BECKHOFF Fieldbus Components

## **Documentation for**

## 2 Channel Accurate Analog Terminals

KL3132: -10 V ... +10 V KL3162: 0 V ... +10 V

KL3172: 0 V ... +2 V KL3182: -2 V ... +2 V

KL3142: 0 mA ... 20 mA KL3152: 4 mA ... 20 mA

Version 1.4

Date: 2008-05-15

#### lotes 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.

#### iability 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.

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#### Safety Instructions

#### afety 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 Beckhoff Automation GmbH.

#### ersonnel 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.

#### escription 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.



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



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



This symbol indicates information that contributes to better understanding.

BECKHOFF KL3132, KL3142, KL3152, KL3162, KL3172, KL3182: Foreword

## **Documentation issue status**

Version	Comment
1.4	<ul><li> control and status byte updated</li><li> mounting description expanded</li></ul>
1.3	<ul> <li>LED description updated (prism, new RUN LEDs)</li> <li>wiring description updated (power contacts, new pinning for terminal points)</li> <li>channel disabling added</li> <li>technical data of KL3142 and KL3152 updated</li> </ul>
1.2.1	• pin assignment corrected
1.2	• register description extended (command 7000)
1.1	<ul> <li>technical data updated</li> <li>description of terminal points 3 and 7 adapted to final pin assignment</li> <li>KL3132, KL3142, KL3152, KL3162 and KL3182 added</li> </ul>
1.0	first version (only KL3172)

#### Firm and hardware version

Docu-	KL3132		KL3162		KL3172		KL3182	
mentation, Version	Firmw.	Hardw.	Firmw.	Hardw.	Firmw.	Hardw.	Firmw.	Hardw.
1.4	2A	01	2A	01	2A	01	2A	01
1.3	2A	01	2A	01	2A	01	2A	01
1.2.1	1A	00	1A	00	1B	00	1A	00
1.2	1A	00	1A	00	1B	00	1A	00
1.1	1A	00	1A	00	1B	00	1A	00
1.0	-	-	-	-	B1	00	-	-

The firmware and hardware 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: WW YY FF HH

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

HH - hardware version

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

35 - week of production 3504 - year of production 20041B - firmware version 1B01 - hardware version 01

#### BECKHOFF KL3132, KL3162, KL3172, KL3182: Product Overview

## Introduction



2-channel analog input terminal, ±2 V, 0 ... 2 V, ±10 V, 0 ... 10 V (accuracy 0.05 %)

The analog input terminals KL3132, KL3162, KL3172 and KL3182 process signals in the range of  $\pm 2$  V, 0 ... 2 V,  $\pm 10$  V or 0 ... 10 V. The voltage is digitized to a resolution of 16 bits, and is transmitted, electrically isolated, to the higherlevel automation device. The input channels of one Bus Terminal have differential inputs and a common, internal ground potential. With their high measurement accuracy of  $\pm 0.05$  % of the full-scale value, these terminals are optimized for high-precision control processes, such as dosing, filling, or quality assurance. The Bus Terminals combine 2 channels within a housing. State and Error LEDs display the state of the terminal.

#### BECKHOFF KL3142, KL3152: Product Overview

## Introduction



2-channel analog input terminal, 0/4 ... 20 mA (accuracy 0.01 %)

The KL3142 and KL3152 analog input terminals handle signals in the range between 0 and 20 mA, and between 4 and 20 mA respectively. The current is digitized to a resolution of 16 bits (the default is 15 bits), and is transmitted, in an electrically isolated form, to the higher-level automation device. The input channels of the Bus Terminals have differential inputs and a common, internal ground potential. With their high measurement accuracy of  $\pm 0.01$  % of the fullscale value, these terminals are optimized for high-precision control processes, such as dosing, filling, or quality assurance. The Bus Terminals combine 2 channels within a housing. Open lead or overload condition are detected, and the terminal status is relayed to the controller via the K-bus. State and Error LEDs display the state of the terminal.

#### BECKHOFF KL3132, KL3162, KL3172, KL3182: Product Overview

## **Technical Data**

Technical data	KL3132 KL3162 KL3172 KL3182				
Number of inputs	2				
Signal voltage	-10 V 0 +10 V 10 V 0 2 V -2 V +2 V				
Input resistance	> 200 kΩ				
Common-mode voltage U <sub>CM</sub>	±10 V				
Resolution	16 bits				
Conversion time	140 ms, configurable				
Meas. error (total meas. range)	±0.05% of the full scale value, self- calibration				
Bit width in the K-Bus I/O	2 x 16 bit user data (optionally 2 x 8 bit control/status)				
Bit width in the input process image	2 data words, 2 status byte				
Bit width in the output process image	2 data words, 2 control byte				
Power supply for the electronics	via the K-Bus				
Electrical isolation	500 V <sub>rms</sub> (differential input / K-Bus)				
Connection	spring force technology				
Current consumption from the K- Bus	typically 85 mA				
Weight	app. 55 g				
Dimensions (w x h x d)	app. 15mm x 100mm x 70mm (aligned width: 12 mm)				
Assembly	on 35 mm 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	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
Protection class	IP 20
Installation position	variable
Approval	CE

#### BECKHOFF KL3142, KL3152: Product Overview

## **Technical Data**

Technical data	KL3142	KL3152			
Number of inputs	2				
Signal voltage	0 20 mA	4 20 mA			
Input resistance	100 Ω shunt				
Common-mode voltage U <sub>CM</sub>	±10 V	±10 V			
Resolution	16 bits				
Conversion time	140 ms				
Meas. error (total meas. range)	±0.05% of the full calibration	scale value, self-			
Bit width in the K-Bus I/O	2 x 16 bit user data bit control/status)	(optionally 2 x 8			
Bit width in the input process image	2 data words, 2 sta	tus byte			
Bit width in the output process image	2 data words, 2 cor	ntrol byte			
Power supply for the electronics	via the K-Bus				
Electrical isolation	500 V <sub>rms</sub> (different	ial input / K-Bus)			
Connection	spring force techno	ology			
Current consumption from the K- Bus	typically 85 mA				
Weight	app. 55 g				
Dimensions (w x h x d)	app. 15mm x 100m (aligned width: 12				
Assembly	on 35 mm mountin EN 50022	g rail according to			
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
	according to EN 60068-2-6 / EN 60068-2-27, EN 60068-2-29
H    V       T = C = C = C = C = C = C = C = C = C =	according to EN 61000-6-2 / EN 61000-6-4
Protection class	IP 20
Installation position	variable
Approval	CE

BECKHOFF KL3132, KL3142, KL3152, KL3162, KL3172, KL3182: Product Overview

# **Basic Function Principles**

The accurate analog input terminals can be used to measure two voltages (KL3132, KL3162, KL3172, KL3182) or two currents (KL3142, KL3152), and to display them with a resolution of 16 bit (65535 steps). High-precision measurements are ensured by cyclic self-calibration.

By default, the inputs are switched as differential inputs. For the terminals terminals KL3132, KL3162, KL3172 and KL3182, the terminal point -E1 of channel 1 can be switched to internal analog ground with bit <u>R32.6</u> of the feature register.

#### **Process data**

Input Signal						Value			
KL3162	KL3172		KL3142		KL3152		Decimal	Hexadecima	
0 V	0 V		0 mA		4 mA		0	0x0000	
10 V	2 V		20 m	20 mA 2		mA 65535		0xFFFF	
Inp	Input Signal				٢	Valı	ıe		
KL313	KL3132 KL3			Dec	cimal	He	xadecima	1	
-10 V -2 V		-2 V		-32768 0		0x8	000		
+10 V +2 V			+32	767	0x7	'FFF			

Analog values are represented as follows:

#### Calculation

The terminal continuously takes measurement readings and stores the raw values of its A/D converter in register  $\underline{R0}$  (RAM). After each recording of the analog signal, a correction is calculated using the compensation and, if necessary, calibration values. This is followed by manufacturer and user scaling:

 $Y_A = (X_{ADC} + B_A) \times A_A$  (1.0) Manufacturer compensation (if calibration inactive)

$Y_A = ((X_{ADC} + B_K) \times A_A) \times (A_{GK} / A_K)$	(1.1) Manufacturer compensation / calibration (if calibration activated)
$Y_H = Y_A x A_H + B_H$	(1.2) Manufacturer scaling
$Y_{aus} = Y_H x A_W + B_W$	(1.3) User scaling

Key

Name	Denomination	Unit	Register
X <sub>ADC</sub>	Output value of the A/D converter	[1]	-
Y <sub>aus</sub>	Process data for controller	[1]	-
В <sub>А</sub>	Offset of the manufacturer compensation (can be deactivated via bit $\underline{R32.5}$ of the feature register)	[1]	<u>R17</u>
A <sub>A</sub>	Gain of the manufacturer compensation (always active)	[1]	<u>R18</u>
в <sub>К</sub>	Calibration offset (can be activated via bit <u>R32.5</u> of the feature register)	[1]	<u>R1</u>
A <sub>K</sub>	Calibration gain (can be activated via bit <u>R32.5</u> of the feature register)	[1]	<u>R2</u>
A <sub>GK</sub>	Gain of the basic calibration (can be activated via bit $\underline{R32.5}$ of the feature register)	[1]	<u>R23</u>
в <sub>Н</sub>	Offset of the manufacturer's scaling (can be activated via bit <u>R32.1</u> of the feature register)	[1]	<u>R19</u>
А <sub>Н</sub>	Gain of the manufacturer's scaling (can be activated via bit <u>R32.1</u> of the feature register)	[1 x 2 <sup>-</sup> <sup>16</sup> + 1]	<u>R20</u>
в <sub>W</sub>	Offset of the user's scaling (can be activated via bit <u>R32.0</u> of the feature register)	[1]	<u>R33</u>
A <sub>W</sub>	Gain of the user's scaling (can be activated via bit <u>R32.0</u> of the feature register)	[1 x 2 <sup>-</sup> <sup>8</sup> + 1]	<u>R34</u>

## Calibration

The analog channels are calibrated periodically. Analog switches are provided for this purpose, so that the various calibration signals can be connected. It is important for this process that the entire signal path, including all passive components, is examined at every phase of the calibration. Only the interference suppression elements (L/C combination) and the analog switches themselves cannot be examined.

The calibration interval is set in register R40 in steps of 100 ms. During calibration, no current process data are present. Value 0 is present. The terminal indicates active calibration by setting bit SB1.6 in the status byte, and by switching off the associated RUN LED. Calibration can be disabled by the controller via control byte CB1.1 if necessary. If calibration is disabled over a prolonged period, the terminal carries out a forced calibration, in order to compensate any voltage drifts that may be caused by changes in temperature. The forced calibration interval is specified via register R44 as a multiple of the calibration interval. If a further calibration between two cycles is required, this can be started manually by setting bit CB1.0. The terminal then acts as if it had triggered a calibration itself.

The functionality of the calibration including all features invariably refers to both channels simultaneously! The channels cannot be calibrated individually. For this reason, the registers <u>R40</u>, <u>R44</u>, <u>R47</u> and <u>R48</u> are only implemented once for both channels.

- In the first phase of the calibration, an input voltage of 0 V is applied to both analog inputs (zero calibration). The zero points of both analog input stages can be determined in this way. For this measurement, the respective absolute value of the channels is of interest. The value is subsequently stored in the RAM (register <u>R1</u>).
- During the second calibration phase, an internal reference voltage of approx. 1,8 V (final calibration) is applied to both analog inputs. In this case, it is no longer the absolute value of the measurement result that is of interest, but only any deviation from the basic calibration value determined during production (register <u>R23</u>). The ratio between the two values is calculated and used in the next <u>correction calculation</u>. The value is subsequently stored in the RAM (register <u>R2</u>).

#### Stabilization of the calibration

During the calibration, a stabilization of the offset and gain values is carried out. The calibration values are only accepted once a certain number (specified via register R47) of measured values is inside a certain tolerance range (specified via register R48). This further increases the precision. This function can be deactivated via bit R32.7.

#### Thresholds

The terminal offers the option of monitoring two thresholds per channel. Threshold 1 can be specified via register <u>R35</u>, and threshold 2 via register <u>R36</u>. They are activated via bits in the feature registers <u>R32.9</u> and <u>R32.10</u>. The status of the current process data value is indicated to the controller via the status byte <u>SB1</u>. Possible states are: Process data equal threshold (3), process data less than threshold (2), process data greater than threshold (1).

#### Limiting the measuring range

The terminal indicates any violation of the measuring range to the higher-level controller via the status byte.

- If the current measured value is greater than 0xFFFF respectively 0x7FFF, bit <u>SB1.1</u> is set.
- If it is less than 0 respectively 0x8000, bit <u>SB1.0</u> is set.

In both cases, the ERROR LED of the respective channel will be on. This function can be deactivated via bit <u>R32.8</u>.

BECKHOFF KL3132, KL3142, KL3152, KL3162, KL3172, KL3182: Product Overview

## LEDs

<b></b>	-11	ſ					
LED	ļ	Display					
K-Bus	ON	K-Bus power supply (5 V) present					
Power (green)	OFF	K-Bus power supply (5 V) not present					
K-Bus	ON	K-Bus data transfer active					
Run (green)	OFF	K-Bus data transfer not active					
	ON	<ul><li>Channel 1 active:</li><li>process data contain valid analog value</li></ul>					
Run 1 (green)	OFF	<ul> <li>Channel 1 not active:</li> <li>calibration is being carried out, process data do not contain an up-to-date analog value (frozen) or</li> <li>channel is disabled (if LED Error 1 does not shine)</li> </ul>					
Error 1	ON	<ul> <li>The analog value is above the valid measuring range as specified via register <u>R21</u> of channel 1. The bit <u>SB1.1</u> is set in status byte for channel 1.</li> <li>The analog value is below the valid measuring range as specified via register <u>R22</u> of channel 1. The bit</li> </ul>					

(red)		<u>SB1.0</u> is set in status byte for channel 1.
	OFF	<ul> <li>the analog value of channel 1 is within the valid measuring range (if LED Run 1 shines) or</li> <li>channel 1 is disabled (if LED Run 1 does not shine)</li> </ul>
		Channel 2 active:
	ON	<ul> <li>process data contain valid analog value</li> </ul>
Run 2 (green)	OFF	<ul> <li>Channel 2 not active:</li> <li>calibration is being carried out, process data do not contain an up-to-date analog value (frozen) or</li> <li>channel is disabled (if LED Error 2 does not shine)</li> </ul>
Error 2 (red)	ON	<ul> <li>The analog value is above the valid measuring range as specified via register <u>R21</u> of channel 2. The bit <u>SB2.1</u> is set in status byte for channel 2.</li> <li>The analog value is below the valid measuring range as specified via register <u>R22</u> of channel 2. The bit <u>SB2.0</u> is set in status byte for channel 2.</li> </ul>
	OFF	<ul> <li>the analog value of channel 2 is within the valid measuring range (if LED Run 2 shines) or</li> <li>channel 1 is disabled (if LED Run 2 does not shine)</li> </ul>

#### Limiting the measuring range

The terminal indicates any violation of the measuring range to the higher-level controller via the status byte. If the current measured value

- is greater than specified in register <u>R21</u>, bit 1 of status byte is set.
- is less than specified in register <u>R22</u>, bit 0 of status byte is set.

In both cases, the ERROR LED of the respective channel will be on. This display can be deactivated with bit <u>R32.8</u>.

BECKHOFF Fieldbus Components: Mounting and Wiring

# Installation of Bus Terminals on mounting rails



Bring the bus terminal 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 mounting rails (DIN rails according to 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**

i Note

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

- The six spring contacts of the K-Bus/E-Bus deal with the transfer of the data and the supply of the Bus Terminal electronics.
- The power contacts deal with the supply for the field electronics and thus represent a supply rail within the bus terminal block. The power contacts are supplied via terminals on the Bus Coupler (up to 24 V) or for higher voltages via power feed terminals.

During the design of a bus terminal block, the pin assignment of the individual Bus Terminals must be taken account of, since some types (e.g. analog Bus Terminals or digital 4-channel Bus Terminals) do not or not fully loop through the power contacts. Power Feed Terminals (KL91xx, KL92xx or EL91xx,

EL92xx) interrupt the power contacts and thus represent the start of a new supply rail.

## **PE power contact**

The power contact labeled PE can be used as a protective earth. For safety reasons this contact mates first when plugging together, and can ground short-circuit currents of up to 125 A.



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.

Wire size width	0,08 2,5 mm <sup>2</sup>
Wire stripping length	8 mm

**i Note** Analog sensors and actors should always be connected with shielded, twisted paired wires.

BECKHOFF KL3132, KL3142, KL3152, KL3162, KL3172, KL3182: Mounting and Wiring

# Connection



Bring the bus terminal system into a safe, powered down state

before starting installation, disassembly or wiring of the **Bus Terminals!** 

Terminal point	No	Connection for		
Input 1+	1	+ input channel 1		
Input 1-	2	- input channel 1		
GND	3	internal ground (internally connected with terminal point 7)		
Shield	4	PE contact (internally connected with terminal point 8)		
Input 2+	5	+ input channel 2		
Input 2-	6	- input channel 2		
GND	7	internal ground (internally connected with terminal point 3)		
Shield	8	PE contact (internally connected with terminal point 4)		

From hardware version 01 two power contacts are transfered to the next terminal. But they are not used by the KL31x2.



Please note this if you replace hardware version 00 with **Attention** higher versions.

The hardware version of your terminal can be found in the serial number printed at the side of the terminal.

BECKHOFF KL3172: Mounting and Wiring

# **Application Example for KL3172**



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

Monitoring the cell voltages of a battery by several KL3172.



Note the following the sum of the cell voltages (in example<br/> $U_B = n \ge 1,5 V$ ) must not exceed the dielectric strengthAttention(electrical isolation 500 V) of the KL3172!

BECKHOFF Fieldbus Components: KS2000 Configuration Software

# **KS2000 Configuration Software**

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 KL3172: 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 KL3172: precise two-channel analog input terminal for signals between 0 and 2 V
- 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 KL3172, the branches *Register*, *Settings* and *ProcData* are displayed:

- <u>Register</u> enables direct access to the KL3172 registers.
- A dialog mask for the parameterization of the KL3172 can be found under <u>Settings</u>.
- ProcData displays the KL3172 process data.

BECKHOFF KL3172: Configuration Software KS2000

# Register

You can access the registers of the KL3172 directly under *Register*. The meaning of the register is explained in the <u>register overview</u>.

BECKHOFF KL3172: Configuration Software KS2000

# Settings

A dialog mask for the parameterization of the KL3172 can be found under *Settings*.

## **Operation mode**

Channel disabled (<u>R32.11</u>)

You disable this cannel here, to get faster cycle time for the other channel (the default is not disabled). A disabled channel is indicated by its switched off Run and Error LED.

User scaling active (<u>R32.0</u>)

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

Manufacturer scaling active (<u>R32.1</u>)

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

Watchdog timer active (<u>R32.2</u>)

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

Signed amount representation (<u>R32.3</u>)

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

Siemens output format (<u>R32.4</u>)

You can activate Siemens output format here (the default is deactivated).

Calibration active (<u>R32.5</u>)

You can deactivate the calibration here (the default is activated).

Differential measurement (R32.6)

You can deactivate the differential measurement here (the default is activated).

Stabilization of calibration active (<u>R32.7</u>)

You can deactivate the stabilization of the calibration here (the default is activated).

Overrange protection (<u>R32.8</u>)

You can deactivate the overrange protection here (the default is activated).

Threshold 1 active (<u>R32.9</u>)

You can activate the threshold 1 here (the default is deactivated).

Threshold 2 active (<u>R32.10</u>)

You can activate the threshold 2 here (the default is deactivated).

## **Register values**

#### User offset (<u>R33</u>)

You can specify the user offset between -32768 and 32767 here (default: 0).

#### User gain (<u>R34</u>)

You can specify the user gain between -0 and 65535 here (default: 256, corresponding to a factor of 1).

#### Calibration interval (<u>R40</u>)

You can specify the calibration interval for the reference signal here in steps of 100 ms (the default is 300 s).

#### Forced calibration interval (R44)

You can specify the interval for the forced calibration here. This interval is always a multiple (the default is  $3_{dec}$ ) of the calibration interval. The interval for forced calibration when the terminal leaves the factory is therefore 3 x 180 s = 900 s.

#### Number of stable measured values (<u>R47</u>)

You can specify the number of measured values used for the calibration here (default: 50).

#### Tolerance for measured value stability (<u>R48</u>)

You can specify the stable measured value tolerance for the calibration here (default: 5).

#### Threshold 1 (<u>R35</u>)

You can specify the threshold 1 here (default: 0).

Threshold 2 (<u>R36</u>)

You can specify the threshold 2 here (default: 0).

Filter constant (<u>R37.11-R37.4</u>)

The filter constant *SF* specifies the 3dB limit frequency of the sinc<sup>3</sup> filter (the default is  $860_{dec}$ ).

Fast-Step Mode<sup>(TM)</sup> enabled (<u>R37.0</u>)

You can activate Fast Step Mode here (the default is deactivated). A fast reaction to jumps at the input follows in fast step mode, in spite of the filter stage being active. In this case the filter is bypassed!

FIR filter enabled (<u>R37.1</u>)

You can deactivate the FIR filter here (the default is activated).

BECKHOFF KL3132, KL3142, KL3152, KL3162, KL3172, KL3182: Access from the user program

# **Process Image**

The terminals KL3132, KL3162, KL3142, KL3152 KL3172 und KL3148 are represented in the process image with up to 6 bytes of input data and 6 bytes of output data. These are organized as follows:

Format	Input data	Output data
Byte	<u>SB1</u>	CB1
Word	DataIN1	DataOUT1
Byte	<u>SB2</u>	CB2
Word	DataIN2	DataOUT2

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 <u>mapping</u> 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 input data words DataIN1 and DataIN2 and the output data words DataOUT1 and DataOUT2 are not used.

# **Representation of the analog values**

Analog voltages are represented by the bus terminals as follows:

#### KL3132

Voltage	Decimal	Hexadecimal
-10 V	-32768	0x8000
+10 V	+32767	0x7FFF

#### KL3162

Voltage	Decimal	Hexadecimal
0 V	0	0x0000
10 V	65535	0xFFFF

#### KL3142

Current	Decimal	Hexadecimal
0 mA	0	0x0000
20 mA	65535	0xFFFF

#### KL3152

Current	Decimal	Hexadecimal
4 mA	0	0x0000
20 mA	65535	0xFFFF

#### KL3172

Voltage	Decimal	Hexadecimal
0 V	0	0x0000
2 V	65535	0xFFFF

#### KL3182

Voltage	Decimal	Hexadecimal
-2 V	-32768	0x8000
+2 V	+32767	0x7FFF

## BECKHOFF KL3132, KL3142, KL3152, KL3162, KL3172, KL3182: Access from the user program

## **/lapping**

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 input terminals only occupy addresses in the input process image. Control and status bytes cannot be accessed.

#### ompact 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	0	Ch1 D1	Ch1 D0	-	-
evaluation: no Motorola format: no Word alignment: any	1	Ch2 D1	Ch2 D0	-	-

#### ompact 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	0	Ch1 D0	Ch1 D1	-	-
evaluation: no Motorola format: yes Word alignment: any	1	Ch2 D0	Ch2 D1	-	-

### complete evaluation

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

#### omplete evaluation in Intel format

	Address	Input da	ta	Output data		
Conditions	Word offset	High byte	Low byte	High byte	Low byte	
Complete	0	Ch1 D0	SB1	Ch1 D0	CB1	
evaluation: yes	1	SB2	Ch1 D1	CB2	Ch1 D1	
Motorola format: no Word alignment: no	2	Ch2 D1	Ch2 D0	Ch2 D1	Ch2 D0	

#### omplete evaluation in Motorola format

	Address	Input da	ta	Output data		
Conditions	Word offset	High byte	Low byte	High byte	Low byte	
Complete	0	Ch1 D1	SB1	Ch1 D1	CB1	
evaluation: yes	1	SB2	Ch1 D0	CB2	Ch1 D0	
Motorola format: yes Word alignment: no	2	Ch2 D0	Ch2 D1	Ch2 D0	Ch2 D1	

#### omplete evaluation in Intel format with word alignment

Default mapping for Lightbus, EtherCAT 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	0	reserved	SB1	reserved	CB1
evaluation: yes Motorola	1	Ch1 D1	Ch1 D0	Ch1 D1	Ch1 D0
format: no	2	reserved	SB2	reserved	CB2
Word alignment: yes	3	Ch2 D1	Ch2 D0	Ch2 D1	Ch2 D0

omplete evaluation in Motorola format with word alignment

	Address	Input data	a	Output da	ata
Conditions	ions Word		Low byte	High byte	Low byte
Complete	0	reserved	SB1	reserved	CB0
evaluation: yes Motorola	1	Ch1 D0	Ch1 D1	Ch1 D0	Ch1 D1
format: yes	2	reserved	SB2	reserved	CB1
Word alignment: yes	3	Ch2 D0	Ch2 D1	Ch2 D0	Ch2 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 KL3132, KL3142, KL3152, KL3162, KL3172, KL3182: Access from the user program

# **Control and Status Byte**

# Channel 1

## Process data mode

### **Control byte 1 (for process data mode)**

The control byte 1 (CB1) is located in the <u>output image</u>, 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	-	-	-	-	-	CaliDisReq	StartManCali

Key

Bit	Name		Description
CB1.7	RegAccess	$0_{bin}$	Register communication off (process data mode)
CB1.6 to CB1.2		0 <sub>bin</sub>	reserved
CB1.1	CaliDisReq	$1_{bin}$	Blocking automatic calibration
CB1.0	StartManCali	$1_{bin}$	start manual calibration

### Status byte 1 (for process data mode)

The status byte 1 (SB1) is located in the <u>input image</u>, 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	Error	StateThreshold2		StateTh	reshold1	Overload	Underload

Key

Bit	Name		Description
SB1.7	RegAccess	0 <sub>bin</sub>	Acknowledgement for process data mode
SB1.6	Error	1 <sub>bin</sub>	last calibration ended with errors (no stablility)
SB1.5			<u>Threshold 2</u> is not activated via bit <u>R32.10</u> of feature register
561.5 /	StateThreshold2	$01_{bin}$	process data is lower than Threshold 2
SB1.4		$10_{bin}$	process data is greater than Threshold 2
		11 <sub>bin</sub>	process data is equal to Threshold 2
SB1.3		00 <sub>bin</sub>	<u>Threshold 1</u> is not activated via bit <u>R32.9</u> of feature register
/	StateThreshold1	$01_{bin}$	process data is lower than Threshold 1
SB1.2		$10_{bin}$	process data is greater than Threshold 1
		11 <sub>bin</sub>	process data is equal to Threshold 1
SB1.1	Overload		Process data are greater than specified in register <u>R21</u> . Red Error LED of this channel is on.
SB1.0	Underload	1 <sub>bin</sub>	Process data are smaller than specified in register <u>R22</u> . Red Error LED of this channel is on (a calibration is active, when SB1.0 and SB1.1 are set at the same time).

## **Register communication**

### **Control byte 1 (for register communication)**

The control byte 1 (CB1) is located in the <u>output image</u>, and is transmitted from the controller to the terminal.

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

Key

Bit	Name	Description
CB1.7	RegAccess	1 <sub>bin</sub> Register communication switched on
CB1.6	D /147	0 <sub>bin</sub> Read access
CD1.0	κ/ νν	1 <sub>bin</sub> Write access
CB1.5 to CB1.0	IR 40 INA -	Register number: Enter here the number of the <u>register</u> that you wish - to read with input data word <u>DataIn</u> , or - to write with output data word <u>DataOut</u> .

## Status byte 1 (for register communication)

The status byte 1 (SB1) is located in the <u>input image</u>, 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. nc	).				

Key

Bit	Name	Description
SB1.7	RegAccess	bin Acknowledgement for register access
SB1.6	R	o <sub>bin</sub> Read access
SB1.5		
to	Reg. no.	Number of the register that was read or written.
SB1.0		
# Channel 2

The control and status bytes of channels 2 (CB2 and SB2) structured like the control and status byte of <u>channel 1</u>.

BECKHOFF KL3132, KL3142, KL3152, KL3162, KL3172, KL3182: Access from the user program

# **Register Overview**

The registers are used for the parameterization of the bus terminals and exist once for each channel. They can be read or written via <u>register communication</u>.

Register no.	Com	nent	Defau	lt value	R/W	Memory	
<u>R0</u>	Raw ADC va	alue	0x0000	0 <sub>dec</sub>	R	RAM	
<u>R1</u>	Calibration v Offset	alue:	typically 0x0046	typically 70 <sub>dec</sub>	R	RAM	
<u>R2</u>	Calibration v	alue: Gain	typically 0xF1CC	typically 61900 <sub>dec</sub>	R	RAM	
R3	reserved		-	-	-	-	
R4	reserved		-		-	-	
R5	reserved		-		-		
<u>R6</u>	Diagnostic register		0x0000	0 <sub>dec</sub>	R	RAM	
<u>R7</u>	Command re	gister	0x0000	0 <sub>dec</sub>	R/W	RAM	
	KL3172:		0x0C64	3172 <sub>dec</sub>			
		KL3182:	0x0C6E	3182 <sub>dec</sub>	- - - -	ROM	
DO	Terminal	KL3132:	0xC3C	3132 <sub>dec</sub>			
<u>R8</u>	type	KL3162:	0xC5A	3162 <sub>dec</sub>			
		KL3142:	0xC46	3142 <sub>dec</sub>			
		KL3152:	0xC50	3152 <sub>dec</sub>			
<u>R9</u>	Firmware revision level		e.g. 0x3141	e.g. 12609 <sub>dec</sub>	R	ROM	
R10	Multiplex shift register		0x0218 / 0x0130	536 <sub>dec</sub> / 304 <sub>dec</sub>	R	ROM	
R11	Signal chann	els	0x0218	536 <sub>dec</sub>	R	ROM	
<u>R12</u>	Minimum da	ta length of	0x0098	152 <sub>dec</sub>	R	ROM	

	one channel		<u> </u>				
R13	Data structure	2	0x0007	7 <sub>dec</sub>	R	ROM	
R14	reserved		-	-	<b> -</b>	-	
R15	Alignment re	gister	typically 0x7F80	typically 32640 <sub>dec</sub>	R/W	RAM	
<u>R16</u>	Hardware ver number	sion	e.g. 0x0000	e.g. 0 <sub>dec</sub>	R/W	SEEPROM	
<u>R17</u>	Manufacturer compensation		typically 0x0046	70 <sub>dec</sub>	R/W	SEEPROM	
<u>R18</u>	Manufacturer compensation		typically 0x5208	typically 21000 <sub>dec</sub>	R/W	SEEPROM	
<u>R19</u>	Manufacturer Offset	scaling:	0x0000	0 <sub>dec</sub>	R/W	SEEPROM	
<u>R20</u>	Manufacturer scaling: Gain	KL3162, KL3172, KL3142, KL3152:	0x0100	256 <sub>dez</sub>	R/W	SEEPROM	
	KL313	KL3132, KL3182:	0x0080	128 <sub>dez</sub>			
<u>R21</u>	l j	KL3162, KL3172, KL3142, KL3152:	0xFFFF	65535 <sub>dec</sub>	R/W	SEEPROM	
	range limit	KL3132, KL3182:	0x7FFF	+32767 <sub>dec</sub>			
<u>R22</u>	Lower measuring	KL3162, KL3172, KL3142, KL3152:	0x0000	0 <sub>dec</sub>	R/W	SEEPROM	
	range limit	KL3132, KL3182:	0x8000	-32768 <sub>dec</sub>			
<u>R23</u>	Reference cal value: Offset	Reference calibration value: Offset		typically 70 <sub>dec</sub>	R/W	SEEPROM	
	Reference cal	ibration	typically	typically			

<u>R24</u>	value: Gain		UXFICC	61900 <sub>dec</sub>	R/W	SEEPROM
R25	reserved	= reserved		_!  -	<u> </u> -	
•••	reserved		<b> </b> -	<b> </b> -	<b> </b> -	<b> </b> -
R30	reserved		-	_	<b> </b> -	-
<u>R31</u>	Code word reg	ister	0x0000	0 <sub>dec</sub>	R/W	RAM
<u>R32</u>	Feature	KL3162, KL3172, KL3142, KL3152:	0x0180	384 <sub>dez</sub>	R/W	SEEPROM
		KL3132, KL3182:	0x0182	386 <sub>dez</sub>		
<u>R33</u>	User offset		0x0000	0 <sub>dec</sub>	R/W	SEEPROM
<u>R34</u>	User gain		0x0100	256 <sub>dec</sub>	R/W	SEEPROM
<u>R35</u>	Threshold 1		0x0000	0 <sub>dec</sub>	R/W	SEEPROM
<u>R36</u>	Threshold 2		0x0000	0 <sub>dec</sub>	R/W	SEEPROM
<u>R37</u>	A/D converter,	Filter constants of the A/D converter, and configuration bits for		13760 <sub>dec</sub>	R/W	SEEPROM
R38	reserved		<u>-</u>		<b> </b> -	-
R39	reserved		-	_	<b> </b> -	-
<u>R40</u>	Calibration int	erval *)	0x0708	1800 <sub>dec</sub>	R/W	SEEPROM
R41	reserved		-	-	<b> </b> -	-
•••	reserved		-	-	-	-
R43	reserved		-	_	<b> </b> -	-
<u>R44</u>	Interval for for calibration **)		0x0003	3 <sub>dec</sub>	R/W	SEEPROM
R45	reserved		-	-	-	-
R46	reserved		-	-	<b> </b> -	<b> </b> -
<u>R47</u>	Number of stal measured value		0x0032	50 <sub>dec</sub>	R/W	SEEPROM

	Tolerance for measured value stability	0x0005	5 <sub>dec</sub>	R/W	SEEPROM
R49	reserved	-	-	-	-
	reserved	-	-	-	-
R63	reserved	-	-	-	-

\*) In multiples of 100 ms

\*\*) In multiples of register <u>R40</u>

BECKHOFF KL3132, KL3142, KL3152, KL3162, KL3172, KL3182: Access from the user program

# **Register Description**

The registers are used for the parameterization of the bus terminals and exist once for each channel. They can be read or written via <u>register communication</u>.

#### **R0: Raw ADC value**

Register R0 contains the raw value of the analog/digital converter. This is the unchanged analog value prior to any scaling.

#### **R1:** Calibration value - offset

After a calibration, the offset value that was determined is entered in register R1 and used for the correction calculation.

#### **R2:** Calibration value - gain

After a calibration, the gain value that was determined is entered in register R2 and used for the correction calculation.

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

Status byte <u>SB</u> is placed into register R6.

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

For a command to be executed, it is first necessary for the user code word, 0x1235, to be entered into register R31.

#### Command 0x7000: Restore Factory Settings

Entering 0x7000 in register R7 restores the factory settings for the following registers of both channels:

KL3162, KL3172, KL3142, KL3152:

R32:  $0x0180 (384_{dec})$ R33:  $0x0000 (0_{dec})$ R34:  $0x0100 (256_{dec})$ R35:  $0x0000 (0_{dec})$ R36:  $0x0000 (0_{dec})$ R37:  $0x35C0 (13760_{dec})$ R40:  $0x0708 (1800_{dec})$ R44:  $0x0003 (3_{dec})$ R47:  $0x0032 (50_{dec})$ R48:  $0x0005 (5_{dec})$  KL3132, KL3182:

R32: 0x0182 (386<sub>dec</sub>) R33: 0x0000 (0<sub>dec</sub>) R34: 0x0100 (256<sub>dec</sub>) R35: 0x0000 (0<sub>dec</sub>) R36: 0x0000 (0<sub>dec</sub>) R37: 0x35C0 (13760<sub>dec</sub>) R40: 0x0708 (1800<sub>dec</sub>) R44: 0x0003 (3<sub>dec</sub>) R47: 0x0032 (50<sub>dec</sub>) R48: 0x0005 (5<sub>dec</sub>)

Note

The *Restore Factory Settings* command resets **both** channels in the terminal to the factory settings simultaneously, regardless of which register set it is called from!

# **R8:** Terminal description

The description of the terminal is contained in register R8. KL3172:  $0x0C64 (3172_{dec})$ KL3182:  $0x0C6E (3182_{dec})$ KL3132:  $0xC3C (3132_{dec})$ KL3162:  $0xC5A (3162_{dec})$ KL3142:  $0xC46 (3142_{dec})$ KL3152:  $0xC50 (3152_{dec})$ 

# **R9:** Firmware revision level

Register R9 contains the ASCII coding of the terminal's firmware revision level, e.g. **0x3141 = '1A'**. The **'0x31'** corresponds here to the ASCII character **'1'**, while the **'0x41'** represents the ASCII character **'A'**. This value can not be changed.

# **R12: Minimum data length of one channel**

Bit 0 to 6 of the most significant byte show the minimum number of output data in bit:  $000.0000_{\text{bin}} = 0_{\text{dec}}$  so 0 Byte.

Bit 0 to 6 of the least significant byte show the minimum number of output data in bit:  $001.1000_{bin} = 24_{dec}$  so 3 Byte.

That bit 7 is set shows, that control and status byte are not mandatory for terminal operation and are not transmitted in compact mode.

#### **R16: Hardware version number**

Register R16 contains the hardware version of the terminal.

#### **R17: Manufacturer compensation - offset**

This register contains the offset of the manufacturer compensation (16 bit signed integer).

#### **R18: Manufacturer compensation - gain**

This register contains the gain of the manufacturer compensation (16 bit unsigned integer x  $2^{-16} + 1$ ). Examples: 0x0000 means factor 1 0xFFFF means factor 2

#### **R19: Manufacturer scaling - offset:**

This register contains the offset of the manufacturer scaling. It can be activated by  $\underline{R32.1}$  in the feature register (16 bit signed integer).

#### **R20: Manufacturer scaling - gain:**

This register contains the gain of the manufacturer scaling. It can be activated by R32.1 in the feature register (16 bit unsigned integer x  $2^{-8} + 1$ ). Examples: 0x0100 means factor 1. 0x0080 means factor 0,5

# **R21: Upper measuring range limit**

This register contains the upper measuring range limit. It can be activated by  $\underline{R32.8}$  in the feature register.

# **R22: Lower measuring range limit**

This register contains the lower measuring range limit. It can be activated by <u>R32.8</u> in the feature register.

# **R23: Reference calibration value: offset**

This register contains the reference value of the calibration, which is determined during the manufacturer compensation.

# **R24: Reference calibration value: gain**

This register contains the reference value of the calibration, which is determined during the manufacturer compensation.

# **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 if the terminal is restarted.

# **R32: Feature register**

The feature register specifies the terminal's configuration.

Bit	R32.15	R32.14	R32.13	R32.12	R32.11	R32.10	R32.9	R32.8
Name	-	-	-	-	disChannel	enTh2	enTh1	enOverProt

I	1-	(	-			
Bit	R32.7	R32.6	R32.5	R32.4	R32.3	RE
Name	enStable	disDiffMeasure	disCali	enSiemensFormat	enAverageFormat	dis

Key

Name	Description	default
-	reserved	0 <sub>bin</sub>
-	reserved	0 <sub>bin</sub>
dicChannol	0 <sub>bin</sub> Channel enabled	0
	1 <sub>bin</sub> Channel disabled	0 <sub>bin</sub>
onTh0	0 <sub>bin</sub> Threshold 2 not active	0
en i nz	1 <sub>bin</sub> Threshold 2 active	0 <sub>bin</sub>
onTh 1	0 <sub>bin</sub> Threshold 1 not active	0
eniiii	1 <sub>bin</sub> Threshold 1 active	0 <sub>bin</sub>
enOverProt	O <sub>bin</sub> Measuring range limitation not active	1
	1 <sub>bin</sub> Measuring range limitation active	L <sub>bin</sub>
enStable	O <sub>bin</sub> Calibration value stabilization not active	1
	1 <sub>bin</sub> Calibration value stabilization active	L <sub>bin</sub>
	0 <sub>bin</sub> Differential measurement active	
disDiffMeasure	1 <sub>bin</sub> Differential measurement not active (only KL3132, KL3162, KL3172, KL3182)	O <sub>bin</sub>
disCali	O <sub>bin</sub> Cyclic calibration of the A/D converter is active	0
	1 <sub>bin</sub> Cyclic calibration of the A/D converter is not active	0 <sub>bin</sub>
	-  - disChannel enTh2 enTh1 enOverProt enStable	-reservedreserved $1$ reserved $1$ </td

R32.4	enSiemensFormat	0 <sub>bin</sub>	Siemens output fe active	ormat not	0 <sub>bin</sub>	
		$1_{\rm bin}$	Siemens output f	ormat active		
R32.3	on Avorage Format	0 <sub>bin</sub>	Signed amount re not active	epresentation	0	
NJ2.J	enAverageFormat		Signed amount re active	epresentation	0 <sub>bin</sub>	
R32.2	2 disWdTimer		watchdog will tri	Watchdog timer is active (the watchdog will trigger if no process data is received for 100 ms)		
		$1_{\rm bin}$	Watchdog timer i			
R32.1	enManScal	0 <sub>bin</sub>	Manufacturer scaling is not active KL3162, KL3162, KL3172, KL3142, KL3152		0 <sub>bin</sub>	
		1 <sub>bin</sub>	Manufacturer scaling is active	KL3132, KL3182:	1 <sub>bin</sub>	
R32.0	enUsrScal		User scaling is no	0 <sub>bin</sub>		
		1 <sub>bin</sub>	User scaling is ac	ctive	Soin	

## **R33: User scaling - offset**

This register contains the offset of the user scaling. User scaling can be activated through bit <u>R32.0</u> in the feature register (16 bit signed integer).

## R34: User scaling - gain

This register contains the gain of the user scaling. User scaling can be activated through bit <u>R32.0</u> in the feature register (16 bit unsigned integer x  $2^{-8} + 1$ ,  $1_{dec}$  corresponds to 0x0100).

## R35: Threshold 1

Threshold 1 is entered in register R35. The threshold can be activated through bit

<u>R32.9</u> in the feature register.

# R36: Threshold 2

Threshold 2 is entered in register R36. The threshold can be activated through bit R32.10 in the feature register.

# **R37:** Filter constants of the A/D converter, and configuration bits for the filter

(Default value: 35C0<sub>hex</sub>)

The terminal possesses two low-pass filter stages:

- The first stage consists of a sinc<sup>3</sup> filter, and is always active.
- The second stage consists of a 22nd order FIR filter. This can be deactivated.

Bit	15 14 13 12 11 10 9 8 7 6 5 4	3	2	1	0
Name	Filter constants SF (SF.11 to SF.0)	Zero	Zero	SkipFIR	Fast

Key

Bit	Name	Description	default
	Filter constants SF	The filter constant <i>SF</i> specifies the 3dB limit frequency of the sinc <sup>3</sup> filter. The value ranges from 150 to 2047. The 3 dB limit frequency $F_{\text{limit}}$ and the 64.5 dB stop frequency $F_{\text{stop}}$ are calculated as follows: Skip $F_{\text{limit}} =$ = 0 11981 / SF $F_{\text{stop}} =$ 43008 / SF	35C <sub>hex</sub> (860 <sub>dec</sub> )

		Skij = 1	o F <sub>limit</sub> = 80486 / SF	
R37.3	Zero	0 <sub>bin</sub>	always be Zero, otherwise	0 <sub>bin</sub>
R37.2	Zero	0 <sub>bin</sub>	Warning errors will occur in the A/D converter!	0 <sub>bin</sub>
R37.1	SkipFIR	$0_{bin}$	FIR filter is active.	0
K37.1	Зкірітік	$1_{bin}$	FIR filter is bypassed.	0 <sub>bin</sub>
		$0_{bin}$	Fast Step Mode is not active.	
R37.0	Fast	1 <sub>bin</sub>	Fast Step Mode is active: a fast reaction will follow jumps at the input, in spite of the filter stage being active. In this case the filter is bypassed!	0 <sub>bin</sub>

#### Examples

Value in R37	F <sub>stop</sub>	cycle time
0x35C0	50 Hz	140 ms
0x2660	70 Hz	100 ms
0x1330	140 Hz	50 ms
0x7FF1		40 ms
0x3FF1		20 ms
0x1001		<4 ms
Value in R37	F <sub>limit</sub>	cycle time
0x7FF2	39,6 Hz	40 ms
0x3FF2	77,36 Hz	20 ms
0x1002	158 Hz	<4 ms

# **R40:** Calibration interval

This register contains the calibration interval for the terminal's automatic calibration. The unit is 100 ms. The automatic calibration can be activated

through bit <u>R32.5</u> in the feature register.

# **R44: Forced calibration interval**

This register contains the interval for the terminal's forced calibration. This interval is always a multiple (the default is  $3_{dec}$ ) of the calibration interval. (R40). The interval for forced calibration when the terminal leaves the factory is therefore 3 x 180 s = 540 s. The forced calibration can be activated through bit R32.5 in the feature register.

#### **R47: Number of stable measured values**

This register contains the number of stable measured values recorded during the calibration.

# **R48:** Tolerance for measured value stability

This register contains the specified stable measured value tolerance.

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 Ferminal

**Output Data** 

Byte 0: Control Byte	Byte 1: DataOUT1, high byte	Byte 2: DataOUT1, low byte
0x89 (1000 1001 <sub>bin</sub> )	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<sub>bin</sub> 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: DatalN1, high byte	Byte 2: DatalN1, 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 register

**i** Note 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.

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 <sub>bin</sub> )	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 01 1111<sub>bin</sub> the register number 31.
- The output data word (Byte 1 and 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 <sub>bin</sub> )	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 writing access. Values that might be shown are not valid!

#### Reading Register 31 (verifying the set code word)

#### **Output Data**

Byte 0: Control	Byte 1: DataOUT1,	Byte 2: DataOUT1,
Byte	high byte	low byte
0x9F (1001 1111 <sub>bin</sub> )	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 01 1111<sub>bin</sub> 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: DatalN1, high byte	Byte 2: DatalN1, low byte
0x9F (1001 1111 <sub>bin</sub> )	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).

#### I. Writing into Register 32 (changing the content of the feature register)

#### Output Data

Byte 0: Control	Byte 1: DatalN1,	Byte 2: DataIN1,
Byte	high byte	low byte
0xE0 (1110 0000 <sub>bin</sub> )	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<sub>bin</sub> the register number 32.
- The output data word (Byte 1 and Byte 2) contains the new value for the feature

register.

# Attention The given value 0x0002 is only an example! 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: DatalN1, low byte
0xA0 (1010 0000 <sub>bin</sub> )	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 writing access. Values that might be shown are not valid!

#### *I*. 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 <sub>bin</sub> )	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<sub>bin</sub> 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 2: DatalN1, low byte
0xA0 (1010 0000 <sub>bin</sub> )	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).

#### . 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 <sub>bin</sub> )	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 01 1111<sub>bin</sub> 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: DatalN1, high byte	Byte 2: DatalN1, low byte
0x9F (1001 1111 <sub>bin</sub> )	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 writing access. Values that might be shown are not valid!

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#### **Seckhoff Headquarters**

Beckhoff Automation GmbH

Eiserstr. 5 33415 Verl Germany

Phone: +49(0)5246/963-0

Fax: +49(0)5246/963-198

e-mail: info@beckhoff.com

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