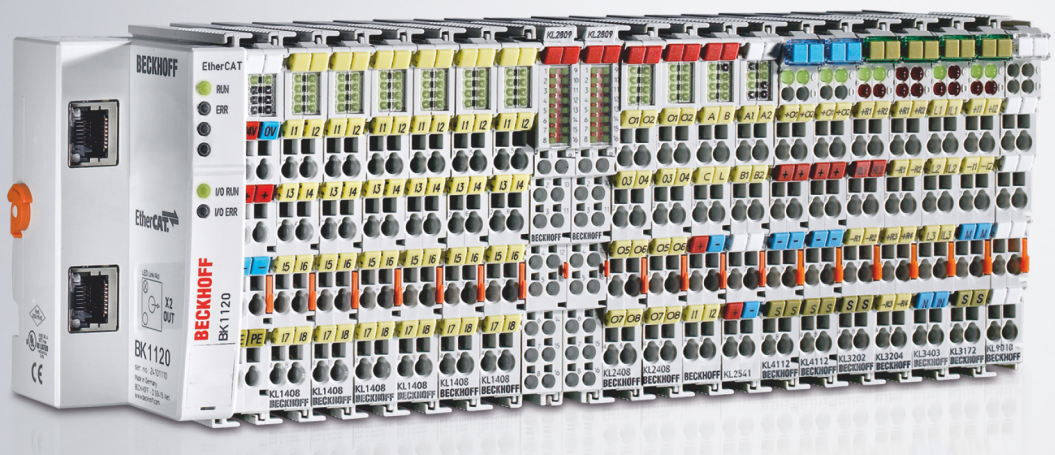
BECKHOFF New Automation Technology

Documentation | EN

KL6821

DALI-2 Multimaster terminal with integrated power supply



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1 Foreword

1.1 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.

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1.2 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.

1.3 Documentation issue status

Version	Comment
1.1.0	• Chapter *Contact assignment* updated
1.0.0	• Chapter *Technical data* updated
0.3	• Chapter *DALI-2 current* added
0.2	• Chapter *Product overview* extended • Chapter *Configuration software KS2000* extended • Link to TwinCAT libraries added
0.1	• First draft

Firmware and hardware versions

Documentation Version	KL6821	
	Firmware	Hardware
1.1.0	09	10
1.0.0	09	09
0.3	09	09
0.2	08	08
0.1	08	08

The firmware and hardware versions (delivery state) of the terminal can be found in the serial number printed on the side.

The KL6821 from firmware 08 and hardware 08 is DALI-2 certified and can be clearly identified by the DALI-2 logo on the terminal side.

Compared to the previous firmware versions (B8 to BD) and hardware versions (01 to 07) and adjustments have been made. For example, the certification-relevant GTIN and also a readable unique serial number are present in the certified KL6821.

Syntax of the serial number

Structure of the serial number: WW YY FF HH	Example with serial number 35 04 1B 01:
WW - week of production (calendar week) YY - year of production FF - firmware version HH - hardware version	35 - week of production 35 04 - year of production 2004 1B - firmware version 1B 01 - hardware version 01

2 Product overview

2.1 Introduction

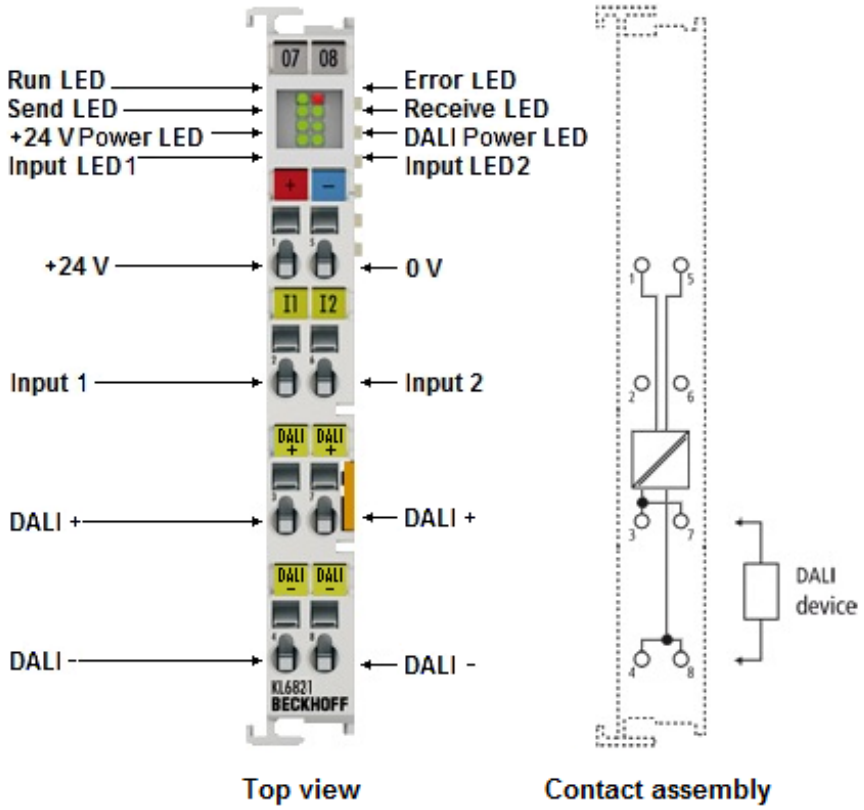


Fig. 1: KL6821

The KL6821 allows the connection of up to 64 DALI control gears and up to 63 DALI-2 control devices. The KS2000 configuration software facilitates parameterization via a PC. The KL6821 contains an integrated DALI-2 power supply that can be switched off with electrically isolated output voltage. No further components are required for operation of the DALI devices. Only TwinCAT function blocks are used for operation. The KL6821 operates fieldbus-independent. DALI control gears (version 1) and DALI-2 devices can be used in mixed operation.

The KL6821 from firmware 08 and hardware 08 is certified according to DALI-2 standard (IEC 62386) Part 101 and Part 103 and can be recognized by the DALI-2 logo on the terminal side.

2.2 Technical data

Technical data	KL6821
Data transfer channels	1
DALI slaves / groups	max. 64 DALI control gears and max. 63 DALI-2 control devices / max. 16 groups
Bit width in the K-bus I/O	4 x 8 bit user data, 1 x 16 bit control/status
Input process image	1 status word and 4 data bytes
Output process image	1 control word and 4 data bytes
Configuration	via the bus coupler or the controller
Power supply for the electronics	via the K-bus
Current consumption via K-bus	typically 55 mA
Current consumption of the 24 V connections	typically 30 mA + DALI current
Input voltage	24 V_{DC} (-15%/+ 20%)
Insulation voltage	DALI bus / K-bus: permanently 1500 V_{AC} DALI bus / power contacts: permanently 1500 V_{AC} K-bus / power contacts: permanently 500 V_{AC}
Transmission	DALI-2 (certified)
DALI power supply unit	max. 250 mA, can be switched off
Guaranteed DALI supply current	220 mA
DALI current with DALI power supply unit switched off	2 mA
Weight	approx. 80 g
Dimensions (W x H x D)	approx. 12 mm x 100 mm x 68 mm
Installation [▶ 22]	on 35 mm mounting rail, conforming to EN 60715
Power loss	approx. 0.5 W + max. 0.5 W depending on DALI output current
Permissible ambient temperature range during operation	0 °C ... + 55 °C
Permissible ambient temperature range during storage	-25 °C ... + 85 °C
Permissible relative air humidity	95 %, no condensation
Vibration / shock resistance	conforms to EN 60068-2-6 / EN 60068-2-27
EMC immunity / emission	conforms to EN 61000-6-2 / EN 61000-6-4
Protection rating	IP20
Installation position	variable
Approvals / markings*	CE, UKCA, EAC

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

2.3 DALI

DALI (Digital Addressable Lighting Interface) is a definition for the standardization of digital interfaces between control gears (lamps) and control devices (sensors and application controllers). The standard (IEC 62386) allows the manufacturers of lighting components to implement complex lighting tasks easily and conveniently.

The KL6811 (DALI version-1/DSI) and KL6821/EL6821 (DALI-2) Bus Terminals are integrated into the bus terminal system and are therefore fieldbus-independent. The DALI data is forwarded to the DALI devices via the respective bus coupler. Bus controllers also offer the option of running PLC programs locally in IEC 61131-3.

To ensure the interoperability of DALI-2 devices with each other, the DALI Alliance (DiiA) provides a certification program. Products that have successfully completed the DALI-2 certification process may use the DALI-2 logo.

All certified DALI-2 devices are entered in the DiiA product database. The product database can be accessed via the DiiA homepage:

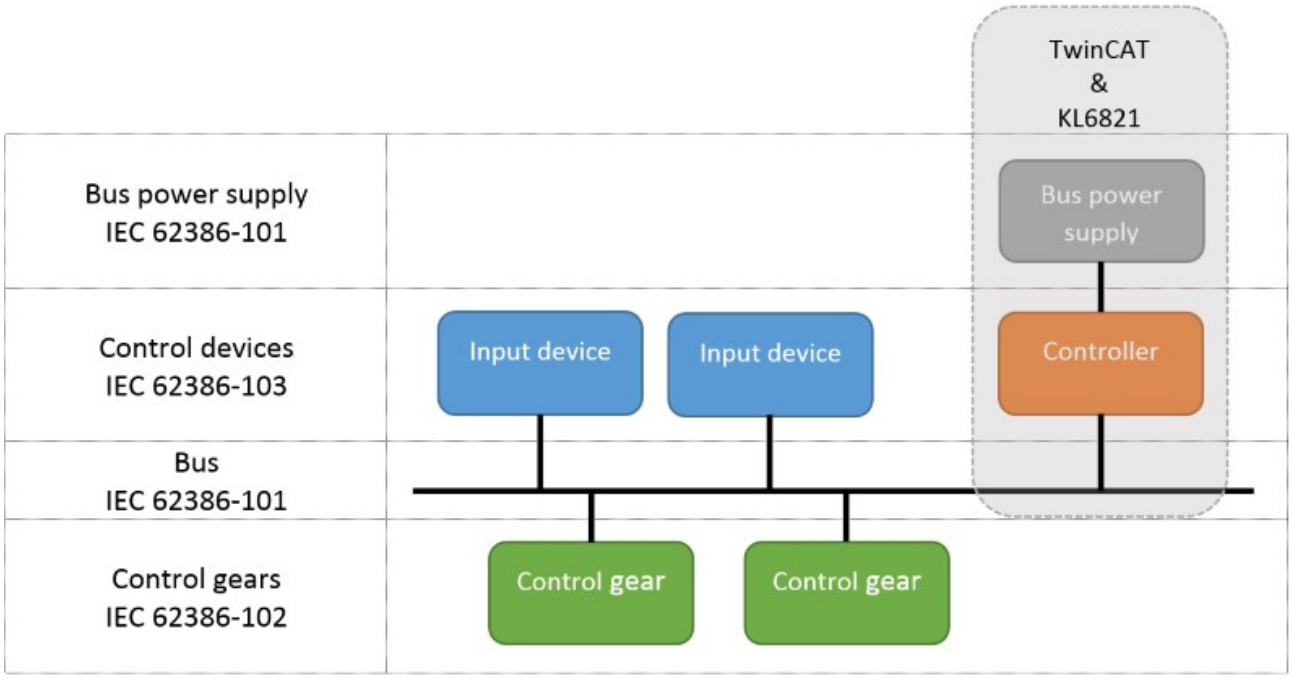
https://www.dali-alliance.org/products/4844/kl6821-dali-dali-2-multi-master-and-power-supply

2.3.1 IEC 62386

DALI is specified in the IEC 62386 standard and offers advantages such as flexibility, simplicity, user friendliness and robustness. IEC 62386 has been revised several times and was extended considerably in November 2014 with the publication of the second revision. While in the first revision only DALI control gears (lamps) were considered, from the second revision onwards DALI control devices (sensors and application controllers) are also included. These are described in the respective section of IEC 62386:

IEC 62386-101	General system properties such as cabling, feed-in and telegram structure
IEC 62386-102	General properties of the DALI control gears.
	IEC 62386-201: Fluorescent lamps (device type 0) IEC 62386-202: Emergency lighting (device type 1) IEC 62386-203: Discharge lamps (device type 2) IEC 62386-207: LED modules (device type 6) ...
IEC 62386-103	General properties of the DALI control devices
	IEC 62386-301: Push buttons IEC 62386-302: Absolute input devices IEC 62386-303: Occupancy sensor IEC 62386-304: Light sensor ...

The IEC 62386-101, IEC 62386-102 and IEC 62386-103 standards describe general properties, while the IEC 62386-2xx and IEC 62386-3xx standards specify the individual device types. IEC 62386-103 and IEC 62386-3xx were included in Revision 2 of the DALI standard.

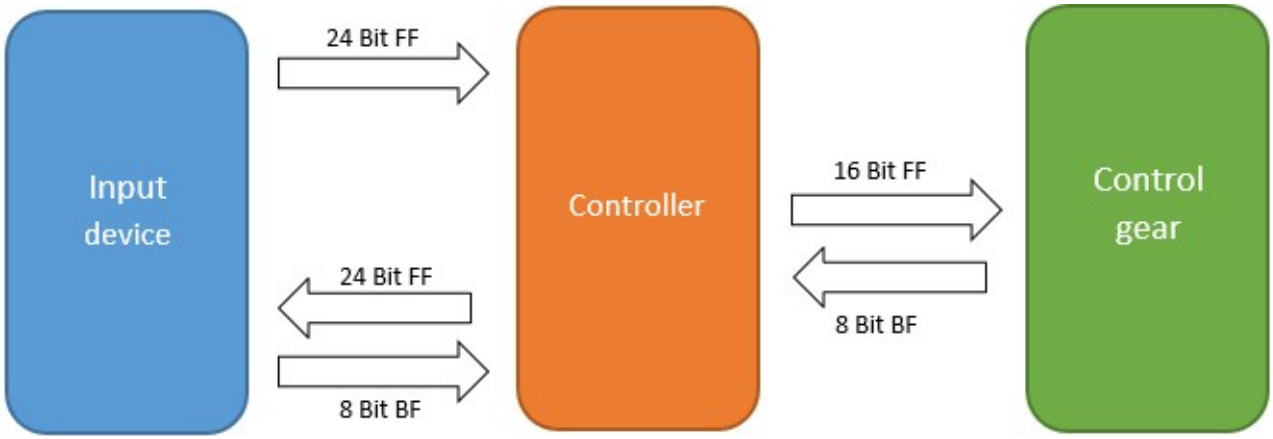


Up to 64 DALI control gears and up to 64 DALI control devices can be connected to the KL6821 per DALI line. The KL6821 represents the DALI controller. One such device exists for each DALI line. Up to 64 control gears, which have to be DALI/DSI devices, can be connected to the KL6811. Any number of DALI lines (KL6821 and KL6811) can be operated with a single TwinCAT controller.

2.3.2 Communication

With regard to the communication, a distinction is made between three telegram types:

- 16-bit query, configuration and control telegram.
- 24-bit query, configuration and control telegram.
- 24-bit event telegram.



BF: backward frame
FF: forward frame

16-bit telegrams

16-bit telegrams are always sent from a DALI controller to a DALI control gear. They are used for configuring the devices, querying parameters or sending control commands. For certain DALI commands the DALI control gear sends an 8-bit response. DALI control gears only send an 8-bit telegram when requested.

In the Tc3_DALI library these commands are identified by the PLC function blocks with the prefix FB_DALI102 or FB_DALI2xx, e.g. FB_DALI102QueryActualLevel or FB_DALI207QueryFeatures.

24-bit telegrams

24-bit telegrams are always sent from a DALI controller to a DALI control device. They are used for configuring the devices, querying parameters or sending control commands. For certain DALI commands the DALI control device sends an 8-bit response.

In the Tc3_DALI library these commands are identified by the PLC function blocks with the prefix FB_DALI103 or FB_DALI3xx, e.g. FB_DALI103QueryOperatingMode or FB_DALI303SetHoldTimer.

24-bit events

DALI control devices are able to send events. They are always evaluated by the DALI controller and have a length of 24 bits.

Individual events can be filtered out and further processed with the function blocks FB_DALIGetInputNotification and FB_DALIGetPowerCycleNotification.

Further information on DALI can be found on the homepage of the DALI Alliance (https://www.dali-alliance.org) and in the IEC 62386 standard.

The KL6811 only supports the first revision of the DALI standard. It is not possible to operate control devices with the KL6811.

2.3.3 Priorities

Since DALI-2 is a multi-master bus system, simultaneous bus access of several DALI masters is controlled based on priorities. According to IEC 62386, all DALI-2 devices that can initiate sending of a DALI command (controllers) or sending of an event (input devices) on the DALI bus are referred to as masters. Under DALI-2, these are also referred to as control devices and are described in more detail in IEC 62386-103.

All DALI-2 devices of a DALI line must share the same data line. To avoid collisions during sending, the sending device checks whether the DALI bus has already been assigned. Sending takes place after a certain settling time, once the DALI bus is free. For high-priority DALI commands the bus access takes place after a short settling time, for low-priority commands the settling time is longer. In other words, high-priority DALI commands are given preference over low-priority DALI commands.

DALI control gears are defined in IEC 62386-102. They are not capable of sending DALI commands or events independently. DALI control gears may only return the 8-bit backward frame to forward frames sent by a DALI controller (see also Communication [▶ 11]). Since a DALI controller waits for the backward frame, the 8-bit backward frame has the shortest settling time. This settling time is shorter than for DALI commands with the highest priority. This means that DALI forward frames can be processed without interference from other DALI commands.

The priorities used by a DALI controller for sending the DALI commands are referred to as command priorities and are mapped by the data type E_DALICommandPriority. Command priorities can have 5 different values:

- **Low**: DALI priority 5
- **Middle low**: DALI priority 4
- **Middle**: DALI priority 3
- **Middle high**: DALI priority 2
- **High**: DALI priority 1

Most function blocks referred to in chapter Part 102 (control gears) have the input *eCommandPriority*. This input is used to specify the priority with which the DALI commands are to be sent via the KL6821.

Events also have a priority (event priority), which is represented by the data type E_DALIEventPriority. Event priorities can have 4 values in the range *Low* (DALI priority 5) to *Middle high* (DALI priority 2). The event priority is written as a parameter (see instance variable eventPriority) into the respective instances of the DALI devices.

Priority *High* (DALI priority 1) is only allowed for DALI-2 commands and cannot be used for events.

Tc3_DALI uses the following default values for the priorities:

E_DALICommandPriority/ E_DALIEventPriority	Application
Low	-
MiddleLow	Light sensor events (Part 304). All other DALI commands.
Middle	Events of push buttons (Part 301), absolute input devices (Part 302) and occupancy sensors (Part 303).
MiddleHigh	DALI commands for writing parameters and for addressing DALI devices.
High	DALI commands for transactions (from the second DALI command).

When selecting priorities, care should always be taken to ensure that time-critical events that are important for switching the lighting have a higher priority than the DALI commands themselves. Non-system-critical DALI commands, such as the cyclic querying of states for the display in a visualization, should be sent with a lower priority.

Priorities for DALI commands (E_DALICommandPriority) are supported from Tc3_DALI V3.11.0.0. The KL6821 must contain firmware BD or later. Older firmware versions always send DALI commands with the priority *High*.

Neither the KL6811 nor the Tc2_DALI library support priorities for DALI commands.

Priorities are always important in situations where DALI sensors (input devices) send events and DALI commands are sent in parallel via the KL6821. If no DALI sensors (input devices) are used, the priority of the DALI commands is of secondary importance, since in this case there is only one DALI master (the KL6821).

Further details about the DALI priorities can also be found in the following chapter Bus Timing [▶ 13].

2.3.4 Bus Timing

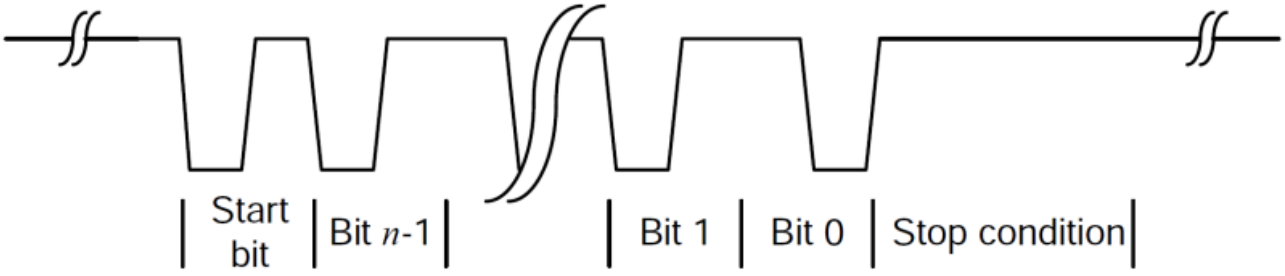
The following describes the structure and operation of the DALI protocol. This description focuses on the most important basic principles. For a full explanation, the IEC 62386 standard, in particular Part 101, should be consulted.

2.3.4.1 Structure data frame

Each Forward Frame (FF) and Backward Frame (BF) basically consists of:

- 1 start bit
- n data bits
- 1 stop condition

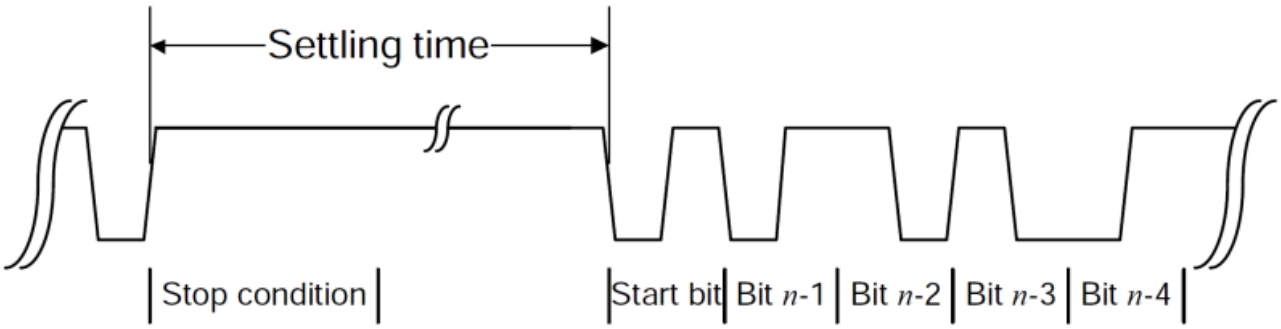
The *most significant bit* (MSB) is transmitted at the beginning.



Transmission is via Manchester coding with a data transfer rate of 1200 bits per second. Thus, each bit has a length of 0.833 ms (1 / 1200 = 0.000833).

The *Stop condition* has a length of at least 2.45 ms.

A fixed time (*settling time*) must be waited between the sending of two data frames before the sending of the next data frame can be started.



The length of the *settling time* depends on the DALI priority with which a data frame is sent. The higher the DALI priority, the smaller the *settling time*.

Settling time	Minimum	Mean value	Maximum
between FF and BF	5.5 ms	8.0 ms	10.5 ms
before each FF (DALI priority *High*)	13.5 ms	14.1 ms	14.7 ms
before each FF (DALI priority *Middle high*)	14.9 ms	15.5 ms	16.1 ms
before each FF (DALI priority *Middle*)	16.3 ms	17.0 ms	17.7 ms
before each FF (DALI priority *Middle low*)	17.9 ms	18.6 ms	19.3 ms
before each FF (DALI priority *Low*)	19.5 ms	20.3 ms	21.2 ms

More information about DALI priorities is also available in the chapter Priorities [▶ 12].

Thus, data frames with a higher DALI priority (low *settling time*) occupy the DALI bus earlier, compared to data frames with a lower DALI priority (high *settling time*).

Certain DALI commands must be sent twice within 100 ms (send-twice) without the receiver being allowed to receive another DALI command in the meantime. Only then will the DALI command be recognized as valid by the receiver. This is primarily used with DALI commands that are used to configure DALI devices. So that the two DALI commands are not interrupted by another DALI command, the 2nd DALI command is always sent with DALI priority *High*. The DALI priority *High* is reserved for these DALI commands and must not be used in any other context.

2.3.4.2 Transmission length

The approximate transmission length can be determined from the bit length and the structure of the data frame. For further (simplified) consideration, a mean *settling time* of 17.0 ms is used for the forward frames (FF), and a mean settling time of 8 ms for the backward frames (BF). Between the two DALI commands sent within 100 ms (send-twice), a *settling time* of 14.1 ms is used.

The number of bits results from the number of data bits (8, 16 or 24) plus the start bit. Thus 9, 17 or 25 bits are transmitted with the respective telegrams.

16-bit telegram without backward frame:
17.0 ms + (17 x 0.833 ms) = **31.2 ms**.

16-bit telegram with backward frame:
17.0 ms + (17 x 0.833 ms) + 8.0 ms + (9 x 0.833 ms) = **46.7 ms**.

16-bit telegram send-twice:
17.0 ms + (17 x 0.833 ms) + 14.1 ms + (17 x 0.833 ms) = **59.4 ms**.

24-bit telegram without backward frame:
17.0 ms + (25 x 0.833 ms) = **37.8 ms**.

24-bit telegram with backward frame:
17.0 ms + (25 x 0.833 ms) + 8.0 ms + (9 x 0.833 ms) = **53.3 ms**.

24-bit telegram send-twice:
17.0 ms + (25 x 0.833 ms) + 14.1 ms + (25 x 0.833 ms) = **72.8 ms**.

The following table lists the average transmission lengths of the individual telegrams. This results in a maximum possible number of telegrams per second. The PLC program should be designed in such a way that the number of telegrams always falls below the maximum.

Telegram	Transmission length	Telegrams per second
16-bit telegram without backward frame	31.2 ms	approx. 32
16-bit telegram with backward frame	46.7 ms	approx. 21
16-bit telegram send-twice	59.4 ms	approx. 16
24-bit telegram without backward frame	37.8 ms	approx. 26
24-bit telegram with backward frame	53.3 ms	approx. 18
24-bit telegram send-twice	72.8 ms	approx. 13

2.3.4.3 Collision detection

The generation of the DALI telegrams is achieved in a DALI device by changing between high and low level within defined times. At a low level, the DALI bus is pulled towards 0 V against a current limitation. With a high level, the DALI connection from the DALI device is high-resistance.

Since DALI is a multi-master system, it may happen that several DALI devices try to send DALI telegrams independently of each other. For this reason, DALI includes collision avoidance, collision detection and collision resolution.

Collision avoidance is achieved by using the DALI priorities. Before a DALI device sends a DALI telegram, it is checked whether the DALI bus is free. Only if the DALI bus is free (high level), a bus access may take place. Correct use of DALI priorities reduces the probability of simultaneous bus access and thus minimizes the number of collisions.

Nevertheless, the DALI priorities cannot completely avoid collisions on the DALI bus, since DALI telegrams from different DALI devices may have the same DALI priority. For this reason, DALI has collision detection and collision resolution.

The following diagram explains the collision resolution.

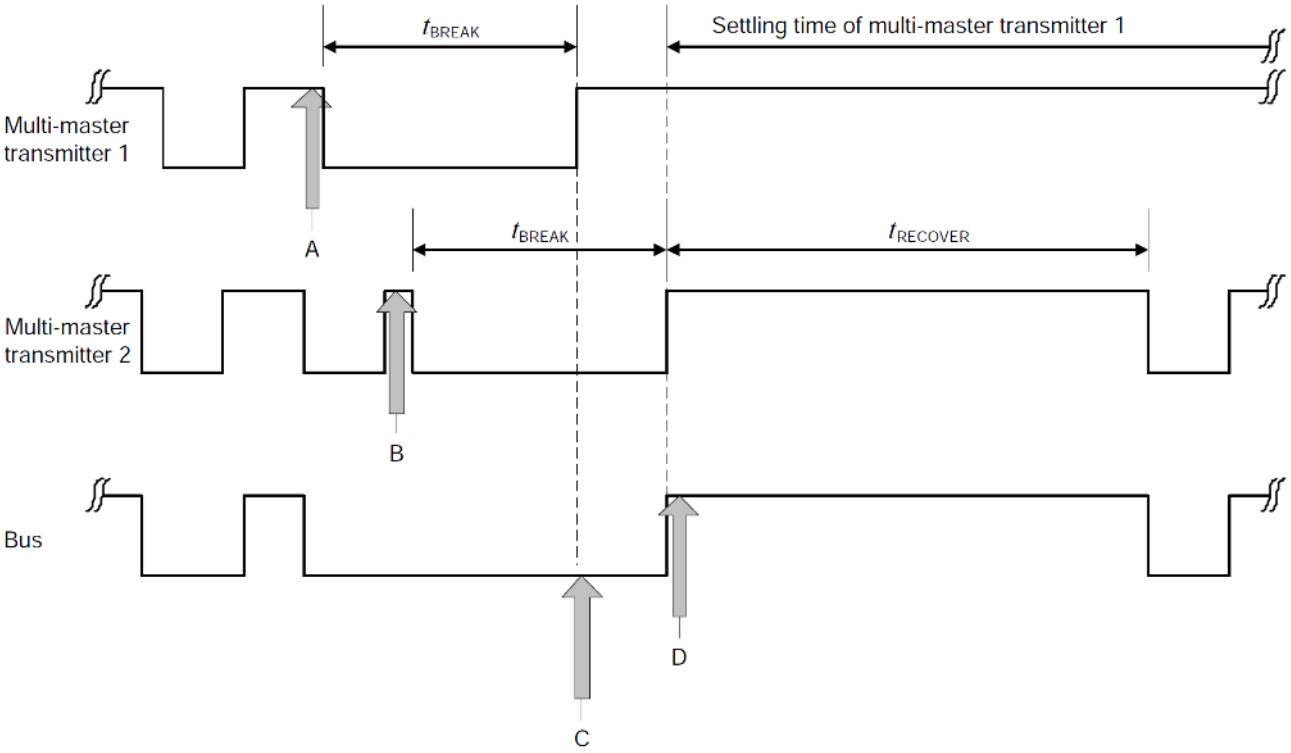
If several DALI devices send a high level, this cannot be detected by the DALI devices. The resulting voltage on the DALI bus is also a high level in this case.

At point A DALI device 1 detects a collision, because an attempt is made to generate a high signal at this point, but the DALI bus is pulled to low level by DALI device 2. DALI device 1 starts the break sequence for this reason. During this time the DALI device pulls the DALI bus to low level.

At point B DALI device 2 tries to generate a high level. However, since the DALI bus is pulled to low level by DALI device 1, DALI device 2 also detects a collision and also starts the break sequence.

At point C the break sequence of DALI device 1 has expired. Subsequently, it is checked whether the DALI bus is still at low level. Since this is the case, the system waits until the DALI bus is free again. DALI device 1 then starts sending the DALI telegram again, including the *settling time*.

If the break sequence is finished at DALI device 2, the DALI bus is not occupied by any other DALI device (point D). Therefore the recover sequence is started at DALI device 2 and then the DALI telegram is sent again directly (without *settling time*).



The break sequence has a length of 1.2 ms to 1.4 ms, while the recover sequence can be between 4.0 ms and 4.6 ms.

Collisions on the DALI bus interrupt the transmission on the DALI bus for several milliseconds. This further reduces the data throughput. For this reason, a DALI system should be put together and configured in such a way that as few collisions as possible occur.

2.3.4.4 Cycle times PLC tasks

For practical application, the cycle times of the PLC tasks should, if possible, always be set so that the maximum data transfer rate from the DALI bus is achieved.

Tests were performed to determine the number of telegrams at different cycle times of the PLC tasks. For this purpose, a PLC program was used, which cyclically sends 6 telegrams independently of each other. Three 16-bit telegrams (2 x without backward frame, 1 x with backward frame) and three 24-bit telegrams (2 x without backward frame, 1 x with backward frame) were sent. Since the send-twice telegrams are only of importance for the configuration of DALI devices, they were not considered further. The total transmission length of the 6 telegrams was thus 238 ms (2 x 21.2 ms + 46.7 ms + 2 x 37.8 ms + 53.3 ms). This means that the sample program could send a maximum of 25 telegrams per second (1000 ms / 238 ms x 6). Events that are additionally sent by possible DALI sensors (input devices) are not taken into account.

	80 ms	60 ms	40 ms	30 ms	20 ms	10 ms	8 ms	6 ms	4 ms
30 ms	6	7	7	8	8	8	8	8	8
15 ms	11	11	12	12	13	13	13	13	13
10 ms	15	15	16	17	17	17	17	17	17
8 ms	18	18	19	19	20	20	20	20	20
6 ms	20	21	21	22	22	22	22	22	22
4 ms	23	23	24	25	25	25	25	25	25
2 ms	23	24	25	25	25	25	25	25	25

The times in the top line (4 ms ... 80 ms) specify the cycle time of the PLC task from which the DALI commands are started. The times (2 ms ... 30 ms) in the first column specify the cycle time of the PLC task for background communication.

2.3.4.5 Summary

Even though the test program is only representative, it can be clearly seen that the cycle time of the background communication has a decisive influence on the data throughput. If a maximum data transfer rate is required on the DALI bus, the following points must be observed:

- K-bus and fieldbus should be arranged so that the cycle time for the PLC task accessing the DALI terminal (background communication) does not exceed 6 ms.
- The number of events of the DALI sensors (input devices) should be as low as possible. The more events are sent, the higher the probability of collisions on the DALI bus. The DALI sensors should be configured so that the number of events is minimal.
- To reduce the number of collisions on the DALI bus, the DALI priorities should be used. Recommendations for this can be found in the chapter DALI priorities [▶ 12].
- A large number of DALI control devices also increases the probability of collisions on the DALI bus. If necessary, the DALI control devices must be divided among different DALI lines. DALI control devices are DALI controllers and DALI sensors (see chapter Communication [▶ 11]).

2.3.5 Memory banks

Memory banks are freely accessible memory areas in which device-specific information and properties can be stored. The contents of the memory banks can be read with FB_DALI10xReadMemoryLocation (see FB_DALI102ReadMemoryLocation and FB_DALI103ReadMemoryLocation) and, if enabled, written with FB_DALI10xWriteMemoryLocationNoReply (see FB_DALI102WriteMemoryLocationNoReply and FB_DALI103WriteMemoryLocationNoReply).

Part of the memory banks can be provided with write protection.

A DALI device can support a maximum of 256 memory banks, each with up to 255 bytes, with memory banks 200 to 255 being reserved. Memory bank 0 and memory bank 1 are predefined by IEC 62386.

Structure of memory bank 0:

Memory bank 0 is read only and contains general, vendor-specific information about the DALI control gear or DALI control device. Every certified DALI device must implement memory bank 0. Up to offset 16#1A the fields are defined by IEC 62386 as follows.

Offset	Description	Default values
16#00	Offset of the last memory area inside the memory bank that can be accessed.	Vendor-specific
16#01	Reserved, not implemented	
16#02	Number of the last memory bank that can be accessed.	Vendor-specific
16#03	GTIN byte 0 (MSB)	Vendor-specific
16#04	GTIN byte 1	Vendor-specific
16#05	GTIN byte 2	Vendor-specific
16#06	GTIN byte 3	Vendor-specific
16#07	GTIN byte 4	Vendor-specific
16#08	GTIN byte 5 (LSB)	Vendor-specific
16#09	Firmware Version (major)	Vendor-specific
16#0A	Firmware Version (minor)	Vendor-specific
16#0B	Identification number byte 0 (MSB)	Vendor-specific
16#0C	Identification number byte 1	Vendor-specific
16#0D	Identification number byte 2	Vendor-specific
16#0E	Identification number byte 3	Vendor-specific
16#0F	Identification number byte 4	Vendor-specific
16#10	Identification number byte 5	Vendor-specific
16#11	Identification number byte 6	Vendor-specific
16#12	Identification number byte 7 (LSB)	Vendor-specific
16#13	Hardware version (major)	Vendor-specific
16#14	Hardware version (minor)	Vendor-specific
16#15	101 Version number of the current DALI standard	Vendor-specific
16#16	102 Version numbers of all integrated DALI control gears	Vendor-specific
16#17	103 Version numbers of all integrated DALI control devices	Vendor-specific
16#18	Number of logical control units in the device	Vendor-specific
16#19	Number of logical control gears in the device	Vendor-specific
16#1A	Index number of this logical DALI control gear or DALI control device	Vendor-specific
16#1B… 16#7F	Reserved, not implemented	
16#80… 16#FE	Additional device information	Vendor-specific
16#FF	Reserved, not implemented	

Structure of memory bank 1:

Memory bank 1 can be used by the device vendor to store further information in the DALI device. Up to offset 16#10 the fields are defined by IEC 62386 as follows.

Offset	Description	Default values	Memory
16#00	Offset of the last memory area inside the memory bank that can be accessed.	Vendor-specific (16#10… 16#FE)	
16#01	Indicator byte	Vendor-specific	
16#02	Lock byte for memory bank 1. Writeable bytes become changeable through the value 16#55. No other values make writing possible.	16#FF	
16#03	OEM GTIN byte 0 (MSB)	16#FF	Lockable by byte 16#02
16#04	OEM GTIN byte 1	16#FF	Lockable by byte 16#02
16#05	OEM GTIN byte 2	16#FF	Lockable by byte 16#02
16#06	OEM GTIN byte 3	16#FF	Lockable by byte 16#02
16#07	OEM GTIN byte 4	16#FF	Lockable by byte 16#02
16#08	OEM GTIN byte 5 (LSB)	16#FF	Lockable by byte 16#02
16#09	OEM Identification number byte 0 (MSB)	16#FF	Lockable by byte 16#02
16#0A	OEM Identification number byte 1	16#FF	Lockable by byte 16#02
16#0B	OEM Identification number byte 2	16#FF	Lockable by byte 16#02
16#0C	OEM Identification number byte 3	16#FF	Lockable by byte 16#02
16#0D	OEM Identification number byte 4	16#FF	Lockable by byte 16#02
16#0E	OEM Identification number byte 5	16#FF	Lockable by byte 16#02
16#0F	OEM Identification number byte 6	16#FF	Lockable by byte 16#02
16#10	OEM Identification number byte 7 (LSB)	16#FF	Lockable by byte 16#02
16#11… 16#FE	Additional device information	Vendor-specific	
16#FF	Reserved, not implemented		

Structure of memory banks 2 to 199:

The device vendor can use memory banks 2 to 199 to supply further parameters. The structure of the memory banks is always as shown below. The vendor of the DALI device must be consulted regarding the contents and the possibility to write individual bytes.

Offset	Description	Default values	Memory
16#00	Offset of the last memory area inside the memory bank that can be accessed.	Vendor-specific (16#03… 16#FE)	
16#01	Indicator byte	Vendor-specific	
16#02	Lock byte for the memory bank. Writeable bytes become changeable through the value 16#55. No other values make writing possible.	16#FF	
16#03… 16#FE	Additional device information	Vendor-specific	Vendor-specific; lockable by byte 16#02 if enabled by the vendor
16#FF	Reserved, not implemented		

2.3.6 DALI-2 current

The DALI power supply of the KL6821 has a maximum output current of 250 mA and a guaranteed DALI current of 220 mA.

To ensure safe operation of the DALI bus, the connected DALI devices must never consume more than the guaranteed DALI-2 current in total.

The current consumption of the DALI devices (control gears, sensors, etc.) can be found in the manufacturers' data sheets or on the DiiA product list (www.dali-alliance.org/products).

Furthermore, a reserve specified in IEC 62386 (guaranteed DALI current / 1.2) should be maintained. This reserve is intended for the subsequent installation of additional devices that may be added in the course of a project.

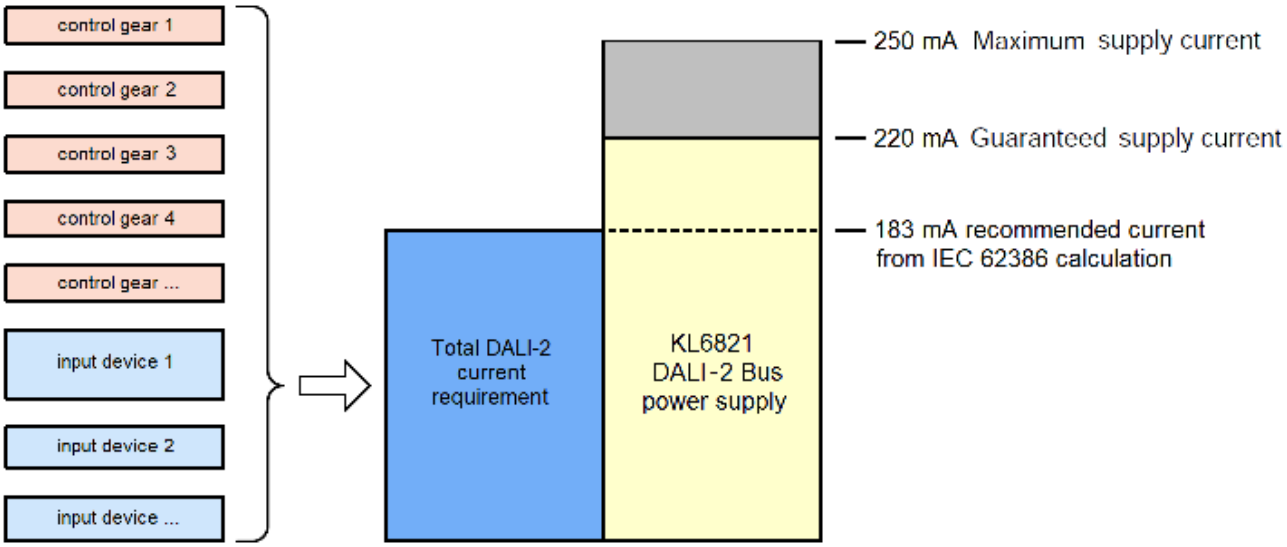


Fig. 2: DALI-2 current

3 Mounting and wiring

3.1 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 spring contacts (see fig.) 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 a KL9010 bus end terminal, to ensure the protection class and ESD protection.

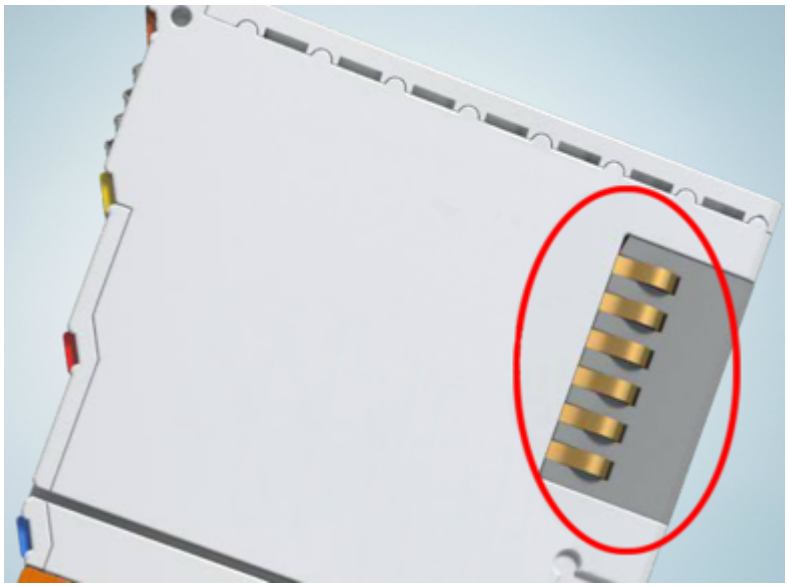


Fig. 3: Spring contacts of the Beckhoff I/O components

3.2 Installation on mounting rails

⚠ WARNING

Risk of electric shock and damage of device!

Bring the bus terminal system into a safe, powered down state before starting installation, disassembly or wiring of the bus terminals!

The Bus Terminal system and is designed for mounting in a control cabinet or terminal box.

Assembly

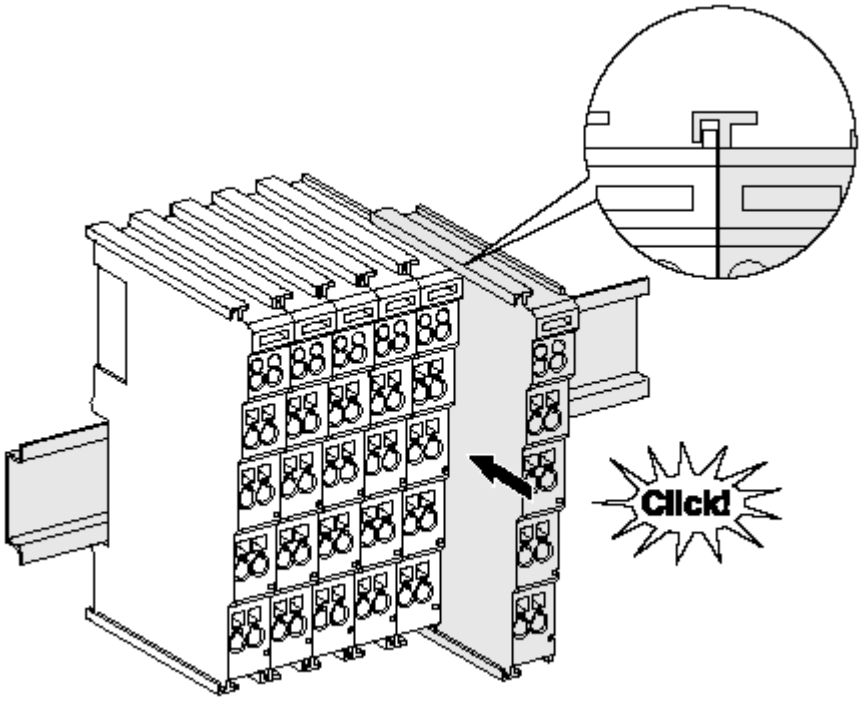


Fig. 4: Attaching on mounting rail

The bus coupler and bus terminals are attached to commercially available 35 mm mounting rails (DIN rails according to EN 60715) by applying slight pressure:

1. First attach the fieldbus coupler to the mounting rail.
2. The bus terminals are now attached on the right-hand side of the fieldbus coupler. Join the components with tongue and groove and push the terminals against the mounting rail, until the lock clicks onto the mounting rail.
   If the terminals are clipped onto the mounting rail first and then pushed together without tongue and groove, the connection will not be operational! When correctly assembled, no significant gap should be visible between the housings.

Fixing of mounting rails

The locking mechanism of the terminals and couplers extends to the profile of the mounting rail. At the installation, the locking mechanism of the components must not come into conflict with the fixing bolts of the mounting rail. To mount the mounting rails with a height of 7.5 mm under the terminals and couplers, you should use flat mounting connections (e.g. countersunk screws or blind rivets).

Disassembly

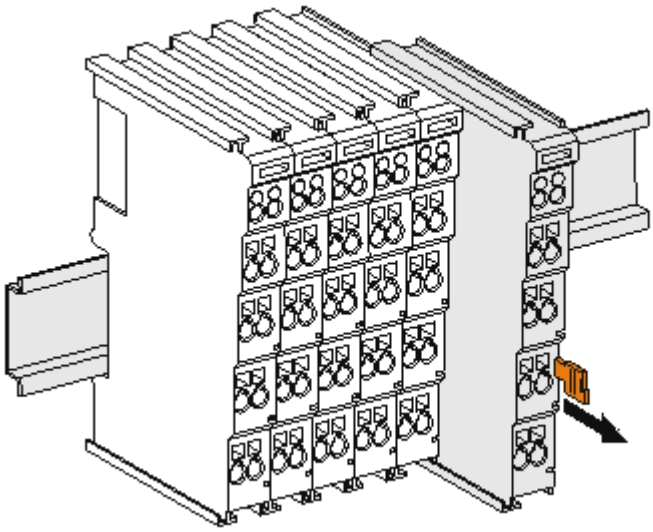


Fig. 5: Disassembling of terminal

Each terminal is secured by a lock on the mounting rail, which must be released for disassembly:

1. Pull the terminal by its orange-colored lugs approximately 1 cm away from the mounting rail. In doing so for this terminal the mounting rail lock is released automatically and you can pull the terminal out of the bus terminal block easily without excessive force.
2. Grasp the released terminal with thumb and index finger simultaneous at the upper and lower grooved housing surfaces and pull the terminal out of the bus terminal block.

Connections within a bus terminal block

The electric connections between the Bus Coupler and the Bus Terminals are automatically realized by joining the components:

- The six spring contacts of the K-Bus/E-Bus deal with the transfer of the data and the supply of the Bus Terminal electronics.
- The power contacts deal with the supply for the field electronics and thus represent a supply rail within the bus terminal block. The power contacts are supplied via terminals on the Bus Coupler (up to 24 V) or for higher voltages via power feed terminals.

Power Contacts

During the design of a bus terminal block, the pin assignment of the individual Bus Terminals must be taken account of, since some types (e.g. analog Bus Terminals or digital 4-channel Bus Terminals) do not or not fully loop through the power contacts. Power Feed Terminals (KL91xx, KL92xx or EL91xx, EL92xx) interrupt the power contacts and thus represent the start of a new supply rail.

PE power contact

The power contact labeled PE can be used as a protective earth. For safety reasons this contact mates first when plugging together, and can ground short-circuit currents of up to 125 A.

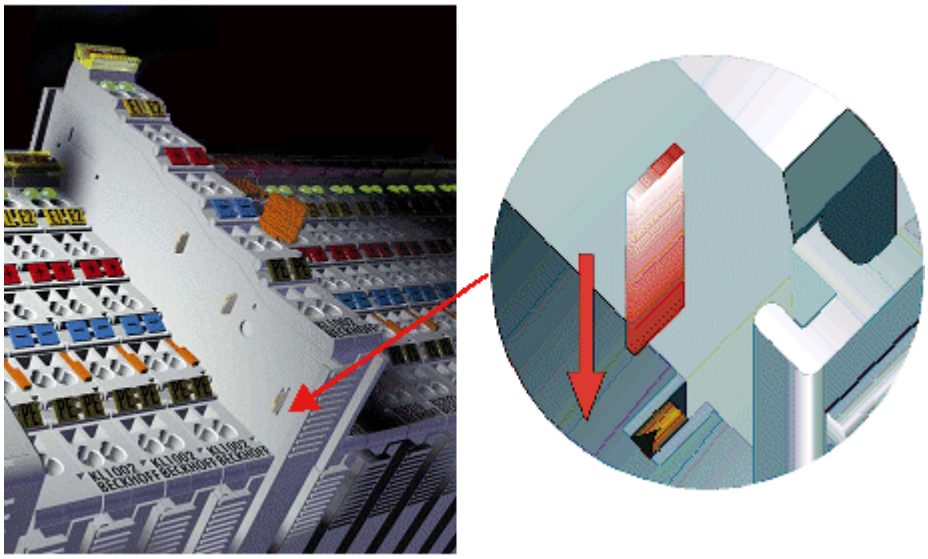


Fig. 6: Power contact on left side

NOTICE

Possible damage of the device

Note that, for reasons of electromagnetic compatibility, the PE contacts are capacitatively coupled to the mounting rail. This may lead to incorrect results during insulation testing or to damage on the terminal (e.g. disruptive discharge to the PE line during insulation testing of a consumer with a nominal voltage of 230 V). For insulation testing, disconnect the PE supply line at the Bus Coupler or the Power Feed Terminal! In order to decouple further feed points for testing, these Power Feed Terminals can be released and pulled at least 10 mm from the group of terminals.

⚠ WARNING

Risk of electric shock!

The PE power contact must not be used for other potentials!

3.3 Disposal

Products marked with a crossed-out wheeled bin shall not be discarded with the normal waste stream. The device is considered as waste electrical and electronic equipment. The national regulations for the disposal of waste electrical and electronic equipment must be observed.

3.4 Connection

3.4.1 Connection system

⚠ WARNING

Risk of electric shock and damage of device!

Bring the bus terminal system into a safe, powered down state before starting installation, disassembly or wiring of the bus terminals!

Overview

The bus terminal system offers different connection options for optimum adaptation to the respective application:

- The terminals of ELxxxx and KLxxxx series with standard wiring include electronics and connection level in a single enclosure.
- The terminals of ESxxxx and KSxxxx series feature a pluggable connection level and enable steady wiring while replacing.
- The High Density Terminals (HD Terminals) include electronics and connection level in a single enclosure and have advanced packaging density.

Standard wiring (ELxxxx / KLxxxx)

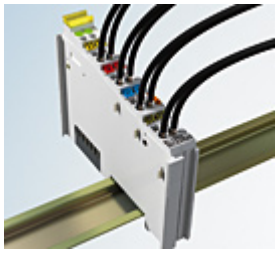


Fig. 7: Standard wiring

The terminals of ELxxxx and KLxxxx series have been tried and tested for years.
They feature integrated screwless spring force technology for fast and simple assembly.

Pluggable wiring (ESxxxx / KSxxxx)

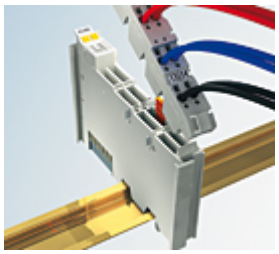


Fig. 8: Pluggable wiring

The terminals of ESxxxx and KSxxxx series feature a pluggable connection level.
The assembly and wiring procedure is the same as for the ELxxxx and KLxxxx series.
The pluggable connection level enables the complete wiring to be removed as a plug connector from the top of the housing for servicing.
The lower section can be removed from the terminal block by pulling the unlocking tab.
Insert the new component and plug in the connector with the wiring. This reduces the installation time and eliminates the risk of wires being mixed up.

The familiar dimensions of the terminal only had to be changed slightly. The new connector adds about 3 mm. The maximum height of the terminal remains unchanged.

A tab for strain relief of the cable simplifies assembly in many applications and prevents tangling of individual connection wires when the connector is removed.

Conductor cross sections between 0.08 mm^2 and 2.5 mm^2 can continue to be used with the proven spring force technology.

The overview and nomenclature of the product names for ESxxxx and KSxxxx series has been retained as known from ELxxxx and KLxxxx series.

High Density Terminals (HD Terminals)

Fig. 9: High Density Terminals

The terminals from these series with 16 terminal points are distinguished by a particularly compact design, as the packaging density is twice as large as that of the standard 12 mm bus terminals. Massive conductors and conductors with a wire end sleeve can be inserted directly into the spring loaded terminal point without tools.

Wiring HD Terminals

The High Density Terminals of the ELx8xx and KLx8xx series doesn't support pluggable wiring.

Ultrasonically “bonded” (ultrasonically welded) conductors

Ultrasonically “bonded” conductors

It is also possible to connect the Standard and High Density Terminals with ultrasonically “bonded” (ultrasonically welded) conductors. In this case, please note the tables concerning the wire-size width [▶ 27]!

3.4.2 Wiring

⚠ WARNING

Risk of electric shock and damage of device!

Bring the bus terminal system into a safe, powered down state before starting installation, disassembly or wiring of the bus terminals!

Terminals for standard wiring ELxxxx/KLxxxx and for pluggable wiring ESxxxx/KSxxxx

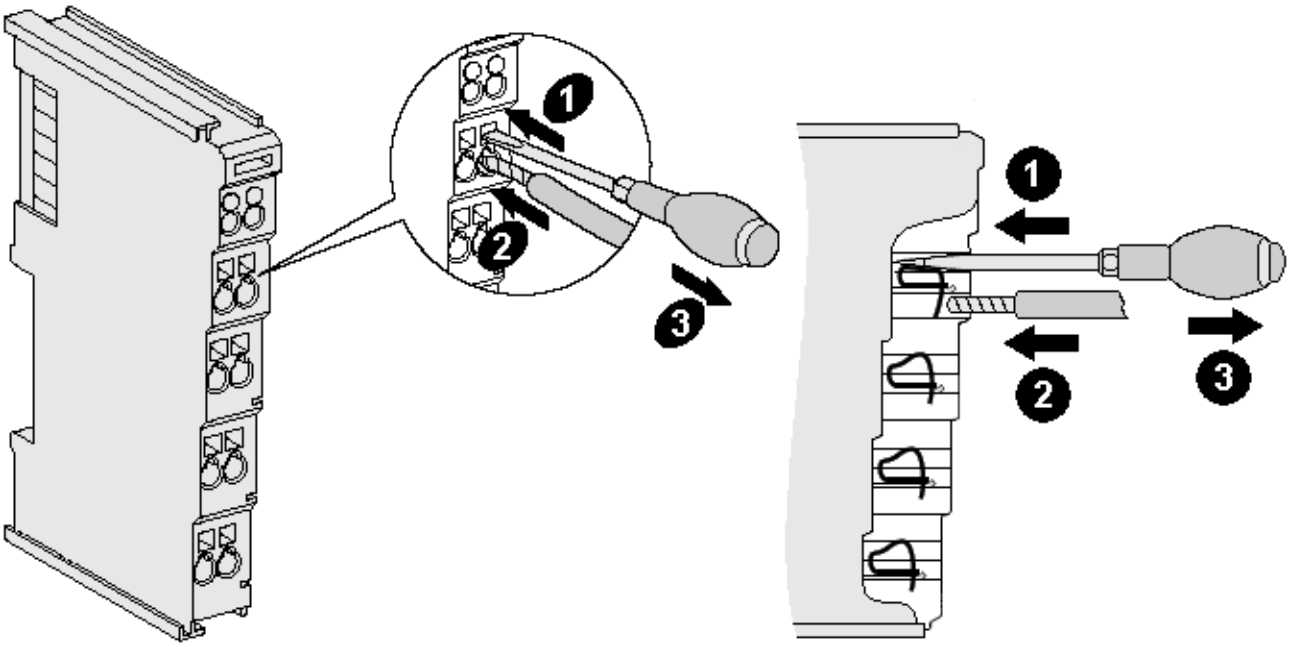


Fig. 10: Connecting a cable on a terminal point

Up to eight terminal points enable the connection of solid or finely stranded cables to the bus terminal. The terminal points are implemented in spring force technology. Connect the cables as follows:

1. Open a terminal point by pushing a screwdriver straight against the stop into the square opening above the terminal point. Do not turn the screwdriver or move it alternately (don't toggle).
2. The wire can now be inserted into the round terminal opening without any force.
3. The terminal point closes automatically when the pressure is released, holding the wire securely and permanently.

See the following table for the suitable wire size width.

Terminal housing	ELxxxx, KLxxxx	ESxxxx, KSxxxx
Wire size width (single core wires)	0.08 ... 2.5 mm²	0.08 ... 2.5 mm²
Wire size width (fine-wire conductors)	0.08 ... 2.5 mm²	0.08 ... 2.5 mm²
Wire size width (conductors with a wire end sleeve)	0.14 ... 1.5 mm²	0.14 ... 1.5 mm²
Wire stripping length	8 ... 9 mm	9 ... 10 mm

High Density Terminals (HD Terminals [▶ 26]) with 16 terminal points

The conductors of the HD Terminals are connected without tools for single-wire conductors using the direct plug-in technique, i.e. after stripping the wire is simply plugged into the terminal point. The cables are released, as usual, using the contact release with the aid of a screwdriver. See the following table for the suitable wire size width.

Terminal housing	High Density Housing
Wire size width (single core wires)	0.08 ... 1.5 mm^2
Wire size width (fine-wire conductors)	0.25 ... 1.5 mm^2
Wire size width (conductors with a wire end sleeve)	0.14 ... 0.75 mm^2
Wire size width (ultrasonically “bonded" conductors)	only 1.5 mm^2 (see notice [▶ 26])
Wire stripping length	8 ... 9 mm

3.4.3 Shielding

Shielding

Encoder, analog sensors and actuators should always be connected with shielded, twisted paired wires.

3.4.4 Contact assignment

⚠ WARNING

Risk of injury through electric shock and damage to the device!

Bring the bus terminal system into a safe, de-energized state before starting mounting, disassembly or wiring of the bus terminals!

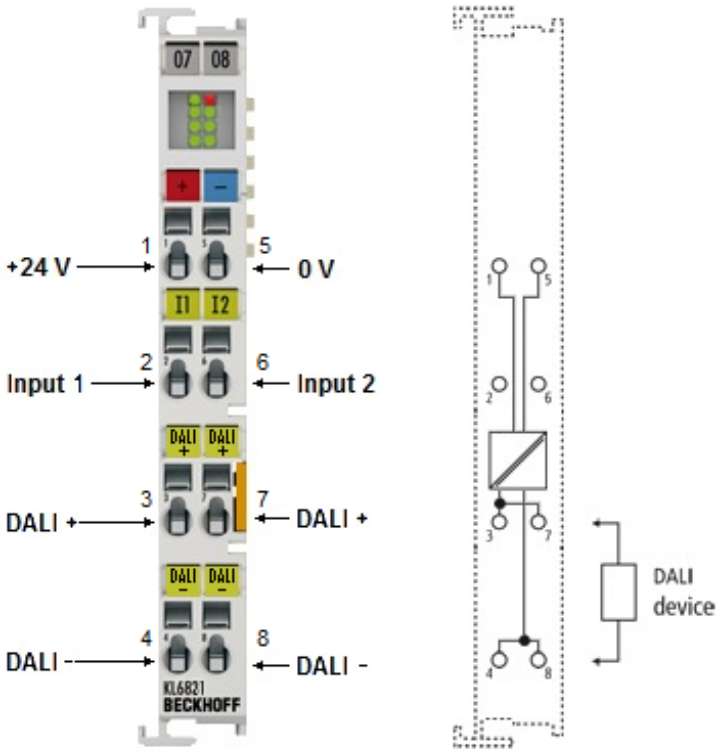


Fig. 11: KL6821 - Contact assignment

Contact assignment

Terminal point	No.	Connection for
+24 V DALI +	1	Power supply connection +24 V
Input 1	2	Digital input 1
DALI +	3	DALI-2 bus + (internally connected to terminal point 7)
DALI -	4	DALI-2 bus - (internally connected to terminal point 8)
0 V	5	Power supply connection 0 V
Input 2	6	Digital input 2
DALI +	7	DALI-2 bus + (internally connected to terminal point 3)
DALI -	8	DALI-2 bus - (internally connected to terminal point 4)

Input 1 and input 2 (terminal point 2 and 6)

The digital Input 1 and Input 2 only work if the supply voltage (24 V) is present and the K-bus is supplied with voltage.

The digital Input 1 and Input 2 have priority over automatic control through the PLC program. If the digital inputs are operated, other PLC-controlled DALI commands are blocked. To enable them a positive edge is required at the bResetInactiveProcessImage input of the function block FB_KL6821Communication. See documentation TwinCAT 3 | PLC library: Tc3_DALI. Alternatively, the priority rule can also be changed by setting it with the KS2000 configuration software (do not lock process image).

The behavior of the digital inputs DI1 and DI2 can be changed via the library function blocks or with the KS2000 configuration software. To support commissioning, the following default behavior is assigned in the delivered state.

Signal	Broadcast DALI command	Action	Comment
Rising edge at DI1	00_{hex}	Turns OFF all control gears (without fading).	Factory setting
Rising edge at DI2	05_{hex}	Switches all control gears to maximum brightness. If a control gear is switched off, it is switched on.	Factory setting

Cable lengths in DALI mode

The DALI bus can be configured in a line or star topology, or in a mix of the two. The maximum cable length must not exceed 300 m!

Cable length	Wire cross-section
up to 100 m	min. 0.5 mm^2
up to 150 m	min. 0.75 mm^2
up to 300 m	min. 1.5 mm^2

Further important boundary conditions derived from IEC 62386:

- The DALI cables must not be terminated with resistors.
- The maximum voltage drop between the sender and the receiver must not exceed 2 V.
- If the maximum cable length is utilized, it is not advisable to lay DALI in combination with the power cable.

3.5 LED displays

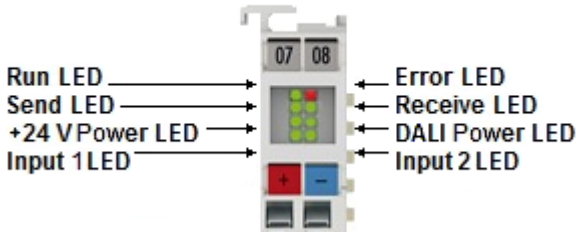


Fig. 12: KL6821 LEDs

LED	Color	State	Meaning
RUN	green	on	Data transmission on the K-bus
Error	Red	on	No 24 V_{DC} power supply at contact 1 and 5 or hardware error
Send	green	flashes	A DALI telegram is sent every time the light came on
Receive	green	flashes	A DALI telegram was received each time the light came on
+24 V Power	green	off	No 24 V_{DC} power supply at contact 1 and 5
		on	24 V_{DC} power supply at contact 1 and 5 okay
DALI Power	green	off	Integrated DALI power supply switched off
		on	Terminal supplies the DALI bus with voltage
Input 1	green	off	DI 1 is switched off
		on	DI 1 is switched on or was active and has not yet been acknowledged
Input 2	green	off	DI 2 is switched off
		on	DI 2 is switched on or was active and has not yet been acknowledged

4 KS2000 Configuration Software

4.1 KS2000 - Introduction

The KS2000 configuration software permits configuration, commissioning and parameterization of bus couplers, of the affiliated bus terminals and of Fieldbus Box Modules. The connection between bus coupler / Fieldbus Box Module and the PC is established by means of the serial configuration cable or the fieldbus.

Fig. 13: KS2000 configuration software

Configuration

You can configure the Fieldbus stations with the Configuration Software KS2000 offline. That means, setting up a terminal station with all settings on the couplers and terminals resp. the Fieldbus Box Modules can be prepared before the commissioning phase. Later on, this configuration can be transferred to the terminal station in the commissioning phase by means of a download. For documentation purposes, you are provided with the breakdown of the terminal station, a parts list of modules used and a list of the parameters you have modified. After an upload, existing fieldbus stations are at your disposal for further editing.

Parameterization

KS2000 offers simple access to the parameters of a fieldbus station: specific high-level dialogs are available for all bus couplers, all intelligent bus terminals and Fieldbus Box modules with the aid of which settings can be modified easily. Alternatively, you have full access to all internal registers of the bus couplers and intelligent terminals. Refer to the register description for the meanings of the registers.

Commissioning

The KS2000 software facilitates commissioning of machine components or their fieldbus stations: Configured settings can be transferred to the fieldbus modules by means of a download. After a *login* to the terminal station, it is possible to define settings in couplers, terminals and Fieldbus Box modules directly *online*. The same high-level dialogs and register access are available for this purpose as in the configuration phase.

The KS2000 offers access to the process images of the bus couplers and Fieldbus Box modules.

- Thus, the coupler's input and output images can be observed by monitoring.
- Process values can be specified in the output image for commissioning of the output modules.

All possibilities in the *online mode* can be used in parallel with the actual fieldbus mode of the terminal station. The fieldbus protocol always has the higher priority in this case.

4.2 KL6821 - Configuration

Connect the configuration interface of your fieldbus coupler with the serial interface of your PC via the configuration cable and start the *KS2000* configuration software.

Click the *Login* button. The configuration software will now load the information for the connected fieldbus station.
In the example shown, this is

- a BK9000 Bus Coupler for Ethernet
- a KL1xx2 digital input terminal
- a KL6821 DALI-2 master terminal
- a KL9010 bus end terminal

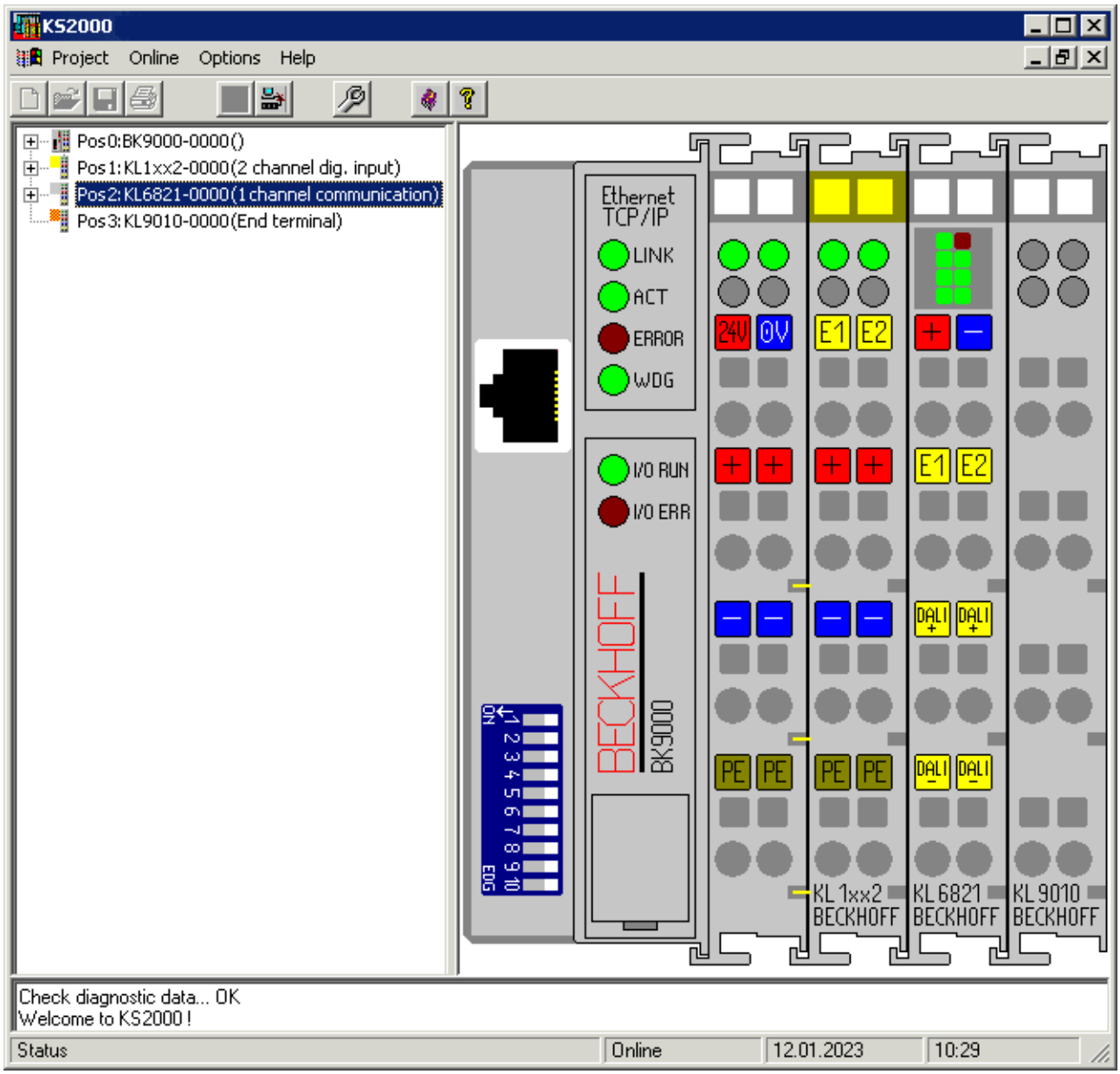


Fig. 14: Display of the fieldbus station in KS2000

The left window of the KS2000 shows the terminals of the fieldbus station in a tree structure.
The right window of the KS2000 shows the terminals of the fieldbus station graphically.

In the tree structure of the left-hand window, click on the plus-sign next to the terminal whose parameters you wish to change (item 2 in the example).

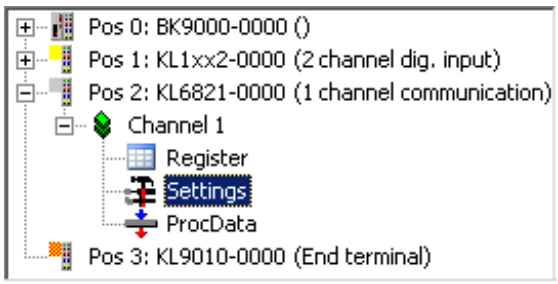


Fig. 15: KS2000 tree branches for channel 1 of the KL6821

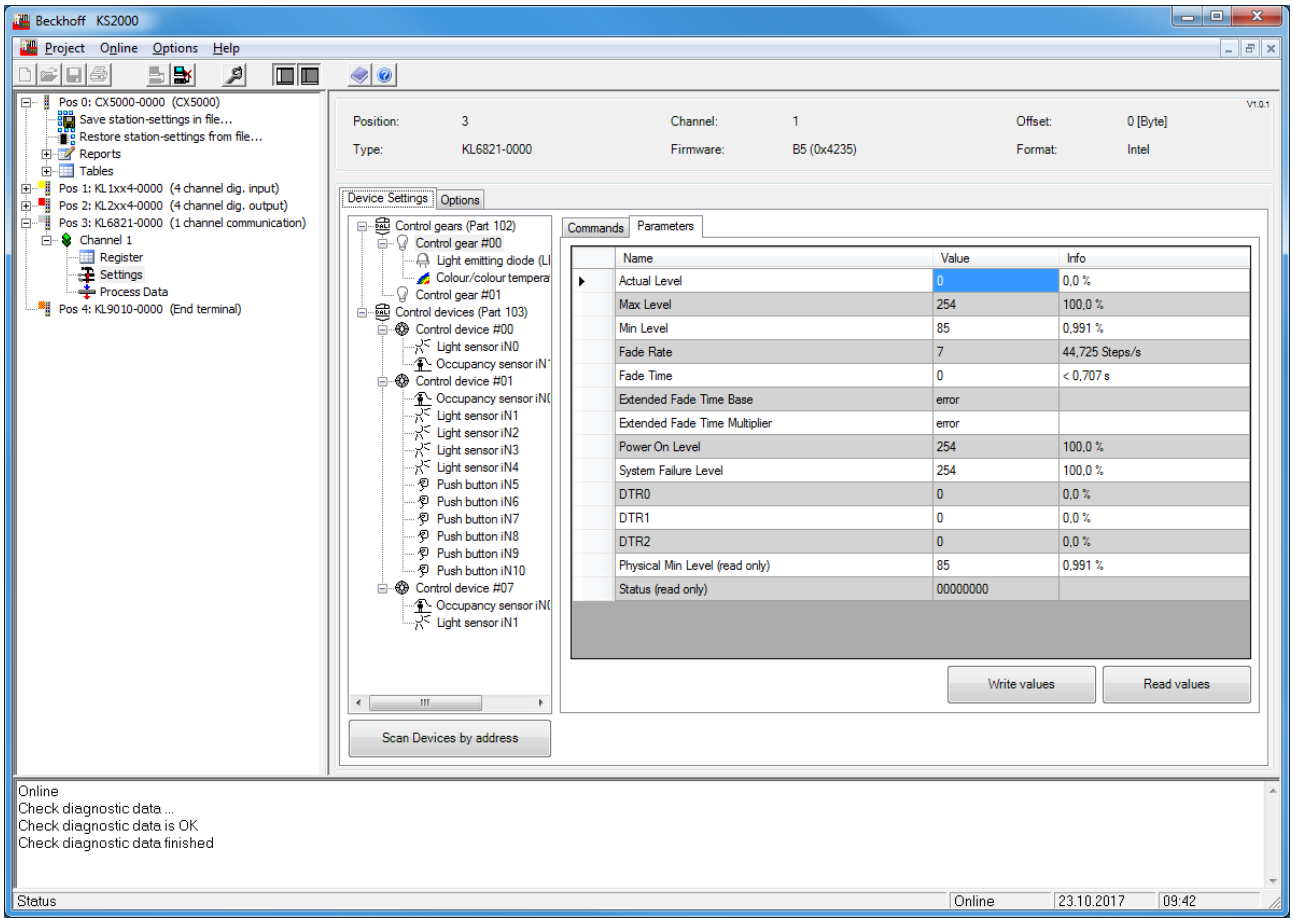
For the KL6821, the branches *Register*, *Settings* and *ProcData* are displayed:

- Register enables direct access to the KL6821 registers.
- Dialog masks for the parameterization of the KL6821 can be found under Settings.
- ProcData shows the KL6821 process data graphically.

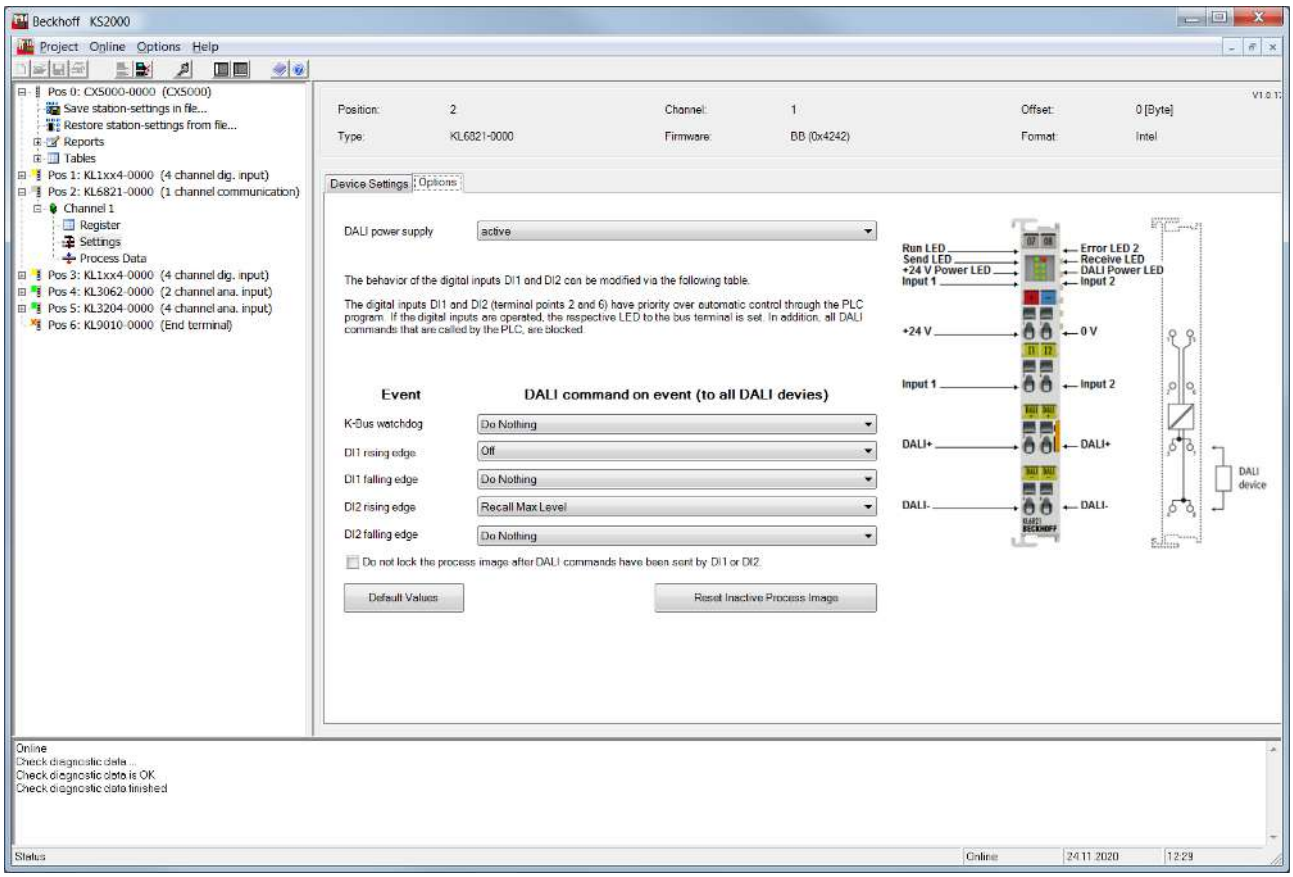
4.3 KL6821 - Settings

The KS2000 provides dialogs for commissioning and diagnosis of DALI devices on the KL6821.

The dialogs offer not only functions for addressing DALI control gears and DALI control devices, but also for writing and reading parameters. The search function automatically detects the DALI device types and displays them in a tree structure.



All parameters of the KL6821 can also be set via the KS2000. This makes it possible, for example, to define the DALI commands that are sent when the digital inputs on the KL6821 are actuated.



Overview of the most important functions in the KS2000 for the KL6821:

- Find DALI devices
- Addressing the DALI devices, including adapting the short addresses
- Scene and group assignment of the DALI control gears
- Configuration of the DALI control gears, including the parameters for the different device types
- Configuration of the DALI control gears, including the parameters for the different sensor types
- Writing/reading of the memory banks
- Definition of DALI commands for DI1 and DI2 (separate for rising and falling edge)
- Definition of the DALI command for the K-bus watchdog (K-bus failure)
- Switching the internal DALI power supply unit on/off
- Activation/deactivation of the blocking of the process image for the PLC as soon as a DALI command is sent by actuating a digital input on the KL6821.

5 Programming

The KL6821 is programmed exclusively via function blocks of the PLC libraries. The libraries are available for TwinCAT 2 as well as for TwinCAT 3.

5.1 TwinCAT libraries

See software documentation in the Beckhoff Information System.

TwinCAT 2: TwinCAT 2 | PLC Library: TcDALIV2

TwinCAT 3: TwinCAT 3 | PLC Lib: Tc3_DALI

6 Appendix

6.1 Support and Service

Beckhoff and their partners around the world offer comprehensive support and service, making available fast and competent assistance with all questions related to Beckhoff products and system solutions.

Beckhoff's branch offices and representatives

Please contact your Beckhoff branch office or representative for local support and service on Beckhoff products!

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More Information:
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