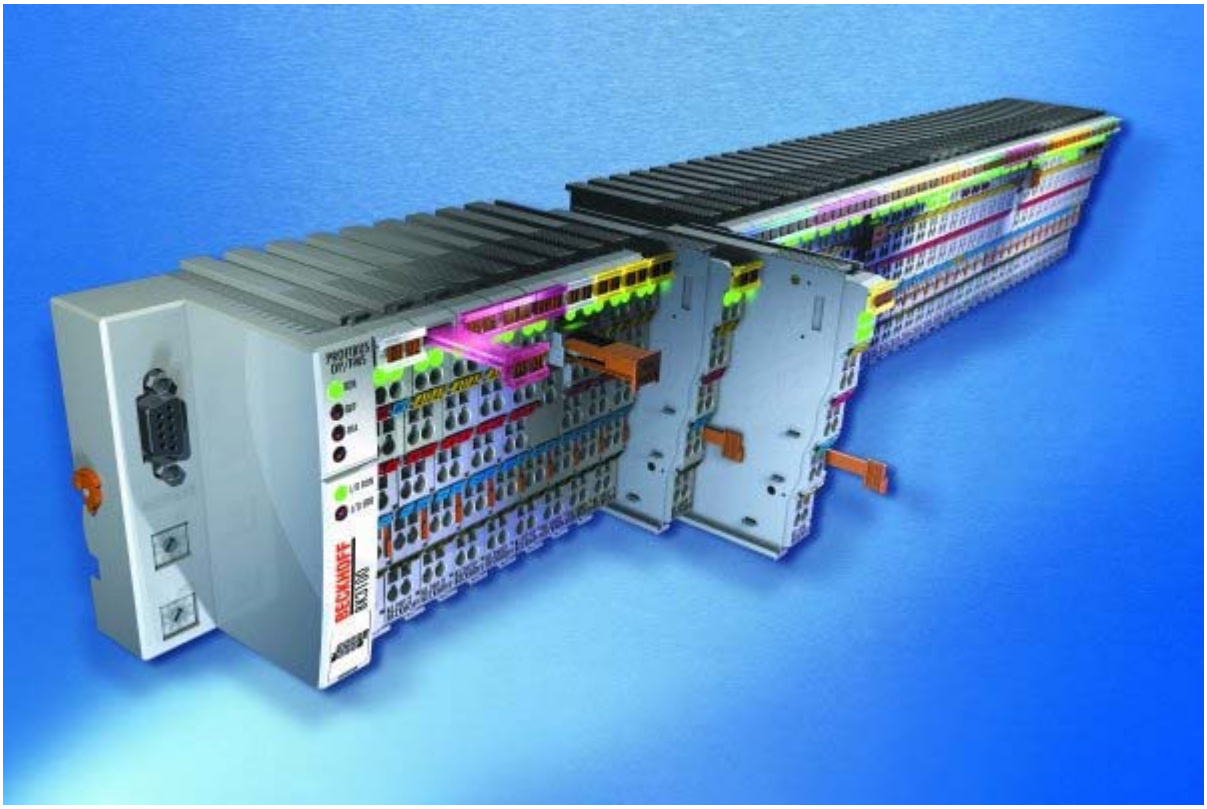
BECKHOFF Fieldbus Components



Documentation for

four and eight channel analog output terminals

KL4404, KL4408 (0 V to +10 V)

KL4434, KL4438 (-10 V to +10 V)

Version: 2.0.0
Date: 03/14/05

BECKHOFF Fieldbus Components: Foreword

Notes on the Documentation

This description is only intended for the use of trained specialists in control and automation

engineering who are familiar with the applicable national standards. It is essential that the following notes and explanations are followed when installing and commissioning these components.

Liability Conditions

The responsible staff must ensure that the application or use of the products described satisfy all the requirements for safety, including all the relevant laws, regulations, guidelines and standards.

The documentation has been prepared with care. The products described are, however, constantly under development. For that reason the documentation is not in every case checked for consistency with performance data, standards or other characteristics. None of the statements of this manual represents a guarantee (Garantie) in the meaning of § 443 BGB of the German Civil Code or a statement about the contractually expected fitness for a particular purpose in the meaning of § 434 par. 1 sentence 1 BGB. In the event that it contains technical or editorial errors, we retain the right to make alterations at any time and without warning. No claims for the modification of products that have already been supplied may be made on the basis of the data, diagrams and descriptions in this documentation.

BECKHOFF Fieldbus Components: Foreword

Safety Instructions

Safety Rules

The responsible staff must ensure that the application or use of the products described satisfy all the requirements for safety, including all the relevant laws, regulations, guidelines and standards.

State at Delivery

All the components are supplied in particular hardware and software configurations appropriate for the application. Modifications to hardware or software configurations other than those described in the documentation are not permitted, and nullify the liability of Elektro BECKHOFF GmbH.

Personnel Qualification

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

Description of safety symbols

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


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

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

Note This symbol indicates information that contributes to better understanding.

BECKHOFF KL4404, KL4408, KL4434 and KL4438: Foreword

Documentation Issue Status

Version	Comment
2.0.0	Eight channel bus terminals added: KL4408 and KL4438
1.0.1	Format of the output values corrected on the pages called *Basic Function Principles*.
1.0	first release
0.1	internal version

Hard and Firmware Version

Documentation Version	KL4404		KL4408		KL4434		KL4438	
	Firmware	Hardware	Firmware	Hardware	Firmware	Hardware	Firmware	Hardv
2.0.0	1C	00	1C	00	1C	00	1C	00
1.0.1	1A	00	-	-	1A	00	-	-
1.0	1A	00	-	-	1A	00	-	-

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

Syntax of the serial number

Structure of the serial number: KK YY FF HH

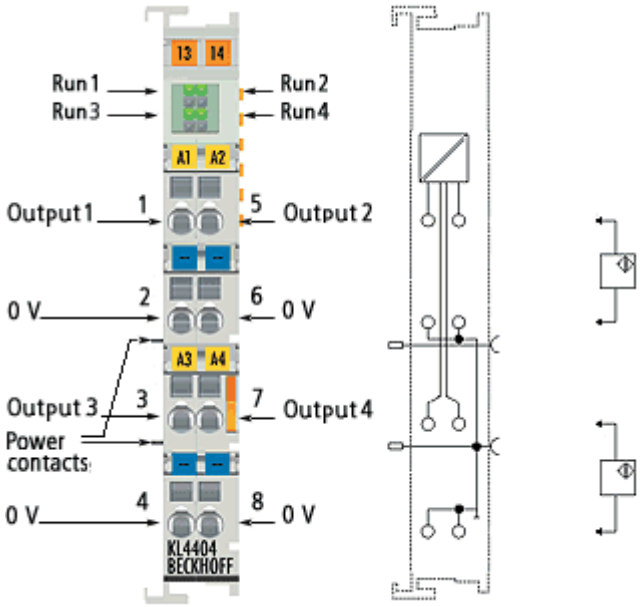
KK - week of production (CW, calendar week)
YY - year of production
FF - firmware version
HH - hardware version

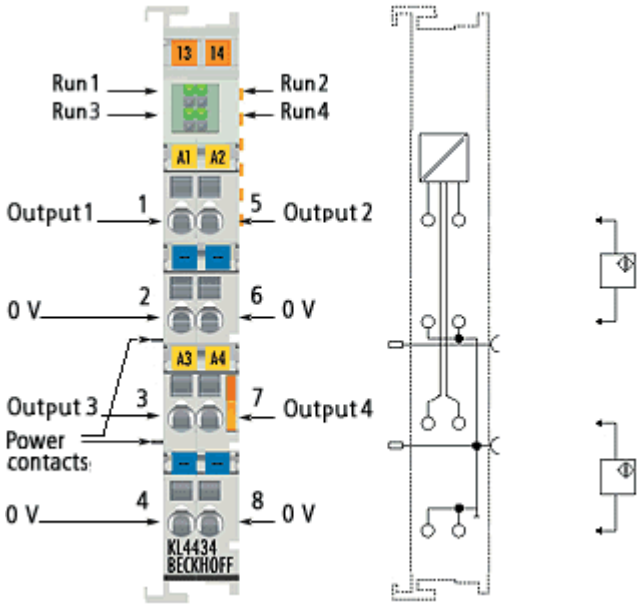
Example with ser. no.: 35 04 1B 01:

35 - week of production 35
04 - year of production 2004
1B - firmware version 1B
01 - hardware version 01

BECKHOFF KL4404 and KL4434: Product Overview

Introduction





The KL4404 analog output terminal generates signals in the range between 0 V to 10 V.
The KL4434 analog output terminal generates signals in the range between -10 V to +10 V.
The voltage is supplied to the process level with a resolution of 12 bits, and is electrically isolated.
The terminals four outputs are 2-wire versions and have a common ground potential. The power contacts are connected through. The reference ground of the outputs is the 0 V power contact. The LEDs indicate the data exchange with the Bus Coupler

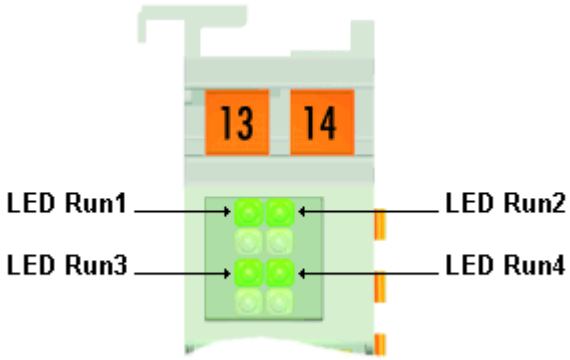
Technical Data

Technical Data	KL4404	KL4434
Number of outputs	4	
Signal voltage	0 ...+10 V	-10 V...+10 V
Load	> 5 kΩ (short-circuit-proof)	
Resolution	12 Bit	
Accuracy	0,1%	
Conversion time	ca. 4 ms	
Electrical isolation	500 V_{rms} (K-Bus/signal voltage)	
Power supply for the electronics	via the K-Bus and via the power contacts	
Current consumption from the K-Bus	typically 20 mA (5 V)	
Current consumption from the power contacts	typically 15 mA (24 V)	
Bit width in the process image	Output: 4 x 16 Bit data, 4 x 8 Bit Control/Status (optional)	
Weight	ca. 85 g	
Dimensions (w x h x d)	ca. 15mm x 100mm x 70mm	
Mounting	on 35 mm C mounting rail according to EN 50022	
Permissible ambient temperature range during operation	0°C ... + 55°C	
Permissible ambient temperature range during storage	-25°C ... + 85°C	
Permissible relative humidity	95%, no condensation	
Vibration / shock resistance	conforms to EN 60068-2-6 / EN 60068-2-27, EN 60068-2-29	
EMC resistance burst / ESD	conforms to EN 61000-6-2 / EN 61000-6-4	
Protection class	IP 20	
Installation position	variable	
Approval	CE	

BECKHOFF Fieldbus Components: Product Overview

Diagnostic LEDs

Operation status of the channels is shown by four green Run LEDs.

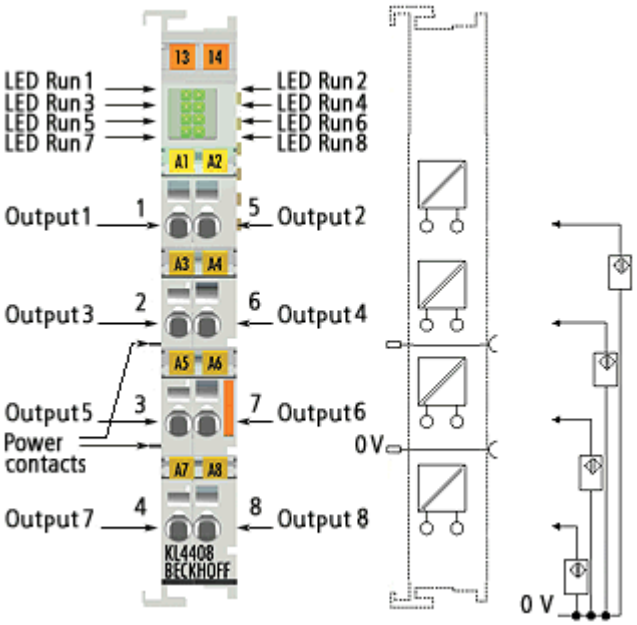


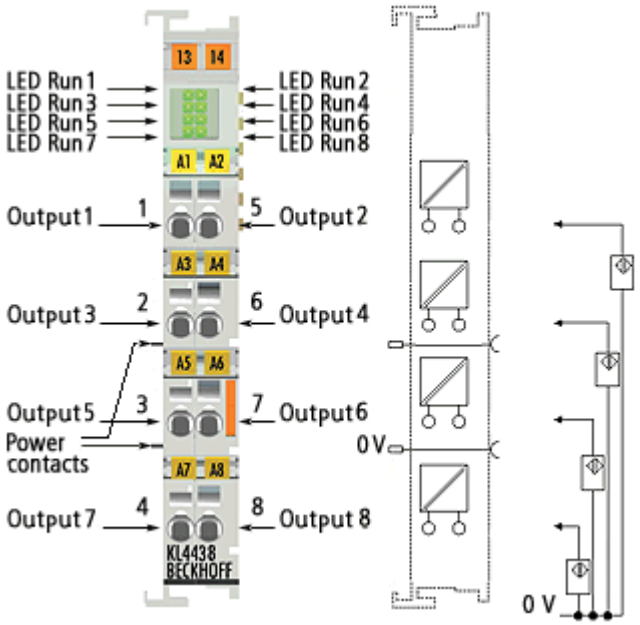
Meaning of LED displays

LED	Color	Channel	Status	
			on	off
Run1	green	1	regular operation	A Watchdog-Timer overflow has occurred. If no process data is transmitted between control system and Bus Coupler for 100 ms, the green LEDs die green LEDs extinguish.
Run2		2		
Run3		3		
Run4		4		

BECKHOFF KL4408 and KL4438: Product Overview

Introduction





The KL4408 analog output terminal generates signals in the range between 0 V to 10 V
The KL4438 analog output terminal generates signals in the range between -10 V to +10 V.
The voltage is supplied to the process level with a resolution of 12 bits, and is electrically isolated. The terminals combine 8 channels in one housing and are particularly suitable for space-saving installation in control cabinets. The use of single conductor connection technology enables the connection of multi-channel actuator technology with minimum space requirements. The Bus Terminals have a common ground potential. The power contacts are connected through. The reference ground of the outputs is the 0 V power contact. The LEDs indicate the data exchange with the Bus Coupler.

BECKHOFF KL4408 and KL4438: Product Overview

Technical Data

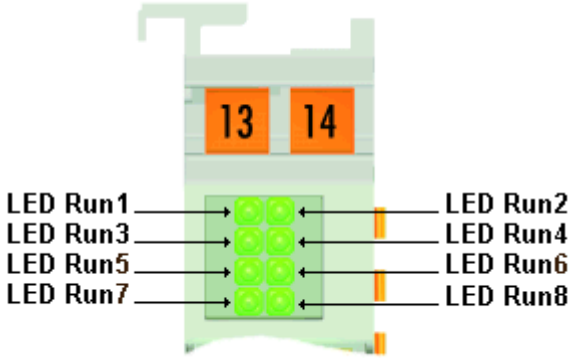
Technical Data	KL4408	KL4438
Number of outputs	8	
Signal voltage	0 ...+10 V	-10 V...+10 V
Load	> 5 kΩ (short-circuit-proof)	
Resolution	12 Bit	
Accuracy	0,3%	
Conversion time	ca. 8 ms	
Electrical isolation	500 V_{rms} (K-Bus/signal voltage)	
Power supply for the electronics	via the K-Bus and via the power contacts	
Current consumption from the K-Bus	typically 20 mA (5 V)	
Current consumption from the power contacts	typically 20 mA (24 V)	
Bit width in the process image	Output: 8 x 16 Bit data, 8 x 8 Bit Control/Status (optional)	
Weight	ca. 85 g	
Dimensions (w x h x d)	ca. 15mm x 100mm x 70mm	
Mounting	on 35 mm C mounting rail according to EN	

	50022
Permissible ambient temperature range during operation	0°C ... + 55°C
Permissible ambient temperature range during storage	-25°C ... + 85°C
Permissible relative humidity	95%, no condensation
Vibration / shock resistance	conforms to EN 60068-2-6 / EN 60068-2-27, EN 60068-2-29
EMC resistance burst / ESD	conforms to EN 61000-6-2 / EN 61000-6-4
Protection class	IP 20
Installation position	variable
Approval	CE

BECKHOFF Fieldbus Components: Product Overview

Diagnostic LEDs

Operation status of the channels is shown by eight green Run LEDs.



Meaning of LED displays

LED	Color	Channel	Status	
			on	off
Run 1	green	1	regular operation	A Watchdog-Timer overflow has occurred. If no process data is transmitted between control system and Bus Coupler for 100 ms, the green LEDs die green LEDs extinguish.
Run 2		2		
Run 3		3		
Run 4		4		
Run 5		5		
Run 6		6		
Run 7		7		
Run 8		8		

BECKHOFF KL4404 and KL4408: Product Overview

KL4404 and KL4408 - Basic Function Principles

The Analog Output Terminals KL4404 and KL4408 generate signals in the range between 0 V and +10 V with a resolution of 12 bits (4095 steps). The terminal outputs are single ended outputs with common ground.

Format of the output values

In the delivery state the process data are shown in two's complement form ($-1_{integer}$ corresponds to 0xFFFF). Other data formats can be selected via the feature register (e.g. sign/amount representation, Siemens format).

Output value		Output voltage
hexadecimal	decimal	
0x0000	0	0 V
0x3FFF	16383	+5 V
0x7FFF	32767	+10 V

Process data equations

The process data that are transferred to the Bus Terminal are calculated using the following equations:

Neither user nor manufacturer scaling is active

$$Y_{dac} = X \times A_a + B_a \qquad (1.0)$$

Manufacturer scaling active (default setting)

$$Y_1 = B_h + A_h \times X \qquad (1.1)$$
$$Y_{dac} = Y_1 \times A_a + B_a$$

User scaling active

$$Y_2 = B_w + A_w \times X \qquad (1.2)$$
$$Y_{dac} = Y_2 \times A_a + B_a$$

Manufacturer and user scaling active

$$Y_1 = B_h + A_h \times X \qquad (1.3)$$
$$Y_2 = B_w + A_w \times Y_1 \qquad (1.4)$$
$$Y_{dac} = Y_2 \times A_a + B_a$$

Key

X:	PLC Process data	
Y_{dac}:	Process data to D/A converter	
B_a , A_a:	Manufacturer gain and offset compensation	(R17, R18)

B_h , A_h: Manufacturer scaling (R19, R20)
B_w, A_w: User scaling (R33, R34)

The equations of the straight line are activated via register R32.

BECKHOFF KL4434 and KL4438: Product Overview

KL4434 and KL4438 - Basic Function Principles

The Analog Output Terminals KL4434 and KL4438 generate signals in the range between -10 V and +10 V with a resolution of 12 bits (4095 steps). The terminal outputs are single ended outputs with common ground.

Format of the output values

In the delivery state the process data are shown in two's complement form ($-1_{integer}$ corresponds to 0xFFFF). Other data formats can be selected via the feature register (e.g. sign/amount representation, Siemens format).

Output value		Output voltage
hexadecimal	decimal	
0x8000	-32768	-10 V
0xC001	-16383	-5 V
0x0000	0	0 V
0x3FFF	16383	+5 V
0x7FFF	32767	+10 V

Process data equations

The process data that are transferred to the Bus Terminal are calculated using the following equations:

Neither user nor manufacturer scaling is active

$$Y_{dac} = X \times A_a + B_a \qquad (1.0)$$

Manufacturer scaling active (default setting)

$$Y_1 = B_h + A_h \times X \qquad (1.1)$$
$$Y_{dac} = Y_1 \times A_a + B_a$$

User scaling active

$Y_2 = B_w + A_w \times X$ (1.2)
$Y_{dac} = Y_2 \times A_a + B_a$

Manufacturer and user scaling active

$Y_1 = B_h + A_h \times X$ (1.3)
$Y_2 = B_w + A_w \times Y_1$ (1.4)
$Y_{dac} = Y_2 \times A_a + B_a$

Key

X:	PLC Process data	
Y_{dac}:	Process data to D/A converter	
B_a , A_a:	Manufacturer gain and offset compensation	(R17, R18)
B_h , A_h:	Manufacturer scaling	(R19, R20)
B_w, A_w:	User scaling	(R33, R34)

The equations of the straight line are activated via register R32.

BECKHOFF Fieldbus Components: Mounting and Wiring

Installation of Bus Terminals on C mounting rails


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

Assembly

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

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

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

Disassembly

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

1. Carefully pull the orange-colored lug approximately 1 cm out of the disassembled terminal, until it protrudes loosely. The lock with the mounting rail is now released for this terminal, and the terminal can be pulled from the mounting rail without excessive force.
2. Grasp the released terminal with thumb and index finger simultaneous at the upper and lower grooved housing surfaces and pull the terminal away from the mounting rail.

Connections within a bus terminal block

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

- The six spring contacts of the K-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.

Note

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

Note that, for reasons of electromagnetic compatibility, the PE contacts are capacitatively coupled to the mounting rail. This may lead to incorrect results during insulation testing or to damage on the terminal (e.g. disruptive discharge to the PE line during insulation testing of a consumer with a nominal voltage of 230 V).

Warning

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

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

Wiring

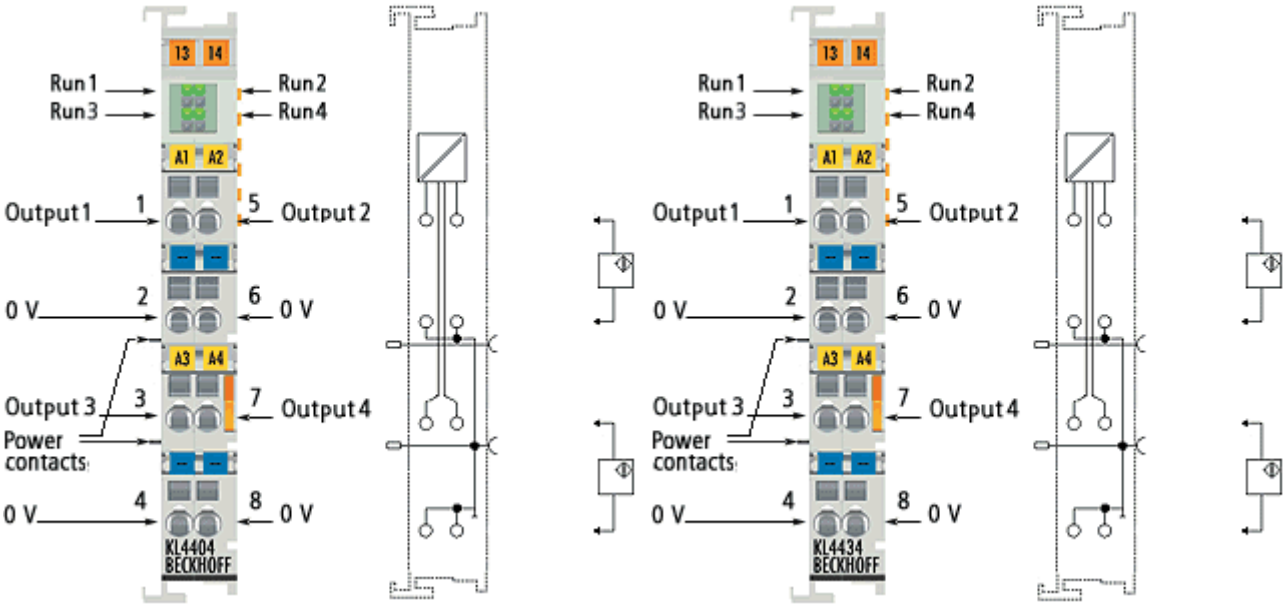
Up to eight connections enable the connection of solid or finely stranded cables to the Bus Terminals. The terminals are implemented in spring force technology. Connect the cables as follows:

1. Open a spring-loaded terminal by slightly pushing with a screwdriver or a rod into the square

opening above the terminal.
2. The wire can now be inserted into the round terminal opening without any force.
3. The terminal closes automatically when the pressure is released, holding the wire securely and permanently.

BECKHOFF KL4404 and KL4434: Mounting and Wiring

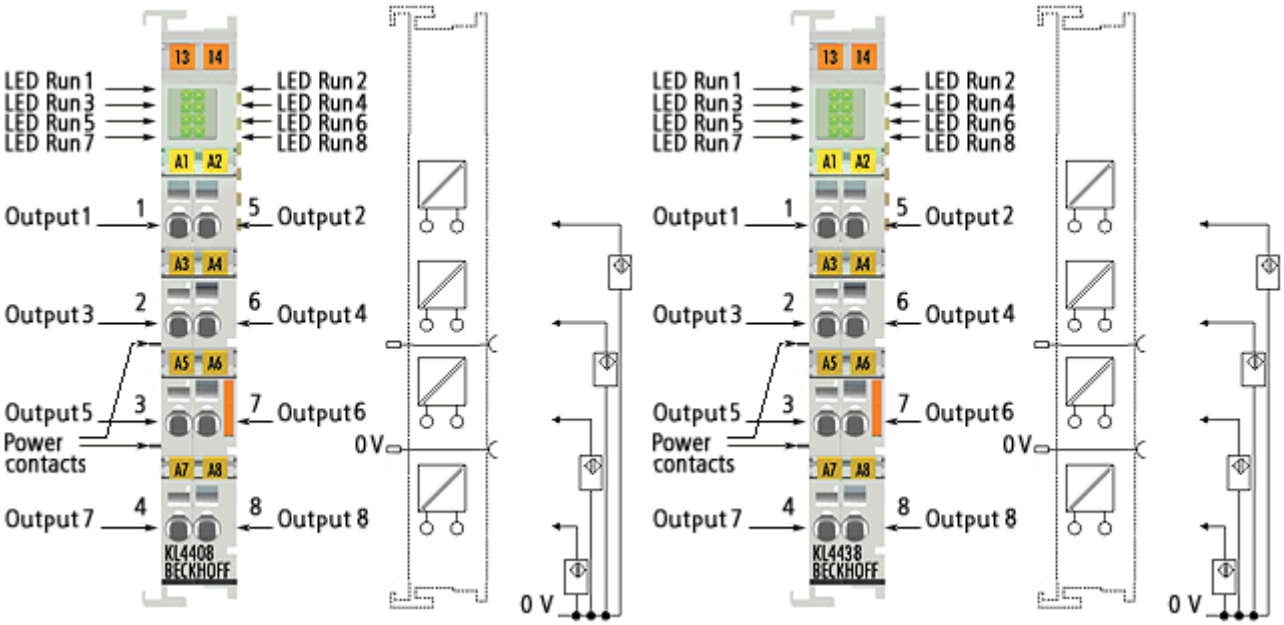
Connection



Terminal point	No.	Connection for
Output 1	1	Output 1, Signal
0 V	2	Output 1, Ground
Output 2	3	Output 2, Signal
0 V	4	Output 2, Ground
Output 3	5	Output 3, Signal
0 V	6	Output 3, Ground
Output 4	7	Output 4, Signal
0 V	8	Output 4, Ground

BECKHOFF KL4408 and KL4438: Mounting and Wiring

Connection



Terminal point	No.	Connection for
Output 1	1	Output 1, Signal
Output 2	2	Output 2, Signal
Output 3	3	Output 3, Signal
Output 4	4	Output 4, Signal
Output 5	5	Output 5, Signal
Output 6	6	Output 6, Signal
Output 7	7	Output 7, Signal
Output 8	8	Output 8, Signal

BECKHOFF Fieldbus Components: Configuration Software KS2000

Configuration Software KS2000

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.

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.

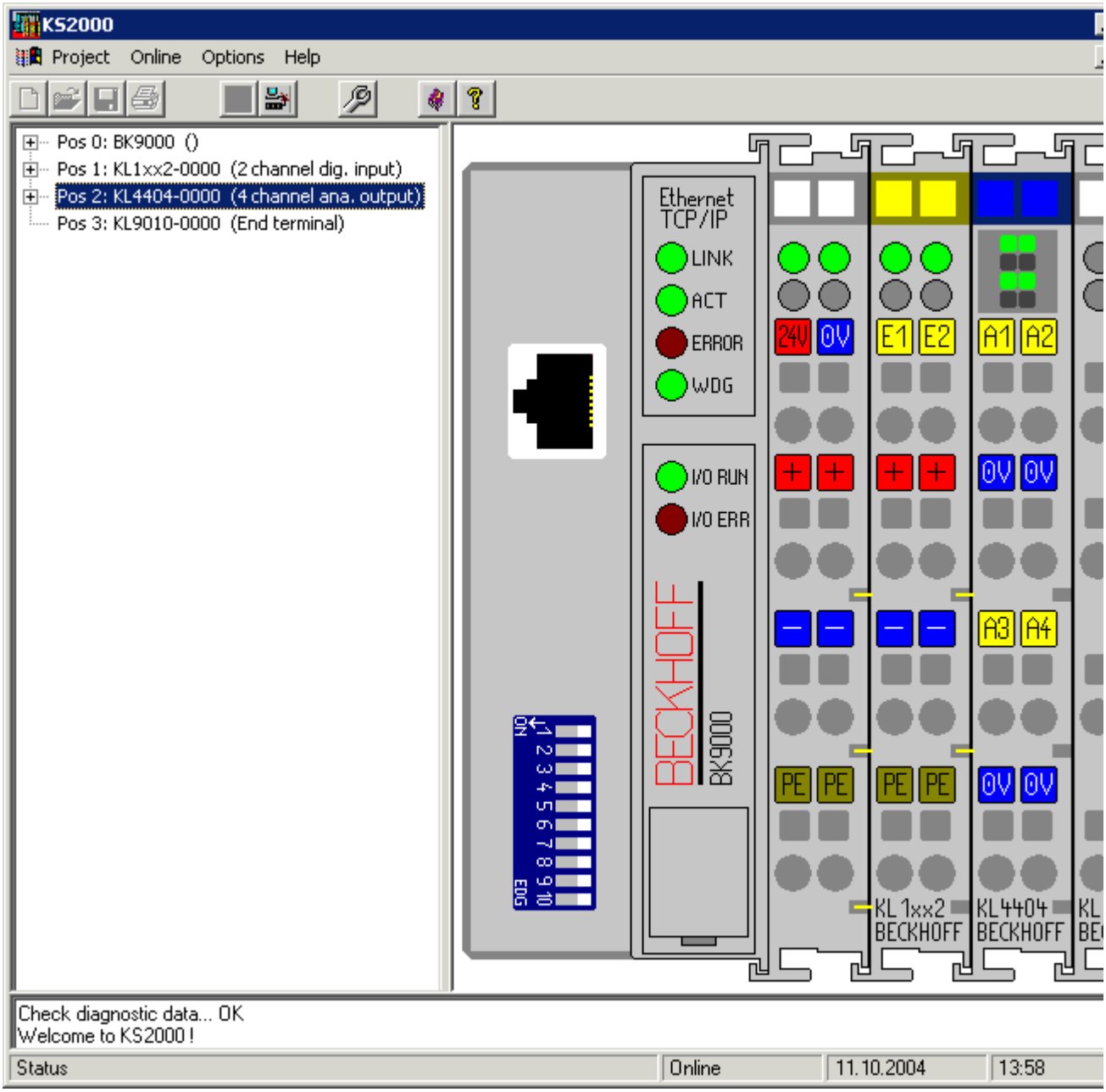
BECKHOFF KL4404 and KL4434: Configuration Software KS2000

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.

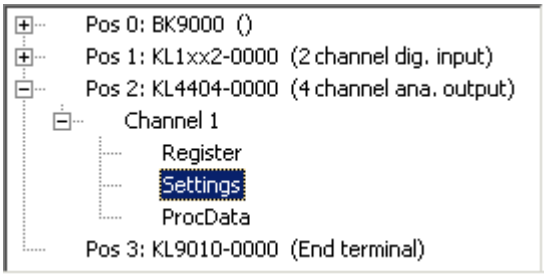
Click on the *Login* button. The configuration software will now load the information for the connected fieldbus station. In the example shown, this is

- a BK9000: Ethernet Coupler
- a KL1xx2: Digital Input Terminal
- a KL4404: Analog Output Terminal
- a KL9010: Bus End Terminal



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).



For the KL4404, the branches *Register*, *Settings* and *ProcData* are displayed:

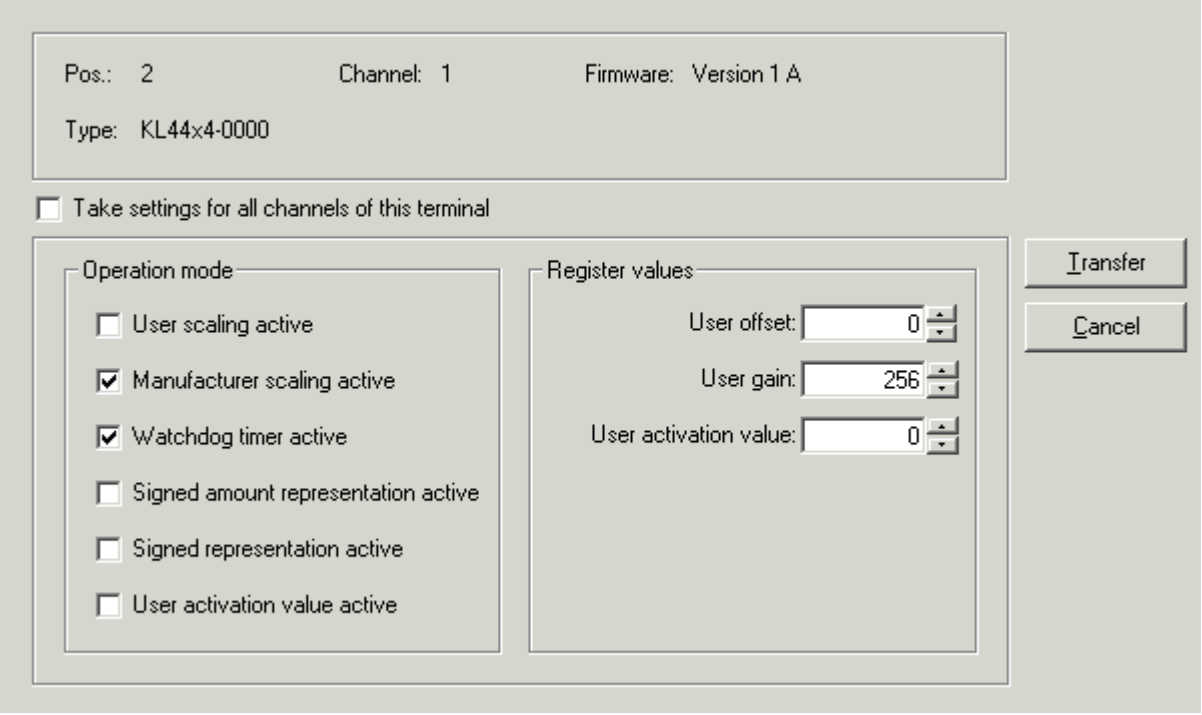
- Register enables direct access to the KL4404 registers.

- A dialog mask for the parameterization of the KL4404 can be found under Settings.
- ProcData displays the KL4404 process data.

BECKHOFF KL4404 and KL4434: Configuration Software KS2000

Settings

A dialog mask for the parameterization of the KL4404 or KL4434 can be found under *Settings*.



Operation mode

User scaling active (R32.0)

You can activate user scaling here (the default is deactivated).

Manufacturer scaling active (R32.1)

You can activate manufacturer scaling here (the default is activated).

Watchdog timer active (R32.2)

You can deactivate the watchdog timer here (the default is activated).

Signed amount representation active (R32.3)

You can activate the signed amount representation here (the default is deactivated).

Signed representation active (R32.5)

You can activate the signed representation here (the default is deactivated).

User activation value active (R32.8)

You can activate the user activation value here (the default is deactivated).

Register values

User offset (R33)

You can specify the user offset here (default: 0).

User gain (R34)

You can specify the user gain here (default: 256).

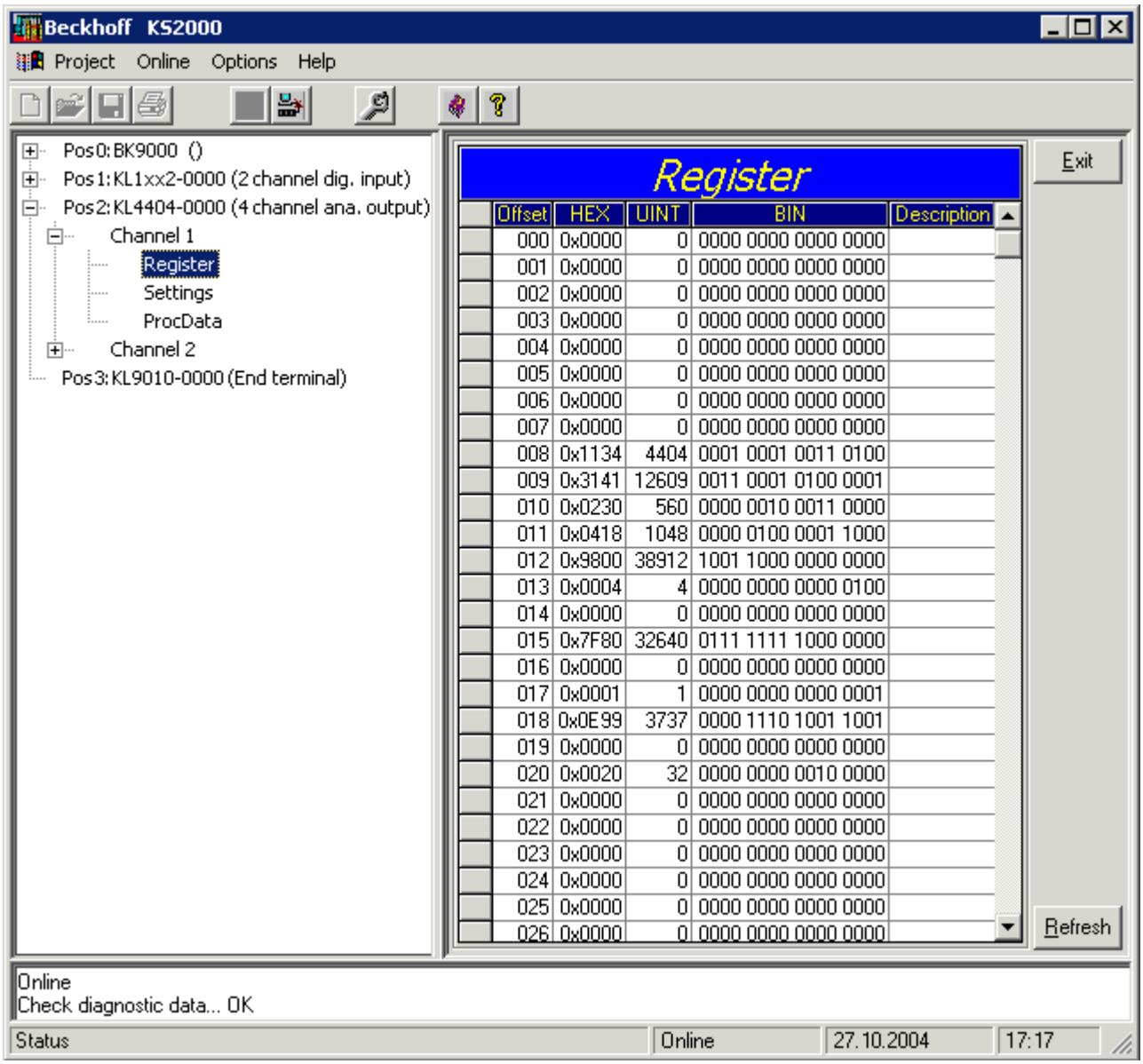
User activation value (R35)

You can specify the user activation value here (default: 0).

BECKHOFF KL4404 and KL4434: KS2000 Configuration Software

Register

You can access the registers of the KL4404 or KL4434 directly under *Register*. The meaning of the register is explained in the register overview.

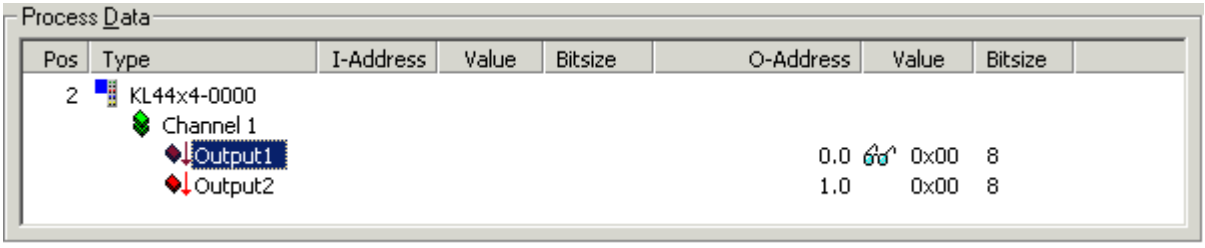


Offset	HEX	UINT	BIN	Description
000	0x0000	0	0000 0000 0000 0000	
001	0x0000	0	0000 0000 0000 0000	
002	0x0000	0	0000 0000 0000 0000	
003	0x0000	0	0000 0000 0000 0000	
004	0x0000	0	0000 0000 0000 0000	
005	0x0000	0	0000 0000 0000 0000	
006	0x0000	0	0000 0000 0000 0000	
007	0x0000	0	0000 0000 0000 0000	
008	0x1134	4404	0001 0001 0011 0100	
009	0x3141	12609	0011 0001 0100 0001	
010	0x0230	560	0000 0010 0011 0000	
011	0x0418	1048	0000 0100 0001 1000	
012	0x9800	38912	1001 1000 0000 0000	
013	0x0004	4	0000 0000 0000 0100	
014	0x0000	0	0000 0000 0000 0000	
015	0x7F80	32640	0111 1111 1000 0000	
016	0x0000	0	0000 0000 0000 0000	
017	0x0001	1	0000 0000 0000 0001	
018	0x0E99	3737	0000 1110 1001 1001	
019	0x0000	0	0000 0000 0000 0000	
020	0x0020	32	0000 0000 0010 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	

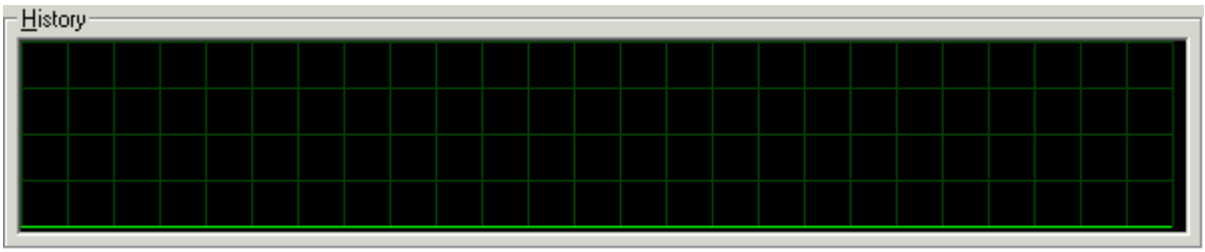
BECKHOFF Fieldbus Components: KS2000 Configuration Software

Process Data

The status byte (State), the control byte (Ctrl) and the process data (Data) are displayed as a tree structure under *ProcData.*

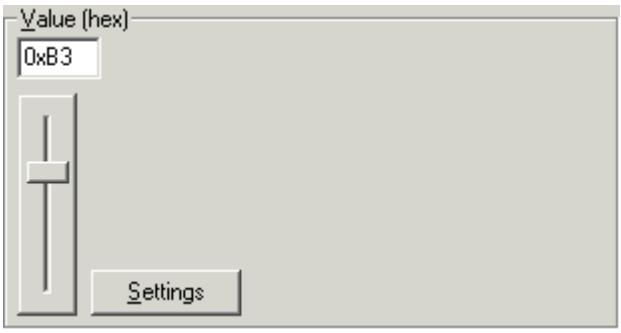


The spectacles mark the data that is presently being displayed graphically in the *History* box.



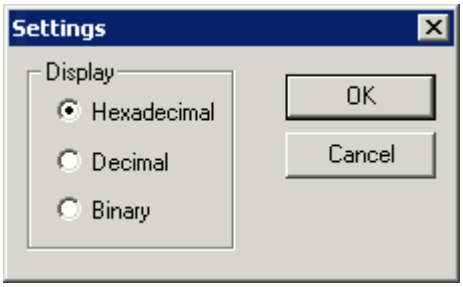
The current value is displayed numerically in the *Value* field.

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



Danger Note that changing initial values (forcing them) can have a direct effect on your automation application.
Only modify these initial 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.



BECKHOFF KL44x4 and KL44x8: Access from the User Program

Process Image

KL4404 and KL4434 as well as KL4414 and KL4424

In the process image KL4404 and KL4434 as well as KL4414 and KL4424 are shown with up to 12 byte input and 12 byte output data.

format	input data	output data
byte	SB1	CB1
word	DataIN1	DataOUT1
byte	SB2	CB2
word	DataIN2	DataOUT2
byte	SB3	CB3
word	DataIN3	DataOUT3
byte	SB4	CB4
word	DataIN4	DataOUT4

Key

SB n: Status byte for channel n
CB n: Control byte for channel n

DataIN n: input data word of channel n
DataOUT n: output data word of channel n

- The mapping of the bytes and words to the addresses of the controlling system can be found on the mapping page.
- The meaning of control und status bytes can be found on the page *control and status bytes*.
- In process data mode the analog values are transmitted within the output data words DataOUT1 to DataOUT4 and the intput data words DataIN1 to DataIN4 are not used.

KL4408 and KL4438 as well as KL4418 and KL4428

KL4408 and KL4438 as well as KL4418 and KL4428 are a special case from their process image: Practically, here are two four channel terminals located in one terminal housing, and they behave like two terminals for the K-Bus!

Each of these eight channel analog terminals has the same process image like two four channel terminals of same signal type, plugged next to each other. In KS2000 configuration software and in TwinCAT System Manager, they are shown like two separate four channel analog terminals!

Note

Consider for the K-Bus diagnosis of your Bus Coupler (e.g. at blink codes, error codes and error arguments), that these eight channel analog terminals are shown to the K-Bus like 2 four channel analog terminals.

If an error occurs and the bus coupler displays the error location, you have to count two terminals for each eight channel analog terminal!

BECKHOFF KL44x4 and KL44x8: Access from the User Program

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 full evaluation
  - Intel or Motorola format
  - word alignment switched on or off

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. For information about the contents of the individual bytes please refer to the pages *Process image* and *Control and status byte*.

Compact evaluation

For compact evaluation, the analog output terminals only occupy addresses in the output process image. Control and status bytes cannot be accessed.

Compact evaluation in Intel format

Default mapping for CANopen, CANCAL, DeviceNet, ControlNet, Modbus, RS232 and RS485 coupler

	Address	Input data		Output data	
Conditions	**Word offset**	**High byte**	**Low byte**	**High byte**	**Low byte**
Complete evaluation: no	0	-	-	Ch1 D1	Ch1 D0
	1	-	-	Ch2 D1	Ch2 D0
Motorola format: no	2	-	-	Ch3 D1	Ch3 D0
Word alignment: any	3	-	-	Ch4 D1	Ch4 D0

Compact evaluation in Motorola format

Default mapping for Profibus and Interbus coupler

	Address	Input data		Output data	
Conditions	**Word offset**	**High byte**	**Low byte**	**High byte**	**Low byte**
Complete evaluation: no	0	-	-	Ch1 D0	Ch1 D1
	1	-	-	Ch2 D0	Ch2 D1
Motorola format: yes	2	-	-	Ch3 D0	Ch3 D1
Word alignment: any	3	-	-	Ch4 D0	Ch4 D1

Complete evaluation

For complete evaluation, the analog output terminals occupy addresses in the input and output process image. Control and status bytes can be accessed.

Complete evaluation in Intel format

	Address	Input data		Output data	
Conditions	**Word offset**	**High byte**	**Low byte**	**High byte**	**Low byte**
Complete evaluation: yes Motorola format: no Word alignment: no	0	Ch1 D0	SB1	Ch1 D0	CB1
	1	SB2	Ch1 D1	CB2	Ch1 D1
	2	Ch2 D1	Ch2 D0	Ch2 D1	Ch2 D0
	3	Ch3 D0	SB3	Ch3 D0	CB3
	4	SB4	Ch3 D1	CB4	Ch3 D1
	5	Ch4 D1	Ch4 D0	Ch4 D1	Ch4 D0

Complete evaluation in Motorola format

	Address	Input data		Output data	
Conditions	**Word offset**	**High byte**	**Low byte**	**High byte**	**Low byte**
Complete evaluation: yes Motorola format: yes Word alignment: no	0	Ch1 D1	SB1	Ch1 D1	CB1
	1	SB2	Ch1 D0	CB2	Ch1 D0
	2	Ch2 D0	Ch2 D1	Ch2 D0	Ch2 D1
	3	Ch3 D1	SB3	Ch3 D1	CB3
	4	SB4	Ch3 D0	CB4	Ch3 D0
	5	Ch4 D0	Ch4 D1	Ch4 D0	Ch4 D1

Complete evaluation in Intel format with word alignment

Default mapping for Lightbus and Ethernet coupler and Bus Terminal Controller (BCxxxx, BXxxxx)

	Address	Input data		Output data	
Conditions	**Word offset**	**High byte**	**Low byte**	**High byte**	**Low byte**
Complete evaluation: yes Motorola format: no Word alignment: yes	0	reserved	SB1	reserved	CB1
	1	Ch1 D1	Ch1 D0	Ch1 D1	Ch1 D0
	2	reserved	SB2	reserved	CB2
	3	Ch2 D1	Ch2 D0	Ch2 D1	Ch2 D0
	4	reserved	SB3	reserved	CB3
	5	Ch3 D1	Ch3 D0	Ch3 D1	Ch3 D0
	6	reserved	SB4	reserved	CB4
	7	Ch4 D1	Ch4 D0	Ch4 D1	Ch4 D0

Complete evaluation in Motorola format with word alignment

	Address	Input data		Output data	
Conditions	**Word offset**	**High byte**	**Low byte**	**High byte**	**Low byte**
Complete evaluation: yes Motorola format: yes	0	reserved	SB1	reserved	CB1
	1	Ch1 D0	Ch1 D1	Ch1 D0	Ch1 D1
	2	reserved	SB2	reserved	CB2
	3	Ch2 D0	Ch2 D1	Ch2 D0	Ch2 D1
	4	reserved	SB3	reserved	CB3
	5	Ch3 D0	Ch3 D1	Ch3 D0	Ch3 D1

Word alignment: yes	6	reserved	SB4	reserved	CB4
	7	Ch4 D0	Ch4 D1	Ch4 D0	Ch4 D1

Key

Complete evaluation: In addition to the process data, the control and status bytes are also mapped in 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 n: status byte for channel n (appears in the input process image).
CB n: control byte for channel n (appears in the output process image).

Ch n D0: channel n, lower-value data byte
Ch n D1: channel n, higher-value data byte

reserved: This byte occupies process data memory, although it has no function.
"-": This byte is not assigned or used by the terminal/module.

BECKHOFF KL44x4 and KL44x8: Access from the User Program

Control and Status Bytes

Channel 1

Process data mode

Control byte 1 in process data mode

Control byte 1 (CB1) is located in the output image, and is transmitted from the controller to the terminal. In process data mode it has no function.

Bit	CB1.7	CB1.6	CB1.5	CB1.4	CB1.3	CB1.2	CB1.1	CB1.0
Name	RegAccess	-	-	-	-	-	-	-

Legend

Bit	Name	Description	
CB1.7	RegAccess	0_{bin}	Register communication off (process data mode)
CB1.6 - CB1.0	-	0_{bin}	reserved

Status byte 1 in process data mode

The status byte 1 (SB1) is located in the input image, and is transmitted from terminal to the controller. In process data mode it has no function.

Bit	SB1.7	SB1.6	SB1.5	SB1.4	SB1.3	SB1.2	SB1.1	SB1.0

Name	RegAccess	-	-	-	-	-	-	-

Legend

Bit	Name	Description	
SB1.7	RegAccess	0_{bin}	Acknowledgement for process data mode
SB1.6 - SB1.0	Error	0_{bin}	reserved

Register communication

Control byte 1 in register communication

Control byte 1 (CB1) is located in the output image, and is transmitted from the controller to the terminal.

Bit	CB1.7	CB1.6	CB1.5	CB1.4	CB1.3	CB1.2	CB1.1	CB1.0
Name	RegAccess	R/W	Reg. no.					

Legend

Bit	Name	Description	
CB1.7	RegAccess	1_{bin}	Register communication switched on
CB1.6	R/W	0_{bin}	Read access
		1_{bin}	Write access
CB1.5 to CB1.0	Reg. no.	Register number: Enter the number of the register that you - want to read with input data word DataIN1 or - want to write with output data word DataOUT1.	

Status byte 1 in register communication

The status byte 1 (SB1) is located in the input image, and is transmitted from terminal to the controller.

Bit	SB1.7	SB1.6	SB1.5	SB1.4	SB1.3	SB1.2	SB1.1	SB1.0
Name	RegAccess	R/W	Reg. no.					

Legend

Bit	Name	Description	
SB1.7	RegAccess	1_{bin}	Acknowledgement for register access
SB1.6	R	0_{bin}	Read access
SB1.5 to SB1.0	Reg. no.	Number of the register that was read or written.	

Channel 2, channel 3 and channel 4

The control and status bytes of channels 2, 3 and 4 are structured like the control and status byte of channel 1.

BECKHOFF Fieldbus Components: Access from the User Program

Register Overview

The following registers are used to parameterize the KL4404, KL4408, KL4434 and KL4438. They exist once for each channel of a terminal and can be read or written by register communication using control-, status- und data bytes.

Register No.	Comment		Default Value		R/W	Memory
R0	Process data for D/A C		-	-	R	RAM
R1	reserved		-		-	-
...	...		...	...	...	...
R5	reserved		-	-	-	-
R6	Diagnostic register (not used)		-	-	R	RAM
R7	Command register (not used)		0x0000	0_{dec}	R/W	RAM
R8	Terminal type	KL4404:	0x1134	4404_{dec}	R	ROM
		KL4408:	0x1138	4408_{dec}		
		KL4434:	0x1152	4434_{dec}		
		KL4438:	0x1156	4438_{dec}		
R9	Firmware revision level		e.g. 0x3141	e.g. $1A_{ASCI}$	R	ROM
R10	Data length (Multiplex shift register)		0x0230	560_{dec}	R	ROM
R11	Signal channels		0x0418	1048_{dec}	R	ROM
R12	Minimum data length		0x9800	38912_{dec}	R	ROM
R13	Data structure (Data type register)		0x0004	4_{dec}	R	ROM
R14	reserved		-	-	-	-
R15	Alignment register		e.g. 0x7F80	e.g. 32640_{dec}	R/W	RAM
R16	Hardware revision number		e.g. 0x0000	e.g. 0_{dec}	R/W	SEEPROM
R17	Hardware compensation: offset (B_a)		0x0000	0_{dec}	R/W	SEEPROM
R18	Hardware compensation: gain (A_a)		typ. 0x0E99	typ. 3737_{dec}	R/W	SEEPROM
R19	Manufacturer scaling: offset (B_h)		0x0001	1_{dec}	R/W	SEEPROM
R20	Manufacturer scaling: gain (A_h)		typ. 0x0020	typ. 32_{dec}	R/W	SEEPROM
R21	Manufacturer switch-on value		0x07FF	2047_{dec}	R/W	SEEPROM
R22	KL4404:	reserved	-	-	-	-
	KL4408:					
	KL4434:	Hardware compensation: gain	0x0E99		R/W	SEEPROM

	KL4438: (A_a) for negative values		3737_{dec}		
R23	reserved	-	-	-	-
...	...	...	...	...	...
R30	reserved	-	-	-	-
R31	Code word register	0x0000	0_{dec}	R/W	RAM
R32	Feature register	0x0006	6_{dec}	R/W	SEEPROM
R33	User scaling: offset (B_w)	0x0000	0_{dec}	R/W	SEEPROM
R34	User scaling: gain (A_w)	0x0100	256_{dec}	R/W	SEEPROM
R35	User switch-on value (Y_2)	0x0000	0_{dec}	R/W	SEEPROM
R36	reserved	-	-	-	-
...	...	...	...	...	...
R63	reserved	-	-	-	-

BECKHOFF Fieldbus Components: Access from the User Program

Register Description

The following registers are used to parameterize the KL4404, KL4408, KL4434 and KL4438. They exist once for each channel of a terminal and can be read or written by register communication using control-, status- und data bytes.

R0: Raw value A/D C

Process data, delivered to the the D/A converter.

R6: Diagnostic register

The diagnostic register of KL4404 and KL4434 is currently not used.

R7: Command register

The command register of KL4404 and KL4434 is currently not used.

R8: Terminal description

Register R8 contains the terminal identifier. e.g.:
- KL4404: 0x1134 (4404_{dec}) or
- KL4434: 0x1152 (4434_{dec})

R9: Firmware revision level

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
0x15x	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.

R17: Hardware compensation - offset (B_a)

This register is used for the offset compensation of the terminal (see equation 1.1). Register value (16 bit signed integer). Default: 0x0001 (1_{dec})

R18: Hardware compensation - gain (A_a)

This register is used for the gain compensation of the terminal (see equation 1.1). Register value (16 bit unsigned integer x 2^{-12}). Default: typically 0x0E99 (3737_{dec})

R19: Manufacturer scaling - offset ($B_{h)}$

This register contains the offset for the manufacturer scaling (see equation 1.3). Register value (16 bit signed integer). Default: 0x0000 (0_{dec})
Manufacturer scaling can be activated via bit R32.1 of the feature register.

R20: Manufacturer scaling - gain (A_h)

This register contains the gain for manufacturer scaling (see equation 1.3). Register value (16 bit unsigned integer x 2^{-8}). Default: typically 0x2000 (8192_{dec})
Manufacturer scaling can be activated via bit R32.1 of the feature register.

R21: Manufacturer activation value

The terminal applies the manufacturer activation value to its output after a system reset or a watchdog timer overflow (terminal has not received any process data for 100 ms) has occurred. Register value (16 Bit signed Integer).

R22: Hardware compensation - gain (A_a) for negative values

(KL4434 only)
This register is used for the gain compensation of the terminal for negative values. Default: typically 0x0E99 (3737_{dec})

R31: Code word register

- If you write 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.

R32: Feature register

The feature register specifies the terminal's configuration. Default: 0x0006 (6_{dec})

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

Bit	R32.7	R32.6	R32.5	R32.4	R32.3	R32.2	R32.1	R32.0
Name	-	-	enSignRepr	-	enSignAmRepr	enWdTimer	enManScal	enUsrScal

Legend

Bit	Name	Description		default
R32.15	-	reserved		0_{bin}
...	...	...		...
R32.9	-	reserved		0_{bin}
R32.8	enUserActValue	0_{bin}	Manufacturer activation value active	0_{bin}
		1_{bin}	User activation value active:	
R32.7	-	reserved		0_{bin}
R32.6	-	reserved		0_{bin}
R32.5	enSignRepr	0_{bin}	Signed representation is not active	0_{bin}
		1_{bin}	Signed representation is active	
R32.4	-	reserved		0_{bin}
R32.3	enSignAmRepr	0_{bin}	Two's complement representation is active	0_{bin}
		1_{bin}	The arithmetic sign of numerical quantities is active (-1_{dec} = 0x8001)	
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	enManScal	0_{bin}	Manufacturer scaling is active	1_{bin}
		1_{bin}	Manufacturer scaling is not active	
R32.0	enUsrScal	0_{bin}	User scaling is not active	0_{bin}
		1_{bin}	User scaling is active	

R33: User scaling - offset (B_w)

This register contains the offset of the user scaling.
User scaling can be activated through bit R32.0 in the feature register.

R34: User scaling - gain (A_w)

This register contains the user scaling gain. Default: 0x0100 (256_{dec}).
User scaling can be activated through bit R32.0 in the feature register.

R35: User activation value

If the user activation value has been activated by bit R32.8 of the feature register, the terminal applies the user activation value instead of the manufacturer activation value to its output if a system reset or a watchdog timer overflow (terminal has not received any process data for 100 ms) happens.

BECKHOFF Fieldbus Components: Access from the User Program

Examples of Register Communication

In the examples, the numbering of the bytes is according to the description without Word-Alignment.

Example 1: Reading the Firmware Issue Status from Register 9 of a Terminal

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 indicates register communication active.
- Bit 0.6 not set indicates reading the register.
- Bit 0.5 to Bit 0.0 indicates with 00 1001_{bin} the register number 9.
- The output data word (Byte 1 and Byte 2) has no function at the reading access. If you want to change a register, you have to write the desired value into the output data 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 in the Status Byte, as an acknowledgement.
- The terminal returns the Firmware Issue Status 0x3341 in ASCII code, in the input data word (Byte 1 and Byte 2). This has to be interpreted as ASCII code:
  - ASCII code 0x33 stands for the cipher 3
  - ASCII code 0x41 stands for the letter A
  Therefore the firmware version is 3A.

Example 2: Writing to an user registers

Note

At normal operation all user registers other than register 31are write protected.
In order to deactivate write protection, you have to write the password (0x1235) into register 31. Write protection is activated again by writing any value other than 0x1235
Note that some of the settings that can be made in registers only become active after the next power restart (power-off/power-on) of the terminal.

I. Writing the code word (0x1235) to 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 indicates: register communication active.
- Bit 0.6 set indicates: writing to the register.
- Bit 0.5 to Bit 0.0 indicates with 00 1111_{bin} the register number 31.
- The output data word (Byte 1 und Byte 2) contains the code word (0x1235) to deactivate the 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:

- In the Status Byte, the terminal returns a value, that differs only at bit 0.6 from the value of the of the Control Byte.
- The input data word (Byte 1 and Byte 2) has no function after the the writing access. Values that might be shown are not valid!

II. Reading Register 31 (verifying 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 indicates register communication active.
- Bit 0.6 not set indicates reading the register.
- Bit 0.5 to Bit 0.0 indicates with 00 1111_{bin} the register number 31.
- The output data word (Byte 1 and Byte 2) has no function at the reading 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 in the Status Byte, as an acknowledgement.
- The terminal returns the current value of the code word register in the input data word (Byte 1 and Byte 2).

III. Writing into Register 32 (changing the content 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 indicates register communication active.
- Bit 0.6 set indicates: writing to the register
- Bit 0.5 to Bit 0.0 indicates with 10 0000_{bin} the register number 32.
- The output data word (Byte 1 and Byte 2) contains the new value for the feature register. The given value 0x0002 is only an example!

Attention The bits of the feature register change the properties of the terminal und and have different meanings, depending on the terminal type. Please check the description of the feature register of your terminal type (chapter *register description*) about the meanings of the bits in detail, before changing the values!

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})	0xXX	0xXX

Explanation:

- In the Status Byte, the terminal returns a value, that differs only at bit 0.6 from the value of the of the Control Byte.
- The input data word (Byte 1 and Byte 2) has no function after the the writing access. Values that might be shown are not valid!

IV. Reading Register 32 (verifying the 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 indicates register communication active.
- Bit 0.6 not set indicates reading the register.
- Bit 0.5 to Bit 0.0 indicates with 10 0000_{bin} the register number 32.
- The output data word (Byte 1 and Byte 2) has no function at the reading 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 in the Status Byte, as an acknowledgement.

- The terminal returns the current value of the feature register in the input data word (Byte 1 and Byte 2).

V. Writing to Register 31 (setting the code word back)

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 indicates register communication active.
- Bit 0.6 set indicates: writing to the register.
- Bit 0.5 to Bit 0.0 indicates with 00 1111_{bin} the register number 31.
- The output data word (Byte 1 und Byte 2) contains 0x0000 to activate the write protection again.

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:

- In the Status Byte, the terminal returns a value, that differs only at bit 0.6 from the value of the of the Control Byte.
- The input data word (Byte 1 and Byte 2) has no function after the the writing access. Values that might be shown are not valid!

BECKHOFF Fieldbus Components: Appendix

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 Support

Support offers you comprehensive technical assistance, helping you no only with the application of individual BECKHOFF products, but also with other, wide-ranging services:

- world-wide support
- design, programming and commissioning of complex automation systems
- and extensive training program for BECKHOFF system components

Hotline: +49(0)5246/963-157

Fax: +49(0)5246/963-9157
e-mail: support@beckhoff.com

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

Hotline: +49(0)5246/963-460
Fax: +49(0)5246/963-479
e-mail: service@beckhoff.com

You will find further support and service addresses on our Internet pages under
http://www.beckhoff.com.

BECKHOFF Headquaters

BECKHOFF Industrie Elektronik

Eiserstr. 5

33415 Verl

Germany

Phone: +49(0)5246/963-0
Fax: +49(0)5246/963-198
e-mail: info@beckhoff.com

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.