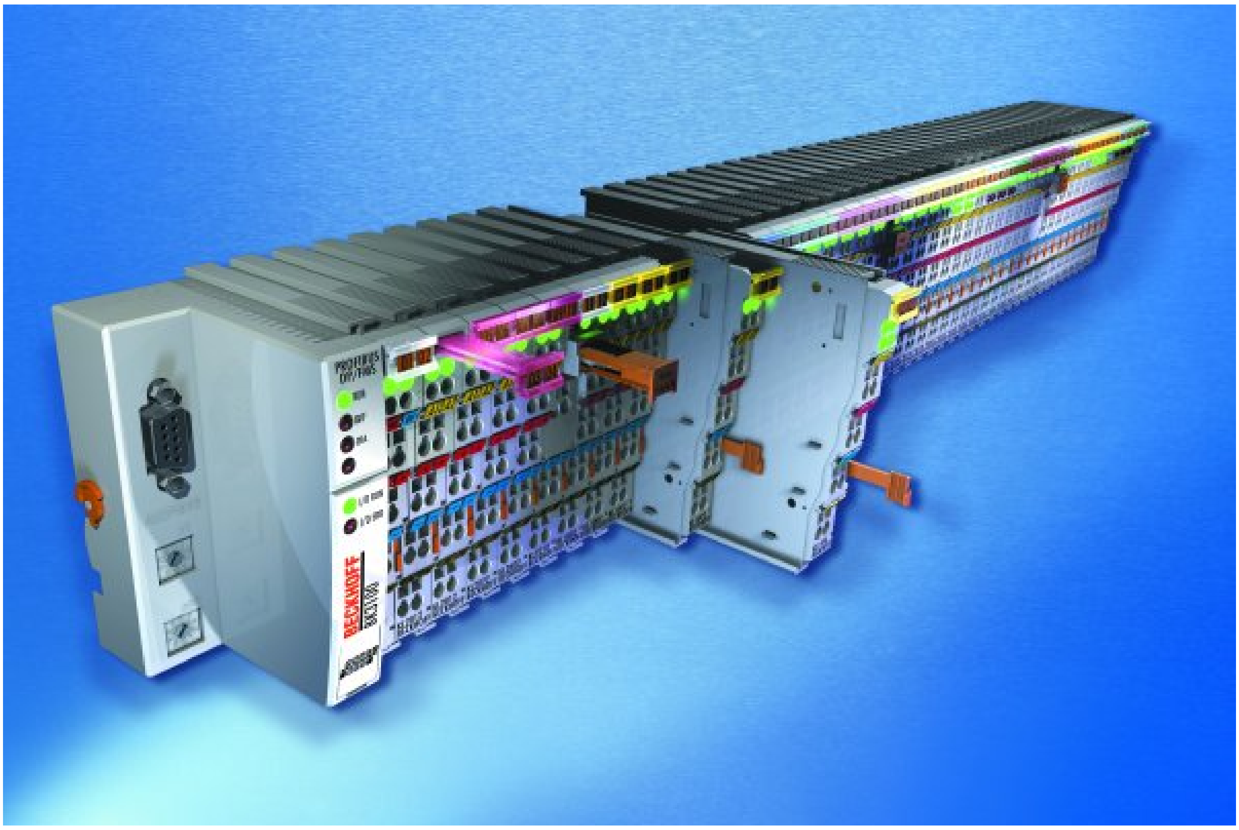

Documentation for

KL3201, KL3202 and KL3204

Single-, Two- and Four-Channel Analog Input Terminals for PT100 (RTD)

Version: 3.2
Date: 2008-03-31

BECKHOFF

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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.

Delivery conditions

In addition, the general delivery conditions of the company Beckhoff Automation GmbH apply.

Copyright

Safety Instructions

State at Delivery

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

Description of safety symbols

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

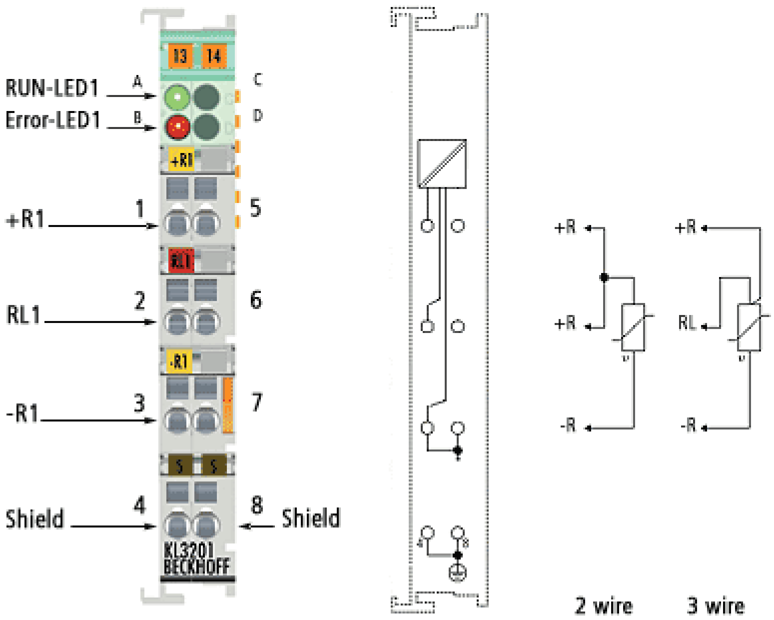
Danger	This symbol is intended to highlight risks for the life or health of personnel.
Attention	This symbol is intended to highlight risks for equipment, materials or the environment.
Note	This symbol indicates information that contributes to better understanding.

Technical data

Technical data	KL3201	KL3202	KL3204
Number of inputs	1	2	4
Power supply	via the K-Bus		
Sensor types	PT100, PT200, PT500, PT1000, Ni100, resistance measurement (e.g. potentiometer connection)		
Connection	2 or 3-wire (pre-set to 3-wire)	2 wire	
Temperature range	-250°C ... +850°C (PT sensors); -60°C ... +250°C (Ni sensors)		
Resolution	0.1°C per digit (measuring range 10 to 5000 Ω: 0.5°C per digit)		
Electrical isolation	500 V_{rms} (K-Bus/signal voltage)		
Conversion time	~ 200 ms	~ 250 ms	
Measuring current	typically 0.5 mA		
Meas. error (total meas. range)	< ± 1°C		
Bits width in process image	Input: 1 x 16 bits of data (1 x 8 bit control/status optional)	Input: 2 x 16 bits of data (2 x 8 bit control/status optional)	Input: 4 x 16 bits of data (4 x 8 bit control/status optional)
Current consumption from K-Bus	typically 60 mA		
Configuration	no address setting, configuration via bus coupler or controller		
Weight	approx. 70 g		
Operating temperature	0°C ... +55°C		
Storage temperature	-25°C ... +85°C		
Relative humidity	95 % no condensation		
Vibration / shock resistance	according to EN 60068-2-6 / EN 60068-2-27, EN 60068-2-29		
EMC resistance burst / ESD	according to EN 61000-6-2 / EN 61000-6-4		
Installation position	any		
Protection class	IP20		

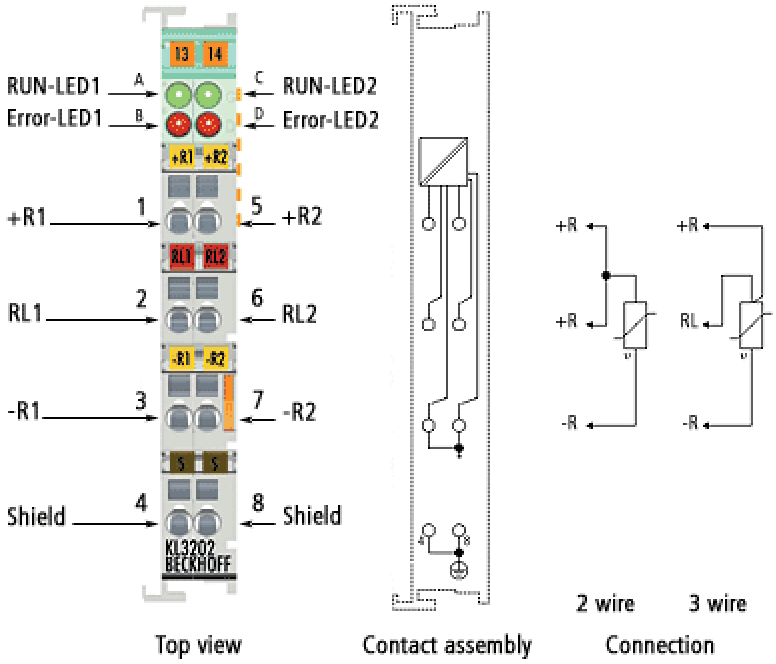
Connection

KL3201

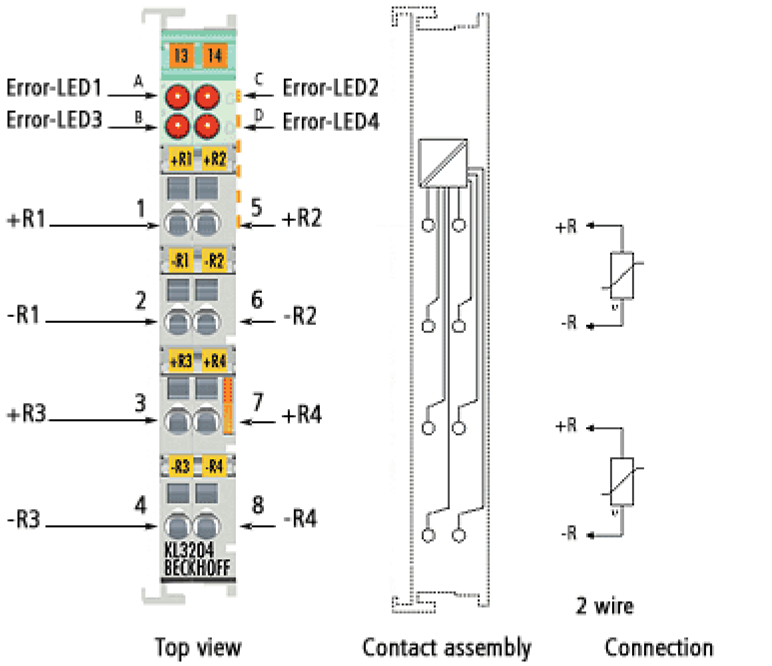


Top view Contact assembly Connection

KL3202



KL3204



Functional description

The KL320x analog input terminals enable resistance sensors to be connected directly. A micro-controller within the terminal is used for converting and linearizing the resistance to a temperature value. The temperatures are displayed as follows:

- Measuring range 10 to 5000 Ω: 1/2 °C (1 digit = 0.5 °C)
- All other measuring ranges: 1/10 °C (1 digit = 0.1 °C)

In addition to this, a broken wire or short circuit is reported to the Bus Coupler or to the controller, and indicated by the ERROR LED. PT100, NI100, PT200, PT500, NI120, NI1000 and PT1000 elements are implemented over their full measuring ranges as resistance sensors. The terminal can be fully configured over a fieldbus. A self-defined scaling of the output can, for instance, be performed, or the temperature conversion can be switched off. In the latter case, the measurement is output in the range from 10 Ω up to 1.2 kΩ with a resolution of 1/16 Ω (the internal resolution of the resistance value is 1/255 Ω).

Output format of the process data

In the delivery state, the measured value is displayed in increments of 1/10° C in two's complement format (integer). The complete measuring range is output for each resistance sensor. Other display types can be selected via the feature register (e.g. sign/amount representation, Siemens output format).

Measured value	Hexadecimal output	Signed integer output
-250.0°C	0xF63C	-2500
-200.0°C	0xF830	-2000
-100.0°C	0xFC18	-1000
-0.1°C	0xFFFF	-1
0.0°C	0x0000	0
0.1°C	0x0001	1
100.0°C	0x03E8	1000
200.0°C	0x07D0	2000
500.0°C	0x1388	5000
850.0°C	0x2134	8500

Resistance limit values

R > 400 Ω: Bits 1 and 6 (over range and error bits) in the status byte are set. The linearization of the characteristic curve is continued with the coefficients of the upper range limit up to the limit stop of the A/D converter (approx. 500 Ω for PT100).
R<18 Ω: Bits 0 and 6 (under range and error bits) in the status byte are set. The smallest negative number is displayed (0x8001 corresponds to -32767).
For over range or under range the red error LED is switched on.

LED display

The LEDs indicate the operating state of the associated terminal channels.
Green LEDs: RUN (not applicable for KL3204)

- On: normal operation
- Off: Watchdog-timer overflow has occurred. If no process data is transmitted to the bus coupler for 100 ms, the green LEDs go out.

Red LEDs: ERROR

- On: Short circuit or wire breakage. The resistance is in the invalid range of the characteristic curve.
- Off: The resistance is in the valid range of the characteristic curve.

Process data

The process data that are transferred to the terminal bus are calculated using the following equations:

X_RL: ADC value of the supply cables
X_RTD: ADC value of the temperature sensor, including one supply cable
X_R: ADC value of the temperature sensor
A_a, B_a: Manufacturer gain and offset compensation (R17, R18)
A_h, B_h: Manufacturer scaling
A_w, B_w: User scaling
Y_R: Temperature sensor resistance value
Y_T: Measured temperature in 1/16 °C
Y_THS: Temperature after manufacturer scaling (1/10 °C)
Y_TAS: Temperature after user scaling
Y_AUS: Process data to PLC

a) Calculation of the resistance value:
X_R = X_RTD-X_RL (1.0)
Y_R = A_a * (X_R - B_a) (1.1)

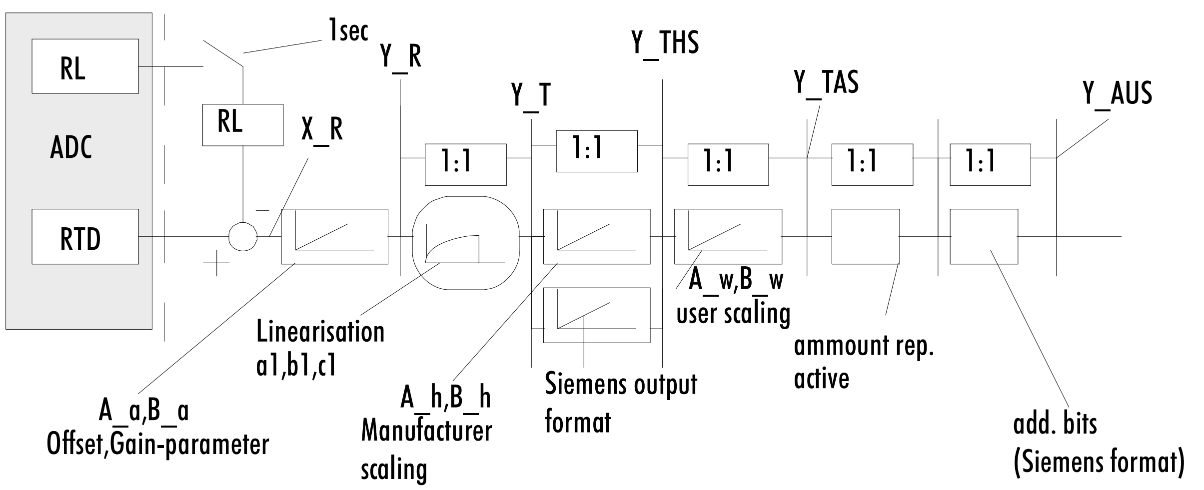
b) Curve linearisation:
Y_T = a_1 * Y_R^2 + b_1* Y_R + c_1 (1.2)
or
Y_T = Y_R if output in Ω (1.3)

c) Neither user nor manufacturer scaling are active:
Y_AUS = Y_T (1.4)

d) Manufacturer scaling active (factory setting):
Y_THS = A_h * Y_T + B_h (1.5)
Y_AUS = Y_THS

e) User scaling active:
Y_TAS = A_w * Y_T + B_w (1.6)
Y_AUS = Y_TAS

f) Manufacturer and user scaling active: (1.7)
Y_1 = A_h * Y_T + B_h
Y_2 = A_w * Y_1 + B_w
Y_AUS = Y_2



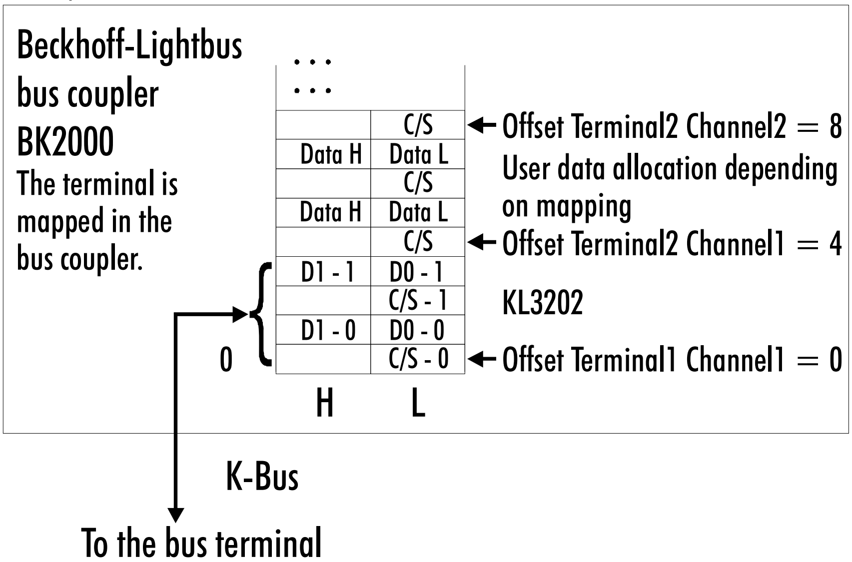
Terminal configuration

The terminal can be configured and parameterized via the internal register structure. Each terminal channel is mapped in the Bus Coupler. Depending on the type of the Bus Coupler and the mapping configuration (e.g. Motorola/Intel format, word alignment etc.) the terminal data are mapped in different ways to the Bus Coupler memory. For parameterizing a terminal, the control and status byte also has to be mapped.

BK2000 Lightbus Coupler

In the BK2000 Lightbus coupler, the control and status byte is mapped in addition to the data bytes. This is always located in the low byte at the offset address of the terminal channel.

Example for KL3202:

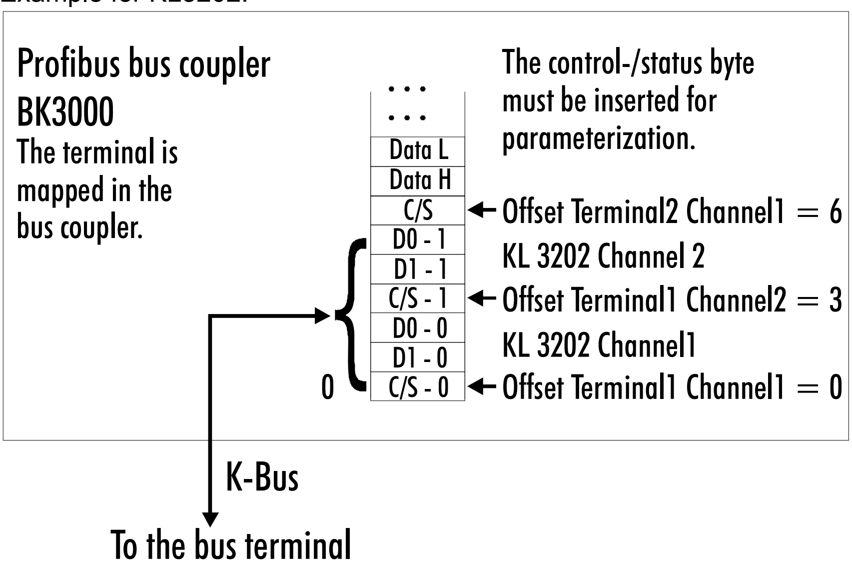


BK3000 PROFIBUS coupler

For the BK3000 PROFIBUS coupler, the master configuration should specify for which terminal channels the control and status byte is to be inserted. If the control and status byte are not evaluated, the terminals occupy 2 bytes per channel:

- KL3201: 2 bytes of input data
- KL3202: 4 bytes of input data
- KL3204: 8 bytes of input data

Example for KL3202:



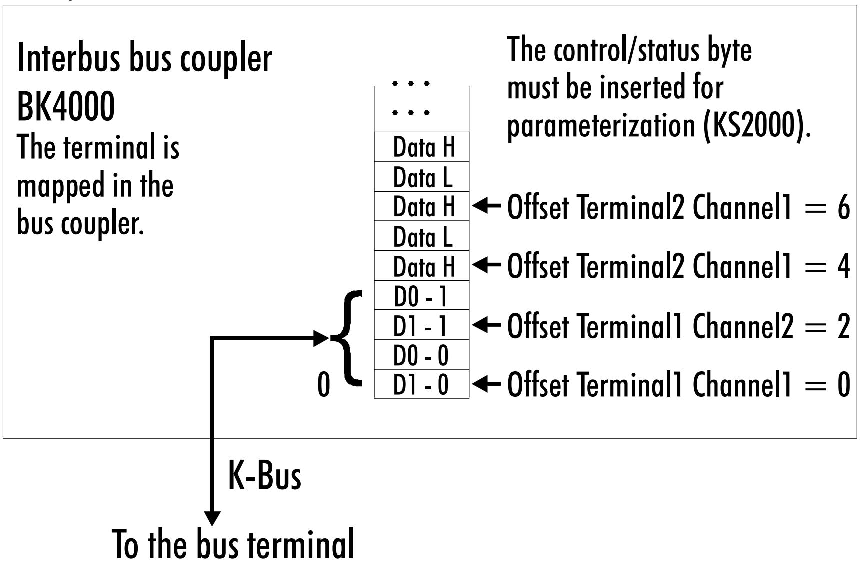
BK4000 Interbus Coupler

The BK4000 Interbus Coupler maps the terminals in the delivery state with 2 bytes per channel:

- KL3201: 2 bytes of input data
- KL3202: 4 bytes of input data
- KL3204: 8 bytes of input data

Parameterization via the fieldbus is not possible. If the control and status byte is to be used, the KS2000 configuration software is required.

Example for KL3202:



Other Bus Couplers and further information

Further information about the mapping configuration of Bus Couplers can be found in the Appendix of the respective Bus Coupler manual under *Master configuration*.

Note

The Appendix contains an overview of possible mapping configurations depending on the parameters that can be set.

Parameterization with KS2000

The parameterization can be carried out independently of the fieldbus system with the KS2000 configuration software via the serial configuration interface in the Bus Coupler.

Register Description

Different operating modes or functionalities may be set for the complex terminals. The *General Description of Registers* explains those register contents that are the same for all complex terminals.

The terminal-specific registers are explained in the following section.

Access to the internal terminal registers is described in the *Register Communication* section.

General Description of Registers

Complex terminals that possess a processor are able to exchange data bi-directionally with the higher-level controller. These terminals are referred to below as intelligent Bus Terminals. These include analog inputs, analog outputs, serial interface terminals (RS485, RS232, TTY etc.), counter terminals, encoder interface, SSI interface, PWM terminal and all other parameterizable terminals.

The main features of the internal data structure are the same for all the intelligent terminals. This data area is organized as words and comprises 64 registers. The important data and parameters of the terminal can be read and set through this structure. It is also possible for functions to be called by means of corresponding parameters. Each logical channel in an intelligent terminal has such a structure (4-channel analog terminals therefore have 4 sets of registers).

This structure is divided into the following areas:
(A detailed list of all registers can be found in the Appendix.)

Register	Application
0 to 7	Process variables
8 to 15	Type register
16 to 30	Manufacturer parameters
31 to 47	User parameters
48 to 63	Extended user area

Process variables

R0 to R7: Registers in the internal RAM of the terminal:

The process variables can be used in addition to the actual process image. Their function is specific to the terminal.

R0 to R5: Terminal-specific registers
The function of these registers depends on the respective terminal type (see terminal-specific register description).

R6: Diagnostic register
The diagnostic register can contain additional diagnostic information. Parity errors, for instance, that occur in serial interface terminals during data transmission are indicated here.

R7: Command register
High-Byte_Write = function parameter
Low-Byte_Write = function number
High-Byte_Read = function result
Low-Byte_Read = function number

Type register

R8 to R15: Registers in the internal ROM of the terminal

The type and system parameters are hard programmed by the manufacturer, and the user can read them but cannot change them.

R8: Terminal type
The terminal type in register R8 is needed to identify the terminal.

R9: Software version (X.y)
The software version can be read as a string of ASCII characters.

R10: Data length
R10 contains the number of multiplexed shift registers and their length in bits. The Bus Coupler sees this structure.

R11: Signal channels
Related to 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 type register

Data type register	
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

R14: Reserved

R15: Alignment bits (RAM)
The alignment bits are used to place the analog terminal in the Bus Coupler on a byte boundary.

Manufacturer parameters

R16 to R30, Manufacturer parameter area (SEEROM)

The manufacturer parameters are specific for each type of terminal. They are programmed by the manufacturer, but can also be modified by the controller. The manufacturer parameters are stored in a serial EEPROM in the terminal, and are retained in the event of voltage drop-out.
These registers can only be altered after a code-word has been set in R31.

User parameters

R31 to R47: User parameter area (SEEROM)

The user parameters are specific for each type of terminal. They can be modified by the programmer. The user parameters are stored in a serial EEPROM in the terminal, and are retained in the event of voltage drop-out. The user area is write-protected by a code-word.

Note

R31: Code-word register in RAM
The code-word **0x1235** must be entered here so that parameters in the user area can be modified. If any other value is entered into this register, the write-protection is active. When write protection is not active, the code word is returned when the register is read. If the write protection is active, the register contains a zero value.

R32: Feature register
This register specifies the terminal's operating modes. Thus, for instance, a user-specific scaling can be activated for the analog I/Os.
R33 to R47 Terminal-specific Registers
The function of these registers depends on the respective terminal type (see terminal-specific register description).

Extended application region

R47 to R63

Extended registers with additional functions.

Terminal-specific register description

Process variables

R0: Raw ADC value X_R
This register contains the raw ADC value.

R1: Raw ADC value of the line resistance between +R1 - RL1 or +R2 - RL2

R2 to R5: Reserved

R6: Diagnostic register
High byte: not used
Low byte: status byte

Manufacturer parameters

R17: Hardware compensation - offset (B_a)
16 bit signed integer
This register is used for offset compensation of the terminal (Eq. 1.1).
Register value approx. 0xEDXX

R18: Hardware compensation - gain (A_a)
16 bits * 16^{-5} (approx. 0.01907 Ω/digit)
This register is used for gain compensation of the terminal (Eq. 1.1).
Register value approx. 0x27XX

R19: Manufacturer scaling - offset (B_h)
16 bit signed integer [0x0000]
This register contains the offset of the manufacturer's straight-line equation (1.5). The straight-line equation is activated via register R32.

R20: Manufacturer scaling - gain (A_h)
16 bits signed integer *2^{-8} [0x00A0]
This register contains the scaling factor of the manufacturer's straight-line equation (1.5). The straight-line equation is activated via register R32.

R21: Additional offset register for two-wire connection
The value of register 1 at short circuit +R1-RL1 or +R2-RL2
[approx. 0x01AX]

User parameters

R32: Feature register
[0x0106]
The feature register specifies the terminal's operating mode.

Feature bit no.		Description of the operating mode
Bit 0	1	User scaling (R33, R44) active [0]
Bit 1	1	Manufacturer scaling (R19, R20) active [1]
Bit 2	1	Watchdog timer active [1] In the delivery state, the watchdog timer is switched on.
Bit 3	1	Sign / amount representation [0] Sign / amount representation is active instead of two's-complement representation (-1 = 0x8001).
Bit 4	1	Siemens output format [0] This bit is used for inserting status information on the lowest 3 bits (see below).
Bit 5.6	-	reserved, do not change
Bit 7	1	Activates filter constant in R37 [0]
Bit 8	1	Over range Protection [1] If the temperature exceeds 850°C the status bits are correspondingly set and the output value is restricted to 850°C.
Bit 9	-	reserved, do not change
Bit 10	1	Two-wire connection [0]
Bit 11	-	reserved, do not change
Bit 15,14,13,12	Element	Valid measuring range
0 0 0 0	PT100	-200°C to 850°C
0 0 0 1	NI100	-60°C to 250°C
0 0 1 0	PT1000	-200°C to 850°C
0 0 1 1	PT500	-200°C to 850°C
0 1 0 0	PT200	-200°C to 850°C
0 1 0 1	NI1000	-200°C to 850°C
0 1 1 0	NI120	-80°C to 320°C
1 1 1 0	Output in Ω	10.0 Ω to 5000.0 Ω
1 1 1 1	Output in Ω	10.0 Ω to 1200.0 Ω

Output format

If only manufacturer scaling via the feature register is active, the output format is as follows:
1 digit corresponds to 1/10 °C or
1 digit corresponds to 1/10 Ω

If no scaling is active, the output format is as follows:
1 digit corresponds to 1/16 °C or
1 digit corresponds to 1/16 Ω

If the Siemens output format is selected, the lowest three bits are used for status evaluation. The process data is represented in bits 3 to 15, with bit 15 representing the sign bit. Scaling of the measurement reading according to the Siemens standard has to be done via user scaling.

Bit Measured value	Bits 15-3	Bit 2 X	Bit 1 Error	Bit 0 Overflow
out of range		0	0	1
in range	Process data	0	0	0

R33: User scaling - offset (B_w)
16 bit signed integer
This register contains the offset of the user straight-line equation (1.6). The straight-line equation is activated via register R32.

R34: User scaling (A_w)
16 bits signed integer* 2^{-8}. This register contains the scaling factor of the user straight-line equation (1.6). The straight-line equation is activated via register R32.

R35 and R36: reserved

R37: Filter constant
[0x0000]

Note

This documentation applies to all terminals from firmware version 3x. The version number can be found within the serial number on the right-hand side face of the terminal: xxxx3xxx

Example: 5298**3A**2A ⇒ The firmware version is **3A**.

Filter constants:	First notch [Hz]	Conversion time [ms]
0x0000	25	250
0x50	100	65
0xA0	50	125
0x140	25	250
0x280	12.5	500

Control and Status byte

Control byte for process data exchange
Gain and offset compensation

The control byte is transmitted from the controller to the terminal. It can be used
- in register mode (REG = 1_{bin}) or
- during process data exchange (REG = 0_{bin}).
The control byte can be used to carry out gain and offset compensation for the terminal (process data exchange). This requires the code word to be entered in R31. The gain and offset of the terminal can then be compensated.
The parameter will only be saved permanently once the code word is reset!

Control byte:
Bit 7 = 0_{bin}
Bit 6 = 1_{bin}: Terminal compensation function is activated
Bit 4 = 1_{bin}: Gain compensation
Bit 3 = 1 offset compensation
Bit 2 = 0_{bin}: Slower cycle = 1000 ms
1_{bin}: Fast cycle = 50 ms
Bit 1 = 1_{bin}: up
Bit 0 = 1_{bin}: down

Status byte for process data exchange

The status byte is transmitted from the terminal to the controller. The status byte contains various status bits for the analog input channel:

status byte:
Bit 7 = 0_{bin}
Bit 6 = 1_{bin}: ERROR (general error bit)
Bit 5 to bit 2: reserved
Bit 1 = 1_{bin}: Over range
Bit 0 = 1_{bin}: Under range

Compensation

Implemented straight-line equation

Y[Ω] = (X_Adc * G + B_h) * A_h + 100 Ω

Hence:
B_h consists of a component that depends on the gain of the A/D converter and a constant for calculating the axis offset of 100 Ω. The gain-dependent component calculates the offset of the external components (the offset of the component can be varied via adjustable amplification). This procedure is necessary, because compensation at 0 Ω is technically not possible. The line is therefore compensated around the point 100 Ω (offset to the point and rotated around this point).

B_h: (B_off * G + B_100)

- Offset compensation should therefore be carried out for PT100 at 100 Ω (or PT1000 at 1000 Ω).
- Gain compensation is then carried out independently of the offset, e.g. at 300 Ω. 300 Ω corresponds to 557.7°C = 0x15C9

Default setting of the registers:

R17: 0xED68 corresponds to -90.8 Ω
R18: 0x4E20 corresponds to 2000 * 16^{-5} = 0.01907 Ω/digit
R19: 0x0000
R20: 0x00A0

R32: 0x0106
R33: 0x0000
R34: 0x0100

The gain and offset compensation only has to be carried out once, i.e. it does not have to be repeated or corrected for any of the other implemented elements.

For the two-wire connection, with short-circuited line resistance (+R1-Rl1) the raw ADC value of the line resistance (contained in R1) has to be entered in register R21.

KL3202 as resistance input 0 to 1 kΩ

If the KL3202 is used for resistance measurements, the following values should be written into the following registers:

R32: Feature register: 0xF401
i.e. user scaling active with display of the measured value in Ohm and two-wire connection.

R33: User scaling - offset (0x0000)

R34: User scaling - gain (0x0010)
the display of the measured value follows:

Resistance in Ω	Output value
0	0
1000	1000

Register communication

Register access via process data exchange
Bit 7 = 1_{bin}: Register mode

If bit 7 of the control byte is set, then the first two bytes of the user data are not used for exchanging process data, but are written into or read from the terminal's register set.

Bit 6 = 0_{bin}: read
Bit 6 = 1_{bin}: write

Bit 6 of the control byte specifies whether a register should be read or written. If bit 6 is not set, then a register is read out without modifying it. The value can then be taken from the input process image.

If bit 6 is set, then the user data is written into a register. As soon as the status byte has supplied an acknowledgement in the input process image, the procedure is completed (see example).

Bit 0 to 5: Address

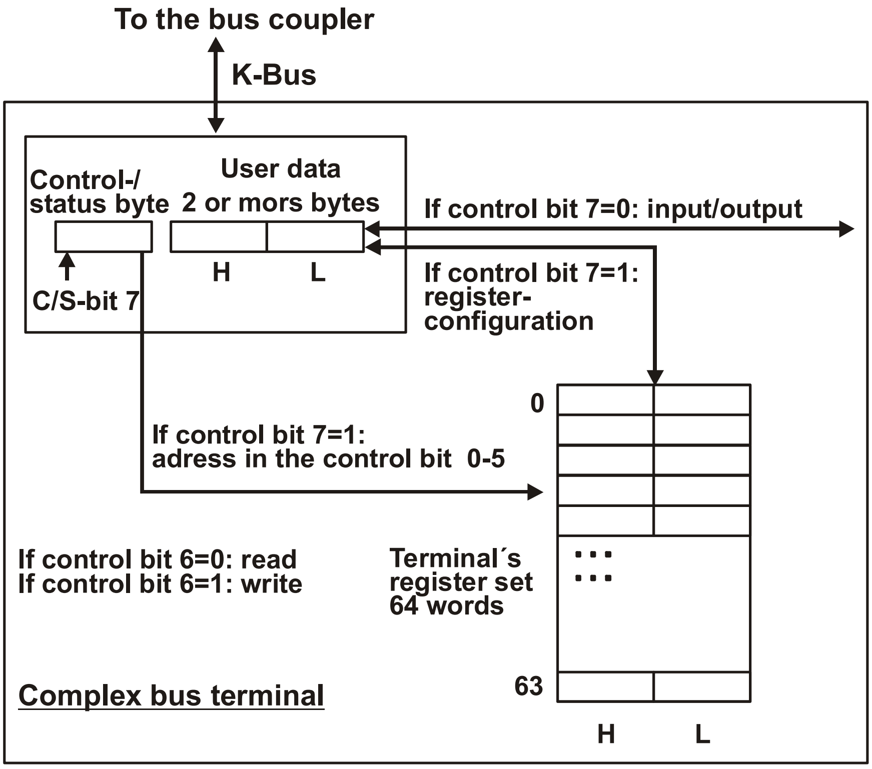
The address of the register that is to be addressed is entered into bits 0 to 5 of the control byte.

Control byte in register mode

MSB

REG=1	W/R	A5	A4	A3	A2	A1	A0

REG = 0_{bin}: Process data exchange
REG = 1_{bin}: Access to register structure
W/R = 0_{bin}: Read register
W/R = 1_{bin}: Write register
A5...A0 = register address
Address bits A5 to A0 can be used to address a total of 64 registers.



The control or status byte occupies the lowest address of a logical channel. The corresponding register values are located in the following 2 data bytes. (The BK2000 is an exception: here, an unused (reserved) data byte is automatically inserted after the control or status byte, and the register value is therefore placed on a word boundary).

Example 1

Reading of register 8 in the BK2000 with a KL3202 and the end terminal:
If the following bytes are transferred from the control to the terminal,

Byte	Byte 3	Byte 2	Byte 1	Byte 0
Name	DataOUT 1	DataOUT 0	Not used	Control byte
Value	0xXX	0xXX	0xXX	0x88

the terminal returns the following type identifier (0x0C82 corresponds to unsigned integer 3202).

Byte	Byte 3	Byte 2	Byte 1	Byte 0
Name	DataIN 1	DataIN 0	Not used	Status byte
Value	0x0C	0x82	0x00	0x88

Example 2

Writing of register 31 in the BK2000 with an intelligent terminal and the end terminal:
If the following bytes (code word) are transferred from the control to the terminal,

Byte	Byte 3	Byte 2	Byte 1	Byte 0
Name	DataOUT 1	DataOUT 0	Not used	Control byte
Value	0x12	0x35	0xXX	0xDF

the code word is set, and the terminal returns the register address with bit 7 for register access as acknowledgement.

Byte	Byte 3	Byte 2	Byte 1	Byte 0
Name	DataIN 1	DataIN 0	Not used	Status byte
Value	0x00	0x00	0x00	0x9F

Appendix

Mapping

As already described in the *Terminal Configuration* section, each Bus Terminal is mapped in the Bus Coupler. In the delivery state, this mapping occurs with the default settings of the Bus Coupler for this terminal. The default setting can be changed with the KS2000 configuration software or with a master configuration software (e.g. TwinCAT System Manager or ComProfibus).

If the terminals are fully evaluated, they occupy memory space in the input and output process image.

The following tables provide information about the terminal mapping, depending on the conditions set in the Bus Coupler.

KL3201

Default mapping for: CANopen, CANCAL, DeviceNet, ControlNet, Modbus, RS232, RS485

Conditions		Word offset	High byte	Low byte
Complete evaluation:	no	0	Ch0 D1	Ch0 D0
Motorola format:	no	1	-	-
Word alignment:	any	2	-	-
		3	-	-

Default mapping for: PROFIBUS, Interbus

Conditions		Word offset	High byte	Low byte
Complete evaluation:	no	0	Ch0 D0	Ch0 D1
Motorola format:	yes	1	-	-
Word alignment:	any	2	-	-
		3	-	-

Conditions		Word offset	High byte	Low byte
Complete evaluation:	yes	0	Ch0 D0	Ch0 CB/SB
Motorola format:	no	1	-	Ch0 D1
Word alignment:	no	2	-	-
		3	-	-

Conditions		Word offset	High byte	Low byte
Complete evaluation:	yes	0	Ch0 D1	Ch0 CB/SB
Motorola format:	yes	1	-	Ch0 D0
Word alignment:	no	2	-	-
		3	-	-

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

Conditions		Word offset	High byte	Low byte
Complete evaluation:	yes	0	res.	Ch0 CB/SB
Motorola format:	no	1	Ch0 D1	Ch0 D0
Word alignment:	yes	2	-	-
		3	-	-

Conditions		Word offset	High byte	Low byte
Complete evaluation:	yes	0	res.	Ch0 CB/SB
Motorola format:	yes	1	Ch0 D0	Ch0 D1
Word alignment:	yes	2	-	-
		3	-	-

Key

See mapping of KL3202.

KL3202

Default mapping for: CANopen, CANCAL, DeviceNet, ControlNet, Modbus, RS232, RS485

Conditions		Word offset	High byte	Low byte
Complete evaluation:	no	0	Ch0 D1	Ch0 D0
Motorola format:	no	1	Ch1 D1	Ch1 D0
Word alignment:	any	2	-	-
		3	-	-

Default mapping for: PROFIBUS, Interbus

Conditions		Word offset	High byte	Low byte
Complete evaluation:	no	0	Ch0 D0	Ch0 D1
Motorola format:	yes	1	Ch1 D0	Ch1 D1
Word alignment:	any	2	-	-
		3	-	-

Conditions		Word offset	High byte	Low byte
Complete evaluation:	yes	0	Ch0 D0	Ch0 CB/SB
Motorola format:	no	1	Ch1 CB/SB	Ch0 D1
Word alignment:	no	2	Ch1 D1	Ch1 D0
		3	-	-

Conditions		Word offset	High byte	Low byte
Complete evaluation:	yes	0	Ch0 D1	Ch0 CB/SB
Motorola format:	yes	1	Ch1 CB/SB	Ch0 D0
Word alignment:	no	2	Ch1 D0	Ch1 D1
		3	-	-

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

Conditions		Word offset	High byte	Low byte
Complete evaluation:	yes	0	res.	Ch0 CB/SB
Motorola format:	no	1	Ch0 D1	Ch0 D0
Word alignment:	yes	2	res.	Ch1 CB/SB
		3	Ch1 D1	Ch1 D0

Conditions		Word offset	High byte	Low byte
Complete evaluation:	yes	0	res.	Ch0 CB/SB
Motorola format:	yes	1	Ch0 D0	Ch0 D1
Word alignment:	yes	2	res.	Ch1 CB/SB
		3	Ch1 D0	Ch1 D1

Key

Complete evaluation:
The terminal is mapped with control and status byte.

Motorola format:
Motorola or Intel format can be set.

Word alignment:
The terminal is at word limit in the Bus Coupler.

Ch n SB: status byte for channel n (appears in the input process image).
Ch n CB: control byte for channel n (appears in the output process image).

Ch n D0: channel n, data byte 0 (byte with the lowest value)
Ch n D1: channel n, data byte 1 (byte with the highest value)

"-": This byte is not used or occupied by the terminal.
res.: reserved:
This byte occupies process data memory, although it is not used.

KL3204

Default mapping for: CANopen, CANCAL, DeviceNet, ControlNet, Modbus, RS232, RS485

Conditions		Word offset	High byte	Low byte
Complete evaluation:	no	0	Ch0 D1	Ch0 D0
Motorola format:	no	1	Ch1 D1	Ch1 D0
Word alignment:	any	2	Ch2 D1	Ch2 D0
		3	Ch3 D1	Ch3 D0

Default mapping for: PROFIBUS, Interbus

Conditions		Word offset	High byte	Low byte
Complete evaluation:	no	0	Ch0 D0	Ch0 D1
Motorola format:	yes	1	Ch1 D0	Ch1 D1
Word alignment:	any	2	Ch2 D0	Ch2 D1
		3	Ch3 D0	Ch3 D1

Conditions		Word offset	High byte	Low byte
Complete evaluation:	yes	0	Ch0 D0	Ch0 CB/SB
Motorola format:	no	1	Ch1 CB/SB	Ch0 D1
Word alignment:	no	2	Ch1 D1	Ch1 D0
		3	Ch2 D0	Ch2 CB/SB
		4	Ch3 CB/SB	Ch2 D1
		5	Ch3 D1	Ch3 D0

Conditions		Word offset	High byte	Low byte
Complete evaluation:	yes	0	Ch0 D1	Ch0 CB/SB
Motorola format:	yes	1	Ch1 CB/SB	Ch0 D0
Word alignment:	no	2	Ch1 D0	Ch1 D1
		3	Ch2 D1	Ch2 CB/SB
		4	Ch3 CB/SB	Ch2 D0
		5	Ch3 D0	Ch3 D1

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

Conditions		Word offset	High byte	Low byte
Complete evaluation:	yes	0	res.	Ch0 CB/SB
Motorola format:	no	1	Ch0 D1	Ch0 D0
Word alignment:	yes	2	res.	Ch1 CB/SB
		3	Ch1 D1	Ch1 D0
		4	res.	Ch2 CB/SB
		5	Ch2 D1	Ch2 D0
		6	res.	Ch3 CB/SB
		7	Ch3 D1	Ch3 D0

Conditions		Word offset	High byte	Low byte
Complete evaluation:	yes	0	res.	Ch0 CB/SB
Motorola format:	yes	1	Ch0 D0	Ch0 D1
Word alignment:	yes	2	res.	Ch1 CB/SB
		3	Ch1 D0	Ch1 D1
		4	res.	Ch2 CB/SB
		5	Ch2 D0	Ch2 D1
		6	res.	Ch3 CB/SB
		7	Ch3 D0	Ch3 D1

Key

See mapping of KL3202.

Register Table

These registers exist once for each channel.

Address	Denomination	Default value	R/W	Storage medium
R0	Raw ADC value	variable	R	RAM
R1	Unprocessed ADC value for the leads	variable	R	
R2	reserved	0x0000	R	
R3	...	...	...	...
R5	reserved	0x0000	R	
R6	Diagnostic register	variable	R	RAM
R7	Command register not used	0x0000	R	
R8	Terminal type	e.g. 3202	R	ROM
R9	Software version number	0x????	R	ROM
R10	Multiplex shift register	0x0218/0130	R	ROM
R11	Signal channels	0x0218	R	ROM
R12	Minimum data length	0x0098	R	ROM
R13	Data structure	0x0000	R	ROM
R14	reserved	0x0000	R	
R15	Alignment register	variable	R/W	RAM
R16	Hardware version number	0x????	R/W	SEEROM
R17	Hardware compensation: Offset	specific	R/W	SEEROM
R18	Hardware compensation: Gain	specific	R/W	SEEROM
R19	Manufacturer scaling: Offset	0x0000	R/W	SEEROM
R20	Manufacturer scaling: Gain	0x00A0	R/W	SEEROM
R21	Offset register two-wire connection method	specific	R/W	SEEROM
R22	reserved	0x0000	R/W	SEEROM
R3	...	...	...	...
R30	reserved	0x0000	R/W	SEEROM
R31	Code word register	variable	R/W	RAM
R32	Feature register	0x0106	R/W	SEEROM
R33	User scaling: Offset	0x0000	R/W	SEEROM
R34	User scaling: Gain	0x0100	R/W	SEEROM
R35	reserved	0x0000	R/W	SEEROM
R36	reserved	0x0000	R/W	SEEROM
R37	Filter constant	0x0138	R/W	SEEROM
R38	reserved	0x0000	R/W	SEEROM
...	...	...	...	...
R63	reserved	0x0000	R/W	SEEROM

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