MANUAL

IXARC KIT ENCODERS WITH BISS LINE INTERFACE

- Absolute singleturn and multiturn on one PCB
- Kit solution – no ball bearing, no tether, very compact: 36 mm diameter
- Digital asynchronous serial interface: BiSS Line
- Designed for 4-wire communication
- 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

POSITAL FRABA

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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 commands about this document.

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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 (32 bit). 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 Line interface enables a direct digital sensor data transmission over a 4-wire interface which is therefore suitable for one cable motor applications (OCT). Access to device and customer related register data, stored in the encoders internal memory is possible.

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 sensor 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 Line kit encoder is presented. The electrical connection and characteristics of the device is provided in chapter 2, a brief description of the BiSS Line protocol is given in chapter 3 and an overview to the memory allocation is presented in chapter 4. The integrated hardware and software features of the kit encoder are described in chapter 5.

2. Electrical Data

2.1 Connector

Connector Type: JST BM06B-GHS-TBT

Pin No.	Symbol (2-wire)	Symbol (4-wire)	Description
1 (blue)	-	GND	Ground reference voltage
2 (pink)	Data - GND	Data -	Inverting pin
3 (gray)	Data + VCC	Data +	Non-inverting pin
4 (red)	-	VCC	Supply Voltage with respect to GND
5 (yellow)	Reserved		Do not connect
6 (green)	Reserved		Do not connect

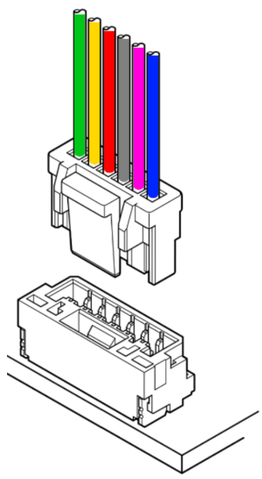

Table 1: Main Connector Allocation.

2.2 Electrical Characteristics

No.	Parameter	Symbol	Min.	Typ.	Max.	Unit	Remark
201	Supply Voltage	VCC	4.75	5.0	12.5	V	@25 °C, DC, other voltages possible on request
202	Power Consumption	PC		0.3	0.35	W	
203	Reverse Polarity Protection				-12.5	V	

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.

No.	Parameter	Symbol	Min.	Typ.	Max.	Unit	Remark
301	Serial Communication Format	BiSS Line (point to point)					-
302	Data Transmission	Bidirectional, asynchronous					-
303	Output Driver	RS-485					-
304	SCD	Multiturn (MT) Singleturn (ST) Fill bits (Zero) Error (ERR) Warning (WARN) CRC			24 bit 17 bit 7 bit 1 bit 1 bit 6 bit		Default
305	CRC	Length Start value Polynomial Transmission			6 bit 0x00 0x43 inverted		Default, can be changed on request
306	Cycle Time	CT	50			µs	
307	Transmission Rate	TR	12.49875	12.5	12.50125	Mbit	Limit depends on line driver and length of line
308	Length of transmission line				100	m	-

309	Maximum Response Time				10	µs	Measured at master
310	Minimum Idle Time (slave)		5			µs	-
311	Release time between master sending and slave sending				600	ns	keep as short as possible

Table 3: BISS Communication Parameters.

3. BiSS Line Interface

The BiSS Line interface provides a communication connection between a master device, representing the motor control unit and its connected slave device, representing the encoder. For BiSS Line two wiring options are available. The connection between the master and the slave can be realized using a 4-wire configuration or a 2-wire configuration. The 4-wire configuration uses two wires for data transmission and two separate power lines, see figure 1. The 2-wire configuration uses only one twisted pair cable for data transmission and power supply, see figure 2.

For both configurations, the data transmission is based on the industrial standard RS-485 using half-duplex asynchronous transmission. All communication is encoded in 8b10b to achieve DC-balance and allow reasonable clock recovery.

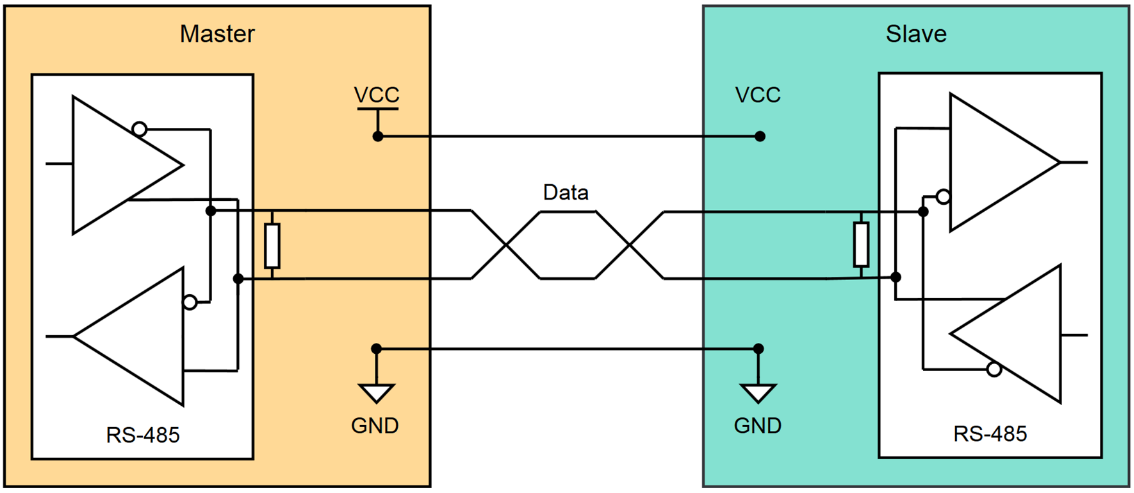

Figure 1: Simplified BiSS Line Interface (4-wire configuration).

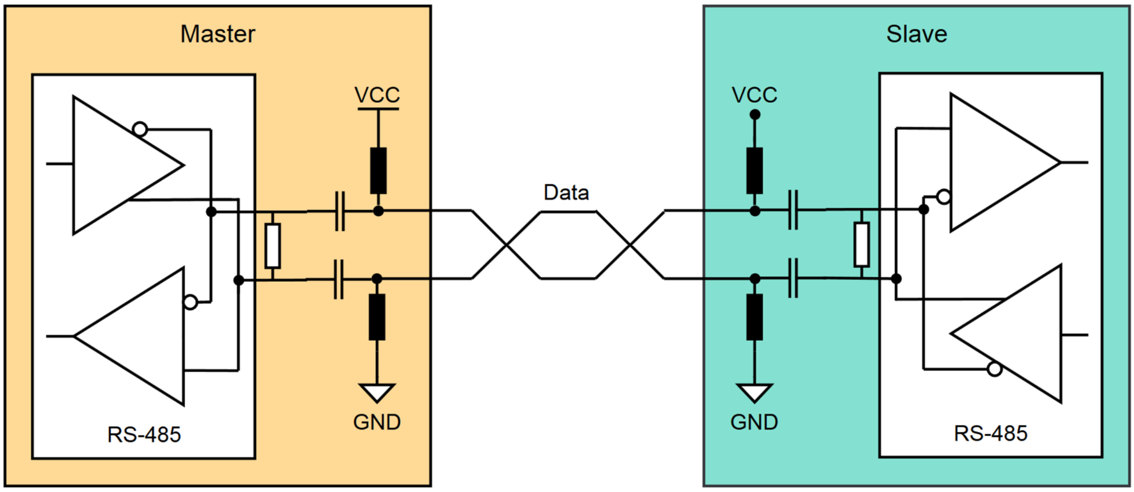

Figure 2: Simplified BiSS Line Interface (2-wire configuration).

3.1 Transmission Protocol

The BiSS Line communication is realized with frames using the RS-485 standard with half-duplex asynchronous transmission. In each BiSS Line Frame 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 frame 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 BiSS Line Frame is described in detail.

3.1.1 BiSS Line Frame

The BiSS Line communication is realized with frames, in which the data exchange between the master and the slave is performed. A simplified overview of the BiSS Line Frame and the data line is given in figure 3. The color of the data indicates whether the master (orange) or the slave (green) is driving the line.

In idle state the master is sending “Idle” symbols on the data line, which is alternating code to maintain DC balance and ensure a signal for clock recovery on the slave side.

The BiSS Line Frame is initiated by the master by sending the “Start” symbol. Subsequent, 20 information bits “Info” are send, of which only the first bit (Control Data Master, CDM bit) is of interest here. The information bits are not 8b10b coded, but BCH(7,15) coded with one fill bit after every third BCH bit, being an exception here. Afterwards the master waits for the slave to drive the line.

When the slave receives the “Start” symbol completely, it is able to sample the information from the master. The slave starts sending “Idle” symbols on the data line, until the current position calculation is ready to output a value. The idle is interrupted by responding with the Control Data Slave (CDS) symbol, followed by the Single Cycle Data (SCD). The SCD consists of:

- Multiturn value (MT) 24 bit
- Singleturn value (ST) 17 bit
- Fill bits (Zero) 7 bit
- Error (ERR) 1 bit
- Warning (WARN) 1 bit
- CRC 6 bit

The MSB is transmitted first.

At the end of the transmission, the slave releases the line and the master sends idle symbols again until the next BiSS Line Frame begins. BiSS Line Frames can be performed with a minimum cycle time of 50 µs.

For more information on the CRC calculation, see [2].

Symbol	8b10b	Binary
Idle	21.5	1010101010
Start	26.7	0101101110
CDS = 0	29.4	0100011101
CDS = 1	26.7	0101101110

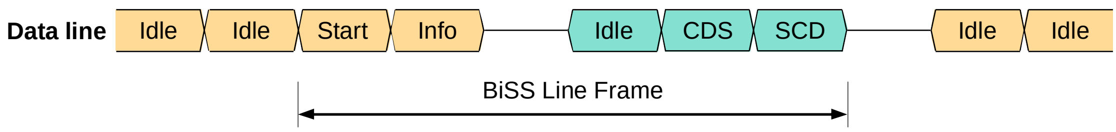

Figure 3: BiSS Line Frame overview. Line driver: master (orange), slave (green).

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. To establish a register communication with the slave (here: kit encoder) a communication master device supporting BiSS Line is needed.

Register communication is performed via the Control Data Frame. The Control Data Frame results from the Control Data (CDM and CDS), which is send in every BiSS Line Frame. Figure 4 illustrates how the Control Data Frame composes from consecutive BiSS Line Frames. The CDM bit is included in the information data “Info” in the first bit. The information data is BCH(7,15) coded with one fill bit after every third BCH bit.

The Control Data Frame is started after passing on at least 14 consecutive BiSS Line Frames with CDM = “0”. 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:

- Read: RW=”10”
- Write: RW=”01”

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

More information about the Control Data Frame can be found in the BiSS C protocol description, see [1].

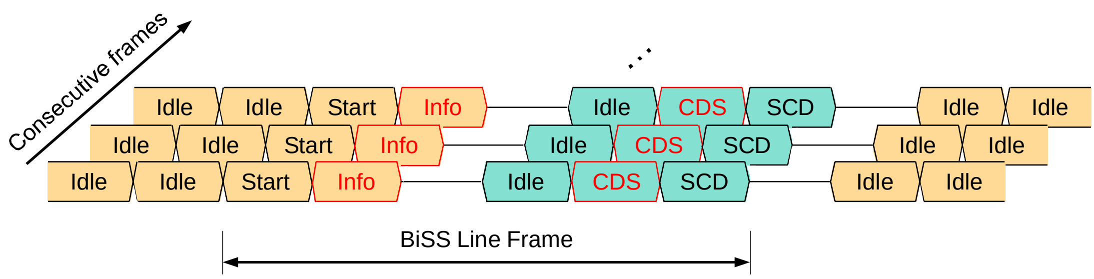

Figure 4: BiSS Control Data Frame composition. Control Data Frame results from Control Data of each BiSS Line Frame.

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 is used to execute special encoder functions such as the Wiegand sensor test. Bank 0x01 is reserved and not allowed for use. Banks 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 8.1 Register Overview.

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 into the bank select register (address 0x40).

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

Figure 5. Register Map.

5. Hardware and Software Features

5.1 Function Overview

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

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

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 must be written into register 0x6B. Next, the desired register value is written to the device mode register 0x6A.

Command Register	Address
Password register	0x6B
Device mode register	0x6A

The following device modes are available:

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

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

5.2 Temperature Readout

The BiSS Line 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 10: Temperature Sensor Properties.

5.3 Wiegand Sensor Test

The BiSS Line 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

1. **Run the motor** at constant rotation speed in CW direction. A rotation speed of 500-2000 rpm is recommended.
2. **Enable device mode** configuration:
   Write password into direct register 0x6B.
3. **Change device mode** to Wiegand sensor test mode: Write value 0x02 into direct register 0x6A.
4. **Start Wiegand sensor test**, **CW direction**: Write value 0x01 into the Wiegand sensor test command register (bank 0, register 0x06).

The duration of the test routine depends on the rotation speed of the motor. The test must run for at least 515 motor revolutions.

5. **Check the result of the test** by reading the Wiegand sensor test status register (bank 0, register 0x07). If the pulse collection in CW direction is finished, the routine waits for the change of motor direction to CCW (value 0x04).
6. **Run the motor in CCW direction**.
7. **Start Wiegand sensor test**, **CCW direction**: Write value 0x02 into the Wiegand sensor test command register (bank 0, register 0x06).

Wiegand Test Status	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

8. **Check the result of the test** by reading the Wiegand sensor test status register (bank 0, register 0x07). If the pulse collection in CCW direction is finished, the test is completed (value 0x06).
9. **(Optional)** Save the acquired result data permanently: Write value 0x05 into the Wiegand sensor test command register (bank 0, register 0x06).
10. **Change device mode** back to operation mode: Write value 0x00 into direct register 0x6A.

The saved result data can be checked at any time, if step 9 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.

Result Data (last test)	Address
Average pulses (CW)	Bank 0, 0x09
Average minus 4x standard deviation (CW)	Bank 0, 0x0A
Average pulses (CCW)	Bank 0, 0x0B
Average minus 4x standard deviation (CCW)	Bank 0, 0x0C

Result Data (saved)	Address
Average pulses (CW)	Bank 0, 0x11
Average minus 4x standard deviation (CW)	Bank 0, 0x12
Average pulses (CCW)	Bank 0, 0x13
Average minus 4x standard deviation (CCW)	Bank 0, 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 into the pulse testing command register (bank 0, register 0x06).
- 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.

5.4 Calibration

The electronic calibration of the BiSS Line 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 Line 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 Status	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, 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

1. **Run the motor in CCW direction** at constant rotation speed of 500 rpm < ±2 rpm.
2. **Unlock device mode** configuration:
   Write password into direct register 0x6B.
3. **Change the device mode** to calibration mode:
   Write value 0x01 into direct register 0x6A.
4. **Start the calibration routine, CCW direction:**
   Write the value 0x01 into the calibration command register (bank 0, register 0x00).
   The execution of the calibration routine takes about 3 seconds and stops automatically.
5. **Read the calibration status register** (bank 0, register 0x01). If the register value is 0x02 the calibration in CCW direction is finished.
6. **Run the motor in CW direction**.
7. **Start the calibration routine, CW direction:**
   Write the value 0x02 into the calibration command register (bank 0, register 0x00).

8. **Read the calibration status register** (bank 0, register 0x01). If the register value is 0x22 the calibration in CW direction is finished.
9. **Change the device mode** back to operation mode: Write value 0x00 into direct register 0x6A.

The calibration data is saved automatically after point 8 is finished.

Note: 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!

5.5 Data Storage

The BiSS Line 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-Motor-Data	Bank 0x04	Bank 0x24	R/W	2 Kbyte Motor Data: customer specific motor data
OEM-Data	Bank 0x25	Bank 0x43	R/W	2 Kbyte OEM Memory: open access for customer use

Table 9: Data Storage Overview.

5.5.1 EDS-Motor-Data

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

1. **Unlock device mode** configuration:
   Write password into direct register 0x6B.
2. **Change the device mode** to OEM / EDS Motor Data Write: Write value 0x04 into direct register 0x6A.
3. **Get write access:**
   1. Read OEM / EDS-Motor Data Write status register (bank 0, register 0x1B): A value of 0x00 indicates permission to get write access to the EDS-Motor Data.
   2. Write the value 0x01 into the OEM / EDS-Motor Data Write - command register (bank 0, register 0x1A).
4. **Write data into flash memory**: Write data into the desired register, by using the BiSS register communication.
5. **Save data permanently:**
   1. Read the OEM / EDS-Motor Data Write - status register (bank 0, register 0x1B). A value of 0x01 indicates permission to get save access to the EDS-Motor Data.
   2. Write the value 0x03 into the OEM / EDS-Motor Data Write - command register (bank 0, register 0x1A)
6. **Cancel write access:**
   Write the value 0x04 into the OEM / EDS-Motor Data Write - command register (bank 0, register 0x1A).
7. **Change the device mode** back to operation mode: Write value 0x00 into direct register 0x6A.

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

Status Register	Register Value
Wait for write access	0x00
Wait for save command	0x01

5.5.2 OEM-Data

Writing the OEM-Data is permitted by default. To write a OEM-Data register, carry out the following sequence:

1. **Unlock device mode** configuration:
   Write password into direct register 0x6B.
2. **Change the device mode** to OEM / EDS Motor Data Write: Write value 0x04 into direct register 0x6A.
3. **Get write access:**
   1. Read OEM / EDS-Motor Data Write status register (bank 0, register 0x1B): A value of 0x00 indicates permission to get write access to the OEM-Data.
   2. Write the value 0x02 into the OEM / EDS-Motor Data Write - command register (bank 0, register 0x1A).
4. **Write data into flash memory:** Write data into the desired register, by using the BiSS register communication.
5. **Save data permanently:**
   1. Read the OEM / EDS-Motor Data Write - status register (bank 0, register 0x1B). A value of 0x01 indicates permission to get save access to the OEM-Data.
   2. Write the value 0x03 into the OEM / EDS-Motor Data Write - command register (bank 0, register 0x1A)
6. **Cancel write access:**
   Write the value 0x04 into the OEM / EDS-Motor Data Write - command register (bank 0, register 0x1A).
7. **Change the device mode** back to operation mode: Write value 0x00 into direct register 0x6A.

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

5.6 Filter Selection

The BiSS Line 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:

1. **Enable device mode** configuration:
   Write password into direct register 0x6B.
2. **Change device mode** to filter selection mode: Write value 0x05 into direct register 0x6A.
3. **Get write access:**
   1. Read filter status register (bank 0, register 0x25). A value of 0x00 indicates permission to get write access.
   2. Write value 0x01 into the filter command register (bank 0, register 0x24).
   3. Read filter status register (bank 0, register 0x25). A value of 0x02 indicates waiting for value.
4. **Set filter:**
   - Balanced filter, write value 0x03 into the filter command register (bank 0, register 0x24).
   - Dynamic filter, write value 0x04 into the filter command register (bank 0, register 0x24).
5. **Save filter selection:**
   1. Read filter status register (bank 0, register 0x25). A value of 0x01 indicates permission to save filter settings.
   2. Write value 0x02 to filter command register (bank 0, register 0x24).
6. **Change the device mode** back to operation mode: Write value 0x00 into direct register 0x6A.

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

6. BiSS Line Master Products

Regarding the BiSS Line interface, the following two products from manufacturer iC-Haus can be used to realize a BiSS Line communication with the corresponding IP core:

- iC-BL EVAL BL1M / BL2M, Evaluation board based on FPGA solution
- MB3U, MB3U-I2C adapter

You can also request just the IP core for BiSS Line for direct implementation on your FPGA without using above hardware.

For more details about the master implementation please contact the manufacturer iC-Haus.
iC-Haus GmbH - Am Kuemmerling 18 - 55294 Bodenheim - Germany,
Phone: +49 6135 9292-0, email: info@ichaus.de

7. 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.

8. Appendix

8.1 Register Overview

8.1.1 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 4: Direct Registers.

8.1.2 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 5: Bank 0 / Special Encoder Functions.