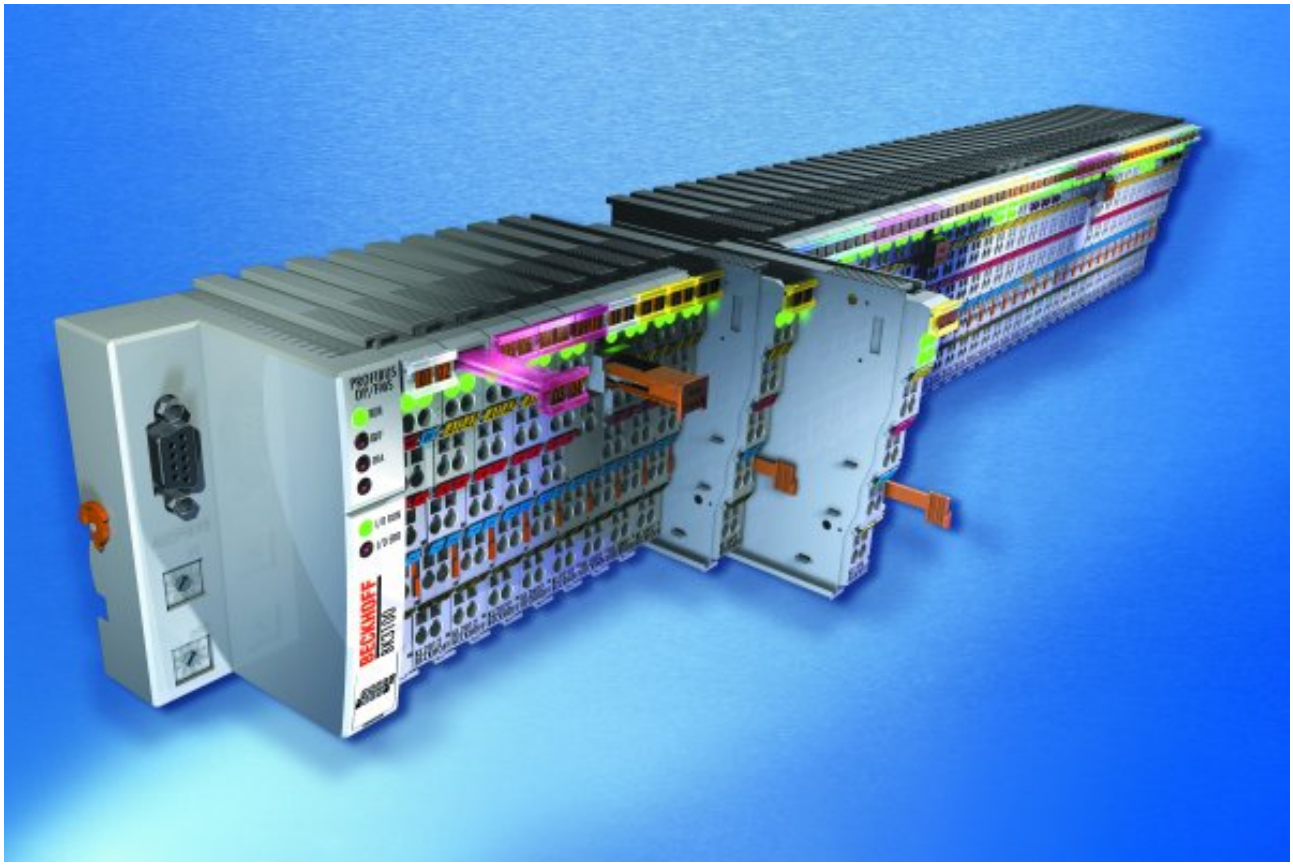

Documentation

KL6781

M-Bus Master Terminals

Version: 2.0.0
Date: 2018-01-16

BECKHOFF

Table of contents

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.
It is the duty of the technical personnel to use the documentation published at the respective time of each installation and commissioning.

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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Patent Pending

The EtherCAT Technology is covered, including but not limited to the following patent applications and patents: EP1590927, EP1789857, DE102004044764, DE102007017835 with corresponding applications or registrations in various other countries.

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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.

Description of symbols

In this documentation the following symbols are used with an accompanying safety instruction or note. The safety instructions must be read carefully and followed without fail!

 **DANGER**	**Serious risk of injury!** Failure to follow the safety instructions associated with this symbol directly endangers the life and health of persons.
 **WARNING**	**Risk of injury!** Failure to follow the safety instructions associated with this symbol endangers the life and health of persons.
 **CAUTION**	**Personal injuries!** Failure to follow the safety instructions associated with this symbol can lead to injuries to persons.
 **Attention**	**Damage to the environment or devices** Failure to follow the instructions associated with this symbol can lead to damage to the environment or equipment.
 **Note**	**Tip or pointer** This symbol indicates information that contributes to better understanding.

1.3 Documentation Issue Status

Version	Comment
2.0.0	• Migration
1.4.0	• Programming description moved to the TwinCAT Information System [▶ 30]. • Library updated to version 2.0.1 • Technical data updated
1.3.0	• Function block FB_MBUS_SBC_ALD1 added • Library updated to version 120
1.2.0	• Programming chapter updated
1.1.0	• Foreword updated • Mounting instructions extended • Description of control and status word expanded • Register description extended • M-bus chapter added • Programming chapter extended
1.0.0	• First release

Firmware and hardware versions

Documentation Version	KL6781	
	Firmware	Hardware
2.0.0	1C	03
1.4.0	1B	01
1.3.0	1B	01
1.2.0	1B	01
1.1.0	1B	01
1.0.0	1A	00

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

Syntax of the serial number

Structure of the serial number: KK YY FF HH

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

Example with ser. no.: 50 11 1A 00:

50 - week of production 50
11- year of production 2011
1A - firmware version 1A
00 - hardware version 00

2 Product overview

2.1 Introduction

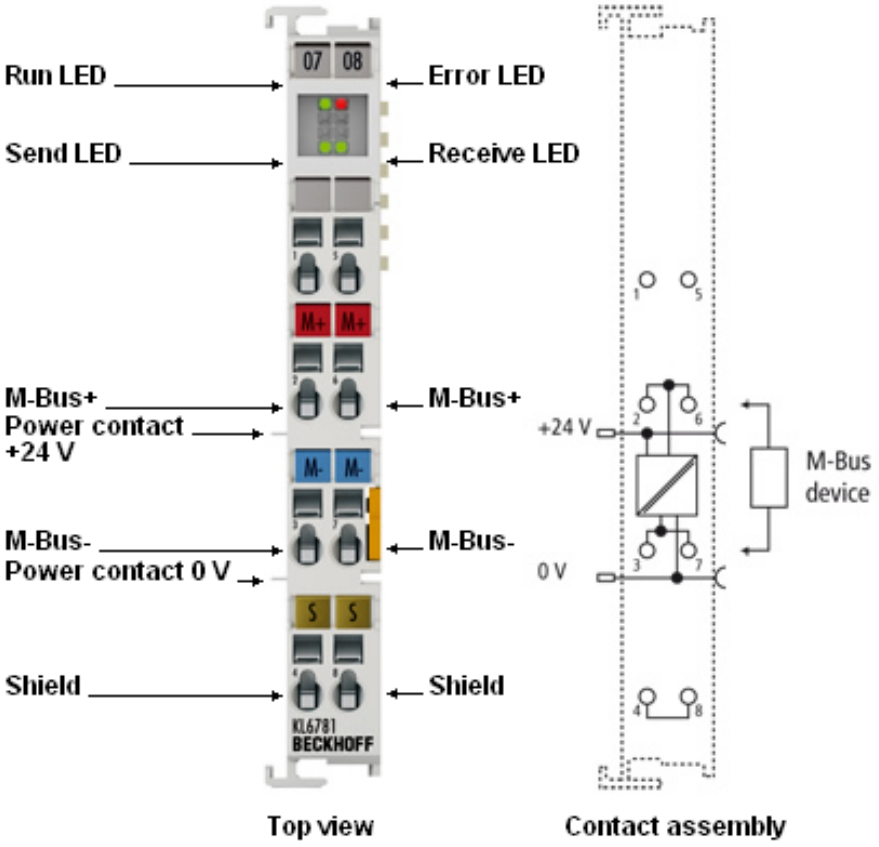

Fig. 1: KL6781

The KL6781 M-bus master terminal enables direct connection of M-Bus devices. The M-bus (meter bus) is a fieldbus for consumption data acquisition from electricity, water, gas or energy meters.

The KL6781 does not contain the M-bus protocol but converts the K-bus data to an M-bus compliant format. On the K-bus, 24 bytes are available for this purpose for each M-bus master terminal.

The TwinCAT M-bus library enables operation without external M-bus gateway, i.e. the M-bus devices can be connected directly to the KL6781.

With a total line length of 300 m, up to 40 M-bus devices can be operated at a KL6781.

2.2 Technical data of the KL6781

Technical Data	KL6781
Data transfer channels	1
M-bus devices	max. 40
Transmission standard	M-bus properties
Data transfer rate	300...9600 baud (default 2,400 baud)
Bus access	Master-slave technique (polling)
Cable length	max. 300 m
Current consumption from the K-bus	typically 65 mA
Current consumption from power contacts	max. 250 mA
Short-circuit strength	yes
Electrical isolation	500 V (K-bus / M-bus)
Width in the process image	input/output: 24 bytes
Configuration	TwinCAT PLC (M-bus function blocks)
Rated voltage	24 V_{DC} (-15% / +20%)
Input voltage	24 V_{DC} (-15% / +20%)
Weight	approx. 60 g
Mounting [▶ 11]	on 35 mm mounting rail conforms to EN 60715
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 see also installation instructions [▶ 13] for terminals with enhanced mechanical load capacity
EMC immunity / emission	conforms to EN 61000-6-2 / EN 61000-6-4
Protection class	IP20
Installation position	variable
Approval	CE, UL

2.3 LED displays

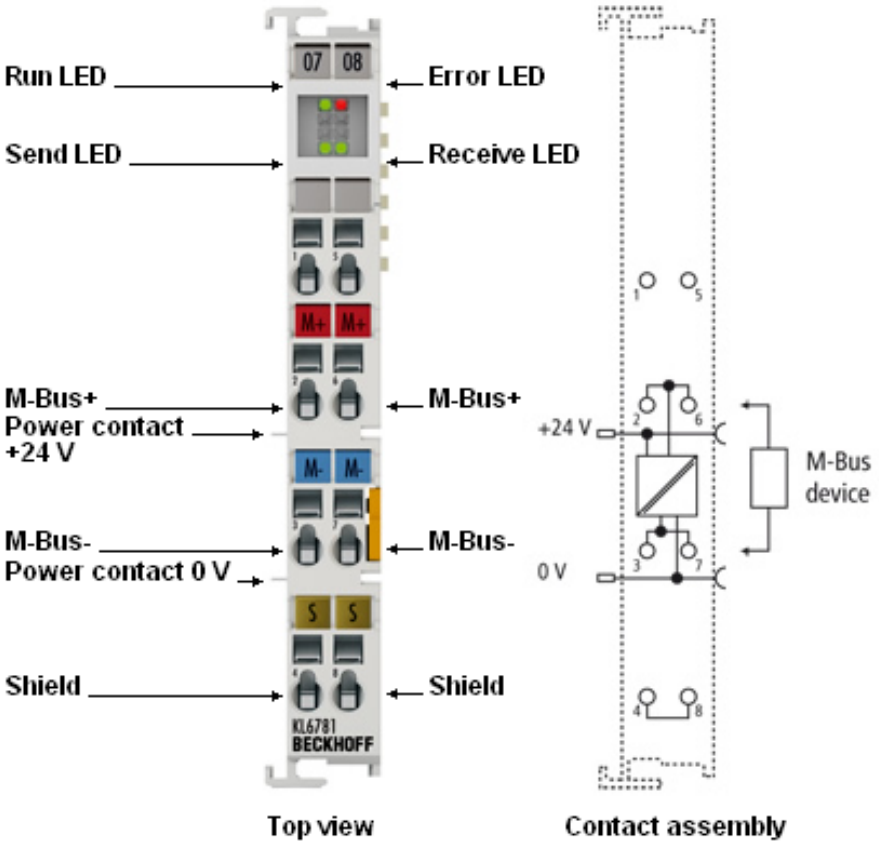

Fig. 2: LEDs

LED	Color	Meaning	
Run	green	This LED indicates the terminal's operating state:	
		on	Normal operation
		off	The RUN LED goes out if no process data is transmitted to the terminal from the Bus Coupler for 100 ms.
Error	red	General error is signaled	
Send	green	Data transmission on the M-bus	
Receive	green	Data transmission on the M-bus	

3 Mounting and wiring

3.1 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!

Assembly

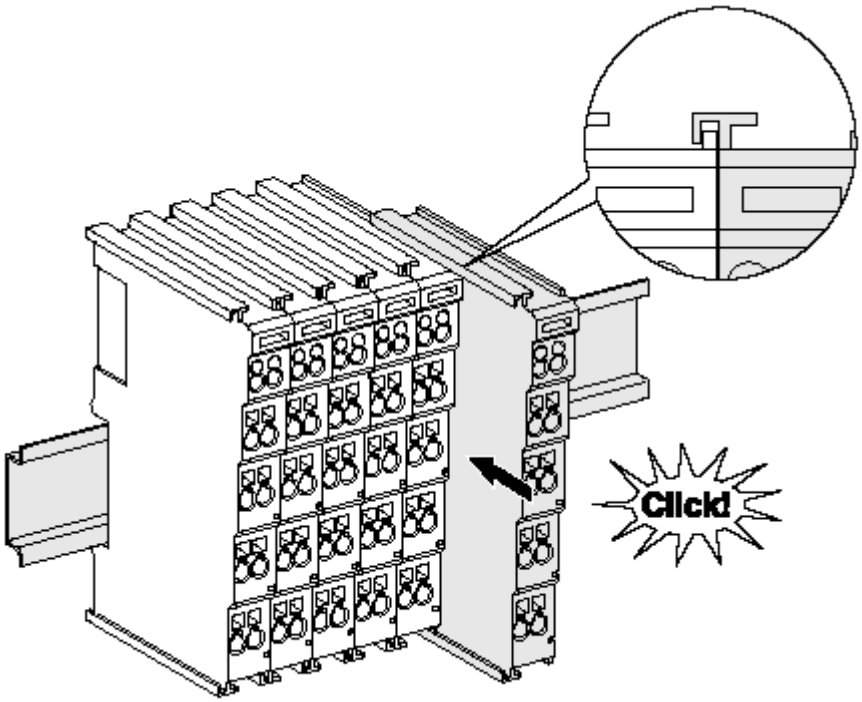

Fig. 3: Attaching on mounting rail

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.

Note	**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

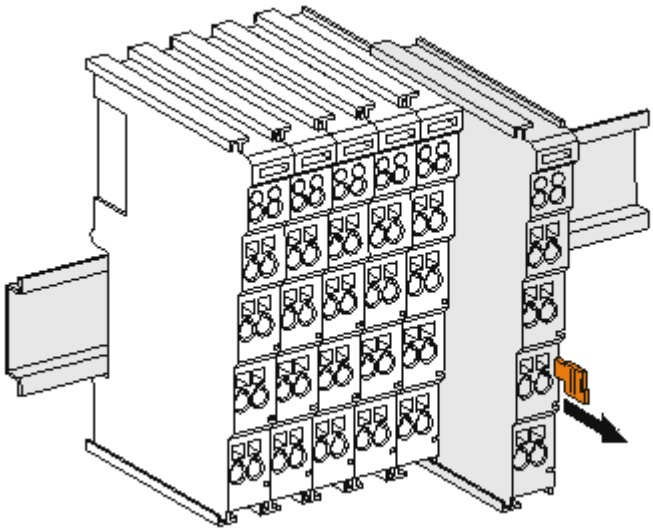

Fig. 4: Disassembling of terminal

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.

Note	**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.

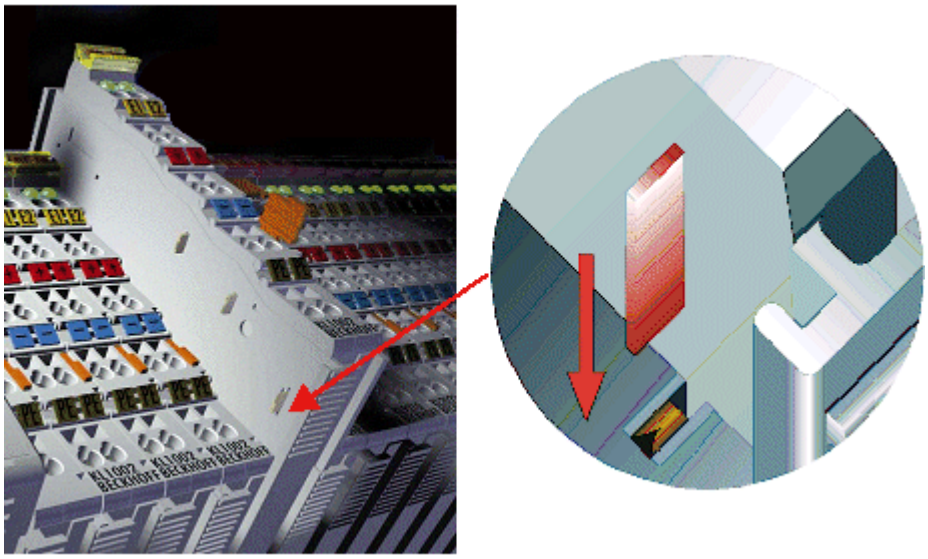

Fig. 5: *Power contact on left side*

Attention	**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!

3.2 Installation instructions for enhanced mechanical load capacity

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!

Additional checks

The terminals have undergone the following additional tests:

Verification	Explanation
Vibration	10 frequency runs in 3 axes
	6 Hz < f < 60 Hz displacement 0.35 mm, constant amplitude
	60.1 Hz < f < 500 Hz acceleration 5 *g*, constant amplitude
Shocks	1000 shocks in each direction, in 3 axes
	25 *g*, 6 ms

Additional installation instructions

For terminals with enhanced mechanical load capacity, the following additional installation instructions apply:

- The enhanced mechanical load capacity is valid for all permissible installation positions
- Use a mounting rail according to EN 60715 TH35-15
- Fix the terminal segment on both sides of the mounting rail with a mechanical fixture, e.g. an earth terminal or reinforced end clamp
- The maximum total extension of the terminal segment (without coupler) is:
  64 terminals (12 mm mounting with) or 32 terminals (24 mm mounting with)
- Avoid deformation, twisting, crushing and bending of the mounting rail during edging and installation of the rail
- The mounting points of the mounting rail must be set at 5 cm intervals
- Use countersunk head screws to fasten the mounting rail
- The free length between the strain relief and the wire connection should be kept as short as possible. A distance of approx. 10 cm should be maintained to the cable duct.

3.3 Connection

3.3.1 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. 6: 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)

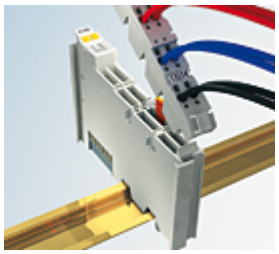

Fig. 7: Pluggable wiring

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. 8: *High Density Terminals*

The Bus 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.

Note	**Wiring HD Terminals** The High Density (HD) Terminals of the ELx8xx and KLx8xx series doesn't support pluggable wiring.

Ultrasonically "bonded" (ultrasonically welded) conductors

Note	**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 below!

3.3.2 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

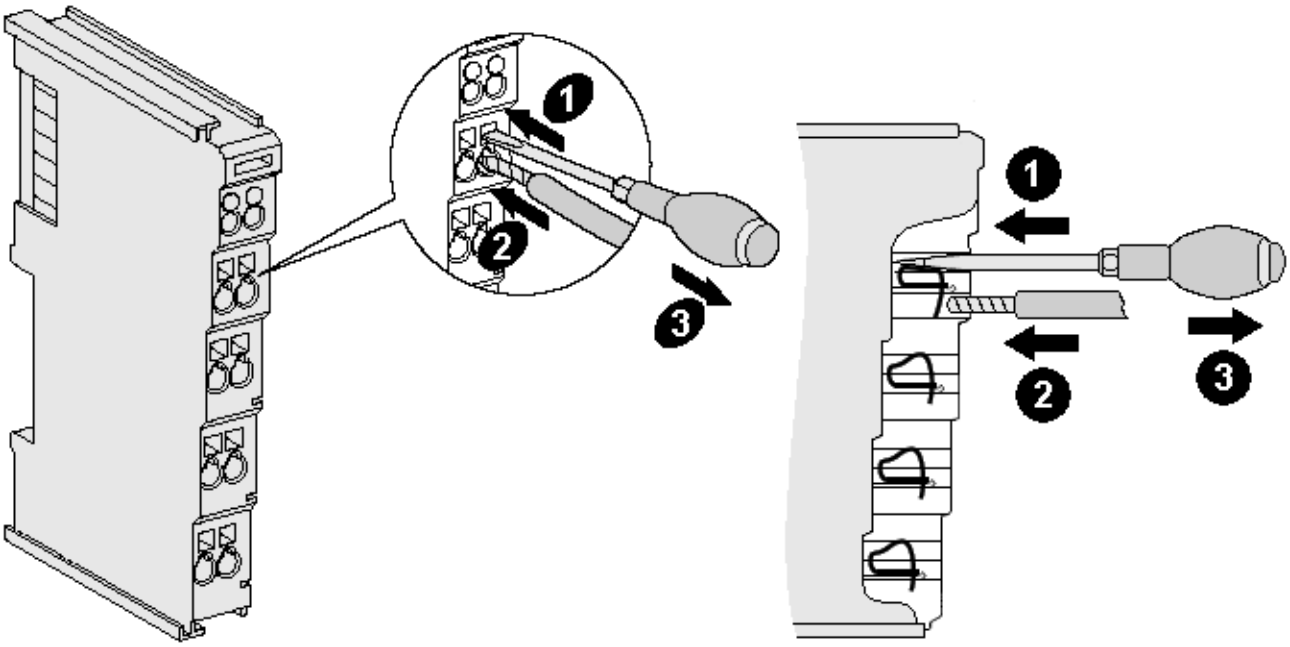

Fig. 9: Connecting a cable on a terminal point

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 [▶ 15]) 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 mm²
Wire size width (fine-wire conductors)	0.25 ... 1.5 mm²
Wire size width (conductors with a wire end sleeve)	0.14 ... 0.75 mm²
Wire size width (ultrasonically “bonded" conductors)	only 1.5 mm²
Wire stripping length	8 ... 9 mm

3.3.3 Connection

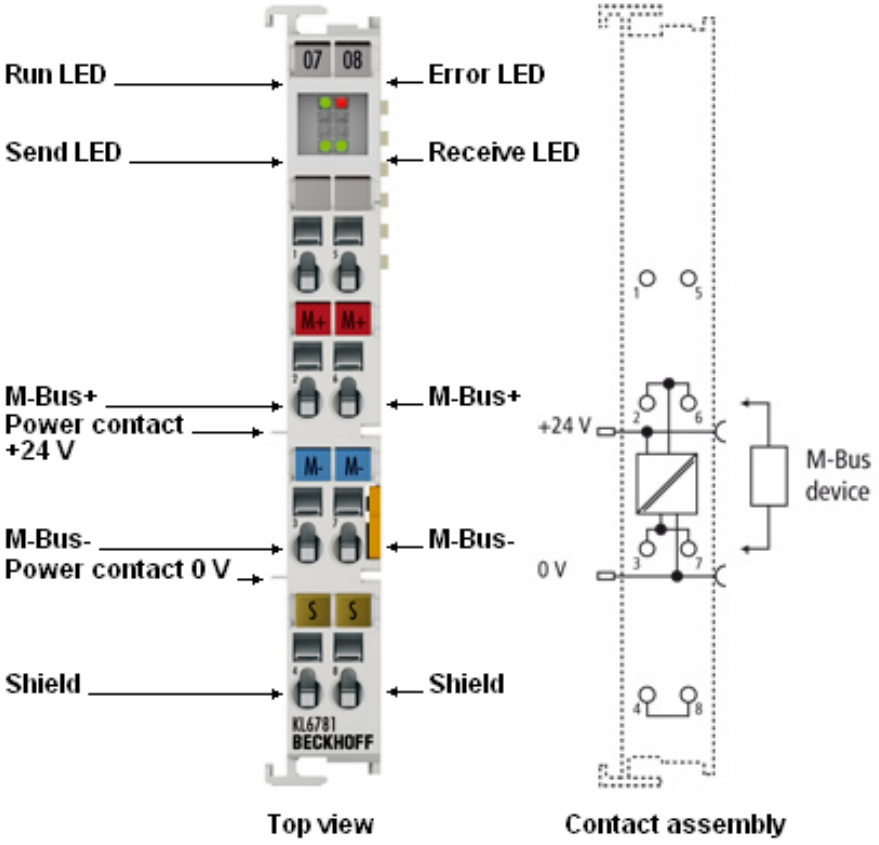

Fig. 10: Connection

Terminal point	Name	Signal
1	reserved	-
2	M-bus+	M-bus plus, internally connected to terminal point 6
3	M-bus-	M-bus minus, internally connected to terminal point 7
4	Shield	Shield connection, internally connected to terminal point 8
5	reserved	-
6	M-bus+	M-bus plus, internally connected to terminal point 2
7	M-bus-	M-bus minus, internally connected to terminal point 3
8	Shield	Shield connection, internally connected to terminal point 4

4 Access from the user program

4.1 Register Overview

The registers are used for parameterization the M-bus master terminal. They can be read or written by means of the register communication [▶ 25].

Register no.	Comment	Default value		R/W	Memory
R0 [▶ 23]	Number of data bytes in the send buffer	variable	variable	R	RAM
R1 [▶ 23]	Number of data bytes in the receive buffer	variable	variable	R	RAM
R2	Number of parity errors	0x0000	0_{dec}	R	-
R3	Number of framing errors	0x0000	0_{dec}	R	-
R4	reserved	0x0000	0_{dec}	R	-
R5	reserved	0x0000	0_{dec}	R	-
R6 [▶ 23]	Diagnostic register	variable	variable	R	RAM
R7 [▶ 23]	Command register	0x0000	0_{dec}	R/W	RAM
R8 [▶ 23]	Terminal type	0x1A7D	6781_{dec}	R	ROM
R9 [▶ 24]	Firmware version	variable	variable	R	ROM
R10	reserved	0x0000	0_{dec}	-	-
...	...	...	...	...	...
R15	reserved	0x0000	0_{dec}	-	-
R16	Hardware version	e.g. 0x0000	e.g.: 0_{dec}	...	EEPROM
R17	reserved	0x0000	0_{dec}	-	-
...	...	...	...	...	...
R18	reserved	0x0000	0_{dec}	-	-
R29 [▶ 24]	Terminal type - special identification	0x0000	0_{dec}	R	EEPROM
R30	reserved	0x0000	0_{dec}	R/W	RAM
R31 [▶ 24]	Code word register	0x0000	0_{dec}	R/W	RAM
R32 [▶ 24]	Baud rate register	0x0004	4_{dec}	R/W	EEPROM
R33	reserved	0x0000	0_{dec}	R/W	-
...	...	...	...	...	...
R63	reserved	0x0000	0_{dec}	R/W	-

4.2 Control and status word

Process data mode

Control word (in process data mode)

The control word (CW) is located in the output process image [▶ 21], and is transmitted from the controller to the terminal.

Bit	CW.15	CW.14	CW.13	CW.12	CW.11	CW.10	CW.9	CW.8	CW.7	CW.6	CW.5	CW.4	CW.3	CW.2	CW.1	CW.0
Name	OL7	OL6	OL5	OL4	OL3	OL2	OL1	OL0	Reg	-	-	-	-	IR	RA	TR

Key

Bit	Name	Description	
CW.15 ... CW.8	OL7 ... OL0 (OutLenght)	1_{dec}... 22_{dec}	Number of output bytes () available for transfer from the controller to the terminal.
CW.7	Reg (RegAccess)	0_{bin}	Register communication off (process data mode)
CW.6 ... CW.3	-	0_{bin}	reserved
CW.2	IR (InitRequest)	0_{bin}	The controller once again requests the terminal to prepare for serial data exchange.
		1_{bin}	The controller requests terminal for initialization. The transmission and reception functions are disabled, the FIFO pointers are reset and the interface is initialized with the values in the appropriate registers. The terminal acknowledges completion of the initialization via bit SW.2 [▶ 19] (IA).
CW.1	RA (ReceiveAccepted)	toggle	The controller acknowledges receipt of data by changing the state of this bit. Only then new data can be transferred from the terminal to the controller.
CW.0	TR (TransmitRequest)	toggle	Via a change of state of this bit the controller notifies the terminal that the DataOut bytes contain the number of bytes indicated via the OL bits. The terminal acknowledges receipt of the data in the status byte via a change of state of bit SW.0 [▶ 19] (TA). Only now new data can be transferred from the controller to the terminal.

Status word (in process data mode)

The status word (SW) is located in the input process image [▶ 21], and is transmitted from terminal to the controller.

Bit	SW.15	SW.14	SW.13	SW.12	SW.11	SW.10	SW.9	SW.8	SW.7	SW.6	SW.5	SW.4	SW.3	SW.2	SW.1	SW.0
Name	IL7	IL6	IL5	IL4	IL3	IL2	IL1	IL0	Reg	-	-	-	BUF_F	IA	RR	TA

Key

Bit	Name	Description	
SW.15 ... SW8	IL7 ... IL0 (InLength)	1_{dec} ... 22_{dec}	Number of input bytes available for transfer from the terminal to the controller.
SW.7	Reg (RegAccess)	0_{bin}	Acknowledgment for process data mode
SW.6 ... SW.4	-	0	reserved
SW.3	BUF_F	1_{bin}	The reception FIFO is full. All further incoming data will be lost!
SW.2	IA (InitAccepted bit)	1_{bin}	Initialization was completed by the terminal.
		0_{bin}	The terminal is ready again for serial data exchange.
SW.1	RR (ReceiveRequest)	toggle	Via a change of state of this bit the terminal notifies the controller that the DataIn bytes contain the number of bytes indicated via the IL bits. The controller has to acknowledge receipt of the data in the control byte via a change of state of bit CW.1 [▶ 19] (RA). Only then new data can be transferred from the terminal to the controller.
SW.0	TA (TransmitAccepted)	toggle	The terminal acknowledges receipt of data by changing the state of this bit. Only then new data can be transferred from the terminal to the controller

Register communication

Control word (in register communication)

The control word (CW) is located in the output process image [▶ 21], and is transmitted from the controller to the terminal.

Bit	CW.15	CW.14	CW.13	CW.12	CW.11	CW.10	CW.9	CW.8	CW.7	CW.6	CW.5	CW.4	CW.3	CW.2	CW.1	CW.0
Name	RegData:								Reg	R/W	Reg. no.					

Key

Bit	Name	Description	
CW.15 ... CW.8	RegData:	One byte of data to be written to the register. The other byte is transferred in the adjacent process data byte.	
CW.7	Reg	1_{bin}	Register communication switched on
CW.6	R/W	0_{bin}	Read access
		1_{bin}	Write access
CW.5 to CW.0	Reg. no.	Register number: Enter the number of the register [▶ 18] that you want to - read with the input data word DataIN [▶ 21] and the HighByte of the status bytes (RegData) or - write the output data word DataOUT [▶ 21] and the HighByte of control word (RegData).	

Status byte (for register communication)

The status word (SW) is located in the input process image [▶ 21], and is transmitted from terminal to the controller.

Bit	SW.15	SW.14	SW.13	SW.12	SW.11	SW.10	SW.9	SW.8	SW.7	SW.6	SW.5	SW.4	SW.3	SW.2	SW.1	SW.0
Name	RegData:								Reg	R/W	Reg. no.					

Key

Bit	Name	Description	
SW.15 ... SW.8	RegData:	One byte of the data read from the register. The other byte is transferred in the adjacent process data byte.	
SW.7	RegAccess	1_{bin}	Acknowledgment for register access
SW.6	R	0_{bin}	Read access
SW.5 to SW.0	Reg. no.	Number of the register that was read or written.	

4.3 Process image

Note

No compact process image

The KL6781 cannot be operated with a compact process image (without control and status word), since the control and status words are required for meaningful process data mode operation of the terminal. The KL6781 is represented with its complex process image, even if you set your Bus Coupler to a compact process image!

The KL6781 is represented in the process image with up to 24 bytes of input data and 24 bytes of output data.

Format	Input data	Output data
Word	SW [▶ 19]	CW [▶ 19]
Byte	DataIn0	DataOut0
Byte	DataIn1	DataOut1
...	...	...
Byte	DataIn21	DataOut21

Key

SW: Status byte
CW: Control byte

DataIN 0 to DataIN 21: 22 bytes for the input data of the M-Bus
DataOUT 0 to DataOUT 21: 22 bytes for the output data of the M-Bus

- For the meaning of the control and status word please refer to the page Control and status word [▶ 19].
- Please refer to the Mapping [▶ 22] page for the assignment of the bytes and words to the addresses of the controller.

4.4 Mapping

The Bus Terminals occupy addresses within the process image of the controller. The assignment of process data (input and output data) and parameterization data (control and status bytes) to the control addresses is called mapping. The type of mapping depends on:

- the fieldbus system used
- the terminal type
- the parameterization of the Bus Coupler (conditions) such as
  - compact or complex evaluation
  - Intel or Motorola format
  - word alignment switched on or off

The following tables show the mapping depending on different conditions. For the content of the individual bytes please refer to pages Process image [▶ 21] and Control and status word [▶ 19].

Compact evaluation

Note	**No compact process image** The KL6781 cannot be operated with a compact process image (without control and status word), since the control and status words are required for meaningful process data mode operation of the terminal. The KL6781 is represented with its complex process image, even if you set your Bus Coupler to a compact process image!

Complete evaluation

Complete evaluation in Intel format

	Address	Input data		Output data	
Conditions	**Word offset**	**High byte**	**Low byte**	**High byte**	**Low byte**
Complete evaluation: any Motorola format: no Word alignment: any	0	SW		CW	
	1	DataIN 1	DataIN 0	DataOUT 1	DataOUT 0
	2	DataIN 3	DataIN 2	DataOUT 3	DataOUT 2
	3	DataIN 5	DataIN 4	DataOUT 5	DataOUT 4
	4	DataIN 7	DataIN 6	DataOUT 7	DataOUT 6
	5	DataIN 9	DataIN 8	DataOUT 9	DataOUT 8
	6	DataIN 11	DataIN 10	DataOUT 11	DataOUT 10
	7	DataIN 13	DataIN 12	DataOUT 13	DataOUT 12
	8	DataIN 15	DataIN 14	DataOUT 15	DataOUT 14
	9	DataIN 17	DataIN 16	DataOUT 17	DataOUT 16
	10	DataIN 19	DataIN 18	DataOUT 19	DataOUT 18
	11	DataIN 21	DataIN 20	DataOUT 21	DataOUT 20

Complex evaluation in Motorola format

	Address	Input data		Output data	
Conditions	**Word offset**	**High byte**	**Low byte**	**High byte**	**Low byte**
Complete evaluation: any Motorola format: yes Word alignment: any	0	SW		CW	
	1	DataIN 0	DataIN 1	DataOUT 0	DataOUT 1
	2	DataIN 2	DataIN 3	DataOUT 2	DataOUT 3
	3	DataIN 4	DataIN 5	DataOUT 4	DataOUT 5
	4	DataIN 6	DataIN 7	DataOUT 6	DataOUT 7
	5	DataIN 8	DataIN 9	DataOUT 8	DataOUT 9
	6	DataIN 10	DataIN 11	DataOUT 10	DataOUT 11
	7	DataIN 12	DataIN 13	DataOUT 12	DataOUT 13
	8	DataIN 14	DataIN 15	DataOUT 14	DataOUT 15
	9	DataIN 16	DataIN 17	DataOUT 16	DataOUT 17
	10	DataIN 18	DataIN 19	DataOUT 18	DataOUT 19
	11	DataIN 20	DataIN 21	DataOUT 20	DataOUT 21

4.5 Register description

The registers are used for parameterization the M-bus master terminal. They can be read or written by means of the register communication.

R0: Number of data bytes in the send buffer

Register R0 contains the number of data in the transmit FIFO.

R1: Number of data bytes in the receive buffer

Register R1 contains the number of data in the receive FIFO.

R6: Diagnostic register

Bit	R6.15	R6.14	R6.13	R6.12	R6.11	R6.10	R6.9	R6.8
Name	-	-	-	-	-	-	-	-

Bit	R6.7	R6.6	R6.5	R6.4	R6.3	R6.2	R6.1	R6.0
Name	-	-	-	BufferOverflow	Overrun	Framing error	Parity error	RxBufferOverflow

Key

Bit	**Name**	**Description**		**default**
R6.15…5	-	-	reserved	-
R6.4	BufferOverflow	1_{bin}	Buffer is full	0_{bin}
R6.3	Overrun	1_{bin}	An overrun error has occurred	0_{bin}
R6.2	Framing error	1_{bin}	A framing error has occurred	0_{bin}
R6.1	Parity error	1_{bin}	A parity error has occurred	0_{bin}
R6.0	RxBufferOverflow	1_{bin}	The receive buffer has overflowed, incoming data is lost.	0_{bin}

R7: Command register

The command register of the KL6781 is not used.

R8: Terminal type

The terminal name is contained in register R8:
KL6781: 0x1A7D (6781_{dec})

R9: Firmware version

Register R9 contains the ASCII coding of the terminal's firmware version, e.g. **0x3141 = '1A'.** The **'0x31'** corresponds here to the ASCII character **'1'**, while the **'0x41'** represents the ASCII character **'A'**.
This value cannot be changed.

R16: Hardware version

Register R16 contains the hardware version of the terminal.

R29: Terminal type - special identification

The name of the special type of the terminal is contained in register R29. KL6781-0000: 0x0000 (0000_{dec})

R31: Code word register

- If you write values into the user registers without first entering the user code word (0x1235) into the code word register, the terminal will not accept the supplied data.
- If you write values into the user registers and have previously entered the user code word (0x1235) in the code word register, these values are stored in the RAM registers and in the SEEPROM registers and are therefore retained when the terminal is restarted.

The code word is reset when the terminal is restarted.

R32: Baud rate register

Bit	R32.15	R32.14	R32.13	R32.12	R32.11	R32.10	R32.9	R32.8
Name	-	-	-	-	-	-	-	-

Bit	R32.7	R32.6	R32.5	R32.4	R32.3	R32.2	R32.1	R32.0
Name	-	-	-	-	-	Baud rate		

Key

Bit	**Name**	**Description**		**default**
R32.15 - R32.3	-	reserved		0_{bin}
R32.2 - R32.0	Baud rate	110_{bin}	9600 baud	100_{bin}
		101_{bin}	4800 baud	
		100_{bin}	2400 baud (default)	
		11_{bin}	1200 baud	
		010_{bin}	600 baud	
		001_{bin}	300 baud	

4.6 Examples of Register Communication

The numbering of the bytes in the examples corresponds to the display without word alignment.

4.6.1 Example 1: reading the firmware version from Register 9

Output Data

Byte 0: Control byte	Byte 1: DataOUT1, high byte	Byte 2: DataOUT1, low byte
0x89 (1000 1001_{bin})	0xXX	0xXX

Explanation:

- Bit 0.7 set means: Register communication switched on.
- Bit 0.6 not set means: reading the register.
- Bits 0.5 to 0.0 specify the register number 9 with 00 1001_{bin}.
- The output data word (byte 1 and byte 2) has no meaning during read access. To change a register, write the required value into the output word.

Input Data (answer of the bus terminal)

Byte 0: Status byte	Byte 1: DataIN1, high byte	Byte 2: DataIN1, low byte
0x89	0x33	0x41

Explanation:

- The terminal returns the value of the control byte as a receipt in the status byte.
- The terminal returns the firmware version 0x3341 in the input data word (byte 1 and byte 2). This is to be interpreted as an ASCII code:
  - ASCII code 0x33 represents the digit 3
  - ASCII code 0x41 represents the letter A
    The firmware version is thus 3A.

4.6.2 Example 2: Writing to an user register

Note	**Code word** In normal mode all user registers are read-only with the exception of Register 31. In order to deactivate this write protection you must write the code word (0x1235) into Register 31. If a value other than 0x1235 is written into Register 31, write protection is reactivated. Please note that changes to a register only become effective after restarting the terminal (power-off/power-on).

I. Write the code word (0x1235) into Register 31.

Output Data

Byte 0: Control byte	Byte 1: DataOUT1, high byte	Byte 2: DataOUT1, low byte
0xDF (1101 1111_{bin})	0x12	0x35

Explanation:

- Bit 0.7 set means: Register communication switched on.
- Bit 0.6 set means: writing to the register.
- Bits 0.5 to 0.0 specify the register number 31 with 01 1111_{bin}.
- The output data word (byte 1 and byte 2) contains the code word (0x1235) for deactivating write protection.

Input Data (answer of the bus terminal)

Byte 0: Status byte	Byte 1: DataIN1, high byte	Byte 2: DataIN1, low byte
0x9F (1001 1111_{bin})	0xXX	0xXX

Explanation:

- The terminal returns a value as a receipt in the status byte that differs only in bit 0.6 from the value of the control byte.
- The input data word (byte 1 and byte 2) is of no importance after the write access. Any values still displayed are invalid!

II. Read Register 31 (check the set code word)

Output Data

Byte 0: Control byte	Byte 1: DataOUT1, high byte	Byte 2: DataOUT1, low byte
0x9F (1001 1111_{bin})	0xXX	0xXX

Explanation:

- Bit 0.7 set means: Register communication switched on.
- Bit 0.6 not set means: reading the register.
- Bits 0.5 to 0.0 specify the register number 31 with 01 1111_{bin}.
- The output data word (byte 1 and byte 2) has no meaning during read access.

Input Data (answer of the bus terminal)

Byte 0: Status byte	Byte 1: DataIN1, high byte	Byte 2: DataIN1, low byte
0x9F (1001 1111_{bin})	0x12	0x35

Explanation:

- The terminal returns the value of the control byte as a receipt in the status byte.
- The terminal returns the current value of the code word register in the input data word (byte 1 and byte 2).

III. Write to Register 32 (change contents of the feature register)

Output data

Byte 0: Control byte	Byte 1: DataIN1, high byte	Byte 2: DataIN1, low byte
0xE0 (1110 0000_{bin})	0x00	0x02

Explanation:

- Bit 0.7 set means: Register communication switched on.
- Bit 0.6 set means: writing to the register.
- Bits 0.5 to 0.0 indicate register number 32 with 10 0000_{bin}.
- The output data word (byte 1 and byte 2) contains the new value for the feature register.

CAUTION	**Observe the register description!** The value of 0x0002 given here is just an example! The bits of the feature register change the properties of the terminal and have a different meaning, depending on the type of terminal. Refer to the description of the feature register of your terminal (chapter *Register description*) regarding the meaning of the individual bits before changing the values.

Input data (response from the Bus Terminal)

Byte 0: Status byte	Byte 1: DataIN1, high byte	Byte 2: DataIN1, low byte
0xA0 (1010 0000_{bin})	0xXX	0xXX

Explanation:

- The terminal returns a value as a receipt in the status byte that differs only in bit 0.6 from the value of the control byte.
- The input data word (byte 1 and byte 2) is of no importance after the write access. Any values still displayed are invalid!

IV. Read Register 32 (check changed feature register)

Output Data

Byte 0: Control byte	Byte 1: DataOUT1, high byte	Byte 2: DataOUT1, low byte
0xA0 (1010 0000_{bin})	0xXX	0xXX

Explanation:

- Bit 0.7 set means: Register communication switched on.
- Bit 0.6 not set means: reading the register.
- Bits 0.5 to 0.0 indicate register number 32 with 10 0000_{bin}.
- The output data word (byte 1 and byte 2) has no meaning during read access.

Input Data (answer of the bus terminal)

Byte 0: Status byte	Byte 1: DataIN1, high byte	Byte 2: DataIN1, low byte
0xA0 (1010 0000_{bin})	0x00	0x02

Explanation:

- The terminal returns the value of the control byte as a receipt in the status byte.
- The terminal returns the current value of the feature register in the input data word (byte 1 and byte 2).

V. Write Register 31 (reset code word)

Output Data

Byte 0: Control byte	Byte 1: DataOUT1, high byte	Byte 2: DataOUT1, low byte
0xDF (1101 1111_{bin})	0x00	0x00

Explanation:

- Bit 0.7 set means: Register communication switched on.
- Bit 0.6 set means: writing to the register.
- Bits 0.5 to 0.0 specify the register number 31 with 01 1111_{bin}.
- The output data word (byte 1 and byte 2) contains 0x0000 for reactivating write protection.

Input Data (answer of the bus terminal)

Byte 0: Status byte	Byte 1: DataIN1, high byte	Byte 2: DataIN1, low byte
0x9F (1001 1111_{bin})	0xXX	0xXX

Explanation:

- The terminal returns a value as a receipt in the status byte that differs only in bit 0.6 from the value of the control byte.
- The input data word (byte 1 and byte 2) is of no importance after the write access. Any values still displayed are invalid!

5 M-bus

5.1 Introduction

M-Bus = metering bus

The M-Bus is a fieldbus for the acquisition of consumption data (e.g. energy meters). Further details about M-Bus can be found under www.m-bus.com. The M-Bus is European standard and is described in the EN1434 standard. The data are sent serially from a slave (measuring device) to a master (level converter with PC). Master and slave are connected via a two-wire line that is protected against polarity reversal. With primary addressing up to 250 slaves can be connected in star, strand or tree topologies. Ring structures are not permitted. Devices from different manufacturers can be operated on the same bus.

The master controls the communication on the bus by requesting data from the slaves. The slaves can respond with a fixed or variable data structure. The M-Bus library only evaluates data with variable data structure (low byte first). The slaves do not communicate with each other. The data have to be requested sequentially from the slaves.

5.2 Overview

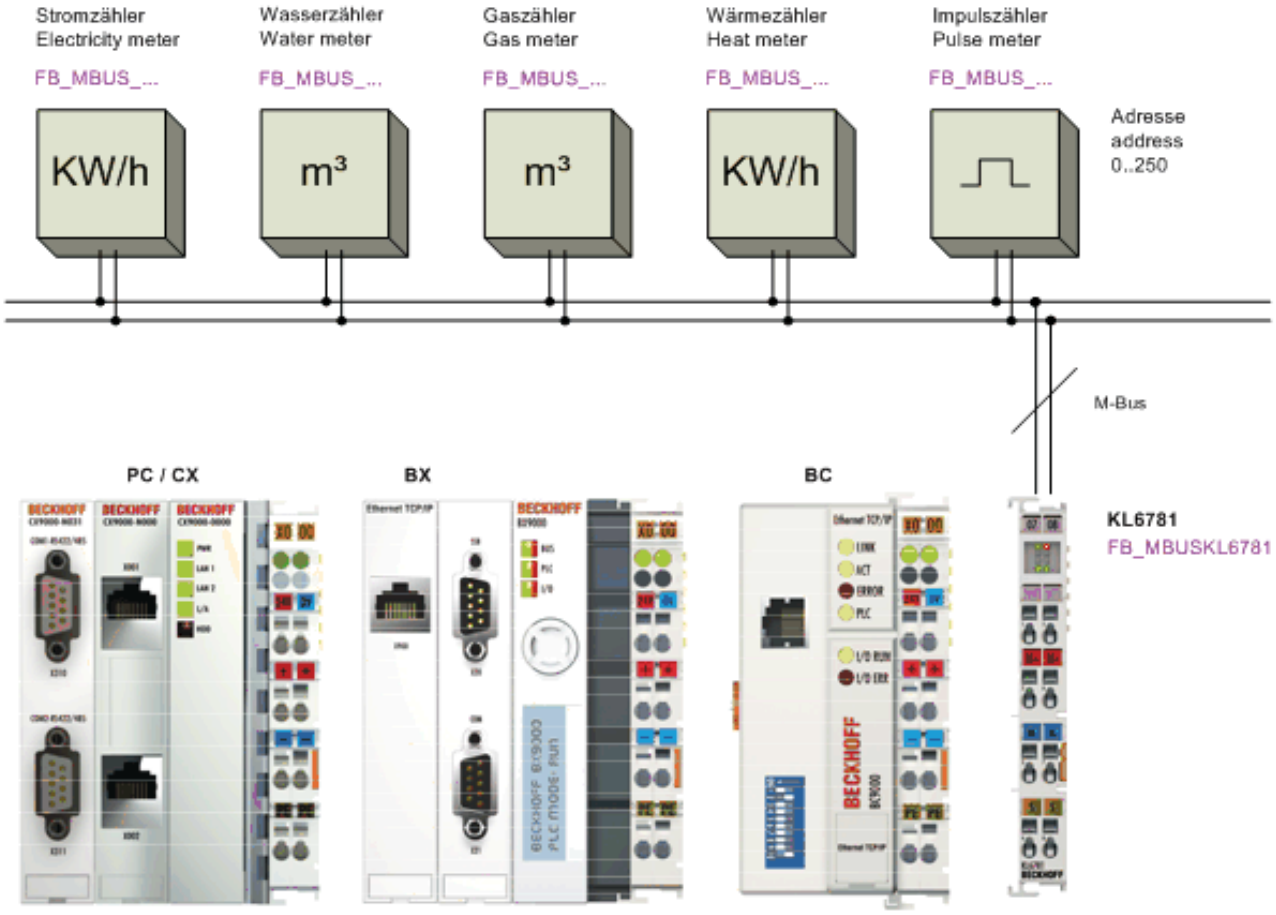

Fig. 11: KL6781 as M-bus master

5.3 Topology

Star, line and tree topology

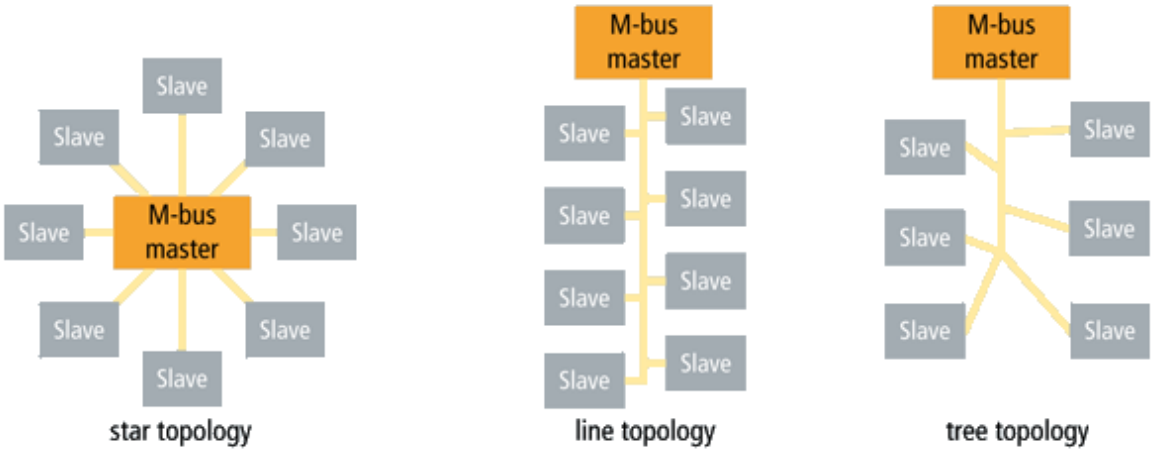

Fig. 12: Star, line and tree topology

Ring topology

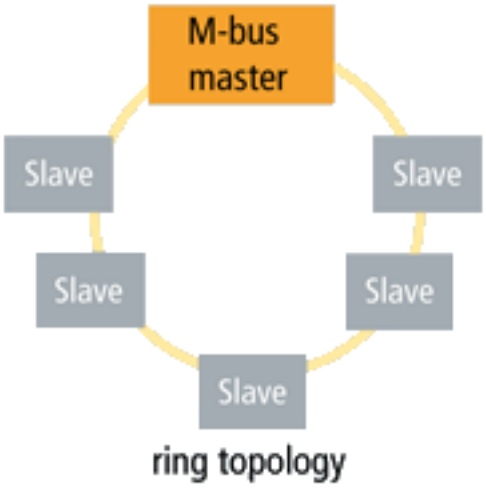

Fig. 13: Ring topology

Note	**Ring topology is not supported** Although ring topology is possible with the M-bus, it is not recommended and therefore not supported by Beckhoff.

6 Programming

6.1 TwinCAT libraries

Software documentation in the Beckhoff Information System:

TwinCAT 2: TwinCAT 2 PLC Lib: M-bus

TwinCAT 3: TwinCAT 3 PLC Lib: Tc2_MBus

7 Appendix

7.1 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.

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

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