

Configuration Instructions for

# KL5001

SSI Sensor Interface

Version: 2.4

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**BECKHOFF**

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# Foreword

## 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.

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.

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The documentation has been prepared with care. The products described are, however, constantly under development.

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# Safety Instructions

## State at Delivery

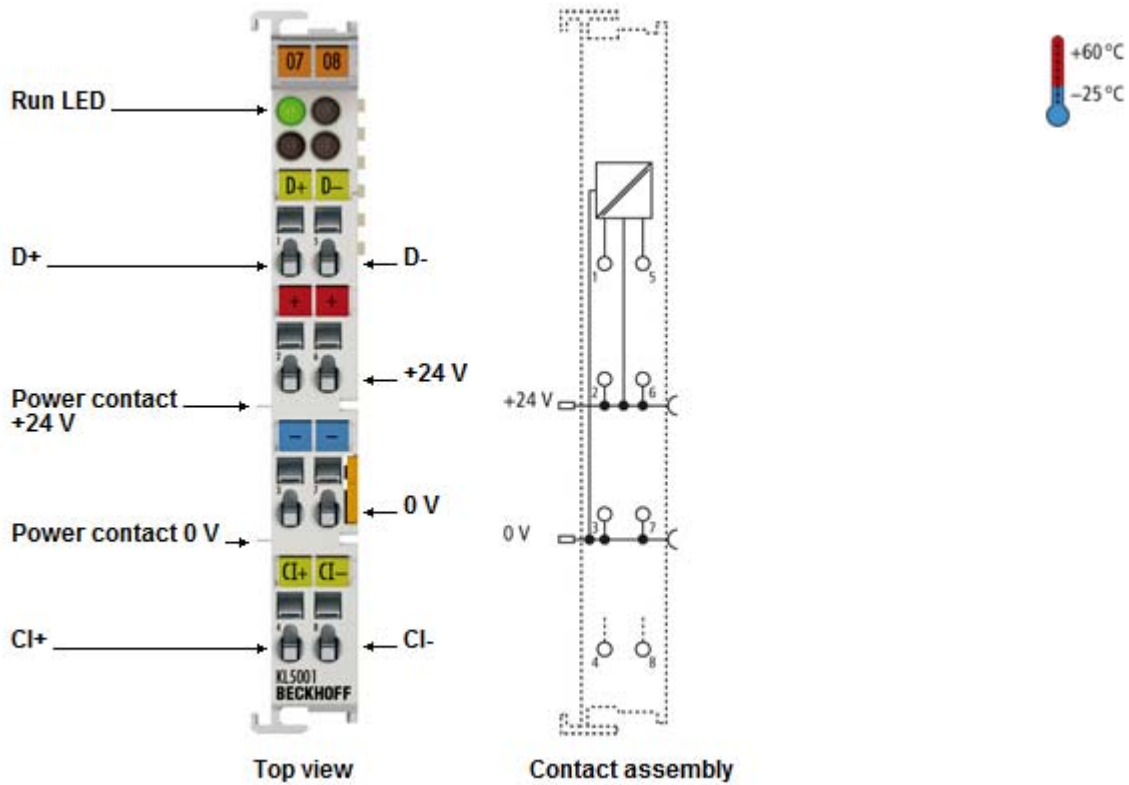
All the components are supplied in particular hardware and software configurations appropriate for the application. Modifications to hardware or software configurations other than those described in the documentation are not permitted, and nullify the liability of Beckhoff Automation GmbH & Co. KG.

## 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..


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


# Technical data



| Technical data                              | KL5001  |
|---|---|
| Encoder connection                          | binary input: D+, D-; binary output: Cl+, Cl-   |
| Power supply                                | 24 V via power contacts   |
| Current consumption                         | typically 20 mA without sensor  |
| Current consumption power contacts          | typ. 20 mA + load   |
| Encoder supply                              | 24 V <sub>DC</sub> (20 ... 29 V <sub>DC</sub> ) via power contacts  |
| Current consumption from K-Bus              | 25 mA typ.  |
| Data transfer rate                          | variable up to 1 MHz, 250 kHz default   |
| Serial input                                | 24 bit width (variable)   |
| Data direction                              | read  |
| Signal output                               | difference signal (RS422)   |
| Signal input                                | difference signal (RS422)   |
| Electrical isolation                        | 500 V (K-Bus / field voltage)   |
| Bit width in the process image              | input: 1 x 32 bit data, (1 x 8 bit control/status optional)   |
| Weight                                      | app. 60 g   |
| Permissible ambient temperature (operation) | -25°C ... +60°C<br>0°C ... +55°C (according to cULus for Canada and USA)<br>0°C ... +55°C (according to ATEX, see special conditions) |
| Permissible ambient temperature (storage)   | -40°C... +85°C  |
| Relative humidity                           | 95%, no condensation  |
| 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   |
| Installation pos. / Protect. class          | any / IP20  |
| Approvals                                   | CE, cULus, ATEX   |

# ATEX - Special conditions

|   |   |
|---|---|
|  <p><b>WARNING</b></p> | <p><b>Observe the special conditions for the intended use of Beckhoff fieldbus components in potentially explosive areas (directive 94/9/EU)!</b></p> <ul style="list-style-type: none"><li>• The certified components are to be installed in a suitable housing that guarantees a protection class of at least IP54 in accordance with EN 60529! The environmental conditions during use are thereby to be taken into account!</li><li>• If the temperatures during rated operation are higher than 70°C at the feed-in points of cables, lines or pipes, or higher than 80°C at the wire branching points, then cables must be selected whose temperature data correspond to the actual measured temperature values!</li><li>• Observe the permissible ambient temperature range of 0 to 60°C for the use of Beckhoff fieldbus components in potentially explosive areas!</li><li>• Measures must be taken to protect against the rated operating voltage being exceeded by more than 40% due to short-term interference voltages!</li><li>• The individual terminals may only be unplugged or removed from the Bus Terminal system if the supply voltage has been switched off or if a non-explosive atmosphere is ensured!</li><li>• The connections of the certified components may only be connected or disconnected if the supply voltage has been switched off or if a non-explosive atmosphere is ensured!</li><li>• The fuses of the KL92xx power feed terminals may only be exchanged if the supply voltage has been switched off or if a non-explosive atmosphere is ensured!</li><li>• Address selectors and ID switches may only be adjusted if the supply voltage has been switched off or if a non-explosive atmosphere is ensured!</li></ul> |
|---|---|

|  |  |
|--|--|
|  <p><b>Note</b></p> | <p><b>Operation of the Bus Terminal System in potentially explosive areas (ATEX)!</b></p> <p>Pay also attention to the continuative documentation</p> <p><i>Notes about operation of the Bus Terminal System in potentially explosive areas (ATEX)</i></p> <p>that is available in the <a href="#">download area</a> of the Beckhoff homepage <a href="http://www.beckhoff.com">http://www.beckhoff.com</a>!</p> |
|--|--|

## Description of functions

The terminal KL5001 is an SSI interface for the direct connection of an SSI sensor. The sensor is powered via the SSI interface. To read out the sensor, the terminal outputs a clock burst and provides the incoming data stream to the controller in the process image. Different operating modes, transmission frequencies, bit widths and code conversions can be set. The individual configuration is stored permanently in a register set.

### LED display

The run LED indicates the operating state of the terminal.

On – normal operation

Off – watchdog timer overflow has occurred. The green LED goes off if no process data is transmitted by the bus coupler for 100 ms.

### Process data Alternative output format

The SSI interface is supplied with a data width of 24 bits and Gray binary number conversion activated in the alternative output format. The baud rate to the SSI sensors is set to 250 kHz. The process data is output in the input data bytes D0 - D3. Mapping of the terminal in the alternative format is described in further detail in the chapter on terminal configuration.

### Standard output format

In the standard output format, 4 bytes of input data are mapped in the bus coupler by default.

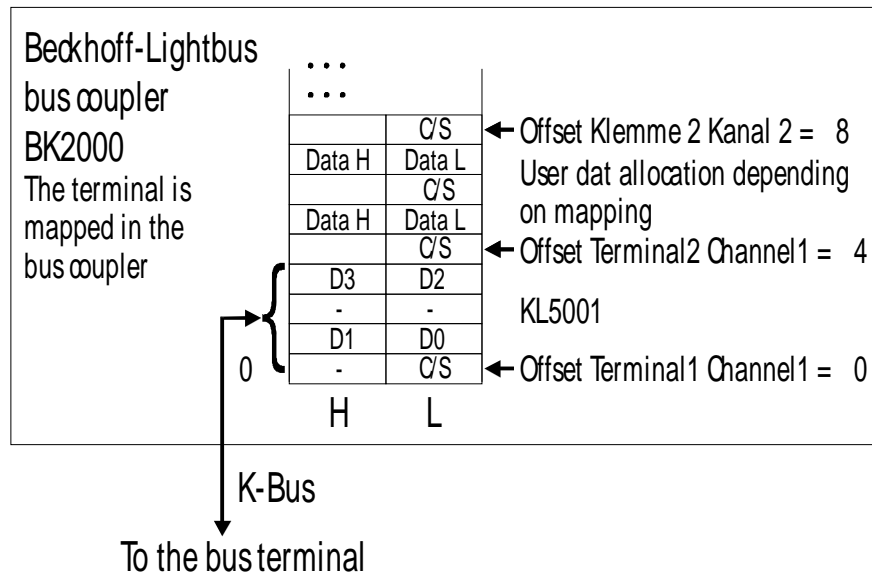
## Terminal configuration

The terminal can be configured and parameterized via the internal register structure.

Each terminal channel is mapped in the bus coupler. The data of the terminal is mapped differently in the memory of the bus coupler depending on the type of the bus coupler and on the set mapping configuration (e.g. Motorola/ Intel format, word alignment, etc.). For parameterization of a terminal, the control/status byte must also be mapped.

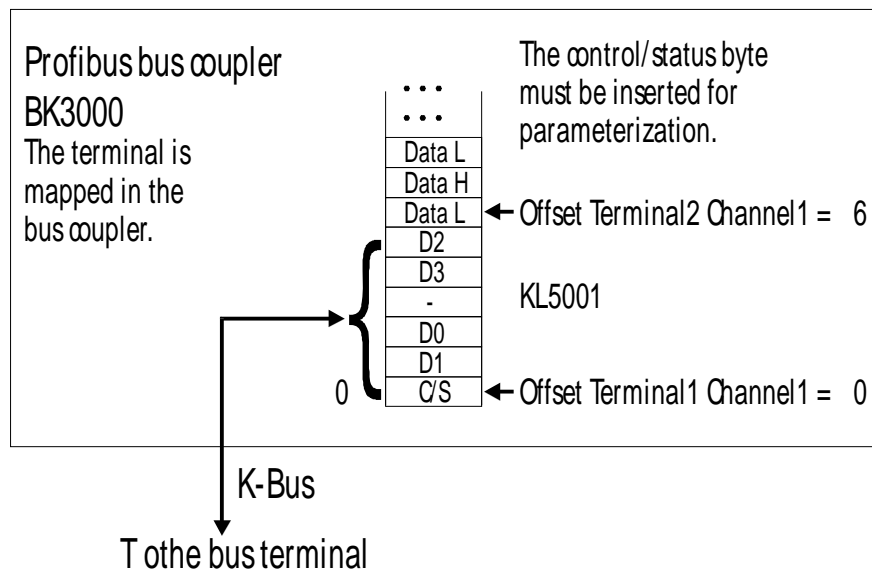
Beckhoff Lightbus coupler BK2000

In the case of the Beckhoff Lightbus coupler BK2000, the control /status byte is also always (i.e. in the case of all analog terminals) mapped in addition to the data bytes. It is always in the low byte at the offset address of the terminal channel.



PROFIBUS coupler BK3000

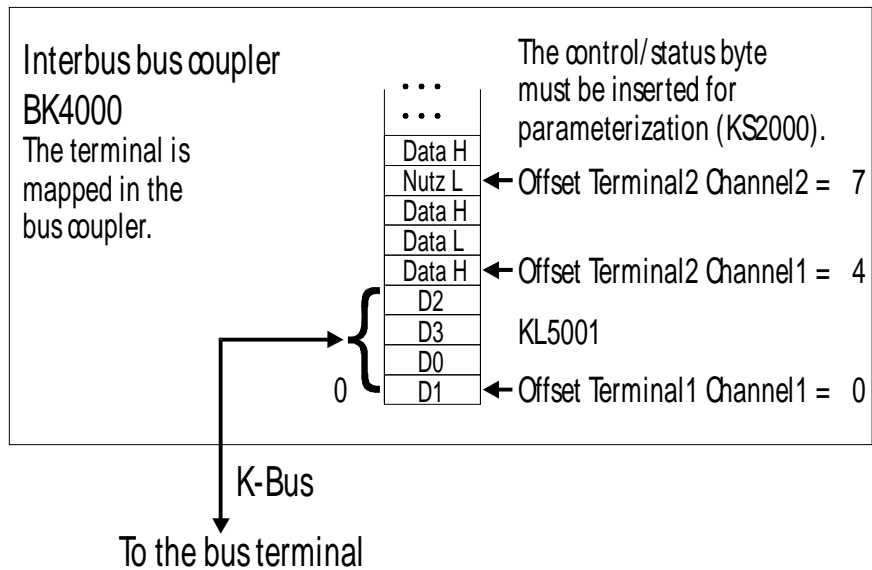
In the case of the PROFIBUS coupler BK3000, for which terminal channels the control/status byte is also to be inserted must be defined in the master configuration. If the control/status byte is not evaluated, the KL5001 occupies 4 bytes of input data. The figure shows the mapping with control/status byte.






Interbus coupler BK4000

By default, the Interbus coupler BK4000 maps the KI5001 with 4 bytes of input data. Parametrization via the field bus is not possible. The KS2000 configuration software is required for configuration if use is to be made of the control/status byte.



Other bus couplers and further information

You will find further information on the mapping configuration of bus couplers in the annex of the respective bus coupler manual and under the heading of "Configuration of Masters".

|  |  |
|--|--|
| <br><b>Note</b> | <p><b>Overview of mapping configurations</b></p> <p>The annex contains an overview of possible mapping configurations depending on the parameters that can be set.</p> |
|--|--|

Parameterization with KS2000

Independently of the field bus system, parameters can be set via the serial configuration interface in the bus coupler using the KS2000 configuration software.

## Register description

The complex terminals can be adjusted to different operating modes or functionalities. The "general description of register" describes the contents of the registers, which are identical for all complex terminals.

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

The access to the internal registers of the terminal is described in the section "register communication".

### General register description

Complex terminals that possess a processor are capable of bi-directionally exchanging data with the higher-level control system. Below, these terminals are referred to as intelligent bus terminals. They include the analog inputs (0 to 10 V, -10 to 10 V, 0 to 20 mA, 4 to 20 mA), the analog outputs (0 to 10 V, -10 to 10 V, 0 to 20 mA, 4 to 20 mA), serial interface terminals (RS485, RS232, TTY, data transfer terminals), counter terminals, encoder interfaces, SSI interfaces, PWM terminals and all other parameterizable terminals.

Internally, all intelligent terminals possess a data structure that is identical in terms of its essential characteristics. This data area is organized in words and embraces 64 memory locations. The essential data and parameters of the terminal can be read and adjusted by way of the structure. Function calls with corresponding parameters are also possible. Each logical channel of an intelligent terminal has such a structure (therefore, 4-channel analog terminals have 4 register sets. This structure is broken down into the following areas.

| Area                    | Address |
|-------------------------|---------|
| Process variables       | 0-7     |
| Type registers          | 8-15    |
| Manufacturer parameters | 16-30   |
| User parameters         | 31-47   |
| Extended user area      | 48-63   |

You will find a list of all registers at the end of this documentation

Process variables

#### **R0 - R7: Registers in the terminal's internal RAM:**

The process variables can be used in addition to the actual process image and their functions are specific to the terminal.

**R0 - R5: These registers have a function that depends on the terminal type.**

#### **R6: Diagnostic register**

The diagnostic register may contain additional diagnostic information. In the case of serial interface terminals, for example, parity errors that have occurred during data transfer are indicated.

#### **R7: Command register**

High-Byte\_Write = function parameter

Low-Byte\_Write = function number

High-Byte\_Read = function result

Low-Byte\_Read = function number

## Type registers

**R8 - R15 Registers in the terminal's internal ROM**

The type and system parameters are programmed permanently by the manufacturer and can only be read by the user but cannot be modified.

**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 an ASCII character string.

**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**

In comparison with R10, the number of logically existing channels is located here. For example, one physically existing shift register may consist of several signal channels.

**R12: Minimum data length**

The respective byte contains the minimum data length of a channel to be transferred. If the MSB is set, then the control/status byte is not necessarily needed for the function of the terminal and, with appropriate configuration of the coupler, is not transferred to the control system.

**R13: Data type register**

| Data type register |   |
|--------------------|---|
| 0x00               | Terminal without valid data type  |
| 0x01               | Byte array  |
| 0x02               | 1 byte n bytes structure  |
| 0x03               | Word array  |
| 0x04               | 1 byte n words structure  |
| 0x05               | Double word array   |
| 0x06               | 1 byte n double words structure   |
| 0x07               | 1 byte 1 double word structure  |
| 0x08               | 1 byte 1 double word structure  |
| 0x11               | Byte-array with a variable logical channel length                           |
| 0x12               | 1 byte n bytes structure with a variable logical channel length (e.g. 60xx) |
| 0x13               | Word-array with a variable logical channel length                           |
| 0x14               | 1 byte n words structure with a variable logical channel length             |
| 0x15               | Double word array with a variable logical channel length                    |
| 0x16               | 1 byte n double words structure with a variable logical channel length      |

**R14: not used****R15: Alignment bits (RAM)**

The analog terminal is set to a byte limit in the terminal bus with the alignment bits.

## Manufacturer parameters

**R16 - R30 is the area of the "Manufacturer parameters" (SEEPROM)**

The manufacturer parameters are specific to each terminal type. They are programmed by the manufacturer but can also be modified from the control system. The manufacturer parameters are stored permanently in a serial EEPROM and are therefore not destroyed by power failures.

These registers can only be modified after setting a code word in R31.

## User parameters

**R31 - R47 "Application parameters" area (SEEROM)**

The application parameters are specific to each terminal type. They can be modified by the programmer. The application parameters are stored permanently in a serial EEPROM in the terminal and cannot be destroyed by power failures. The user area is write protected over a code word.

**Note****R31: Code word-register in the RAM**

The code word **0x1235** must be entered here to enable modification of parameters in the user area. Write-protection is set if a different value is entered in this register. When write protection is inactive, the code word is returned during reading of the register. The register contains the value zero when write protection is active.

**R32: Feature-register**

This register defines the operating modes of the terminal. For example, a user-specific scaling can be activated for the analog I/Os.

**R33 - R47**

Registers that depend on the terminal type

## Extended application area

**R47 - R63**

These registers have not yet been implemented.

## Terminal-specific register description

Application parameters

### R32: feature register

[0x0007]

The feature register determines the operating modes of the terminal.

| Feature bit No. |     | Description of the operating mode   |
|-----------------|-----|---|
| Bit 0           | 0/1 | 0: binary output<br>1: gray binary number conversion [default]<br>The numbers are output as binary numbers  |
| Bit 1           | 0/1 | 0: standard output format<br>1: alternative output format [default]   |
| Bit 2           | 0/1 | 0: free run<br>1: synchronous mode [default]<br>The data is loaded in synchronism with the read cycle of the terminal bus.  |
| Bit 3           | 0/1 | 0: multi turn evaluation of the sensor [default], max. 25 bit<br>1: single turn evaluation of the sensor, max. 13 bit   |
| Bit 4           | 0/1 | 0: enable frame error [default]<br>1: disable frame Error<br>After the last valid bit, no check is made as to whether the data line is supplying a zero signal.   |
| Bit 5*          | 0/1 | Some SSI sensors display the state of their power supply with the power failure bit (PFB).<br>0: Power Failure not displayed [default]<br>1: Power Failure displayed:<br>bit 2 of the KL5001's status byte shows the latest transmitted state of PFB. |
| Bit 6*          | 0/1 | 0: variable data frame disabled [default]<br>1: variable data frame enabled:<br>The data frame length is specified in in R35 and it is limited from 2 to 32 bit.  |
| Bit 7 - 15      | -   | reserved, don't change  |

\*) from hardware version 09 and firmware version 4 A

### R33: baud rate

[0x0002]

The baud rate for reading the SSI sensor is selected via this register.

High byte = not used

| Low byte | Baud rate         |
|----------|-------------------|
| 1        | 1 MHz             |
| 2        | 250 kHz [default] |
| 3        | 125 kHz           |
| 4        | 100 kHz           |
| 5        | 83 kHz            |
| 6        | 71 kHz            |
| 7        | 62.5 kHz          |

### R34: data length

[0x18]

The data length that appears in the process image can be set by this register.

The permissible value range is: 0 to 32 bits

HB = not used

Low byte = 0...32 bits in hexadecimal notation

**R35\*: Variable frame length**

If bit R32.6 is set in the feature register (R32), the data frame length is parameterizable via Register R35. The data frame length should be  $\geq$  the data length (R34). Otherwise a FRAME\_E is generated within the Status Byte.

\*) from hardware version 09 and firmware version 4 A

STATUS byte during process data exchange

The status byte is transferred from the terminal to the controller. The status byte contains various status bits of the SSI sensor interface terminal KL5001.

MSB

|       |       |   |   |   |     |         |          |
|-------|-------|---|---|---|-----|---------|----------|
| REG=0 | ERROR | 0 | 0 | 0 | PFB | FRAME_E | SSI_IN_E |
|-------|-------|---|---|---|-----|---------|----------|

| Bit      | Function   |
|----------|--|
| ERROR    | A general error has occurred. This bit is set if a FRAME or SSI_IN error has occurred.   |
| PFB*     | Power Failure Bit: displays the state of the power supply of SSI sensors supporting this.  |
| FRAME_E  | An invalid data frame has occurred, i.e. the data frame is not terminated with zero (possibly a wire breakage on clock lines).   |
| SSI_IN_E | The SSI input of the terminal has low level when no data transfer is taking place. (SSI has no power supply or wire breakage at the SSI data inputs D+ or D- or data lines swapped.) |

\*) from hardware version 09 and firmware version 4 A

## Register communication KL5001

Register access via process data transfer  
Bit 7=1: register mode

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

Bit 6=0: read  
Bit 6=1: write

In bit 6 of the control byte, you define whether a register is to be read or written. When bit 6 is not set, a register is read without modification. The value can be taken from the input process image.

When bit 6 is set, the user data is written into a register. The operation is concluded as soon as the status byte in the input process image has supplied an acknowledgement (see examples).

Bits 0 to 5: address

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

Control byte in the register mode

MSB

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

REG = 0 : Process data transfer

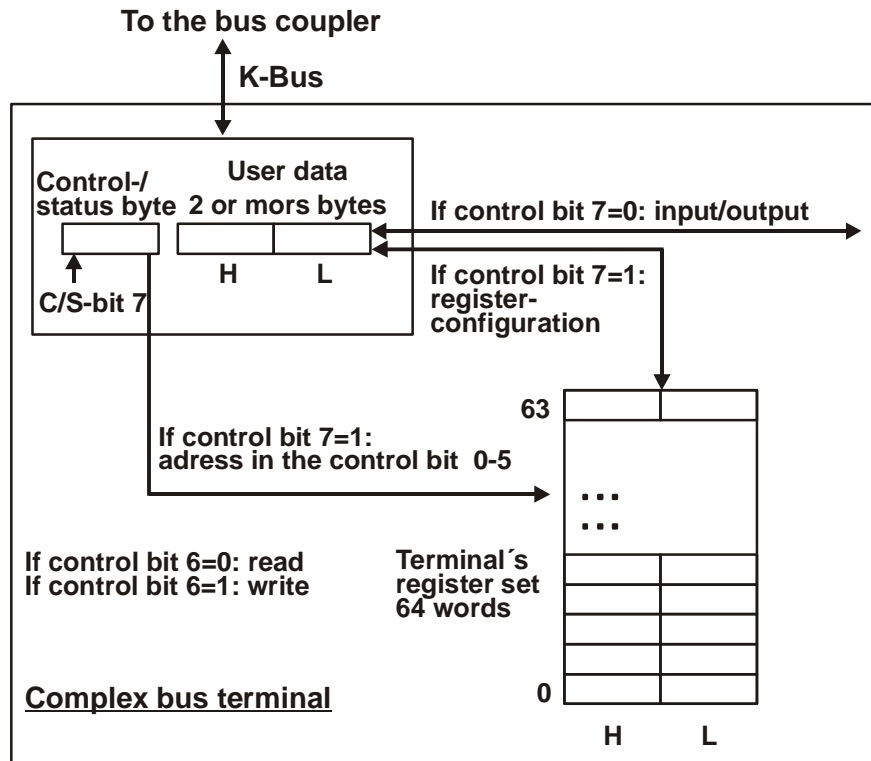
REG = 1 : Access to register structure

W/R = 0 : Read register

W/R = 1 : Write register

A5..A0 = Register address

A total of 64 registers can be addressed with the addresses A5....A0.



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 to the rule: here, an unused data byte is inserted after the control or status byte, thus setting the register value to a word limit).

Example

Reading register 8 in the BK2000 with a KI3022 and the end terminal.

If the following bytes are transferred from the controller to the terminal,

| Byte0   | Byte1    | Byte2               | Byte3              |
|---------|----------|---------------------|--------------------|
| Control | Not used | Data OUT, high byte | Data OUT, low byte |
| 0x88    | 0xXX     | 0xXX                | 0xXX               |

the terminal returns the following type designation (0x0BCE corresponds to the unsigned integer 3022).

| Byte0  | Byte1    | Byte2              | Byte3             |
|--------|----------|--------------------|-------------------|
| Status | Not used | Data IN, high byte | Data IN, low byte |
| 0x88   | 0x00     | 0x0B               | 0xCE              |

A further example

Writing register 31 in the BK2000 with an intelligent terminal and the end terminal.

If the following bytes (user code word) are transferred from the controller to the terminal,

| Byte0   | Byte1    | Byte2               | Byte3              |
|---------|----------|---------------------|--------------------|
| Control | Not used | Data OUT, high byte | Data OUT, low byte |
| 0xDF    | 0xXX     | 0x12                | 0x35               |

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

| Byte0  | Byte1    | Byte2              | Byte3             |
|--------|----------|--------------------|-------------------|
| Status | Not used | Data IN, high byte | Data IN, low byte |
| 0x9F   | 0x00     | 0x00               | 0x00              |

# Appendix

As already described in the chapter terminal configuration, each bus terminal is mapped in the bus coupler. In the standard case, this mapping is done with the default setting in the bus coupler / bus terminal. This default setting can be modified with the Beckhoff KS2000 configuration software or using master configuration software (e.g. ComProfibus or TwinCAT System Manager). The following tables provide information on how the KL5001 maps itself in the bus coupler depending on the set parameters.

## Mapping in the bus coupler

### Standard Format

The KL5001 is mapped in the bus coupler depending on the set parameters. If the terminal is evaluated completely, the terminal occupies memory space in the process image of the input and outputs.

|                      |            | I/O Offset | High Byte | Low Byte |
|----------------------|------------|------------|-----------|----------|
| Complete evaluation: | no         | 3          |           |          |
| Motorola format:     | no         | 2          |           |          |
| Word alignment:      | don't care | 1          | D3        | D2       |
|                      |            | 0          | D1        | D0       |

|                      |            | I/O Offset | High Byte | Low Byte |
|----------------------|------------|------------|-----------|----------|
| Complete evaluation: | no         | 3          |           |          |
| Motorola format:     | yes        | 2          |           |          |
| Word alignment:      | don't care | 1          | D0        | D1       |
|                      |            | 0          | D2        | D3       |

|                      |     | I/O Offset | High Byte | Low Byte |
|----------------------|-----|------------|-----------|----------|
| Complete evaluation: | yes | 3          |           |          |
| Motorola format:     | no  | 2          |           | D3       |
| Word alignment:      | no  | 1          | D2        | D1       |
|                      |     | 0          | D0        | CB/SB    |

|                      |     | I/O Offset | High Byte | Low Byte |
|----------------------|-----|------------|-----------|----------|
| Complete evaluation: | yes | 3          |           |          |
| Motorola format:     | yes | 2          |           | D0       |
| Word alignment:      | no  | 1          | D1        | D2       |
|                      |     | 0          | D3        | CB/SB    |

|                      |     | I/O Offset | High Byte | Low Byte |
|----------------------|-----|------------|-----------|----------|
| Complete evaluation: | yes | 3          |           |          |
| Motorola format:     | no  | 2          | D3        | D2       |
| Word alignment:      | yes | 1          | D1        | D0       |
|                      |     | 0          | -         | CB/SB    |

|                      |     | I/O Offset | High Byte | Low Byte |
|----------------------|-----|------------|-----------|----------|
| Complete evaluation: | yes | 3          |           |          |
| Motorola format:     | no  | 2          | D0        | D1       |
| Word alignment:      | yes | 1          | D2        | D3       |
|                      |     | 0          | -         | CB/SB    |



Alternative Format

In the alternative format the KL5001 is mapped with 4 or 6 data bytes. If the terminal is evaluated completely, the terminal occupies memory space in the process image of the input **and** outputs.

Default: CANCEL, CANopen, RS232, RS485, ControlNet, and DeviceNet coupler

|                         | I/O Offset | High Byte | Low Byte |
|-------------------------|------------|-----------|----------|
| Complete evaluation: no | 3          |           |          |
| MOTOROLA format: no     | 2          |           |          |
| Word alignment: no      | 1          | D3        | D2       |
|                         | 0          | D1        | D0       |

Default: Interbus and PROFIBUS coupler

|                         | I/O Offset | High Byte | Low Byte |
|-------------------------|------------|-----------|----------|
| Complete evaluation: no | 3          |           |          |
| Motorola format: yes    | 2          |           |          |
| Word alignment: no      | 1          | D2        | D3       |
|                         | 0          | D0        | D1       |

|                          | I/O Offset | High Byte | Low Byte |
|--------------------------|------------|-----------|----------|
| Complete evaluation: yes | 3          |           |          |
| Motorola format: no      | 2          | D3        | D2       |
| Word alignment: no       | 1          | -         | D1       |
|                          | 0          | D0        | CB/SB    |

|                          | I/O Offset | High Byte | Low Byte |
|--------------------------|------------|-----------|----------|
| Complete evaluation: yes | 3          |           |          |
| Motorola format: yes     | 2          | D2        | D3       |
| Word alignment: no       | 1          | -         | D0       |
|                          | 0          | D1        | CB/SB    |

Default: EtherCAT and Lightbus coupler, Bus Terminal Controller (BCxxxx, BXxxxx)

|                          | I/O Offset | High Byte | Low Byte |
|--------------------------|------------|-----------|----------|
| Complete evaluation: yes | 3          | D3        | D2       |
| Motorola format: no      | 2          | -         | -        |
| Word alignment: yes      | 1          | D1        | D0       |
|                          | 0          | -         | CB/SB    |

|                          | I/O Offset | High Byte | Low Byte |
|--------------------------|------------|-----------|----------|
| Complete evaluation: yes | 3          | D2        | D3       |
| Motorola format: yes     | 2          | -         | -        |
| Word alignment: yes      | 1          | D0        | D1       |
|                          | 0          | -         | CB/SB    |

Key

Complete evaluation: The terminal is mapped with control / status byte.  
 Motorola format: The Motorola or Intel format can be set.  
 Word alignment: The terminal is at a word limit in the bus coupler.  
 CB: Control-Byte (appears in the PI of the outputs).  
 SB: Status-Byte (appears in the PI of the inputs).  
 D0 – D3: Data bytes

## Table of the register

### Register set

| Address | Description                 | Default value | R/W | Storage medium |
|---------|-----------------------------|---------------|-----|----------------|
| R0      | not used                    | 0x0000        | R   |                |
| R1      | not used                    | 0x0000        | R   |                |
| R2      | not used                    | 0x0000        | R   |                |
| R3      | not used                    | 0x0000        | R   |                |
| R4      | not used                    | 0x0000        | R   |                |
| R5      | not used                    | 0x0000        | R   |                |
| R6      | Diagnostic register         | variable      | R   | RAM            |
| R7      | Command register - not used | 0x0000        | R   |                |
| R8      | Terminal type               | 5001          | R   | ROM            |
| R9      | Firmware version            | 0x????        | R   | ROM            |
| R10     | Multiplex shift register    | 0x0218        | R   | ROM            |
| R11     | Signal channels             | 0x0128        | R   | ROM            |
| R12     | Minimum data length         | 0x00A8        | R   | ROM            |
| R13     | Data structure              | 0x0000        | R   | ROM            |
| R14     | not used                    | 0x0000        | R   |                |
| R15     | Alignment register          | variable      | R/W | RAM            |
| R16     | Hardware version number     | 0x????        | R/W | SEEROM         |
| R17     | not used                    | 0x0000        | R/W | SEEROM         |
| R18     | not used                    | 0x0000        | R/W | SEEROM         |
| R19     | not used                    | 0x0000        | R/W | SEEROM         |
| R20     | not used                    | 0x0000        | R/W | SEEROM         |
| R21     | not used                    | 0x0000        | R/W | SEEROM         |
| R22     | not used                    | 0x0000        | R/W | SEEROM         |
| R23     | not used                    | 0x0000        | R/W | SEEROM         |
| R24     | not used                    | 0x0000        | R/W | SEEROM         |
| R25     | not used                    | 0x0000        | R/W | SEEROM         |
| R26     | not used                    | 0x0000        | R/W | SEEROM         |
| R27     | not used                    | 0x0000        | R/W | SEEROM         |
| R28     | not used                    | 0x0000        | R/W | SEEROM         |
| R29     | not used                    | 0x0000        | R/W | SEEROM         |
| R30     | not used                    | 0x0000        | R/W | SEEROM         |
| R31     | Code word register          | variable      | R/W | RAM            |
| R32     | Feature register            | 0x0007        | R/W | SEEROM         |
| R33     | Baud rate                   | 0x0002        | R/W | SEEROM         |
| R34     | Data length                 | 0x0018        | R/W | SEEROM         |
| R35     | Variable Frame Length*      | 0x0000        | R/W | SEEROM         |
| R36     | not used                    | 0x0000        | R/W | SEEROM         |
| R37     | not used                    | 0x0000        | R/W | SEEROM         |
| R38     | not used                    | 0x0000        | R/W | SEEROM         |
| R39     | not used                    | 0x0000        | R/W | SEEROM         |
| R40     | not used                    | 0x0000        | R/W | SEEROM         |
| R41     | not used                    | 0x0000        | R/W | SEEROM         |
| R42     | not used                    | 0x0000        | R/W | SEEROM         |
| R43     | not used                    | 0x0000        | R/W | SEEROM         |
| R44     | not used                    | 0x0000        | R/W | SEEROM         |
| R45     | not used                    | 0x0000        | R/W | SEEROM         |
| R46     | not used                    | 0x0000        | R/W | SEEROM         |
| R47     | not used                    | 0x0000        | R/W | SEEROM         |

\*) from hardware version 08 und firmware version 4A

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