Smart encoders & actuators

User's guide

ASC85

- Singleturn rotary encoder with optical scanning
- Large 50 mm / 1.9685" thru-bore shaft
- 25 bit resolution, high accuracy ±0.005°
- SSI and BiSS C-mode interfaces
- Sine-Cosine 1Vpp additional track
- For direct integration into robots, radars and motors

Suitable for the following models:

- ASC85-...-BG...
- ASC85-...-GG...
- ASC85-...-SC...

Table of Contents

This manual is periodically reviewed and revised. As required we suggest checking if a new or updated edition of this document is available at Lika Electronic s.r.l.'s website. Lika Electronic s.r.l. assumes no responsibility for any errors or omissions in this document. Critical evaluation of this manual by the user is welcomed. Your comments assist us in preparation of future documentation, in order to make it as clear and complete as possible. Please send an e-mail to the following address info@lika.it for submitting your comments, suggestions and criticisms.

General contents

Subject Index

Typographic and iconographic conventions

In this guide, to make it easier to understand and read the text the following typographic and iconographic conventions are used:

- parameters and objects both of Lika device and interface are coloured in **GREEN**;
- alarms are coloured in **RED**;
- states are coloured in **FUCSIA**.

When scrolling through the text some icons can be found on the side of the page: they are expressly designed to highlight the parts of the text which are of great interest and significance for the user. Sometimes they are used to warn against dangers or potential sources of danger arising from the use of the device. You are advised to follow strictly the instructions given in this guide in order to guarantee the safety of the user and ensure the performance of the device. In this guide the following symbols are used:

	This icon, followed by the word **WARNING**, is meant to highlight the parts of the text where information of great significance for the user can be found: user must pay the greatest attention to them! Instructions must be followed strictly in order to guarantee the safety of the user and a correct use of the device. Failure to heed a warning or comply with instructions could lead to personal injury and/or damage to the unit or other equipment.
	This icon, followed by the word **NOTE**, is meant to highlight the parts of the text where important notes needful for a correct and reliable use of the device can be found. User must pay attention to them! Failure to comply with instructions could cause the equipment to be set wrongly: hence a faulty and improper working of the device could be the consequence.
	This icon is meant to highlight the parts of the text where suggestions useful for making it easier to set the device and optimize performance and reliability can be found. Sometimes this symbol is followed by the word **EXAMPLE** when instructions for setting parameters are accompanied by examples to clarify the explanation.

Preliminary information

This guide is designed to provide the most complete and exhaustive information the operator needs to correctly and safely install and operate the **ASC85 absolute encoders with SSI / BiSS C-mode interface**.

ASC85 is the large thru-bore rotary encoder with high 25 bit singleturn resolution and high ±0.005° accuracy. This encoder is able to provide a 25 bit total amount of position information (25 bits = 33,554,432 cpr). Thus the overall length of the SSI data packet is 25 bits; while the overall length of the BiSS data packet is 33 bits (25 bit position information + 1 bit error nE + 1 bit warning nW + 6 bit CRC cyclic redundancy check). It further provides additional 1Vpp Sine-Cosine signals for speed feedback (4,096 sinusoidal waves per mechanical revolution). For information on the resolution of the encoder please see the order code.

To make it easier to read and understand the text, this guide can be divided into three main sections.

In the first section some general information concerning the safety, the mechanical installation and the electrical connection as well as tips for setting up and running properly and efficiently the unit are provided.
In the second section, entitled **SSI interface**, both general and specific information is given on the SSI interface.
In the third section, entitled **BiSS C-mode interface**, both general and specific information is given on the BiSS C-mode interface. In this section the parameters implemented in the unit are fully described.

1 - Safety summary

1.1 Safety

- Always adhere to the professional safety and accident prevention regulations applicable to your country during device installation and operation;
- installation and maintenance operations have to be carried out by qualified personnel only, with power supply disconnected and stationary mechanical parts;
- device must be used only for the purpose appropriate to its design: use for purposes other than those for which it has been designed could result in serious personal and/or the environment damage;
- high current, voltage and moving mechanical parts can cause serious or fatal injury;
- warning! Do not use in explosive or flammable areas;
- failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards of design, manufacture, and intended use of the equipment;
- Lika Electronic assumes no liability for the customer's failure to comply with these requirements.

1.2 Electrical safety

- Turn off power supply before connecting the device;
- connect according to explanation in the "4 - Electrical connections" section on page 14;
- if not used, connect Zero setting and Counting direction inputs to 0Vdc;
  - to set the zero, connect Zero setting input to +Vdc for 100 µs at least, then disconnect +Vdc; normally voltage must be at 0Vdc; zero must be set after Counting direction; we suggest setting the zero when the encoder shaft is not running;
  - Counting direction: CW increasing count (viewed from fixing plate side): connect to 0Vdc; CCW increasing count: connect to +Vdc;
- in compliance with the 2014/30/EU norm on electromagnetic compatibility, following precautions must be taken:
  - before handling and installing, discharge electrical charge from your body and tools which may come in touch with the device;
  - power supply must be stabilized without noise, install EMC filters on device power supply if needed;
  - always use shielded cables (twisted pair cables whenever possible);
  - avoid cables runs longer than necessary;
  - avoid running the signal cable near high voltage power cables;
  - mount the device as far as possible from any capacitive or inductive noise source, shield the device from noise source if needed;
  - to guarantee a correct working of the device, avoid using strong magnets on or near by the unit;
  - minimize noise by connecting the shield and/or the connector housing and/or the frame to ground. Make sure that ground is not affected by noise. The connection point to ground can be situated both on the device side and on user's side. The best solution to minimize the interference must be carried out by the user.

1.3 Mechanical safety

- Install the device following strictly the information in the "3 - Mounting instructions" section on page 12;
- mechanical installation has to be carried out with stationary mechanical parts;
- do not disassemble the encoder;
- do not tool the encoder or its shaft;
- delicate electronic equipment: handle with care; do not subject the device and the shaft to knocks or shocks;
- respect the environmental characteristics declared by manufacturer.

2 - Identification

Device can be identified through the **order code** and the **serial number** printed on the label applied to its body. Information is listed in the delivery document too. Please always quote the order code and the serial number when reaching Lika Electronic. For any information on the technical characteristics of the product refer to the technical catalogue.

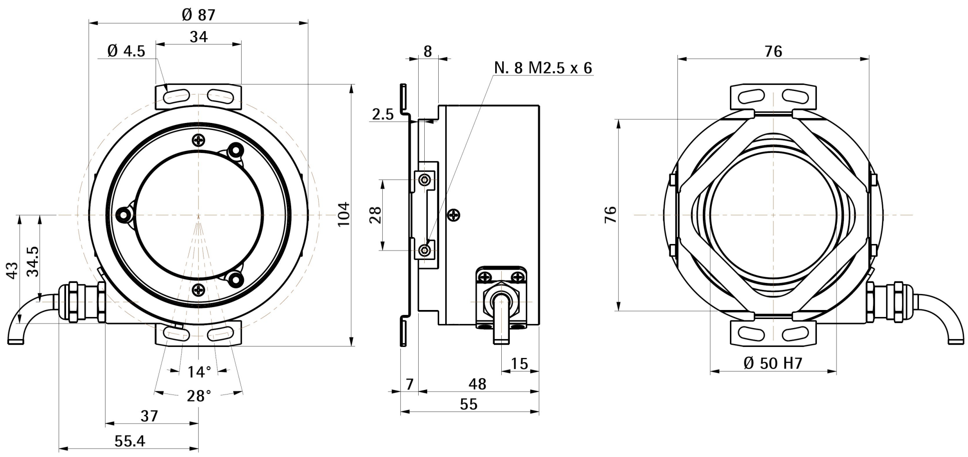
Warning: encoders having order code ending with "/Sxxx" may have mechanical and electrical characteristics different from standard and be supplied with additional documentation for special connections (Technical Info).

3 - Mounting instructions

WARNING
Installation must be carried out by qualified personnel only, with power supply disconnected and mechanical parts compulsorily in stop.

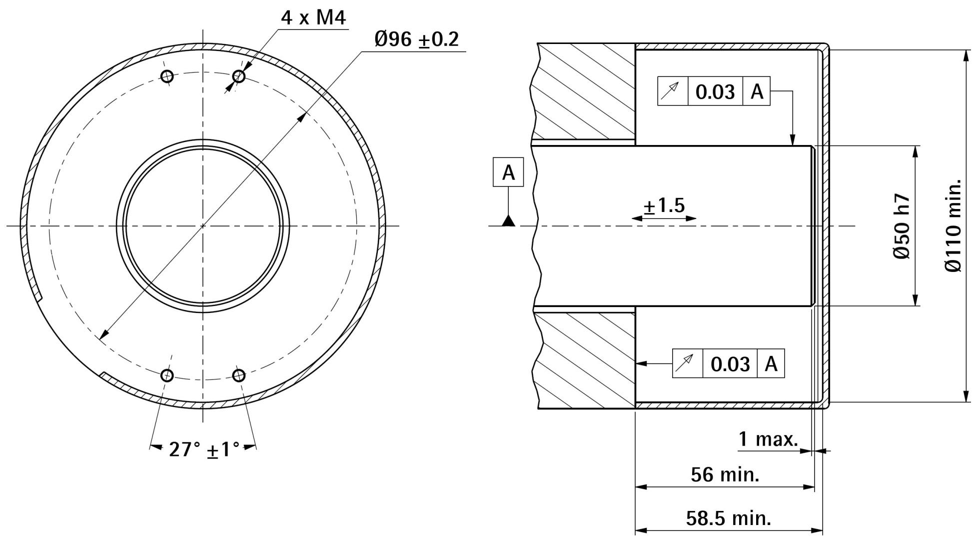
3.1 ASC85 encumbrance sizes

(values are expressed in mm)



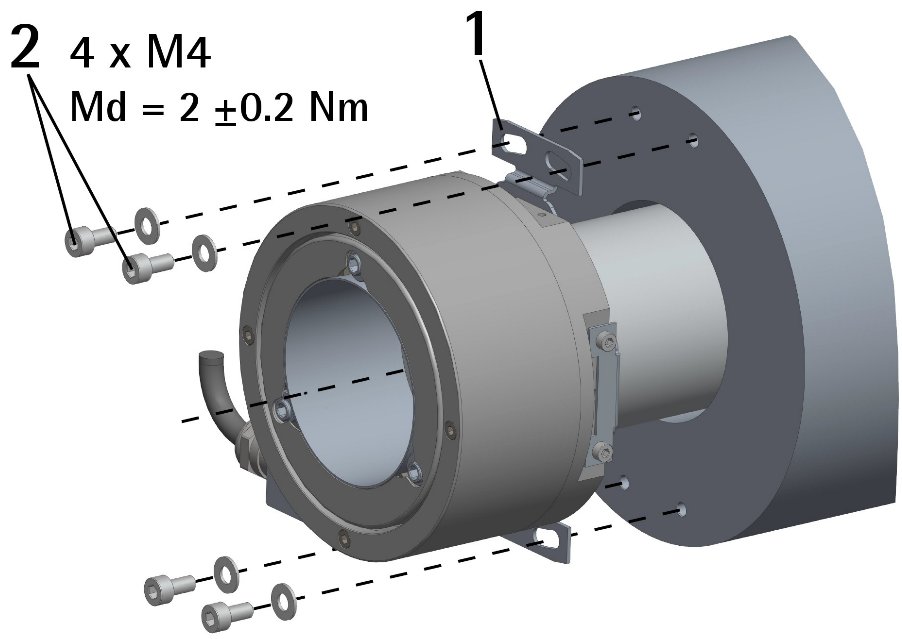
3.2 Mechanical characteristics of the mounting support

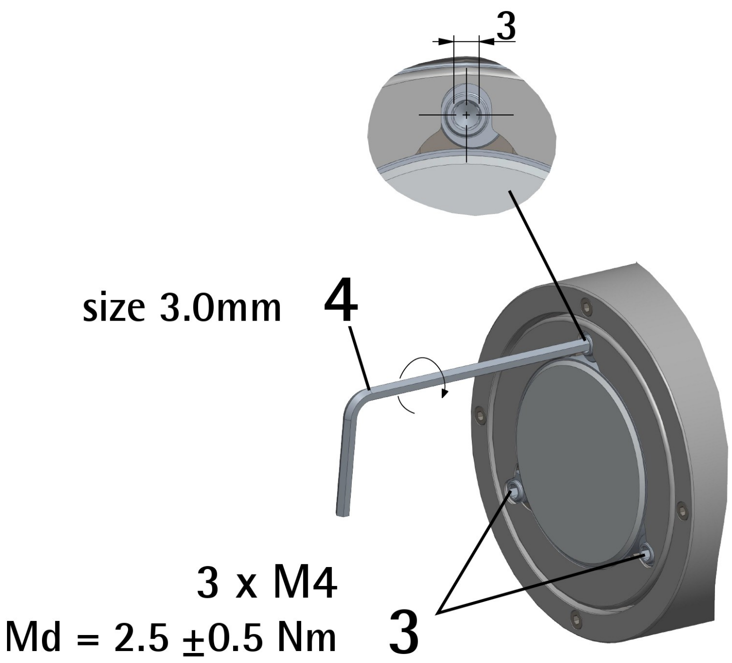
(values are expressed in mm)



3.3 Mounting the encoder

- Mount the encoder on the motor shaft. Avoid forcing the encoder shaft;
- fasten the fixing plate **1** to the rear of the motor using four M4 screws with washers **2**; max. tightening torque: 2 ±0.2 Nm;
- fix the encoder shaft by tightening the three M4 eccentric screws **3** by means of a 3.0 mm size hex key **4**. Max. tightening torque: 2.5 ±0.5 Nm.





4 - Electrical connections

WARNING

Power supply must be turned off before performing any electrical connection!

If wires of unused signals come in contact, irreparable damage could be caused to the device. Thus they must be cut at different lengths and insulated singularly.

Function	M23 12-pin	M12 12-pin	TF12 cable
CLOCK IN + / MA +	2	3	Violet
CLOCK IN - / MA -	1	4	Yellow
DATA OUT + / SLO +	3	5	Grey
DATA OUT - / SLO -	4	6	Pink
A (COS +)	5	9	Green
/A (COS -)	6	10	Brown
B (SIN +)	7	11	Red
/B (SIN -)	10	12	Black
Counting direction [1]	8	8	Blue
Zero setting / Preset [1]	9	7	White
0Vdc	12	1	White_Green
+Vdc [2]	11	2	Brown_Green
Shield	Case	Case	Shield

n.c. = not connected

1 Only available for SSI interface (see the order codes ...-BG... and ...-GG...)

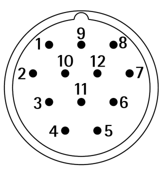
2 See the order code for power supply voltage level

EXAMPLE

ASC85-...-SC**1**-... +Vdc = +5Vdc ± 5%

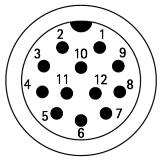
ASC85-...-SC**2**-... +Vdc = +10Vdc +30Vdc

4.1 M23 12-pin connector



M23 12-pin connector
Counter-clockwise
Male frontal side

4.2 M12 12-pin connector



M12 12-pin connector
Male frontal side

4.3 TF12 cable specifications

Model:	LIKA TF12 encoder cable
Cross section:	6 x 2 x 28AWG twisted pairs
Jacket:	Special flame retardant PVC compound, RZ-TM2 quality
Shield:	Tinned copper braid, coverage > 80% with tinned copper drain wire
Outer diameter:	5.4 mm ±0.1 mm / 0.213" ±0.004"
Min. bend radius:	Outer diameter x 10
Work temperature:	-15°C +80°C / +5°F +176°F
Conductor resistance:	< 242.02 Ω/Km (+20°C / +68°F) (UL 758 table 5.2.1)

4.4 GND connection

Minimize noise by connecting the shield and/or the connector housing and/or the frame to ground. Make sure that ground is not affected by noise. The connection point to ground can be situated both on the device side and on user's side. The best solution to minimize the interference must be carried out by the user.

4.5 1Vpp sinusoidal output signals

For any further information on the 1Vpp sinusoidal signals please refer to the "7 - 1Vpp Sine/Cosine output signals" section on page 41.

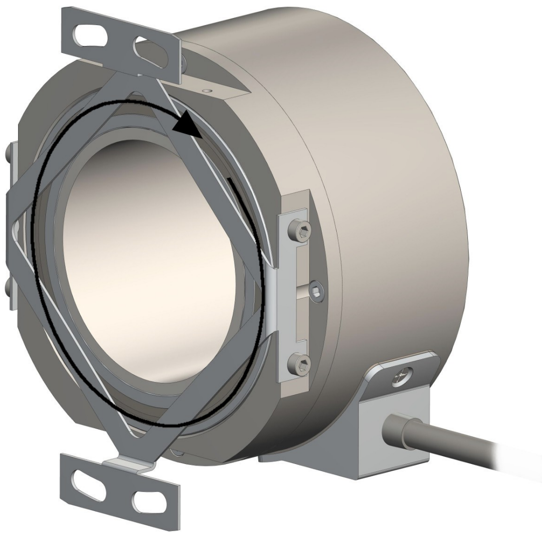
4.6 Counting direction input

NOTE
The Counting direction input is available for the SSI interface only (see the order codes ...-BG... and ...-GG...). For the BiSS interface refer to the **Code sequence** parameter on page 28.

The Counting direction input allows to set whether the position value output by the encoder increases when the encoder shaft rotates clockwise (CW) or counter-clockwise (CCW). The clockwise rotation is intended as shown in the Figure. If the Counting direction input is connected to 0Vdc, the position value increases when the encoder shaft rotates clockwise; on the contrary, if the Counting direction input is connected to +Vdc, the position value increases when the encoder shaft rotates counter-clockwise. If not used, connect the Counting direction input to 0Vdc (standard counting direction, see the Figure).

WARNING
After changing the counting direction you are required to set a new zero.

NOTE
The counting direction function affects the absolute position information, not the sine/cosine signals.



4.7 Zero setting input

NOTE
The Zero setting input is available for the SSI interface only (see the order codes ...-BG... and ...-GG...). For the BiSS interface refer to the **Preset / Offset** register on page 30.

The output position information at a point in the shaft rotation can be set to 0. The Zero setting input allows the operator to activate the zero setting function by using an input signal sent by a PLC or other controller. To activate the zero setting function, connect the Zero setting input to +Vdc for 100 µs at least, then disconnect +Vdc; normally voltage must be at 0Vdc. Zero setting must be set after Counting direction. We suggest setting the zero setting function when the encoder shaft is not running. If not used, connect the Zero setting input to 0Vdc.

5 - SSI interface

Order code: ASC85-...-BG...
ASC85-...-GG...

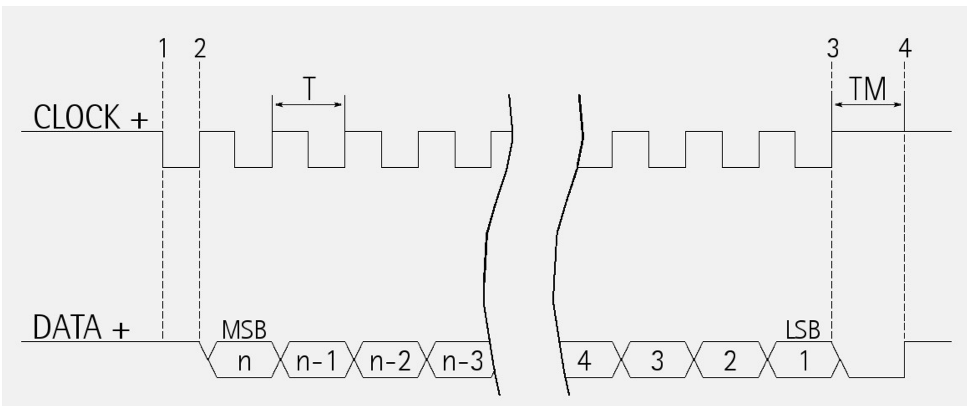
5.1 SSI (Synchronous Serial Interface)

SSI (the acronym for **Synchronous Serial Interface**) is a synchronous point-to-point serial interface engineered for unidirectional data transmission between one Master and one Slave. Developed in the first eighties, it is based on the RS-422 serial standard. Its most peculiar feature is that data transmission is achieved by synchronizing both the Master and the Slave devices to a common clock signal generated by the controller; in this way the output information is clocked out at each controller's request. Furthermore only two pairs of twisted wires are used for data and clock signals, thus a six-wire cable is required.
The main advantages in comparison with parallel or asynchronous data transmissions are:

- less conductors are required for transmission;
- less electronic components;
- possibility of insulting the circuits galvanically by means of optocouplers;
- high data transmission frequency;
- hardware interface independent from the resolution of the absolute encoder.

Furthermore the differential transmission increases the noise immunity and decreases the noise emissions. It allows multiplexing from several encoders, thus process controls are more reliable with simplified line design and easier data management.

Data transmission is carried out as follows.
At the first falling edge of the clock signal (**1**, the logic level changes from high to low) the absolute position value is stored while at the following rising edge (**2**) the transmission of data information begins starting from the MSB.



At each change of the clock signal and at each subsequent rising edge (**2**) one bit is clocked out at a time, up to LSB, so completing the data word transmission. The cycle ends at the last rising edge of the clock signal (**3**). This means that up to n + 1 rising edges of the clock signals are required for each data word transmission (where n is the bit resolution); for instance, a 13-bit encoder needs 14 clock edges. If the number of clocks is greater than the number of bits of the data word, then the system will send a zero (low logic level signal) at each additional clock, zeros will either lead (LSB ALIGNED protocol) or follow (MSB ALIGNED protocol) or lead and/or follow (TREE FORMAT protocol) the data word. After the period Tm monoflop time, having a typical duration of 12 µsec, calculated from the end of the clock signal transmission, the encoder is then ready for the next transmission and therefore the data signal is switched high.
The clock signal has a typical logic level of 5V, the same as the output signal which has customarily a logic level of 5V in compliance with RS-422 standard.
The output code can be either Binary or Gray (see the order code).

5.2 "MSB left aligned" protocol

"MSB left aligned" protocol allows to left align the bits, beginning from MSB (most significant bit) to LSB (least significant bit); MSB is then sent at the first clock cycle. If the number of clock signals is higher than the data bits, then unused bits are forced to logic level low (0) and follow the data word. This protocol can be used in encoders having any resolution.
The number of clocks to be sent to the encoder must equal the number of data bits at least, anyway it can be higher, as stated previously. The great advantage of this protocol over the TREE format or the LSB RIGHT ALIGNED format is that data can be transmitted with a minimum time loss and Tm monoflop time can immediately follow the data bits without any additional clock signal.
The length of the word is variable according to the resolution, as shown in the following table.

Model ...-BG..., ...-GG...	Length of the word	Max. number of information
ASC85-25-00-...	25 bits	33,554,432

The output code can be either BINARY or GRAY (see the order code).

Structure of the position information

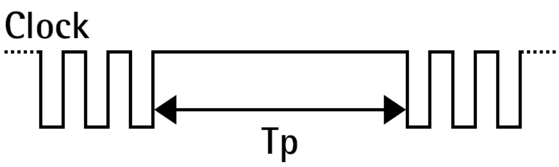
ASC8525/...	bit	24	...	0
	value	MSB	...	LSB

5.3 Recommended transmission rates

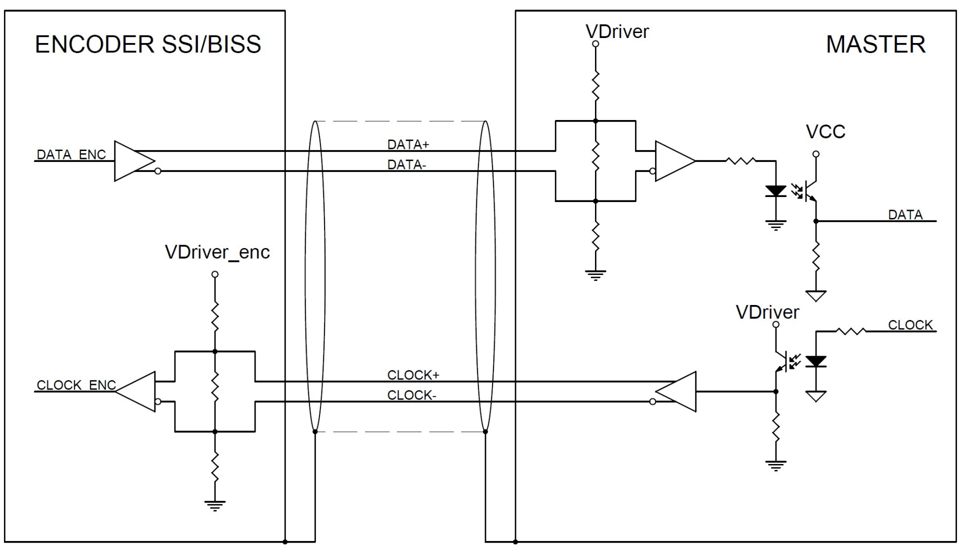
The SSI interface has a frequency of data transmission ranging between 100 kHz and 4 MHz.
CLOCK IN and DATA OUT signals comply with the "EIA standard RS-422".
The SSI clock frequency (baud rate) depends on the length of the cable and must comply with the technical information reported in the following table:

Cable length	Baud rate
< 50 m	< 400 kHz
< 100 m	< 300 kHz
< 200 m	< 200 kHz
< 400 m	< 100 kHz

The time interval between two Clock sequence transmissions must be at least 12 µs (Tp > 12 µs).



5.4 Recommended SSI input circuit



6 - BiSS C-mode interface

Order code: ASC85-...-SC...

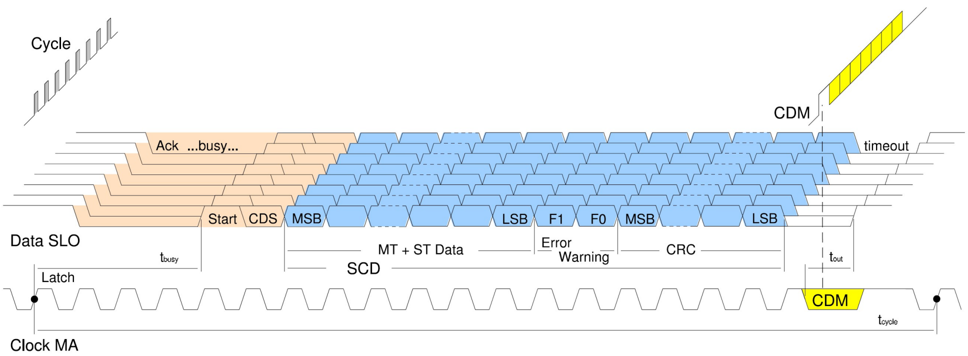
Lika encoders are always Slave devices and comply with the "BiSS C-mode interface" and the "Standard encoder profile".
Refer to the official BiSS website for all information not listed in this manual (www.biss-interface.com).
The device is designed to work in a point-to-point configuration and has to be installed in a "single Master, single Slave" network.
CLOCK IN (MA) and DATA OUT (SLO) signal levels are according to the "EIA standard RS-422".

WARNING
Never install the encoder in a "single Master, multi Slave" network.

6.1 Communication

The BiSS C-mode protocol uses two types of data transmission protocols:

- **Single Cycle Data (SCD):** it is the main data transmission protocol. It is used to send process data from the Slave to the Master. For any information refer to the "6.2 Single Cycle Data SCD" section on page 21.
- **Control Data (CD):** transmission of a single bit following the SCD data. It is used to read or write data into the registers of the Slave. For any information refer to the "6.3 Control Data CD" section on page 22.



6.2 Single Cycle Data SCD

6.2.1 SCD structure

SCD data has a fixed length of 33 bits. It consists of the following elements: 25 bit position value (**Position**), 1 error bit nE (**Error**), 1 warning bit nW (**Warning**) and a 6 bit CRC Cyclic Redundancy Check (**CRC**).

bit	33 ... 8	7	6	5 ... 0
function	Position	Error	Warning	CRC

Position
(25 bits)
It is the process data transmitted from the Slave to the Master. It has a fixed length of 25 bits.
It provides information about the current position of the encoder.
The transmission starts with msb (most significant bit) and ends with lsb (least significant bit). It is lsb aligned; if the resolution is scaled (see the **Counts per revolution** registers on page 28), the high bits starting from bit 33 msb down are set to 0.

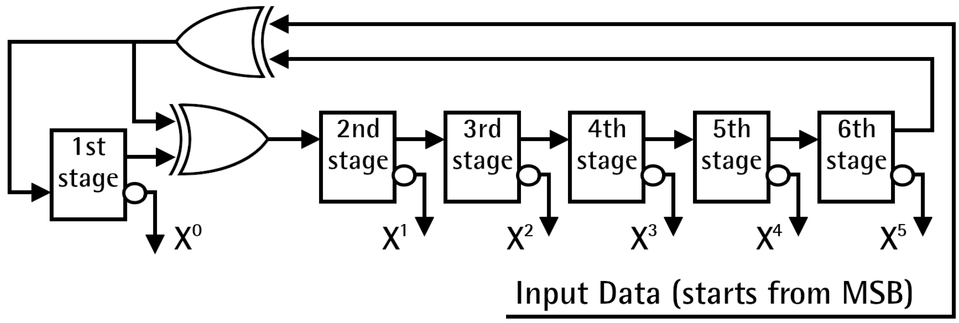
bit	33	...	...	8
value	msb	...	...	lsb

Error
(1 bit)
It is intended to communicate the normal or fault status of the Slave.
When nE = "0" (low active), an error is active in the system. For a comprehensive list of the available error messages and their meaning please refer to the register 74 **Active errors** on page 31.
nE = "1": no active error
= "0": error status: an error is active in the system.

Warning
(1 bit)
It is intended to communicate the normal or fault status of the Slave.
When nW = "0" (low active), a warning is active in the system. For a comprehensive list of the available warning messages and their meaning please refer to the register 74 **Active errors** on page 31.
nW = "1": no active warning
= "0": warning status: a warning is active in the system.

CRC
(6 bits)
Correct transmission control (inverted output). Cyclic Redundancy Check is an error checking which is the result of a "Redundancy Checking" calculation performed on the message contents. This is intended to check whether transmission has been performed properly. It is 6-bit long.
Polynomial: X^6+X^1+1 (binary: 1000011)

Logic circuit



6.3 Control Data CD

Main control data is described in this section. Please refer to the official BiSS documents for complete CD structure: "BiSS C Protocol Description" in the BiSS homepage.

Register address
It sets the number of the register you need either to read or to write. It is 7-bit long.

RW
RW = "01": when you need to write in the register.
RW = "10": when you need to read in the register.
It is 2-bit long.

DATA
When you need to write in a register (**RW** = "01"), it allows to enter the value to be written in the register (transmitted from the Master to the Slave).
When you need to read in a register (**RW** = "10"), it shows the value read in the register (transmitted from the Slave to the Master).
It is 8-bit long.

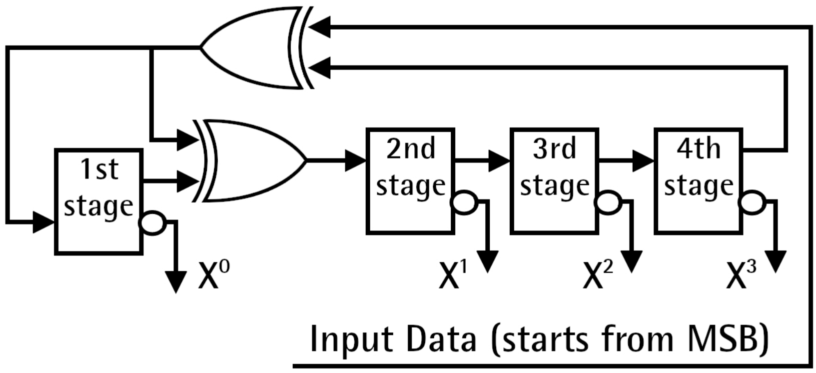
Data bit structure:

bit	7	...	...	0
	msb	...	...	lsb

CRC

Correct transmission control (inverted output). Cyclic Redundancy Check is an error checking which is the result of a "Redundancy Checking" calculation performed on the message contents. This is intended to check whether transmission has been performed properly. It is 4-bit long.
Polynomial: X^4+X^1+1 (binary: 10011)

Logic circuit:



6.4 Implemented registers

Register (hex)	Function
40	Bank selection
42 - 43	Profile ID
44 ... 47	Serial number
48	Command
49	Configuration
4A ... 4D	Counts per revolution
4E - 4F	Number of revolutions
50 ... 53	Preset / Offset
55	Device type
56	N° of bits used for singleturn
57	N° of bits used for multiturn
58	Sine / Cosine resolution
74	Active errors
75	Sensor 1 and Interpolator error register
76	Diagnosis register

77	Sensor 2 error register
78 ... 7D	Device ID
7E - 7F	Manufacturer ID

All registers described in this section are listed as follows:

Function name
[Address, Attribute]
Description of the function and specification of the default value.

- Address: the register address is expressed in hexadecimal notation.
- Attribute: ro = read only
  rw = read and write
  wo = write only
- Default parameter value is written in **bold**.

Bank selection

[40, rw]
ASC85 encoder is equipped with an internal EEPROM that offers the user 7 kbit of additional storage space for user data.
The EEPROM is organized in 16 memory banks.
Banks 0 and 1 are reserved and not available to user.
Banks 2 to 15 provides 64 byte free memory space each one. 64 registers are addressed from 00 hex to 3F hex in each bank and can be used to store personal data.
The **Bank selection** register is used to switch to the additional memory banks 2 to F on the internal EEPROM.
The value of the **Bank selection** register is not saved in non-volatile memory. After each power-on its value will be 00 hex and the banks 0-1 will be selected automatically.

Value of the register	Bank	Availability
00 hex	Bank 0	Reserved use
01 hex	Bank 1	
02 hex	Bank 2	Additional storage space available to user
...	...	
0F hex	Bank 15	

Profile ID

[42 - 43, ro]

These registers contain the identification code of the used profile.
The used encoder profile is **BP1: Standard Encoder Profile**. Default value for the Profile ID is:

Register	42	43
	MSB	LSB
	28	19
	Singleturn resolution, Variant 0-24++	Data length = 25 bits (see on page 21)

See "Standard encoder profile", "data format", "Variant 0-24".

Serial number

[44 ... 47, ro]

These registers contain the serial number of the device in ascending order expressed in hexadecimal notation.

Serial number **registers structure:**

Register	44	45	46	47
	Serial number			
	MSB	...	...	LSB
	$2^{31} \dots 2^{24}$	$2^{23} \dots 2^{16}$	$2^{15} \dots 2^{8}$	$2^{7} \dots 2^{0}$

EXAMPLE

Serial number 171256846 dec is expressed as shown in the table:

Register	44	45	46	47
	0A	35	2C	0E

Command

[48, wo]

Value	Function
00	Normal operation
01	Save parameters on EEPROM
02	Save parameters and activate Preset / Offset
04	Load and save default parameters, encoder initialization

After having set a new value in some register, use the **Save parameters on EEPROM** function in this register to store it. Set "01" in the register.

After having set a new value in some register, use the **Save parameters and activate Preset / Offset** function in this register to both store it and activate the preset / offset function in the same time. Set "02" in the register.

As soon as the command is sent, the register is set back to "00" (**Normal operation**) automatically.
Wait min. 30 ms (EEPROM writing time) before using a new function.

Load and save default parameters, encoder initialization: default parameters are set at the factory by Lika Electronic engineers to allow the operator to run the device for standard operation in a safe mode. As soon as the command is sent the default parameters are uploaded and activated. All parameters which have been set previously are overwritten, thus previously set values are lost. The complete list of machine data and the relevant default parameters preset by Lika Electronic engineers are available on page 42. It also enable the initialization of the encoder on the physical zero of the disk.
To execute the function proceed as follows.

1. Set "04" in the **Command** register 48.
2. The position of the sensor 1 is available in the dataframe now.
3. **Error** and **Warning** bits are set to 0 (active) and warn about the beginning of the physical zero search process.
4. Check the position value and rotate the encoder shaft until you reach the physical zero position.
5. As soon as the system reads the physical zero point, the **Error** bit is set to 1 (not active, no error), while the **Warning** bit is still set to 0 (active warning).
6. In this stage of the process the possibility to read the registers is inhibited.
7. Again set "04" in the **Command** register 48.
8. The sensor 2 is synchronized with the sensor 1.
9. The **Warning** bit is set to 1 too (not active, no warning).
10. The possibility to read the registers is resumed.

WARNING
If the physical zero search process does not succeed, the **Physical zero function error active** bit 4 in the **Active errors** register 74 activates.

WARNING
As soon as the command is sent, all parameters which have been set previously are overwritten, thus previously set values are lost!

Configuration

[49, rw]

Bit	Function	Bit = 0	Bit = 1
0 lsb	Reserved use		
1	**Set preset / offset**	**Preset**	Offset
2	**Enable preset / offset**	**Enable**	Disable
3	Not used		
4	Not used		
5	**Output code**	Gray	**Binary**
6	**Code sequence**	**CW**	CCW
7 msb	Not used		

Set preset / offset

This parameter is available only if the **Enable preset / offset** parameter is set to 0 = ENABLE. It allows to activate either the preset function (**Set preset / offset** = 0 = PRESET) or the offset function (**Set preset / offset** = 1 = OFFSET); the Preset or Offset value has to be set in the **Preset / Offset** registers. After having enabled the preset / offset functions (**Enable preset / offset** = 0 = ENABLE), this item allows to activate either the preset function or the offset function. The value set in the **Preset / Offset** registers will have a different meaning depending on the value of this parameter whether it is set to PRESET or OFFSET. In the first case (**Set preset / offset** = 0 = PRESET) the **Preset / Offset** registers are used to set the preset, i.e. any desired position value (less than the total resolution) can be set for the actual position of the encoder shaft (e.g. "0", zero setting); while in the second case (**Set preset / offset** = 1 = OFFSET) the **Preset / Offset** registers are used to set the offset, i.e. the system adds an offset to the actual position: position = actual position + Offset. To activate the preset / offset value use the **Save parameters and activate Preset / Offset** function in the **Command** register (set "02" in the register 48).
For any information on the preset and the offset functions refer to the **Preset / Offset** registers on page 30.

Enable preset / offset

It enables (bit 2 = 0 = ENABLE) or disables (bit 2 = 1 = DISABLE) the preset/offset function. After having enabled the use of the functions you have to choose whether to activate the preset or the offset in the **Set preset / offset** parameter. Then to activate a new value set it next to the **Preset / Offset** registers and send the "**Save parameters and activate Preset / Offset**" function (set "02" in the register 48 **Command**).

Output code

It allows to select the code for the transmission of the position value: bit 5 = 0 = Gray code; bit 5 = 1 = Binary code.

Code sequence

The **Code sequence** bit allows to set whether the position information output by the encoder increases when the shaft rotates clockwise or counter-clockwise. Clockwise and counter-clockwise rotations are viewed from the shaft side (see the Figure on page 16). Please note that the counting direction affects the absolute position information, not the sine/cosine signals. It is possible to choose the following options: CW and CCW. When the counting direction is set to CW -**Code sequence** = 0 = CW-, the encoder will provide the increasing count when the encoder is turning clockwise (and the decreasing count when the encoder is turning counter-clockwise). When the option CCW is set -**Code sequence** = 1 = CCW-, the encoder will provide the increasing count when the encoder is turning counter-clockwise (and the decreasing count when the encoder is turning clockwise).

The new setting will be active immediately after the transmission. Use the "**Save parameters on EEPROM**" function (set "01" in the register 48 **Command**) to store the new value.

Default = **20 hex**

Counts per revolution

[4A ... 4D, rw]

Register	4A	4B	4C	4D
	Counts per revolution			
	MSB	...	...	LSB
	2^{31} ... 2^{24}	2^{23} ... 2^{16}	2^{15} ... 2^{8}	2^{7} ... 2^{0}

These registers set the number of counts (information) per revolution (singleturn resolution). You are allowed to set whatever integer value less than or equal to the number of physical information per revolution.
The counts per revolution will be forced to the default value (number of physical information per revolution) if the entered value is out of the allowed range.
The new setting will be active immediately after the transmission. Use the "**Save parameters on EEPROM**" function (set "01" in the register 48 **Command**) to store the new value.
Default = **33,554,432 (02 00 00 00 hex, 25 bits)**

After the modification of the registers 4A ... 4D **Counts per revolution**, the Preset and Offset values have to be updated according to the new resolution!

Setting a custom singleturn resolution

As stated, by means of the the registers 4A ... 4D **Counts per revolution**, it is possible to enter a custom value for the singleturn resolution of the encoder. Any value even if not a power of 2 can be set.

Please note that, when you set a new resolution, the registers 50 ... 53 **Preset / Offset** are set to zero.
Let's say we need to set the encoder as follows:

- registers 4A ... 4D **Counts per revolution** = 3,600 cpr (0E 10 hex);
- output code: Gray, shifted code (**Output code** bit 5 in the **Configuration** register = 0; registers 50 ... 53 **Preset / Offset** = F8 hex = 248);
- CCW counter-clockwise counting direction (**Code sequence** bit 6 in the **Configuration** register = 1).

To do this, proceed as follows:

Function	ADR	DATA Tx
writing the **Counts per revolution** registers	4A	00
	4B	00
	4C	0E
	4D	10

writing the **Preset / Offset** registers	50	00
	51	00
	52	00
	53	F8

Function	ADR	DATA Tx	
writing the **Configuration** register	49, bit 7	0	42
	49, bit 6	1	
	49, bit 5	0	
	49, bit 4	0	
	49, bit 3	0	
	49, bit 2	0	
	49, bit 1	1	
	49, bit 0	0	
Save parameters on EEPROM	48	1	

The encoder will be set to a singleturn resolution of 3,600 cpr and the counting range will be from 248 to 3,847.

Number of revolutions

[4E and 4F, ro]

Register	4E	4F
	Number of revolutions	
	MSB	LSB
	2^{15} ... 2^{8}	2^{7} ... 2^{0}

These registers show the number of revolutions (multiturn resolution).
Default = **1 (01 hex, singleturn encoder)**

Preset / Offset

[50 ... 53, rw]

This function is available only if the **Enable preset / offset** parameter in the **Configuration** register is set to 0 = ENABLE. Furthermore it has a double function depending on whether the **Set preset / offset** parameter in the **Configuration** register is set to 0 = PRESET or to 1 = OFFSET. In the first case (**Set preset / offset** = 0 = PRESET) the **Preset / Offset** registers are used to set the preset; while in the second case (**Set preset / offset** = 1 = OFFSET) the **Preset / Offset** registers are used to set the offset. Set the preset / offset value only when the device is not moving.

Preset

The Preset function is meant to assign a desired value to a physical position of the encoder. The chosen physical position will get the value set next to this item and all the previous and following positions will get a value according to it. This function is useful, for example, when the zero position of the encoder and the zero position of the axis need to match. The preset value will be set for the position of the encoder in the moment when the preset value is activated.
To activate the preset:

- stop the encoder in the desired position;
- if required, enter the desired value next to these **Preset / Offset** registers;
- then send the **Save parameters and activate Preset / Offset** command in the **Command** register (set "02" in the register 48).

Offset

The offset function is meant to assign a value to a desired physical position of the encoder so that the output position information is shifted according to the value set next to these **Preset / Offset** registers. In other words, it adds an offset to the actual position so that: position = actual position + Offset. The number of transmitted values will match the set resolution, but the output information will range between the **Preset / Offset** value (minimum value) and the sum of the set resolution + the **Preset / Offset** value (maximum value). The offset value will be set for the position of the encoder in the moment when the offset value is activated.
To activate the offset:

- stop the encoder in the desired position;
- if required, enter the desired value next to these **Preset / Offset** registers;
- then send the **Save parameters and activate Preset / Offset** command in the **Command** register (set "02" in the register 48).

Preset / Offset structure:

Register	50	51	52	53
	MSB	...	...	LSB
	2^{31}- 2^{24}	2^{23}- 2^{16}	2^{15} - 2^{8}	2^{7} - 2^{0}

Use the "**Save parameters and activate Preset / Offset**" function (set "02" in the register 48 **Command**) to store and activate the new value.
The Preset value must be less than or equal to the "Total resolution". The Offset value must be less than or equal to the difference between the hardware total resolution and the total resolution.
Default = **00 00 00 00 hex**.

Device type

[55, ro]
It describes the type of device.
Default = **03 hex**: singleturn rotary encoder with BiSS C-mode interface + Sine / Cosine additional signals

N° of bits used for singleturn

[56, ro]
This register contains the number of bits used for the singleturn resolution according to the **Counts per revolution** registers (see the registers 4A ... 4D).
Default = **19 hex**

N° of bits used for multiturn

[57, ro]
This register contains the number of bits used for the multiturn resolution according to the **Number of revolutions** (see the registers 4E and 4F).
Default = **00 hex**

Sine / Cosine resolution

[58, ro]
This register informs about the number of Sine/Cosine periods per revolution. For complete information please refer to the "7 - 1Vpp Sine/Cosine output signals" section on page 41.
Default = **20 hex**: 4096 Sine / Cosine wave signals per revolution

Active errors

[74, ro]
This register is meant to warn that an error condition is active in the sensors 1, in the sensor 2, or in the interpolator (the relevant bit = "1"). Register 75 **Sensor 1 and Interpolator error register** (see on page 33), register 76 **Diagnosis register** (see on page 34), and register 77 **Sensor 2 error register** (see on page 36) provide more detailed information on the error occurred. Please note that,

after resetting the message (the reset is performed upon reading out position data), if the problem that caused the message to be triggered has not been solved, the error message will be invoked to appear again.

Register	74							
	msb							lsb
bit	7	6	5	4	3	2	1	0

Bit 0

Sensor 2 error active

The encoder is equipped with 2 reading sensors. They are mounted 180 degrees apart and their operation is suited to increase the accuracy of the measuring system. When this bit has logic level high 1 = ACTIVE ERROR, it indicates that there is a fault in the sensor 2. For detailed information on the error occurred refer to the register 77 **Sensor 2 error register** (see on page 36).

Bit 1

Not used.

Bit 2

Sensor 1 error active

The encoder is equipped with 2 reading sensors. They are mounted 180 degrees apart and their operation is suited to increase the accuracy of the measuring system. When this bit has logic level high 1 = ACTIVE ERROR, it indicates that there is a fault in the sensor 1. For detailed information on the error occurred refer to the registers 75 **Sensor 1 and Interpolator error register** (see on page 33) and 76 **Diagnosis register** (see on page 34).

Bit 3

Interpolator error active

When this bit has logic level high 1 = ACTIVE ERROR, it indicates that there is a fault in the interpolator. For detailed information on the error occurred refer to the registers 75 **Sensor 1 and Interpolator error register** (see on page 33) and 76 **Diagnosis register** (see on page 34).

Bit 4

Physical zero function error active

When this bit has logic level high 1 = ACTIVE ERROR, it indicates that an error occurred while executing the **Load and save default parameters, encoder initialization** function in the **Command** register, see on page 25

Bits 5 ... 7

Not used.

Sensor 1 and Interpolator error register

[75, ro]

This register is meant to show the fault that is currently active in the sensor 1 or in the interpolator. In some cases the type of fault is further specified by activating (= "1") the relevant bit in the register 76 **Diagnosis register**, see on page 34. The bits in this register are active simultaneously with the bit 2 **Sensor 1 error active** or the bit 3 **Interpolator error active** in the register 74 **Active errors** (see on page 31). Please note that, after resetting the message (the reset is performed upon reading out position data), if the problem that caused the message to be triggered has not been solved, the error message will be invoked to appear again.

Register	**75**							
	msb							lsb
bit	7	6	5	4	3	2	1	0

Bit 0

Control error

When this bit has logic level high 1 = ACTIVE ERROR, it indicates that a control error is currently active. For more detailed information on the kind of error, refer to bit 2 **Signal level minimum amplitude**, bit 3 **Amplitude control minimum current**, bit 6 **Signal level maximum amplitude**, and bit 7 **Amplitude control maximum current** in the register 76 **Diagnosis register**, see on page 34.

Bit 1

Signal error

When this bit has logic level high 1 = ACTIVE ERROR, it indicates that a signal error is currently active. For more detailed information on the kind of error, refer to bit 0 **AC minimum amplitude**, bit 1 **DC minimum offset**, bit 4 **AC maximum amplitude**, and bit 5 **DC maximum offset** in the register 76 **Diagnosis register**, see on page 34.

Bit 2

Not used.

Bit 3

Synchronization error

When this bit has logic level high 1 = ACTIVE ERROR, it indicates that a failure occurred in the internal synchronization between the cycle counter and the interpolator.

Bit 4

Configuration error

When this bit has logic level high 1 = ACTIVE ERROR, it indicates that a configuration error is currently active. It may be triggered because of one of the following reasons:

- switching on without EEPROM;
- CRC error at switching on with EEPROM;
- write error after write access to the EEPROM following a command;
- temporarily during write access to the EEPROM following a command;
- CRC error after a software reset following a command;
- CRC error after CRC verification following a command;
- temporarily during CRC verification following a command;
- failure in the EEPROM.

Bit 5

Interpolation error

When this bit has logic level high 1 = ACTIVE ERROR, it indicates that the conversion has not been carried out at time of read access.

Bit 6

Absolute data error

When this bit has logic level high 1 = ACTIVE ERROR, it indicates that an absolute data interface error is currently active. It may be triggered because of one of the following reasons:

- the absolute data interface received BiSS data containing a CRC error;
- the absolute data interface received BiSS data with error bit nE (**Error**) low active (0).

NOTE

Please note that the **Absolute data error** bit is kept at 0 if the absolute data interface is not configured.

Bit 7

Not used.

Diagnosis register

[76, ro]

This register offers diagnostic information and specifies the kind of problem signalled through bit 0 **Control error** or bit 1 **Signal error** in the register 75 **Sensor 1 and Interpolator error register**, see on page 33. The high logic level (= "1") shows the error that is currently active. The bits in this register are active simultaneously with the bit 2 **Sensor 1 error active** or the bit 3 **Interpolator**

error active in the register 74 **Active errors** (see on page 31). Please note that, after resetting the message (the reset is performed upon reading out position data), if the problem that caused the message to be triggered has not been solved, the error message will be invoked to appear again.

Register	76							
	msb							lsb
bit	7	6	5	4	3	2	1	0

Bit 0

AC minimum amplitude

This error is active simultaneously with the bit 1 **Signal error** in the register 75 **Sensor 1 and Interpolator error register**, see on page 33.
The signal monitoring circuit verifies that differential signals show a correct AC amplitude. As soon as the lower differential voltage threshold (minimum amplitude of the signals) is detected, the error bit is set to 1.

Bit 1

DC minimum offset

This error is active simultaneously with the bit 1 **Signal error** in the register 75 **Sensor 1 and Interpolator error register**, see on page 33.
The signal monitoring circuit verifies that all analogue signal lines show a correct DC voltage. As soon as the minimum voltage threshold (minimum offset) is detected, the error bit is set to 1.

Bit 2

Signal level minimum amplitude

This error is active simultaneously with the bit 0 **Control error** in the register 75 **Sensor 1 and Interpolator error register**, see on page 33.
The signal level monitoring circuit has detected the lower threshold (minimum amplitude). The error bit is set to 1.

Bit 3

Amplitude control minimum current

This error is active simultaneously with the bit 0 **Control error** in the register 75 **Sensor 1 and Interpolator error register**, see on page 33.
The monitoring circuit of the Amplitude Control output current has detected the lower threshold (minimum current). The error bit is set to 1.

Bit 4

AC maximum amplitude

This error is active simultaneously with the bit 1 **Signal error** in the register 75 **Sensor 1 and Interpolator error register**, see on page 33.
The signal monitoring circuit verifies that differential signals show a correct AC amplitude. As soon as the upper differential voltage threshold (maximum amplitude of the signals) is detected, the error bit is set to 1.

Bit 5

DC maximum offset

This error is active simultaneously with the bit 1 **Signal error** in the register 75 **Sensor 1 and Interpolator error register**, see on page 33.
The signal monitoring circuit verifies that all analogue signal lines show a correct DC voltage. As soon as the maximum voltage threshold (maximum offset) is detected, the error bit is set to 1.

Bit 6

Signal level maximum amplitude

This error is active simultaneously with the bit 0 **Control error** in the register 75 **Sensor 1 and Interpolator error register**, see on page 33.
The signal level monitoring circuit has detected the upper threshold (maximum amplitude). The error bit is set to 1.

Bit 7

Amplitude control maximum current

This error is active simultaneously with the bit 0 **Control error** in the register 75 **Sensor 1 and Interpolator error register**, see on page 33.
The monitoring circuit of the Amplitude Control output current has detected the upper threshold (maximum current). The error bit is set to 1.

Sensor 2 error register

[77, ro]

This register is meant to show the fault that is currently active in the sensor 2. The bits in this register are active simultaneously with the bit 0 **Sensor 2 error active** in the register 74 **Active errors** (see on page 31). Please note that, after resetting the message (the reset is performed upon reading out position data), if the problem that caused the message to be triggered has not been solved, the error message will be invoked to appear again.

Register	77							
	msb							lsb
bit	7	6	5	4	3	2	1	0

Bit 0

Illumination error

When this bit has logic level high 1 = ACTIVE ERROR, it indicates that the amplitude is above the threshold or the control range has been exceeded.

Bit 1

Not used.

Bit 2

Internal data error (bit rate single step error)

When this bit has logic level high 1 = ACTIVE ERROR, it indicates that singleturn and multiturn data did not changed a single step at a time.

Bit 3

EEPROM interface error

When this bit has logic level high 1 = ACTIVE ERROR, it indicates that an error occurred during a communication with the EEPROM.

Bit 4

SAR conversion error

When this bit has logic level high 1 = ACTIVE ERROR, it indicates that the SAR conversion by the successive-approximation-register analog-to-digital converter has not been completed yet.

Bit 5

Transmission error in BiSS register data

When this bit has logic level high 1 = ACTIVE ERROR, it indicates that a CRC error occurred during the BiSS register data transmission.

Bit 6

External error

When this bit has logic level high 1 = ACTIVE ERROR, it indicates that an external error or an internal error occurred.

Bit 7

Not used.

Device ID

[78 ... 7D, ro]

These registers contain the Device ID (name and software release). The identification name is expressed in hexadecimal ASCII code.
Registers 78 ... 7B show the name of the device.
Registers 7C and 7D show the software release.

Device ID registers structure:

Register	78	79	7A	7B	7C	7D
	2^{47} ... 2^{40}	2^{39} ... 2^{32}	2^{31} ... 2^{24}	2^{23} ... 2^{16}	2^{15} ... 2^{8}	2^{7} ... 2^{0}
Hex	**41**	**53**	**38**	**35**	**xx**	**xx**
ASCII	**A**	**S**	**8**	**5**	**xx**	**xx**

Manufacturer ID

[7E – 7F, ro]

These registers contain the Manufacturer ID. The Manufacturer ID is expressed in hexadecimal ASCII code.

Manufacturer ID registers structure:

Register	7E	7F
	2^{15} ... 2^{8}	2^{7} ... 2^{0}
Hex	**4C**	**69**
ASCII	**L**	**i**

Li = Lika Electronic

6.5 Application notes

Data transmission:

Parameter	Value
Clock Frequency	Min 100 KHz, max 10 MHz
BiSS time-out	adaptive (typically 0.35 µs @ 10 MHz)

6.6 EXAMPLES

All values are expressed in hexadecimal notation.

6.6.1 Setting the Configuration register

We need to set the preset, the Binary output code, and the inverted code sequence.

Bit 0	= reserved	= 0
Bit 1 **Set preset / offset**	= PRESET	= 0
Bit 2 **Enable preset / offset**	= ENABLE	= 0
Bit 3	= not used	= 0
Bit 4	= not used	= 0
Bit 5 **Output code**	= BINARY	= 1
Bit 8 **Code sequence**	= CCW	= 1
Bit 7	= non used	= 0

01100000_2 = 60 hex

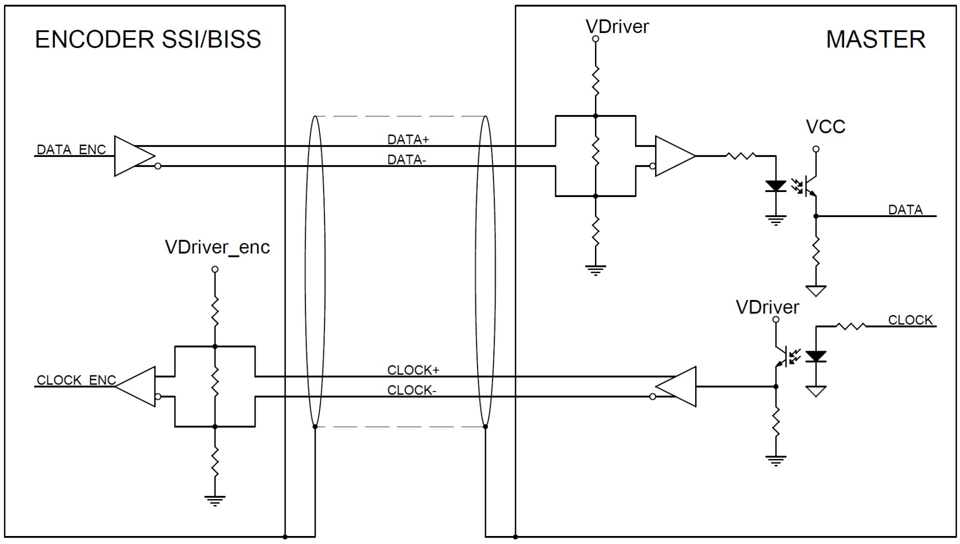
Function	ADR	DATA Tx
writing the Configuration register	49	60
Save parameters on EEPROM	48	01

6.6.2 Setting the Preset / Offset

After having activated the PRESET function (**Enable preset / offset** = 0 = ENABLE; **Set preset / offset** = 0 = PRESET in the Configuration register, see the previous section), you want to set the new Preset value = 100000_{10} = 00 01 86 A0 hex

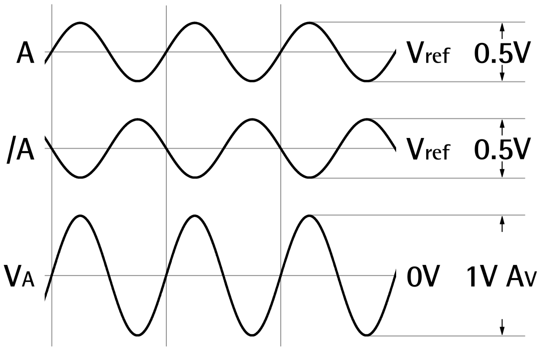
Function	ADR	DATA Tx
writing the Preset / Offset registers	50	00
	51	01
	52	86
	53	A0
Save parameters and activate Preset / Offset	48	02

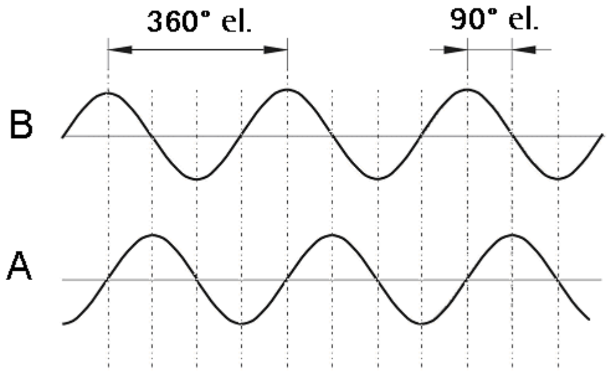
6.7 Recommended BiSS input circuit



7 - 1Vpp Sine/Cosine output signals

A (COSINE) and B (SINE) signals are to be intended with CW rotation as viewed in the Figure on page 16. They provide 4,096 sinusoidal waves per mechanical revolution with amplitude 1Vpp. 1Vpp output level results from differential signals detection. The frequency of output signals is proportional to the rotational speed of the encoder.

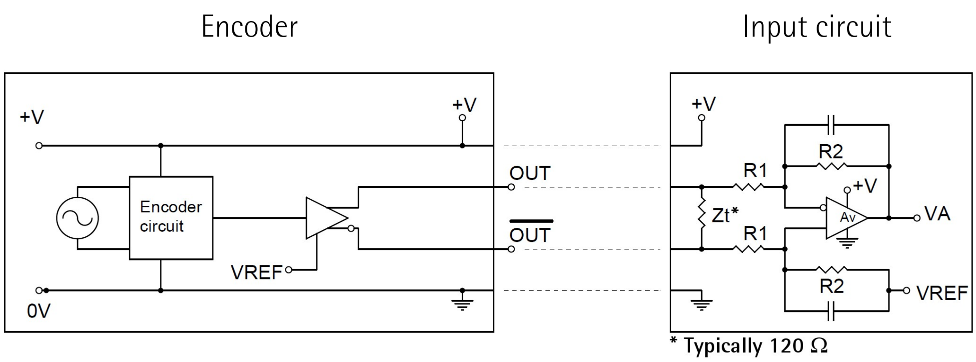




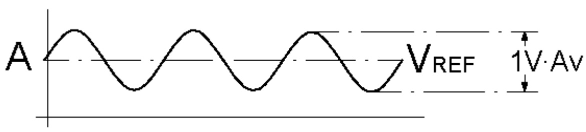
7.1 Output signals voltage level

The voltage level refers to the differential value between normal and inverted signal (differential).

Recommended input circuit



$V_{REF} = 2.5V \pm 0.5V$ $V_A = 1Vpp * Av$ $Av = R2 / R1$



8 - Default parameters list

BiSS C-mode interface

Parameters list	Default value *		
Bank selection	00		
Profile ID	28 19		
Serial number	specific for each device		
Command	00		
Configuration	20		
Bit 0 reserved use	0		
Bit 1 Set preset / offset	0 = Preset		
Bit 2 Enable preset / offset	0 = Enable		
Bit 3 not used	0		
Bit 4 not used	0		
Bit 5 Output code	1 = Binary		
Bit 6 Code sequence	0 = CW		
Bit 7 not used	0		
Counts per revolution	02 00 00 00		
Number of revolutions	00 01		
Preset / Offset	00 00 00 00		
Device type	03		
N° of bits used for singleturn	19		
N° of bits used for multiturn	00		
Sine / Cosine resolution	20		
Active errors	-		
Sensor 1 and Interpolator error register	-		
Diagnosis register	-		
Sensor 2 error register	-		
Device ID	41 53 38 35 xx xx		
Manufacturer ID	4C 69		

* All values are expressed in hexadecimal notation.

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Document release	Release date	Description	HW-SW	Interface
1.0	19.05.2017	First issue	0.1	-
1.1	16.03.2018	SCD data structure of BiSS modified	1.1	-
1.2	01.06.2018	M12 12-pin connector instead of M12 8-pin. Counting direction and Zero setting inputs added to SSI interface	1.1	-
1.3	06.07.2018	Section "4 - Electrical connections" updated	1.1	-
1.4	12.11.2018	Bank selection register added. Sine-Cosine additional track information added	1.1	-
1.5	13.07.2020	Binary code version added	2.0	-
1.6	18.02.2022	New BiSS parametrization, Figure "Encumbrance sizes" updated	2.1, 2.2, 2.3	-
1.7	01.03.2023	Information about Counts per revolution and Number of revolutions registers amended, new order code, minor amendments	3.3	-
1.8	15.05.2024	**Load and save default parameters, encoder initialization** function in the Command register updated (initialization of the physical zero position)	3.3	-

This device is to be supplied by a Class 2 Circuit or Low-Voltage Limited Energy or Energy Source not exceeding 30 Vdc. Refer to the order code for supply voltage rate.
Ce dispositif doit être alimenté par un circuit de Classe 2 ou à très basse tension ou bien en appliquant une tension maxi de 30Vcc. Voir le code de commande pour la tension d'alimentation.

Dispose separately

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