only.

11.4.2.6 Write Multiple Registers 0x10:

This function writes n * 16 bits to N registers ((NET) marker words in the easyE4)

Table 103: Request-PDU

Function Code	1 byte	0x10 ;Write Multiple Registers
Start address	2 byte	Must always be 1 less than the starting marker word (if you want MW1 to be written to, there must be a 0 here)
Number of registers	2 byte	1-123 (0x0001 to 0x007B)
Bye Count	1 byte	2 * N
Register values being written (marker words)	n * 2 byte	Values being written

n = Number of registers being written to

Response to the request being received

1. The starting address is analyzed (distributed among bytes 1 and 2)
   a. Byte 1 = Hi; Byte 2 = Lo
2. The number of registers is analyzed (distributed among bytes 3 and 4)
   a. Byte 3 = Hi; Byte 4 = Lo
3. The number of bytes is analyzed
4. The marker words are written to the target registers

If the values are written successfully, a response is sent.

This response will contain the function code, the starting address, and the number of registers from the request
(→ Section "Write Multiple Registers 0x10:", page 551 Request PDU)

Table 104: Response-PDU

Function Code	1 byte	0x10 ;Write Multiple Registers

Start address	2 byte	Same value as in request
Number of registers	2 byte	Number of registers written to (the value should match the request)

11.4.3 Modbus TCP error handling

Read Coils 0x01:

In the event of an error, Modbus TCP will send an error frame.

Fault Code	1 byte	0x81 ; Read Coils
Exception Code	1 byte	02 or 03 or 04

Exception Code 02 = Invalid address, i.e.:

- 0 (the user keeps specifying addresses as one-based addresses)
- Undefined* (please refer to the "Modbus map" table) or
- Un-enabled*

Exception Code 03 = The number of outputs is not >= 0x0001 and <= 0x07D0

Exception Code 04 = (Error in server) n.a.**

*For an error message, it is sufficient if only one of the requested addresses is not unlocked or is invalid.

**Data in the image table is protected from other modules by semaphores; as of this writing, no known criterion for a "read coil" error in the server.

Read Discrete Inputs 0x02:

In the event of an error, Modbus TCP will send an error frame.

Fault Code	1 byte	0x82 ; Read Discrete Input
Exception Code	1 byte	02 or 03 or 04

Exception Code 02 = Starting address is invalid, i.e.:

- 0 (the user keeps specifying addresses as one-based addresses)
- Undefined* (please refer to the "Modbus map" table) or
- Un-enabled*

Exception Code 03 = The number of inputs is not >= 0x0001 and <= 0x07D0

Exception Code 04 = (Error in server) n.a.**

*For an error message, it is sufficient if only one of the requested addresses is not unlocked or is invalid.

**A read operation always returns consistent data from the image table, since this data is protected from other modules by semaphores. In other words, as of this writing, there is no known criterion for a "read discrete inputs" error in the server.

Read Holding Registers 0x03:

In the event of an error, Modbus TCP will send an error frame.

Fault Code	1 byte	0x83 ; Read Holding Registers
Exception Code	1 byte	02 or 03 or 04

Exception Code 02 = Starting address is invalid, i.e.:

- 0 (the user keeps specifying addresses as one-based addresses)
- Undefined* (please refer to the "Modbus map" table) or
- Un-enabled*

Exception Code 03 = The number of inputs is not >= 0x0001 and <= 0x07D0

Exception Code 04 = (Error in server) n.a.**

If no analog I/O is physically present (e.g., analog I/O smart modules missing or faulty), the image table (values = 0) will still be delivered to the client. No check, no error message.

*For an error message, it is sufficient if only one of the requested addresses is not unlocked or is invalid.

**A read operation always returns consistent data from the image table, since this data is protected from other modules by semaphores. In other words, as of this writing, there is no known criterion for a "read holding registers" error in the server.

Read Input Registers 0x04:

In the event of an error, Modbus TCP will send an error frame.

Fault Code	1 byte	0x84 ; Read Input Registers
Exception Code	1 byte	02 or 03 or 04

Exception Code 02 = Starting address is invalid, i.e.:

- 0 (the user keeps specifying addresses as one-based addresses)
- Undefined* (please refer to the "Modbus map" table) or
- Un-enabled*

Exception Code 03 = The number of inputs is not >= 0x0001 and <= 0x07D0

Exception Code 04 = (Error in server) n.a.**

If no analog I/O is physically present (e.g., analog I/O smart modules missing or faulty), the image table (values = 0) will still be delivered to the client. No check, no error message.

*For an error message, it is sufficient if only one of the requested addresses is not unlocked or is invalid.

**A read operation always returns consistent data from the image table, since this data is protected from other modules by semaphores. In other words, as of this writing, there is no known criterion for a "read input registers" error in the server.

Write Single Register 0x06:

In the event of an error, Modbus TCP will send an error frame.

Fault Code	1 byte	0x90 ;Write Single Register
Exception Code	1 byte	02 or 03 or 04

Exception Code 02 = Target address is invalid, i.e.,

- 0 (the user keeps specifying addresses as one-based addresses)
- Undefined* (please refer to table → Section "Modbus map", page 557) or
- Un-enabled*

*For an error message, it is sufficient if only one of the requested addresses is not unlocked or is invalid.

Exception Code 04 = Error when attempting to write to the register (marker word)**

**A write operation can always write consistent data to the image table, since this data is protected from other modules by semaphores. In other words, as of this writing, there is no known criterion for a "Write Single Register" error in the server.

Values are only allowed to be written if all required addresses are valid and unlocked.

Write Multiple Registers 0x10:

In the event of an error, Modbus TCP will send an error frame.

Fault Code	1 byte	0x86 ;Write Multiple Registers
Exception Code	1 byte	02 or 03 or 04

Exception Code 02 = Target address is invalid, i.e.,

- 0 (the user keeps specifying addresses as one-based addresses)
- Undefined*(please refer to table → Section "Modbus map", page 557) or
- Un-enabled*

Exception Code 03 = The number of registers is not >= 0x0001 and <= 0x007B

OR

Number of bytes != Number of registers x 2

Exception Code 04 = Error when attempting to write to the registers**

Values are only allowed to be written if all required addresses are valid and unlocked.

*For an error message, it is sufficient if only one of the requested addresses is not unlocked or is invalid.

**A write operation can always write consistent data to the image table, since this data is protected from other modules by semaphores. In other words, as of this writing, there is no known criterion for a "write multiple registers" error in the server.

Unknown function:

If the client requests an unsupported function, the Modbus TCP server must return the following error frame after receiving the request:

Fault Code	1 byte	0x80 + Function code
Exception Code	1 byte	01

This will indicate to the client that the desired function is not supported by the server.

11.4.4 Modbus map

Table 105: How the Modbus registers and read data for the Modbus server are mapped easyE4 control relays

Function code Modbus	Modbus reg. #	Operand	Description	Remark
0x01 (Read Coil) Max. 512 coils at once, 8 coils are grouped into a byte	1	Q1	Bit output 1	Local outputs base device
	…	…	…	
	4	Q4	Bit output 4	
	17	Q17	Expansion Bit output	Local outputs expansion
	…	…	…	
	128	Q128	Expansion Bit output	
	1001	M1	Marker bit 1	
	...	…	…	
	1512	M512	Marker bit 512	
	2001	N1	NET marker bit 1	Only the local NET marker bits are returned
	…	…	…	
	2512	N512	loc. NET marker bit 512	
0x03 (Read Holding Register) Max. 125 registers at once, 1 register = 2 byte/1word	1	QA1	16-bit analog output 1	Local analog outputs base device
	…	…	…	
	4	QA4	16-bit analog output 4	
	5	QA5	Expansion 16-bit analog output	Local analog outputs expansion
	…	…	…	
	148	QA48	Expansion 16-bit analog output	
	1001	MW1	Marker word 1	
	…	…	…	
	1512	MW512	Marker word 512	
	2001	NW1	loc. Net marker word 1	Only local NET marker words will be returned, i.e., no double words, no bytes, and no markers from the other stations will be returned
	…	…	…	
	2032	NW32	NET marker word 32	
	5000		RTC (second)	5000: Seconds; 5001: Minutes; 5002: Hours; 5003: Day; 5004: Month; 5005: Year
	….	…	…	
	5005		RTC (year)	

Function code Modbus	Modbus reg. #	Operand	Description	Remark
0x02 (Read discrete input) Max. 512 inputs at once, 8 inputs are grouped into a byte	1	I1	Bit input 1	Local inputs base device
	…	…	…	
	8	I8	Bit input 8	
	17	I17	Expansion bit input	local inputs expansion
	…	…	…	
	128	I128	Expansion bit input	
	1001	M1	Marker bit 1	
	…	…	…	
	1512	M512	Marker bit 512	
	2001	N1	NET marker bit 1	Only the local NET marker bits and no marker bits of the other stations are returned
	…	…	…	
	2512	N512	NET marker bit 512	
	3001	ID1	Diagnostics bit 1	Diagnostics for base device
	…	…	…	
	3024	ID24	Diagnostics bit 24	
0x04 (Read Input Register) Max. 125 registers at once, 1 register = 2 bytes / 1 word	1	IA1	Value input 1 16Bit	Local analog inputs base device
	…	…	…	
	8	IA8	Value input 8 16Bit	
	17	IA17	Value input 16Bit	Local analog inputs expansion
	…	…	…	
	48	IA48	Value input 16Bit	
	1001	MW1	Marker word 1	
	…	…	…	
	1512	MW512	Marker word 512	
	2001	NW1	NET marker word 1	Only the local NET marker words will be returned, i.e., accessing NET markers from other nodes is not possible. NET marker bytes and NET marker double words can be calculated based on the NET marker words.
	…	…	…	
	2032	NW32	NET marker word 32	

If a function code is used on Modbus registers that are not listed (gray), a value of 0 or an exception code will be returned.

Table 106: How the Modbus registers and write data for the easyE4 Modbus server are mapped

Function code Modbus	Modbus reg.#	Operand	Description	Remark
0x06 (Write Single Register) and 0x10 (Write Multiple Register)				
	1001	MW1	Marker word 1	
	…	…	…	
	1512	MW512	Marker word 512	
	2001	NW1	NET marker word 1	
	…	…	…	
	2032	NW32	NET marker word 32	



Please note that little-endian is used when converting bytes to words in an easyE4. If you want to implement Modbus communications with big-endian, you will need to make the necessary adjustments.

See also

easySoft 7 Help

11.5 Setting up a web server

Only possible with easySoft 7.

The web server function is intended to make it even more convenient for users to use an easyE4 control relay.
All the easyE4 web server functions can be used through the web.
In other words, this means that the web offers an additional interface for communication, such as an additional HMI for the easyE4 device.

The device status can be ready directly on the display on EASY-E4-...-12...C1 devices – please refer to → Section "Status display on easyE4 control relays with display and keypad", page 81.
EASY-E4-...-12...CX1 devices without a display can also be read directly using the web server function.

The web server needs to be configured in easySoft 7 by opening the Project view and then going to the Webserver tab – please refer to Webserver tab.

11.5.1 Configuring the web server function in easySoft 7

You can configure the web server functions you want for each <program>.e70 file in easySoft 7.

- Select the device you want from the catalog in the Project view
- Click on the Webserver tab.

Under the tab, there is a Webserver configuration section that can be used to enable and configure the web server functionality, as well as an Access control section.

- ☑ To turn on, enable the checkbox by clicking on it.
- ☐ To turn off, disable the checkbox by clicking on it.

As soon as you enable the web server function, the Webserver passwords and user names dialog box will appear. You will need to enter the password for the administrator in order to show that you are allowed to set up this functionality.

(This administrator password will have previously been defined in the web browser application.)

You will then be able to create up to two users.

- Enter a username into the corresponding text field.
- Enter a password into the corresponding text field.

→ Please note the security requirements for the password:
At least eight ASCII characters with at least one uppercase character, one lowercase character, one number, and one special character.

- Enter a web server login text into the corresponding text field.

Please note than changing the web server login text for the device will require you to set up the passwords again.

Clicking on OK or Cancel will take you back to the Webserver configuration section.

- Now select whether you want the web server to be ◉ Always enabled
  or
- if ◉ Activation by program should instead be required.

One reason you may want to consider having a specific program enable the web server is for added protection.

80 will be set as the default "HTTP port".
If you change this port, please make sure that the HTTP port is set to the same value both on the web browser and on the easyE4 device.

- Set the HTTP port you want.
- Enable SSL/TLS encryption if necessary.

Now define the ranges that can be written to via the web server with the From and To drop-down menus.

- Select the range for Enable marker (write)
- Select the range for Enable NET marker (write)

11.6 E-mail function

Only possible with easySoft 7.

The e-mail function can be used to have the easyE4 control relay send a message to up to three different recipient groups.

Precondition:
In order for the e-mail function to work, there must be an Ethernet connection between the easyE4 control relay and an external server.
This server must either provide the mail server itself or the connection to the mail server that will be used.

The e-mail message will be triggered:

- If an error occurs in the NET group (all devices located on the same network as the easyE4)
- The controller's operating state changes
  or
- The program is deleted

In addition, e-mails can be sent to recipients if an alarm function block has been configured in the relevant program.

Since the easyE4 control relay cannot send any messages itself, the e-mail function is the ideal way to ensure that the defined people will promptly receive a notification when required.
These notifications will be triggered automatically if there is an active connection between the easyE4 and a mail server and the latter has been configured accordingly.

In addition, the e-mail functionality comes with the advantage of traceability. This traceability can be viewed much the same way as data logging.
The following will be saved:

- When an error occurred
- When the operating state changed
- When programs were deleted

11.6.1 Configuring the easySoft 7

You can configure the e-mail function as necessary in easySoft 7.

- ▶ Select the device you want from the catalog in the Project view
- ▶ Click on the E-Mail tab.

There are three sections under the tab: E-mail recipient, Mail server settings, and System messages

You can enter up to three recipients or recipients groups in the E-mail recipient section.

Within this context, a "recipient group" is a list of several recipients separated with semicolons.
The definition for each group can have a maximum length of 254 bytes.

- There is an activation bit for each recipient group.
  When an e-mail is triggered (e.g., by the alarm function block), it will only be sent to the groups that are activated.
- The mail server address (64 bytes)
- The domain name (64 bytes)
- The SMTP server's SMTP port
- The SMTP username (32 bytes)
- The SMTP user password (32 bytes)
- Whether the SMTP address is an IP address or a DNS name
- ID of the recipient group for the system e-mails that should be sent in the event of errors, in the event that the operating mode switches to STOP, and in the event that the program is deleted.
- Connection type (not encrypted, STARTTLS, SSL / TLS)

- ▶ Enable the checkbox for a recipient group.
- ▶ Enter the recipient's e-mail address.

In the System messages section, select the events that should trigger an e-mail to the recipient group.

- ▶ Enable the messages you want
- ▶ In the Send to recipient group drop-down menu, select the recipient group to which the selected messages should be sent.

You will need to enter the connection data for the mail server in the Mail server settings section. If the settings do not match, it will not be possible to send the easyE4 system messages.

- ▶ Start by selecting whether you will be entering an IP address or a DNS name (preferred).
- ▶ Now enter the corresponding information.

Enter the mail server's IP address into the IP address field or, alternatively, the mail server's DNS name into the DNS name field.

You can find out the DNS name, domain, and service port with a quick search on the Internet.

Simply search for <SMTP server> followed by the mail server you will be using, e.g., Yahoo, Gmail, GMX

You will often find the entire domain name. The DNS name is the part up to the first dot (" .")

- Now enter the mail server domain.
  The mail server domain name is the part after the first dot (" .")
  "gmail.com" for Gmail, for example
- Enter the e-mail service port.
  The service port will depend on the selected connection security option.
- Use the Connection security drop-down menu to select one of the following three options:
  - 1. Not encrypted
  - 2. STARTTLS
  - 3. SSL/TLS (most common connection security protocol)
- Finally, you will need to enter your login name and password for the mail server into the two fields at the bottom right.

11.6.2 Programming an alarm function block to trigger notifications

To add an alarm function block, start by selecting the device you want in the starting window and then clicking on the "Programming" button at the bottom left.

A dialog box in which you can select the programming language you want will appear.

▶ Select the programming language you want.

Once you make your selection, the Programming view will appear.

Go to the list on the left side and look for the "Other function blocks" folder. The alarm function block that uses the e-mail function will be found there.

▶ Select the alarm function block and drag it to the white canvas at the top right.

▶ Now click on the alarm function block. The corresponding parameters will appear at the bottom.

Use the "AL" drop-down menu to assign a number to the function block. You can also add a comment in the field to the right of the drop-down menu.

The purpose of the "Function block release by EN is necessary" checkbox is to define whether the alarm function block should be enabled and disabled based on the EN input. Do not enable this option if you want the alarm function block to always be enabled.

You can use the "Webserver active as long as there is a state of 1 at input EN" checkbox to define whether the web server in the easyE4 should be active as long as EN is active.

Use the "Parameter display" drop-down menu to select the "Call enabled" or "Call disabled" option.

Finally, select the "Type of information transmission" and "Recipient assignment" options you want and enter the subject and message that should be sent by e-mail.

See also

→ Section "AL - Alarm function block", page 349

12. Faults

This section provides troubleshooting information for your easyE4 in case it does not behave as expected.

Fault	Cause	Remedy
The base device will not boot up	There is no supply voltage	Check the input wiring. Switch on the device.
The display stays or turns dark.	The backlight is deactivated.	Turn on the backlight; please refer to the text function block description or check the corresponding function in the program with easySoft 7.

If a easyE4 device does not behave as expected, the following tips can help you in rectifying any possible problems. If a program does not function as expected, in spite of a thorough simulation in easySoft 7, the power flow display in the easyE4 display enables you to test the logic operations of the circuit diagram.

Only qualified persons should test electrical voltages while the easyE4 device is in operation.

12.1 Messages from the operating system

Messages on the LCD display		Explanation	Remedy
No display		Power supply interrupted	Restore power
		LCD is faulty	easyE4 replace
Temporary display			
	TEST: EEPROM	Only when switched on for the first time	-
	TEST: CLOCK		
Continuous display			
	ERROR: EEPROM	The memory for storing the retentive values or the easyE4 circuit diagram memory is faulty.	easyE4 replace
	ERROR: CLOCK	Clock error	easyE4 replace

12.2 Possible situations when creating programs

Situations when creating a program	Explanation	Remedy
Cannot enter contact or relay in program	easyE4 device is in RUN mode	Select STOP mode
Time switch switches at wrong times	Time or time switch parameters not correct	Check time and parameters
Message when using a memory card PROG INVALID	Memory card in easyE4 device contains no circuit diagram	Change easyE4 device type or the circuit diagram on the memory card
	Circuit diagram on the memory card uses contacts/ relays that the easyE4 device does not recognize	
Power flow display does not show changes to the rungs	easyE4 device is in STOP mode	Select RUN mode
	Association/ connection not fulfilled	Check and modify circuit diagram and parameter sets
	Relay does not activate coil	
	Incorrect parameter values/time	
	Analog value comparison is incorrect Time value of timing relay is incorrect Function of timing relay is incorrect	
Relay Q or M does not pick up	Relay coil has been wired up several times	Check coil field entries
Input not detected	Loose terminal contact	Check installation instructions, check external wiring
	No voltage to switch/button	
	Wire break	
	easyE4 device input is faulty	Replace easyE4 device
Relay output Q does not switch and activate the load	easyE4 device in STOP mode	Select RUN mode
	No voltage at relay contact	Check installation instructions, check external wiring
	easyE4 device power supply interrupted	
	easyE4 device circuit diagram does not activate relay output	
	Wire break	
	easyE4 device relay is faulty	Replace easyE4 device

12.3 Event

Event	Explanation	Remedy
The ACTUAL values are not being stored retentively.	Retention has not been switched on.	Switch on retention in the SYSTEM menu.
The RETENTION… menu is not displayed in the SYSTEM menu.	easyE4 device is in RUN operating mode.	Select STOP mode
The retentive data is cleared when there is a mode change from RUN to STOP.	This behavior only occurs when using the PW02 (pulse width modulation) function block in easyE4.	Avoid using the PW02 function block.
The SYSTEM menu is not displayed.	The device model does not feature this menu.	Change easyE4 device if you need retention
When the device is switched on, the easyE4 switches to STOP mode	No circuit diagram in the easyE4 device	Load, input circuit diagram
	RUN START is deactivated at easyE4.	Activating RUN mode in Menu SYSTEM OPTIONS.
The contacts of the BC (data block comparison) and BT (block transfer) function blocks flash in the power flow display	The display of the easyE4 is being updated to intermediate states too frequently although the contacts are operating properly	Ignore this section of the power flow display.
The display is not showing anything	No supply voltage	Switch on the power supply
	easyE4 device faulty	Press the OK button. If no menu appears, replace the easyE4 device.
	Text displayed with too many spaces	Enter text or do not activate text output

12.4 Functionality of the NET faulty

NOTICE

You can make a visual check the functionality of the NET by means of the NET LED and in the circuit diagram via diagnostics bit ID01-ID08.

Checking the functionality of the NET using the NET LED

Status of the NET LED	Description
Off	NET not operational, fault in configuration
Continuous light	NET station fault - possible causes: • Net is initialized and at least one station has not been detected. Check the plug-in connections. • You have modified the NET ID or baud rate for at least one station after the configuration has been completed. Change the configuration. • You have deleted the program on a NET station and thus also its NET configuration. Reconfigure the NET via station 1. • You have expanded an existing NET station and replaced it with a new device which cannot be assigned parameters.
Flashing	NET operating fault-free

12.4.1 Monitoring based on diagnostic bits

Diagnostic bits ID01 - ID08 provide information on the presence or absence of NET stations. The state of the diagnostic bits is defined by the reception of a sign of life signal that every NET station sends.

If the sign of life signal of a configured NET station is no longer received, the diagnostics bit ID01-ID08 for the missing NET station is immediately set to 1 for all remaining stations.

The sign of life signal is sent cyclically depending on the baud rate.

The presence of the configured NET stations is evaluated at the following time intervals:

Table 107: NET station time intervals

Baud Rate	Station must send a "sign of life" every ...	Station detects a missing sign of life signal from …
[Kbit/s]	[ms]	[ms]
1000	60	180
500	60	180
250	120	360
125	240	720
50	600	1800
20	1500	4500
10	3000	9000

If, for example, the station with NET ID 7 is missing, the diagnostics bit ID7 changes to 1 on every remaining NET station. The missing station is also indicated by means of a permanent light on the LED NET for all remaining NET stations.

NOTICE

In order to ensure that a circuit diagram with NET operands (e.g. 3GT01) is always working with the latest data, you should query the diagnostics bit ID.. of the sending NET station (see following example) before evaluating the operands.

If you do not evaluate the appropriate diagnostics bit, this may cause malfunctions in your application.

Example of scanning the diagnostics bit ID..

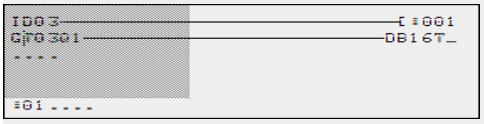


Figure 256: Scanning the diagnostics bit in the circuit diagram

= Visible area

Reaction to missing sign of life signal on a NET station with or without a program.

Station with circuit diagram	NET station 1 detects the failure of a NET station 2 to 8 without a circuit diagram: Input values received via nI.., nR.., nQ.., nS.., nRN.. and GT.. are set to 0. The output values for this NET station are not changed.
Station without circuit diagram NET station with a NET ID 2…8 in REMOTE IO mode	The output values Q01 - Q08 and S01 - S08 received from NET station 1 are set to 0.

After the supply voltage is switched on, the Other NET stations and NET stations of type easyE4 start up NET communication at different speeds. When these different types are used on a NET in mixed operation and are started simultaneously, a faster starting NET station will set its diagnostics contact ID.. = 1 to indicate a NET station of type easyE4 as missing.

Solution:

On all "other NET stations" delay the evaluation of the diagnostics bit ID.. for the NET stations of type easyE4 device by approx. 5 s by using the T function block (timing relay).

12.4.2 Replacing a NET station

If you wish to replace a NET station NT2 - NT8 in a running plant, you should take preparatory measures in order to ensure fault-free commissioning of this NET station.

Example

In a network run with a baud rate of 250 KB, the NET station NT7 is to be replaced.

If you are using a easyE4 device as replacement that is still in its default state and does not have a NET-ID, this device is not automatically integrated in the network. Even connected to the power supply and the NET, the LED NET remains off. In this case a configuration can not be written to it with the configuration software easySoft7 (Communications view -> Device list field, NT7).

The following procedure ensures fault-free commissioning of the replacement device.

Connect the easyE4 replacement device to the power supply and connect it at the same position to the NET as the device to be replaced.

Switch the device display of all NET stations to Status display.

Start the automatic configuration of the NET. However, you can also do this via the programming software. As an alternative to the automatic configuration, you can also switch the supply voltage of the configured NET stations off and on.

All NET stations in the NET configuration will temporarily switch to STOP.

12.4.3 Station with NET-ID 1 fails

If the power supply of station NET-ID 1 fails during operation, the other NET stations can no longer be notified of the associated operating mode change.

NET stations with NET-ID 2 - 8 on which REMOTE RUN is activated therefore stay in RUN mode until the missing sign of life is detected. The time until the missing sign of life is detected depends on the baud rate and is from 180 - 9000 ms (→ Section "Monitoring based on diagnostic bits", page 571). Up to this time, a NET station 2 - 8 operates with the data previously received via the NET.

The further behavior of the NET stations 2 - 8 depends on whether REMOTE IO is also activated as well as REMOTE RUN:

NET station 2 - 8 with activated REMOTE RUN

This type of NET station sets the data received via the NET to zero. It retains its operating state and sets the diagnostics bit ID1 to 1 (see following safety measure).

NET stations 2 - 8 with activated REMOTE RUN and REMOTE IO that function as input/output devices, i.e. without their own circuit diagram

This type of NET station sets the data received via the NET to zero. It switches to the STOP mode if the device display is showing the Status menu. The device follows NET station 1 when it switches back to RUN mode.

Safety measure: On every NET station with a program, monitor the diagnostics bits ID.. in order to detect a missing NET station as quickly as possible → Section "Monitoring based on diagnostic bits", page 571.

13. Maintenance

13.1 Cleaning and maintenance

The easyE4 are maintenance-free.
However, the following work may need to be carried out:

- Cleaning the easyE4 when soiled.

When soiled:



CAUTION
POINTY, SHARP OBJECTS AND CORROSIVE LIQUIDS
When cleaning the device:

- Do not use any pointy or sharp objects (e.g., knives).
- Do not use aggressive or abrasive cleaning products or solvents.

Make sure that no liquids get into the device (short-circuit hazard) and that the device is not damaged in any way.

▶ Clean the device with a clean, soft, damp cloth.

13.2 Repairs

Contact your local supplier or technical support for repairs.



CAUTION
DESTRUCTION
The easyE4 should only be opened by the manufacturer or by an authorized center. Operate the device until only with the enclosure fully closed and sealed.

Use the original packaging to ship the device.

13.3 Storage, transport and disposal

13.3.1 Storage and transport



CAUTION
UV LIGHT
Plastics will become brittle when exposed to UV light. This artificial aging will reduce the easyE4 unit's lifespan. Protect the device from direct sunlight and other sources of UV radiation.



CAUTION
SHORT-CIRCUIT HAZARD
If the device is or has been exposed to environmental fluctuations (ambient temperature, air humidity), condensation may form on or inside it. As long as this condensation is present, there will be a short-circuit hazard.
Do not switch on the device when it has condensation in or on it.
If the device has condensation in or on it, or if the panel has been exposed to environmental fluctuations, let the panel settle into the existing ambient temperature before switching it on.

The ambient conditions must be met when transporting and storing the easyE4.

The ambient air temperature for storage and transportation must not exceed the maximum specified limit:

Ambient climatic conditions	
Air pressure (in operation)	795 - 1080 hPa
	max. 2000 m NHN
Temperature	
Operation	- 25 – +55 °C (-13 – +131 °F) The display is readable between ϑ -5°C (-23°F) ≦ T ≦ 50°C (122°F).
Storage / Transport	- 40 – +70 °C (-40 – +158 °F)
Humidity	Relative humidity 5 - 95 %
Condensation	Prevent condensation by means of suitable measures



Before commissioning
If storing/transporting the device in cold weather conditions or in such a way that it will be exposed to extreme differences in temperature, make sure that no condensation forms on or inside the device.
If there is condensation in or on the device, do not switch on the device until it is completely dry.

Use the original packaging to ship the device.

The easyE4 is sturdily built, but the components inside it are sensitive to excessively strong vibrations and/or mechanical shock.

Accordingly, make sure to protect the easyE4 from mechanical loads that exceed the scope of the unit's intended use.

The device should only be transported in its original packaging after being packed properly.

13.3.2 Disposal



EXPLOSION HAZARD
LITHIUM BATTERY
The lithium battery inside the easyE4 may explode if handled incorrectly.

▶ Dispose of the unit professionally.



Important!

Dispose of recyclables as required by your local recycling regulations.

easyE4 no longer being used must be professionally disposed of as per local standards or returned to the manufacturer or relevant sales department.

Materials used in the packaging

Packaging	Material
Outer packaging	Cardboard
Inner packaging	Cardboard Plastic bag: polyethylene (PE)

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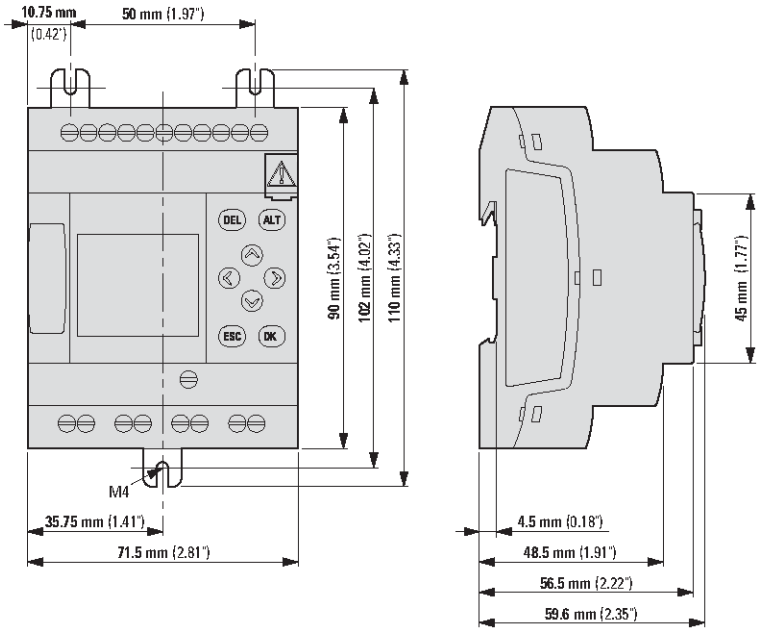
A.1 Dimension and weight specifications

Base devices with 4 space unit front dimension

EASY-E4-UC-12RC1, EASY-E4-DC-12TC1



EASY-E4-UC-12RCX1, EASY-E4-DC-12TCX1

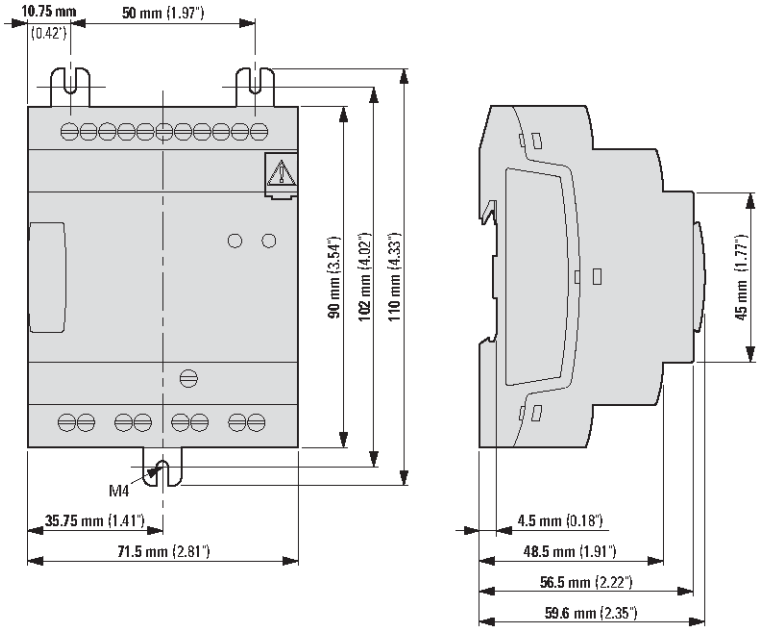


Figure 257: Dimensions in mm (Inch)

Width x Height x Depth (without plug)	71.5 mm x 90 mm x 58 mm (2.81" x 3.54" x 2.28")
Weight	0.20 kg

Expansion devices with 4 space unit front dimension

EASY-E4-UC-16RE1,EASY-E4-DC-16TE1

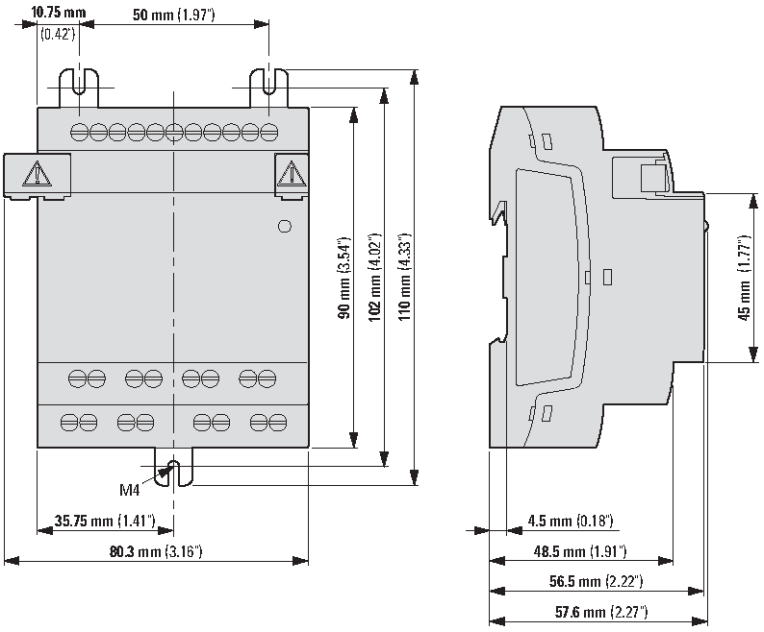


Figure 258: Dimensions in mm (Inch)

Width x Height x Depth (without plug)	71.5 mm x 90 mm x 58 mm (2.81" x 3.54" x 2.28")
Weight	0.20 kg

Appendix
A.1 Dimension and weight specifications

Expansion devices with 2 space unit front dimension

EASY-E4-UC-8RE1,EASY-E4-DC-8TE1, EASY-E4-DC-6AE1

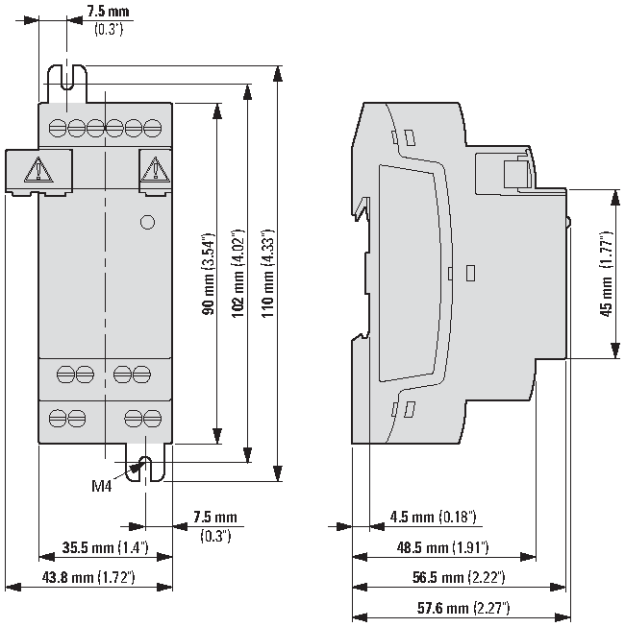


Figure 259: Dimensions in mm (Inch)

Width x Height x Depth (without plug)	3.5 mm x 90 mm x 58 mm (1.4" x 3.54" x 2.28")
Weight	0.18 kg

A.2 Approvals and declarations

The following specifications apply to all easyE4 devices.

Approvals and declarations	
cUL	Application for easyE4 approval submitted
CE	easyE4 units comply with all applicable European Union (EU) Directives and feature the CE marking.
NEMA	easyE4 device complies with the applicable guidelines in North America
Marine approval (shipping classification)	Application for easyE4 approval submitted

Applied standards and directives		
EMC (relevant for CE)		2004/108/EEC 2014/30/EU
	IEC/EN 61000-6-2	Interference immunity for industrial environments
	IEC/EN 61000-6-3	
Security		
	IEC/EN 61010	Safety requirements for electrical equipment for measurement, control and laboratory use
Product standards		
	EN 50178_x	Electronic equipment for use in power installations
	IEC/EN 61131-2	Programmable controllers: Equipment requirements and tests
Mechanical shock resistance	IEC/EN 60068-2-27	15g /11ms
Vibration	IEC/EN 60068-2-6	Displacement amplitude: 5–9 Hz: 3.5 mm; 9–60 Hz: 0.15 mm Acceleration amplitude: 60–150 Hz: 2 g
Environmental tests	IEC/EN 60068-2-30	

A.3 Technical data

A.3.1 Data sheets

The current specifications for the device can be found in the corresponding data sheet at www.eaton.eu/ecat

A.3.1.1 Base devices

with display and buttons	with LED indicators for diagnostics
197211 - EASY-E4-UC-12RC1	197212 - EASY-E4-UC-12RCX1
197213 - EASY-E4-DC-12TC1	197214 - EASY-E4-DC-12TCX1

A.3.1.2 Expansions

with relay outputs	with transistor outputs
197217 - EASY-E4-UC-8RE1	197219 - EASY-E4-DC-8TE1
197218 - EASY-E4-UC-16RE1	197220 - EASY-E4-DC-16TE1

with analog inputs
197223 - EASY-E4-DC-6AE1

A.3.1.3 Accessory devices

197225 - EASY-E4-CONNECT1	Spare parts package, consisting of three (3) connectors and three (3) end covers
197226 - EASYSOFT-SWLIC	Programming software license easySoft 7
191087 - MEMORY-SDU-A1	microSD memory card

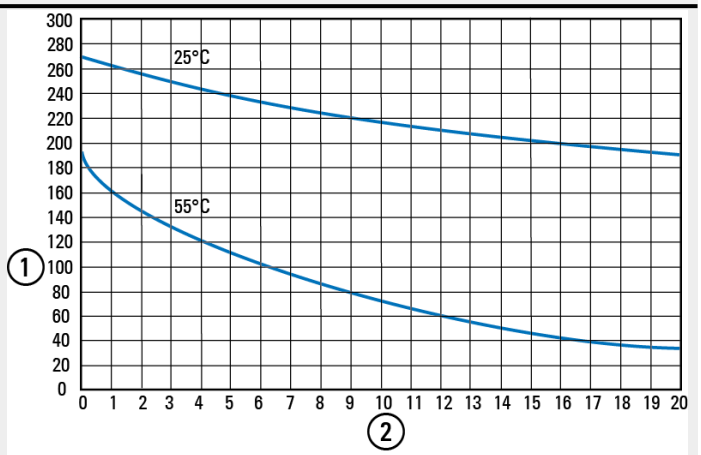
Ambient climatic conditions	
Air pressure (in operation)	795 - 1080 hPa
	max. 2000 m NHN
Temperature	
Operation	- 25 – +55 °C (-13 – +131 °F) The display is readable between ϑ -5°C (-23°F) ≦ T ≦ 50°C (122°F).
Storage / Transport	- 40 – +70 °C (-40 – +158 °F)
Humidity	Relative humidity 5 - 95 %
Condensation	Prevent condensation by means of suitable measures

EASY-E4-	UC -12RC1	UC-12RCX1	DC -12TC1	DC-12TCX1
Eaton Catalog No.	**197211**	**197212**	**197213**	**197214**
Basic function	Control relay, expandable with I/O expansions from the easyE4 series; Ethernet port for connecting to a network Real-time clock			
Display with keypad	Monochrome 6 x 16 lines	-	Monochrome 6 x 16 lines	-
Specifications for connection to supply voltage	12/24 VDC, 24 VAC		24 V DC	
Input points	Digital: 8, of which 4 can be used as analog inputs			
Connection type	Screw terminal, (AWG 22 - 12) solid 0.2 - 4 mm², flexible with ferrule 0.2 - 2.54 mm²,			
Mounting	Tophat rail IEC/EN 60715 (35 mm) or screw fixing with fixing brackets ZB4-101-GF1 (accessories)			
Protection rating (IEC/EN 60529, EN 50178, VBG 4)	IP 20			
Electromagnetic compatibility (EMC)	Overvoltage category/pollution degree III/2			
Radio interference suppression	EN 61000-6-3 Class B			

Table 108: Ethernet

Ethernet	
Porting	RJ45 plug, 8-pin
Wire type	CAT5

Table 109: Real time clock

Real-time clock	
Back-up of real-time clock	 ① Backup time (hours) with fully charged double layer capacitor ② Service life (years)
Accuracy of the real-time clock	typ. ± 2 s/day (± 0.2 h/year) depending on ambient air temperature fluctuations of up to ± 5 s/day (± 0.5 h/year) are possible

A.4 Further reading

Hardware

For more information on additional devices and modules, please refer to the following documentation:

Installation instructions Base devices	IL050020ZU
Installation leaflet for I/O expansions	IL050021ZU
Installation instructions Fixing bracket	IL05009005Z

Download Center,Eaton Online Catalog

Enter "easy" into the search box and the catalog will take you directly to the corresponding product group in the Automation, Control and visualization section.

http://www.eaton.eu/doc

http://www.eaton.eu/ecat

Product information

For up-to-date information, please consult the product page on the Internet.

http://www.eaton.eu/easy

Application examples

A number of applications are available for download from the product page at http://www.eaton.eu/easy.

These examples come with a description, the circuit diagram, and the easySoft 7 project (in the EDP and LD programming languages as of this writing).

Tutorials

For helpful videos that explain how to use specific functions, please visit the product page at http://www.eaton.eu/easy.

Product training

The Eaton Experience Center Training (EEC) has a series of training courses available for the easyE4. For more information, as well as to download the workshop catalog, please visit:

http://www.eaton.eu/training

Community

easyForum is an additional source of help that can be found on the Internet at:

http://www.easy-forum.net

A.5 Sample Projects

To get a quick look at the possibilities offered by the easyE4 series, please visit the corresponding product page on the Internet (the page includes a series of application examples and tutorials).

Application examples

A number of applications are available for download from the product page at http://www.eaton.eu/easy.

These examples come with a description, the circuit diagram, and the easySoft 7 project (in the EDP and LD programming languages as of this writing).

Tutorials

For helpful videos that explain how to use specific functions, please visit the product page at http://www.eaton.eu/easy.

If you do not have an Internet connection available, you can try out one of the application examples here if you have already installed easySoft 7:

Chaser light

Task definition

Say that you want to use the easyE4 to switch on four lamps in sequence and then switch them off accordingly.
Starting from the first lamp all the way to the fourth lamp, and then vice versa from the fourth lamp all the way to the first lamp, and so on. The system can be switched on and off with main switch S1.

The selector switch S2 defines whether the chaser light is to be activated permanently or only at the set times (daily from 6 PM to 10 PM).

Three different speeds can be set for the chaser light:

- Switch S3 > Fast chaser light speed (0.30 sec.)
- Switch S4 > Medium chaser light speed (0.60 sec)
- Switches S3 and S4 simultaneously > Slow chaser light speed (1 sec)

Wiring topic

1. Inputs:

I1	Main switch S1 (system ON / OFF)
I2	Selector switch S2 (time switch ON/ OFF
I3	Switch S3 (chaser light speed)
I4	Switch S4 (chaser light speed)

2. Outputs:

Q1	Lamp H1
Q2	Light H2
Q3	Lamp H3
Q4	Lamp H4

3. Parameters:

T1	Fast pulse speed (0.30 sec)
T2	Medium pulse speed (0.60 sec)
T3	Slow pulse speed (1 sec)
C1-C4	Number of pulses
H1	Chaser light on times

 easy-E4_Running_light_ES_EN_EDP.e70

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Glossary

Client
The term "client" refers to an application that requests specific services from a server.

*****

***.bmp**
Pixel-based file format for two-dimensional raster graphics

***.csv**
Comma-Separated Values (Character-Separated Values) Data format for text

***.DLL**
Dynamic link library

***.jpg**
Pixel-based file format for the JPEG (Joint Photographics Expert Group) image file format The JPEG format does not support transparency

***.png**
PNG (Portable Network Graphics) image file format for graphics and video software, The PNG file format supports transparency with its alpha channel

***.tiff**
Vector-based image file format for graphics and video software, The TIFF format supports transparency, as well as images using 8-bit channels (grayscale, RGB, CMYK, etc.)

***.uf7**
User function block file format

***.zip**
ZIP file format used to compress and archive files

A

Address reference
The term "address reference" refers to the data packet's start address.

Alpha channel
Transparency information for PNG images Used to specify the degree of transparency for each pixel

Application
Short for "application software," a computer program that performs a function useful to the user.

B

B
Build

Bitmap
Image file in the BMP raster graphics image file format.

Boot
Booting up, starting (up) - automatic process that takes place after the device is switched on, and in which a simple program in ROM memory starts a more complex program.

C

CBA
Communication Board Adapter

CEST
Central European Summer Time

CIDR
ClasslessInterDomainRouting

CIS
Card Information Structure

Command sequence

Path information List of the commands that the device operator must tap in succession in order to get to the location described; for example: Start\Project Overview\Variables folder.

Communication

The transfer of data between the panel and the PLC, controller, or peripheral connected to it.

CRC

Operating system checksum

D

Data Set Ready

The transmitter is ready to send data.

Data Terminal Ready

The receiver is ready to receive data.

DCF77

German longwave time signal, Frankfurt frequency 77

DHCP

Dynamic Host Configuration Protocol

DHCP (used to obtain an IP address automatically)

You can enable this setting if you do not want to configure every single individual computer within a network, provided there is a DHCP server on the network. When this setting is enabled, the computer will get information such as an IP address, subnet mask, gateway, and DNS from the DHCP server. In most cases, the router used on a network will also feature a DHCP server.

DNS

Domaine Name System

DNS (Domain Name Server)

When you enter an address such as www.intel.com into a browser or FTP client, your computer will first need to ask a server for the IP address behind the name in order to actually be able to reach the address. The server that provides this information is known as a "domain name server." Every single Internet provider provides this service, and most providers have a secondary DNS in case their primary DNS fails. and most providers have a secondary DNS in case their primary DNS fails.DNS records are the IP addresses for these servers.

DSR

Data Set Ready

DST

Daylight Saving Time

DTR

Data Terminal Ready

E

EDP

Easy Device Programming - programming method

F

FAT

File Allocation Table

File Allocation Table

FATs are used to define filesystems.

Firewall

Firewalls are used to prevent outside attempts to access IP addresses on a private network. In other words, they are used to protect internal data. When configured correctly, they can also be used to set up rules or lists that prevent specific URLs from being requested, e.g., when they are in violation of company policy. A firewall's main task is to use the information in a packet (the source and destination IP addresses, as well as the port) to decide whether the packet should be rejected or allowed to pass. This also prevents packets not

meant for the network from subjecting the network to an unnecessary load, as well as packets meant for the private network from reaching the Internet.

FTP

File Transfer Protocol

FUP

Function block diagram - programming method

G

Gateway

Gateway When two computers on different networks want to communicate with each other, the networks need to be connected with a router. For example, surfing on the Internet requires for packets to be routed from the Internet to the network and vice versa. By using a subnet mask, a computer can know whether the receiver can be found on its network or whether it is located outside of it. If it is located outside the network, the computer will send a packet to the router specified with the gateway IP address.

H

HMI

Human Machine Interface

I

IL

Installation instructions

IP Address

IP addresses are 32 bits (4 bytes) long and are used to uniquely identify networks, subnetworks, and individual computers that work with the TCP/IP protocol. A distinction is drawn between private address spaces for local networks (intranet) and public addresses (Internet).

IR

Infrared

K

KOP

Ladder diagram - programming method

L

LAN

Local Area Network

M

MDI

Multi Document Interface

Menu bar

Menu ribbon that can be expanded and collapsed and that provides the various available commands

MESZ

Central European Summer Time

MN

Manual - Operation manual

Modulo

From the Latin modulo, i.e., "a small measure"

O

Object

Static or dynamic element used for engineering purposes. Static objects are located in the view's background and do not change at runtime. In contrast, dynamic objects are located in the view's foreground, and their appearance can change as a result of data changes.

Operating system

A group of programs that control and manage the processes in a computer and its connected devices.

OS

Operation System

P

PCMCIA

Personal Computer Memory Card International Association (PCMCIA)

Peer to Peer (P2P)

Peer-to-peer is a term used for computers that are connected to each other in an architecture in which both computers can assume the role of server and client.

PELV (protective extra low voltage)

Protective low voltage that provides protection against electric shock. It refers to how machines are electrically installed – one side of the circuit or a point on the PELV circuit's power source needs to be connected to the protective bonding circuit.

Personal computer

A personal computer is made up of a central processing unit, RAM, external data storage devices, an operating system, and application programs, and is connected to peripheral devices (monitor, printer). PCs can be stationary or portable.

Personal Computer Memory Card International Association (PCMCIA)

PCMCIA Card, also known as PC Card, is a standard for the expansion cards for portable computers used in Eaton touch panels. PCMCIA cards are energy-efficient and support hot plugging, i.e., they can be replaced during ongoing operation. Plug and play is supported thanks to the fact that all the properties required in order to automatically configure the driver are stored on the card's CIS.

PID controller

Proportional–Integral–Derivative Controller

PLC

Programmable logic controller The controller or peripheral that is connected to the HMI.

Polling

Cyclical reading of the PLC's addressed variables

Port

Ports can be seen as virtual mailboxes for data packets. A computer can communicate with other computers on 65536 different ports.

Projected capacitive touch

A display designed for high precision, user friendliness, and durability. It is designed to bring the controls that have now become prevalent in consumer electronics to machines, with advantages such as a gesture-based user interface, two-finger multi-touch depending on the application software being used, intuitive operation that enables operators to start working right away, and the fact that no calibration is required

PU

Polyurethane

R

Registers

Subpages in a dialog box or object

Retention

Refers to the ability of operands to retain their value (memory contents) in the event of a loss of voltage

ROM (read-only memory)

Non-volatile read-only memory

Router

Routers are devices used to forward ("route") requests from a network to the Internet (or to another network). Routers provide a measure of security for private networks, as nodes

outside of the network will be unable to determine which specific computer requested the data. This is because all the computers on the private network will appear under the same IP address on the Internet.

RxD

Receive cable for received data

S

SD card

Secure Digital memory cards are non-volatile, rewritable flash data storage devices that are used with Eaton and are commonly referred to as microSD cards. Data written to these cards is stored in a non-volatile manner that does not require any additional (secondary) power.

SELV (safety extra low voltage)

Circuit in which no dangerous voltage occurs even in the event of a single fault.

Server:

The term "server" is usually used to refer to computers that provide services on a network. Admittedly, however, this definition is not very precise. More specifically, servers are applications on a computer that are responsible for providing or processing data. In fact, every computer can provide such services. Servers are not active in and of themselves. They wait until they are addressed by a client, after which they perform the corresponding tasks. Each server application provides its service on the network via a specific port.

Slot

Refers to a slot for a memory card

SNTP

Simple Network Time Protocol

SSL/TLS

Secure Sockets Layer/ Transport Layer Security

ST

Structured Text - programming method

Stroke

A hub is a device used to connect various network devices together. Hubs broadcast all data to all connected devices (devices connected with a patch cable).

Subnet mask

A subnet mask is an IP address "filter." It has the same syntax as an IP address. This mask defines which computers can transfer data between themselves within a network. This also means that subnet masks define the maximum size of the corresponding subnetworks.

Switch

Switches are networking devices that are more advanced than hubs. One of the main features that sets them apart from the latter is the fact that they are more "intelligent" and forward data packets much more efficiently by sending them only to the devices that need to receive them. Multiple data packets can pass through a switch at the same time. Among other things, this means that switches have a significantly higher total bandwidth (throughput) than hubs. Moreover, switches learn which stations are connected to which ports, meaning that additional data transfers will not result in any ports being subjected to unnecessary loads, i.e., that data will only be forwarded to the port connected to the intended destination. With the exception of their higher price, switches are superior to hubs in every way.

System character set

Font type and size used to output system messages.

T

TE

Space units

Toolbar

The toolbar provides all important functions so that they can be accessed directly. All the buttons in a toolbar can also be found as menu options in the menu.

Transfer parameters

Baud rate, data bit, start bit, stop bit, and parity

TxD

Transmit cable for transmitted data

U

UNC

Unified Coarse Thread

URL

Uniform Resource Locator

User

Operator using the device on which the user interface created with Galileo is running.

UTC

Universal Time Coordinated

W

widescreen

Widescreen format

Windows

Dialog boxes, prompts, etc. that open while the application is running and remain on the current program page Synonyms: dialogue box, dialog These windows are shown by the application in various situations in order to obtain specific input or confirmations from the user. Dialog boxes expect input from the user, while prompts are shown to get the user's confirmation for specific messages.

Windows Embedded Compact 7 pro

A component-based, multi-functional real-time operating system designed to meet the needs of even the most demanding industrial applications. The operating system will unpack itself into the device's RAM memory every time the device is started, making it possible to de-energize the device without the need for a UPS or other similar precautions. As the successor to WinCE 6, Windows Embedded Compact 7 features a large selection of standard technologies, communication servers/clients, and web services. • Fast boot time • Multi-touch support (two-finger) • Long-term availability

WINS

Windows Internet Name Service, Name resolution service within Microsoft networks. In order for this service to be used, there must be a WINS server. If there is no WINS server, names will be resolved using broadcasts and other mechanisms. A fixed name can be assigned to an IP address in WINS so that a computer will continue to be recognized even if its IP address changes.

Eaton's electrical business is a global leader with expertise in power distribution and circuit protection; backup power protection; control and automation; lighting and security; structural solutions and wiring devices; solutions for harsh and hazardous environments; and engineering services. Eaton innovation is powering what matters across industries and around the world, helping customers solve their most critical electrical power management challenges.

Eaton is a power management company with 2017 sales of $20.4 billion. We provide energy-efficient solutions that help our customers effectively manage electrical, hydraulic and mechanical power more efficiently, safely and sustainably. Eaton is dedicated to improving the quality of life and the environment through the use of power management technologies and services. Eaton has approximately 96,000 employees and sells products to customers in more than 175 countries. For more information, visit Eaton.com.

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11/18 MN050009 EN

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