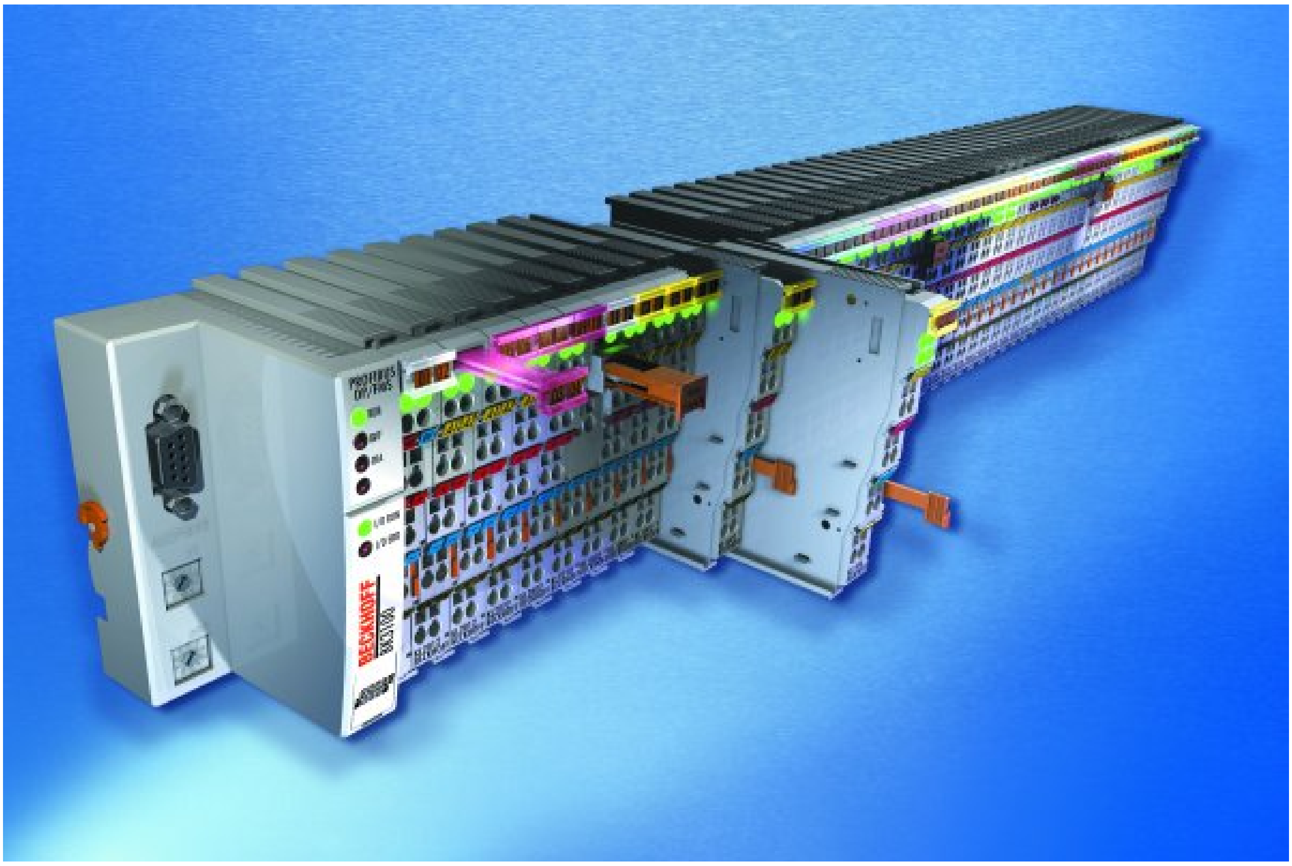

Documentation

KL3681, KS3681

Multimeter Terminals

Version: 2.1.0
Date: 2017-10-06

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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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
2.1.0	• Update chapter *Notes on the documentation* • Update chapter *connection system -> connection*
2.0.0	• migration (complete Document) • LED Display: meaning of K-bus run led exchanged (off/ on)
1.0.0	• technical data updated • description of parameterization via KS2000 configuration software extended • description of control and status byte corrected • description of process image added
0.5	preliminary version (only German)

Firm and hardware versions

Documentation Version	KL3681-0000, KS3681-0000	
	Firmware	Hardware
2.1.0	1C	01
2.0.0	1C	01
1.0.0	1C	01
0.5	1C	01

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

Syntax of the serial number

Structure of the serial number: WW YY FF HH

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

Example with ser. no.: 02 13 00 01:

02 - week of production 02
13 - year of production 2013
00 - firmware version 09
01 - hardware version 01

2 Product overview

2.1 Introduction

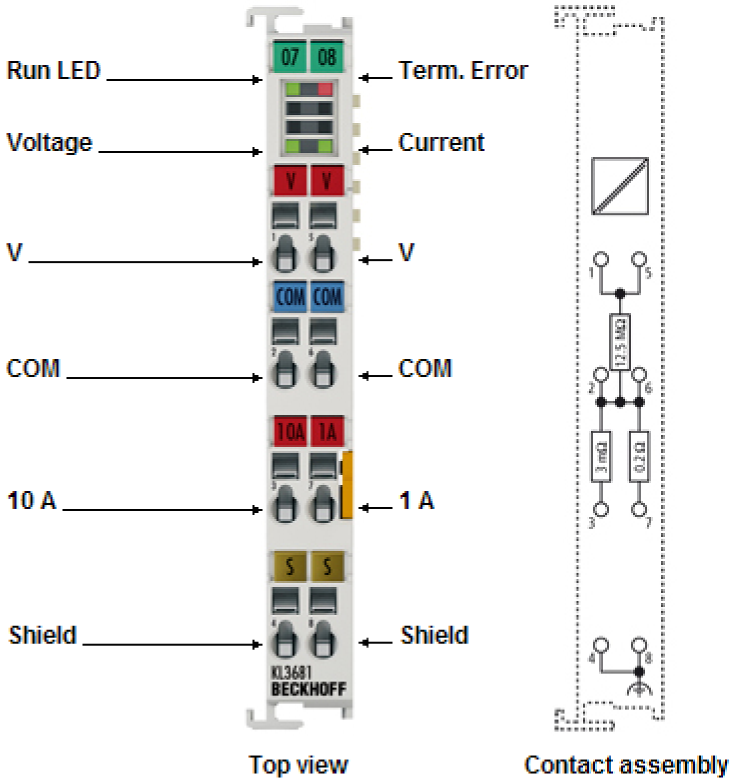


Fig. 1: KL3681-0000

Digital Multimeter Terminal

The KL3681 Bus Terminal enables measurement of currents and voltages in a wide input range. The measuring ranges are switched automatically, as usual in advanced digital multimeters. For current measurements, two current paths are available, one of which is a high-current path for up to 10 A. The current and the voltage measurement facility can be used for DC and AC. The alternating parameters are output as true RMS values. The measurement readings can be read and processed with commercially available fieldbus systems. At the same time, the KL3681 enables the measuring type and range to be set via the bus.

Excellent interference immunity is achieved through the fully electrically isolated design of the electronic measuring system and the dual-slope conversion system. High precision and simple, high-impedance measurement from 300 mV to 300 V allow the Bus Terminal to be used like a digital multimeter.

In measuring applications in particular, the voltage to be expected is often not yet known during the planning phase. Automatic adjustment of the measurement range simplifies use and reduces stock levels. The selected measuring type and overload are indicated by LEDs.

2.2 Technical data

Technical data		KL3681	KS3681
Number of inputs		1, voltage or current (1 A / 10 A)	
Technology		digital multimeter with automatic range selection	
Measured values		current, voltage (AC/DC)	
Measuring voltage		300 mV, 3 V, 30 V, 300 V	
Measuring current		100 mA, 1 A and 10 A via high-current path	
Resolution		18 bit + sign in each measurement range	
Internal resistance	Measuring range DC 300 mV to 300 V	12,5 MΩ	
	Measuring range DC 100 mA to 1 A	0,2 Ω	
	Measuring range DC 10 A	3 mΩ	
	Measuring range AC 300 mV to 300 V	1 MΩ, ca. 33 pF	
	Measuring range AC 100 mA to 1 A	0,2 Ω	
	Measuring range AC 10 A	3 mΩ	
Measuring error		0.01 % DC voltage measurement at 25°C	
Measuring procedure		DC with arithmetic averaging, AC with true RMS value calculation TrueRMS, 0...1 kHz input signal, Crest factor < 3 allowed	
Update time		0.5 s, 1 s for measuring range selection	
Electrical isolation		1500 V (terminal / E-bus)	
Supply voltage for internal circuit		via K-Bus	
Current consumption from via E-bus		typically 100 mA	
Configuration		via KS2000 Configuration Software	
Pluggable wiring		no	yes
Weight		approx. 70 g	
Permissible ambient temperature temperature for operation		0°C ... + 55°C	
Permissible ambient temperature temperature for storage		-25°C ... + 85°C	
Permissible Relative humidity		95 %, no condensation	
Dimensions		approx. 15 mm x 100 mm x 70 mm (width aligned: 12 mm)	
Mounting [▸ 15]		on 35 mm mounting rail conforms to EN 60715	
Vibration / shock resistance		conforms to EN 60068-2-6 / EN 60068-2-27	
EMC resistance burst / ESD		conforms to EN 61000-6-2 / EN 61000-6-4	
Protection class		IP20	
Installation pos.		variable	
Approval		CE	

2.3 Basic function principles

Features

The functionality of the KL3681 is similar to that of a commercial digital multimeter. The terminal offers the following features:

- Single-channel measurement

- AC/DC voltage measurement, automatic range selection: “Autorange” or specified via the controller
  Measurement ranges: 300 mV, 3 V, 30 V, 300 V
- AC/DC current measurement in the 1 A path (internal fuse: 1.25 A) or 10 A path (no internal fuse)
  Measurement ranges: 100 mA, 1 A, 10 A
- Formation of measured values:
  Alternating current and alternating voltage are calculated as true RMS values, no DC component
  Direct current and direct voltage are calculated as arithmetic average value
- Electrical isolation from the fieldbus
- Very good interference immunity through dual-slope conversion technique
- Display of measurement type (current/voltage) and overload through LED
- Typical update rate approx. two seconds, after measuring range change approx. one second

Quick start

The factory setting for the multimeter terminal enables voltages up to 300 V_{DC} to be measured directly without additional settings. The Autorange function is active and selects the measuring range automatically.

The measured value is displayed with 1 bit per microvolt, i.e. no adjustment is required.

Functional description

Measuring ranges and output

The terminal starts measuring automatically. New measurement readings will be put out as soon as the calculation is complete. If the last used and the requested measuring range do not match, the bit “Data invalid” is set. In the event of an error (generally measuring range exceeded) the respective error bits are set. New measurement values are provided approx. every 0.5 seconds. The filter time is reset if the measuring range is changed via Autorange or by the user during the filter period. If the value fluctuates too much in Autorange mode, it may not be possible to determine a new measured value. As a remedy the filter can be deactivated.

The terminal has an extended measuring range, if a larger measuring range is available (Example: 30 V range, extended measuring range is 300 V). In Autorange mode the extended measuring range is used as a hysteresis range. In the extended measuring range overflow and underflow bits and the error bit are set at 115 % of the normal measuring range.

Note	**Please note** • In AC mode only the RMS value of AC voltage is shown (no DC component). • Error bits are under-range, over-range and data invalid. The error bit is set together with these bits. In some cases several bits may be set simultaneously in the event of an error (e.g.: Overrange and Data invalid). • Since the terminal integrates the input value over an interval of 20 ms (16.66 ms in 60 Hz mode), superimposed interferences of the input values from the supply network can largely be compensated.

Measuring range selection

The measuring range is selected in process data mode via the control byte [▶ 29].

The Autorange function selects the best measuring range for the selected measurement type. In Autorange mode the 10 A measuring ranges are distinct types of measurement, i.e. it is not possible to switch from 1 A and 10 A or back (Causes: different input contacts as like fuse protection of the1 A range with 1.25 A).

The limits for changing the measuring ranges range are 10 % above the full scale value (extended measuring range, larger range) and 10 % of the full scale value (smaller range). If "Left aligned" view is selected, the limits are 100 % and 5 % of the full scale value.

Filter

The built-in filter averages the values for the last half second. If the measuring range is changed the filter is reset. The filter is active by default. If the filter is switched off the terminal supplies approx. 16 measured values per second.

Mains frequency

The integration times are adapted to the mains frequency (50, 60 Hz). The default is 50 Hz.

Presentation

The presentation of the values in the process data can be changed.

left aligned (0)
Left-justified presentation, full-scale value corresponds to 0x7FFFE000 (0x7FFFFFFF) or 0x80000000.

right aligned (1)
Right-aligned presentation: 18 bit resolution of the measuring range, end value corresponds to 0x0003FFFF (262143_{dec}) or 0xFFFC0000 (-262144_{dec}).
In the extended measuring range these limits are exceeded!

scaled (2)
Scaled presentation: this presentation corresponds to 1 bit per µV / µA. Examples:
- Mode 0, Autorange, 2.5 V: 2500000_{dec}
- Mode 2, 800 mA: 800000_{dec}

float (5)
Scaled presentation in floating-point format

Scaled presentation (2) is set as default.

i Note	**Please note** • Only in scaled presentation the factors 0.1/1/10/100 are taken into account between the measuring ranges. • In left aligned presentation the extended measuring range is not available.

Zero Compenzation Interval

The compensation function compensates the internal offset drift of the ADC. The interval length is selectable.

If setting 4 "Triggered by PDO" is used, the time for reading the internal offset can be selected manually via the "Start Calibration" process data bit.

i Note	**50 Hz mode** In 50 Hz mode this function should not be used (0: off).

Calibration

The terminal features manufacturer and user calibration options, which can be switched on and off independently. The calibration always applies to all measuring ranges. Adaptation in 60 Hz mode and compensation of the AC system offset cannot be switched off.

2.4 Process data

Calculation of process data

The process data are calculated in up to seven steps between reading of the ADC and the process data output.

Designation	Calculation formula	not active
Offset correction	$Y_Z = X_{ADC} - (B_Z - B_{ZCal})$	$Y_Z = X_{ADC}$
Filter for averaging over 8 values	$Y_F = 1/8 \cdot \sum_{i=0}^{8} Y_{Zi}$	$Y_F = Y_Z$
60 Hz mode adaptation	$Y_{60} = (Y_F - B_F) \cdot 7/8 + (Y_F - B_F) \cdot A_F$	$Y_{60} = Y_F$
Calibration active	$Y_H = (Y_{60} - B_K) \cdot 7/8 + (Y_{60} - B_K) \cdot A_K$	$Y_H = Y_{60}$
	$Y_A = (Y_H - B_A) \cdot 7/8 + (Y_H - B_A) \cdot A_A$	$Y_A = Y_H$
AC system offset	$Y = (Y_A - X_{SO}) \cdot 2$ for $0 < Y_A < 2 \cdot X_{SO}$	$Y = Y_A$ (condition not met)
Scaling	$Y_{Scal} = Y \cdot \frac{F_{Scal}}{2^{18}} \cdot 10^{Range}$	-

The scaling includes the powers of ten selected in the range.
All gain factors should therefore correspond to 1/8 in order to obtain a total factor of 1. The value 8192 (0x2000) results in a total factor of 1.

Designation	Meaning	Register	Designation	Meaning	Register
X_{ADC}	Output value of the A/D converter	R0 [▶ 34]			
Y_Z	Measured value after ADC offset correction		B_Z	Current ADC Zero value	
			B_{ZCal}	ADC Zero at the time of calibration	
Y_F	Measured value after averaging				
Y_{60}	Measured value after adaptation of the 60 Hz integration time		B_F	60 Hz offset	
			A_F	60 Hz gain	
Y_H	Measured value after manufacturer calibration		B_K	Manufacturer offset	
			A_K	Manufacturer gain	
Y_A	Measured value after user calibration		B_A	User offset	
			A_A	User gain	
Y	Measured value after AC system offset		X_{SO}	AC system offset	
Y_{Scal}	Measured value after scaling		F_{Scal}	End value in 1 bit per 1µV / 1µA	

Determining (user) gain values

The terminal has one user compensation value pair for each measuring range and measurement type, i.e. 14 pairs in total. "+1" (0x4000) is not used in order to increase the resolution of the gain value.
Since the gain values may be less than 1, a factor of 1/8 is multiplied to the gain value. For a gain of 1 the gain value must be 0x2000.

For gain G = 1 the following applies:

$$A_A = (G - 7/8) \cdot 2^{16}$$

$$A_A = 0x2000$$

For other values G must be replaced with the required gain factor.

Before the compensation the value display option should be set to "right-aligned": Register R32.12 to R32.15 [▶ 36] value assignment of 1_{dec}.

2.5 LED Display

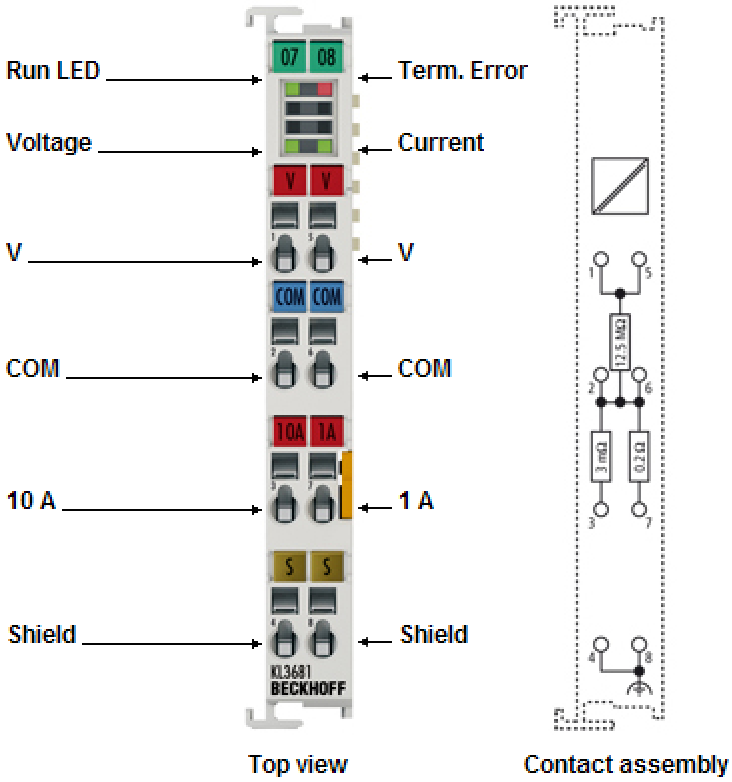


Fig. 2: KL3681-0000 - LED display

LED	Color	Meaning	
RUN	green	off	K-Bus data transfer not active
		on	K-Bus data transfer active
Term. Error	red	on	An error has occurred (see status byte [▸ 30])
Voltage	green	on	Indicates voltage measurement
Current	green	on	Indicates current measurement

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

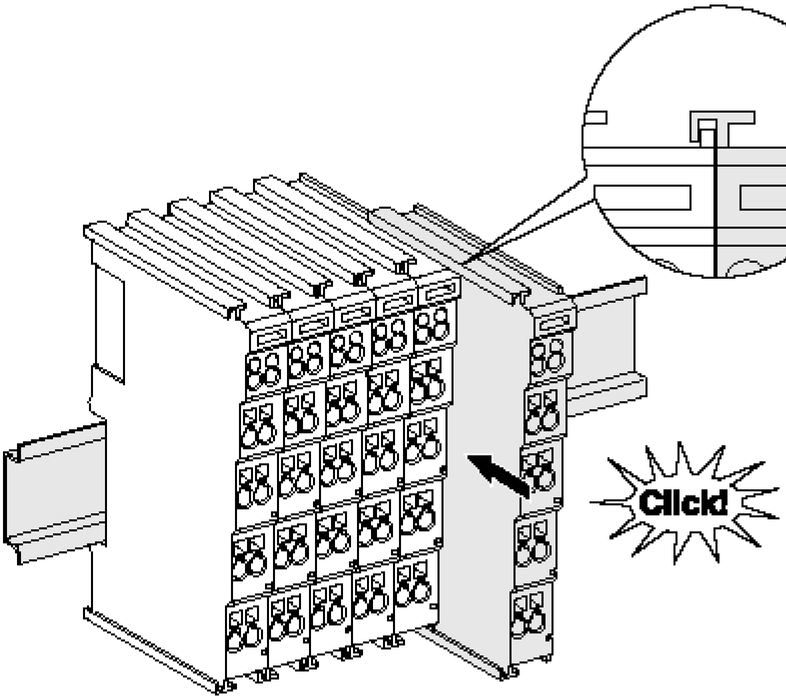


Fig. 3: Attaching on mounting rail

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

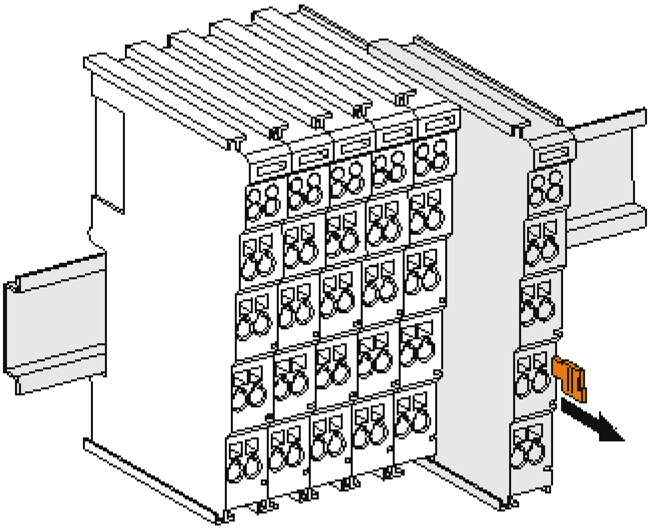


Fig. 4: Disassembling of terminal

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.

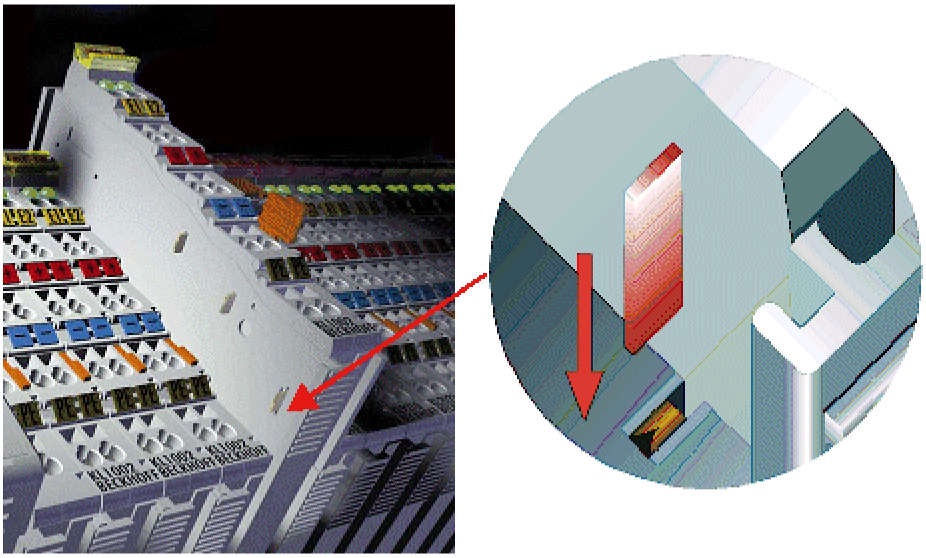


Fig. 5: *Power contact on left side*

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 Connection

3.2.1 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)

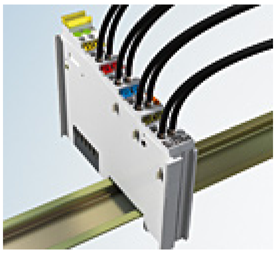


Fig. 6: Standard wiring

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)

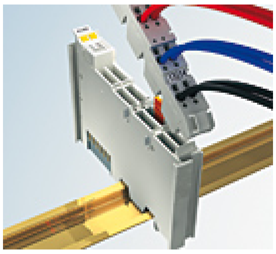


Fig. 7: Pluggable wiring

The terminals of ESxxxx and KSxxxx series feature a pluggable connection level.
The assembly and wiring procedure for the KS series is the same as for the ELxxxx and KLxxxx series.
The KS/ES series terminals enable 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)

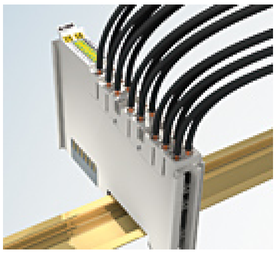


Fig. 8: *High Density Terminals*

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!

3.2.2 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

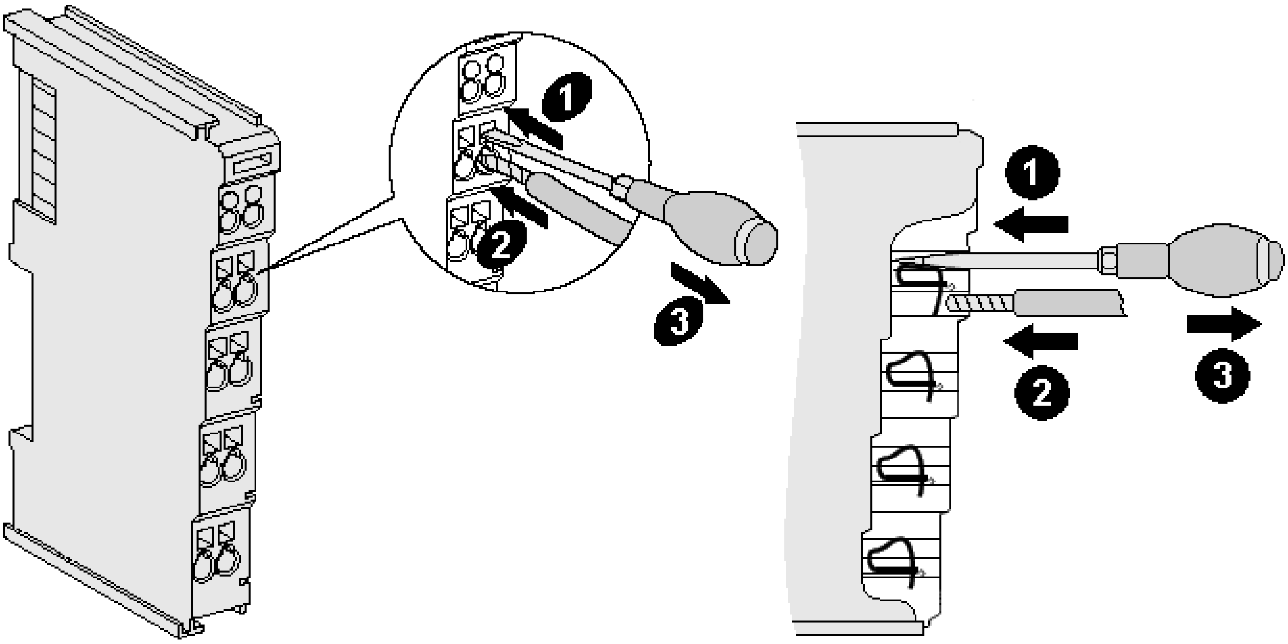


Fig. 9: Connecting a cable on a terminal point

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 [▸ 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 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

3.2.3 Shielding

Note

Shielding

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

3.3 KL3681 - Connection

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!

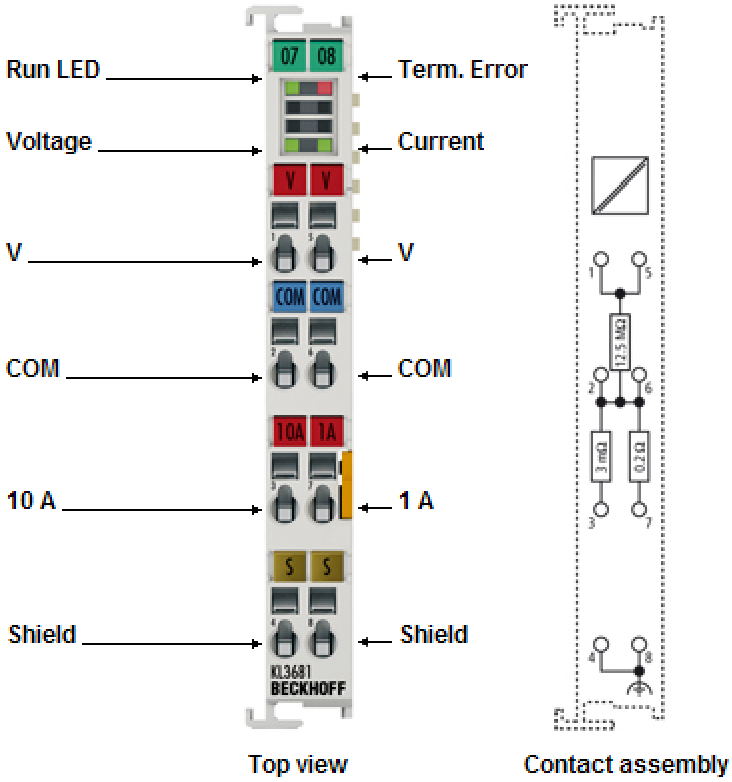


Fig. 10: Terminal points of KL3681

Terminal point	No.	Comment
V	1	Terminal point for voltage measurement (internally connected with terminal point 5)
COM	2	Ground (internally connected with terminal point 6)
10 A	3	Terminal point for current measurement, 10 A range
Shield	4	Shield (internally connected with terminal point 8)
V	5	Terminal point for voltage measurement (internally connected with terminal point 1)
COM	6	Ground (internally connected with terminal point 2)
1 A	7	Terminal point for current measurement, 1 A range
Shield	8	Shield (internally connected with terminal point 4)

WARNING

Danger for persons through electric shock!

For voltages greater than 25 V_{AC} (42 V peak) or 60 V_{DC} the fuse opening must be covered by an additional terminal or the EL9011 end terminal. Risk of electric shock!

Attention

10 A branch is not fuse-protected

The current branch for 10 A is not fuse-protected. The device may be damaged if the current in the 10 A branch exceeds 10 A.

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. 11: 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.

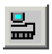
The KS2000 offers access to the process images of the bus couplers and Fieldbus Box modules.

- 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 KL3681: Multimeter Terminal
- a KL9010: Bus End Terminal

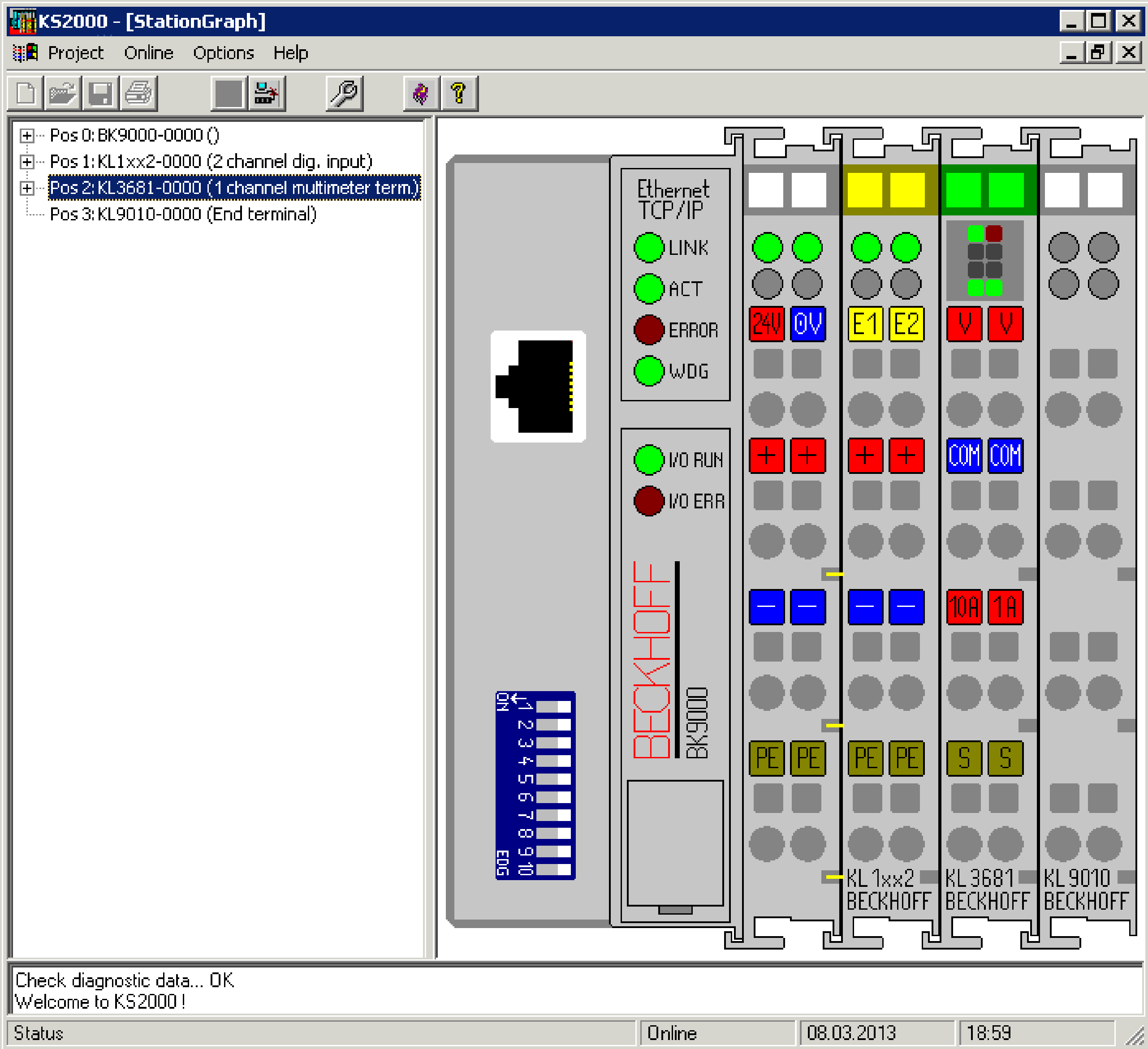


Fig. 12: View of fieldbus station within KS2000

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).

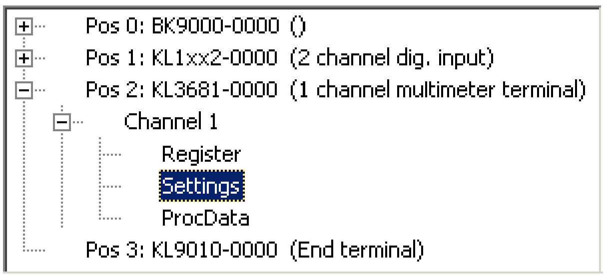


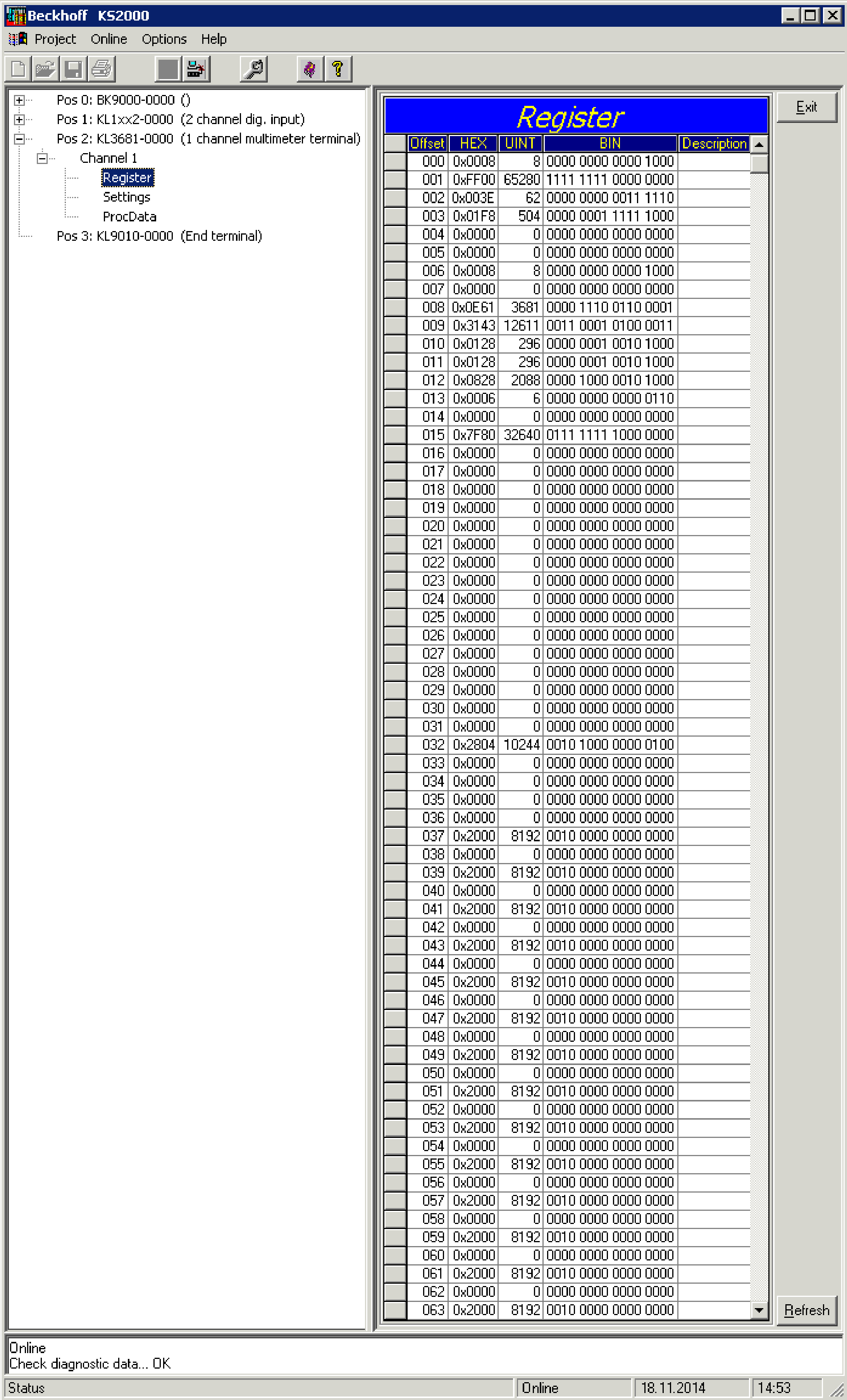
Fig. 13: KS2000 branch for channel 1 of KL3681

For the KL3404, the branches *Register*, *Settings* and *ProcData* are displayed:

- Register [▶ 25] enables direct access to the KL3681 registers.
- A dialog mask for the parameterization of the KL3681 can be found under Settings [▶ 27].
- ProcData displays the KL3681 process data.

4.3 Register

You can access the registers of the KL3681 directly under *Register*. The meaning of the register is explained in the register overview [▶ 32].



Offset	HEX	UINT	BIN	Description
000	0x0008	8	0000 0000 0000 1000	
001	0xFF00	65280	1111 1111 0000 0000	
002	0x003E	62	0000 0000 0011 1110	
003	0x01F8	504	0000 0001 1111 1000	
004	0x0000	0	0000 0000 0000 0000	
005	0x0000	0	0000 0000 0000 0000	
006	0x0008	8	0000 0000 0000 1000	
007	0x0000	0	0000 0000 0000 0000	
008	0x0E61	3681	0000 1110 0110 0001	
009	0x3143	12611	0011 0001 0100 0011	
010	0x0128	296	0000 0001 0010 1000	
011	0x0128	296	0000 0001 0010 1000	
012	0x0828	2088	0000 1000 0010 1000	
013	0x0006	6	0000 0000 0000 0110	
014	0x0000	0	0000 0000 0000 0000	
015	0x7F80	32640	0111 1111 1000 0000	
016	0x0000	0	0000 0000 0000 0000	
017	0x0000	0	0000 0000 0000 0000	
018	0x0000	0	0000 0000 0000 0000	
019	0x0000	0	0000 0000 0000 0000	
020	0x0000	0	0000 0000 0000 0000	
021	0x0000	0	0000 0000 0000 0000	
022	0x0000	0	0000 0000 0000 0000	
023	0x0000	0	0000 0000 0000 0000	
024	0x0000	0	0000 0000 0000 0000	
025	0x0000	0	0000 0000 0000 0000	
026	0x0000	0	0000 0000 0000 0000	
027	0x0000	0	0000 0000 0000 0000	
028	0x0000	0	0000 0000 0000 0000	
029	0x0000	0	0000 0000 0000 0000	
030	0x0000	0	0000 0000 0000 0000	
031	0x0000	0	0000 0000 0000 0000	
032	0x2804	10244	0010 1000 0000 0100	
033	0x0000	0	0000 0000 0000 0000	
034	0x0000	0	0000 0000 0000 0000	
035	0x0000	0	0000 0000 0000 0000	
036	0x0000	0	0000 0000 0000 0000	
037	0x2000	8192	0010 0000 0000 0000	
038	0x0000	0	0000 0000 0000 0000	
039	0x2000	8192	0010 0000 0000 0000	
040	0x0000	0	0000 0000 0000 0000	
041	0x2000	8192	0010 0000 0000 0000	
042	0x0000	0	0000 0000 0000 0000	
043	0x2000	8192	0010 0000 0000 0000	
044	0x0000	0	0000 0000 0000 0000	
045	0x2000	8192	0010 0000 0000 0000	
046	0x0000	0	0000 0000 0000 0000	
047	0x2000	8192	0010 0000 0000 0000	
048	0x0000	0	0000 0000 0000 0000	
049	0x2000	8192	0010 0000 0000 0000	
050	0x0000	0	0000 0000 0000 0000	
051	0x2000	8192	0010 0000 0000 0000	
052	0x0000	0	0000 0000 0000 0000	
053	0x2000	8192	0010 0000 0000 0000	
054	0x0000	0	0000 0000 0000 0000	
055	0x2000	8192	0010 0000 0000 0000	
056	0x0000	0	0000 0000 0000 0000	
057	0x2000	8192	0010 0000 0000 0000	
058	0x0000	0	0000 0000 0000 0000	
059	0x2000	8192	0010 0000 0000 0000	
060	0x0000	0	0000 0000 0000 0000	
061	0x2000	8192	0010 0000 0000 0000	
062	0x0000	0	0000 0000 0000 0000	
063	0x2000	8192	0010 0000 0000 0000	

Fig. 14: Register view within KS2000

4.4 Settings

The dialog mask for the parameterization of the KL3681 can be found under *Settings*.

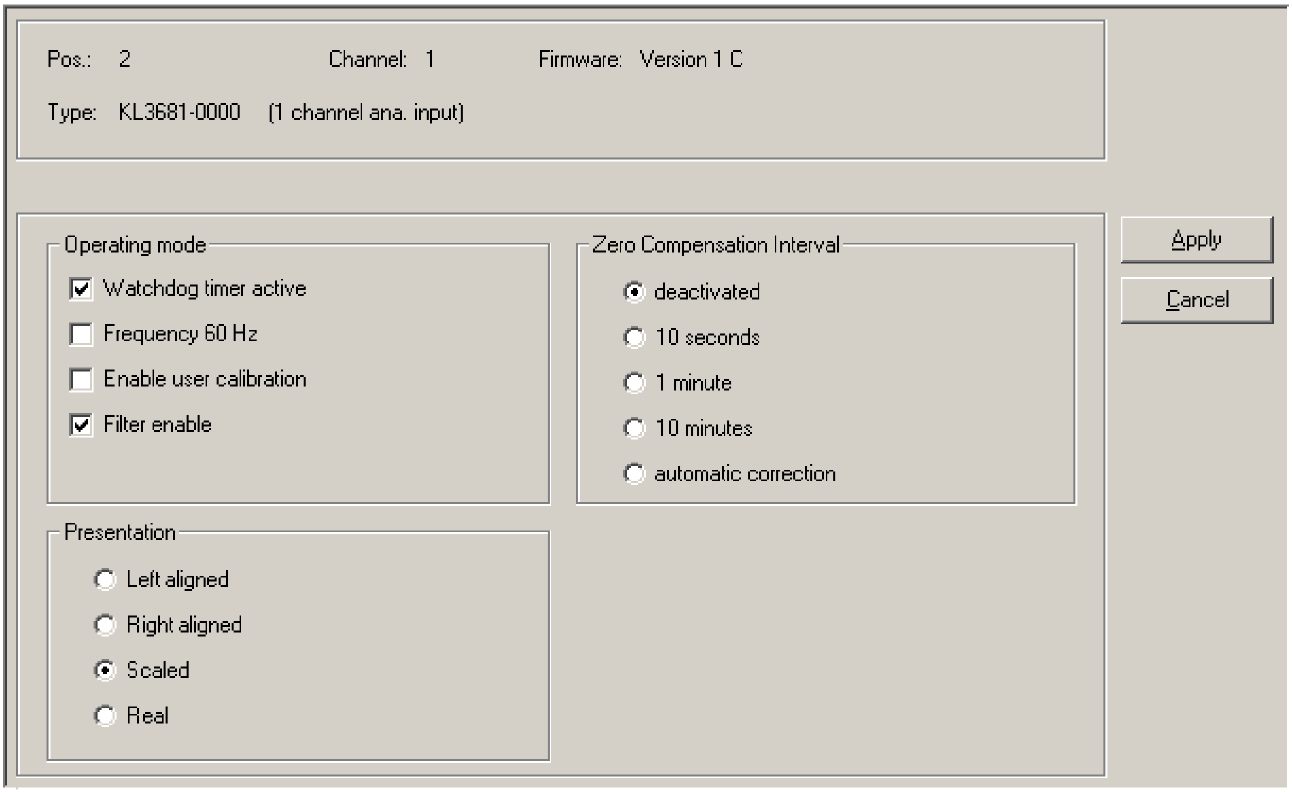


Fig. 15: Settings via KS2000

Operating mode

Watchdog timer active (register page 0, register R32.2 [▶ 36])

Here you can deactivate the watchdog timer (default: active).

Frequency 60 Hz (register page 0, register R32.7 [▶ 36])

Here you can switch the terminal to a mains frequency of 60 Hz (default: 50 Hz).

User calibration active (register page 0, register R32.8 [▶ 36])

Here you can activate user calibration (default: inactive)

Filter enable (register page 0, register R32.11 [▶ 36])

Here you can disable the watchdog (default: enable).

Presentation

Here you can select the presentation format for the process data (default: scaled).

Options (register page 0, registers R32.15 to R32.12 [▶ 36])

- Left aligned*
- Right aligned
- Scaled
- Real

*) In left aligned presentation the extended measuring range is not available.

Zero Compensation Interval

Here you can specify the interval for zero compensation (default: deactivated).

Options (register page 0, register R33 [▸ 36])

- deactivated
- 10 seconds
- 1 minute
- 10 minutes
- automatic correction

5 Access from the user programm

5.1 Process image

Complex mapping

The following 9 bytes are transferred bi-directionally between KL3681 and control:

Byte offset (without word alignment*)	Byte offset (with word alignment*)	Format	Input data	Output data
0	0	Byte	Status byte (SB [▶ 30])	Control byte (CB [▶ 29])
1	2	Word	DataIN0	DataOUT0
3	4	Word	DataIN1	DataOUT1
5	6	Word	DataIN2	DataOUT2
7	8	Word	DataIN3	DataOUT3

*) Word alignment: The Bus Coupler places values on even byte addresses

Compact mapping (from firmware version 1C)

The following 8 bytes are transferred bi-directionally between KL3681 and control:

Byte offset (with and without word alignment*)	Format	Input data	Output data
0	Word	DataIN0	DataOUT0
2	Word	DataIN1	DataOUT1
4	Word	DataIN2	DataOUT2
6	Word	DataIN3	DataOUT3

*) word alignment has no effect with compact mapping

5.2 Control and status byte

Process data mode

Control byte (in process data mode)

The control byte (CB) is located in the output image [▶ 29] and is transmitted from the controller to the terminal.

Bit	CB.7	CB.6	CB.5	CB.4	CB.3	CB.2	CB.1	CB.0
Name	RegAccess	StartCalibration	StartCalibration	disAutorange	Voltage/Current	DC/AC	Range	

Bit	Name	Description	
CB.7	RegAccess	0_{bin}	Register communication off (process data mode)
CB.6	R/W	0_{bin}	Read access
		1_{bin}	Write access
CB.5	StartCalibration	1_{bin}	initiates an automatic correction of the internal measuring range (only if register R33 = 4)
CB.4	disAutorange	0_{bin}	auto range enabled
		1_{bin}	auto range disabled
CB.3	Voltage/Current	0_{bin}	Voltage
		1_{bin}	Current
CB.2	DC/AC	0_{bin}	DC
		1_{bin}	AC
CB.1, CB.0	Range	Measuring range (see also CB.2)	
		00_{bin}	3 V or 1 A
		01_{bin}	30 V or 10 A
		10_{bin}	300 V
		11_{bin}	300 mV or 100 mA

Status byte (in process data mode)

The status byte (SB) is located in the input image [▸ 29] and is transmitted from terminal to the controller.

Bit	SB.7	SB.6	SB.5	SB.4	SB.3	SB.2	SB.1	SB.0
Name	RegAccess	Error	-	noAutorange	data Invalid	extended range	overrange	underrange

Bit	Name	Description	
SB.7	RegAccess	0_{bin}	Acknowledge for process data mode
SB.6	Error	1_{bin}	measuring range exceeded, over or under range, the error LED shines or converting error or invalid measuring range
SB.5	reserved	0_{bin}	reserved
SB.4	-	0_{bin}	auto range is enabled
		1_{bin}	auto range is disabled
SB.3	data invalid	1_{bin}	invalidprocess data, e.g. invalid value, e.g. filter latency, start up
SB.2	extended range*	1_{bin}	The extended measuring range (~10% of upper range value) is used (hysteresis area of auto range functionality).
SB.1	overrange	1_{bin}	Exceeding of the electrical measuring range
SB.0	underrange	1_{bin}	Undershooting of the electrical measuring range at DC mode (not displayed in AC mode

*) The extended range is only available for the measuring ranges 300 mV, 3 V, 30 V and 100 mA.

Register communication

Control byte (at register communication)

The control byte (CB) is located in the output image [▸ 29] and is transmitted from the controller to the terminal.

Bit	CB.7	CB.6	CB.5	CB.4	CB.3	CB.2	CB.1	CB.0
Name	RegAccess	R/W	Register no.					

Bit	Name	Description	
CB.7	RegAccess	1_{bin}	Register communication switched on
CB.6	R/W	0_{bin}	Read access
		1_{bin}	Write access
CB.5 to CB.0	Register no.	Register number: Enter here the number of the register [▸ 32] that you wish - to read with input data word DataIN [▸ 29], or - to write with output data word DataOUT [▸ 29].	

Status byte (at register communication)

The status byte (SB) is located in the input image [▸ 29] and is transmitted from terminal to the controller.

Bit	SB.7	SB.6	SB.5	SB.4	SB.3	SB.2	SB.1	SB.0
Name	RegAccess	R/W	Register no.					

Bit	Name	Description	
SB.7	RegAccess	1_{bin}	Acknowledge for register access
SB.6	R	0_{bin}	Read access
SB.5 to SB.0	Register no.	Number of the register that was read or written.	

5.3 Register overview

All registers can be read or written via register communication [▸ 38].

Registers R0 to R31 (direct access)

These registers are used to parameterize the terminal KL3681.

Register no.	Comment	Default value		R/W	Memory
R0 [▸ 34]	Raw value of the A/D converter	0x0000	0_{dec}	R	RAM
R1 [▸ 34]	Current measuring range / mode	0x0000	0_{dec}	R	RAM
R2 [▸ 34]	Internal calibration value	0x0000	0_{dec}	R	RAM
R3 [▸ 34]	Sampling duration in milliseconds	0x0000	0_{dec}	R	RAM
R4 [▸ 34]	Register page selection register	0x0000	0_{dec}	R/W	RAM
R5 [▸ 37]	reserved	-	-	-	-
R6 [▸ 34]	Diagnostic register	0x0000	0_{dec}	R	RAM
R7 [▸ 34]	Command register	0x0000	0_{dec}	R/W	RAM
R8 [▸ 34]	Terminal type	0x0E61	3681_{dec}	R	ROM
R9 [▸ 35]	Firmware version	e.g.	e.g. $1A_{ASCI}$	R	ROM
R10	Multiplex shift register, data length	0x0130	304_{dec}	R	ROM
R11	Signal channels			R	ROM
R12	Minimum data length			R	ROM
R13	Data structure			R	ROM
R14	reserved	-	-	-	-
R15	Alignment register	typically	typically	R/W	RAM
R16 [▸ 35]	Hardware version number			R/W	SEEPROM
R17	reserved	-	-	-	-
...	reserved	-	-	-	-
R28	reserved	-	-	-	-
R29	Terminal type, version	0x0000	0_{dec}	R	ROM
R30	reserved	-	-	-	-
R31 [▸ 35]	Code word register	0x0000	0_{dec}	R/W	RAM

Register page 0

These registers are also used for parameterization of the KL3681 (access selectable via register R4 [▸ 34]).

Register no.	Comment	Default value		R/W	Memory
R32 [▶ 36]	Feature register	0x2804	10244_{dec}	R/W	SEEPROM
R33 [▶ 36]	Zero Comp Interval	0x0000	0_{dec}	R/W	SEEPROM
R34	reserved	-	-	-	-
R35	reserved	-	-	-	-
R36 [▶ 36]	User scaling, measuring range 300 mV_{DC}, offset	0x0000	0_{dec}	R/W	SEEPROM
R37 [▶ 37]	User scaling, measuring range 300 mV_{DC}, gain	0x2000	8192_{dec}	R/W	SEEPROM
R38 [▶ 37]	User scaling, measuring range 3 V_{DC}, offset	0x0000	0_{dec}	R/W	SEEPROM
R39 [▶ 37]	User scaling, measuring range 3 V_{DC}, gain	0x2000	8192_{dec}	R/W	SEEPROM
R40 [▶ 37]	User scaling, measuring range 30 V_{DC}, offset	0x0000	0_{dec}	R/W	SEEPROM
R41 [▶ 37]	User scaling, measuring range 30 V_{DC}, gain	0x2000	8192_{dec}	R/W	SEEPROM
R42 [▶ 37]	User scaling, measuring range 300 V_{DC}, offset	0x0000	0_{dec}	R/W	SEEPROM
R43 [▶ 37]	User scaling, measuring range 300 V_{DC}, gain	0x2000	8192_{dec}	R/W	SEEPROM
R44 [▶ 37]	User scaling, measuring range 300 mV_{AC}, offset	0x0000	0_{dec}	R/W	SEEPROM
R45 [▶ 37]	User scaling, measuring range 300 mV_{AC}, gain	0x2000	8192_{dec}	R/W	SEEPROM
R46 [▶ 37]	User scaling, measuring range 3 V_{AC}, offset	0x0000	0_{dec}	R/W	SEEPROM
R47 [▶ 37]	User scaling, measuring range 3 V_{AC}, gain	0x2000	8192_{dec}	R/W	SEEPROM
R48 [▶ 37]	User scaling, measuring range 30 V_{AC}, offset	0x0000	0_{dec}	R/W	SEEPROM
R49 [▶ 37]	User scaling, measuring range 30 V_{AC}, gain	0x2000	8192_{dec}	R/W	SEEPROM
R50 [▶ 37]	User scaling, measuring range 300 V_{AC}, offset	0x0000	0_{dec}	R/W	SEEPROM
R51 [▶ 37]	User scaling, measuring range 300 V_{AC}, gain	0x2000	8192_{dec}	R/W	SEEPROM
R52 [▶ 37]	User scaling, measuring range 100 mA_{DC}, offset	0x0000	0_{dec}	R/W	SEEPROM
R53 [▶ 38]	User scaling, measuring range 100 mA_{DC}, gain	0x2000	8192_{dec}	R/W	SEEPROM
R54 [▶ 38]	User scaling, measuring range 1 A_{DC}, offset	0x0000	0_{dec}	R/W	SEEPROM
R55 [▶ 38]	User scaling, measuring range 1 A_{DC}, gain	0x2000	8192_{dec}	R/W	SEEPROM
R56 [▶ 38]	User scaling, measuring range 10 A_{DC}, offset	0x0000	0_{dec}	R/W	SEEPROM
R57 [▶ 38]	User scaling, measuring range 10 A_{DC}, gain	0x2000	8192_{dec}	R/W	SEEPROM
R58 [▶ 38]	User scaling, measuring range 100 mA_{AC}, offset	0x0000	0_{dec}	R/W	SEEPROM
R59 [▶ 38]	User scaling, measuring range 100 mA_{AC}, gain	0x2000	8192_{dec}	R/W	SEEPROM
R60 [▶ 38]	User scaling, measuring range 1 A_{AC}, offset	0x0000	0_{dec}	R/W	SEEPROM
R61 [▶ 38]	User scaling, measuring range 1 A_{AC}, gain	0x2000	8192_{dec}	R/W	SEEPROM
R62 [▶ 38]	User scaling, measuring range 10 A_{AC}, offset	0x0000	0_{dec}	R/W	SEEPROM
R63 [▶ 37]	User scaling, measuring range 10 A_{AC}, gain	0x2000	8192_{dec}	R/W	SEEPROM

Register page 1

These registers are used for calibration of the KL3681 (access selectable via register R4 [▶ 34]).

Register no.	Comment	Default value		R/W	Memory
R32 [▶ 38]	Internal calibration data			R	SEEPROM
...	...			...	...
R35 [▶ 38]	Internal calibration data			R	SEEPROM
R36 [▶ 38]	Manufacturer calibration			R	SEEPROM
...	...			...	...
R63 [▶ 38]	Manufacturer calibration			R	SEEPROM

5.4 Register description

The following registers are used for parameterization of the KL3681. They can be read or written via the register communication [▶ 30] with the aid of control [▶ 30], status [▶ 30] and data bytes [▶ 29].

R0: Raw value A/D-C

Raw value of the A/D converter (X_R)

R1: Current measuring range / mode

R2: Internal calibration value

R3: Sampling duration

In milliseconds

R4: Register page selection register

This register defines which register page is displayed in registers R32 to R63 [▶ 36] (default: 0x0000).

The terminal supports two register pages.

- Register page 0 is used to save the configuration data (see from register RP0.R32 [▶ 36])
- Register page 1 is used for internal calibration data and manufacturer calibration and must not be changed by the user!

R6: Diagnostic register

The status byte [▶ 29] is mapped to the low-order byte (bit 7 to bit 0) of register R6.
The high-order byte (bit 15 to bit 8) of register R6 is reserved.

R7: Command register

Note	**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 [▶ 35].

Command 0x7000: Restore Factory Settings

An entry of 0X7000 in register R7 sets the following registers for the two channels to the following default values:

RP0.R32 [▶ 36]: 0x2804 (10244_{dec})

RP0.R33 [▶ 36]: 0x0000 (0_{dec})

RP0.R34: 0x0000 (0_{dec})

RP0.R35: 0x0000 (0_{dec})

RP0.R36 [▶ 36], RP0.R38 ... RP0.R62: 0x0000 (0_{dec})

RP0.R37 [▶ 37], RP0.R39 ... RP0.R63: 0x2000 (8192_{dec})

R8: Terminal description

The terminal identifier is contained in register R8: KL3681: 0x0E61 (3681_{dec}).

R9: Firmware version

Register R9 contains the ASCII coding of the terminal's firmware revision level, e.g. **0x3141 (1A)**$_{ASCII}$. **'0x31'** corresponds to the ASCII character **'1'** and **'0x41'** to the ASCII character **'A'**. This value can not be changed.

R10: Data length (multiplex shift register)

R10 contains the number of multiplexed shift registers and their length in bits.

R11: Signal channels

Unlike R10, this contains the number of channels that are logically present. Thus for example a shift register that is physically present can perfectly well consist of several signal channels.

R12: Minimum data length

The particular byte contains the minimum data length for a channel that is to be transferred. If the MSB is set, the control and status byte is not necessarily required for the terminal function and is not transferred to the control, if the Bus Coupler is configured accordingly.

R13: Data structure (data type register)

Data type register	Meaning
0x00	Terminal with no valid data type
0x01	Byte array
0x02	Structure: 1 byte, n bytes
0x03	Word array
0x04	Structure: 1 byte, n words
0x05	Double word array
0x06	Structure: 1 byte, n double words
0x07	Structure: 1 byte, 1 double word
0x08	Structure: 1 byte, 1 double word
0x11	Byte array with variable logical channel length
0x12	Structure: 1 byte, n bytes with variable logical channel length (e.g. 60xx)
0x13	Word array with variable logical channel length
0x14	Structure: 1 byte, n words with variable logical channel length
0x15	Double word array with variable logical channel length
0x16	Structure: 1 byte, n double words with variable logical channel length

R15: Alignment register

Via the alignment register bits, the Bus Coupler arranges the address range of an analog terminal such that it starts at a byte boundary.

R16: Hardware version number

Register R16 contains the hardware revision level of the terminal; this value can not be changed.

R29: Terminal type, special version

The special terminal identifier is contained in register R8: KL3681-0000: 0x0000 (0)$_{dec)}$.

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 if the terminal is restarted.

The code word is reset with each restart of the terminal.

Register page 0

If register page 0 was selected with register R4 [▶ 34], registers R32 to R63 have the following meaning.

R32: Feature register

The feature register specifies the terminal's configuration. Default: 0x2804 (10244_{dec})

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

Bit	R32.7	R32.6	R32.5	R32.4	R32.3	R32.2	R32.1	R32.0
Name	frequency	-	-	-	-	enWdTimer	-	-

Bit	Name	Description		Default
R32.15 to R32.12	presentation	0_{dec}	Left aligned (In left aligned presentation the extended measuring range is not available!)	2_{dec}
		1_{dec}	right aligned	
		2_{dec}	scaled: 1 bit per µV/µA	
		3_{dec}	reserved	
		4_{dec}	reserved	
		5_{dec}	float: Scaled presentation in floating-point format	
		6_{dec}	reserved	
		7_{dec}	reserved	
R32.12	-	reserved		0_{bin}
R32.11	enFilter	0_{bin}	Filter not active	1_{bin}
		1_{bin}	filter active	
R32.10	enLimit2	0_{bin}	Threshold 2 is not active	0_{bin}
		1_{bin}	Threshold 2 is active	
R32.9	enLimit1	0_{bin}	Threshold 1 is not active	0_{bin}
		1_{bin}	Threshold 1 is active	
R32.8	enUserCalli	0_{bin}	User calibration not active	0_{bin}
		1_{bin}	User calibration active	
R32.7	frequency	0_{bin}	50 Hz mains frequency	0_{bin}
		1_{bin}	60 Hz mains frequency	
R32.6	-	reserved		0_{bin}
...	...	...		...
R32.3	-	reserved		0_{bin}
R32.2	enWdTimer	0_{bin}	Watchdog timer is not active	1_{bin}
		1_{bin}	Watchdog timer is active (the watchdog is triggered if no process data are received for 100 ms)	
R32.1	-	reserved		0_{bin}
R32.0	-	reserved		0_{bin}

R33: Zero Comp Interval

R36: User scaling, measuring range 300 mV_{DC}, offset

(Default: 0x0000)

R37: User scaling, measuring range 300 mV$_{DC}$, gain

(Default: 0x2000)

R38: User scaling, measuring range 3 V$_{DC}$, offset

(Default: 0x0000)

R39: User scaling, measuring range 3 V$_{DC}$, gain

(Default: 0x2000)

R40: User scaling, measuring range 30 V$_{DC}$, offset

(Default: 0x0000)

R41: User scaling, measuring range 30 V$_{DC}$, gain

(Default: 0x2000)

R42: User scaling, measuring range 300 V$_{DC}$, offset

(Default: 0x0000)

R43: User scaling, measuring range 300 V$_{DC}$, gain

(Default: 0x2000)

R44: User scaling, measuring range 300 mV$_{AC}$, offset

(Default: 0x0000)

R45: User scaling, measuring range 300 mV$_{AC}$, gain

(Default: 0x2000)

R46: User scaling, measuring range 3 V$_{AC}$, offset

(Default: 0x0000)

R47: User scaling, measuring range 3 V$_{AC}$, gain

(Default: 0x2000)

R48: User scaling, measuring range 30 V$_{AC}$, offset

(Default: 0x0000)

R49: User scaling, measuring range 30 V$_{AC}$, gain

(Default: 0x2000)

R50: User scaling, measuring range 300 V$_{AC}$, offset

(Default: 0x0000)

R51: User scaling, measuring range 300 V$_{AC}$, gain

(Default: 0x2000)

R52: User scaling, measuring range 100 mA$_{DC}$, offset

(Default: 0x0000)

R53: User scaling, measuring range 100 mA$_{DC}$, gain

(Default: 0x2000)

R54: User scaling, measuring range 1 A$_{DC}$, offset

(Default: 0x0000)

R55: User scaling, measuring range 1 A$_{DC}$, gain

(Default: 0x2000)

R56: User scaling, measuring range 10 A$_{DC}$, offset

(Default: 0x0000)

R57: User scaling, measuring range 10 A$_{DC}$, gain

(Default: 0x2000)

R58: User scaling, measuring range 100 mA$_{AC}$, offset

(Default: 0x0000)

R59: User scaling, measuring range 100 mA$_{AC}$, gain

(Default: 0x2000)

R60: User scaling, measuring range 1 A$_{AC}$, offset

(Default: 0x0000)

R61: User scaling, measuring range 1 A$_{AC}$, gain

(Default: 0x2000)

R62: User scaling, measuring range 10 A$_{AC}$, offset

(Default: 0x0000)

R63: User scaling, measuring range 10 A$_{AC}$, gain

(Default: 0x2000)

Register page 1

If register page 1 was selected with register R4 [▸ 34], registers R32 to R63 have the following meaning.

R32 to R35: Internal calibration data

These registers contain internal calibration data and must not be changed by the user!

R36 to R63: Manufacturer calibration

These registers are used for manufacturer calibration and must not be changed by the user!

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

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!

6 Appendix

6.1 Accessories

Fuse

Spare fuses are available as accessories. The *upper* of the two built-in fuses in the EL3681 is designated as a spare fuse.

WARNING	**Danger for persons through electric shock!** The fuse may only be changed if the Bus Terminal is in a safe, de-energized state.

The fuse can be removed with pliers by pulling it upwards from its sockets (see Figure).

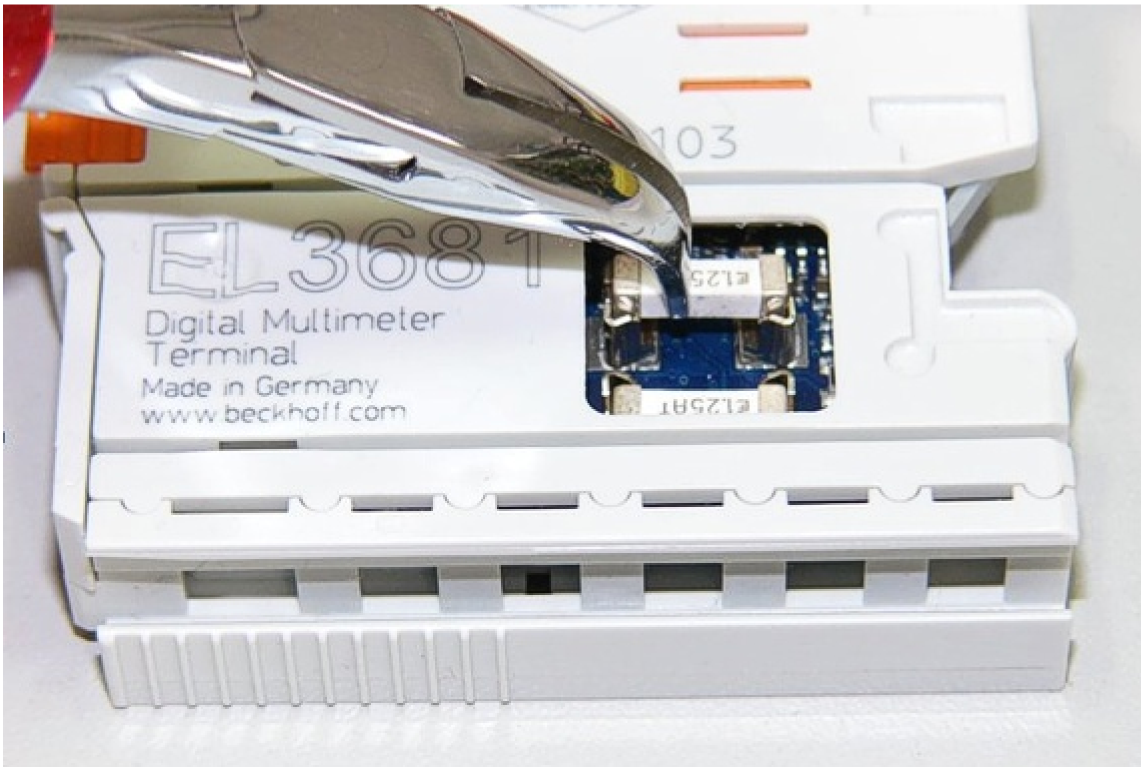


Fig. 16: Replacing the fuse

Attention	**Pull the fuse evenly to avoid damaging the sockets!** An improper taking out of the fuses can result in damage to the sockets!

Order number for the fuse

ZB8000-0001, pack of 10 fuses, 1.25 A

6.2 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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