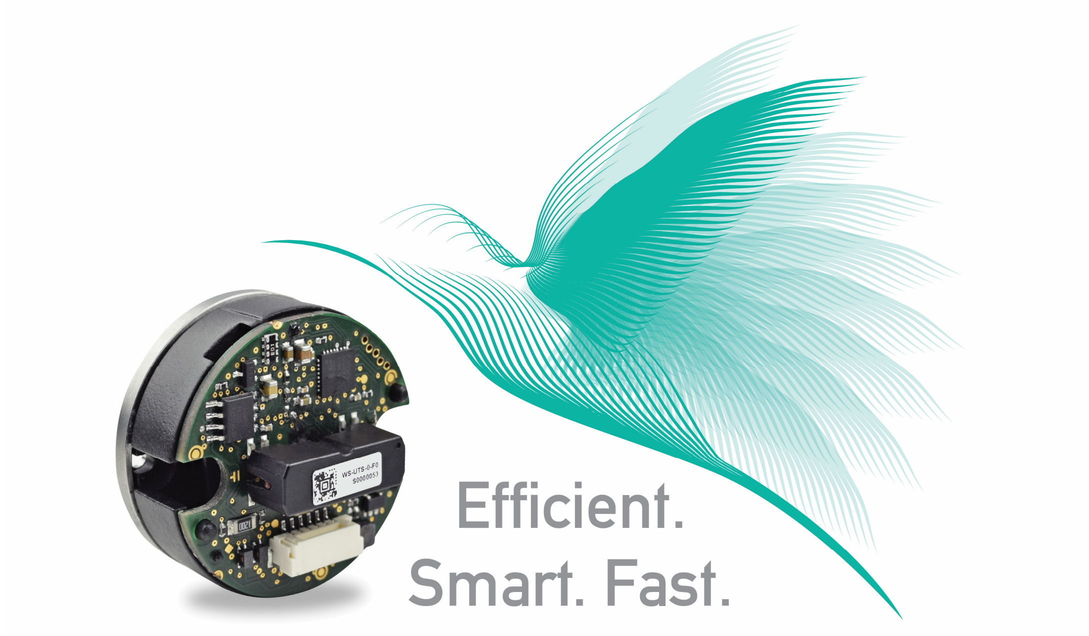
POSITAL FRABA

MANUAL
IXARC KIT ENCODERS WITH BISS C INTERFACE



- Absolute singleturn and multiturn on one PCB
- Kit solution – no ball bearing, no tether, very compact: 36 mm diameter
- Digital serial interface: BiSS C
- Electrical resolution: Up to 17 bit singleturn and 32 bit multiturn
- Operating temperature: -40 to +105 °C / -40 to 221 °F
- Very robust, insensitive to dust or humidity
- Easy installation, no manual alignment due to electronic calibration, relaxed mechanical tolerances
- In comparison to resolvers, full digital interface, no signal processing on motor controller required, no additional expensive voltage generator needed
- Additional functionality like electronic datasheet (EDS), up to 4 Kbyte OEM memory
- Integrated temperature sensor on board
- Kit design includes shielding concept against external fields e.g. from magnetic brake

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Contents

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Release Note

Version Date: 20.09.2018

Version Number: 4.4

Authors: ABA, MLE, MLA, DKI

Reviewer: MLO, MFO, MLE, KMA

Valid for

IXARC Encoder Kit Type:	KCD-BC00B-1617-XXXX-XXX
	KCD-BC01B-1617-XXXX-XXX
From firmware version:	1.1.2

User Annotation

Pease note, that no responsibility is assumed by POSITAL for any consequences arising out of the use of this material. This document is not intended as an instruction manual for untrained people.

POSITAL welcomes all readers to send us feedback and comments about this document.

Contact

FRABA America

T +1 609 750-8705

info@posital.com

FRABA Europe

T +49 221 96213-0

info@posital.eu

FRABA Asia

T +65 6514 8880

info@posital.sg

Safety

- The encoder must be installed only by qualified personal, exhibiting the electric and mechanic knowledge.
- Implicitly consider the valid professional association safety and accident regulations for your country.
- Switch off the supply voltage of all devices connected to the encoder before installation.
- Implicitly avoid an electrical supply voltage during the connection of the encoder.
- Avoid shocks to motor shaft and mounting flange, that may cause mechanical damage of the encoder.
- Rotary machine shafts may cause injury, because these parts may catch hair and cloths.
- Mount the encoder in an ESD-conform fashion, avoid high voltages, e.g. caused by body discharge.
- The encoder and encoder housing must be free of metal chips and metallic dust.
- Implicitly consider the specifications of the encoder. The device must be operated in the specified range.

1. Introduction

With a combination of accuracy, reliability, robustness and cost efficiency POSITAL's magnetic kit encoders provide a unique variety of functionalities. An electrical resolution of up to 17 bit offers an accurate singleturn measurement. The multiturn range covers more than one million revolutions. A large temperature range between -40 °C and +105 °C makes the kit encoders applicable in lots of environmental conditions. The kit encoder components include an electronics package mounted on a compact 35 mm diameter PCB and a small permanent magnet, designed to be mounted on the end of a motor shaft. The electronics package includes four Hall sensors, a powerful 32-bit microprocessor and a rotation counter based on POSITAL's Wiegand energy harvesting system. The BiSS C interface enables a direct digital sensor data transmission and an access to device and customer related register data, stored in the kit encoders internal memory.

The multiturn counting is realized by POSITAL's energy harvesting system, based on the Wiegand effect. At any revolution, a voltage pulse is generated, which triggers the increment of an internal multiturn counter. This Wiegand pulse counting requires no external energy source. Therefore, a backup battery or complex gear systems can be eliminated.

In contrast to optical encoders, the installation of POSITAL's magnetic kit encoders requires no clean room similar conditions and can be performed under normal factory conditions. The integrated electronic autocalibration function corrects position errors due to minor misalignments between motor shaft and electronics package and makes a manual alignment procedure obsolete. In addition, a software integrated Wiegand pulse test determines the performance of the multiturn counter system. The kit encoder's embedded software monitors the system and provides associated error codes, that are transmitted during normal sensor operation. Furthermore, status and error information can be read out from the memory register.

In this manual, an overview of our BiSS C kit encoder is presented. The electrical connection and characteristics of the device are provided in chapter 2, a brief description of the BiSS C protocol is given in chapter 3 and an overview to the memory allocation is presented in chapter 4. Chapter 5 gives a description of the serial communication protocol UBICOM, which can be used for configuration purposes aside from BiSS C. The integrated hardware and software features of the kit encoder are described in chapter 6.

2. Electrical Data

2.1 Connector

Connector Type: BM08B-GHS-TBT (JST)

Pin No.	KCD-BC00B	KCD-BC01B	BiSS Std.	Description
1 (blue)	GND	GND	V -	Ground reference voltage
2 (rose)	-	Preset	-	Preset trigger
3 (gray)	-	Config	-	Config via serial communication (UBICOM)
4 (green)	Data +	Data +	SLO +	BiSS Slave Data +
5 (yellow)	Data -	Data -	SLO -	BiSS Slave Data -
6 (white)	CLK -	CLK -	MA -	BiSS Clock -
7 (brown)	CLK +	CLK +	MA +	BiSS Clock +
8 (red)	VCC	VCC	V +	Supply Voltage with respect to GND

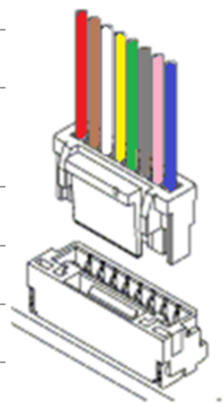

Table 1: Main Connector Allocation.

2.2 Electrical Characteristics

Item No.	Parameter	Symbol	Typekey	Min.	Typ.	Max.	Unit	Remark
201	Supply Voltage	VCC	KCD-BC00B	4.75	5.0	12.5	V	@25 °C, DC, other voltages possible on request.
			KCD-BC01B			15.0		
202	Power Consumption	PC			0.3		W	-
203	Reverse Polarity Protection		KCD-BC00B			-12.5	V	-
			KCD-BC01B			-15.0		

Table 2: Kit Encoder Electrical Characteristics.

2.3 Communication Parameters

The communication parameters are listed below and can also be found in the memory of the kit encoder. The corresponding entries can be accessed by the registers in the EDS banks (see 7.1.3, 7.1.4).

Item No.	Parameter	Symbol	Min.	Typ.	Max.	Unit	Remark
301	Serial Communication Format	BiSS C (point to point)					-
302	Output Driver	RS-422					-
303	BiSS C, SCD	Multiturn (MT) Singleturn (ST) Error (ERR) Warning (WARN) CRC			16 bit 17 bit 1 bit 1 bit 6 bit		Default. MSB first, left aligned.
304	CRC	Length Start value Polynomial Transmission			6 bit 0x00 0x43 inverted		Default, can be changed on re-quest.
305	Clock Frequency	CF	0.1		10	MHz	-
306	Interface Cycle Time	CT	50			µs	-
307	BiSS Timeout	Bto	7		12.5	µs	-
308	BiSS Busytime	Bbt	5	5.5	7	µs	-

Table 3: BISS Communication Parameters.

3. BiSS C Interface

The BiSS C interface provides a communication connection between a master device, representing the motor control unit and its connected slave device, representing the kit encoder. The devices are connected in a point to point configuration, that only requires two unidirectional lines (clock and data) using differential signaling each. The slave device is synchronized by the clock signal (MA), generated by the master. Therefore, it receives the transferred clocks and passes on its generated signal to the slave output line (SLO), which is directly connected to the input line of the master (see figure 1). A detailed description of the protocol is presented by iC-Haus [1].

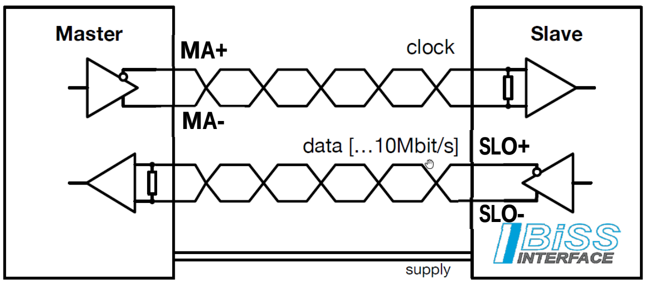

Figure 1: BiSS Interface, point-to-point.

3.1 Transmission Protocol

The BiSS C protocol describes a serial communication that is cycle based. For each transmission cycle two types of data are transmitted: Single Cycle Data (SCD) and Control Data (CD).

The Single Cycle Data is primary used to transmit sensor data as the current singleturn and multiturn value from the kit encoder (slave) to the master. The Control Data is transmitted with one bit per cycle and allows register communication as the reading and writing of the slave register, see section 3.1.2.

In the following section 3.1.1, the transmission cycle of the BiSS communication is described in detail.

3.1.1 BiSS Transmission Frame

The communication between master and slave follows a defined pattern based on the BiSS transmission frame (see figure 2).

The BiSS transmission frame is started and ended by the master clock signal (MA). The first falling edge of the MA latches the kit encoder position. With the first rising edge, the slave sets the SLO line to “0” to generate the acknowledge signal (ACK). The acknowledge signal is active (SLO =”0”) until the sensor data is processed and ready to send. When the slave is ready to send data, the start bit is set (SLO=”1”) synchronized with the MA clock. The next bit sent, is the Control Data Slave bit (CDS). Control Data are transmitted with one bit per cycle. Afterwards the Single Cycle Data (SCD) is send.

The SCD consists of:

Multiturn value (MT)	Singleturn value (ST)	Error (ERR)	Warning (WARN)	CRC
16 bit	17 bit	1 bit	1 bit	6 bit

The MSB is transmitted first. The transmission frame ends with a timeout (SLO=”0”). During this time, the Control Data Master bit (CDM) is defined by the master. The idle state of MA and SLO is “1” till the beginning of the next cycle.

The CRC is calculated on the bit string including MT, ST, ERR and WARN. For more information on the CRC calculation, see [2].

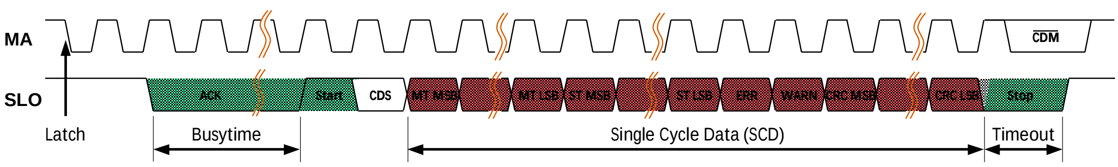

Figure 2: BISS Transmission Frame Overview.

3.1.2 Register Communication

By using register communication, the slave registers can be accessed. This allows the execution of the sensor calibration, the Wiegand sensor test and the query of status and device information. Therefore, the slave registers are accessed with their corresponding addresses. There are two ways to establish a register communication with the kit encoder (slave). The first option is to build up serial communication via the config pin using the UBICOM protocol. For the definition and further details on the UBICOM protocol see chapter 5. The second option is to use a communication device supporting BiSS C (BiSS C master), such as a BiSS reader.

When using the BiSS C protocol, register communication is performed via the control frame. The control frame results from the Control Data (CDM and CDS), which is send every cycle in the transmission frame, see figure 3 for an example. The corresponding timing diagram of the control frame is illustrated in figures 4 and 5.

The control frame is started after passing on at least 14 consecutive cycles with CDM = “0” (note, that CDM bit is inverted). The read and write access to the registers is started by setting the start bit and the Control Select bit (CTS) to “1”. Afterwards the device ID of the slave (3 bits, here: 0x00) is send, followed by the desired register address ADR (7 bits) and CRC (4 bits). If multiple slaves are connected, ID Lock bits (IDL) are send back to communicate which slaves are occupied at present. The next two CDM bits R and W determine, whether a read or write access is set to the addressed register. For read access send RW = ”10”, for write access send RW = ”01.”

If the addressed register is being written, the slave sends back the read value to the master for confirmation. The control frame ends with a stop bit “0” and subsequently a new frame can be started.

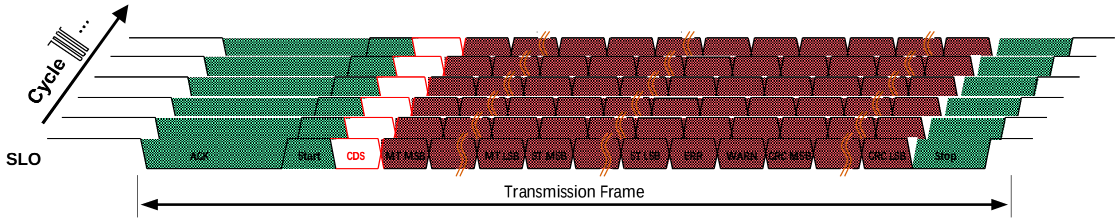

Figure 3: BiSS Control Frame composition. Control Frame results from Control Data of each cycle (here:CDS bits).

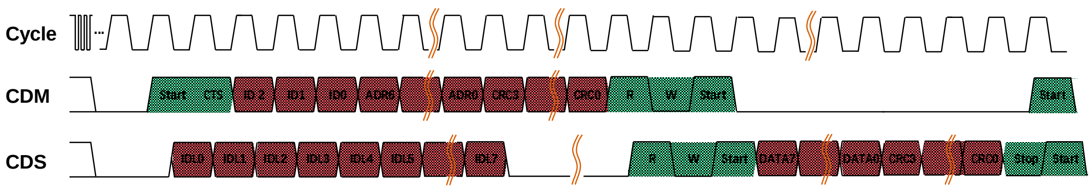

Figure 4: BiSS Control Frame, read access. Timing diagram of command communication.

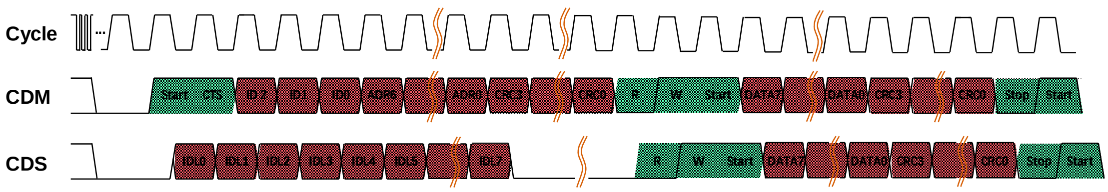

Figure 5: BiSS Control Frame, write access. Timing diagram of command communication.

4. Registers

Due to the limited number of 7 bits for addressing, the accessible memory is partitioned into two 64 byte sections. The first section is defined from address 0x00 to 0x3F and is called bank section. The content of these registers depends on the selected bank. The active bank is selected by the bank selection register (address 0x40). The second section is fixed and always directly accessible from address 0x40 to 0x7F, called direct register.

The kit encoder has 68 banks which are used e.g. for encoder functions, to save electronic datasheets (EDS Encoder Data, EDS Motor Data) and OEM data. Bank 0x00 and 0x01 are used to execute special encoder functions such as the Wiegand sensor test. Bank 0x02 and 0x03 contain the electronic datasheets (EDS). Banks 0x04 to 0x43 are empty upon delivery and can be used to save data for your own needs e.g. motor related data. A detailed overview of the registers and the register entries is provided in the appendix, see 7.1 Register Overview.

4.1 Register Accessing

Registers can be addressed by using the BiSS register communication. The direct registers (second section) can be addressed directly. To access a specific bank register, write the bank number to the bank select register (address 0x40).

The following **example** demonstrates the reading of the "Minimum BiSS timeout", located in register 0x05 in bank 0x02 (EDS Encoder Data):

1. Select bank 2:
   Write value 0x02 to the bank select register 0x40 (direct register).
2. Read register 0x05. The read value contains the "Minimum BiSS timeout".

Register Address	Size	Bank 0x00…0x01	Bank 0x02…0x03	Bank 0x04…0x23	Bank 0x24…0x43
0x00 … 0x3F	64 byte	Special Encoder Functions	EDS Encoder Data	EDS Motor Data	OEM Data
0x40 … 0x7F	64 byte	Direct Registers			

Figure 6: Register Map.

5. UBICOM Protocol

Beside BiSS C protocol it is possible to calibrate and configure the kit encoder via an input / ouput pin defined as config pin used for serial communication. The UBICOM protocol defines a simple protocol over the UART Interface. The Interface is used in half-duplex master slave mode. The slave (encoder) does only answer on request. Hardware connection with the encoder is made on the config pin.

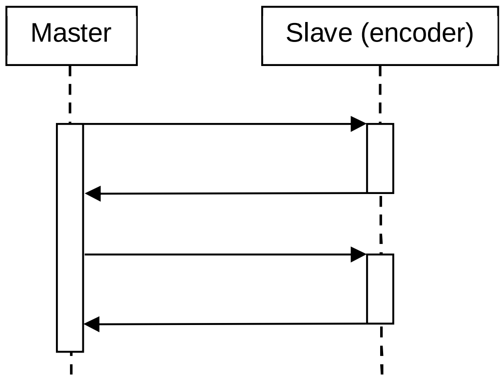

Figure 7: Transmission diagram.

5.1 Message Format

The data is default send with 115200 Baud in 8N1 over the UART port (RS232 TTL level).

Header				Payload	Checksum
Sync	**Address**	**Command**	**LEN**		
0x80	<node>	<cmd>	LSB><MSB><	<data_0>… <data_n>	<chk>

SYNC	Start of frame is always 0x80.
Address	Default 0x01
Command	See description below
LEN	Length of Data (only the Data content count)
Payload	Depends on command. See description
Checksum	The checksum is calculated over all bytes and then inverted. Example: NOT(0x80+0x01+0x01+0x02+0x00+0x00) = NOT(0x84) = 0x7B

Table 4: UBICOM definitions.

5.2 Commands

Read parameter

Get status information from the Slave. This is also used to determine if a programming cycle has completed.

Command	Name	LEN	Data
0x01	Read parameter	0x02	<Register number>

Table 5: Command read message (Master -> Slave)

The DUT replies with a status message:

Command	Name	LEN	Data
0x01	Read parameter	0x01	<Register content>

Table 6: Command read response (Slave -> Master)

Write parameter

Get status information from the slave. This is also used to determine if a programming cycle has completed.

Command	Name	LEN	Data
0x02	Write parameter	0x03	<Register number><Data>

Table 7: Command write message (Master -> Slave)

The DUT replies with a status message:

Command	Name	LEN	Data
0x02	Write parameter	0x01	<Status>

Table 8: Command write response (Slave -> Master)

The status is DATA_ACK==0x90 or DATA_NAK==0xA0.

Get position word

Command	Name	LEN	Data
0x03	Get position word	0x01	0x01

Table 9: Command get position (Master -> Slave)

The slave replies with the positon word. The data is transmitted LSB first.
The position data has a length of 33 bit with 16 bit MT and 17 bit ST.

Command	Name	LEN	Data
0x03	Get position word	0x05	<LSB> Position word <MSB>

Table 10: Command get position response (Slave -> Master)

Note, the use of the UBICOM protocol via the config pin is valid from firmware version 1.2.0.

6. Hardware and Software Features

6.1 Function Overview

The BiSS C kit encoder provides a set of additional features aside the actual angle measurement:

- Temperature Readout
- Singleturn Calibration
- Wiegand Sensor Test
- OEM Data Storage
- Electronic Datasheets
- Filter Selection
- Preset Function

The features can be run directly by BiSS C register communication or by use of serial communication via the config pin using the UBICOM protocol. For the serial communication, there is a hardware and software available for direct application. For more details see chapter 7.

The activation of a feature requires the activation of the corresponding device mode, except for the temperature readout. The change of the device mode is password secured. To enable the device mode configuration, the password “0x2A” must be written to register 0x6B. Next, the desired register value is written to the device mode register 0x6A.

Command Register	**Register Address (direct)**
Password register (password: 0x2A)	0x6B
Device mode register	0x6A

The following device modes are available:

Device Mode Register	**Register Value**
Operation mode	0x00
Calibration mode	0x01
Wiegand Sensor Test mode	0x02
OEM/EDS Motor Data Write	0x04
Filter Selection mode	0x05
Preset mode	0x07

Note, that the device must be set back to operation mode, after carrying out a feature!

The password register is not reset by changing the mode back to operation mode.

6.2 Temperature Readout

The BiSS C kit encoder has an internal temperature sensor, used to monitor the encoder temperature. The measured temperature value T_{reg} is stored in the direct register 0x66. The register value T_{reg} can be converted to °C with equation:

$$T[°C] = T_{reg} - 50$$

and to °F with equation:

$$T[°F] = 1.8 * T_{\mathrm{reg}} + 32$$

The specifications of the integrated temperature sensor can be found in table 10. A change of the device mode is not necessary for this encoder feature.

Attention: The sensor measures the encoder temperature and is not intended to substitute a motor temperature sensor!

Parameter	**Symbol**	**Remark**
Interface	TSI	BiSS register entry, size: 8 bit
Register Address	TSRA	Direct register 0x66
Temperature Accuracy	TSA	5 °C
Temperature Range	TSR	-40 to 130 °C

Table 11: Temperature Sensor Properties.

6.3 Wiegand Sensor Test

The BiSS C kit encoder uses a magnetic Wiegand counter to provide absolute multiturn values. The software integrated Wiegand sensor test measures the Wiegand sensor properties, by analyzing Wiegand pulses for 515 motor shaft revolutions. The test must be carried out for both clockwise (CW) and counter clockwise (CCW) rotations and can be performed by the following sequence. Carry out the sequence for CW first and afterwards for CCW direction.

VIDEO INSTRUCTION

No.	Register Address	Value	OP	Remark
1	-	-	-	**Run the motor** at constant rotation speed in CW direction. A rotation speed of 500-2000 rpm is recommended.
2	0x6B (direct register)	-	W	**Enable device mode** configuration: Write password 0x2A to register.
3	0x6A (direct register)	0x02	W	**Change device mode** to Wiegand sensor test mode.
4	0x40 (direct register)	0x00	W	**Select bank 0:** Write value 0x00 to the bank selection register.
5	0x06 (bank 0)	0x01	W	**Start Wiegand sensor test**, **CW direction.** The duration of the test routine depends on the rotation speed of the motor. The test must run for at least 515 motor revolutions.
6	0x07 (bank 0)		R	**Check the result of the test** by reading the Wiegand sensor test status register. If the pulse collection in CW direction is finished, the routine waits for the change of motor direction to CCW (value 0x03).
7	-	-	-	**Run the motor in CCW direction**.
8	0x06 (bank 0)	0x02	W	**Start Wiegand sensor test**, **CCW direction.**
9	0x07 (bank 0)		R	**Check the result of the test** by reading the Wiegand sensor test status register. If the pulse collection in CCW direction is finished, the test is completed (value 0x06).
10	0x06 (bank 0)	0x05	W	**(Optional)** Save the acquired result data permanently.
11	0x6A (direct register)	0x00	W	**Change device mode** back to operation mode.

The saved result data can be checked at any time, if step 10 was executed. The average pulse height of the analyzed pulses and its standard deviation is saved for CW and CCW direction. A Wiegand pulse height average minus 4x standard deviation greater than 5.3 V is recommended for operation.

Wiegand Sensor Test Status Register	Register Value
Test stopped	0x00
Pulse Collection active (CW)	0x01
Wait for change of motor rotation direction	0x03
Pulse Collection active (CCW)	0x04
Test complete	0x06
Test failed	0x07

Result Data (last test)	Register Address (bank 0)
Average Pulses (CW)	0x09
Average minus 4x Standard Deviation (CW)	0x0A
Average Pulses (CCW)	0x0B
Average minus 4x Standard Deviation (CCW)	0x0C

Result Data (saved)	Register Address (bank 0)
Average Pulses (CW)	0x11
Average minus 4x Standard Deviation (CW)	0x12
Average Pulses (CCW)	0x13
Average minus 4x Standard Deviation (CCW)	0x14

Note

- The result data values must be divided by 10 to get the value in volts.
- The Wiegand sensor test can be stopped at any time by writing value 0x03 to the pulse testing command register (0x06, bank 0).
- The measured pulses are not depended on rotation speed, but low rotation speeds can lead to long test times.

Attention

- The encoder cannot be used as a feedback system during the test!
- It is highly recommended to run the Wiegand sensor test once after installation is finished.
- The encoder is not able to identify the rotation direction of the motor during the test, so make sure rotation and test direction match.

6.4 Calibration

The electronic calibration of the BiSS kit encoder is required to improve the measurement accuracy of the kit encoder after installation.

The device is delivered in a pre-calibrated state. In factory state the accuracy of the encoder after installation is limited to an angle error below ± 0.3° typically. This is caused by mechanical tolerances during the mounting of the kit encoder onto the motor shaft (static or build-up tolerances). By using the offered electronic calibration procedure, the impact of the static mounting tolerances on the kit encoder accuracy can be cancelled out and the system angle error will be improved towards the specified accuracy.

Please note, that after the electronic calibration further movements of the mounted magnet on the shaft towards the kit encoder (due to dynamic tolerances e.g. thermal expansion of the shaft or play of the ball bearing) should be minimized as these tolerances have a negative impact on the total system accuracy. To achieve the specified accuracy, it is recommended to keep the dynamic tolerance below ±0.1 mm. The sum of static and dynamic tolerances must always be bellow ±0.3 mm.

External Conditions for Calibration

To successfully calibrate the BiSS kit encoder several external conditions must be fulfilled. The sensor must be completely mounted (including housing for magnetic shielding) and fixed in the final position before the calibration is started. All external conditions should match the normal operation conditions as far as possible. The operating temperature of the kit encoder must be in the range of 25 °C to 40 °C (77 °F to 104 °F).

Calibration Register	**Register Address (bank 0)**
Command register	0x00
Status register	0x01

Calibration Status Register	**Register Value**
Calibration finished (CCW)	0x02
Calibration finished (CW)	0x22
Wrong rotation direction	0x30
Temperature out of range	0x31
Calibration failure	0x33

Calibration Procedure

The calibration of the fully mounted sensor requires a rotation of the motor shaft at constant speed of 500 rpm, where the deviation of the angular velocity should be less than 2 rpm.

Note, that the resulting angular accuracy is directly dependent on the rotation speed uniformity.

The calibration procedure is performed by carrying out the following sequence:

VIDEO INSTRUCTION

No.	Register Address	Value	OP	Remark
1	-	-	-	**Run the motor in CCW direction** at constant rotation speed of 500 rpm < ±2 rpm.
2	0x6B (direct register)		W	**Unlock device mode** configuration: Write password 0x2A to register.
3	0x6A (direct register)	0x01	W	**Change the device mode** to calibration mode.
4	0x40 (direct register)	0x00	W	**Select bank 0:** Write value 0x00 to the bank selection register.
5	0x00 (bank 0)	0x01	W	**Start the calibration routine, CCW direction:** Write value 0x01 to the calibration command register. The execution of the calibration routine takes about 5 seconds and stops automatically.
6	0x01 (bank 0)		R	**Read the calibration** status until the register value is 0x02, then the calibration in CCW direction is finished.
7	-	-	-	**Run the motor in CW direction**.
8	0x00 (bank 0)	0x02	W	**Start the calibration routine, CW direction:** Write value 0x02 to the calibration command register.
9	0x01 (bank 0)		R	**Read the calibration status register** until the register value is 0x22, then the calibration in CW direction is finished. The calibration data is saved automatically.
10	0x6A (direct register)	0x00	W	**Change the device mode** back to operation mode.

Note, that If calibration fails in CW direction the calibration table is lost, which leads to an increase of the angle error.

Attention: The encoder cannot be used as a feedback system during calibration!

6.5 Data Storage

The BiSS kit encoder offers the capability to access two different internal memory regions to store data: The EDS-Motor-Data and the OEM-Data. The corresponding memory addresses are given in table 9. The accessibility of the specific memory depends on the access rights.

Memory	Start-Addr.	End-Addr.	Access	Remark
EDS Encoder Data	Bank 0x02	Bank 0x03	R	We support the BiSS Profile 3 as Standard Encoder Profile.
EDS-Motor-Data	Bank 0x04	Bank 0x23	R/W	2 Kbyte Motor Data: customer specific motor data
OEM-Data	Bank 0x24	Bank 0x43	R/W	2 Kbyte OEM Memory: open access for customer use

Table 12: Data Storage Overview.

Writing the EDS-Motor-Data or OEM-Data is permitted by default. The write access is protected by a password. To write an EDS-Motor or OEM-Data register, carry out the following sequence:

No.	Register Address	Value	OP	Remark
1	0x6B (direct register)		W	**Unlock device mode** configuration: Write password 0x2A to register.
2	0x6A (direct register)	0x04	W	**Change the device mode** to OEM / EDS Motor Data Write.
3	0x40 (direct register)	0x00	W	**Select bank 0:** Write value 0x00 to the bank selection register.
4	0x1B (bank 0)		R	**Get write access:** Read OEM / EDS-Motor Data Write status register until a value of 0x00 indicates permission to get write access to the EDS-Motor Data.
5	0x1A (bank 0)	0x01 or 0x02	W	Write the value to the OEM / EDS-Motor Data Write - command register. 0x01: access EDS-Motor Data 0x02: access OEM-Data
6			W	**Write data to flash memory**: Write data to the desired register, by using the BiSS register communication.
7	0x1B (bank 0)		R	**Save data permanently:** Read the OEM / EDS-Motor Data Write - status register until a value of 0x01 indicates permission to get save access to the EDS-Motor Data.
8	0x1A (bank 0)	0x03	W	Write the value 0x03 to the OEM / EDS-Motor Data Write - command register

9	0x1A (bank 0)	0x04	W	**Cancel write access:** Write the value 0x04 to the OEM / EDS-Motor Data Write - command register.
10	0x6A (direct register)	0x00	W	**Change the device mode** back to operation mode: Write value to direct register 0x6A.

OEM / EDS-Motor Data Register	**Register Address (bank 0)**
Command register	0x1A
Status register	0x1B

OEM / EDS-Motor Data Command	**Register Value**
Get write access EDS-Motor Data	0x01
Get write access OEM-Data	0x02
Save data	0x03
Cancel write access	0x04

OEM / EDS-Motor Data Status Register	**Register Value**
Wait for write access	0x00
Wait for save command	0x01

Attention: Reading and writing data during motor operation is not allowed.

6.6 Filter Selection

The BiSS kit encoder offers two different filter options:

- **Balanced (default)**
  This filter provides a very well-balanced relation of signal noise and dynamic behavior.
- **Dynamic**
  This filter provides position values with short latency, but increased signal noise. Therefore, this filter is suitable for very fast and dynamic motor control loops.

To check which filter is currently active, read direct register 0x6E (balanced: 0x03, dynamic: 0x04). To activate a filter setting, carry out the following sequence:

No.	Register Address	Value	OP	Remark
1	0x6B (direct register)		W	**Enable device mode** configuration: Write password 0x2A to register.
2	0x6A (direct register)	0x05	W	**Change device mode** to filter selection mode.
3	0x40 (direct register)	0x00	W	**Select bank 0:** Write value 0x00 to the bank selection register.
4	0x25 (bank 0)		R	**Get write access:** Read filter status register. A value of 0x00 indicates permission to get write access.
5	0x24 (bank 0)	0x01	W	Write value 0x01 to the filter command register.
6	0x25 (bank 0)		R	Read filter status register. A value of 0x02 indicates waiting for value.
7	0x24 (bank 0)		W	**Set filter:** ▪ Balanced filter, value 0x03 ▪ Dynamic filter, value 0x04
8	0x25 (bank 0)		R	**Save filter selection:** Read filter status register. A value of 0x01 indicates permission to save filter settings.
9	0x24 (bank 0)	0x02	W	Write value to filter command register. Encoder reboots with new filter setting.
10	0x6A (direct register)	0x00	W	**Change the device mode** back to operation mode.

Filter Selection Register	Register Address (bank 0)
Command register	0x24
Status register	0x25

Commands	**Register Value**
Get write access	0x01
Save filter selection	0x02
Balanced filter	0x03
Dynamic filter	0x04

Attention: The encoder cannot be used as a feedback system during the filter change!

Note, that the filter selection feature is only supported from firmware version 1.1.0.

6.7 Preset Function

The preset function can be used to adapt the encoder position to the mechanical alignment of the system. By performing a preset, the actual position value of the encoder (both, singleturn and multiturn) is set to the desired preset value. The preset value is specified in registers 0x02 to 0x07 (bank 1) e.g. 0x070605040302. In registers 0x02 to 0x04 (bank 1) the singleturn preset value is saved in little endian format. In registers 0x05 to 0x07 (bank 1) the multiturn preset value is saved in little endian format. The preset can be triggered via hardware or software.

Preset Value	Singleturn preset value			Multiturn preset value		
Register Address (bank 1)	0x02	0x03	0x04	0x05	0x06	0x07
Endianness	LSB		MSB	LSB		MSB

Table 13: Preset value register.

Hardware preset

To perform a preset via hardware, the voltage level at the preset pin has to be pulled to V_{preset} and hold for at least t_{min} = 100 ms (see table 10, see figure 3). The manufacturer default value is 0. After t_{min} the preset value is overtaken independent of a longer high level on the input channel and the kit encoder is conducting a reset.

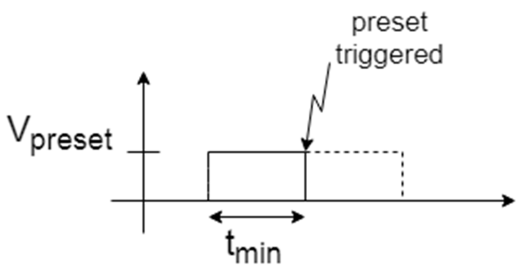

Figure 8: Preset hardware trigger.

Software preset

To change the preset value and perform a preset via software, follow the steps below:

No.	Register Address	Value	OP	Remark
1	0x6B (direct register)		W	**Enable device mode** configuration: Write password 0x2A to register.
2	0x6A (direct register)	0x07	W	**Change device mode** to preset mode. If no change of the preset value is desired, proceed with step 8.
3	0x40 (direct register)	0x01	W	**Select bank 1:** Write value 0x01 to the bank selection register.
4	0x00 (bank 1)	0x02	W	**Enable preset value edit.**

5	0x01 (bank 1)		R	Read status register, a value of 0x01 indicates waiting for value.
6	0x02 – 0x04 (bank 1).		W	Enter singleturn preset value.
7	0x05 – 0x07 (bank 1).		W	Enter multiturn preset value.
8	0x00 (bank 1)	0x03	W	Save preset value.
9	0x00 (bank 1)	0x01	W	**Perform preset.**
10	0x6A (direct register)	0x00	W	**Change the device mode** back to operation mode.

Example

Assuming it is desired to preset the singleturn position of a kit encoder with 17 bit singleturn resolution.

Desired singleturn position: 270°
Corresponding decimal value in digits: 98304
Expressed as a hex value: 0x18000

For this configuration, the register entries must be set as followed:

Register Address (bank 1)	0x02	0x03	0x04
Register Value	0x00	0x80	0x01

Preset Register	**Register Address (bank 1)**
Command register	0x00
Status register	0x01
Singleturn preset value	0x02 – 0x04
Multiturn preset value	0x05 – 0x07

Commands	**Register Value**
Perform preset	0x01
Enable preset value edit	0x02
Save preset value	0x03

Note, that the preset function is only supported with KCD-BC01B-1617-XXXX-XXX from firmware version 1.2.0.

Item No.	Parameter	Symbol	Min.	Typ.	Max.	Unit	Remark
401	Preset voltage range	V_{preset}	0.0		VCC	V	-
402	Preset low voltage level		0		0.8	V	-
403	Preset high voltage level		2		VCC	V	
404	Preset hold time	t_{min}	100			ms	-
405	Preset value			0			MT+ST

Table 14: Preset parameter table.

7. Plug & Play via USB

For easy commissioning there is the option to connect the encoder to a PC and access, configure or calibrate the encoder. We do recommend two ready-to-use solutions.

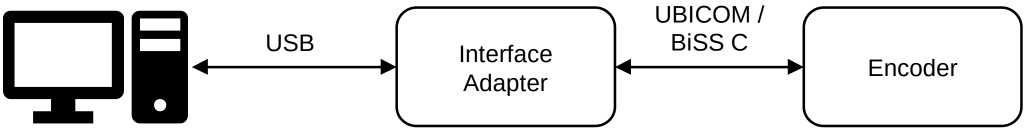

Figure 9: Connection of interface adapter.

Kit Control Box
Using UBICOM for communication

- Access position and register data
- Software GUI to run the main kit encoder functions
- Easy way to perform calibration, preset, Wiegand sensor test and configure filter settings
- Readout encoder temperature and firmware version
- Alternatively program your own encoder related requests based on the UBICOM protocol

For more details see: **https://www.posital.com/en/products/kit-encoders/kit-control-box.php**

Figure 10: Kit Control Box and software GUI by POSITAL.

BiSS Reader

Using BiSS C for communication

- Access position and register data
- Encoder features can be run by BiSS C register communication
- Connect multiple encoders simultaneously

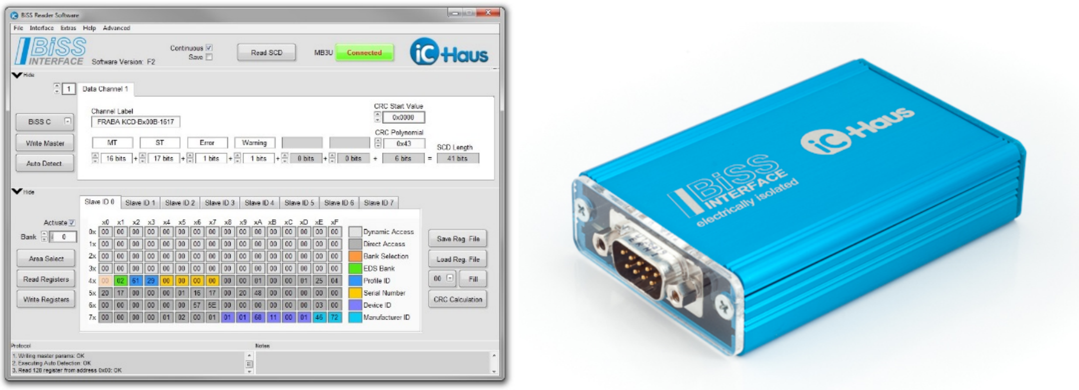

Figure 11: BiSS reader software and BiSS reader MB5U by iC-Haus. [3]

For more details see:

http://www.ichaus.de/product/MB3U

http://www.ichaus.de/product/MB5U

8. References

[1] iC-Haus GmbH: BiSS Interface - PROTOCOL DESCRIPTION (C-Mode). Rev C5, 2008.
[2] iC-Haus GmbH: BiSS Interface AN3: CYCLIC REDUNDANCY CODES. Rev E1, 2012.
[3] iC-Haus GmbH: MB5U High Performance isolated BiSS to PC Adapter (USB). Rev B1, 2018.

9. Appendix

9.1 Register Overview

9.1.1 Direct Registers

Register Address	Description / Symbol	Access	Default Value
0x40	BANK Select	R/W	-
0x41	EDS Start Bank	R	0x02
0x42	Profile ID	R	0x61
0x43		R	0x29
0x44	Serial Number, U32	R	-
0x45		R	-
0x46		R	-
0x47		R	-
0x66	Temperature Intern	R	-
0x68	Fault Register	R	-
0x69	Warning Register	R	-
0x6A	Device Mode	R/W	0x00
0x6B	Protection	R/W	0x00
0x6E	Selected Filter	R	0x03
0x74	Major Firmware Release	R	-
0x75	Minor Firmware Release	R	-
0x76	Firmware Patch Level	R	-
0x78	Device ID	R	0x01
0x79		R	0x01
0x7A		R	0x68

0x7B		R	0x11
0x7C		R	0x00
0x7D		R	0x01
0x7E	Manufacturer Coder	R	0x46
0x7F		R	0x72

Table 15: Direct Registers.

9.1.2 Bank 0 / Special Encoder Functions

Register Address	Description / Symbol	Access	Default Value
0x00	Calibration Command	R/W	0x00
0x01	Calibration Status	R	0x00
0x06	Wiegand Sensor Test, Command Register	R/W	0x00
0x07	Wiegand Sensor Test, Status Register	R	0x00
0x08	Wiegand Sensor Test, Error Code	R	0x00
0x09	Wiegand Sensor Test, Average Pulses CW (last test result)	R	0x00
0x0A	Wiegand Sensor Test, Average minus 4x Standard Deviation CW (last test result)	R	0x00
0x0B	Wiegand Sensor Test, Average Pulses CCW (last test result)	R	0x00
0x0C	Wiegand Sensor Test, Average minus 4x Standard Deviation CCW (last test result)	R	0x00
0x0D	Wiegand Sensor Test, Average Pulses CW (FRABA Production)	R	-
0x0E	Wiegand Sensor Test, Average minus 4x Standard Deviation CW (FRABA Production)	R	-
0x0F	Wiegand Sensor Test, Average Pulses CCW (FRABA Production)	R	-
0x10	Wiegand Sensor Test, Average minus 4x Standard Deviation CCW (FRABA Production)	R	-

0x11	Wiegand Sensor Test, Average Pulses CW (saved test result)	R	-
0x12	Wiegand Sensor Test, Average minus 4x Standard Deviation CW (saved test result)	R	-
0x13	Wiegand Sensor Test, Average Pulses CCW (saved test result)	R	-
0x14	Wiegand Sensor Test, Average minus 4x Standard Deviation CCW (saved test result)	R	-
0x1A	OEM / EDS-Motor Data Write, Command Register	R/W	-
0x1B	OEM / EDS-Motor Data Write, Status Register	R	-
0x24	Filter Selection, Command Register	R/W	-
0x25	Filter Selection, Status Register	R	-

Table 16: Bank 0 / Special Encoder Functions.

9.1.3 Bank 1 / Special Encoder Functions

Register Address	Description / Symbol	Access	Default Value
0x00	Preset Command	R/W	0x00
0x01	Preset Status	R	0x00
0x02	Preset singleturn value, byte 0	R/W	0x00
0x03	Preset singleturn value, byte 1	R/W	0x00
0x04	Preset singleturn value, byte 2	R/W	0x00
0x05	Preset multiturn value, byte 0	R/W	0x00
0x06	Preset multiturn value, byte 1	R/W	0x00
0x07	Preset multiturn value, byte 2	R/W	0x00

Table 17: Bank 1 / Special Encoder Functions.

9.1.4 Bank 2 / EDS Encoder Data

We support the BiSS Profile 3 as Standard Encoder Profile.

Register Address	Description / Symbol	Access	Default Value
0x00	EDS Version (continuous number)	R	0x01
0x01	EDS Length (bank count completely)	R	0x02

0x02	Bank Address USER Start (bank selection in address 64, 255 = not available)	R	0x04
0x03	Bank Address USER End (bank selection address 64)	R	0x43
0x05	Minimum BiSS Timeout (0 = adaptive)	R	0x1C
0x06	Maximum BiSS Timeout (0 = adaptive)	R	0x30
0x0B	Minimum Cycle Time (0 = no limitation)	R	-
0x0C	Maximum Processing Time SCD	R	0x20
0x0E	Maximum "power on delay" until control communication is available	R	0x01
0x0F		R	0xF4
0x10	Number of data channel in this device (number of words)	R	0x01
0x11	Area of validity for this EDS (number of slave addresses)	R	0x01
0x14	Bank Address for content description data channel 1 (profile EDS)	R	0x03
0x15	Data Length, Data Channel 1	R	0x23
0x16	Data Format, Data Channel 1	R	0x00
0x17	CRC Polynomial (8:1) for Data Channel 1	R	0x21
0x3F	Checksum (addition of all bytes in this bank)	R	-

Table 18: Bank 2 / Electronic Data Sheet, Encoder Data.

9.1.5 Bank 3 / EDS Encoder Data

We support the BiSS Profile 3 as Standard Encoder Profile.

Register Address	Description / Symbol	Access	Default Value
0x00	BiSS Profile 3 Version	R	0x01
0x01	Length of this profile	R	0x01
0x02	Profile Identification BP3 (content also available in addresses 0x42 and 0x43)	R	0x61
0x03		R	0x29
0x04	Feedback bit 1	R	0x01
0x05	Feedback bit 2	R	0x02

0x06	Maximum "power on delay" until position data is available	R	0xFF
0x08	Encoder Type	R	0x00
0x0A	Data Length MULTITURN	R	0x10
0x0C	Data Length COARSE	R	0x11
0x1C	CRC Polynomial (32:1)	R	0x00
0x1D		R	0x00
0x1E		R	0x00
0x1F		R	0x21
0x20	CRC Start Value	R	0x00
0x21		R	0x00
0x22		R	0x00
0x23		R	0x00
0x2C	Maximum revolution speed/maximum speed [1/min]	R	0x2E
0x2D		R	0xE0
0x30	Minimum operating temperature [K]	R	0x00
0x31		R	0xE9
0x32	Maximum operating temperature [K]	R	0x01
0x33		R	0x7A
0x34	Minimum operating voltage [mV]	R	0x13
0x35		R	0x88
0x36	Maximum operating voltage [mV]	R	0x2E
0x37		R	0xE0
0x38	Maximum current consumption [mA]	R	0x00
0x39		R	0x46
0x3F	Checksum (addition of all bytes in this bank)	R	-

Table 19: Bank 3 / Electronic Data Sheet, Encoder Data.