BECKHOFF New Automation Technology

Documentation | EN

EL10xx, EL11xx

Digital Input Terminals

2024-01-16 | Version: 4.8

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1 Foreword

1.1 Product overview EtherCAT digital input terminals

EL1002, EL1004, EL1008 [▶ 16] (2, 4, 8 channels; 24 V_{DC}, 3 ms input filter)
EL1004-0020 [▶ 16] (4 channels; 24 V_{DC}, 3 ms input filter, 2500 V electrical isolation)

EL1012, EL1014, EL1018 [▶ 22] (2, 4, 8 channels; 24 V_{DC}, 10 µs input filter)

EL1024 [▶ 28] (4 channels; 24 V_{DC}, 3 ms input filter for type 2 sensors)

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EL1084, EL1088 [▶ 33] (4, 8 channels; 24 V_{DC}, 3 ms input filter, switching to negative potential)

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EL1104 [▶ 37] (4 channels; 24 V_{DC}, 3 ms input filter, with sensor supply)

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1.2 Notes on the documentation

Intended audience

This description is only intended for the use of trained specialists in control and automation engineering who are familiar with the applicable national standards.
It is essential that the documentation and the following notes and explanations are followed when installing and commissioning these components.
The qualified personnel is obliged to always use the currently valid documentation.

The responsible staff must ensure that the application or use of the products described satisfy all the requirements for safety, including all the relevant laws, regulations, guidelines and standards.

Disclaimer

The documentation has been prepared with care. The products described are, however, constantly under development.

We reserve the right to revise and change the documentation at any time and without prior announcement.

No claims for the modification of products that have already been supplied may be made on the basis of the data, diagrams and descriptions in this documentation.

Trademarks

Beckhoff®, TwinCAT®, TwinCAT/BSD®, TC/BSD®, EtherCAT®, EtherCAT G®, EtherCAT G10®, EtherCAT P®, Safety over EtherCAT®, TwinSAFE®, XFC®, XTS® and XPlanar® are registered trademarks of and licensed by Beckhoff Automation GmbH. Other designations used in this publication may be trademarks whose use by third parties for their own purposes could violate the rights of the owners.

Patent Pending

The EtherCAT Technology is covered, including but not limited to the following patent applications and patents: EP1590927, EP1789857, EP1456722, EP2137893, DE102015105702 with corresponding applications or registrations in various other countries.

EtherCAT® is registered trademark and patented technology, licensed by Beckhoff Automation GmbH, Germany.

Copyright

1.3 Guide through documentation

NOTICE

Further components of documentation

This documentation describes device-specific content. It is part of the modular documentation concept for Beckhoff I/O components. For the use and safe operation of the device / devices described in this documentation, additional cross-product descriptions are required, which can be found in the following table.

Title	Description
EtherCAT System Documentation (PDF)	• System overview • EtherCAT basics • Cable redundancy • Hot Connect • EtherCAT devices configuration
Explosion Protection for Terminal Systems (PDF)	Notes on the use of the Beckhoff terminal systems in hazardous areas according to ATEX and IECEx
Control Drawing I/O, CX, CPX (PDF)	Connection diagrams and Ex markings (conform to cFMus)
EtherCAT Terminals in the Marine Sector (PDF)	Notes for operation of the Beckhoff EtherCAT Terminal System in the Marine Sector (DNV GL)
Infrastructure for EtherCAT/Ethernet (PDF)	Technical recommendations and notes for design, implementation and testing
Software Declarations I/O (PDF)	Open source software declarations for Beckhoff I/O components

The documentations can be viewed at and downloaded from the Beckhoff website (www.beckhoff.com) via:

- the “Documentation and Download” area of the respective product page,
- the Download finder,
- the Beckhoff Information System.

1.4 Safety instructions

Safety regulations

Please note the following safety instructions and explanations!
Product-specific safety instructions can be found on following pages or in the areas mounting, wiring, commissioning etc.

Exclusion of liability

All the components are supplied in particular hardware and software configurations appropriate for the application. Modifications to hardware or software configurations other than those described in the documentation are not permitted, and nullify the liability of Beckhoff Automation GmbH & Co. KG.

Personnel qualification

This description is only intended for trained specialists in control, automation and drive engineering who are familiar with the applicable national standards.

Signal words

The signal words used in the documentation are classified below. In order to prevent injury and damage to persons and property, read and follow the safety and warning notices.

Personal injury warnings

⚠ DANGER
Hazard with high risk of death or serious injury.

⚠ WARNING
Hazard with medium risk of death or serious injury.

⚠ CAUTION
There is a low-risk hazard that could result in medium or minor injury.

Warning of damage to property or environment

NOTICE
The environment, equipment, or data may be damaged.

Information on handling the product

This information includes, for example:
recommendations for action, assistance or further information on the product.

1.5 Documentation issue status

Version	Comment
4.8	• Update chapter “Technical data” • Update structure
4.7	• Update chapter “Technical data” • Update structure
4.6	• Update chapter “Technical data” • Update structure
4.5	• Update chapter “UL notice” • Update chapter “Technical data” • Update structure
4.4	• Addenda EL1004-0020 • Structural update • Update Chapter "Technical data" • Update Chapter "LEDs and connection"
4.3	• Structural update • Update Chapter "Technical data" • Update Chapter "LEDs and connection"
4.2	• Structural update • Update Chapter "Technical data"
4.1	• Structural update • Correction Chapter "Application notes" • Change Chapter "Configuration with the TwinCAT System Manager" > "Configuration with the TwinCAT System Manager – digital input – and output terminals" • Change chapter "CoE Interface" > "Coe Interface: notes"
4.0	• First publication in PDF format • Structural update
3.3	• “Technical data” section updated • “Assembly instructions with increased mechanical load capacity” section supplemented
3.2	• Technical data supplemented • Structural update
3.1	• Connection diagrams updated
3.0	• Note regarding firmware compatibility added
2.9	• UL requirements added
2.8	• Technical description amended, technical note added
2.7	• Technical description (EL101x, EL1114) amended
2.6	• Technical description (EL1024, EL1034) amended
2.5	• Technical description amended
2.4	• Technical data amended (EL1124)
2.3	• Technical data amended
2.2	• Technical data amended
2.1	• Terminals EL1124, EL1144, EL1034 added, technical data amended
2.0	• Terminals EL1002, EL1008, EL1018, EL1084, EL1088, EL1094, EL1098, EL1104, EL1114 added, technical data amended
1.0	• Technical data amended
0.1	• Provisional documentation for EL10xx

1.6 Version identification of EtherCAT devices

1.6.1 General notes on marking

Designation

A Beckhoff EtherCAT device has a 14-digit designation, made up of

- family key
- type
- version
- revision

Example	Family	Type	Version	Revision
EL3314-0000-0016	EL terminal 12 mm, non-pluggable connection level	3314 4-channel thermocouple terminal	0000 basic type	0016
ES3602-0010-0017	ES terminal 12 mm, pluggable connection level	3602 2-channel voltage measurement	0010 high-precision version	0017
CU2008-0000-0000	CU device	2008 8-port fast ethernet switch	0000 basic type	0000

Notes

- The elements mentioned above result in the **technical designation**. EL3314-0000-0016 is used in the example below.
- EL3314-0000 is the order identifier, in the case of “-0000” usually abbreviated to EL3314. “-0016” is the EtherCAT revision.
- The **order identifier** is made up of
  - family key (EL, EP, CU, ES, KL, CX, etc.)
  - type (3314)
  - version (-0000)
- The **revision** -0016 shows the technical progress, such as the extension of features with regard to the EtherCAT communication, and is managed by Beckhoff.
  In principle, a device with a higher revision can replace a device with a lower revision, unless specified otherwise, e.g. in the documentation.
  Associated and synonymous with each revision there is usually a description (ESI, EtherCAT Slave Information) in the form of an XML file, which is available for download from the Beckhoff web site.
  From 2014/01 the revision is shown on the outside of the IP20 terminals, see Fig. *“EL5021 EL terminal, standard IP20 IO device with batch number and revision ID (since 2014/01)”*.
- The type, version and revision are read as decimal numbers, even if they are technically saved in hexadecimal.

1.6.2 Version identification of EL terminals

The serial number/ data code for Beckhoff IO devices is usually the 8-digit number printed on the device or on a sticker. The serial number indicates the configuration in delivery state and therefore refers to a whole production batch, without distinguishing the individual modules of a batch.

Structure of the serial number: **KK YY FF HH**	Example with serial number 12 06 3A 02:
KK - week of production (CW, calendar week)	12 - production week 12
YY - year of production	06 - production year 2006
FF - firmware version	3A - firmware version 3A
HH - hardware version	02 - hardware version 02

Fig. 1: EL2872 with revision 0022 and serial number 01200815

1.6.3 Beckhoff Identification Code (BIC)

The Beckhoff Identification Code (BIC) is increasingly being applied to Beckhoff products to uniquely identify the product. The BIC is represented as a Data Matrix Code (DMC, code scheme ECC200), the content is based on the ANSI standard MH10.8.2-2016.

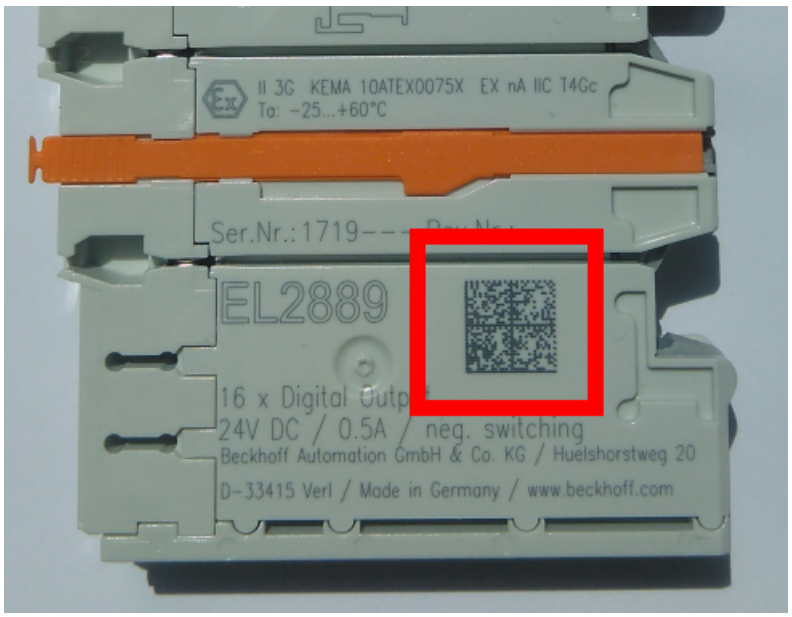


Fig. 2: BIC as data matrix code (DMC, code scheme ECC200)

The BIC will be introduced step by step across all product groups.

Depending on the product, it can be found in the following places:

- on the packaging unit
- directly on the product (if space suffices)
- on the packaging unit and the product

The BIC is machine-readable and contains information that can also be used by the customer for handling and product management.

Each piece of information can be uniquely identified using the so-called data identifier (ANSI MH10.8.2-2016). The data identifier is followed by a character string. Both together have a maximum length according to the table below. If the information is shorter, spaces are added to it.

Following information is possible, positions 1 to 4 are always present, the other according to need of production:

Position	Type of information	Explanation	Data identifier	Number of digits incl. data identifier	Example
1	Beckhoff order number	**Beckhoff order number**	1P	8	1P072222
2	Beckhoff Traceability Number (BTN)	**Unique serial number, see note below**	SBTN	12	SBTNk4p562d7
3	Article description	**Beckhoff article description, e.g. EL1008**	1K	32	1KEL1809
4	Quantity	**Quantity in packaging unit, e.g. 1, 10, etc.**	Q	6	Q1
5	Batch number	Optional: Year and week of production	2P	14	2P401503180016
6	ID/serial number	Optional: Present-day serial number system, e.g. with safety products	51S	12	51S678294
7	Variant number	Optional: Product variant number on the basis of standard products	30P	32	30PF971, 2*K183
...					

Further types of information and data identifiers are used by Beckhoff and serve internal processes.

Structure of the BIC

Example of composite information from positions 1 to 4 and with the above given example value on position 6. The data identifiers are highlighted in bold font:

1P072222**S**BTNk4p562d7**1K**EL1809 **Q**1 **51S**678294

Accordingly as DMC:

Fig. 3: Example DMC **1P**072222**S**BTNk4p562d7**1K**EL1809 **Q**1 **51S**678294

BTN

An important component of the BIC is the Beckhoff Traceability Number (BTN, position 2). The BTN is a unique serial number consisting of eight characters that will replace all other serial number systems at Beckhoff in the long term (e.g. batch designations on IO components, previous serial number range for safety products, etc.). The BTN will also be introduced step by step, so it may happen that the BTN is not yet coded in the BIC.

NOTICE

This information has been carefully prepared. However, the procedure described is constantly being further developed. We reserve the right to revise and change procedures and documentation at any time and without prior notice. No claims for changes can be made from the information, illustrations and descriptions in this information.

1.6.4 Electronic access to the BIC (eBIC)

Electronic BIC (eBIC)

The Beckhoff Identification Code (BIC) is applied to the outside of Beckhoff products in a visible place. If possible, it should also be electronically readable.

The interface that the product can be electronically addressed by is crucial for the electronic readout.

K-bus devices (IP20, IP67)

Currently, no electronic storage or readout is planned for these devices.

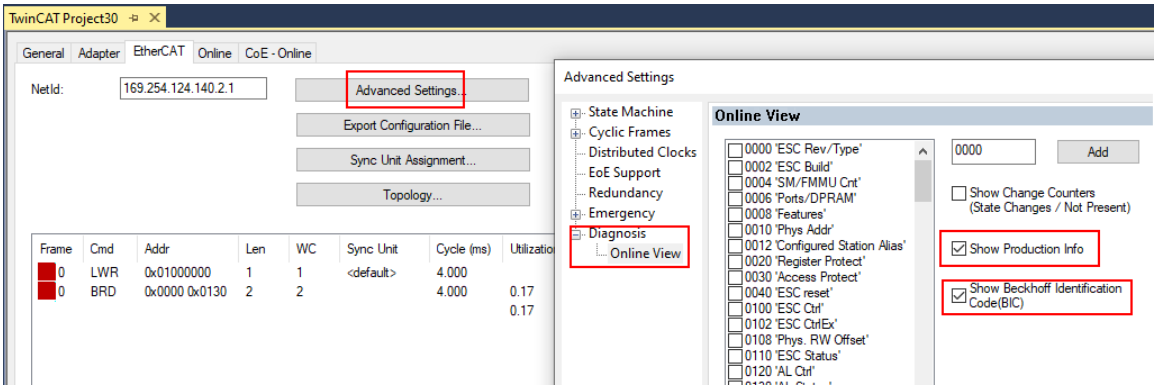
EtherCAT devices (IP20, IP67)

All Beckhoff EtherCAT devices have an ESI-EEPROM which contains the EtherCAT identity with the revision number. The EtherCAT slave information, also colloquially known as the ESI/XML configuration file for the EtherCAT master, is stored in it. See the corresponding chapter in the EtherCAT system manual (Link) for the relationships.

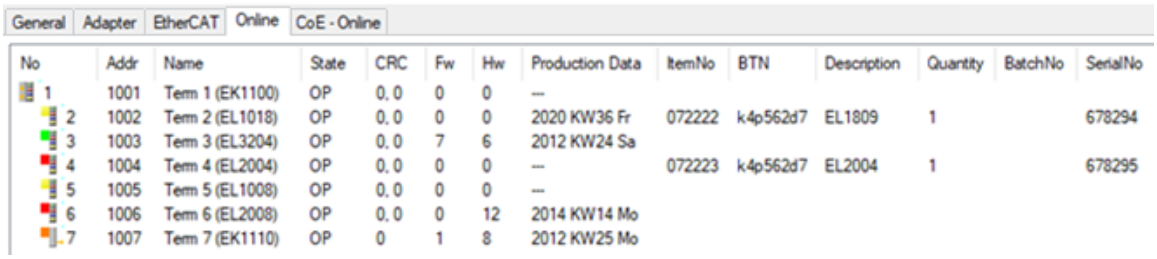
Beckhoff also stores the eBIC in the ESI-EEPROM. The eBIC was introduced into Beckhoff IO production (terminals, box modules) in 2020; as of 2023, implementation is largely complete.

The user can electronically access the eBIC (if present) as follows:

- With all EtherCAT devices, the EtherCAT master (TwinCAT) can read the eBIC from the ESI-EEPROM
  - From TwinCAT 3.1 build 4024.11, the eBIC can be displayed in the online view.
  - To do this, check the "Show Beckhoff Identification Code (BIC)" checkbox under EtherCAT → Advanced Settings → Diagnostics:

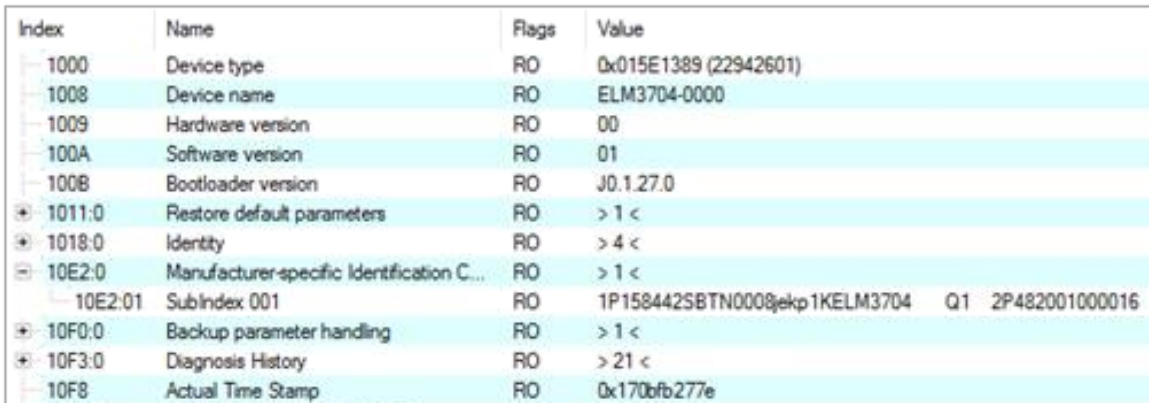


  - The BTN and its contents are then displayed:



  - Note: As shown in the figure, the production data HW version, FW version, and production date, which have been programmed since 2012, can also be displayed with "Show production info".
  - Access from the PLC: From TwinCAT 3.1. build 4024.24, the functions *FB_EcReadBIC* and *FB_EcReadBTN* for reading into the PLC are available in the Tc2_EtherCAT library from v3.3.19.0.
- EtherCAT devices with a CoE directory may also have the object 0x10E2:01 to display their own eBIC, which can also be easily accessed by the PLC:

- The device must be in PREOP/SAFEOP/OP for access:



Index	Name	Flags	Value
1000	Device type	RO	0x015E1389 (22942601)
1008	Device name	RO	ELM3704-0000
1009	Hardware version	RO	00
100A	Software version	RO	01
100B	Bootloader version	RO	J0.1.27.0
1011:0	Restore default parameters	RO	> 1 <
1018:0	Identity	RO	> 4 <
10E2:0	Manufacturer-specific Identification C...	RO	> 1 <
10E2:01	SubIndex 001	RO	1P158442SBTN0008jekp1KELM3704 Q1 2P482001000016
10F0:0	Backup parameter handling	RO	> 1 <
10F3:0	Diagnosis History	RO	> 21 <
10F8	Actual Time Stamp	RO	0x170bfb277e

  - The object 0x10E2 will be preferentially introduced into stock products in the course of necessary firmware revision.
  - From TwinCAT 3.1. build 4024.24, the functions *FB_EcCoEReadBIC* and *FB_EcCoEReadBTN* for reading into the PLC are available in the Tc2_EtherCAT library from v3.3.19.0
- The following auxiliary functions are available for processing the BIC/BTN data in the PLC in *Tc2_Utilities* as of TwinCAT 3.1 build 4024.24
  - F_SplitBIC: The function splits the Beckhoff Identification Code (BIC) sBICValue into its components using known identifiers and returns the recognized substrings in the ST_SplittedBIC structure as a return value
  - BIC_TO_BTN: The function extracts the BTN from the BIC and returns it as a return value
- Note: If there is further electronic processing, the BTN is to be handled as a string(8); the identifier "SBTN" is not part of the BTN.
- Technical background
  The new BIC information is written as an additional category in the ESI-EEPROM during device production. The structure of the ESI content is largely dictated by the ETG specifications, therefore the additional vendor-specific content is stored using a category in accordance with the ETG.2010. ID 03 tells all EtherCAT masters that they may not overwrite these data in the event of an update or restore the data after an ESI update.
  The structure follows the content of the BIC, see here. The EEPROM therefore requires approx. 50..200 bytes of memory.
- Special cases
  - If multiple hierarchically arranged ESCs are installed in a device, only the top-level ESC carries the eBIC information.
  - If multiple non-hierarchically arranged ESCs are installed in a device, all ESCs carry the eBIC information.
  - If the device consists of several sub-devices which each have their own identity, but only the top-level device is accessible via EtherCAT, the eBIC of the top-level device is located in the CoE object directory 0x10E2:01 and the eBICs of the sub-devices follow in 0x10E2:nn.

PROFIBUS; PROFINET, and DeviceNet devices

Currently, no electronic storage or readout is planned for these devices.

2 Product description

2.1 EL1002, EL1004-00x0, EL1008 - Introduction

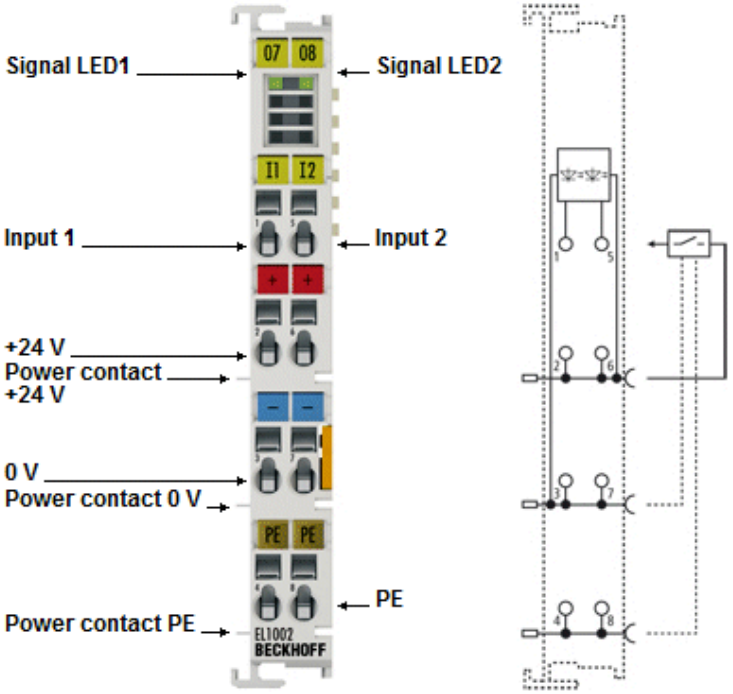


Fig. 4: EL1002

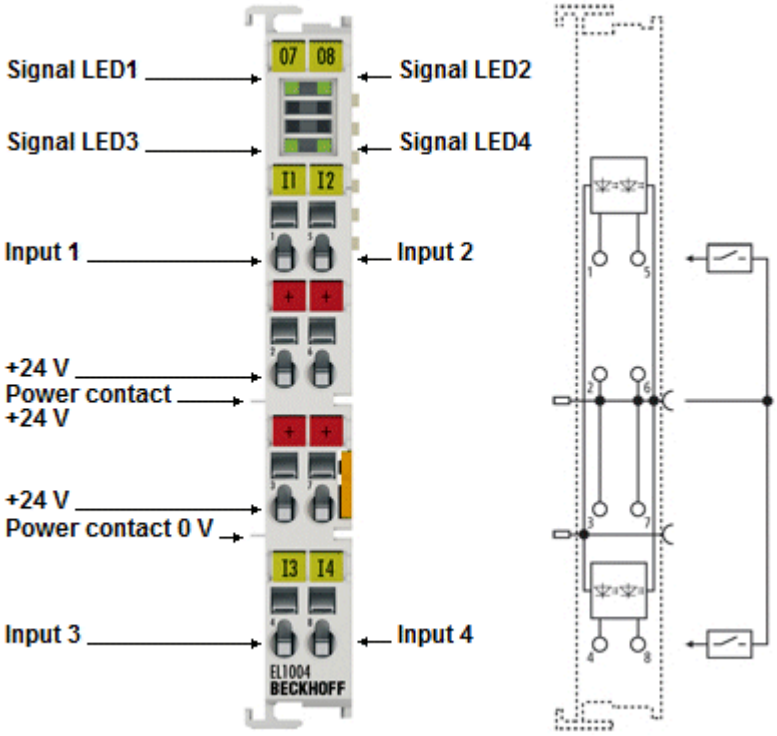


Fig. 5: EL1004

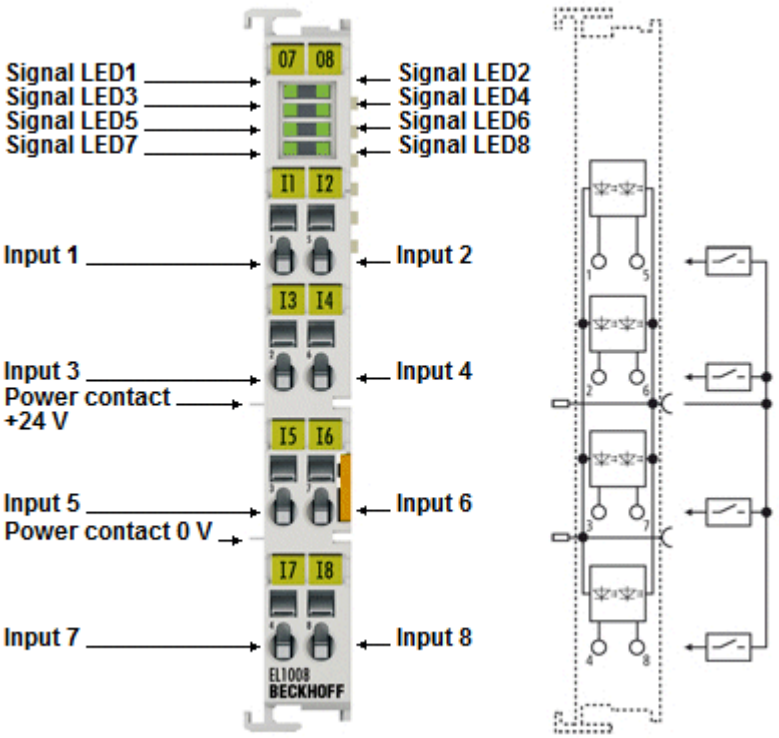


Fig. 6: EL1008

Two-, four- and eight-channel digital input terminals 24 V_{DC}, 3 ms input filter

The EL1002, EL1004 and EL1008 digital input terminals acquire binary control signals from the process level and transmit them, in an electrically isolated form, to the higher-level automation device. They differ in the number of channels and the pin assignment. The digital input terminals of the EL100x series feature an input filter (3 ms) and indicate their signal state through an LED for each channel.
The variant of the EL1004-0020 is designed with a functional potential separation of 2500 V (test voltage E-bus / field voltage).

2.1.1 EL1002 - LEDs and connection

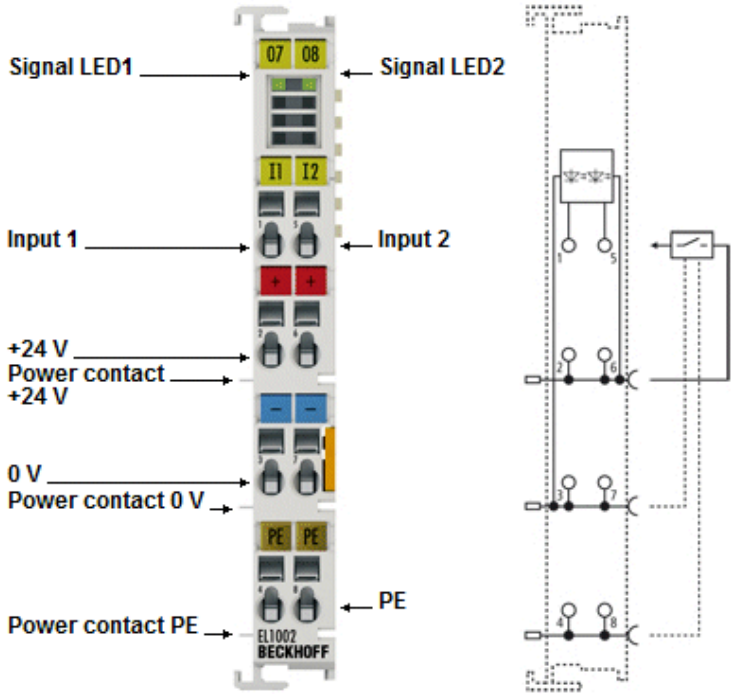


Fig. 7: EL1002

EL1002 - LEDs			
LED	**Color**	**Meaning**	
INPUT 1 INPUT 2	green	off	Signal voltage "0" (-3 V ... 5 V)
		on	Signal voltage "1" (11 V ... 30 V)

EL1002 - Connection		
Terminal point		**Description**
Name	**No.**	
Input 1	1	Input 1
+24 V	2	Sensor supply for input 1 (internally connected to terminal point 6 and positive power contact)
0 V	3	Ground for input 1 (internally connected to terminal point 7 and negative power contact)
PE	4	PE (internally connected to terminal point 8)
Input 2	5	Input 2
+24 V	6	Sensor supply for input 2 (internally connected to terminal point 2 and positive power contact)
0 V	7	Ground for input 2 (internally connected to terminal point 3 and negative power contact)
PE	8	PE (internally connected to terminal point 4)

2.1.2 EL1004-00x0 - LEDs and connection

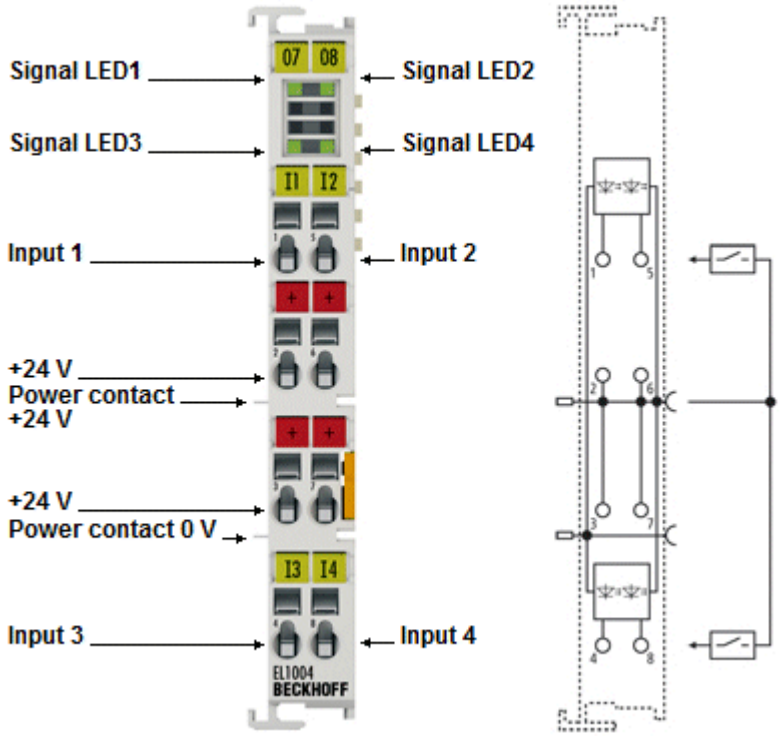


Fig. 8: EL1004

EL1004-00x0 - LEDs

LED	Colour	Meaning	
INPUT 1- 4	green	off	Signal voltage "0" (-3 V ... 5 V)
		on	Signal voltage "1" (11 V ... 30 V)

EL1004-00x0 - Connection

Terminal point		Description
Name	No.	
Input 1	1	Input 1
+24 V	2	Sensor supply for input 1 (internally connected to terminal points 3, 6, 7 and positive power contact)
+24 V	3	Sensor supply for input 3 (internally connected to terminal points 2, 6, 7 and positive power contact)
Input 3	4	Input 3
Input 2	5	Input 2
+24 V	6	Sensor supply for input 2 (internally connected to terminal points 2, 3, 7 and positive power contact)
+24 V	7	Sensor supply for input 4 (internally connected to terminal points 2, 3, 6 and positive power contact)
Input 4	8	Input 4

2.1.3 EL1008 - LEDs and connection

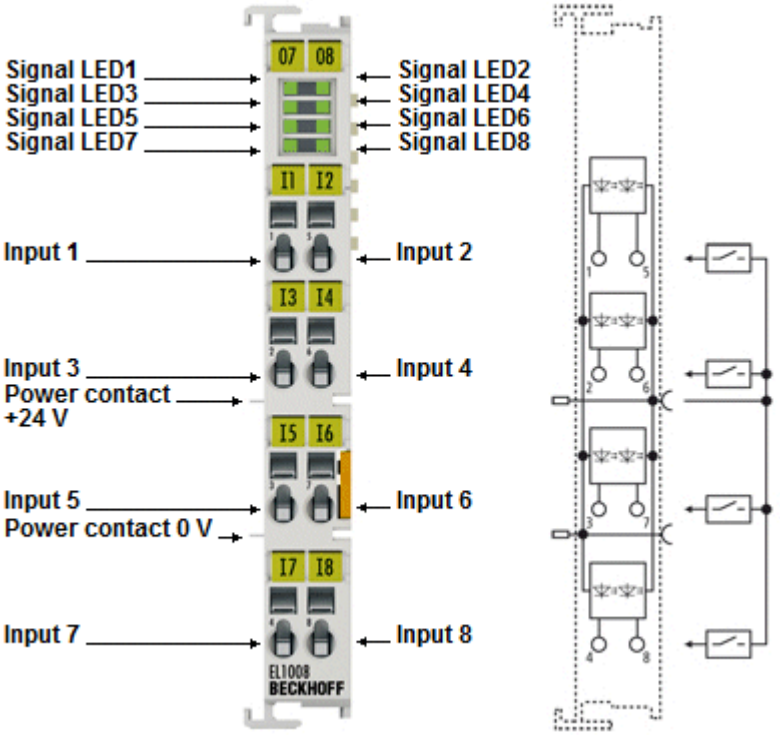


Fig. 9: EL1008

EL1008 - LEDs

LED	Colour	Meaning	
INPUT 1- 8	green	off	Signal voltage "0" (-3 V ... 5 V)
		on	Signal voltage "1" (11 V ... 30 V)

EL1008 - Connection

Terminal point		Description
Name	No.	
Input 1	1	Input 1
Input 3	2	Input 3
Input 5	3	Input 5
Input 7	4	Input 7
Input 2	5	Input 2
Input 4	6	Input 4
Input 6	7	Input 6
Input 8	8	Input 8

2.1.4 EL1002, EL1004-00x0, EL1008 - Technical data

Technical data	EL1002	EL1004	EL1004-0020	EL1008
Number of inputs	2	4		8
Number of simultaneously controllable inputs, depending on the ambient temperature	2 (-25°C … +60°C)	4 (-25°C ... +55°C) 2 (> +55°C)	4 (0°C ... +55°C)	8 (-25°C ... +55°C) 4 (> +55°C) (aligned in horizontal installation position) [▶ 63]
Nominal voltage of the inputs	24 V_{DC} (-15% / +20%)			
Signal voltage "0"	-3 V ... 5 V (EN 61131-2, type 1/3)			
Signal voltage "1"	11 V ... 30 V (EN 61131-2, type 1/3)			
Input filter	3 ms			
Input current	typically 3 mA (EN 61131-2, type 1/3)			
Current consumption power contacts	typ. 2 mA + load			
Current consumption via E-bus	typ. 90 mA			
Electrical isolation	500 V (E-bus/field voltage)		2500 V functional isolation (test voltage E-bus / field voltage, production test).	500 V (E-bus/field voltage)
Bit width in the process image	2 input bits	4 input bits		8 input bits
Configuration	no address setting, configuration via TwinCAT System Manager			
Weight	approx. 55 g			
Permissible ambient temperature range during operation	-25°C ... +60°C (extended temperature range)		0°C ... +55°C	-25°C ... +60°C (extended temperature range, aligned in horizontal installation position [▶ 63]) -25°C ... +45°C (all other installation positions [▶ 63])
Permissible ambient temperature range during storage	-40°C ... +85°C		-25°C ... +85°C	-40°C ... +85°C
Permissible relative humidity	95%, no condensation			
Dimensions (W x H x D)	approx. 15 mm x 100 mm x 70 mm (width aligned: 12 mm)			
Mounting [▶ 51]	on 35 mm mounting rail conforms to EN 60715			
Enhanced mechanical load capacity	Yes, see also Installation instructions for terminals with increased mechanical load capacity [▶ 65]		-	Yes, see also Installation instructions for terminals with increased mechanical load capacity [▶ 65]
Vibration/shock resistance	according to EN 60068-2-6/EN 60068-2-27			
EMC resistance burst/ESD	conforms to EN 61000-6-2 / EN 61000-6-4			
Protection class	IP20			
Installation position	variable			see note [▶ 63]
Approvals/markings*	CE, UKCA, EAC cULus [▶ 58], ATEX [▶ 53], IECEx [▶ 54], cFMus [▶ 56], DNV GL		CE, UKCA, EAC, cULus [▶ 58]	CE, UKCA, EAC, cULus [▶ 58], ATEX [▶ 53], IECEx [▶ 54], cFMus [▶ 56], DNV GL

*) Real applicable approvals/markings see type plate on the side (product marking).

Ex markings

Standard	Marking
ATEX	II 3 G Ex nA IIC T4 Gc
IECEx	Ex nA IIC T4 Gc
cFMus	Class I, Division 2, Groups A, B, C, D Class I, Zone 2, AEx/Ex ec IIC T4 Gc

2.2 EL1012, EL1014, EL1018 - Introduction

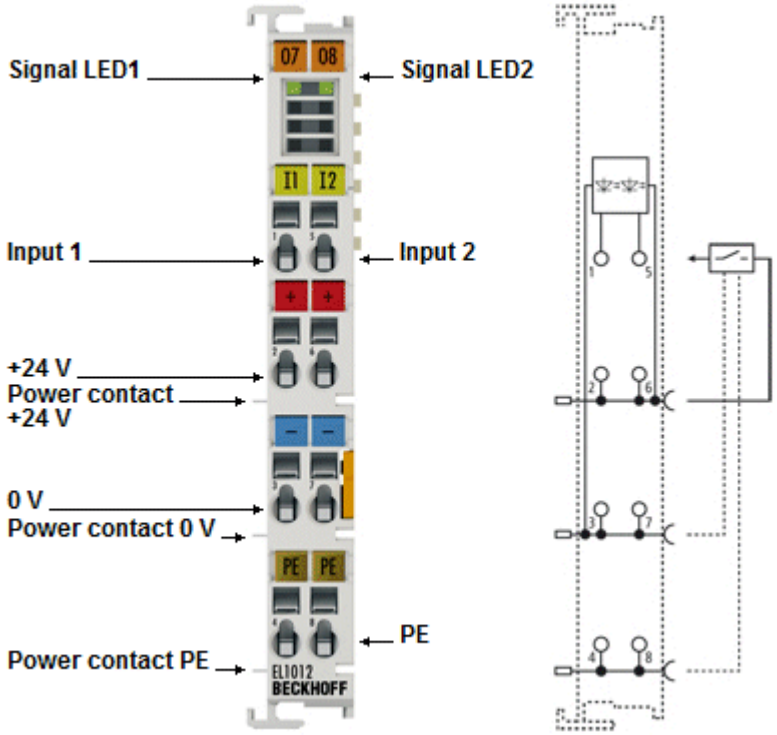


Fig. 10: EL1012

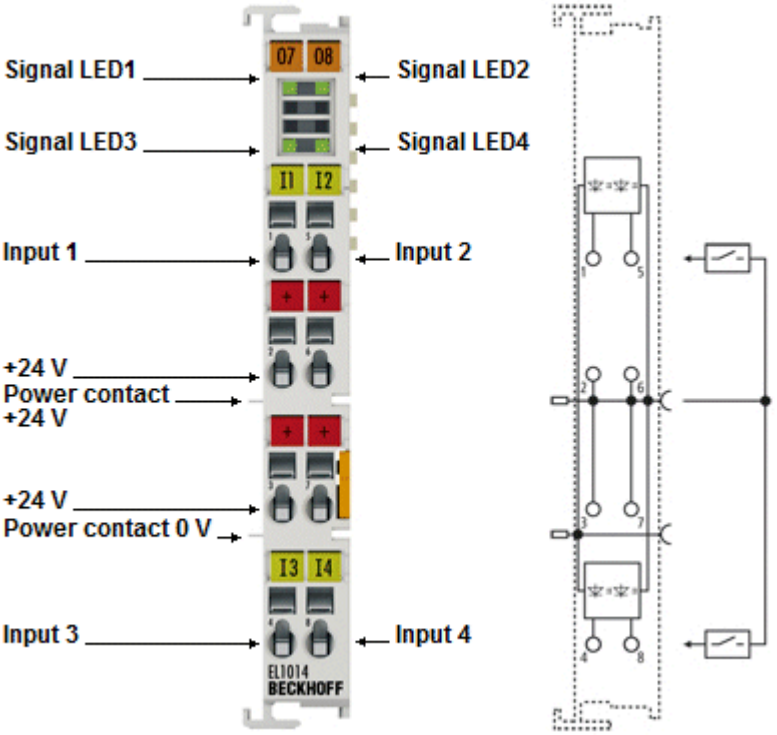


Fig. 11: EL1014

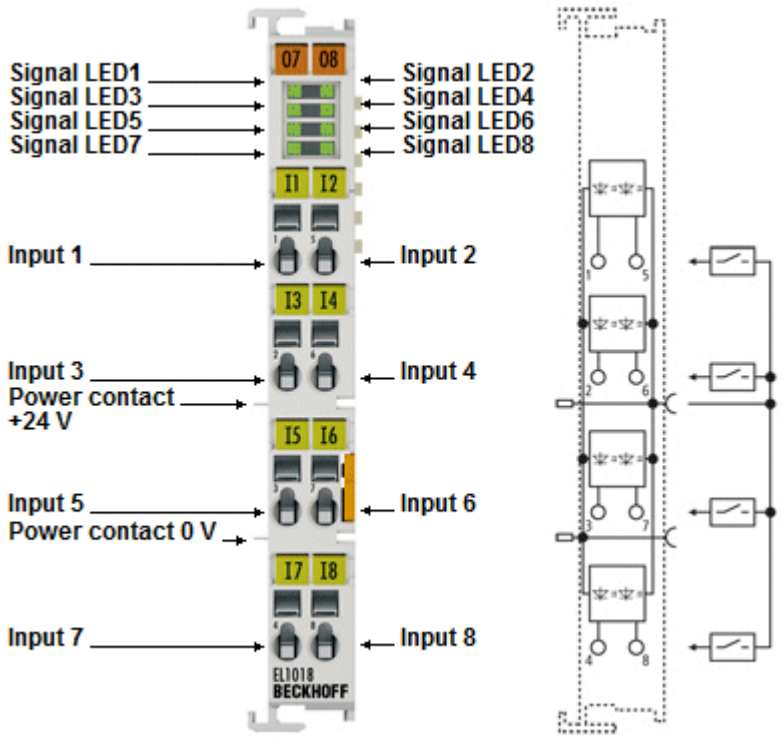


Fig. 12: EL1018

Two-, four- and eight-channel digital input terminals 24 V_{DC}, 10 µs input filter

The EL101x digital input terminals acquire binary control signals from the process level and transmit them, in an electrically isolated form, to the higher-level automation device. They differ in the number of channels and the pin assignment. The digital input terminals of the EL101x series feature an input filter (10 µs) and indicate their signal state through an LED for each channel.

2.2.1 EL1012 - LEDs and connection

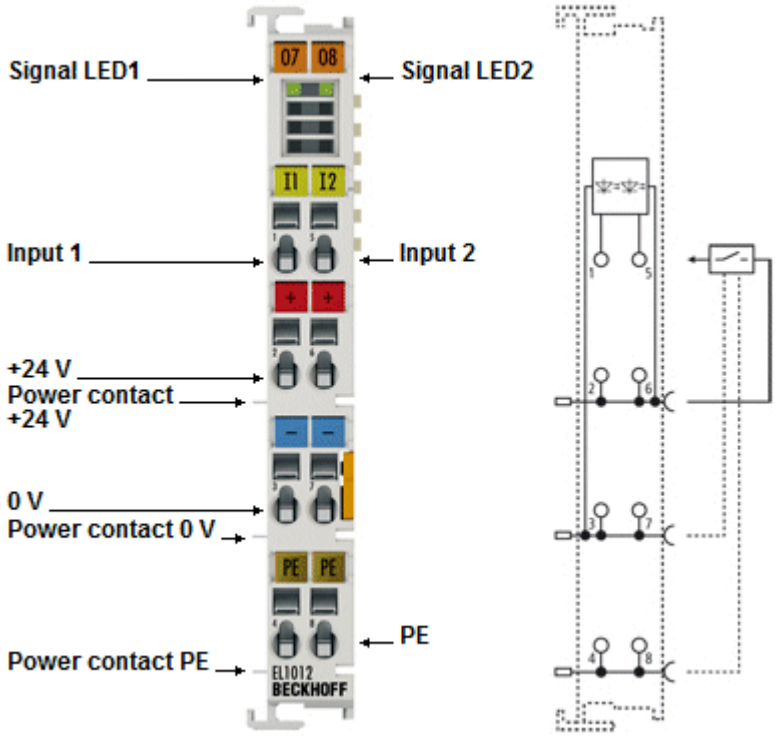


Fig. 13: EL1012

EL1012 - LEDs

LED	Color	Meaning	
INPUT 1 INPUT 2	green	off	Signal voltage "0" (-3 V ... 5 V)
		on	Signal voltage "1" (11 V ... 30 V)

EL1012 – Connection

Terminal point		Description
Name	No.	
Input 1	1	Input 1
+24 V	2	Sensor supply for input 1 (internally connected to terminal point 6 and positive power contact)
0 V	3	Ground for input 1 (internally connected to terminal point 7 and negative power contact)
PE	4	PE (internally connected to terminal point 8)
Input 2	5	Input 2
+24 V	6	Sensor supply for input 2 (internally connected to terminal point 2 and positive power contact)
0 V	7	Ground for input 2 (internally connected to terminal point 3 and negative power contact)
PE	8	PE (internally connected to terminal point 4)

2.2.2 EL1014 - LEDs and connection

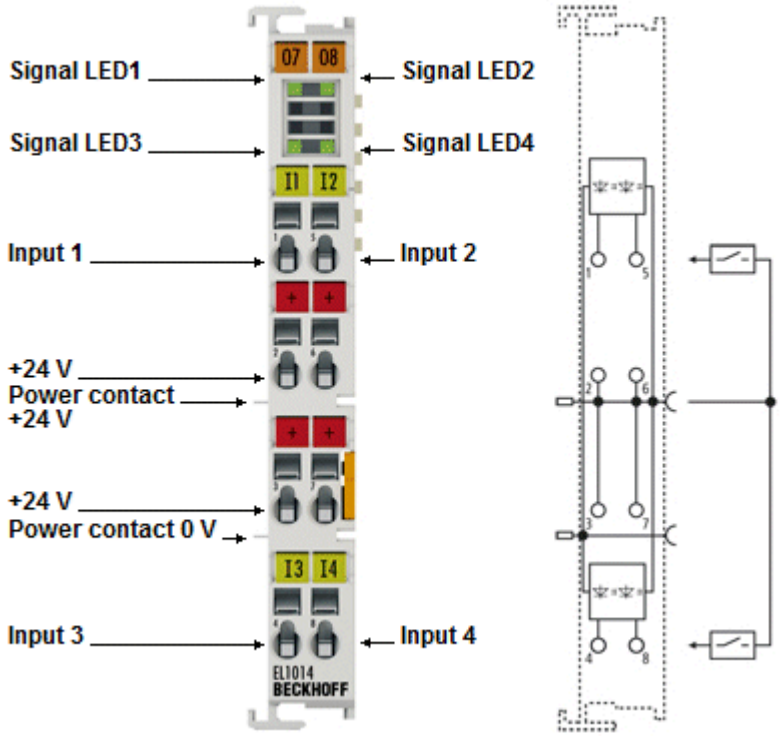


Fig. 14: EL1014

EL1014 - LEDs

LED	Color	Meaning	
INPUT 1- 4	green	off	Signal voltage "0" (-3 V ... 5 V)
		on	Signal voltage "1" (11 V ... 30 V)

EL1014 - Connection

Terminal point		Description
Name	No.	
Input 1	1	Input 1
+24 V	2	Sensor supply for input 1 (internally connected to terminal points 3, 6, 7 and positive power contact)
+24 V	3	Sensor supply for input 3 (internally connected to terminal points 2, 6, 7 and positive power contact)
Input 3	4	Input 3
Input 2	5	Input 2
+24 V	6	Sensor supply for input 2 (internally connected to terminal points 2, 3, 7 and positive power contact)
+24 V	7	Sensor supply for input 4 (internally connected to terminal points 2, 3, 6 and positive power contact)
Input 4	8	Input 4

2.2.3 EL1018 - LEDs and connection

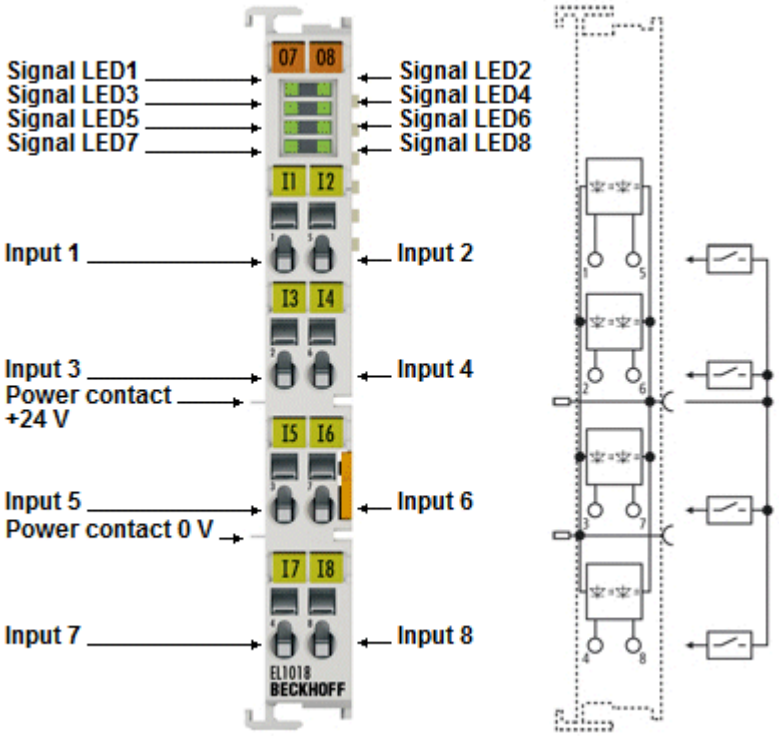


Fig. 15: EL1018

EL1018 - LEDs

LED	Color	Meaning	
INPUT 1- 8	green	off	Signal voltage "0" (-3 V ... 5 V)
		on	Signal voltage "1" (11 V ... 30 V)

EL1018 - Connection

Terminal point		Description
Name	No.	
Input 1	1	Input 1
Input 3	2	Input 3
Input 5	3	Input 5
Input 7	4	Input 7
Input 2	5	Input 2
Input 4	6	Input 4
Input 6	7	Input 6
Input 8	8	Input 8

2.2.4 EL1012, EL1014, EL1018 - Technical data

Technical data	EL1012	EL1014	EL1018
Number of inputs	2	4	8
Number of simultaneously controllable inputs, depending on the ambient temperature	2 (-25°C … +60°C)	4 (-25°C ... +55°C) 2 (> +55°C)	8 (-25°C ... +55°C) 4 (> +55°C) (aligned in horizontal installation position) [▶ 63]
Nominal voltage of the inputs	24 V_{DC} (-15% / +20%)		
Signal voltage "0"	-3 V ...5 V (EN 61131-2, type 1/3)		
Signal voltage "1"	11 V ... 30 V (EN 61131-2, type 1/3)		
Input filter	10 µs typ. (10...50 µs)		
Input current	typically 3 mA (EN 61131-2, type 1/3)		
Current consumption power contacts	typ. 2 mA + load		
Current consumption via E-bus	typ. 90 mA	typ. 90 mA	typ. 90 mA
Electrical isolation	500 V (E-bus/field voltage)		
Bit width in the process image	2 input bits	4 input bits	8 input bits
Configuration	no address setting, configuration via TwinCAT System Manager		
Weight	approx. 55 g		
Permissible ambient temperature range during operation	-25°C ... +60°C (extended temperature range)		-25°C ... +60°C (extended temperature range, aligned in horizontal installation position [▶ 63]) -25°C ... +45°C (all other installation positions [▶ 63])
Permissible ambient temperature range during storage	-40°C ... +85°C		
Permissible relative humidity	95%, no condensation		
Dimensions (W x H x D)	approx. 15 mm x 100 mm x 70 mm (width aligned: 12 mm)		
Mounting [▶ 51]	on 35 mm mounting rail conforms to EN 60715		
Enhanced mechanical load capacity	yes, see also Installation instructions for terminals with increased mechanical load capacity [▶ 65]		
Vibration/shock resistance	according to EN 60068-2-6/EN 60068-2-27		
EMC resistance burst/ESD	conforms to EN 61000-6-2 / EN 61000-6-4		
Protection class	IP20		
Installation position	variable		see note [▶ 63]
Approvals/markings*	CE, UKCA, EAC, cULus [▶ 58], ATEX [▶ 53], IECEx [▶ 54], DNV GL		

*) Real applicable approvals/markings see type plate on the side (product marking).

Ex markings

Standard	Marking
ATEX	II 3 G Ex nA IIC T4 Gc
IECEx	Ex nA IIC T4 Gc

2.3 EL1024, EL1034 - Introduction

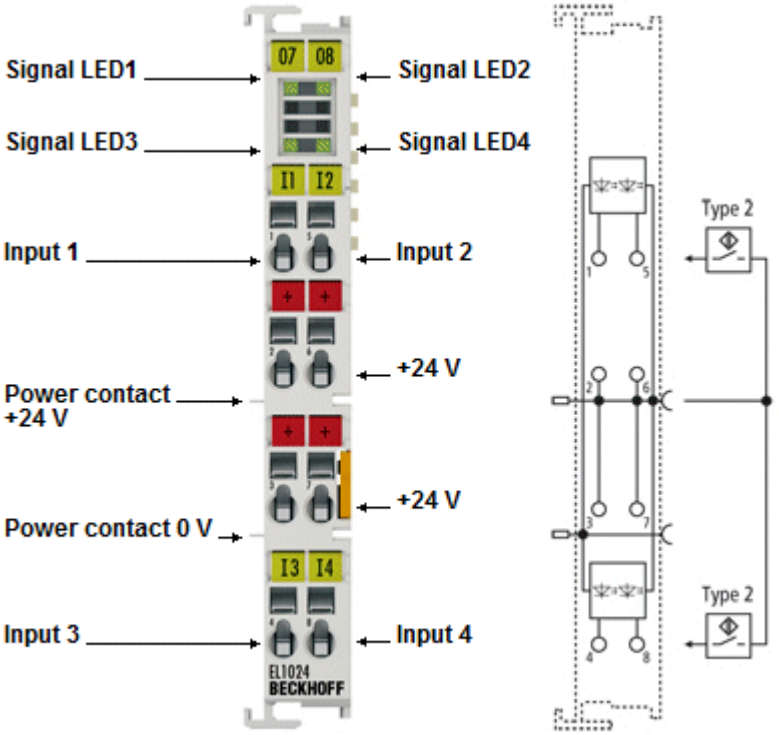


Fig. 16: EL1024

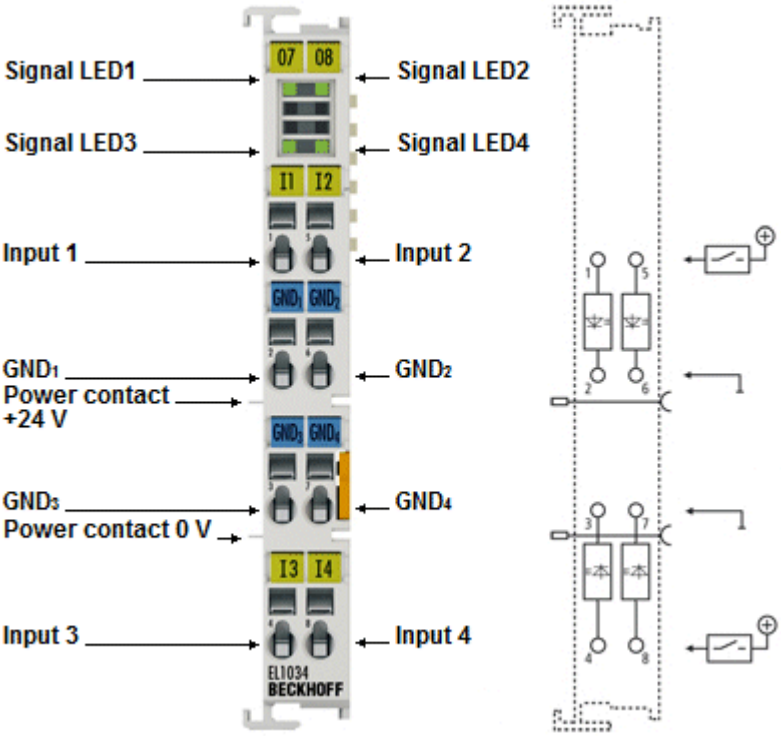


Fig. 17: EL1034

EL1024 - four-channel digital input terminals 24 $V_{DC,}$ for type 2 sensors
EL1034 - four-channel digital input terminals 24 V_{DC}, potential-free inputs

The EL1024 digital input terminal acquires the binary 24 V control signals and transmits them, in an electrically isolated form, to the higher-level automation system. The EtherCAT Terminal contains four channels that indicate its signal state by means of light emitting diodes. With its input signal the EL1024 corresponds to IEC 61131-2, Type 2. Additionally, the 4-channel EtherCAT Terminals enable the direct connection of four 2-wire sensors. Four +24 V connection points are provided.

The EL1034 features electrical isolation of the individual channels. With its input signal it corresponds to IEC 61131-2, Type 1.

2.3.1 EL1024 - LEDs and connection

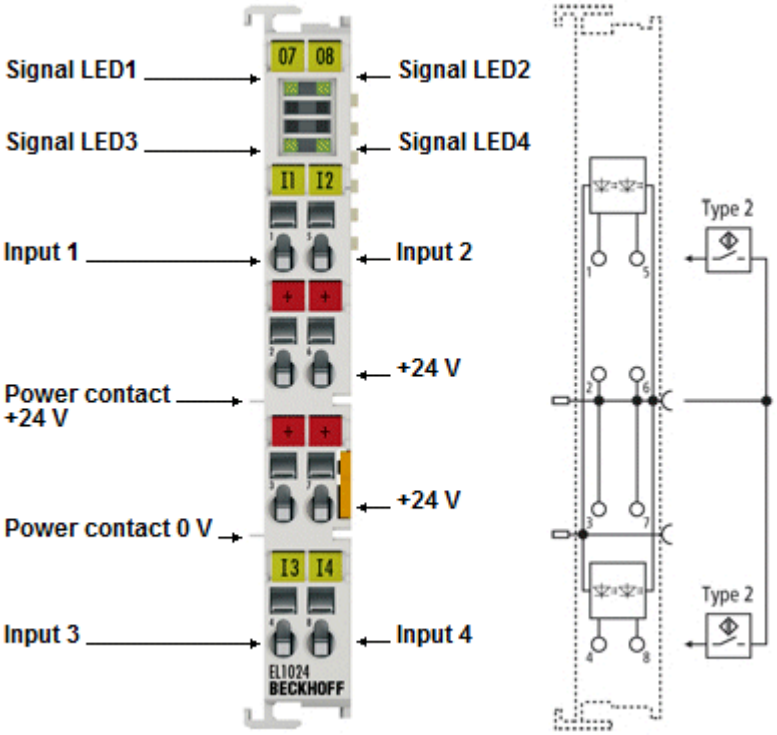


Fig. 18: EL1024

EL1024 - LEDs

LED	Color	Meaning	
INPUT 1- 4	green	off	Signal voltage "0" (-3 V ... 5 V)
		on	Signal voltage "1" (11 V ... 30 V)

EL1024 - Connection

Terminal point		Description
Name	No.	
Input 1	1	Input 1
+24 V	2	Sensor supply for input 1 (internally connected to terminal points 3, 6, 7 and positive power contact)
+24 V	3	Sensor supply for input 3 (internally connected to terminal points 2, 6, 7 and positive power contact)
Input 3	4	Input 3
Input 2	5	Input 2
+24 V	6	Sensor supply for input 2 (internally connected to terminal points 2, 3, 7 and positive power contact)
+24 V	7	Sensor supply for input 4 (internally connected to terminal points 2, 3, 6 and positive power contact)
Input 4	8	Input 4

2.3.2 EL1034 - LEDs and connection

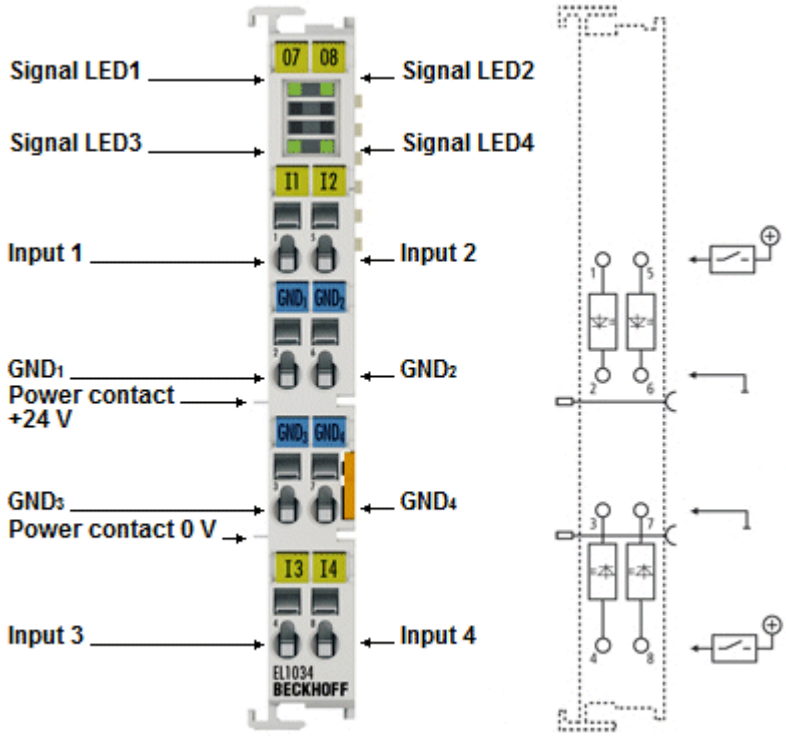


Fig. 19: EL1034

EL1034 - LEDs

LED	Color	Meaning	
INPUT 1- 4	green	off	Signal voltage "0" (-3 V ... 5 V)
		on	Signal voltage "1" (15 V ... 30 V)

EL1034 - Connection

Terminal point		Description
Name	No.	
Input 1	1	Input 1
GND 1	2	Ground (GND) 1
GND 3	3	Ground (GND) 3
Input 3	4	Input 3
Input 2	5	Input 2
GND 2	6	Ground (GND) 2
GND 4	7	Ground (GND) 4
Input 4	8	Input 4

2.3.3 EL1024, EL1034 - Technical data

Technical data	EL1024	EL1034
Number of inputs	4	4 (potential-free)
Nominal voltage of the inputs	24 V_{DC} (-15% / +20%)	
Signal voltage "0"	-3 V ... 5 V (EN 61131-2, type 2)	-3 V ... 5 V (EN 61131-2, type 1)
Signal voltage "1"	11 V ... 30 V (EN 61131-2, type 2)	15 V ... 30 V (EN 61131-2, type 1)
Input filter	3 ms	10 µs
Input current	typically 6 mA (EN 61131-2, type 2)	typically 3 mA (EN 61131-2, type 1)
Current consumption power contacts	typ. 30 mA + load	-
Current consumption via E-bus	typ. 90 mA	
Electrical isolation	500 V (E-bus/field voltage)	
Bit width in the process image	4 input bits	
Configuration	no address setting, configuration via TwinCAT System Manager	
Weight	approx. 55 g	
Permissible ambient temperature range during operation	0°C ... +55°C	
Permissible ambient temperature range during storage	-25°C ... +85°C	
Permissible relative humidity	95%, no condensation	
Dimensions (W x H x D)	approx. 15 mm x 100 mm x 70 mm (width aligned: 12 mm)	
Mounting [▶ 51]	on 35 mm mounting rail conforms to EN 60715	
Enhanced mechanical load capacity	yes, see also Installation instructions for terminals with increased mechanical load capacity [▶ 65]	
Vibration/shock resistance	according to EN 60068-2-6/EN 60068-2-27	
EMC resistance burst/ESD	conforms to EN 61000-6-2 / EN 61000-6-4	
Protection class	IP20	
Installation position	variable	
Approvals/markings*	CE, UKCA, EAC, cULus [▶ 58], ATEX [▶ 52], IECEx [▶ 54]	

*) Real applicable approvals/markings see type plate on the side (product marking).

Ex markings

Standard	Marking
ATEX	II 3 G Ex nA IIC T4 Gc
IECEx	Ex nA IIC T4 Gc

2.4 EL108x, EL109x - Introduction

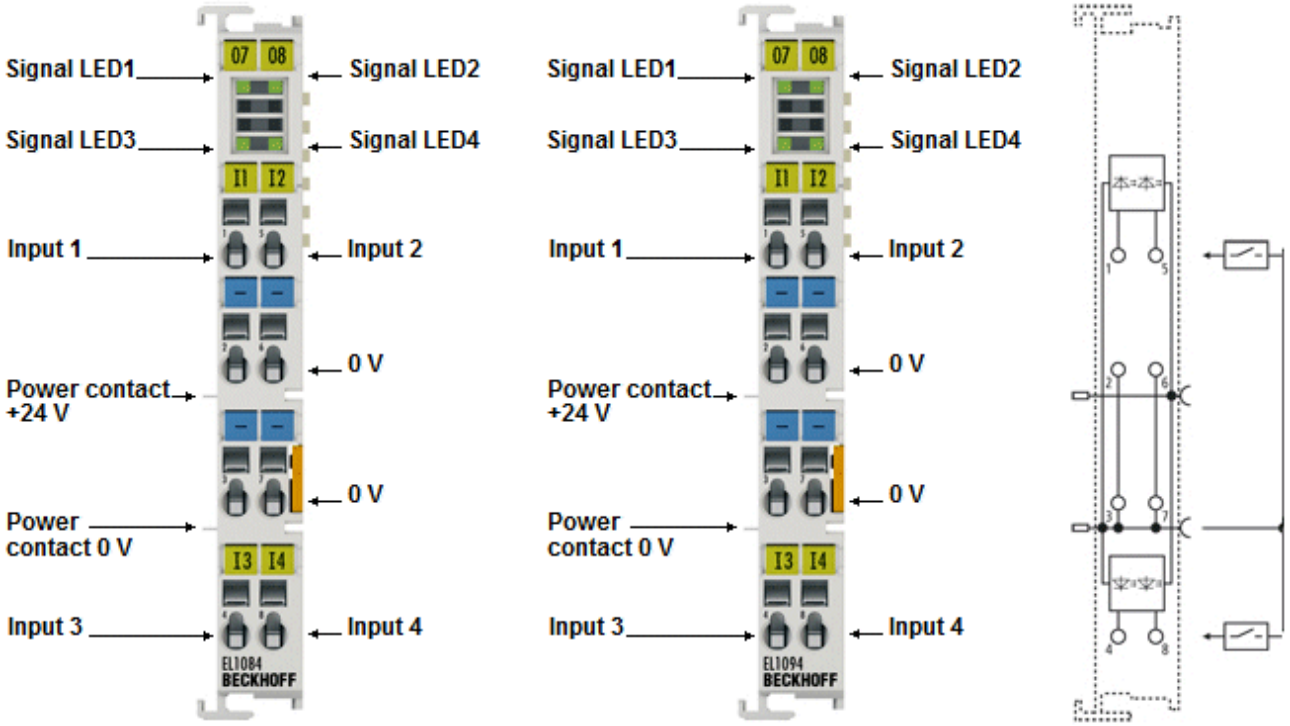


Fig. 20: EL1084, EL1094

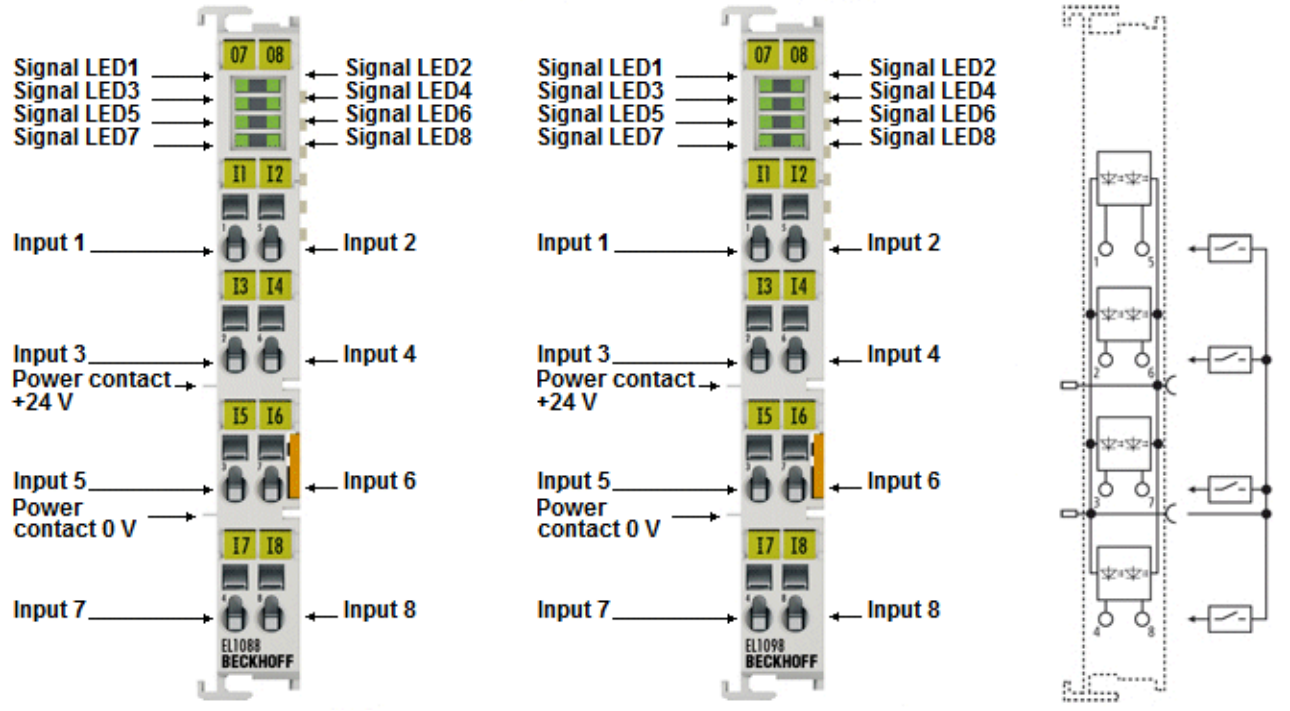


Fig. 21: EL1088, EL1098

Four- and eight-channel digital input terminals 24 V_{DC}, switching to negative potential

The EL108x and EL109x digital input terminals acquire the binary control signals from the process level and transmit them, in an electrically isolated form, to the higher-level automation device. The EL108x and EL109x versions have input filters of different speeds. Four 2-wire sensors can be connected to the EL1084 and EL1094 EtherCAT Terminals. The EL1088 and EL1098 8-channel terminals are suitable for multi-channel sensors with single-wire connections. The EtherCAT Terminals indicate their signal state by means of light emitting diodes.

2.4.1 EL1084, EL1094 - LEDs and connection

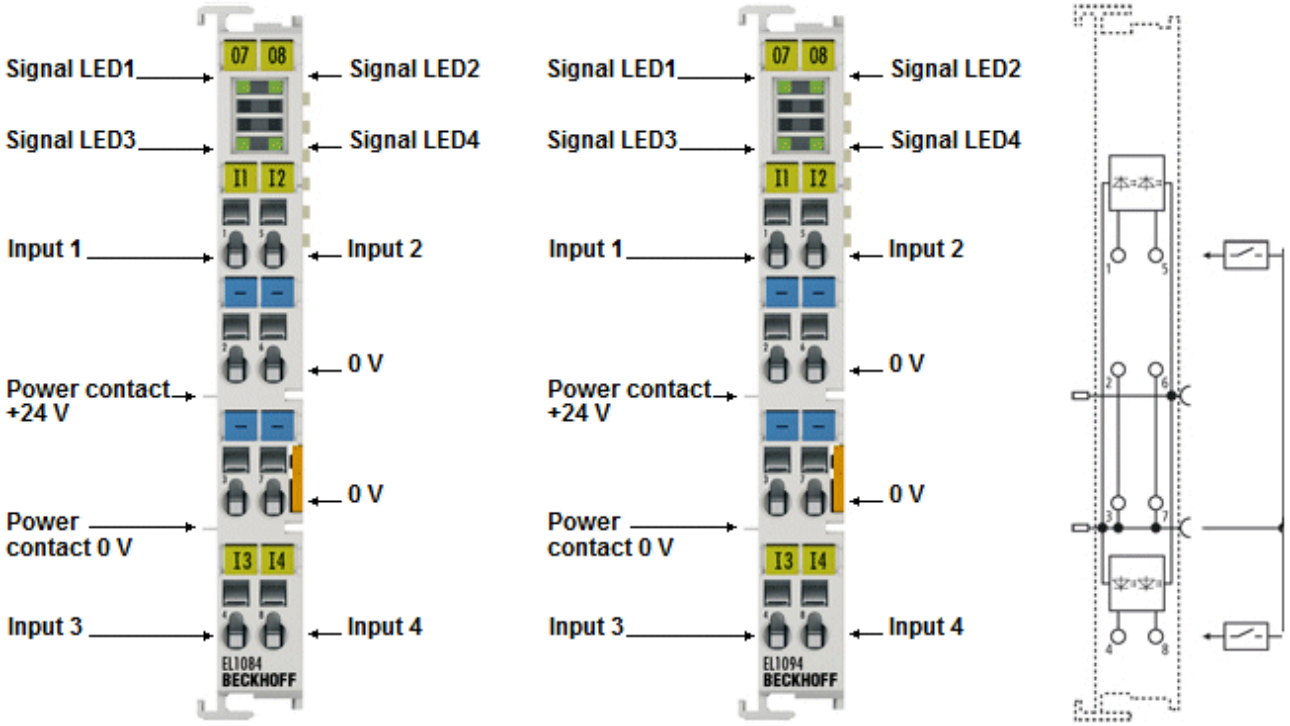


Fig. 22: EL1084, EL1094

EL1084, EL1094 - LEDs

LED	Color	Meaning	
INPUT 1- 4	green	off	Signal voltage "0" (18 V ... 30 V)
		on	Signal voltage "1" (0 V ... 7 V)

EL1084, EL1094 - Connection

Terminal point		Description
Name	No.	
Input 1	1	Input 1
0 V	2	0 V (internally connected to terminal point 3, 6, 7 and negative power contact)
0 V	3	0 V (internally connected to terminal point 2, 6, 7 and negative power contact)
Input 3	4	Input 3
Input 2	5	Input 2
0V	6	0 V (internally connected to terminal point 2, 3, 7 and negative power contact)
0V	7	0 V (internally connected to terminal point 2, 3, 6 and negative power contact)
Input 4	8	Input 4

2.4.2 EL1088, EL1098 - LEDs and connection

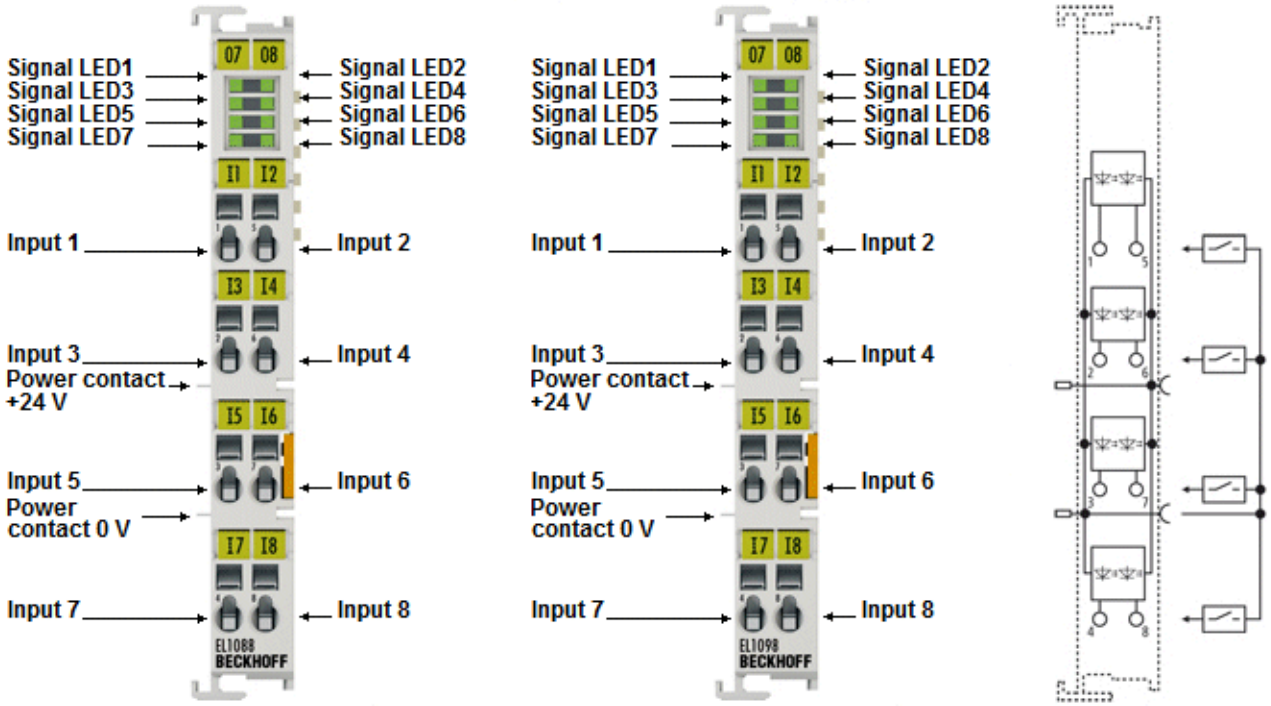


Fig. 23: EL1088, EL1098

EL1088, EL1098 - LEDs

LED	Color	Meaning	
INPUT 1- 8	green	off	Signal voltage "0" (18 V ... 30 V)
		on	Signal voltage "1" (0 V ... 7 V)

EL1088, EL1098 - Connection

Terminal point		Description
Name	No.	
Input 1	1	Input 1
Input 3	2	Input 3
Input 5	3	Input 5
Input 7	4	Input 7
Input 2	5	Input 2
Input 4	6	Input 4
Input 6	7	Input 6
Input 8	8	Input 8

2.4.3 EL1084, EL1088, EL1094, EL1098 - Technical data

Technical data	EL1084	EL1088	EL1094	EL1098
Number of inputs	4	8	4	8
Nominal voltage of the inputs	24 V_{DC} (-15% / +20%)			
Signal voltage "0"	18 V ... 30 V			
Signal voltage "1"	0 V ... 7 V			
Input filter	3 ms	3 ms	10 µs	10 µs
Input current	typ. 3 mA			
Current consumption power contacts	typ. 20 mA	typ. 25 mA	typ. 20 mA	typ. 25 mA
Current consumption via E-bus	typ. 90 mA			
Electrical isolation	500 V (E-bus/field voltage)			
Bit width in the process image	4 input bits	8 input bits	4 input bits	8 input bits
Configuration	no address setting, configuration via TwinCAT System Manager			
Weight	approx. 55 g			
Permissible ambient temperature range during operation	0°C ... +55°C	0°C ... +55°C (aligned in horizontal installation position) 0°C ... +45°C (all other installation positions, see Note [▶ 63])	0°C ... +55°C	0°C ... +55°C (aligned in horizontal installation position) 0°C ... +45°C (all other installation positions, see Note [▶ 63])
Permissible ambient temperature range during storage	-25°C ... +85°C			
Permissible relative humidity	95%, no condensation			
Dimensions (W x H x D)	approx. 15 mm x 100 mm x 70 mm (width aligned: 12 mm)			
Mounting [▶ 51]	on 35 mm mounting rail conforms to EN 60715			
Enhanced mechanical load capacity	yes, see also Installation instructions for terminals with increased mechanical load capacity [▶ 65]			
Vibration/shock resistance	according to EN 60068-2-6/EN 60068-2-27			
EMC resistance burst/ESD	conforms to EN 61000-6-2 / EN 61000-6-4			
Protection class	IP20			
Installation position	variable	see note [▶ 63]	variable	see note [▶ 63]
Approvals/markings*	CE, UKCA, EAC, cULus [▶ 58], ATEX [▶ 52], IECEx [▶ 54], DNV GL			

*) Real applicable approvals/markings see type plate on the side (product marking).

Ex markings

Standard	Marking
ATEX	II 3 G Ex nA IIC T4 Gc
IECEx	Ex nA IIC T4 Gc

2.5 EL1104, EL1114 - Introduction

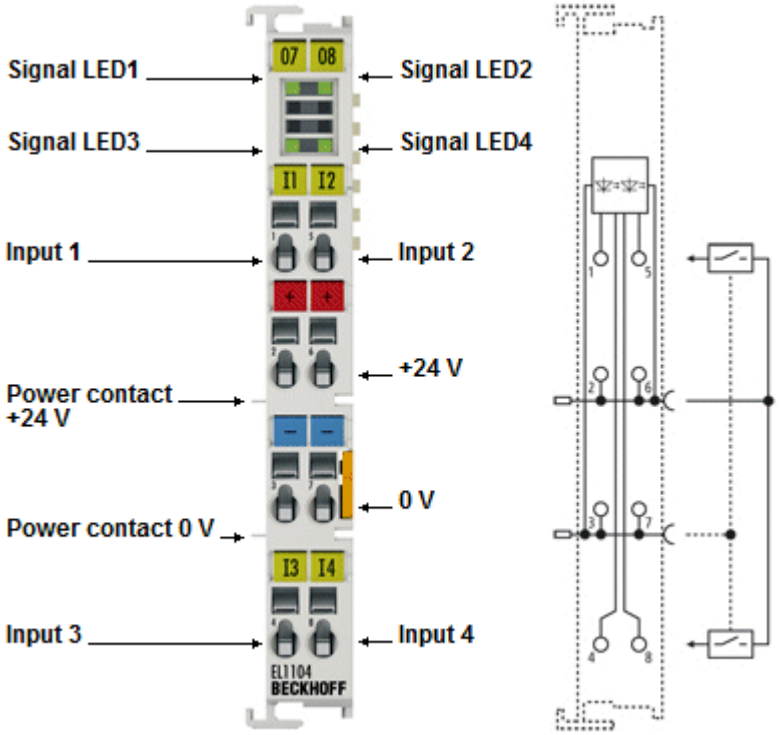


Fig. 24: EL1104

Four-channel digital input terminals 24 V_{DC} with sensor supply

The EL1104 and EL1114 digital input terminals acquire the binary control signals from the process level and transmit them, in an electrically isolated form, to the higher-level automation unit. The EL1104 and EL1114 versions have input filters of different speeds. The EtherCAT Terminals contain four channels that indicate their signal state by means of light emitting diodes.

2.5.1 EL1104, EL1114 - LEDs and connection

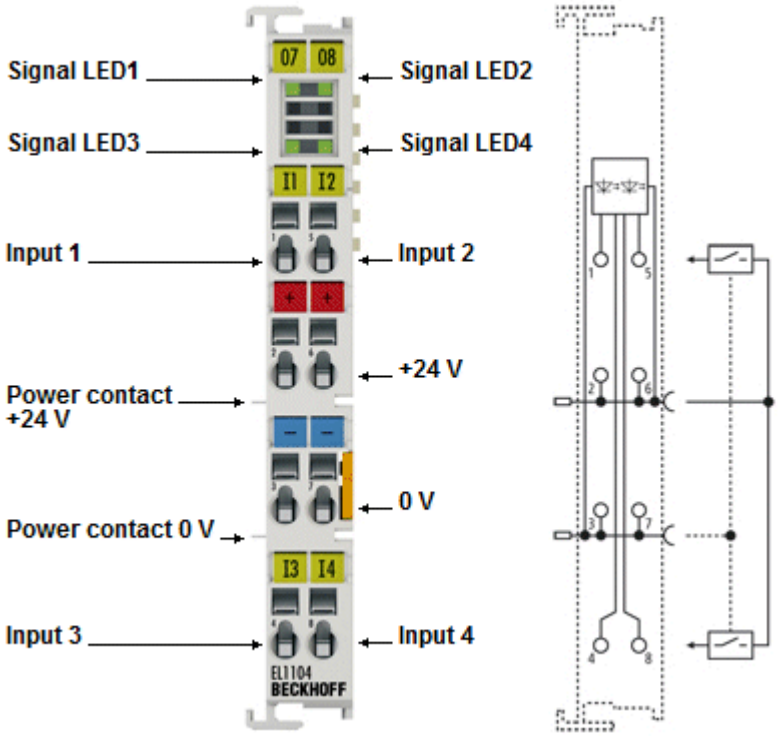


Fig. 25: EL1104

EL1104, EL1114 - LEDs

LED	Color	Meaning	
INPUT 1- 4	green	off	Signal voltage "0" (-3 V ... 5 V)
		on	Signal voltage "1" (11 V ... 30 V)

EL1104, EL1114 - Connection

Terminal point		Description
Name	No.	
Input 1	1	Input 1
+24 V	2	Sensor supply +24 V (internally connected to terminal point 6 and positive power contact)
0 V	3	Sensor supply 0 V (internally connected to terminal point 7 and negative power contact)
Input 3	4	Input 3
Input 2	5	Input 2
+24 V	6	Sensor supply +24 V (internally connected to terminal point 2 and positive power contact)
0 V	7	Sensor supply 0 V (internally connected to terminal point 3 and negative power contact)
Input 4	8	Input 4

2.5.2 EL1104, EL1114 - Technical data

Technical data	EL1104	EL1114
Number of inputs	4	
Number of simultaneously controllable inputs, depending on the ambient temperature	4 (-25°C ... +55°C) 2 (> +55°C)	4 (0°C ... +55°C)
Nominal voltage of the inputs	24 V_{DC} (-15% / +20%)	
Signal voltage "0"	-3 V ... 5 V (EN 61131-2, type 1/3)	
Signal voltage "1"	11 V ... 30 V (EN 61131-2, type 1/3)	
Input filter	3 ms	10 µs typ. (10...50 µs)
Input current	typically 3 mA (EN 61131-2, type 1/3)	
Current consumption power contacts	typ. 2 mA + load	
Current consumption from the E-bus	typ. 90 mA	
Electrical isolation	500 V (E-bus/field voltage)	
Bit width in the process image	4 input bits	
Configuration	no address setting, configuration via TwinCAT System Manager	
Weight	approx. 55 g	
Permissible ambient temperature range during operation	-25°C ... +60°C (extended temperature range)	0°C ... +55°C
Permissible ambient temperature range during storage	-40°C ... +85°C	-25°C ... +85°C
Permissible relative humidity	95%, no condensation	
Dimensions (W x H x D)	approx. 15 mm x 100 mm x 70 mm (width aligned: 12 mm)	
Mounting [▶ 51]	on 35 mm mounting rail conforms to EN 60715	
Enhanced mechanical load capacity	yes, see also Installation instructions for terminals with increased mechanical load capacity [▶ 65]	
Vibration/shock resistance	according to EN 60068-2-6/EN 60068-2-27	
EMC resistance burst/ESD	conforms to EN 61000-6-2 / EN 61000-6-4	
Protection class	IP20	
Installation position	variable	
Approvals/markings*	CE, UKCA, EAC, cULus [▶ 58], ATEX [▶ 53], IECEx [▶ 54]	CE, UKCA, EAC, cULus [▶ 58], ATEX [▶ 52], IECEx [▶ 54]

*) Real applicable approvals/markings see type plate on the side (product marking).

Ex markings

Standard	Marking
ATEX	II 3 G Ex nA IIC T4 Gc
IECEx	Ex nA IIC T4 Gc

2.6 EL1124, EL1144, EL1134 - Introduction

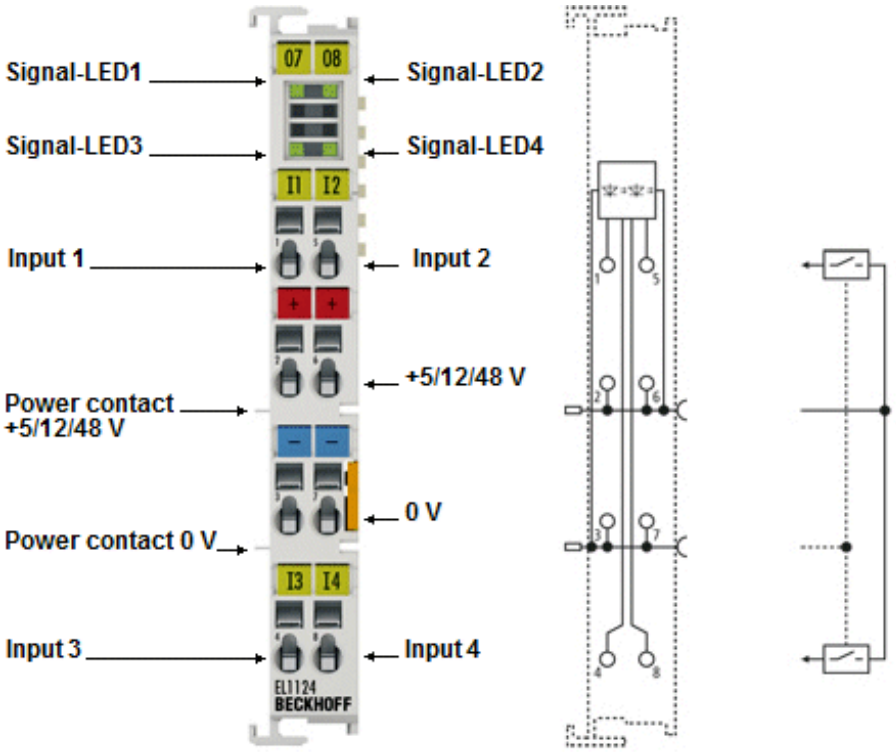


Fig. 26: EL1124

Four-channel digital input terminals + 5 / 12 / 48 V_{DC}

The EL1124 (5 V_{DC}), EL1144 (12 V_{DC}) and EL1134 (48 V_{DC}) digital input terminals acquire the binary control signals and transmit them, in an electrically isolated form, to the higher-level automation unit. The EtherCAT Terminals contain four channels that indicate their signal state by means of light emitting diodes. These versions have different input voltages.

2.6.1 EL1124, EL1144, EL1134 - LEDs and connection

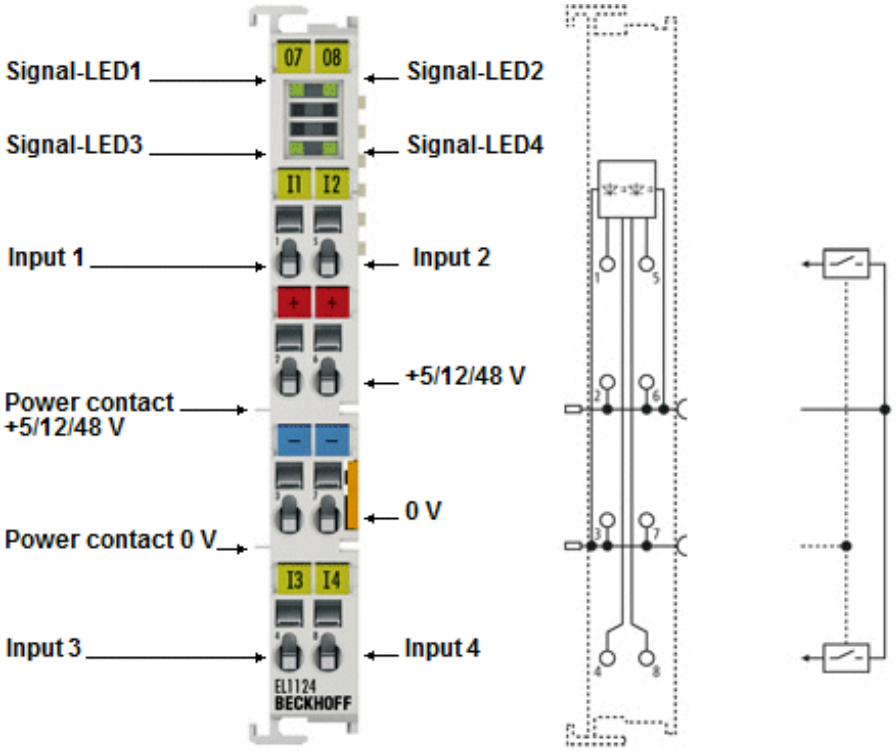


Fig. 27: EL1124

EL1124, EL1144, EL1134 - LEDs

LED	Color	Meaning	
INPUT 1- 4	green	off	EL1124: Signal voltage "0" (< 0.8 V)
			EL1144: Signal voltage "0" (< 2,4 V)
			EL1134: Signal voltage "0" (-3…5 V)
		on	EL1124: Signal voltage "1" (> 2.4 V)
			EL1144: Signal voltage "1" (> 8.5 V)
			EL1134: Signal voltage "1" (15…30 V)

EL1124, EL1144, EL1134 - Connection

Terminal point		Description
Name	No.	
Input 1	1	Input 1
+ 5 / 12 / 48 V	2	+ 5 / 12 / 48 V (internally connected to terminal point 6 and positive power contact)
0 V	3	0 V (internally connected to terminal point 7 and negative power contact)
Input 3	4	Input 3
Input 2	5	Input 2
+ 5 / 12 / 48 V	6	+ 5 / 12 / 48 V (internally connected to terminal point 2 and positive power contact)
0 V	7	0 V (internally connected to terminal point 3 and negative power contact)
Input 4	8	Input 4

2.6.2 EL1124, EL1144, EL1134 - Technical data

Technical data	EL1124	EL1144	EL1134
Number of inputs	4		
Nominal voltage of inputs	5 V_{DC}	12 V_{DC}	48 V_{DC}
Signal voltage "0"	< 0.8 V	< 2.4 V	-3…5 V (IEC 61131-2, type 1)
Signal voltage "1"	>2.4 V	> 8.5 V	15…30 V (IEC 61131-2, type 1)
Input filter	<<1 µs (50 ns typ.)	10 µs	10 µs
Input current	50 µA typ.	3 mA typ.	3 mA typ. (IEC 61131-2, type 1)
Current consumption power contacts	typ. 14 mA + load	typ. 14 mA + load	typ. 10 mA + load
Current consumption via E-bus	90 mA typ.		
Electrical isolation	500 V (E-bus/field voltage)		
Bit width in the process image	4 input bits		
Configuration	no address setting, configuration via TwinCAT System Manager		
Weight	approx. 55 g		
Permissible ambient temperature range during operation	0°C ... +55°C		
Permissible ambient temperature range during storage	-25°C ... +85°C		
Permissible relative humidity	95%, no condensation		
Dimensions (W x H x D)	approx. 15 mm x 100 mm x 70 mm (width aligned: 12 mm)		
Mounting [▶ 51]	on 35 mm mounting rail conforms to EN 60715		
Enhanced mechanical load capacity	Yes, see also Installation instructions for terminals with increased mechanical load capacity [▶ 65]		
Vibration/shock resistance	according to EN 60068-2-6/EN 60068-2-27		
EMC resistance burst/ESD	conforms to EN 61000-6-2 / EN 61000-6-4		
Protection class	IP20		
Installation position	variable		
Approvals/markings*	CE, UKCA, EAC, cULus [▶ 58], ATEX [▶ 52], IECEx [▶ 54]		

*) Real applicable approvals/markings see type plate on the side (product marking).

Ex markings

Standard	Marking
ATEX	II 3 G Ex nA IIC T4 Gc
IECEx	Ex nA IIC T4 Gc

2.7 Application notes

General note

To ensure proper function of the input circuit, the power voltage is required for the following series:

Power voltage 24 V_{DC}:

- EL100x
- EL101x
- EL1104, EL1114
- EL18xx

Power voltage 5 V_{DC}:

- EL1124

Notes for EL1x1x series (10 µs typ.)

Application for frequency measurement

Due to their fast input filters (typ. 10 µs, 10..50 µs), terminals from the EL1x1x series can be used for frequency measurement. The filter time refers to the time over which an external signal with rated voltage or zero signal level must be present at the terminal point until it reaches the evaluation unit via the input circuit.

The maximum limit frequency depends on the following factors:

- EtherCAT cycle time
- Filter time in the input circuit
- Asymmetry of the filter time for rising and falling edge
- Duty factor for input signal
- Edge steepness of the input signal

Due to the production-related fluctuation range of the filter time the maximum limit frequency may be lower than the upper limit defined by the cycle when the EL1x1x is used for frequency measurement.

Example:

- Task cycle: 100 µs
- Actual filter time for rising edge: 10 µs
- Actual filter time for falling edge: 50 µs
- Duty factor 1:1

Derivation:

- Limit frequency from cycle time: 5000 Hz; depending on the cycle a half-period must be detected
- Asymmetry of the filter time: 40 µs
- Therefore minimum detectable half-period: 100 + 40 = 140 µs
- Therefore maximum detectable limit frequency: 3500 Hz

If detection of higher frequencies is required, it is advisable to either use an adequately fast input circuit (e.g. EL1202), or the input signal must compensate the actual asymmetry in the terminal through a duty factor not equal to 1:1.

3 Basics communication

3.1 EtherCAT basics

Please refer to the EtherCAT System Documentation for the EtherCAT fieldbus basics.

3.2 EtherCAT cabling – wire-bound

The cable length between two EtherCAT devices must not exceed 100 m. This results from the FastEthernet technology, which, above all for reasons of signal attenuation over the length of the cable, allows a maximum link length of 5 + 90 + 5 m if cables with appropriate properties are used. See also the Design recommendations for the infrastructure for EtherCAT/Ethernet.

Cables and connectors

For connecting EtherCAT devices only Ethernet connections (cables + plugs) that meet the requirements of at least category 5 (CAt5) according to EN 50173 or ISO/IEC 11801 should be used. EtherCAT uses 4 wires for signal transfer.

EtherCAT uses RJ45 plug connectors, for example. The pin assignment is compatible with the Ethernet standard (ISO/IEC 8802-3).

Pin	Color of conductor	Signal	Description
1	yellow	TD +	Transmission Data +
2	orange	TD -	Transmission Data -
3	white	RD +	Receiver Data +
6	blue	RD -	Receiver Data -

Due to automatic cable detection (auto-crossing) symmetric (1:1) or cross-over cables can be used between EtherCAT devices from Beckhoff.

Recommended cables

It is recommended to use the appropriate Beckhoff components e.g.
- cable sets ZK1090-9191-xxxx respectively
- RJ45 connector, field assembly ZS1090-0005
- EtherCAT cable, field assembly ZB9010, ZB9020

Suitable cables for the connection of EtherCAT devices can be found on the Beckhoff website!

E-Bus supply

A bus coupler can supply the EL terminals added to it with the E-bus system voltage of 5 V; a coupler is thereby loadable up to 2 A as a rule (see details in respective device documentation).
Information on how much current each EL terminal requires from the E-bus supply is available online and in the catalogue. If the added terminals require more current than the coupler can supply, then power feed terminals (e.g. EL9410) must be inserted at appropriate places in the terminal strand.

The pre-calculated theoretical maximum E-Bus current is displayed in the TwinCAT System Manager. A shortfall is marked by a negative total amount and an exclamation mark; a power feed terminal is to be placed before such a position.

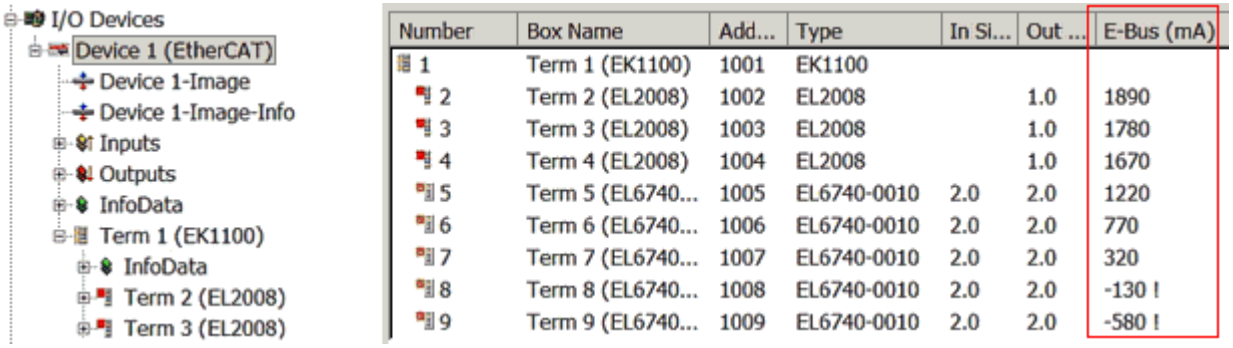


Fig. 28: System manager current calculation

NOTICE

Malfunction possible!

The same ground potential must be used for the E-Bus supply of all EtherCAT terminals in a terminal block!

3.3 General notes for setting the watchdog

The EtherCAT terminals are equipped with a safety device (watchdog) which, e. g. in the event of interrupted process data traffic, switches the outputs (if present) to a presettable state after a presettable time, depending on the device and setting, e. g. to FALSE (off) or an output value.

The EtherCAT slave controller (ESC) features two watchdogs:

- SM watchdog (default: 100 ms)
- PDI watchdog (default: 100 ms)

Their times are individually parameterized in TwinCAT as follows:

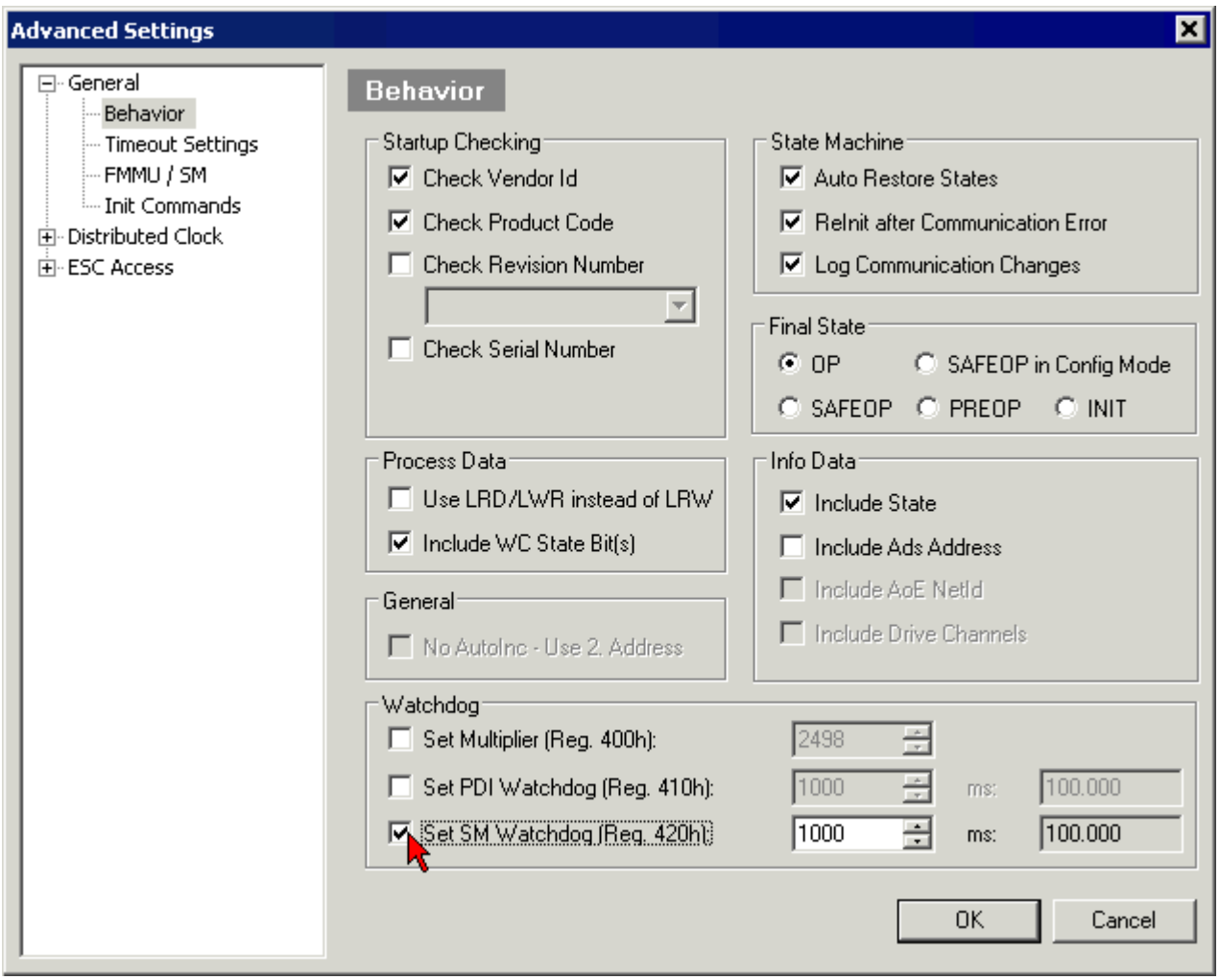


Fig. 29: eEtherCAT tab -> Advanced Settings -> Behavior -> Watchdog

Notes:

- the Multiplier Register 400h (hexadecimal, i. e. x0400) is valid for both watchdogs.
- each watchdog has its own timer setting 410h or 420h, which together with the Multiplier results in a resulting time.
- important: the Multiplier/Timer setting is only loaded into the slave at EtherCAT startup if the checkbox in front of it is activated.
- if it is not checked, nothing is downloaded and the setting located in the ESC remains unchanged.
- the downloaded values can be seen in the ESC registers x0400/0410/0420: ESC Access -> Memory

SM watchdog (SyncManager Watchdog)

The SyncManager watchdog is reset with each successful EtherCAT process data communication with the terminal. If, for example, no EtherCAT process data communication with the terminal takes place for longer than the set and activated SM watchdog time due to a line interruption, the watchdog is triggered. The status of the terminal (usually OP) remains unaffected. The watchdog is only reset again by a successful EtherCAT process data access.

The SyncManager watchdog is therefore a monitoring for correct and timely process data communication with the ESC from the EtherCAT side.

The maximum possible watchdog time depends on the device. For example, for "simple" EtherCAT slaves (without firmware) with watchdog execution in the ESC it is usually up to 170 seconds. For complex EtherCAT slaves (with firmware) the SM watchdog function is usually parameterized via Reg. 400/420 but executed by the µC and can be significantly lower. In addition, the execution may then be subject to a certain time uncertainty. Since the TwinCAT dialog may allow inputs up to 65535, a test of the desired watchdog time is recommended.

PDI watchdog (Process Data Watchdog)

If there is no PDI communication with the EtherCAT slave controller (ESC) for longer than the set and activated PDI watchdog time, this watchdog is triggered.

PDI (Process Data Interface) is the internal interface of the ESC, e.g. to local processors in the EtherCAT slave. With the PDI watchdog this communication can be monitored for failure.

The PDI watchdog is therefore a monitoring for correct and timely process data communication with the ESC, but viewed from the application side.

Calculation

Watchdog time = [1/25 MHz * (Watchdog multiplier + 2)] * PDI/SM watchdog

Example: default setting Multiplier=2498, SM watchdog=1000 -> 100 ms

The value in Multiplier + 2 corresponds to the number of 40ns base ticks representing one watchdog tick.

⚠ CAUTION

Undefined state possible!

The function for switching off the SM watchdog via SM watchdog = 0 is only implemented in terminals from version -0016. In previous versions this operating mode should not be used.

⚠ CAUTION

Damage of devices and undefined state possible!

If the SM watchdog is activated and a value of 0 is entered the watchdog switches off completely. This is the deactivation of the watchdog! Set outputs are NOT set in a safe state if the communication is interrupted.

3.4 EtherCAT State Machine

The state of the EtherCAT slave is controlled via the EtherCAT State Machine (ESM). Depending upon the state, different functions are accessible or executable in the EtherCAT slave. Specific commands must be sent by the EtherCAT master to the device in each state, particularly during the bootup of the slave.

A distinction is made between the following states:

- Init
- Pre-Operational
- Safe-Operational and
- Operational
- Boot

The regular state of each EtherCAT slave after bootup is the OP state.

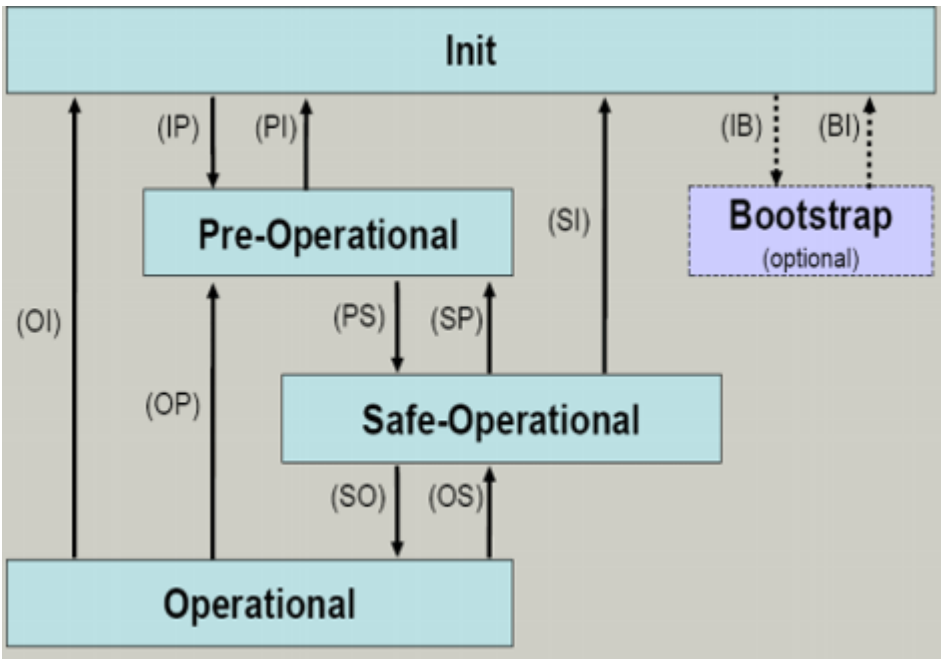


Fig. 30: States of the EtherCAT State Machine

Init

After switch-on the EtherCAT slave in the *Init* state. No mailbox or process data communication is possible. The EtherCAT master initializes sync manager channels 0 and 1 for mailbox communication.

Pre-Operational (Pre-Op)

During the transition between *Init* and *Pre-Op* the EtherCAT slave checks whether the mailbox was initialized correctly.

In *Pre-Op* state mailbox communication is possible, but not process data communication. The EtherCAT master initializes the sync manager channels for process data (from sync manager channel 2), the FMMU channels and, if the slave supports configurable mapping, PDO mapping or the sync manager PDO assignment. In this state the settings for the process data transfer and perhaps terminal-specific parameters that may differ from the default settings are also transferred.

Safe-Operational (Safe-Op)

During transition between *Pre-Op* and *Safe-Op* the EtherCAT slave checks whether the sync manager channels for process data communication and, if required, the distributed clocks settings are correct. Before it acknowledges the change of state, the EtherCAT slave copies current input data into the associated DP-RAM areas of the EtherCAT slave controller (ECSC).

In *Safe-Op* state mailbox and process data communication is possible, although the slave keeps its outputs in a safe state, while the input data are updated cyclically.

Outputs in SAFEOP state

The default set watchdog monitoring sets the outputs of the module in a safe state - depending on the settings in SAFEOP and OP - e.g. in OFF state. If this is prevented by deactivation of the watchdog monitoring in the module, the outputs can be switched or set also in the SAFEOP state.

Operational (Op)

Before the EtherCAT master switches the EtherCAT slave from *Safe-Op* to *Op* it must transfer valid output data.

In the *Op* state the slave copies the output data of the masters to its outputs. Process data and mailbox communication is possible.

Boot

In the *Boot* state the slave firmware can be updated. The *Boot* state can only be reached via the *Init* state.

In the *Boot* state mailbox communication via the *file access over EtherCAT* (FoE) protocol is possible, but no other mailbox communication and no process data communication.

3.5 CoE - Interface: notes

This device has no CoE.

Detailed information on the CoE interface can be found in the EtherCAT system documentation on the Beckhoff website.

3.6 Distributed Clock

The distributed clock represents a local clock in the EtherCAT slave controller (ESC) with the following characteristics:

- Unit *1 ns*
- Zero point *1.1.2000 00:00*
- Size *64 bit* (sufficient for the next 584 years; however, some EtherCAT slaves only offer 32-bit support, i.e. the variable overflows after approx. 4.2 seconds)
- The EtherCAT master automatically synchronizes the local clock with the master clock in the EtherCAT bus with a precision of < 100 ns.

For detailed information please refer to the EtherCAT system description.

4 Mounting and wiring

4.1 Instructions for ESD protection

NOTICE

Destruction of the devices by electrostatic discharge possible!

The devices contain components at risk from electrostatic discharge caused by improper handling.

- Please ensure you are electrostatically discharged and avoid touching the contacts of the device directly.
- Avoid contact with highly insulating materials (synthetic fibers, plastic film etc.).
- Surroundings (working place, packaging and personnel) should by grounded probably, when handling with the devices.
- Each assembly must be terminated at the right hand end with an EL9011 or EL9012 bus end cap, to ensure the protection class and ESD protection.

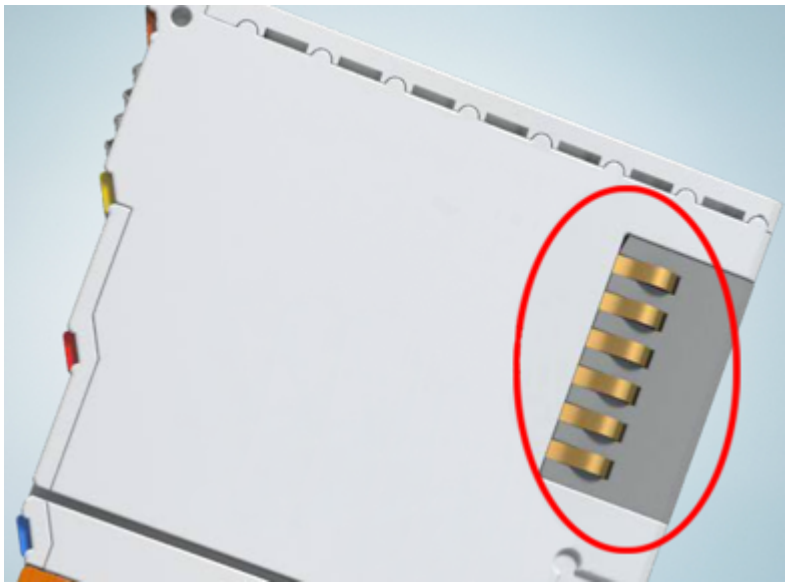


Fig. 31: Spring contacts of the Beckhoff I/O components