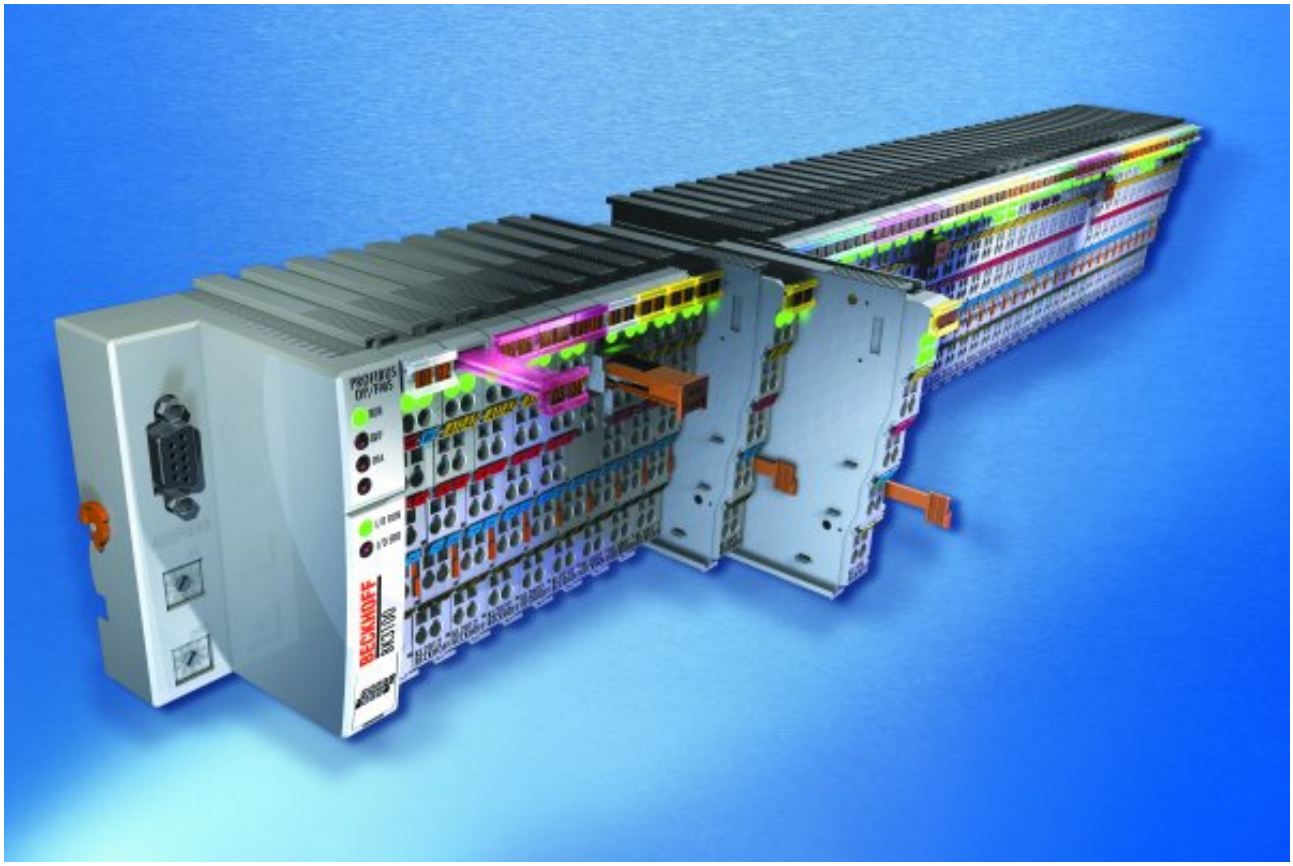

Documentation

KL6031 and KL6041

Serial Interface Terminals

Version: 2.0.0
Date: 2020-01-14

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.

Trademarks

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Patent Pending

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

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

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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 instructions

In this documentation the following instructions are used.
These instructions must be read carefully and followed without fail!

⚠ DANGER

Serious risk of injury!

Failure to follow this safety instruction directly endangers the life and health of persons.

⚠ WARNING

Risk of injury!

Failure to follow this safety instruction endangers the life and health of persons.

⚠ CAUTION

Personal injuries!

Failure to follow this safety instruction can lead to injuries to persons.

NOTE

Damage to environment/equipment or data loss

Failure to follow this instruction can lead to environmental damage, equipment damage or data loss.

Tip or pointer

This symbol indicates information that contributes to better understanding.

1.3 Documentation issue status

Version	Comment
2.0.0	• Migration
1.2.0	• Technical data updated • Extended temperature range • ATEX notes added
1.1	• Correction - C/S word
1.0	• Supplement added to description of operation with TwinCAT
0.2	• Description added to operation with TwinCAT PLC software
0.1	• first provisional documentation for KL6031 and KL6041

Firmware and hardware versions

Documentation Version	KL6031-0000		KL6041-0000	
	Firmware	Hardware	Firmware	Hardware
2.0.0	3C	03	3D	05
1.2.0	2A	00	2A	00
1.1	2A	00	2A	00
1.0	2A	00	2A	00
0.2	2A	00	2A	00
0.1	2A	00	2A	00

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

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.: 12 06 3A 02:

12 - week of production 12
06 - year of production 2006
3A - firmware version 3A
02 - hardware version 02

2 Product overview

2.1 KL6031 - Introduction

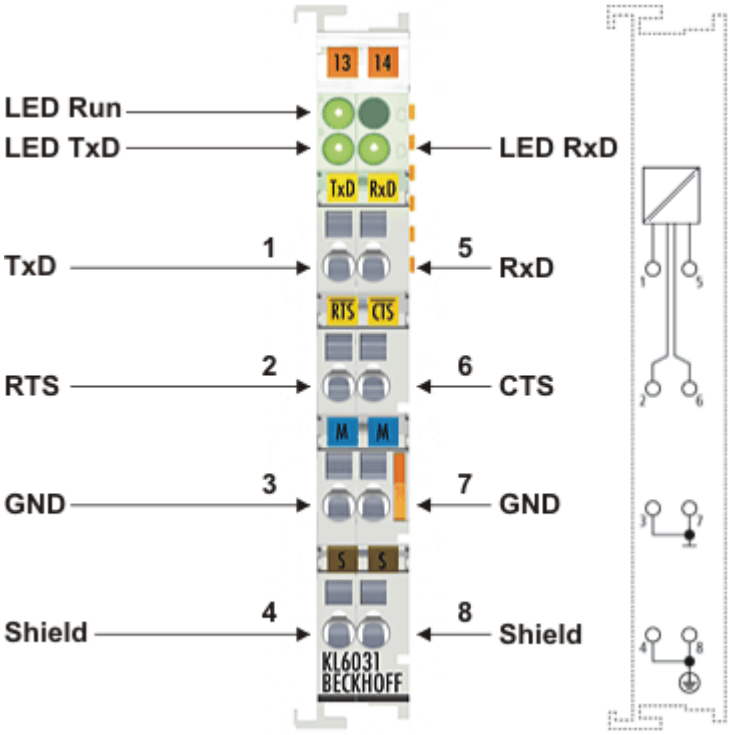

Fig. 1: KL6031

The KL6031 serial interface allows devices with RS232 interface to be connected. It operates in conformity with the CCITT V.28/DIN 66 259-1 standards. The device connected to the KL6031 terminal communicates with the automation device via the Bus Coupler. The active communication channel operates independently of the higher-level bus system in full duplex mode at up to 115.2 kbit/s. The RS232 interface guarantees high immunity to interference through electrically isolated signals.

LEDs

LED	Color	Meaning	
RUN	green	This LED indicates the terminal's operating state:	
		on	normal operation
		off	A watchdog timer overflow has occurred. The RUN LED goes out if no process data is transmitted to the terminal from the Bus Coupler for 100 ms.
TxD	green	State of the transmit signal line	
RxD	green	State of the receive signal line	

Connections

Terminal point	Name	Signal
1	TxD	Signal line (Transmit Data)
5	RxD	Signal line (Receive Data)
2	RTS	Control line (Request To Send)
6	CTS	Control line (Clear To Send)
3	GND	Ground (internally bridged with terminal 7)
7	GND	Ground (internally bridged with terminal 3)
4	Shield	Shield (internally bridged with terminal 8)
8	Shield	Shield (internally bridged with terminal 4)

2.2 KL6031 - Technical data

Technical data	KL6031-0000, KS6031-0000
Data transfer channels	2 (1/1), TxD and RxD, full duplex
Data transfer rate	9600 bit/s, 8 data bits, no parity and one stop bit are pre-set (max. 115200 bit/s)
Bit distortion	< 3%
RS232 cable length	max. 15 m
Signal voltage "low"	-18 V ... -3 V
Signal voltage "high"	3 V ... 18 V
Power supply	via the K-bus
Electrical isolation	500 V (K-bus/signal voltage)
Data buffer	1024 byte receive buffer, 128 byte transmit buffer
Bit width in process image	input/output: 22 x 8 bit user data, 2 x 8 bit control/ status (up to 22 bytes of user data possible)
Configuration	no address setting, configuration via bus coupler or controller
Current consumption from K-bus	55 mA
Weight	approx. 50 g
Permissible ambient temperature range during operation	-25°C ... +60°C (extended temperature range)
Permissible ambient temperature range during storage	-45 °C ... +85 °C
Permissible relative humidity	95% no condensation
Mounting	on 35 mm mounting rail according to EN 60715
Pluggable wiring	for all KSxxxx terminals
Vibration / shock resistance	conforms to EN 60068-2-6 / EN 60068-2-27 see also Installation instructions [▶ 16] for 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, cULus, ATEX, GL

2.3 KL6031 – Basic function principles

The KL6031 serial interface terminal enables the connection of devices with an RS232 interface (e.g. bar code scanners). Data can be exchanged with the controller in full duplex mode, independent of the higher-level bus system. The receive buffer has 1024 bytes, the transmit buffer 16 bytes. The data transfer between terminal and controller is handled via a handshake in the status and control byte. The factory setting of the terminal is 9600 bit, 8 data bits, 1 stop bit, no parity, RTS/CTS control active.

LED display

The Run LED indicates the operating state of the terminal.

- On – normal operation
- Off – Watchdog timer overflow has occurred. If no process data is transmitted from the Bus Coupler for 100 ms, the green LED goes out.

The TxD and RxD LEDs indicate the states of the signal lines.

Process data - alternative output format

In the alternative output format, 4 or 5 bytes (3 bytes for data and 1 or 2 control/status byte(s)) are mapped in the Bus Coupler. The KL6031 is delivered in the alternative format. The mapping of the terminal in the alternative format is described in more detail in the chapter "Terminal configuration".

Process data - standard output format

In the standard output format, 4 bytes of user data (3 bytes of user data and 1 Control/Status byte) are mapped by default in the Bus Coupler. By changing the parameters of the KL6031, up to 5 bytes of user data can be transferred.

Reference

The chapter "Access from the user program" provides an overview of the possible mapping configurations [▶ 39] depending on the adjustable parameters.

2.4 KL6041 - Introduction

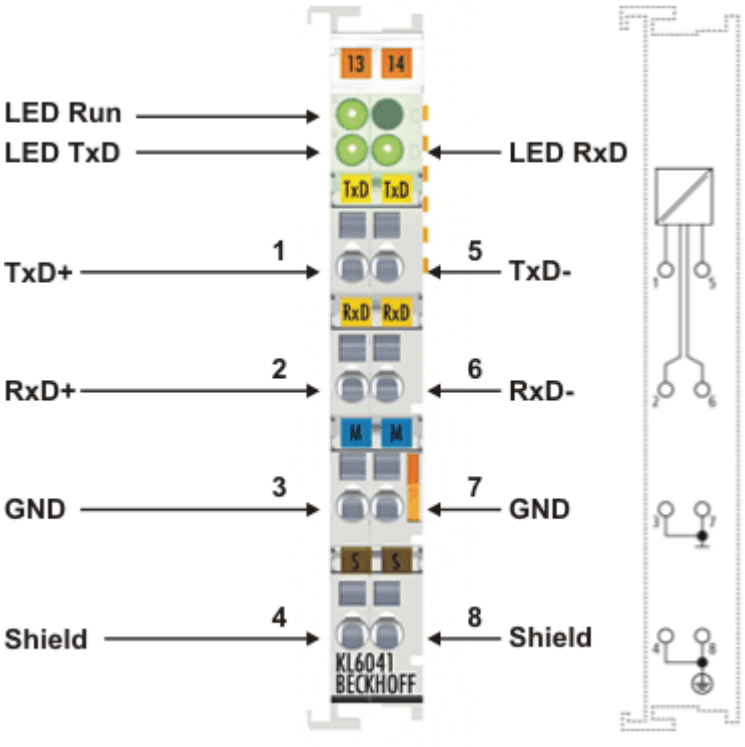

Fig. 2: KL6041

The KL6041 serial interface enables the connection of devices with an RS422 or RS485 interface. The device connected to the KL6041 terminal communicates with the automation device via the Bus Coupler. The active communication channel operates independently of the higher-level bus system in full or half duplex mode at up to 115.2 kbit/s. The differential signal transmission according to RS422 guarantees high immunity to interference through electrically isolated signals.

LEDs

LED	Color	Meaning	
RUN	green	This LED indicates the terminal's operating state:	
		on	normal operation
		off	A watchdog timer overflow has occurred. The RUN LED goes out if no process data is transmitted to the terminal from the Bus Coupler for 100 ms.
TxD	green	State of the transmit signal line	
RxD	green	State of the receive signal line	

Connections

Terminal point	Name	Signal
1	TxD+	Signal line + (Transmit Data)
5	TxD-	Signal line - (Transmit Data)
2	RxD+	Signal line + (Receive Data)
6	RxD-	Signal line - (Receive Data)
3	GND	Ground (internally bridged with terminal 7)
7	GND	Ground (internally bridged with terminal 3)
4	Shield	Shield (internally bridged with terminal 8)
8	Shield	Shield (internally bridged with terminal 4)

2.5 KL6041 - Technical data

Technical data	KL6041-0000, KS6041-0000
Data transfer channels	TxD and RxD, full/half duplex
Data transfer rate	9600 bit/s, 8 data bits, no parity and one stop bit are pre-set (max. 115200 bit/s)
Bit transfer	with differential signal
Line impedance	120 Ω
Transmission link	approx. 1000 m twisted-pair
Power supply	via the K-bus
Current consumption from K-bus	typ. 65 mA
Electrical isolation	500 V (K-bus/signal voltage)
Data buffer	1024 byte receive buffer, 128 byte transmit buffer
Bit width in process image	input/output: 22 x 8 bit user data, 2 x 8 bit control/ status (up to 22 bytes of user data possible)
Configuration	no address setting, configuration via bus coupler or controller
Weight	approx. 50 g
Permissible ambient temperature range during operation	25°C ... +60°C (extended temperature range)
Permissible ambient temperature range during storage	-45 °C ... +85 °C
Permissible relative humidity	95% no condensation
Mounting	on 35 mm mounting rail according to EN 60715
Pluggable wiring	for all KSxxxx terminals
Vibration / shock resistance	conforms to EN 60068-2-6 / EN 60068-2-27 see also Installation instructions [▶ 16] for 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, cULus, ATEX, GL

2.6 KL6041 – Basic function principles

The KL6041 serial interface terminal enables the connection either

- of devices with an RS485 interface or
- of a device with an RS422 interface (peer to peer).

Depending on the higher-level fieldbus system, data can be exchanged with the controller in full-duplex or half-duplex mode. The size of the receive buffer is 1024 bytes, that of the transmit buffer 128 bytes. The data transfer between terminal and controller is handled via a handshake in the status and control byte. The factory setting of the terminal is 9600 bit, 8 data bits, 1 stop bit, no parity, full duplex mode.

LED display

The Run LED indicates the operating state of the terminal.
On – normal operation
Off – Watchdog timer overflow has occurred. If no process data is transmitted from the Bus Coupler for 100 ms, the green LED goes out.

The TxD and RxD LEDs indicate the states of the signal lines.

Process data - standard output format

In the standard output format, 22 bytes of user data and 1 Control/Status word are mapped in the Bus Coupler. By changing the parameters of the KL6041, up to 3 or 5 bytes of user data can be transmitted.

Connection for RS485 transfer

In RS485 mode, data are exchanged in half duplex mode. A bus structure can be created in this operation mode.

Fig. 3: RS485

Connection for RS422 transfer

The data are transmitted in full duplex in the RS422 operation mode. Only peer-to-peer connections can be established.

Fig. 4: RS422

Reference

The chapter on *Access from the user program* contains an overview of possible mapping configurations [▶ 39], depending on the configurable parameters.

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

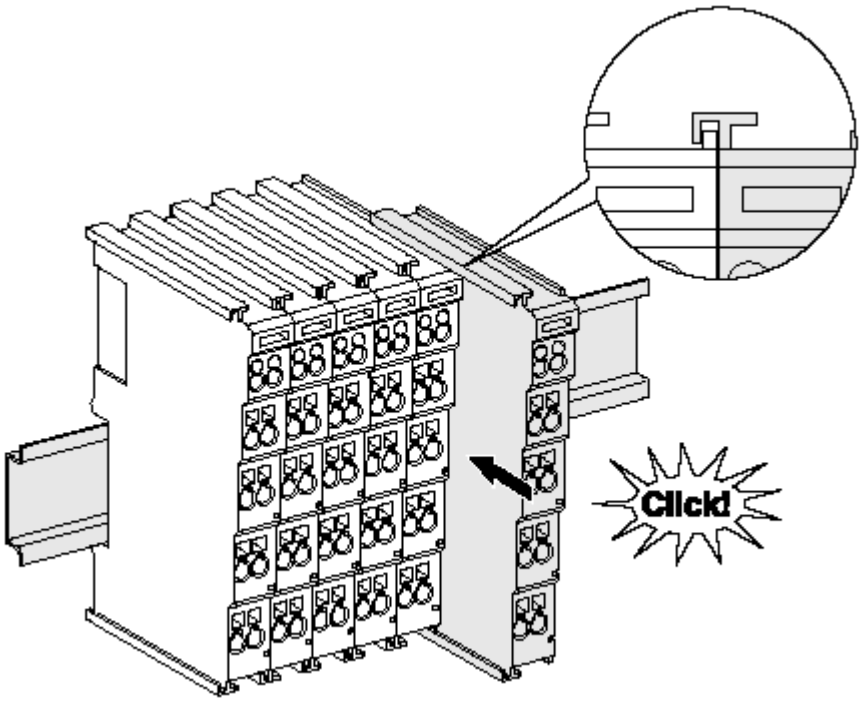

Fig. 5: Attaching on mounting rail

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

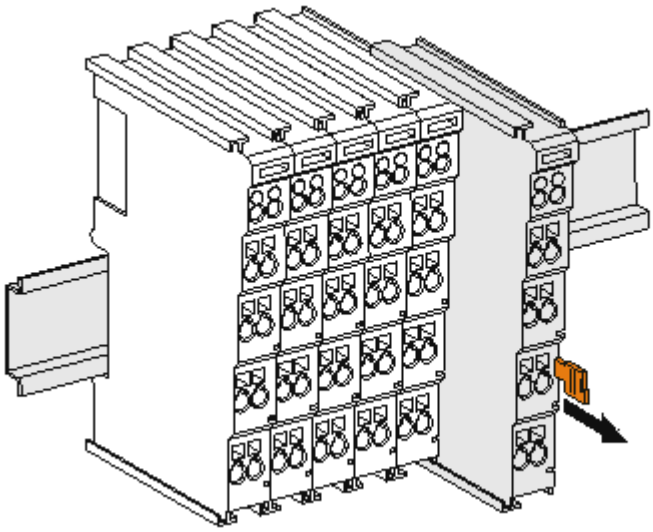

Fig. 6: Disassembling of terminal

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.

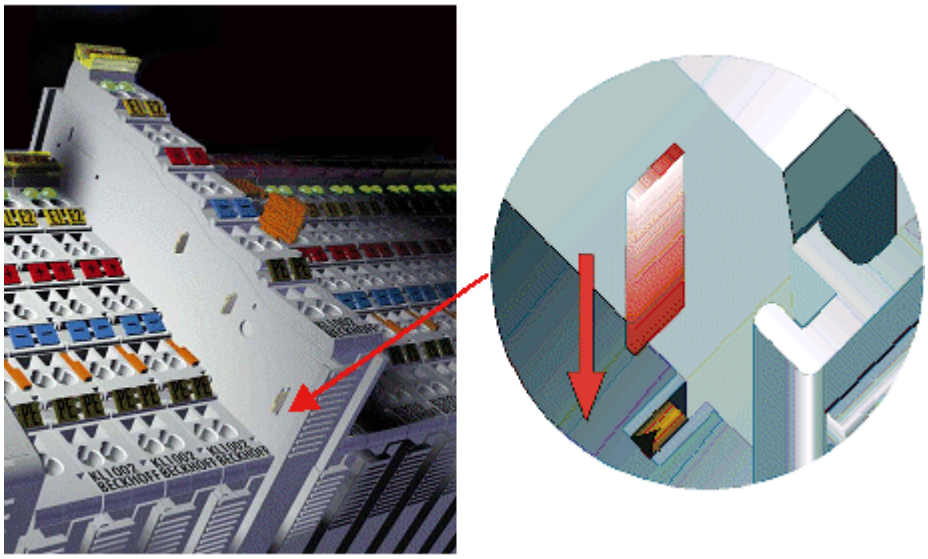

Fig. 7: Power contact on left side

NOTE

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)

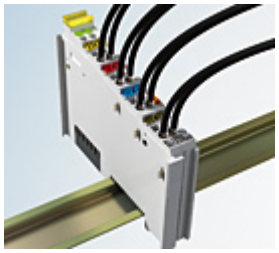

Fig. 8: Standard wiring

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)

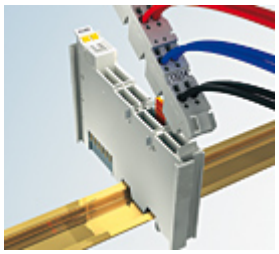

Fig. 9: Pluggable wiring

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. 10: 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.

Wiring HD Terminals

The High Density (HD) 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 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

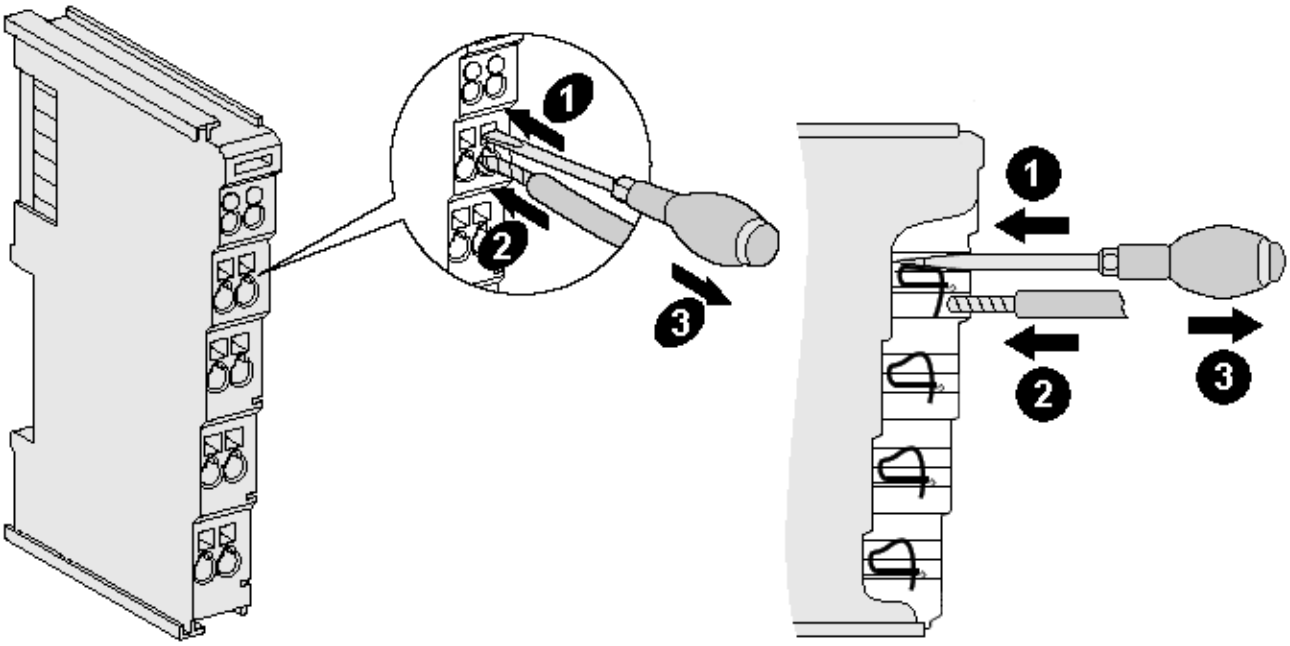

Fig. 11: Connecting a cable on a terminal point

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 [▶ 18]) 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
Wire stripping length	8 ... 9 mm

3.4 ATEX - Special conditions (extended temperature range)

⚠ WARNING

Observe the special conditions for the intended use of Beckhoff fieldbus components with extended temperature range (ET) in potentially explosive areas (directive 2014/34/EU)!

- The certified components are to be installed in a suitable housing that guarantees a protection class of at least IP54 in accordance with EN 60079-15! The environmental conditions during use are thereby to be taken into account!
- If the temperatures during rated operation are higher than 70°C at the feed-in points of cables, lines or pipes, or higher than 80°C at the wire branching points, then cables must be selected whose temperature data correspond to the actual measured temperature values!
- Observe the permissible ambient temperature range of -25 to 60°C for the use of Beckhoff fieldbus components with extended temperature range (ET) in potentially explosive areas!
- Measures must be taken to protect against the rated operating voltage being exceeded by more than 40% due to short-term interference voltages!
- The individual terminals may only be unplugged or removed from the Bus Terminal system if the supply voltage has been switched off or if a non-explosive atmosphere is ensured!
- The connections of the certified components may only be connected or disconnected if the supply voltage has been switched off or if a non-explosive atmosphere is ensured!
- The fuses of the KL92xx/EL92xx power feed terminals may only be exchanged if the supply voltage has been switched off or if a non-explosive atmosphere is ensured!
- Address selectors and ID switches may only be adjusted if the supply voltage has been switched off or if a non-explosive atmosphere is ensured!

Standards

The fundamental health and safety requirements are fulfilled by compliance with the following standards:

- EN 60079-0:2012+A11:2013
- EN 60079-15:2010

Marking

The Beckhoff fieldbus components with extended temperature range (ET) certified according to the ATEX directive for potentially explosive areas bear the following marking:

II 3G KEMA 10ATEX0075 X Ex nA IIC T4 Gc Ta: -25 … +60°C

or

II 3G KEMA 10ATEX0075 X Ex nC IIC T4 Gc Ta: -25 … +60°C

3.5 ATEX Documentation

Notes about operation of the Beckhoff terminal systems in potentially explosive areas (ATEX)

Pay also attention to the continuative documentation

Notes about operation of the Beckhoff terminal systems in potentially explosive areas (ATEX)

that is available in the download area of the Beckhoff homepage http:\\www.beckhoff.com!

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. 12: 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 Parameterization with KS2000

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 on 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 KL6041 single-channel serial interface terminal
- a KL6031 single-channel serial interface terminal
- a KL9010 Bus End Terminal

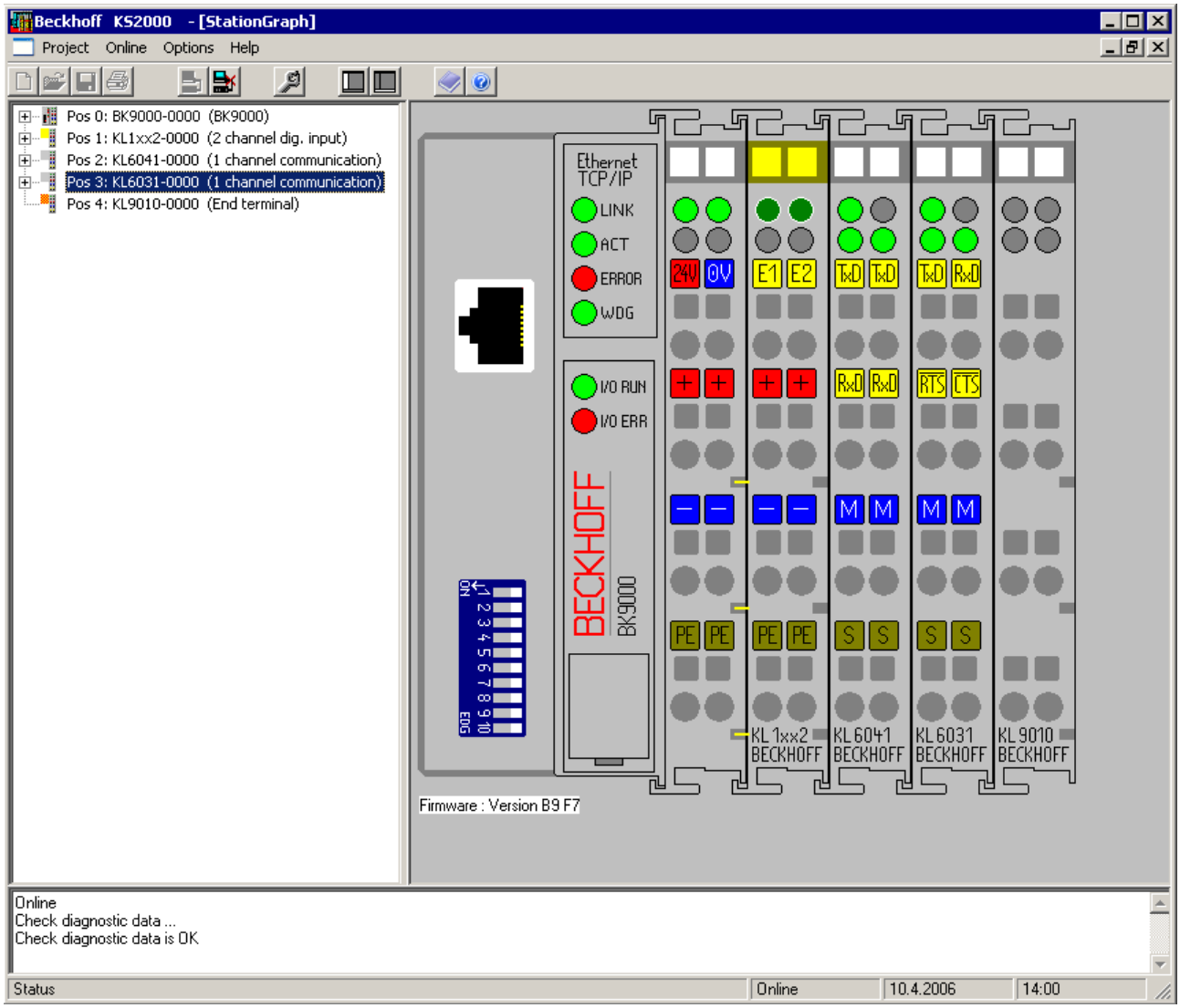

Fig. 13: Display of the fieldbus station in KS2000

The left-hand KS2000 window displays the terminals of the fieldbus station in a tree structure.
The right-hand KS2000 window contains a graphic display of the fieldbus station terminals.

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).

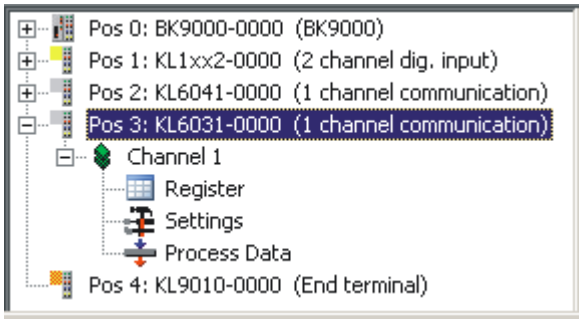

Fig. 14: KS2000 tree branch for channel 1 of the KL6031

For the KL6031 or KL6041, the branches *Register*, *Settings* and *ProcData* are displayed:

- Register [▶ 25] enables direct access to the KL6031/KL6041 registers.
- Dialog masks for the parameterization of the KL6031/KL6041 can be found under Settings [▶ 26].
- ProcData [▶ 30] displays the KL6031/KL6041 process data.

4.3 Register

Under *Register* you can directly access the registers of the KL6031/KL6041. The meaning of the register is explained in the Register Overview [▶ 35].

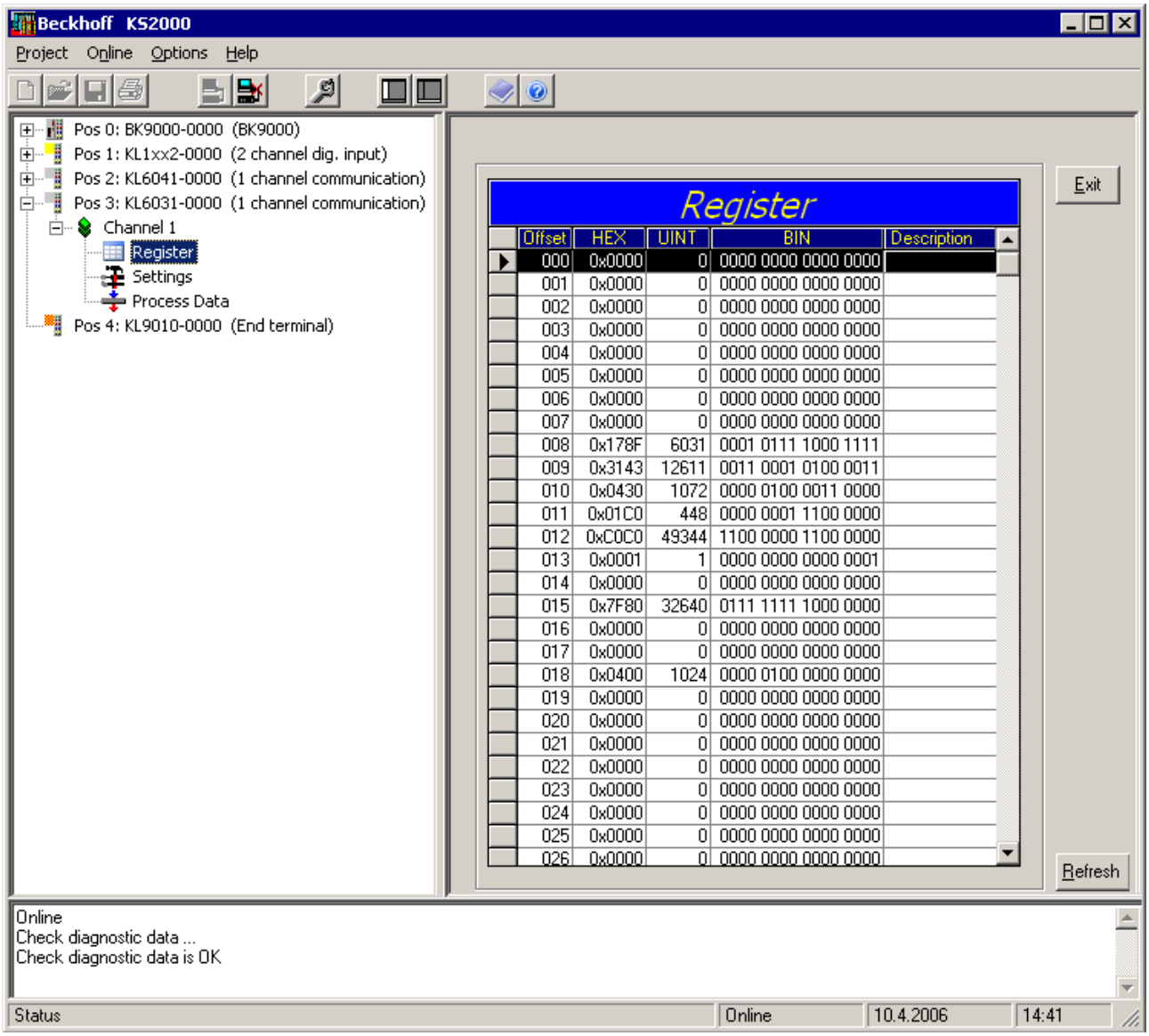

Fig. 15: Register view in KS2000

4.4 KL6031 - Common Settings

Common Settings tab for parameterization of the KL6031.

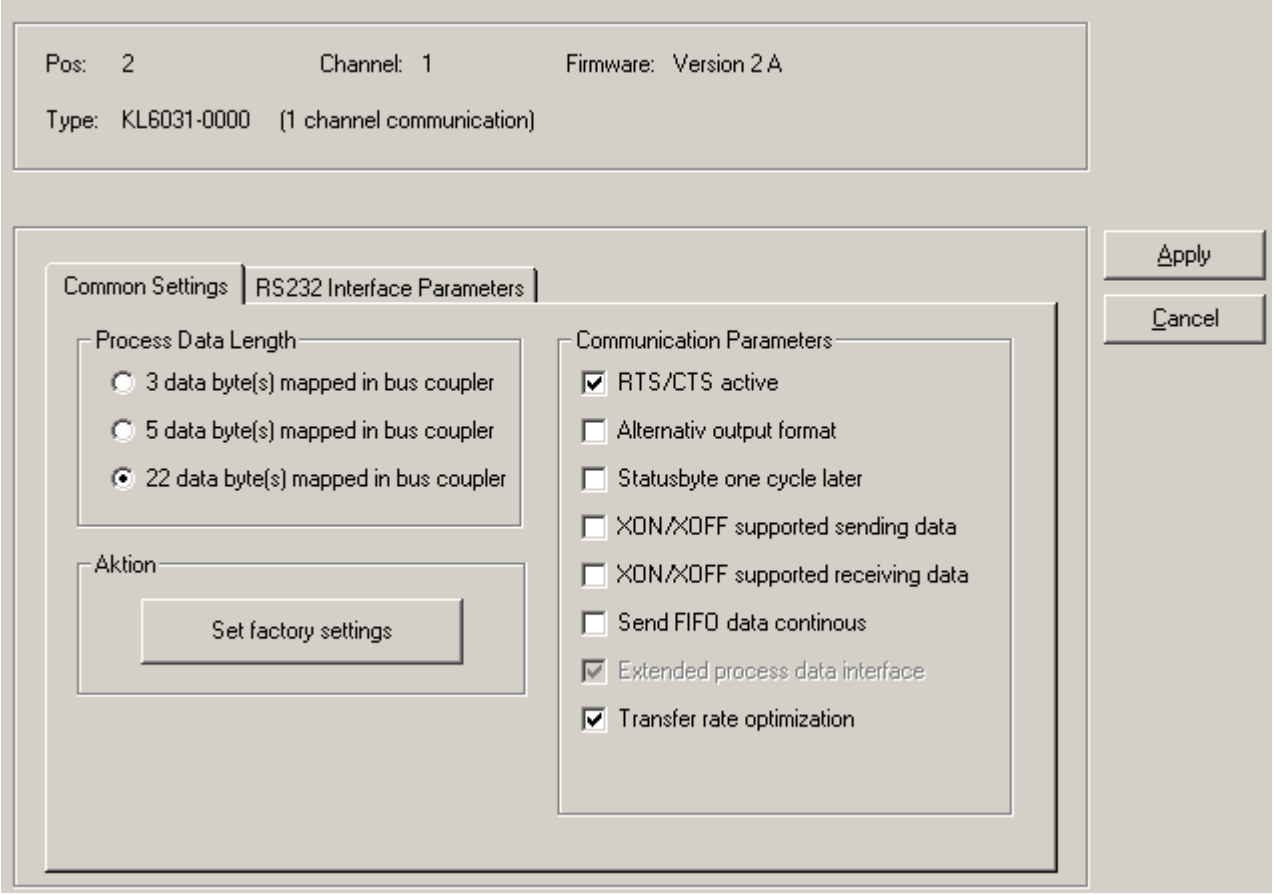

Fig. 16: Settings via KS2000

General

Take Settings for all channels of this terminal

The settings made are adopted for all channels of the terminal (default: deactivated).

Process Data Length (R34.7 [▶ 37])

Here, you can set the user data length (3, 5 or 22 bytes) of the process data image (default: 22 bytes).

Set Factory Settings (R7 [▶ 36])

Here, you can restore the terminal's factory settings and save them with "Apply".

Communication Parameters

- RTS/CTS activated (R34.0 [▶ 37]),
  (default: activated)
- Alternative output format (R34.1 [▶ 37]),
  (default: deactivated)
- Status byte one cycle later (R34.2 [▶ 37]),
  (default: deactivated)
- XON/XOFF supported sending data (R34.3 [▶ 37]),
  (default: deactivated)

- XON/XOFF supported receiving data (R34.4 [▶ 37]), (default: deactivated)
- Send FIFO data continuously (R34.6 [▶ 37]), (default: deactivated)
- Extended process data interface (R34.7 [▶ 37]), (set automatically)
- Transfer rate optimization (R34.8 [▶ 37]), (default: activated)

4.5 KL6041 - Common Settings

Common Settings tab for parameterization of the KL6041.

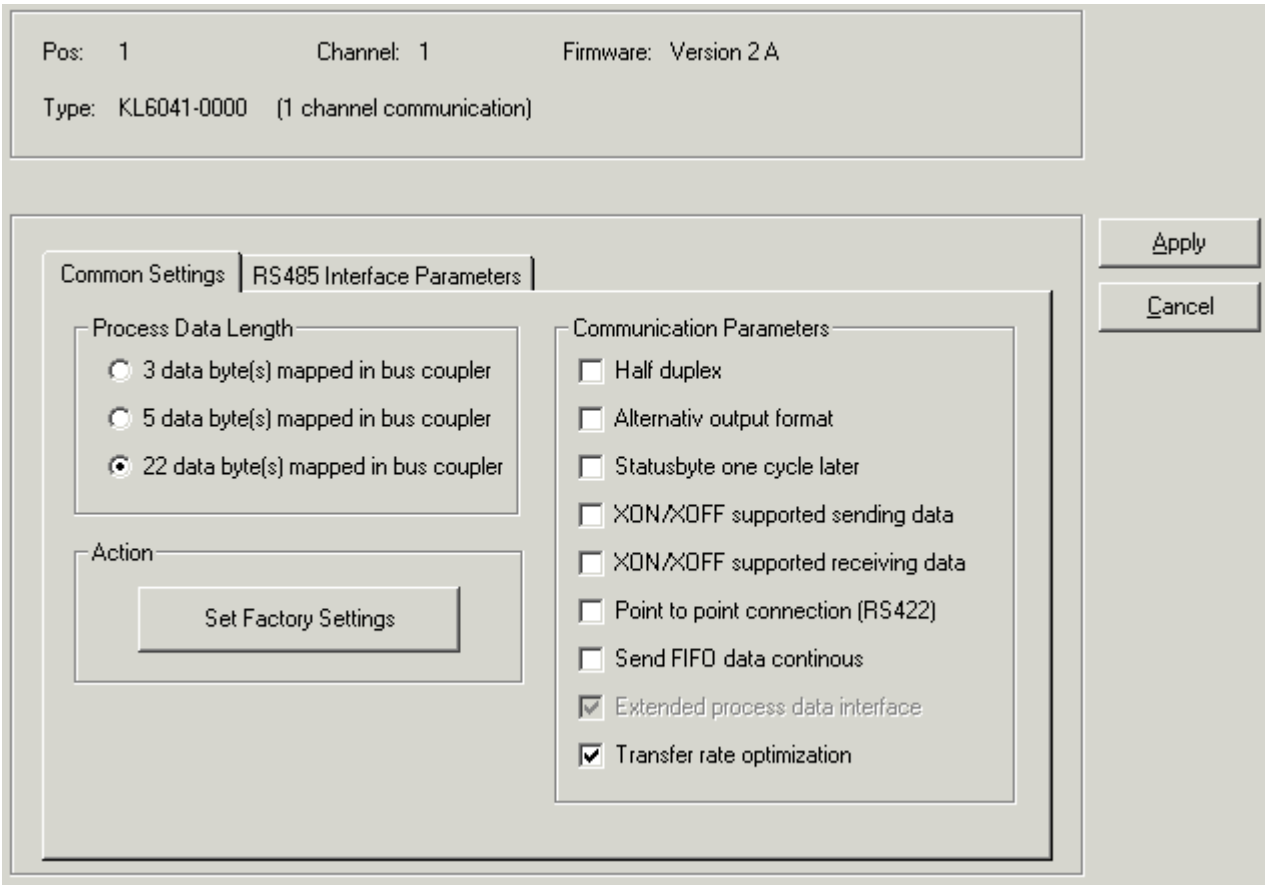

Fig. 17: Settings via KS2000

General

Take Settings for all channels of this terminal

The settings made are adopted for all channels of the terminal (default: deactivated).

Process Data Length (R34.7 [▶ 37])

Here, you can set the user data length (3, 5 or 22 bytes) of the process data image (default: 22 bytes).

Set Factory Settings (R7 [▶ 36])

Here, you can restore the terminal's factory settings and save them with "Apply".

Communication Parameters (R34)

- Half duplex (R34.0 [▶ 37]),
  (default: deactivated)
- Alternative output format (R34.1 [▶ 37]),
  (default: deactivated)
- Status byte one cycle later (R34.2 [▶ 37]),
  (default: deactivated)
- XON/XOFF supported sending data (R34.3 [▶ 37]),
  (default: deactivated)
- XON/XOFF supported receiving data (R34.4 [▶ 37]),
  (default: deactivated)
- Point to point connection (R34.5 [▶ 37]),
  (default: deactivated)
- Send FIFO data continuously (R34.6 [▶ 37]),
  (default: deactivated)
- Extended process data interface (R34.7 [▶ 37]),
  (set automatically)
- Transfer rate optimization (R34.8 [▶ 37]),
  (default: activated)

4.6 RS232(485) interface parameters

RS232(485) Interface Parameters tab for parameterizing the KL6031/KL6041.
(The example below shows the KL6031 tab).

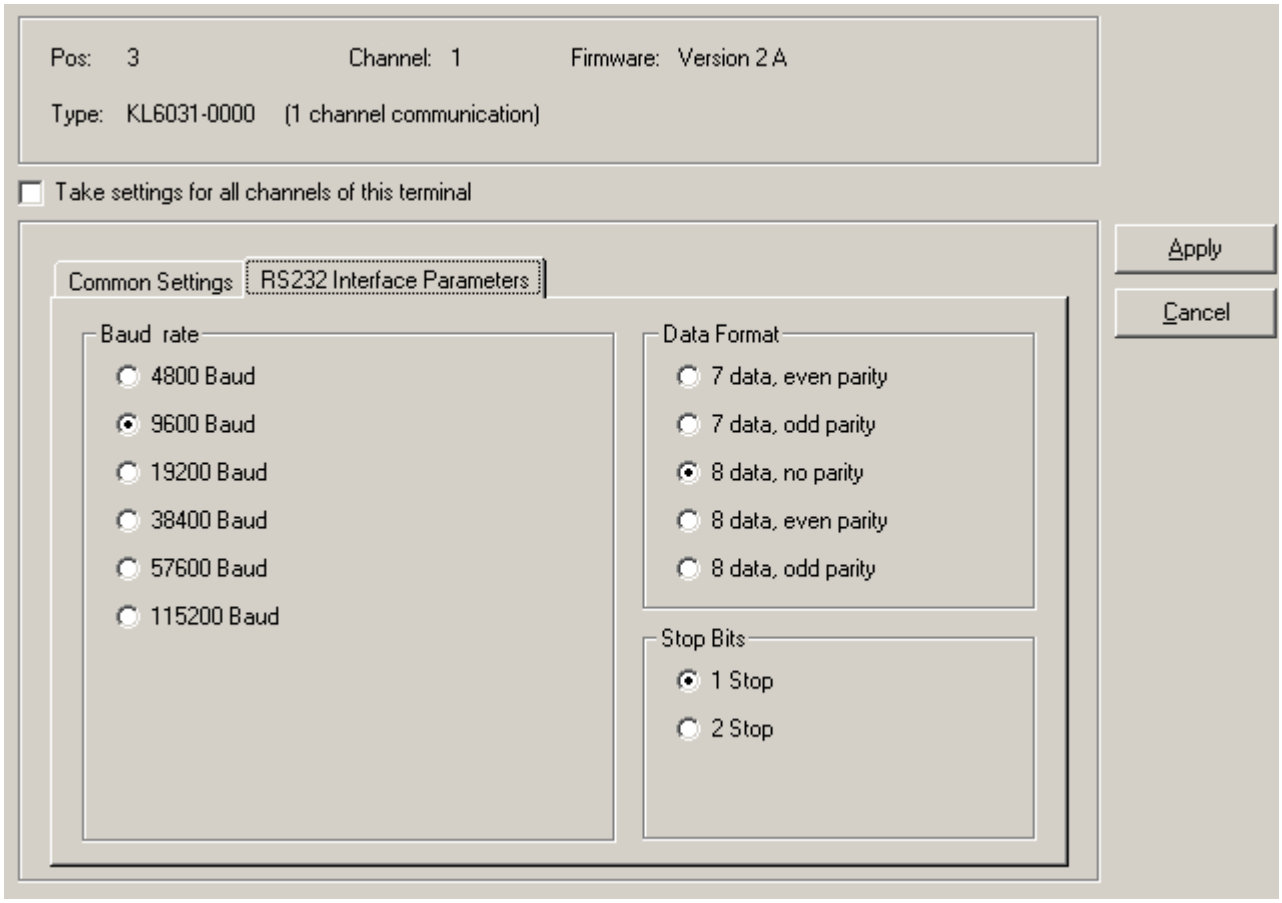

Fig. 18: Settings via KS2000

Baud rate (R32 [▶ 37])

You can set the baud rate for the terminal here (default: 9600 bit/s).

Data format (R33 [▶ 37])

Data format setting (default: 8 data bits, no parity).

Stop bits (R33.3 [▶ 37])

Setting 1 or 2 stop bits via register R33, bit 3 (default: 1 stop bit).

4.7 Process data

The Status byte (Status), the Control byte (Ctrl) and the process data (Data) are displayed in a tree structure under *ProcData*.

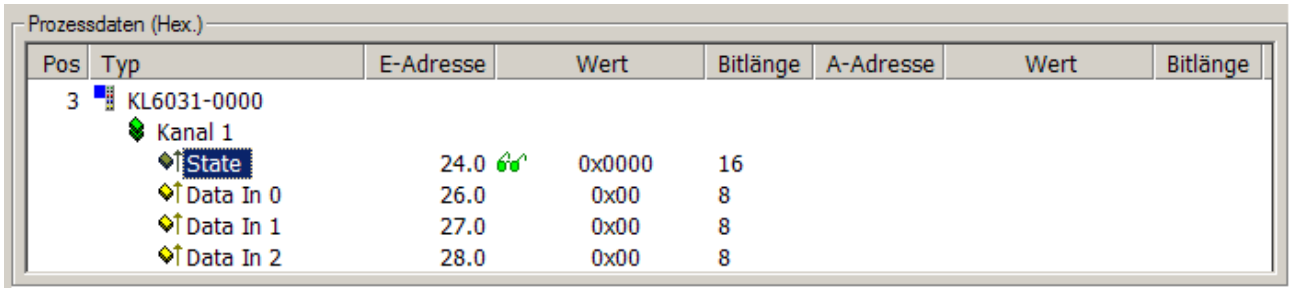

Fig. 19: ProcData

The spectacles mark the data that are currently graphically displayed in the *History* field.

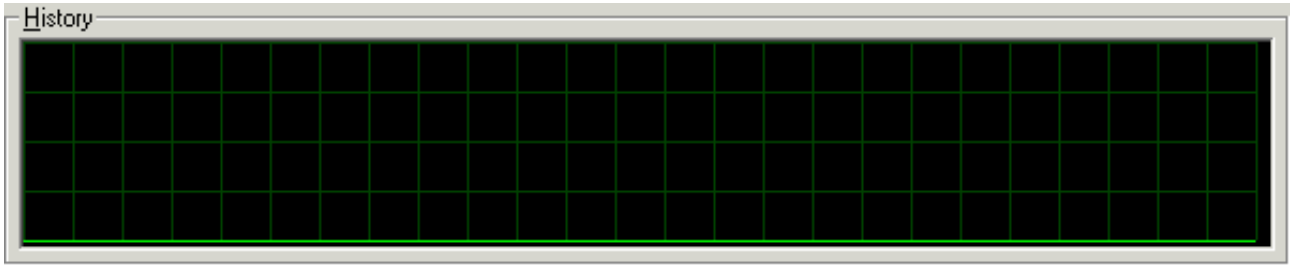

Fig. 20: History field

The current input value is displayed numerically in the *Value* field.

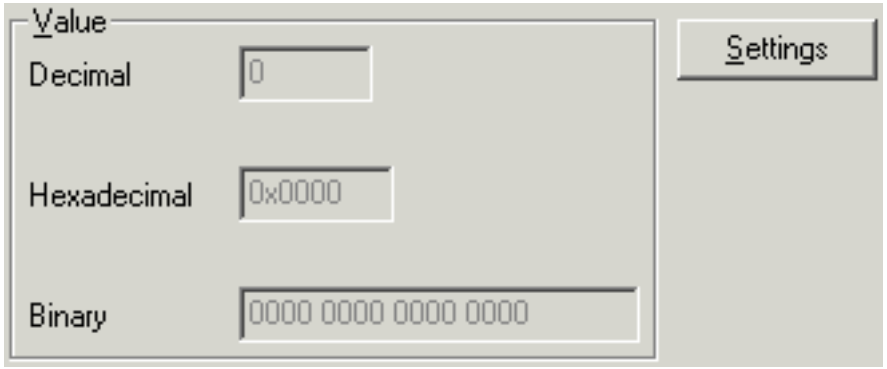

Fig. 21: Value field

Output values can be modified through direct input or by means of the fader control.

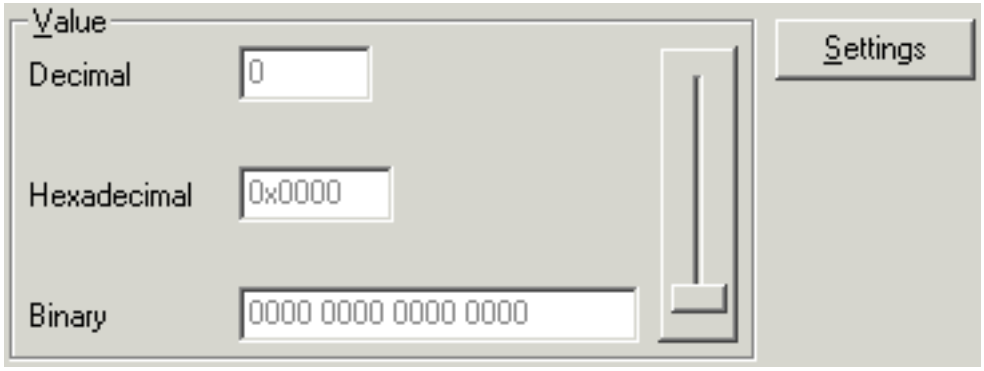

Fig. 22: Value field

⚠ CAUTION

Danger for persons, the environment or devices!

Note that changing output values (forcing) can have a direct effect on your automation application. Only modify these output values if you are certain that the state of your equipment permits it, and that there will be no risk to people or to the machine!

After pressing the *Settings* button you can set the format of the numerical display to hexadecimal, decimal or binary.

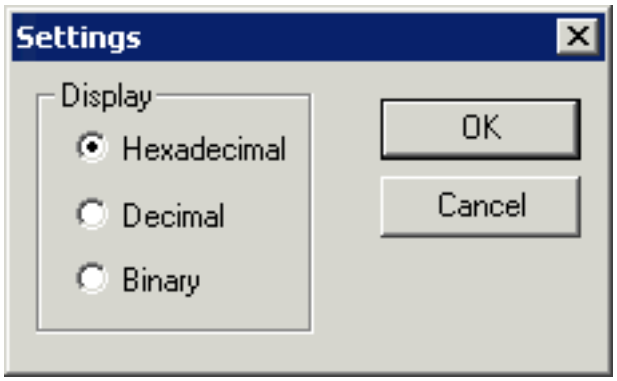

Fig. 23: Settings

5 Access from the user program

5.1 Control and status word

Control word

The control word (CW) is located in the output process image, 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	-	OL2*	OL1*	OL0*	SC	IR	RA	TR

Bits CW.15 to CW.8 are only shown if the large process image is used.
If the small or medium process image is used, only bits CW.7 to CW.0 are shown as control bytes! The number of output bytes available for transfer from the controller to the terminal is displayed by bits OL2* ... OL0*.

Key

Bit	Name	Description	
CW.15 ... CW8	OL7 ... OL0 (OutLenght)	1_{dec}... 22_{dec}	If the large process image is used: Number of output bytes () available for transfer from the controller to the terminal.
		-	If the small/medium process image is used: not shown
CW.7	-	0_{bin}	reserved
CW.6 … CW.4	OL2* ... OL0* (OutLenght*)	0	If the large process image is used: reserved
		1 ... 6	If the medium process image is used: Number of output bytes available for transfer from the controller to the terminal.
		1 ... 4	If the small process image is used: Number of output bytes available for transfer from the controller to the terminal.
CW.3	SC (SendContinious)	rise	Continuous sending of data from the FIFO. The send buffer is filled (up to 128 bytes) by the controller. The buffer content is sent with rising edge of bit SC. The terminal acknowledges the data transfer to the controller through setting of bit SW.2. SW.2 is cancelled with CW.3.
CW.2	IR (InitRequest)	1_{bin}	The controller requests terminal for initialization. The send and receive functions are blocked, the FIFO pointers are reset and the interface is initialized with the values from the relevant registers (R32-R35 [▶ 37], R18 [▶ 37]). The terminal acknowledges completion of the initialization via bit SW.2 [▶ 32] (IA).
		0_{bin}	The controller once again requests the terminal to prepare for serial data exchange.
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 [▶ 32] (TA). Only now new data can be transferred from the controller to the terminal.

Status word

The status word (SW) is located in the input process image, 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	-	IL2*	IL1*	IL0*	BUF_F	IA	RR	TA

Bits SW.15 to SW.8 are only shown if the large process image is used.
If the small or medium process image is used, only bits SW.7 to SW.0 are shown as status bytes! The number of input bytes available for transfer from the terminal to the controller is displayed by bits IL2* ... IL0*.

Key

Bit	Name	Description	
SW.15 ... SW8	IL7 ... IL0 (InLenght*)	1_{dec} ... 22_{dec}	If the large process image is used: Number of input bytes available for transfer from the terminal to the controller.
		-	If the small/medium process image is used: not shown
SW.7	-	0_{bin}	reserved
SW.6 ... SW.4	IL2* ... IL0* (InLenght*)	0	If the large process image is used: reserved
		1 ... 6	If the medium process image is used: Number of input bytes available for transfer from the terminal to the controller.
		1 ... 4	If the small process image is used: Number of input bytes available for transfer from the terminal to the controller.
SW.3	BUF_F	1_{bin}	The receive 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 [▶ 32] (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 now new data can be transferred from the controller to the terminal.

Data transfer examples

The examples use the large process image.

Data transfer from the controller to the terminal

Control word		Status word		Comment
CW.15 ... CW.8	CW.7 ... CW.1	SW.15 ... SW.8	SW.7 ... SW.1	
0000 0000_{bin}	0000 0000_{bin}	xxxx $xxxx_{bin}$	0000 x0x0_{bin}	Start of data transmission
0000 00**10**$_{bin}$	0000 000**1**$_{bin}$	xxxx $xxxx_{bin}$	0000 x0x0_{bin}	The controller requests transmission of **2** bytes by the terminal
0000 0010_{bin}	0000 0001_{bin}	xxxx $xxxx_{bin}$	0000 x0x**1**$_{bin}$	Command is executed: Terminal has loaded **2** bytes into the transmission FIFO
000**1 0000**$_{bin}$	0000 000**0**$_{bin}$	xxxx $xxxx_{bin}$	0000 x0x1_{bin}	The controller requests transmission of **16** bytes by the terminal
0001 0000_{bin}	0000 0000_{bin}	xxxx $xxxx_{bin}$	0000 x0x**0**$_{bin}$	Command is executed: Terminal has loaded **16** bytes into the transmission FIFO

Data transfer from the terminal to the controller

Control word		Status word		Comment
CW.15 ... CW.8	CW.7 ... CW.1	SW.15 ... SW.8	SW.7 ... SW.1	
xxxx $xxxx_{bin}$	0000 000x$_{bin}$	0000 0000_{bin}	0000 000x$_{bin}$	Start of data transmission
xxxx $xxxx_{bin}$	0000 000x$_{bin}$	0000 00**11**$_{bin}$	0000 001**x**$_{bin}$	The terminal requests transfer of **3** bytes from the controller
xxxx $xxxx_{bin}$	0000 001**x**$_{bin}$	0000 0011_{bin}	0000 001x$_{bin}$	Acknowledgement: Controller has received **3** bytes from the receive FIFO
xxxx $xxxx_{bin}$	0000 001x$_{bin}$	000**1 0110**$_{bin}$	0000 00**0**x$_{bin}$	The terminal requests transfer of **22** bytes from the controller
xxxx $xxxx_{bin}$	0000 00**0**x$_{bin}$	0001 0110_{bin}	0000 000x$_{bin}$	Acknowledgement: Controller has received **22** bytes from the receive FIFO

Initialization

Control word		Status word		Comment
CW.15 ... CW.8	**CW.7 ... CW.1**	**SW.15 ... SW.8**	**SW.7 ... SW.1**	
xxxx $xxxx_{bin}$	xxxx $xxxx_{bin}$	xxxx $xxxx_{bin}$	xxxx $xxxx_{bin}$	Start of data transmission
$0000\ 0000_{bin}$	$0000\ 0\mathbf{1}00_{bin}$	$0000\ 0000_{bin}$	$0000\ 0000_{bin}$	The controller requests terminal initialization
$0000\ 0000_{bin}$	$0000\ 0100_{bin}$	$0000\ 0000_{bin}$	$0000\ 0\mathbf{1}00_{bin}$	Command is executed: Terminal initialization is complete
$0000\ 0000_{bin}$	$0000\ 0\mathbf{0}00_{bin}$	$0000\ 0000_{bin}$	$0000\ 0100_{bin}$	The controller requests the terminal to prepare for serial data exchange
$0000\ 0000_{bin}$	$0000\ 0000_{bin}$	$0000\ 0000_{bin}$	$0000\ 0\mathbf{0}00_{bin}$	Command is executed: Terminal is ready for serial data exchange

5.2 Register overview

The registers are used for the parameterization of the interface terminals. They can be read or written by means of the register communication.

Register no.	Comment		Default value		R/W	Memory
R0 [▶ 36]	Number of data bytes in the send buffer		variable	-	R	RAM
R1 [▶ 36]	Number of data bytes in the receive buffer		variable	-	R	RAM
R2	reserved		0x0000	0_{dec}	R	-
R3	reserved		0x0000	0_{dec}	R	-
R4	reserved		0x0000	0_{dec}	R	-
R5	reserved		0x0000	0_{dec}	R	-
R6 [▶ 36]	Diagnostic register		variable	-	R	RAM
R7 [▶ 36]	Command register		0x0000	0_{dec}	R	-
R8 [▶ 36]	Terminal type	KL6031:	0x178F	6031_{dec}	R	ROM
		KL6041:	0x1799	6041_{dec}		
R9 [▶ 36]	Firmware version		e.g. 0x3143	e.g. $1C_{ASCII}$	R	ROM
R10	Multiplex shift register		variable	-	R	ROM
R11	Signal channels		variable	-	R	ROM
R12	Minimum data length		variable	-	R	ROM
R13	Data structure		0x0000	0_{dec}	R	ROM
R14	reserved		-	-	R	-
R15	Alignment register		variable	-	R/W	RAM
R16 [▶ 36]	Hardware version number		e.g. 0x0000	e.g. 0_{dec}	R/W	EEPROM
R17	reserved		-	-	-	-
R18 [▶ 37]	Buffer full message		0x0400	1024_{dec}	R/W	EEPROM
...	...		...	...	...	...
R30	reserved		-	-	-	-
R31 [▶ 37]	Code word register		variable	-	R/W	RAM
R32 [▶ 37]	Baud rate		0x0006	6_{dec}	R/W	EEPROM
R33 [▶ 37]	Data Frame		0x0003	3_{dec}	R/W	EEPROM
R34 [▶ 37]	Feature register		0x0181	385_{dec}	R/W	EEPROM
R35 [▶ 37]	Number of data bytes to the Bus Coupler		0x0017	23_{dec}	R/W	EEPROM
R36	reserved		0x0000	0_{dec}	R/W	EEPROM
...	...		...	...	...	...
R63	reserved		0x0000	0_{dec}	R/W	EEPROM

5.3 Register description

All registers can be read or written via register communication. They are used for parameterizing the terminals.

R0: Number of data bytes in the send buffer

R0 contains the number of data in the transmission FIFO.

R1: Number of data bytes in the receive buffer

R0 contains the number of data in the receive FIFO.

R6: Diagnostic register

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

R7: Command register

User code word

For the following commands to be executed, it is first necessary for the user code word, 0x1235, to be entered into register R31 [▶ 37]!

Command 0x7000: Restore Factory Settings

Entering 0x7000 in register R7 restores the delivery state for the following registers.

R18 [▶ 37]: 0x0400
R32 [▶ 37]: 0x0006
R33 [▶ 37]: 0x0003
R34 [▶ 37]: 0x0181
R35 [▶ 37]: 0x0017

R8: Terminal type

The terminal name is contained in register R8:
KL6031: 0x178F (6031_{dec})
KL6041: 0x1799 (6041_{dec})

R9: Firmware version

Register R9 contains the ASCII coding of the terminal's firmware version, e.g. **0x3143 = '1C'**. The **'0x31'** corresponds here to the ASCII character **'1'**, while the **'0x43'** represents the ASCII character **'C'**.
This value cannot be changed.

R16: Hardware version number

Register R16 contains the hardware version of the terminal.

R18: Buffer full

Register R18 defines the number of data in the input FIFO from which the BUF_F bit is set in the Status word

R31-R35: User registers

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 written into the RAM registers and in the EEPROM registers and are therefore retained if the terminal is restarted.

The code word is reset when the terminal is restarted.

R32: Bit/s rate

R32 defines the bit/s rate of the terminal. The delivery state is 9600 bit/s.

Bit 15 … 4	Bit 3	Bit 2	Bit 1	Bit 0	Baud rate
reserved	1	0	1	0	115200 bit/s
reserved	1	0	0	1	57600 bit/s
reserved	1	0	0	0	38400 bit/s
reserved	0	1	1	1	19200 bit/s
reserved	0	1	1	0	9600 bit/s (default)
reserved	0	1	0	1	4800 bit/s

R33: Data Frame

R33 defines the setting of the data format. The delivery state is 8 data bits, no parity.

Bit 15 … 4	Bit 3	Bit 2	Bit 1	Bit 0	Meaning
reserved	0_{bin}: 1 stop bit; 1_{bin}: 2 stop bits	1	0	1	8 data bits, odd parity
reserved	0_{bin}: 1 stop bit; 1_{bin}: 2 stop bits	1	0	0	8 data bits, even parity
reserved	0_{bin}: 1 stop bit; 1_{bin}: 2 stop bits	0	1	1	8 data bits, no parity (default)
reserved	0_{bin}: 1 stop bit; 1_{bin}: 2 stop bits	0	1	0	7 data bits, odd parity
reserved	0_{bin}: 1 stop bit; 1_{bin}: 2 stop bits	0	0	1	7 data bits, even parity

R34: Feature register

R34 defines the operation mode of the terminal.

Bit	Description of the operation mode		default
R34.15 … R34.9	-	reserved	-
R34.8	0_{bin}	No transfer rate optimization The data are immediately placed on the bus.	1_{bin}
	1_{bin}	Transfer rate optimization After receipt of a byte, the system waits for max. 4 ms for a further byte. If the receive buffer is full, the data are immediately placed on the bus.	
R34.7	0_{bin}	Small and medium process data image 3 or 5 bytes of user data (setting in R35 [▶ 37]) can be transferred.	1_{bin}
	1_{bin}	Extended process data image Up to 22 bytes of user data (setting in R35 [▶ 37]) can be transferred. (Compatible couplers: BCxx50, BXxxxx, CXxxxx, BKxx20, BKxx50, BKxx50)	
R34.6	0_{bin}	Direct transmission from the FIFO The buffer contents are transmitted immediately.	0_{bin}
	1_{bin}	Continuous transmission from the FIFO The send buffer is filled (up to 128 bytes) by the controller. The filled buffer contents will be transmitted on the rising edge of the bit "Control Byte (Word), Bit 3" (CB.3, CW.3). Once the data have been transferred, the terminal confirms this to the controller by setting the bit "Status Byte (Word), Bit 2" (SB.2, SW.2). SB.2 (SW.2) is canceled with CB3 (CW.3).	
R34.5	0_{bin}	KL6031:	reserved	-
		KL6041:	Point to point connection disabled	0_{bin}
	1_{bin}	KL6031:	reserved	-
		KL6041:	Point to point connection enabled	-
R34.4	0_{bin}	No support for the XON/XOFF protocol when receiving data		0_{bin}
	1_{bin}	Support for the XON/XOFF protocol when receiving data The terminal sends the control character XOFF when the terminal buffer contains 1014 characters. XON is sent if XOFF was sent previously and the value falls below the lower buffer limit of 18 bytes.		
R34.3	0_{bin}	No support for the XON/XOFF protocol when transmitting data		0_{bin}
	1_{bin}	Support for the XON/XOFF protocol when transmitting data The terminal transmits the data transferred by the controller until it receives from the controller the sign XOFF ($DC3_{ASCII}$ == 0x13) from the partner. Thereafter, transmission is prevented until the sign ($DC1_{ASCII}$ == 0x11) is received.		
R34.2	0_{bin}	No delayed Status byte		0_{bin}
	1_{bin}	Delayed Status byte The Status byte is copied by the terminal into the shift register of the K-bus one cycle later than the higher-value data bytes. This reduces the rate of data transmission to the controller.		
R34.1	0_{bin}	Standard output format (note R35 [▶ 37]!)		0_{bin}
	1_{bin}	Alternative output format In the alternative output format, 4 or 5 bytes (3 bytes for data and 1 or 2 control/status byte(s)) are mapped in the Bus Coupler.		
R34.0	0_{bin}	KL6031:	RTS, CTS deactivated	-
		KL6041:	Full duplex	0_{bin}
	1_{bin}	KL6031:	RTS, CTS activated	1_{bin}
		KL6041:	Half duplex	-

R35: Number of data bytes mapped in the Bus Coupler

R35 defines the number of data bytes mapped in the Bus Coupler.

Bit 15 … 15	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Data bytes
reserved	1	0	1	1	1	22 bytes + 1 Control/Status word in the extended process data image (see R34.7 [▶ 37])
reserved	0	0	1	1	0	5 bytes + 1 Control/Status byte
reserved	0	0	0	1	1	3 bytes + 1 Control/Status byte

R36 - 63: reserved

5.4 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 activated or deactivated

The Bus Couplers (BKxxxx, LCxxxx) and Bus Terminal Controllers (BCxxxx, BXxxxx) are supplied with certain default settings. The default setting can be changed with the KS2000 configuration software or with a master configuration software (e.g. TwinCAT System Manager or ComProfibus).

The following tables show the mapping depending on different conditions.

Complex evaluation

In the case of complex evaluation, the serial interface terminals occupy addresses in the input and output process image. Control and Status words can be accessed.

22-byte process image

Complex evaluation in Intel format

	Address	Input data		Output data	
Conditions	**Word offset**	**High byte**	**Low byte**	**High byte**	**Low byte**
Complex evaluation: yes 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**
Complex evaluation: yes 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

5-byte process image

Complex evaluation in Intel format without word alignment

	Address	Input data		Output data	
Conditions	**Word offset**	**High byte**	**Low byte**	**High byte**	**Low byte**
Complex evaluation: yes Motorola format: no Word alignment: no	0	DataIn 0	SB	DataOut 0	CB
	1	DataIn 2	DataIn 1	DataOut 2	DataOut 1
	2	DataIn 4	DataIn 3	DataOut 4	DataOut 3
	3	reserved	DataIn 5	reserved	DataOut 5

Complex evaluation in Intel format with word alignment

	Address	Input data		Output data	
Conditions	**Word offset**	**High byte**	**Low byte**	**High byte**	**Low byte**
Complex evaluation: yes Motorola format: no Word alignment: yes	0	reserved	SB	reserved	CB
	1	DataIn 1	DataIn 0	DataOut 1	DataOut 0
	2	DataIn 3	DataIn 2	DataOut 3	DataOut 2
	3	DataIn 5	DataIn 4	reserved	DataOut 4

Complex evaluation in Motorola format without word alignment

	Address	Input data		Output data	
Conditions	**Word offset**	**High byte**	**Low byte**	**High byte**	**Low byte**
Complex evaluation: yes Motorola format: yes Word alignment: no	0	DataIn 1	SB	DataOut 1	CB
	1	DataIn 3	DataIn 0	DataOut 3	DataOut 0
	2	DataIn 5	DataIn 2	DataOut 5	DataOut 2
	3	reserved	DataIn 4	reserved	DataOut 4

Complex evaluation in Motorola format with word alignment

	Address	Input data		Output data	
Conditions	**Word offset**	**High byte**	**Low byte**	**High byte**	**Low byte**
Complex evaluation: yes Motorola format: yes Word alignment: yes	0	reserved	SB	reserved	CB
	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

3-byte process image

Complex evaluation in Intel format without word alignment

	Address	Input data		Output data	
Conditions	**Word offset**	**High byte**	**Low byte**	**High byte**	**Low byte**
Complex evaluation: yes Motorola format: no Word alignment: no	0	DataIn 0	SB	DataOut 0	CB
	1	DataIn 2	DataIn 1	DataOut 2	DataOut 1

Complex evaluation in Intel format with word alignment

	Address	Input data		Output data	
Conditions	**Word offset**	**High byte**	**Low byte**	**High byte**	**Low byte**
Complex evaluation: yes Motorola format: no Word alignment: yes	0	reserved	SB	reserved	CB
	1	DataIn 1	DataIn 0	DataOut 1	DataOut 0
	2	reserved	DataIn 2	reserved	DataOut 2

Complex evaluation in Motorola format without word alignment

	Address	Input data		Output data	
Conditions	**Word offset**	**High byte**	**Low byte**	**High byte**	**Low byte**
Complex evaluation: yes Motorola format: yes Word alignment: no	0	DataIn 1	SB	DataOut 1	CB
	1	DataIn 2	DataIn 0	DataOut 2	DataOut 0

Complex evaluation in Motorola format with word alignment

	Address	Input data		Output data	
Conditions	**Word offset**	**High byte**	**Low byte**	**High byte**	**Low byte**
Complex evaluation: yes Motorola format: yes Word alignment: yes	0	reserved	SB	reserved	CB
	1	DataIn 0	DataIn 1	DataOut 0	DataOut 1
	2	DataIn 2	reserved	DataOut 2	reserved

Compact evaluation

Operation with a compact process image is not possible

Operation of the KL6031 / KL6041 with a compact process image (without Control and Status bytes) is not possible, because Control and Status bytes are required for meaningful process data mode of the KL6031 / KL6041. Even if you set your Bus Coupler to the compact process image, the KL6031 / KL6041 will still be represented with a complete process image!

Key

Complex evaluation: In addition to the process data, the control and status bytes are also mapped into the address space.
Motorola format: Motorola or Intel format can be set.

Word alignment: In order for the channel address range to commence at a word boundary, empty bytes are inserted into the process image as appropriate.
SB / SW: Status byte / Status word for channel n (appears in the input process image)
CB / CW: Control byte for channel n (appears in the output process image)
reserved: This byte is assigned to the process data memory, although it has no function.

5.5 Examples of Register Communication

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

5.5.1 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.

5.5.2 Example 2: Writing to an user register

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!

5.6 Operation with TwinCAT PLC software

Required TwinCAT version

These Bus Terminals are only supported from TwinCAT version 2.0 of the serial communication library (ComLibV2). In the case of Bus Terminals, the K-bus update time of the Bus Coupler must be considered when selecting the cycle time. Further information on configuration and operation with TwinCAT can be found in the Beckhoff Infosys at http://infosys.beckhoff.com/.

KL6031 and KL6041 in 22-byte mode

The Beckhoff KL6031 und KL6041 serial Bus Terminals are operated in the delivered standard version with a 24-byte process image (22 bytes of user data + 1 Control/Status word), so that 22 data bytes can be transferred both from and to the terminal.
Three PLC cycles are required for the data exchange between the PLC and the Bus Terminal. The maximum effective data transfer rate (bps) depends on the cycle time T of the PLC and the number of bits necessary to transfer one data byte (LB):

bps = (LB x PA / 3) / T
LB = 1 start bit + n data bits + p parity bits + m stop bits
PA = number of user data in the process image

The maximum effective data transfer rate is upwardly limited by the physical bit/s rate configured in the Bus Terminal.

bps = (10 bits x 22/3) / 0.010 s ≈ 7333 bps

KL6031 and KL6041 in 5-byte mode

The serial Bus Terminal can also be reconfigured in such a way that 5 data bytes can be transferred both from and to the terminal in 5-byte mode (6-byte process image). 3 PLC cycles are still necessary for each exchange. The effective data rate for a given cycle time of the PLC is thus 5/3 greater than in 3-byte mode.

bps = (10 bits x 5/3) / 0.010 s ≈ 1666 bps

The Bus Terminals cannot be re-programmed while the PLC is running, since the 3-byte and 5-byte modes differ in the register mapping and in the TwinCAT System Manager configuration.

KL6031 and KL6041 in 3-byte mode

When operating the KL6031 + KL6041 in 3-byte mode, 3 data bytes (4-byte process image) can be transferred to and received by the terminal in a bus telegram. Since every data exchange between the PLC and the Bus Terminal requires 3 PLC cycles, the effective transfer rate is one byte per cycle.

bps = (10 bits x 3/3) / 0.010 s ≈ 1000 bps

Serial PC Interface

The serial PC interface (COM1, COM2 etc.) is handled by the TwinCAT system similarly to the serial bus terminal, but use larger data transfer buffers than the serial bus terminal. COMlib uses a 64-byte buffer, so up to 64 data bytes are transferred at once between the PLC and the interface driver. 3 PLC cycles are again needed for the exchange of a data block with the serial PC interface.

bps = (LB x 64/3) / T

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!

The addresses of Beckhoff's branch offices and representatives round the world can be found on her internet pages:
http://www.beckhoff.com

You will also find further documentation for Beckhoff components there.

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Beckhoff Support

Support offers you comprehensive technical assistance, helping you not only with the application of individual Beckhoff products, but also with other, wide-ranging services:

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- design, programming and commissioning of complex automation systems
- and extensive training program for Beckhoff system components

Hotline:	+49 5246 963 157
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Beckhoff Service

The Beckhoff Service Center supports you in all matters of after-sales service:

- on-site service
- repair service
- spare parts service
- hotline service

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Table of figures