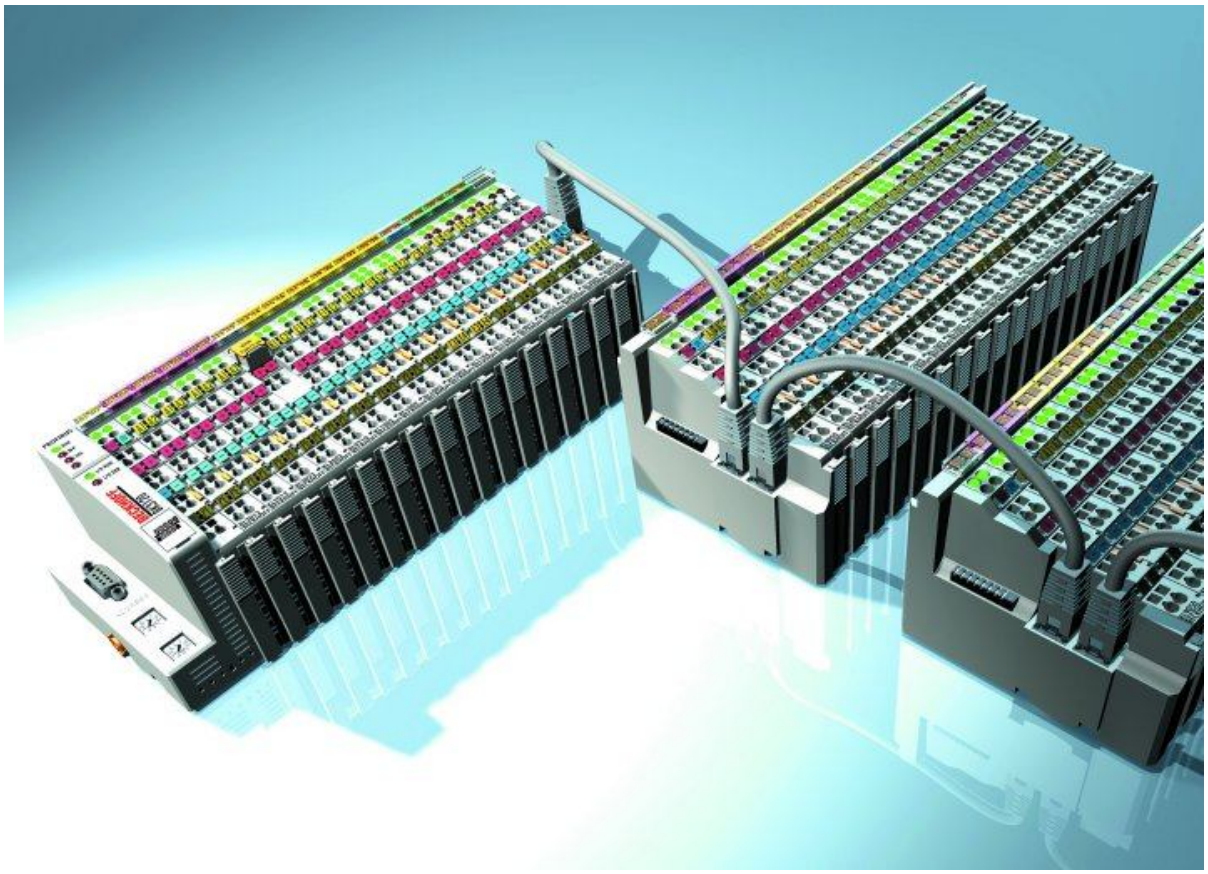
BECKHOFF Fieldbus Components



Documentation for

KL9020 and KL9050

K-Bus Extension

Version: 1.2.0

Date: 2007-10-15

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BECKHOFF Automation: Foreword

Notes on the Documentation

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 following notes and explanations are followed when installing and commissioning these components.

Liability Conditions

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.

The documentation has been prepared with care. The products described are, however, constantly under development. For that reason the documentation is not in every case checked for consistency with performance data, standards or other characteristics. None of the statements of this manual represents a guarantee (Garantie) in the meaning of § 443 BGB of the German Civil Code or a statement about the contractually expected fitness for a particular purpose in the meaning of § 434 par. 1 sentence 1 BGB. In the event that it contains technical or editorial errors, we retain the right to make alterations at any time and without warning. 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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BECKHOFF Automation: Foreword

Safety Instructions

Safety Rules

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.

State at Delivery

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.

Personnel Qualification

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

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Description of safety symbols

The following safety symbols are used in this operating manual. They are intended to alert the reader to the associated safety instructions.

 **Danger** This symbol is intended to highlight risks for the life or health of personnel.

 **Warning** This symbol is intended to highlight risks for equipment, materials or the environment.

 **Note** This symbol indicates information that contributes to better understanding.

BECKHOFF KL9020, KL9050: Foreword

Documentation Issue Status

Version	Comment
1.2.0	• Description of assembling a K-Bus Extension extended • Mounting description expanded
1.1.1	• Foreword and Appendix updated • Product overview for KL9050 updated
1.1	• Ordering information updated • Description of diagnostic LEDs corrected
1.0	first release

Firm and Hardware Versions

Documentation Version	KL9020		KL9050	
	Firmware	Hardware	Firmware	Hardware
1.2.0	03	08	01	03
1.1.1	03	07	01	02
1.1	01	02	01	01
1.0	01	02	01	01

The firmware and hardware version (delivery status) can be found in the serial number printed at the side of the terminal.

Syntax of the serial number

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Structure of the serial number: WW YY FF HH

WW - week of production (CW, calendar week)
YY - year of production
FF - firmware version
HH - hardware version

Example with ser. no.: 35 05 03 07:

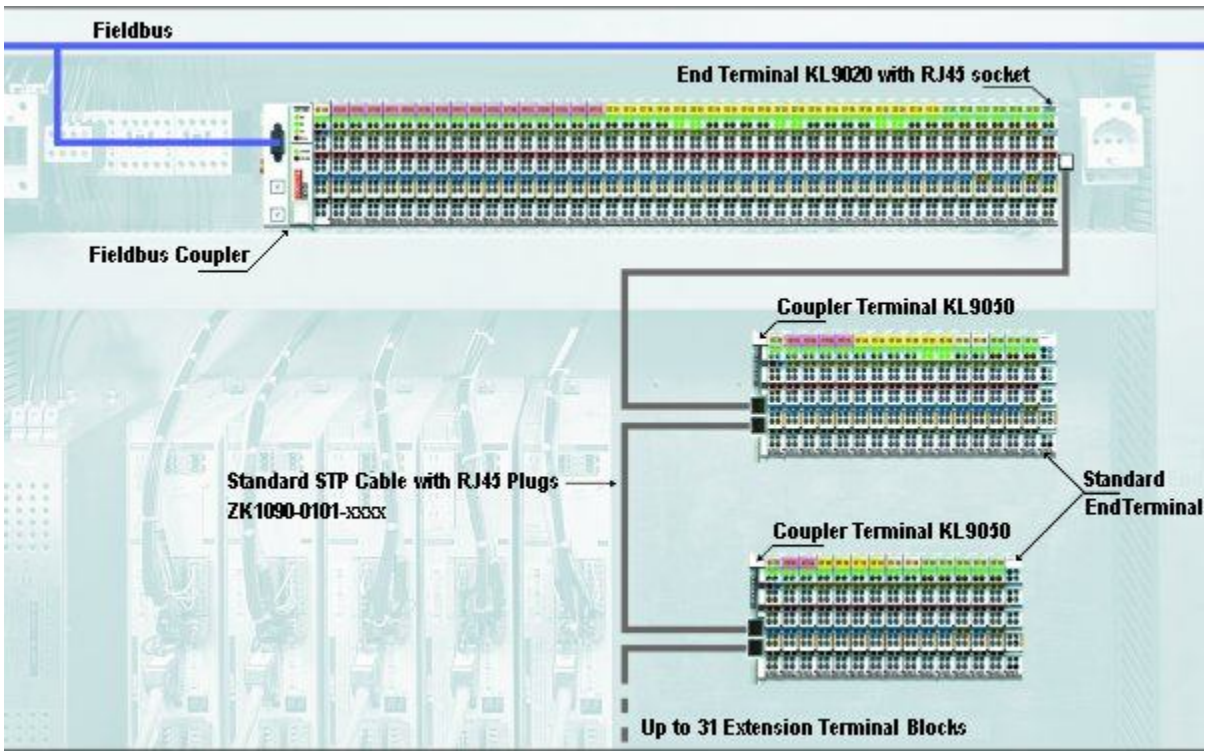
35 - week of production 35
05 - year of production 2005
03 - firmware version 03
07 - hardware version 07

BECKHOFF KL9020, KL9050: Product Overview

Functional Description

System expansion

Based on a bus terminal block consisting of a Bus Coupler and a maximum of 64 Bus Terminals, using the K-Bus Extension Terminals KL9020 and KL9050 your system can be expanded by up to 31 terminal blocks. The expansion terminal blocks can be equipped with a maximum of 64 Bus Terminals each. The maximum permissible configuration consists of 255 Bus Terminals and 1020 I/Os. The K-Bus Extension Terminals KL9020 and KL9050 enable a distance of 5 meters max. between two terminal blocks and therefore an overall system length of 155 meters.



The K-Bus Extension Terminals KL9020 and KL9050 integrate seamlessly into the Beckhoff Bus Terminal system in terms of their appearance and functionality. The transparent terminal lugs used for labeling indicate their function as system terminals.

KL9020

The End Terminal with RJ45 socket (KL9020) is plugged into the end of the bus terminal block instead of a standard End Terminal (KL9010) and enables the connection of the K-Bus extension cable. The electronics of the KL9020 are supplied via the K-Bus from the Fieldbus Coupler.

KL9050

In the expansion terminal blocks, the Coupler Terminal KL9050 replaces the Fieldbus Coupler and takes over its function. Start the expansion station by installing a Coupler Terminal KL9050 on the mounting rail and connect its RJ45 socket (identified with IN) to the preceding bus terminal block via a K-Bus extension cable with a maximum length of 5 meters. Connect the K-Bus extension cable

- of the first expansion terminal block to the End Terminal with RJ45 socket (KL9020) of the terminal block with the Fieldbus Coupler;
- of all other expansion terminal blocks to the RJ45 socket (identified with OUT) of the Coupler Terminal (KL9050) of the preceding expansion terminal block.

The power contacts and the corresponding connecting points of the Coupler Terminal are electrically isolated from the K-Bus.

K-Bus extension cable

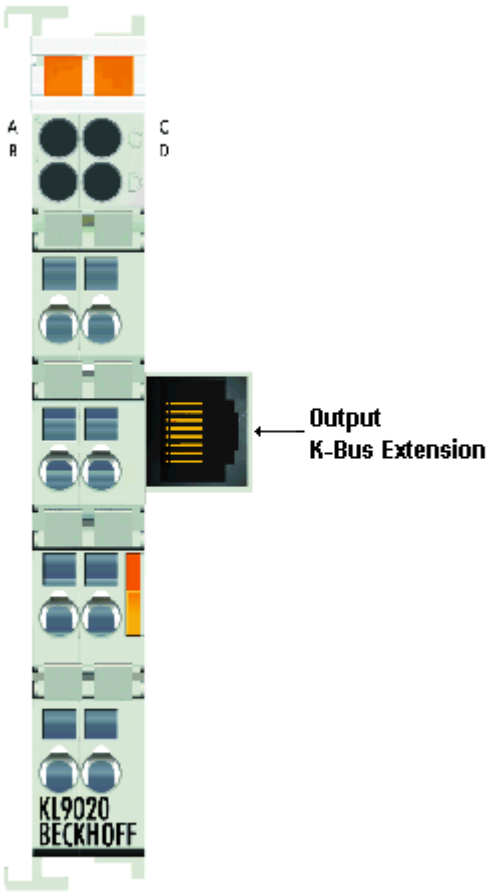
Data transmission between the terminal blocks is via 8 pole Ethernet cable with RJ45 plugs. Beckhoff offers pre-assembled cables in different lengths, which can be customized with commercially available Ethernet tools.

Note The K-Bus Extension Terminals should also work with cables from other manufacturers. However, Beckhoff recommends the use of Beckhoff Ethernet cables, which are tested for the specified functionality.

BECKHOFF KL9020: Product Overview

KL9020: End Terminal with RJ45 socket

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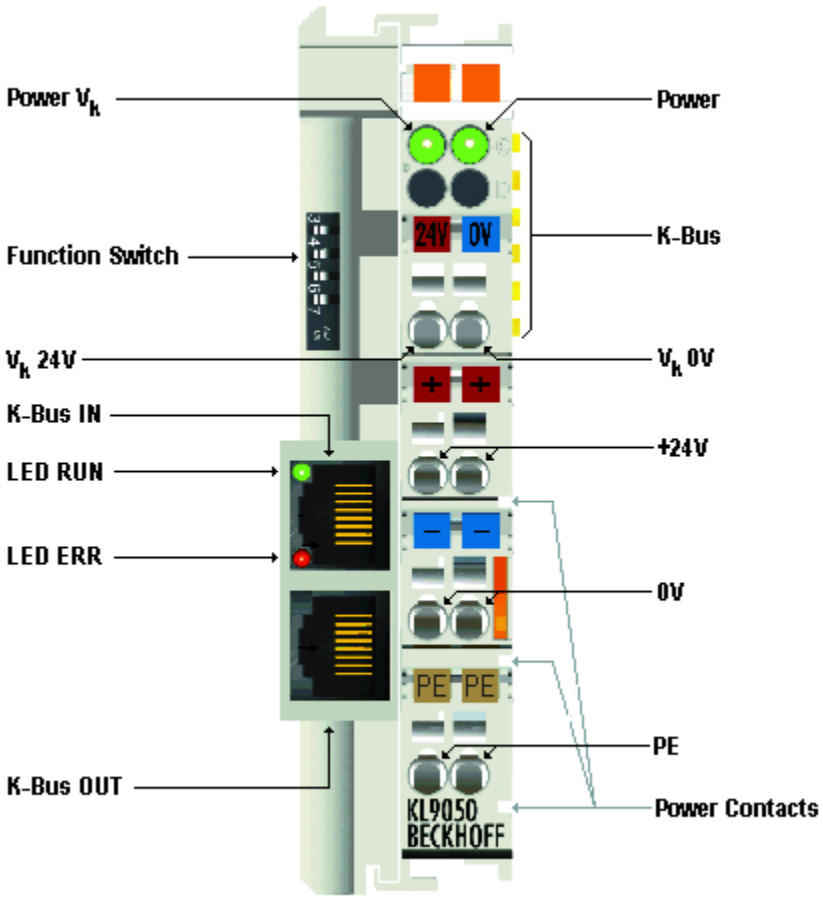


Interface	Function
K-Bus extension output	RJ45 socket for the continuing K-Bus extension

BECKHOFF KL9050: Product Overview

KL9050: Coupler Terminal

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LED	No.	Function
Power V_k, green	A	LED indicates whether the supply voltage for the electronics of the Coupler Terminal is switched on.
Power, green	C	LED indicates whether the supply voltage for the I/O terminals of the terminal block is switched on. The power supply of the terminals is via the power contacts.
RUN (K-Bus IN), green	-	LED indicating that the K-Bus is transferring data
ERR (K-Bus IN), red	-	LED indicating a fault on the K-Bus

Terminal Point	No.	Function
V_k 24V	1	feeding of the +24 V power supply for the Coupler Terminal electronics
+24 V	2	feeding of the +24 V power supply for the power contacts (connected internally to terminal point 5)
0 V	3	feeding of the 0 V power supply for the power contacts (connected internally to terminal point 7)
PE	4	PE connector (connected internally to terminal point 8)

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V_k 0V	5	feeding of the 0 V power supply for the Coupler Terminal electronics
+24 V	6	feeding of the +24 V power supply for the power contacts (connected internally to terminal point 2)
0 V	7	feeding of the 0 V power supply for the power contacts (connected internally to terminal point 3)
PE	8	PE connector (connected internally to terminal point 4)

Interface	Function
K-Bus IN	RJ45 socket for the incoming K-Bus extension
K-Bus OUT	RJ45 socket for the continuing K-Bus extension
K-Bus	Internal K-Bus of the bus terminal block
Power Contacts	Internal power contacts of a bus terminal block
Function Switch	Switch for the terminating resistor of the Coupler Terminal

BECKHOFF KL9020, KL9050: Product Overview

Technical data

Technical data	General
Number of Bus Terminals per Fieldbus Coupler	with Fieldbus Coupler BKxx20 or BKxx50: max. 255 with Fieldbus Coupler BKxx00 or BKxx10: max. 64
Number of bytes per Fieldbus Coupler	limited by Fieldbus Coupler and Fieldbus Limit (see documentation for the Fieldbus Coupler being used)
Increase in run-time due to K-Bus extension	negligible (see run-time calculation in the documentation for the Fieldbus Coupler used)
Length of cable between 2 terminal blocks	max. 5 meters
Total length of cable (from KL9020 to the last KL9050)	max. 155 meters (31 x 5 meters)
Topology	Bus structure

Technical data	KL9020 End Terminal with RJ45 socket for K-Bus extension
Fieldbus	independent
Number of KL9020 per Fieldbus Coupler	1
Configuration	automatic
Current consumption on the K-Bus	typically 70 mA
Dielectric strength	500 V_{rms} (shielding, base plate / K-Bus)
Permissible ambient temperature range during operation	0°C ... +55°C

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Permissible ambient temperature range during storage	-25 °C ... +85°C
Permissible relative humidity	95%, no condensation
Vibration / shock resistance	conforms to EN 60068-2-6 / EN 60068-2-27, EN 60068-2-29
EMC resistance burst / ESD	conforms to EN 61000-6-2 / EN 61000-6-4
Weight	approx. 46 g
Dimensions (W x H x D)	approx. 26 mm x 100 mm x 70 mm
Assembly	on 35 mm mounting rail according to EN 50022
Installation position	any
Type of protection	IP20
Approvals	CE, see Beckhoff Homepage

Technical data	KL9050 K-Bus Extension Coupler Terminal
Number of Bus Terminals per KL9050	max.64
Number of KL9050 per Fieldbus Coupler	max.31
Configuration	via switch Function switch
Supply voltage	24 V_{DC} (-15%/+20%)
Current consumption (via Terminals V_k 24V, V_k 0V)	200 mA max. Calculation: 70 mA + (K-Bus current of the terminal block) / 4
Starting current	2.5 x nominal current
K-Bus power supply (for Bus Terminals)	max.400 mA
Power contacts voltage	power supply 30 V_{DC}
Power contact current load	max. 10 A (short-circuit 125 A)
Dielectric strength	500 V_{rms} (power contacts / supply voltage / fieldbus)
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
Vibration / shock resistance	conforms to EN 60068-2-6 / EN 60068-2-27, EN 60068-2-29
EMC resistance burst / ESD	conforms to EN 61000-6-2 / EN 61000-6-4
Weight	approx. 75 g
Dimensions (W x H x D)	approx. 24.5 mm x 100 mm x 70 mm
Assembly	on 35 mm mounting rail according to EN 50022
Installation position	any

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Type of protection	P20
Approvals	CE, see Beckhoff Homepage

BECKHOFF KL9020, KL9050: Product Overview

Ordering information

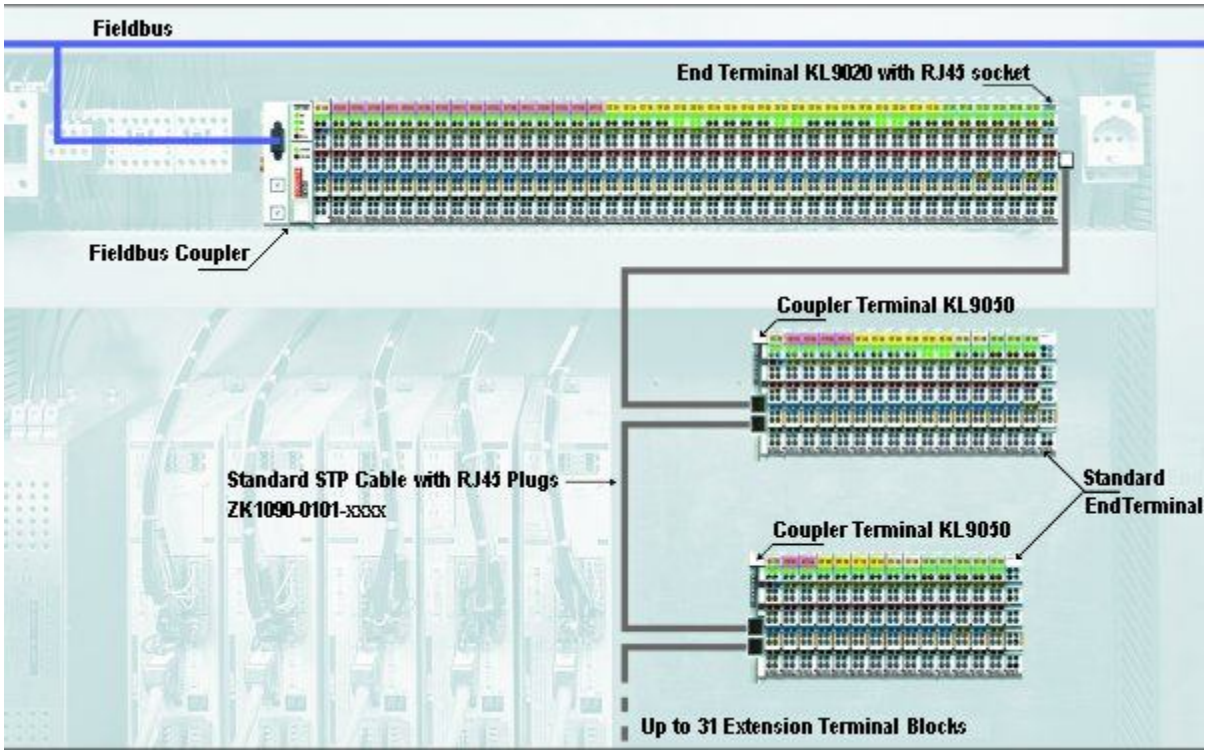
Order designation	Description
KL9020	End Terminal with RJ45 socket for K-Bus extension
KL9050	K-Bus Extension Coupler Terminal
ZK1090-0101-1005	K-Bus extension cable with two pre-assembled plugs, double shielded, grey, 50 cm
ZK1090-0101-1010	K-Bus extension cable with two pre-assembled plugs, double shielded, grey, 100 cm
ZK1090-0101-1020	K-Bus extension cable with two pre-assembled plugs, double shielded, grey, 200 cm
ZK1090-0101-1030	K-Bus extension cable with two pre-assembled plugs, double shielded, grey, 300 cm
ZK1090-0101-1050	K-Bus extension cable with two pre-assembled plugs, double shielded, grey, 500 cm
ZK1090-0000-1000	K-Bus extension cable without plugs, double shielded, grey, coiled
ZS1090-0001-0000	Modular RJ45 plug with anti-kink envelope, grey

BECKHOFF KL9020, KL9050: Mounting and Wiring

Assembling a K-Bus Extension

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

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Assembly

During installation, follow the notes in Section *Installation of Bus Terminals on mounting rails*.

1. Ensure that the system is powered down and in a safe state.
2. Install the first bus terminal block, consisting of the Fieldbus Coupler and the desired Bus Terminals, on a mounting rail.
   Instead of a standard End Terminal (KL9010), install an End Terminal with RJ45 socket (KL9020) as the last terminal at the end of the first bus terminal block.
3. Install the first expansion terminal block, consisting of a Coupler Terminal (KL9050) and the desired Bus Terminals, on a mounting rail.
   Install a standard End Terminal (KL9010) as the last terminal at the end of the first expansion terminal block.
4. Connect one RJ45 plug of an Ethernet cable into the RJ45 socket of the KL9020 of the first bus terminal block until it clicks into place.
   Connect the other RJ45 plug of the Ethernet cable into the RJ45 socket (labeled *IN*) of the expansion terminal block Coupler Terminal (KL9050) until it clicks into place.
5. Install the next expansion terminal block, consisting of a Coupler Terminal (KL9050) and the desired Bus Terminals, on a mounting rail.
   Install a standard End Terminal (KL9010) as the last terminal at the end of this expansion terminal block.
6. Connect one RJ45 plug of an Ethernet cable into the RJ45 socket (labeled *OUT*) of the KL9020 of the previous expansion terminal block until it clicks into place.
   Connect the other RJ45 plug of the Ethernet cable into the RJ45 socket (labeled *IN*) of the KL9020 of the added expansion terminal block until it clicks into place.
7. Repeat steps 5 and 6 in order to connect further expansion terminal blocks. A maximum of 31 expansion terminal blocks can be connected.
8. Set the *Function Switch* on all Coupler Terminals (KL9050) correctly.

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Function Switch

Activate the terminating resistor at the last expansion terminal block of your K-Bus extension system by switching the *Function Switch* on the last Coupler Terminal (KL9050) to the position *Last.*

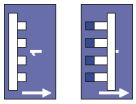
Correct setting of the *Function Switches* of all Coupler Terminals (KL9050) within a K-Bus extension system must be ensured:

Danger

- The *Function Switch* of all Coupler Terminals (KL9050) to which a continuing Ethernet cable is connected must be set to position *Next*!
- The *Function Switch* may be set to the position *Last* only at the last Coupler Terminal (KL9050) of the K-Bus extension system!

Function Switch:

All expansion terminal blocks connected after a Coupler Terminal (KL9050), whose *Function Switch* is set to position *Last*, are not included correctly in the process image:



- The inputs of these terminals are not visible in the process image!
- The outputs of these terminals are not controlled by the process image!

Correct setting of the *Function Switches* must also be ensured if Coupler Terminals (KL9050) are replaced!

Notes about topology

Note

The end KL9020 terminal with RJ45 connector is only allowed to be connected to terminal blocks opened by a fieldbus coupler!
All expansion terminal blocks have to be terminated by a KL9010 standard end terminal!

Note

To every KL9050 Coupler Terminal at minimum one terminal with process image has to be connected!
The operation of an expansion terminal block with only a KL9010 (without inputs or outputs) is not allowed!

Disassembly

During disassembly, follow the notes in Section *Installation of Bus Terminals on mounting rails*.

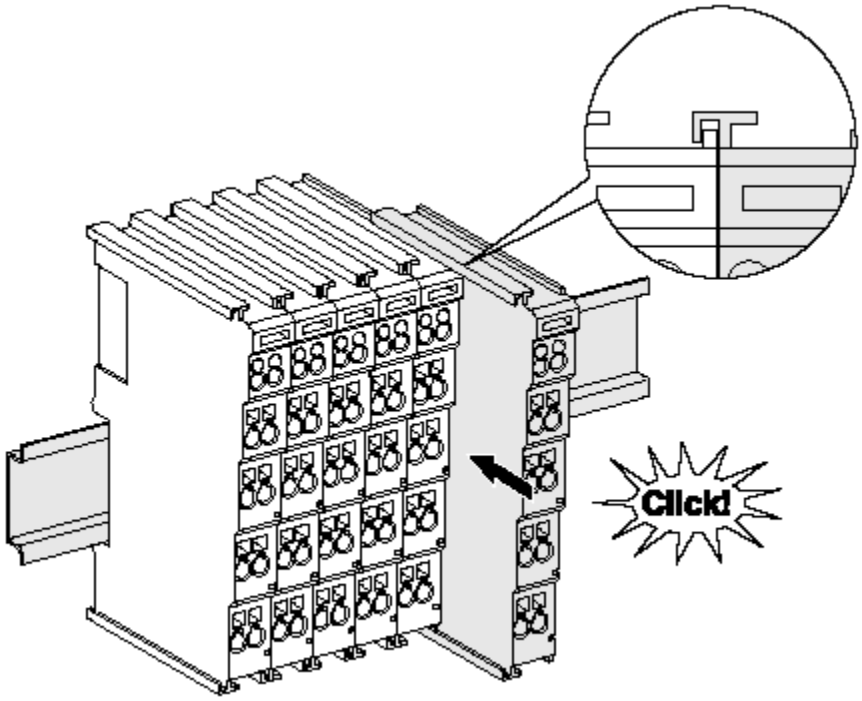
1. Ensure that the system is powered down and in a safe state.
2. Press the plastic lock of the RJ45 plug and pull it from the socket.
3. Carefully pull the orange-colored lug approximately 1 cm out of the disassembled terminal, until it protrudes loosely. The lock with the C mounting rail is now released for this terminal, and the terminal can be pulled from the mounting rail without excessive force.
4. Grasp the released terminal with thumb and index finger simultaneous at the upper and lower grooved housing surfaces and pull the terminal away from the mounting rail.

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Installation of Bus Terminals on mounting rails

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

Assembly



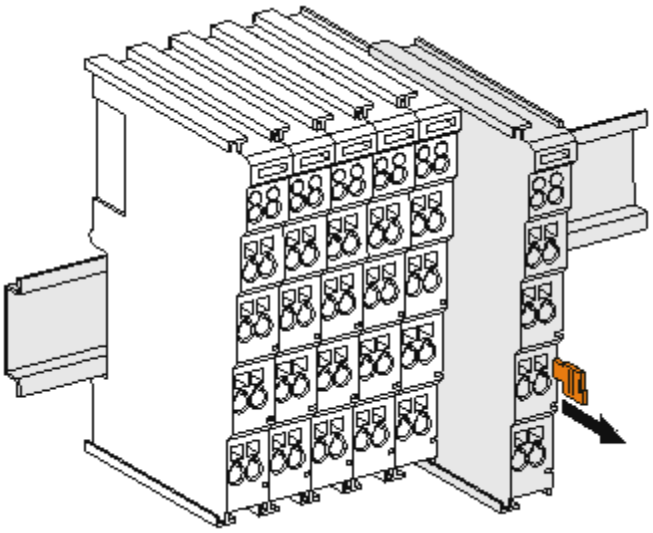
The Bus Coupler and Bus Terminals are attached to commercially available 35 mm mounting rails (DIN rails according to EN 50022) by applying slight pressure:

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.

During the installation of the Bus Terminals, the locking mechanism of the terminals must not come into conflict with the fixing bolts of the mounting rail.

Disassembly

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

1. Carefully pull the orange-colored lug approximately 1 cm out of the disassembled terminal, until it protrudes loosely. The lock with the mounting rail is now released for this terminal, and the terminal can be pulled from the mounting rail 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 away from the mounting rail.

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.

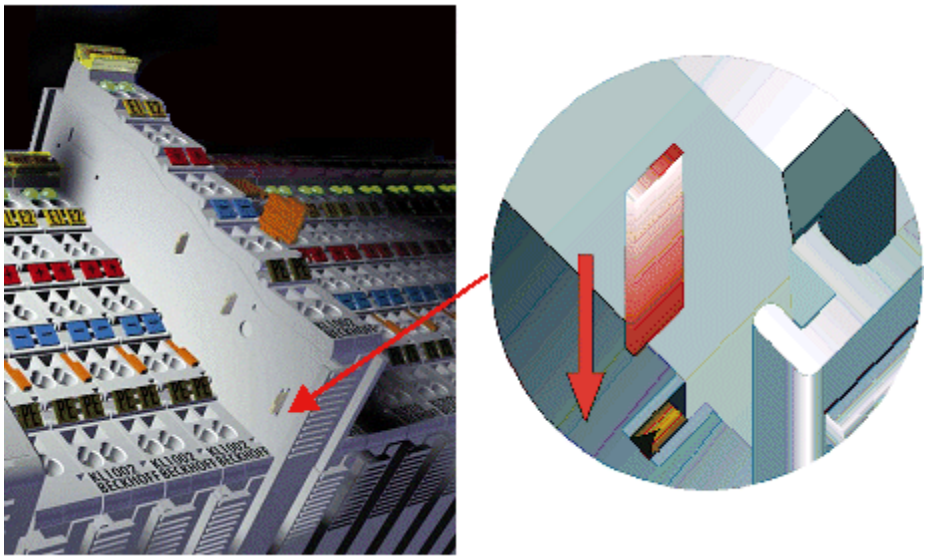
Note

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.

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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).

Warning

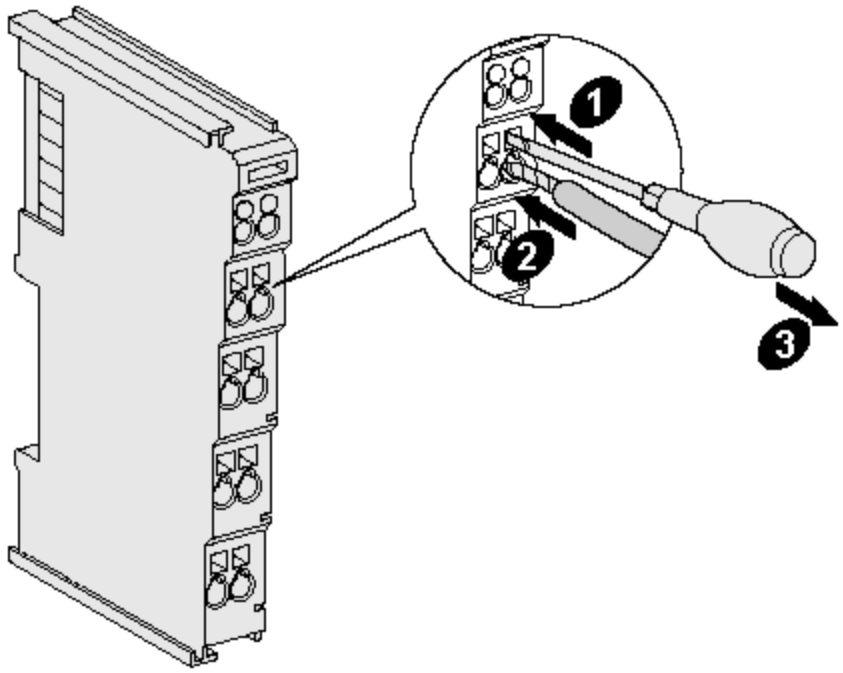
For insulation testing, disconnect the PE supply line at the Bus Coupler or the Power Feed Terminal! In order to decouple further feed points for testing, these Power Feed Terminals can be released and pulled at least 10 mm from the group of terminals.

Danger

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

Wiring

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Up to eight connections enable the connection of solid or finely stranded cables to the Bus Terminals. The terminals are implemented in spring force technology. Connect the cables as follows:

1. Open a spring-loaded terminal by slightly pushing with a screwdriver or a rod into the square opening above the terminal.
2. The wire can now be inserted into the round terminal opening without any force.
3. The terminal closes automatically when the pressure is released, holding the wire securely and permanently.

Wire stripping length	0,08 ... 2,5 mm^2
Wire size with	8 mm

Note Analog sensors and actors should always be connected with shielded, twisted paired wires.

BECKHOFF KL9020, KL9050: Mounting and Wiring

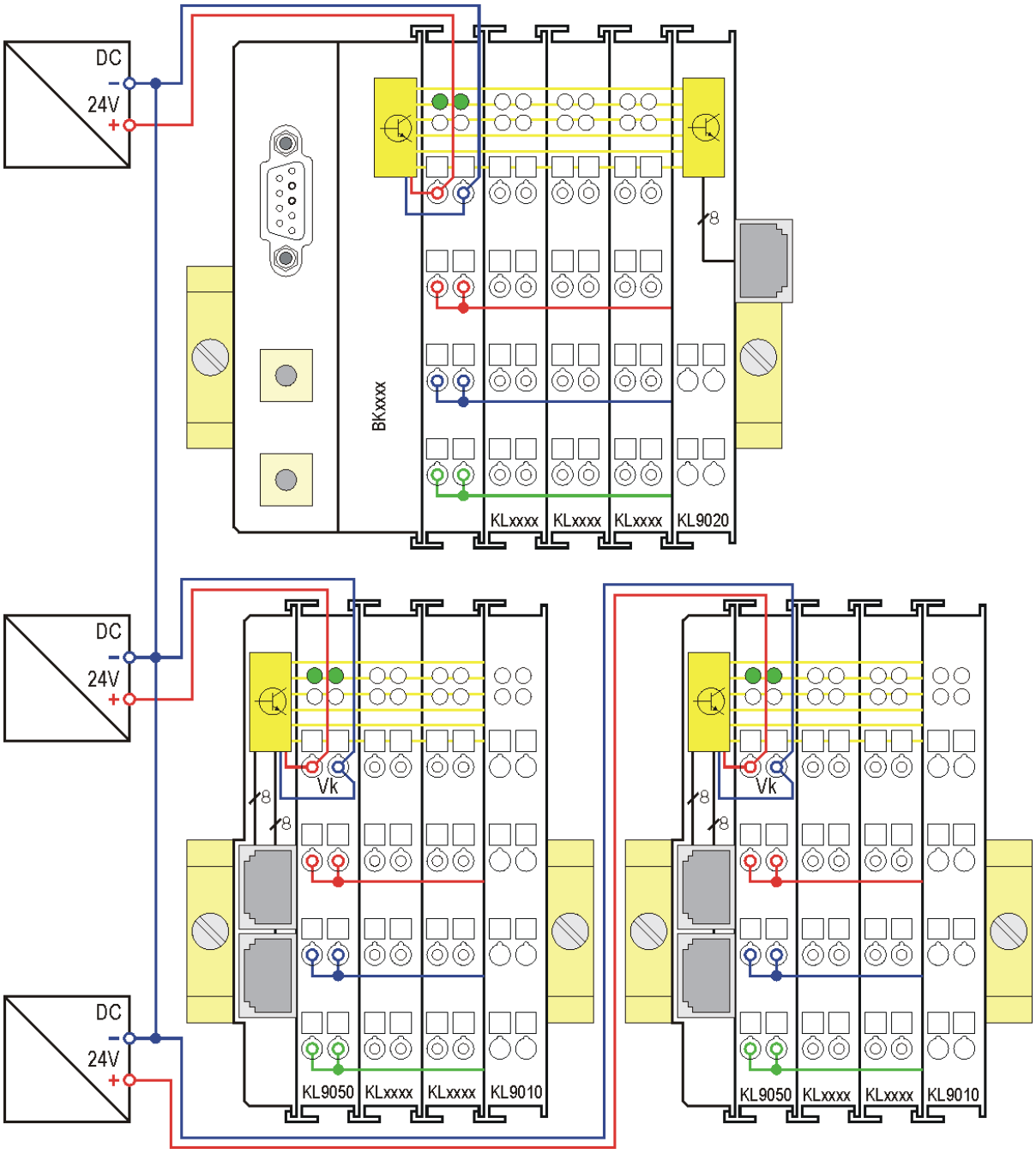
Power supply

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

The supply connections V_k for the module electronics (K-Bus) and supply connections for the field devices (power contacts) of a terminal block are galvanically separated from each other and can be supplied via separate 24 V_{DC} voltage sources. If no electrical isolation is required between K-Bus and field devices, the module electronics and the field devices can be supplied from a single voltage source.

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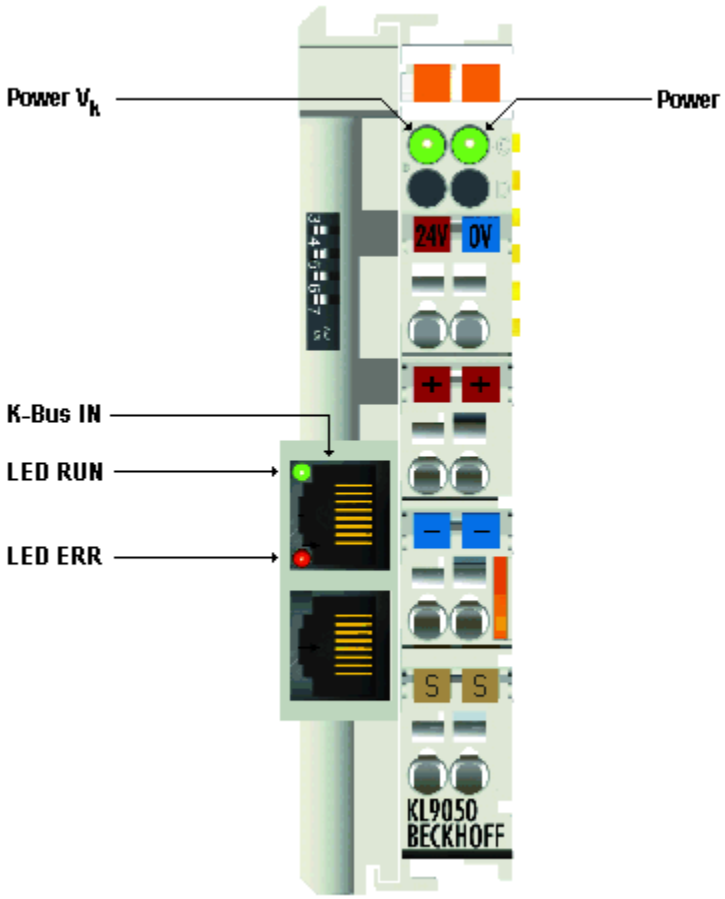
Warning For the trouble-free operation of a K-Bus extension system, the ground connection of the K-Bus power supplies (V_k 0V) of all terminal blocks must be connected with each other via a low-impedance connection (see Figure). This also includes the ground connection of the K-Bus power supply of the higher-level Fieldbus Coupler!



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Diagnostic LEDs

Coupler Terminal (KL9050)



Diagnostic LEDs for power supply

LED	Function	Display	Meaning
Power V_k (green)	Indicates whether the supply voltage for the electronics of the Coupler Terminal is switched on.	on	Supply voltage present
		off	Power supply has failed or is switched off
Power (green)	Indicates whether the supply voltage for the I/O terminals of the terminal block is switched on. The power supply of the terminals is via the power contacts.	on	Supply voltage present
		off	Power supply has failed or is switched off

Diagnostic LEDs on the RJ45 socket for the incoming K-Bus extension (K-Bus IN)

LED	LED		

***RUN* (green)**	***ERR* (red)**	**Meaning**	**Possible causes**
on	off	Data transmission on the K-Bus extension is active	• Supply voltage present • Connection properly established
off	on	Data transmission on the K-Bus extension is interrupted	• Ethernet cable not connected • Cable fracture or short-circuit of the Ethernet cable • RJ45 plug was pulled • *Function Switch* of a KL9050 not set correctly
off	off	Data transmission on the K-Bus extension is interrupted	• The supply voltage for the electronics of the Coupler Terminal has failed? • Coupler Terminal faulty

End Terminal with RJ45 socket (KL9020)

The End Terminal KL9020 has no separate diagnostic LEDs. For diagnosing the K-Bus of your bus terminal block, the diagnostic LEDs *I/O RUN* and *I/O ERR* of the Fieldbus Coupler installed there are used.

Typical diagnostic LEDs of a Fieldbus Coupler

LED *I/O RUN* (green)	**LED *I/O ERR* (red)**	**Meaning**	**Possible causes**
on	off	Data transmission on the K-Bus is active	• Supply voltage present • Connection properly established
off	flashing	Data transmission on the K-Bus is interrupted	• Bus Terminal not properly plugged in • Configuration error • Installed Bus Terminal faulty
off	off	Data transmission on the K-Bus is interrupted	• The supply voltage for the electronics of the Fieldbus Coupler has failed • Fieldbus Coupler faulty

Behavior in case of an error

If the communication between two or several bus terminal blocks of a K-Bus extension system is interrupted

- the green LEDs *RUN* on the K-Bus extension input sockets (K-Bus IN) of all KL9050 will go out;
- the red LEDs *ERR* on the K-Bus extension input sockets (K-Bus IN) of all KL9050 will go on;
- the green LED I/O RUN of your Fieldbus Coupler will go out;
- the red LED *I/O ERR* of the higher-level Fieldbus Coupler will flash rapidly, indicating an interruption of the communication

Blink Code

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If you now perform a reset for the Fieldbus Coupler, the Fieldbus Coupler searches for the cause of the fault and indicates it as a blink code via the LED *I/O ERR*.

A blink code is made up as follows:

- rapid flicker
- short break
- LED flashes m times for Error Code m
- short break
- LED flashes n times for error code argument n
- short break

Count the error code and the error code argument. The flash code is repeated continuously.

The error code for a K-Bus interruption is 4. The error code argument indicates the Bus Terminal after which communication was interrupted. Examples are shown in the Fault table for K-Bus interruption.

Fault table for K-Bus interruption

Examples of fault indications in the event of communication interruption on the K-Bus

Error	Display	Specific display	Possible cause	Remedy
	LED *ERR* of the Coupler Terminals KL9050 are on	LED *I/O ERR* of the higher-level Fieldbus Coupler flashes rapidly	K-Bus or K-Bus extension was interrupted	After any interruption of the data transmission on the K-Bus, the higher-level Fieldbus Coupler requires a reset in order to restart the data transmission or to locate the fault.
	LED *ERR* of the Coupler Terminals KL9050 are on		The Ethernet cable of a K-Bus extension is not plugged in correctly	Fault after the n-th Bus Terminal: ensure that the RJ45 plug is connected correctly.
	LED *I/O ERR* of the higher-level Fieldbus Coupler flashes as follows after switching on (Blink Code): - fast		The *Function Switch* of the last Coupler Terminal is not in position *Load*	Set the *Function Switch* of the last Coupler Terminal to position *Load*!
			Wrong Ethernet cable	Fault after the n-th Bus Terminal: Do not use a crossed Ethernet cable for K-Bus extension!
	- 4 times slow	LED *Power* V_k of	The supply voltage	Check the supply voltages of the bus

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	- n times slow	the affected Coupler Terminal is not on	of a Coupler Terminal has failed	terminal block after the n-th Bus Terminal
no data transmission on the K-Bus and the K-Bus extension		LED *I/O ERR* of the higher-level Fieldbus Coupler flashes rapidly	Ethernet cable too long	The length of the Ethernet cable between two terminal blocks must not exceed 5 m.
				The overall length of the K-Bus extension must not exceed 155 m (31 x 5 m).
			Ethernet cable defective	Check the Ethernet cable.
	LED *ERR* of the Coupler Terminals KL9050 are on		Wrong End Terminal installed: The End Terminal with RJ45 socket (KL9020) is only used at the bus terminal block with the Fieldbus Coupler.	All expansion terminal blocks must be terminated with standard End Terminals (KL9010)! See notes about topology of K-Bus extension.

Please see the documentation your Fieldbus Coupler for further error codes (m≠4) and the associated error code arguments.

BECKHOFF Automation: Appendix

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