Smart encoders & actuators

User's guide

SMLA + MTLA tape or MRA ring

Absolute encoder for curved and linear axes

- SMLA absolute magnetic encoder for curved and linear axes
- Installation on MTLA magnetic tape or MRA ring
- Range of resolutions down to 12.2 µm / up to 32,768 cpr
- SSI and BiSS C-mode interfaces with error information
- IP68 protection rate

Suitable for the following models:

- SMLA -BG1-...
- SMLA -BG2-...
- SMLA -GG1-...
- SMLA -GG2-...
- SMLA -SC1-...
- SMLA -SC2-...

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General contents

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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 **SMLA series absolute encoder for curved axes**.
SMLA is designed to measure displacements in industrial machines and automation systems. The measurement system includes a magnetic tape or a magnetic ring and a magnetic sensor with conversion electronics. The tape / ring is magnetized with a coded sequence of North-South poles generating an absolute pattern. As the axis rotates (i.e. the ring turns; otherwise as the encoder moves along the magnetic tape), the sensor detects the displacement and yields the absolute position information through the SSI interface (order code SMLA-BGx-... and SMLA-GGx-...) or the BiSS C-mode interface (order code SMLA-SCx-...).
It is mandatory to pair the sensor with the specific **MTLA type magnetic tape or MRA magnetic ring**. See the order code: SMLA-GG1-...**T1**: T1 = MTLA-400-50 magnetic tape; SMLA-GG1-...**R3**: R3 = MRA/202-128N-180 magnetic ring.
Please note that thanks to the pliability of the tape we suggest installing the encoder also on curved surfaces (as well as on linear axes).

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 the unit according to the explanation in the "4 – Electrical connections" section on page 17;
- connect Zero Setting/Preset and Counting direction inputs to 0Vdc, if not used;
  - to set the encoder to zero/preset, connect Zero setting/Preset input to +Vdc for 100 µs at least, then disconnect +Vdc; normally voltage must be at 0Vdc; zero/preset setting must be performed after Counting direction setting; we suggest performing the zero/preset setting when the encoder is in stop;
  - Counting direction: increasing count = connect to 0Vdc; decreasing count = connect to +Vdc;
- in compliance with 2014/30/EU norm on electromagnetic compatibility, following precautions must be taken:
  - before handling and installing the equipment, 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 sensor 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;

- do not stretch the cable; do not pull or carry by cable; do not use the cable as a handle.

1.3 Mechanical safety

- Install the device following strictly the information in the "3 - Mounting instructions" section on page 11;
- mechanical installation has to be carried out with stationary mechanical parts;
- do not disassemble the unit;
- do not tool the unit;
- delicate electronic equipment: handle with care;
- do not subject the device to knocks or shocks;
- protect the unit against acid solutions or chemicals that may damage it;
- respect the environmental characteristics of the product;
- we suggest installing the unit providing protection means against waste, especially swarf as turnings, chips, or filings; should this not be possible, please make sure that adequate cleaning measures (as for instance brushes, scrapers, jets of compressed air, etc.) are in place in order to prevent the sensor and the magnetic tape / ring from jamming.

CAUTION
Keep magnets away from the tape / ring, it could be damaged by strong magnetic fields.

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 purchasing spare parts or needing assistance. For any information on the technical characteristics of the product refer to the technical datasheet.

Warning: devices 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 has to be carried out by qualified personnel only, with power supply disconnected and mechanical parts compulsorily in stop.

WARNING
Install the unit providing protection means against waste, especially swarf as turnings, chips or filings; should this not be possible, please make sure that adequate cleaning measures (as for instance brushes, scrapers, jets of compressed air, etc.) are in place in order to prevent the sensor and the magnetic tape / ring from jamming.
Make sure the mechanical installation meets the system's requirements for both the sensor and the tape indicated in this guide.

3.1 Overall dimensions

(values expressed in mm)

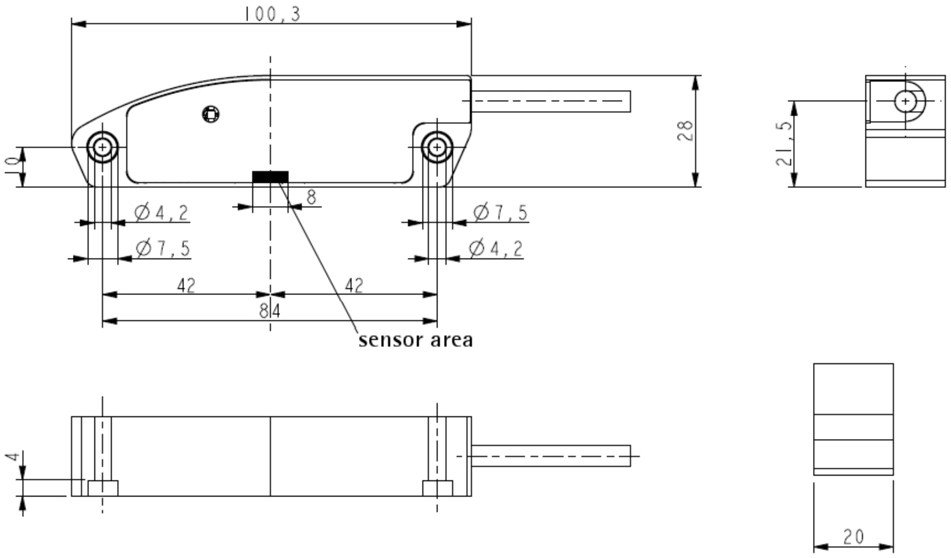


Figure 1

3.2 Magnetic tape

It is mandatory to pair the sensor with the specific **MTLA type magnetic tape**. See the order code: SMLA-GG1-...**T1**: T1 = MTLA-400-50 magnetic tape. For detailed information on the MTLA type tape and how to mount it refer to the specific technical documentation.
Install the unit providing protection means against waste, especially swarf as turnings, chips or filings; should this not be possible, please make sure that adequate cleaning measures (as for instance brushes, scrapers, jets of compressed air, etc.) are in place in order to prevent the sensor and the magnetic tape from jamming.

Make sure the mechanical installation meets the system's requirements of distance, planarity and parallelism between the sensor and the tape indicated in Figure 5 all along the whole measuring length. Avoid contact between the parts.
The Figure 4 shows how the sensor and the magnetic tape must be installed; please note that you must strictly comply with the mounting direction!
MTLA magnetic tape can be provided with a cover strip to protect its magnetic surface (see the order code).
The arrow indicates the **standard counting direction** (count up when the sensor moves in the direction indicated by the arrow in Figure 4). See also the "4.6 Counting direction input" section on page 19.

WARNING
The system cannot operate if mounted otherwise than illustrated in Figure 4. Please mind the direction of the cable outlet.

NOTE
Thanks to the pliability of the tape we suggest installing the encoder on curved surfaces (as well as on linear axes). The minimum bend radius is: **R ≥ 75 mm / 2.95"**.

WARNING
The maximum length of the tape is (805 mm / 31.69") / (400 mm / 15.75"). As the sensor area has always to be fully within the limits of the tape magnetic surface, then the maximum measuring length is the maximum length of the tape minus the sensor area = (805 – 8 = 797 mm / 31.378") / (400 – 8 = 392 mm / 15.4").

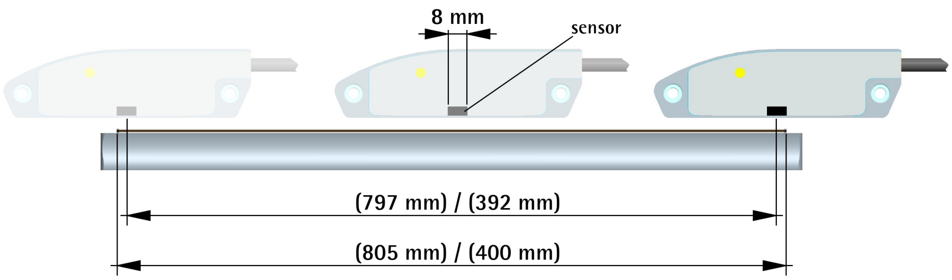


Figure 2

CAUTION
Keep magnets away from the tape, it could be damaged by strong magnetic fields.

3.3 Magnetic ring

It is mandatory to pair the sensor with the specific **MRA type magnetic ring**. See the order code: SMLA-GG1-...**R3**: R3 = MRA/202-128N-180 ring model.
The Figure 3 shows how the sensor and the magnetic ring must be installed; the arrow indicates the **standard counting direction** (increasing count when the ring turns in the direction indicated by the arrow). See also the "4.6 Counting direction input" section on page 19.

WARNING
The system cannot operate if mounted otherwise than illustrated in Figure 3. Please mind the direction of the cable outlet.

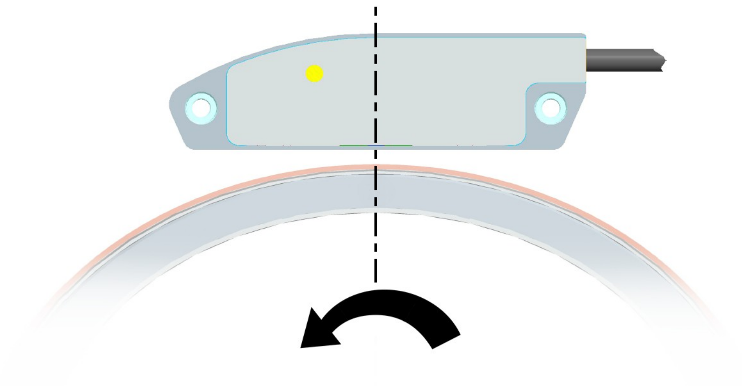


Figure 3

Several types of MRA magnetic rings featuring different mechanical characteristics and mounting options are available. For technical features and dimensions of the rings please refer to the product datasheet. For complete information please refer to the specific documentation.

CAUTION
Keep magnets away from the ring, it could be damaged by strong magnetic fields.

3.4 Mounting the sensor

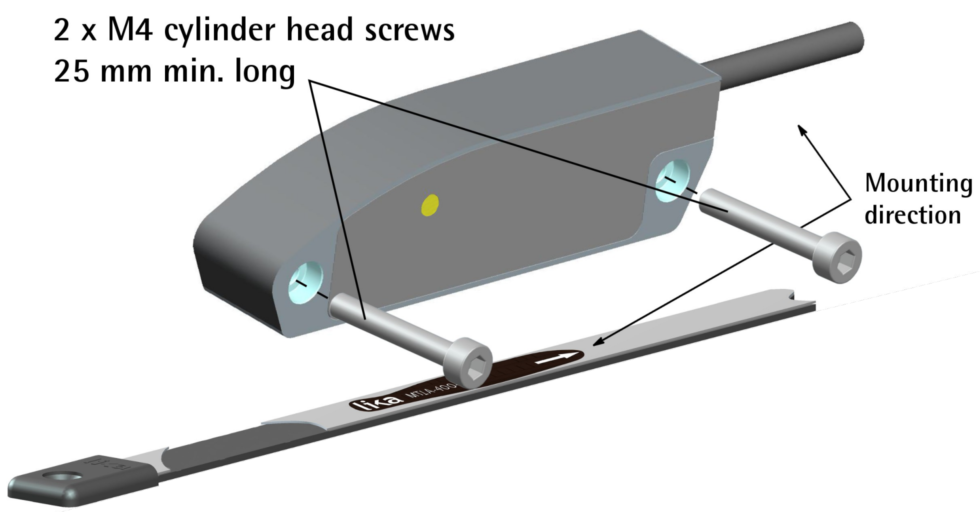


Figure 4

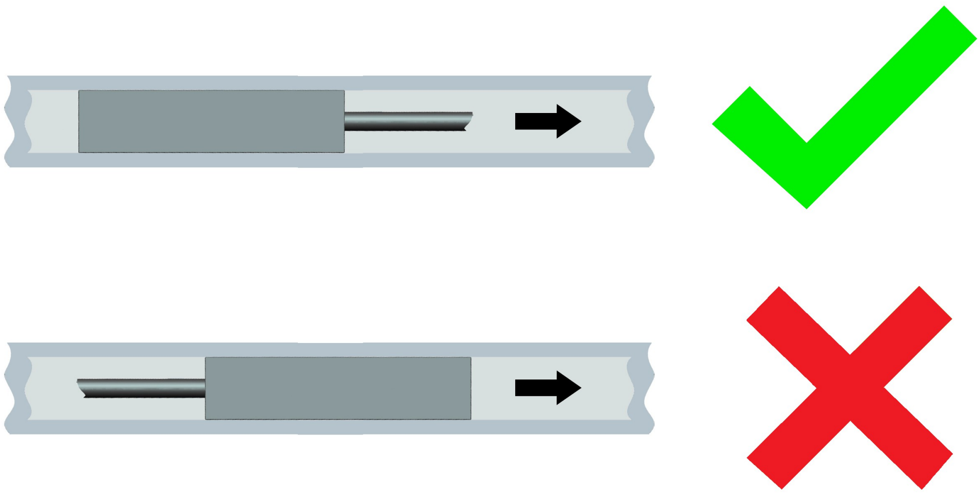
Make sure the mechanical installation complies with the system requirements concerning distance, planarity and parallelism between the sensor and the tape / ring as shown in Figure 5. Avoid contact between the parts.
Fix the sensor by means of **two M4 x 25 UNI5931 cylinder head screws** inserted in the provided holes. Recommended tightening torque: **2.5 Nm**.
Recommended **minimum bend radius** of the cable: **R ≥ 42 mm**.
Please note that the MTLA magnetic tape can be provided with a cover strip to protect its magnetic surface (see the order code). Therefore the distance between the sensor and the magnetic tape is different whether the cover strip is applied.

The allowed gap D (see Figure 5) between the sensor and the tape / ring is indicated in the following table:

Gap sensor / MTLA magnetic tape or MRA ring (D)	
without cover strip	with cover strip (MTLA only)
1.0 ±0.2 mm / 0.04" ±0.008"	0.7 ±0.2 mm / 0.03" ±0.008"

WARNING
The measurement system is calibrated in order to operate optimally at the distance indicated in the table above. The system cannot work if it is installed at a greater distance. On the contrary, if it is installed closer, the sensor provides the absolute information correctly, yet its precision decreases.
Make sure that the mechanical installation complies with the system requirements concerning distance, planarity, and parallelism between the sensor

and the tape / ring as shown in Figure 5 all along the whole measuring length. Avoid contact between the parts.
Mount the sensor as shown in the Figures. Please mind the direction of the cable outlet. The system cannot operate if mounted otherwise than illustrated in the Figures.



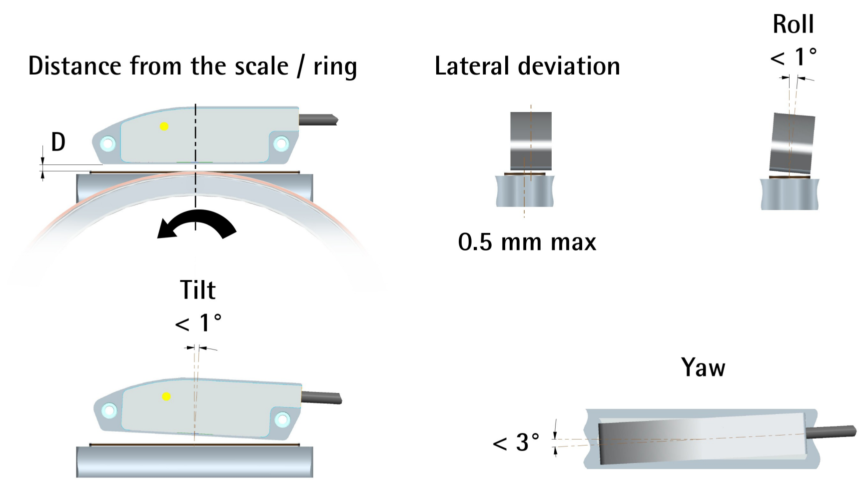


Figure 5

WARNING
After having installed the sensor on the magnetic tape / ring a zero setting / Preset operation is compulsorily required. The zero setting / Preset operation is also required every time either the sensor or the tape / ring is replaced. For any information on the zero/preset setting operation please refer to the "4.5 Zero setting/Preset input" section on page 18 and (BiSS interface only) to the **Preset** registers on page 32.

WARNING

The arrow in Figure 3 e Figure 4 is intended to indicate the **standard counting direction** (count up information when the sensor moves / the ring rotates in the direction of the arrow). See also the "4.6 Counting direction input" section on page 19.

4 – Electrical connections

WARNING
Electrical connection has to be carried out by qualified personnel only, with power supply disconnected and mechanical parts compulsorily in stop.

WARNING
If wires of unused signals come in contact, irreparable damage could be caused to the device. Please insulate them singularly.

Function	M8 cable	M12 8-pin
0Vdc power supply	Black	1
+Vdc power supply *	Red	2
Clock IN + / MA +	Yellow	3
Clock IN - / MA -	Blue	4
Data OUT + / SLO +	Green	5
Data OUT - / SLO -	Orange	6
Zero setting / Preset	White	7
Counting direction	Grey	8
Shielding	Shield	Case

* See the order code for power supply voltage level

EXAMPLE
SMLA-GG**1**-14 +Vdc = +5Vdc ± 5%
SMLA-GG**2**-14 +Vdc = +10Vdc +30Vdc

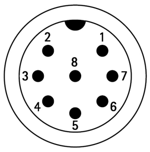
4.1 M8 cable specifications

Model : LIKA HI-FLEX sensor cable type M8
Wires : 2 x 0.22 mm² + 6 x 0.14 mm² (24/26 AWG)
Jacket : Matt Polyurethane (TPU) halogen free, oil, hydrolysis, abrasion resistant
Shield : tinned copper braid, coverage ≥ 85%
Outer diameter : 5.3 mm ÷ 5.6 mm (0.209" ÷ 0.220")
Min. bend radius : Ø x 7.5
Work temperature : -40°C +90°C (-40°F +194°F) – dynamic installation
-50°C +90°C (-58°F +194°F) – fixed installation
Conductor resistance : ≤ 90 Ω/km / ≤ 148 Ω/km

4.2 M12 8-pin connector

Male, frontal side

A coding



4.3 Connection of the shield

For signals transmission always use shielded cables. The cable shielding must be connected properly to the metal ring nut of the connector in order to ensure a good earthing through the frame of the device.

4.4 Ground connection

Minimize noise by connecting the shield and/or the connector housing and/or the sensor 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 Zero setting/Preset input

The output position information at any point in the travel can be set either to 0 (SSI interface) or to a desired value called preset (BiSS C interface; the preset value has to be set next to the **Preset** registers, see on page 32). The Zero setting/Preset input allows the operator to activate the zero/preset value through an input signal sent by a PLC or other controller. This can be very useful for setting -for instance- the zero position of both the sensor and the machine. If not used, connect the Zero setting/Preset input to 0Vdc. To activate the zero setting/preset function, connect the Zero setting/Preset input to +Vdc for 100 µs at least, then disconnect +Vdc; normally voltage must be at 0Vdc; Zero setting/Preset must be set after Counting direction. We suggest setting the zero/preset when the encoder is in stop.

NOTE

In the BiSS interface the preset can be activated also by using the **Save parameters and activate Preset** function of the **Command** register. For detailed information please refer to the **Preset** registers on page 32 and the **Command** register on page 35.

NOTE

Please note that in a linear application, after setting the zero point, the positive counting will be from 0 towards the max. value (see on page 21); if you move the axis before the 0 point, the detected value will decrement starting from the max. number of information – 1 down. For example:

...	4093	4094	4095	0	1	2	3	...

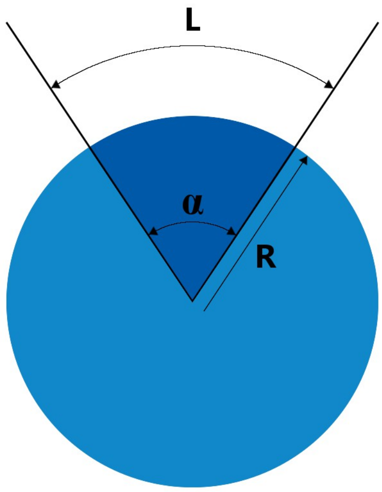
4.6 Counting direction input

The **standard counting direction** is to be intended with sensor moving as indicated by the arrow in Figure 4 / or ring turning as indicated by the arrow in Figure 3. The counting direction circuit allows to reverse the counting direction. In other words it allows the count up when the sensor moves / the ring turns in reverse of the standard direction, i.e. in the opposite direction to the one shown by the arrow in Figure 4 / Figure 3. Connect the Counting direction input to 0Vdc if not used. Connect the counting direction input to 0Vdc to have an increasing count when the sensor moves / the ring turns as indicated by the arrow in Figure 4 / Figure 3; connect the counting direction input to +Vdc to have an increasing count when the sensor moves / the ring turns in reverse of the standard direction, i.e. in the opposite direction to the one shown by the arrow in Figure 4 / Figure 3.

WARNING

After having set the new counting direction it is necessary to set the sensor to zero/preset, see the previous "4.5 Zero setting/Preset input" section.

4.7 Calculating the angular resolution



The **angular resolution** can be defined as the spacing expressed in degrees (°) between two consecutive discrete points, i.e. the sequence of information provided by the encoder.

The angular resolution of a tape applied on either a curved or a circular surface results from the following calculation:

$$\text{Angular resolution} = \frac{\alpha}{\text{Number of information}}$$

where:

$$\alpha = \frac{L \times 360}{2\pi R}$$

L being the length of the tape; and R being the radius of the curved or circular surface.
The number of information is the number of pulses/counts provided by the measuring system for the whole tape length L.

As you can easily see in the Figure above, α is the magnitude of the angle corresponding to the length of the tape applied on the circular surface. The formula for calculating the magnitude of the angle α (i.e. the size of the arc) can be argued considering that, if the magnitude of the circumference ($2\pi R$) is 360°, then the magnitude of the tape angle will be 360° (circumference) or a fraction of 360° (arc).

The length of the MTLA tape can be 400 mm / 15.75" (T1 = MTLA-400, see the order code) or 805 mm = 31.69" (T2 = MTLA-805, see the order code), the SMLA absolute encoder will provide **4,096** information when the SMLA-xxx-**12**-... is installed; **8,192** information when the SMLA-xxx-**13**-... is installed; **16,384** information when the SMLA-xxx-**14**-... is installed; and **32,768** information when the SMLA-xxx-**15**-... is installed. If you mount only half the tape (for example, in the MTLA-400-50 = 200 mm / 7.87"), then the number of information provided, for example, by the SMLA-xxx-12-... encoder will be down to half (2,048 cpr). For the absolute encoder resolution please refer to the order code.
There follows an example to better understand how to calculate the angular resolution.

EXAMPLE

Absolute encoder system: SMLA-xxx-13-... encoder paired with MTLA-400 absolute tape

Let's suppose you mount a 400 mm long MTLA absolute tape on an arc having a size of R = 100 mm. The MTLA tape is paired with an SMLA-xxx-**13**-... sensor. The resolution of the encoder is 8,192 cpr, as you can read in the order code.

As previously stated, the angular resolution is calculated as follows:

$$\text{Angular resolution} = \frac{\alpha}{\text{Number of information}}$$

First of all let's calculate the magnitude of the angle α.

$$\alpha = \frac{L \times 360}{2\pi R} = \frac{400 \times 360}{2\pi \times 100} = \frac{144{,}000}{628.3} = 229.18$$

The number of information can be read in the order code: SMLA-xxx-13-... = 2^{13} = 8,192 cpr.

Thus it will be:

$$\text{Angular resolution} = \frac{\alpha}{\text{Number of information}} = \frac{229.18}{8{,}192} = 0.028°$$

4.8 Features summary

	SMLA-xxx-12-...	SMLA-xxx-13-...	SMLA-xxx-14-...	SMLA-xxx-15-...
Resolution cpr	4,096	8,192	16,384	32,768
Linear resolution µm (with MTLA-400)	97.6	48.8	24.4	12.2
Linear resolution µm (with MTLA-805)	196.5	98.2	49.1	24.5
Length of MTLA-400 tape (max. measuring length)	400 mm / 15.75" (392 mm / 15.43")			
Length of MTLA-805 tape (max. measuring length)	805 mm / 31.69" (797 mm / 31.38")			
Max. number of information (max. value)	12 bits (4,095)	13 bits (8,191)	14 bits (16,383)	15 bits (32,767)

5 - SSI interface

Order codes: SMLA-BGx-...
SMLA-GGx-...

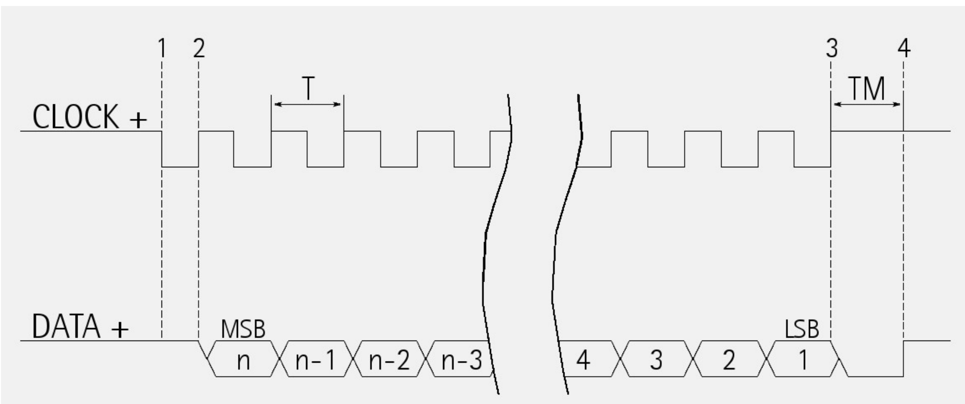
5.1 SSI (Synchronous Serial Interface)

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 16 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); LSB is then sent at the last 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 sensors having any resolution.
The word has a variable length according to resolution, as shown in the following table.

	SMLA-BGx-12-... SMLA-GGx-12-...	SMLA-BGx-13-... SMLA-GGx-13-...	SMLA-BGx-14-... SMLA-GGx-14-...	SMLA-BGx-15-... SMLA-GGx-15-...
Tape model	T1 = MTLA-400-50 T2 = MTLA-805-50			
Length of MTLA-400 tape (max. measuring length)	400 mm / 15.75" (392 mm / 15.4")			
Length of MTLA-805 tape (max. measuring length)	805 mm / 31.69" (797 mm / 31.38")			
Resolution cpr	4,096	8,192	16,384	32,768
Linear res. µm MTLA-400	97.6	48.8	24.4	12.2
Linear res. µm MTLA-805	196.5	98.2	49.1	24.5
Length of the word	13 bits	14 bits	15 bits	16 bits
Max. number of information (max. value)	12 bits (4,095)	13 bits (8,191)	14 bits (16,383)	15 bits (32,767)

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

Structure of the transmitted position value:

SMLA-xxx-12-...	**bit**	**12**	**...**	**1**	**0**
SMLA-xxx-13-...	**bit**	**13**	**...**	**1**	**0**
SMLA-xxx-14-...	**bit**	**14**	**...**	**1**	**0**
SMLA-xxx-15-...	**bit**	**15**	**...**	**1**	**0**
	value	MSB	...	LSB	Error bit

WARNING
The position value issued by the sensor is expressed in absolute information; to convert the pulses into a metric measuring unit you must multiply the number of detected pulses by the resolution (see the "4.8 Features summary" section on page 21).

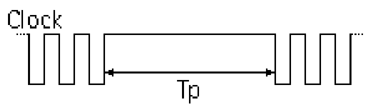
EXAMPLE
SMLA-GG2-**14**-... + MTLA-**400**, linear resolution = 24.4 µm
detected pulses = 71
position value = 71 * 24.4 µm = 1732.4 µm = 1.7324 mm

5.3 Recommended transmission rates

The SSI interface has a frequency of data transmission ranging between 100 kHz and 2 MHz.
The CLOCK IN signals and the DATA OUT signals comply with the "EIA standard RS-422".
The 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 16 µs (Tp = pause time > 16 µs).



5.4 Error bit

The error bit is intended to communicate the normal or fault status of the Slave.

"1": correct status (the sensor is working properly, there are not active errors)

"0": an error is active:

- position calculation error, invalid position value; the sensing electronics is not able to read the tape / ring; this problem may be caused, for instance, by an excessive distance between the sensor and the tape / ring, by a wrong/reversed assembly of the elements, by a damage to the magnetic surface of the tape / ring; see the "3 - Mounting instructions" section on page 11;
- the power supply is not as required, please refer to the order code;
- EEPROM error.

NOTE

For any information on the structure of the position information word, please refer to the "5.2 MSB Left Aligned protocol" section on page 23.

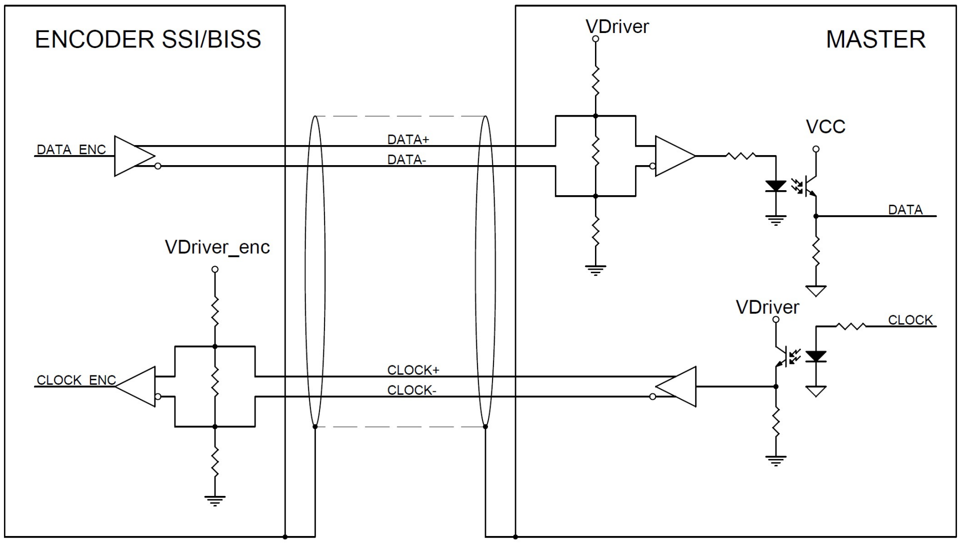
The operating or fault status of the device is shown visually also by the LED installed in the side of the sensor, refer to the "7 - Diagnostic LED" section on page 38.

For any information on errors and their solution please refer to the sections "8 - Error and fault diagnostics" on page 39 and "10 - Troubleshooting" on page 41.

5.5 Helpful information

- The position information increases when the sensor moves / the ring turns in the direction indicated by the arrow in Figure 4, starting from a min. value up to a max. value; min. and max. values depend on the specific MTLA magnetic tape / MRA magnetic ring installed in your application.
- If required by your application, at installation execute a zero setting / Preset operation of the position read by the Master.

5.6 Recommended SSI circuit



6 - BiSS C-mode interface

Order code: SMLA-SCx-...

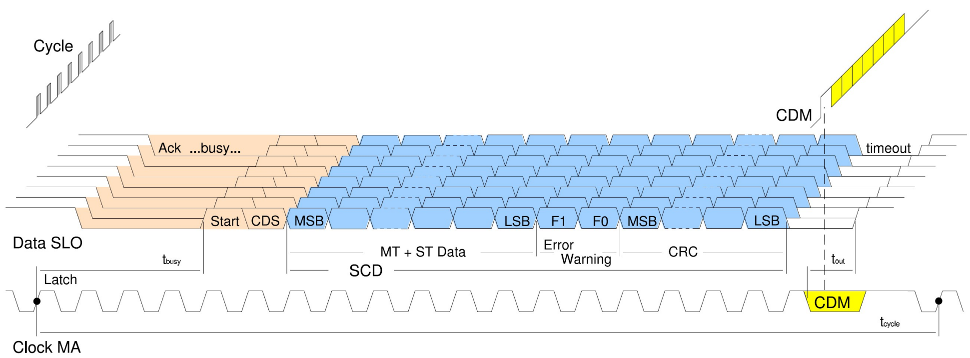
Lika encoders are always Slave devices and comply with the “BiSS C-mode interface” and the “Standard encoder profile”.
Refer to the official BiSS website for all information not listed in this manual (www.biss-interface.com).
The device is designed to work in a point-to-point configuration and has to 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 28.
- **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 30.



6.2 Single Cycle Data SCD

SCD structure is different according to the resolution of the SMLA model encoder.

6.2.1 SCD structure

SCD data has variable length according to the resolution of the encoder. It consists of the following elements: position value (**Position**), 1 error bit nE (**Error (nE)**), 1 warning bit nW (**Warning (nW)**) and a 6-bit CRC Cyclical Redundancy Checking (**CRC**).

12-bit encoder model (SMLA-SCx-12)

bit	19 ... 8	7	6	5 ... 0
function	Position	Error (nE)	Warning (nW)	CRC

13-bit encoder model (SMLA-SCx-13)

bit	20 ... 8	7	6	5 ... 0
function	Position	Error (nE)	Warning (nW)	CRC

14-bit encoder model (SMLA-SCx-14)

bit	21 ... 8	7	6	5 ... 0
function	Position	Error (nE)	Warning (nW)	CRC

15-bit encoder model (SMLA-SCx-15)

bit	22 ... 8	7	6	5 ... 0
function	Position	Error (nE)	Warning (nW)	CRC

Position

It is the process data transmitted by the Slave to the Master. It has a variable length according to the resolution of the encoder.

The transmission starts with MSB (most significant bit) and ends with LSB (less significant bit).

The position value issued by the sensor is expressed in absolute information; to convert the pulses into a metric measuring unit you must multiply the number of detected pulses by the resolution (see the “4.8 Features summary” section on page 21).

EXAMPLE

SMLA-SC1-**14**-... + MTLA-**400**, linear resolution = 24.4 µm

detected pulses = 71

position value = 71 * 24.4 µm = 1732.4 µm = 1.7324 mm

Error (nE)
(1 bit)
The error bit nE is intended to communicate the normal or fault status of the Slave.

"1": correct status (the sensor is working properly, there are not active errors)

"0": an error is active:

- position calculation error, invalid position value; the sensing electronics is not able to read the tape / ring; this problem may be caused, for instance, by an excessive distance between the sensor and the tape / ring, by a wrong/reversed assembly of the elements, by a damage to the magnetic surface of the tape / ring; see the "3 - Mounting instructions" section on page 11;
- the power supply is not as required, please refer to the order code;
- EEPROM error.

NOTE
The operating or fault status of the device is shown visually also by the LED installed in the side of the sensor, refer to the "7 - Diagnostic LED" section on page 38.
For any information on errors and their solution please refer to the sections "8 - Error and fault diagnostics" on page 39 and "10 - Troubleshooting" on page 41.

Warning (nW)
(1 bit)
The warning bit nW is intended to communicate the normal status of the Slave or the presence of a fault condition that does not prevent the unit from running.

"1": correct status (the sensor is working properly, there are not active warnings)

"0": a warning is active:

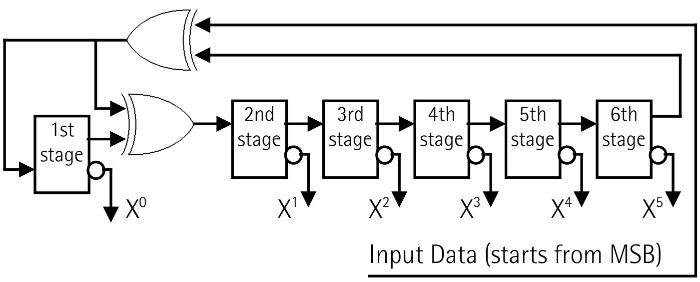
- distance error: the specified mounting tolerances between the sensor and the tape / ring are not met, see the "3 - Mounting instructions" section on page 11;
- frequency error: the speed of the sensor on the tape / the speed of the ring is greater than the maximum one allowed.

When a warning condition occurs, the position information is good, however the system precision may be worse than in a normal condition. For such reason it is necessary to comply with the mounting tolerances and/or to drop the speed of the sensor on the tape / the speed of the ring. The LED does not light up.

NOTE
For any information on fault conditions and their solution please refer to the sections "8 - Error and fault diagnostics" on page 39 and "10 - Troubleshooting" on page 41.

CRC
Correct transmission control (inverted output). Cyclical Redundancy Checking is an error checking which is the result of a "Redundancy Checking" calculation performed on the message contents. This is intended to check whether the 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 (http://www.biss-interface.com/).

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

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

DATA

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

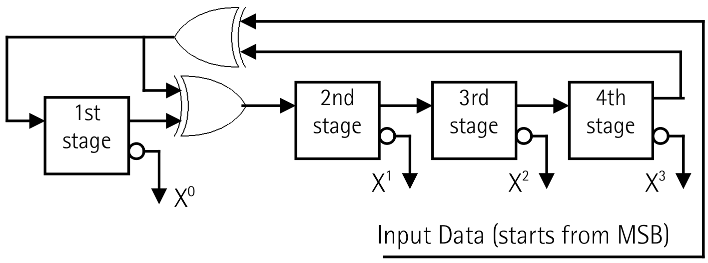
Data bit structure:

bit	7	...	...	0
	MSB	...	...	LSB

CRC

Correct transmission control (inverted output). Cyclical Redundancy Checking is an error checking which is the result of a "Redundancy Checking" calculation performed on the message contents. This is intended to check whether the 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
12 - 13	Preset
40	Preset setting enable
60 ... 63	Serial number
77	Command
78 ... 7B	Device ID
7C	Time-out
7D	Software version
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**.

Preset
[12 - 13, rw]

WARNING
You are allowed to enter a value next to the **Preset** registers only after having set the value "01" next to the **Preset setting enable** register. As soon as you have entered the desired preset value, you must set the value "00" next to the **Preset setting enable** register and then save data.

These registers allow the operator to set the Preset value. Preset function is meant to assign a certain value to a desired physical position of the encoder. The chosen physical position (i.e. the transmitted position value) will get the value set next to these registers and all the previous and following positions will get a value according to it. For instance, this can be useful for getting the zero point of the encoder and the zero point of the application to match. The preset value will be set for the position of the encoder in the moment when the command is sent through the **Save parameters and activate Preset** function of the **Command** register (or through the Zero setting/Preset input signal, see the "4.5 Zero setting/Preset input" section on page 18).

After having entered a value next to the Preset registers you can either save it without activating the preset function or both save and activate it at the same time.
Use the **Save parameters** function (set "01" in the Command register) to save the new Preset value without activating it.

Use the **Save parameters and activate Preset** function (set "02" in the Command register) to both save and activate the new Preset value.

The max. allowed Preset value depends on the resolution of the device (please refer to the "4.8 Features summary" section on page 21):
SMLA-SCx-12 → max preset = 0F FFh (12 bits)
SMLA-SCx-13 → max preset = 1F FFh (13 bits)
SMLA-SCx-14 → max preset = 3F FFh (14 bits)
SMLA-SCx-15 → max preset = 7F FFh (15 bits)
Default = **00 00h.**
Min. Value = 00 00h
Max. value = according to resolution

NOTE
We suggest setting the preset when the sensor is not moving or the ring is not rotating.

Preset registers structure:

Register	12	13
	LSB	MSB
	2^7 - 2^0	2^{15} - 2^8

NOTE
The Preset value must be expressed in a 16-bit format, thus the Preset value you want to set must be adjusted by multiplying it by the factor $2^{16\text{-nbit}}$, where nbit is the number of bits relating to the resolution of the encoder. See the following example.

PRESET SETTING EXAMPLE
In a 14-bit resolution encoder (2^{14} = 16,384 information), you want to set the following Preset value = $10{,}000_{10}$.

1. As previously stated, first of all you must enable the setting of the Preset registers by entering the value "01" next to the Preset setting enable register.

2. Then multiply the desired preset value ($10{,}000_{10}$) by the factor $2^{16\text{-nbit}}$, i.e. 2^2 (16 – 14 = 2).
   Thus the Preset value to be set in the registers will be:
   $10{,}000_{10} * 2^{16-14} = 40{,}000_{10}$ = 9C 40 hex.

3. Then, before saving the entered data, set the value "00" next to the **Preset setting enable** register.

4. To save the new Preset value, you must use the **Save parameters** function in the **Command** register (set "01" in the **Command** register).

5. Otherwise, to both save and activate the the new Preset value at the same time, you must use the **Save parameters and activate Preset** function in the **Command** register (set "02" in the **Command** register).

Function	ADDR	DATA Tx
Preset setting enable	40	01
Writing in the Preset register	12	40
	13	9C
Preset setting enable	40	00
Save parameters function in the Command register	77	01
	or	
Save parameters and activate Preset function in the Command register	77	02

Preset setting enable

[40, wo]

It allows the operator to enable the setting of the Preset registers. You are allowed to set a new preset value only after having entered the value "01" next to this Preset setting enable register. As soon as you have entered the desired preset value, you must set the value "00" next to this Preset setting enable register and then save data.

Serial number

[60 ... 63, ro]

These registers contain the serial number of the device expressed in hexadecimal notation.
Register 60: year of production.
Register 61: week of production.
Registers 62 and 63: serial number in ascending order.

Command

[77, wo]

Value	Function
01	Save parameters
02	Save parameters and activate Preset

After having set a new value in any register use the **Save parameters** function in the **Command** register to save the new value. Set "01" in the **Command** register.
After having set a new value in any register use the **Save parameters and activate Preset** function in the **Command** register to both save the new value and activate the preset function at the same time. Set "02" in the **Command** register.
After having sent the command the register is set back to "00" automatically.
Wait 30 ms at least (EEPROM writing time) before activating a new function.

Device ID

[78 ... 7B, ro]
These registers contain the Device ID. Identification name is expressed in hexadecimal ASCII code.

Register	**78**	**79**	**7A**	**7B**
Hex	53	4D	4C	41
ASCII	S	M	L	A

Time-out

[7C, rw]
It allows to set the minimum interval time between two transmission sequences.
After having set the desired time-out value, save data using the **Save parameters** function (**Command** register = "01").

Time-out	Bit 7 ... bit 2	Bit 1	Bit 0
16 µs	0 ... 0	0	0
8 µs	0 ... 0	0	1
2 µs (default)	0 ... 0	1	0
1 µs	0 ... 0	1	1

NOTE
You can save the entered time-out value also by using the **Save parameters and activate Preset** function in the **Command** register (**Command** register = "02"). Please note that in this case you both save time-out data and activate the preset function (see on page 32).

Software version

[7D, ro]

This register contains the software version of the device. Data is expressed in hexadecimal ASCII code.

Register	7D
Hex	xx
ASCII	x

EXAMPLE

If the value in the register 7D is "31" hex, then the software version is "1".

Manufacturer ID

[7E – 7F, ro]

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

Register	7E	7F
Hex	4C	69
ASCII	L	i

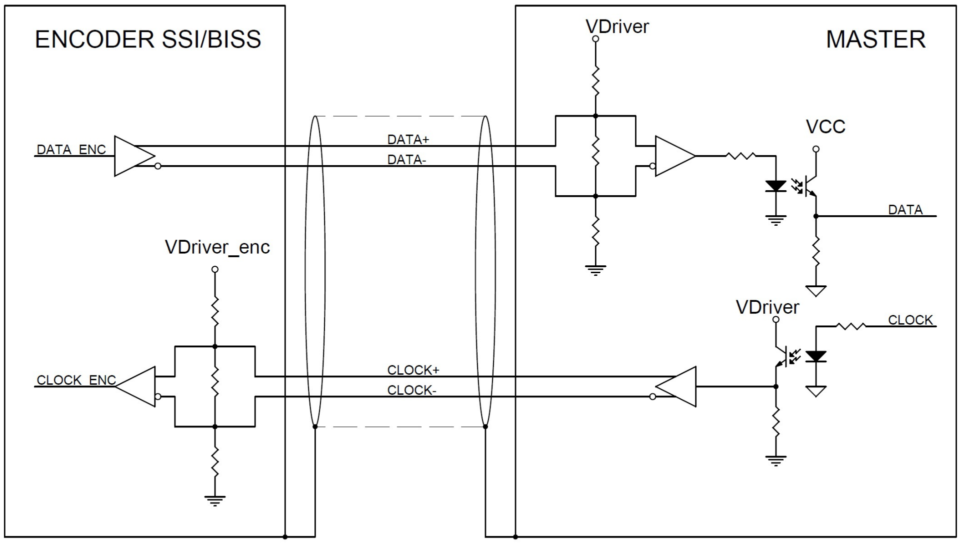
Li = Lika Electronic

6.5 Application notes

Data transmission:

Parameter	Value
Clock Frequency	Min 200 kHz, max 10 MHz
BiSS time-out	It can be set up, see the **Time-out** register

6.6 Recommended BiSS input circuit



7 - Diagnostic LED

One LED is installed in the side of the sensor and is designed to show visually the operating or fault status of the device, as explained in the following table. The operating or fault status of the device is also communicated through the error bit, refer to the "5.4 Error bit" section on page 25 (SSI interface) or to the "Error (nE)" section on page 29 (BiSS interface).

LED	Description
OFF	The sensor is working properly, there are not active errors.
ON lit red	Position calculation error, invalid position value; the sensing electronics is not able to read the tape / ring; this problem may be caused, for instance, by an excessive distance between the sensor and the tape / ring, by a wrong/reversed assembly of the elements, by a damage to the magnetic surface of the tape / ring; see the "3 - Mounting instructions" section on page 11.
	The power supply is not as required, please refer to the order code.
	EEPROM error.

For further information refer also to the sections "8 - Error and fault diagnostics" on page 39 and "10 - Troubleshooting" on page 41.

8 - Error and fault diagnostics

At power on or during operation the following errors may occur:

- when switching on the system an alarm is triggered through both the diagnostic LED and the dedicated bit (SSI interface: refer to the "5.4 Error bit" section on page 25; BiSS interface: refer to the "Error (nE)" section on page 29): the tape / ring is not read correctly; it may be due to one of the following reasons: the tape / ring and/or the sensor are not mounted properly (for instance: the tape is mounted contrariwise to the sensor; or it is mounted upside down; see the "3 - Mounting instructions" section on page 11); the magnetic surface of the tape / ring is damaged somewhere; the sensor is damaged; this may cause invalid data to be transmitted; as soon as the problem is solved the LED switches off and the error bit switches to high logic level;
- during operation an alarm is triggered through both the diagnostic LED and the dedicated bit (SSI interface: refer to the "5.4 Error bit" section on page 25; BiSS interface: refer to the "Error (nE)" section on page 29): as previously stated, the tape / ring is not read correctly; it may be due to one of the following reasons: the tape / ring and/or the sensor are not mounted properly (for instance: the tape is mounted contrariwise to the sensor; or it is mounted upside down; see the "3 - Mounting instructions" section on page 11); the magnetic surface of the tape / ring is damaged somewhere; the sensor is damaged; furthermore, the alarm may be caused by a position calculation error so that the resulting position value is invalid. The last valid position is "frozen" (kept in memory) until the next valid position is detected on the tape / ring.

NOTE

In the SSI interface, the device status is both shown visually through the diagnostic LED (see the "7 - Diagnostic LED" section on page 38) and transmitted via the error bit (see the "5.4 Error bit" section on page 25).
In the BiSS interface, the device status is both shown visually through the diagnostic LED (see the "7 - Diagnostic LED" section on page 38) and transmitted via the error bit (see the "Error (nE)" section on page 29). Refer also to the "Warning (nW)" section on page 29.

For any further information refer also to the "10 - Troubleshooting" section on page 41.

9 - Maintenance

WARNING

Maintenance operations have to be carried out by qualified personnel only, with power supply disconnected and mechanical parts compulsorily in stop.

The magnetic measurement system does not need any special maintenance; anyway it has to be handled with the utmost care as any delicate electronic equipment. From time to time we recommend the following operations:

- periodically check the soundness of the structure and make sure that there are no loose screws; tighten them if necessary;
- check the gap between the sensor and the magnetic tape / ring. The wear of the machine may increase the tolerances;
- the surface of the magnetic tape / ring has to be regularly cleaned using a soft and clean cloth to remove dust, chips, moisture etc.

10 - Troubleshooting

The following list shows some typical faults that may occur during installation and operation of the magnetic measurement system.

Fault:
The system does not work (no pulse output).

Possible cause:

- The tape / ring and/or the sensor are not installed properly. The active surface of the tape / ring does not match the sensitive part of the sensor; or the sensor installation does not comply with the mounting direction. The tape / ring and the sensor need to be coupled as explained in the mounting instructions. The system cannot operate if mounted otherwise. For correct installation please refer to the "3 - Mounting instructions" section on page 11.
- A magnetic part or a protection surface is interposed between the sensor and the tape / ring. Only non-magnetic materials are allowed between the sensor and the tape / ring.
- Installation does not meet the mounting tolerances between the sensor and the tape / ring indicated in this guide. During operation the sensor hit the surface of the tape / ring (check whether the sensor sensitive part is damaged). Or the sensor is mounted too far from the tape / ring.
- The sensor has been damaged by short circuit or wrong connection (reverse polarity protection is provided for the version SMLA-xx2-... only).

Fault:
The measured values are either inaccurate or not provided in the whole measuring length.

Possible cause:

- The mounting tolerances between the sensor and the tape / ring are not met all along the whole measuring length. See the "3 - Mounting instructions" section on page 11.
- The sensor is not installed properly on the tape / ring (see the "3 - Mounting instructions" section on page 11).
- The connection cable runs near high voltage cables or the shield is not connected properly. Check the earthing point.
- The frequency of Master clock is set too high or too low and the transmission cannot be synchronized correctly. See the "5 - SSI interface" section on page 22; or the "6 - BiSS C-mode interface" section on page 27.
- A section of the magnetic surface has been damaged mechanically or magnetically; this may cause a failure to read the position or a position calculation error so that the resulting position value is invalid.
- The measuring error is caused by a torsion or plays in the machine structure. Check for movements in the mechanics of the machine.

11 - Default parameters list

BiSS C-mode interface

Parameters list	Default value *		
Preset	00 00		
Preset setting enable	00		
Time-out	02		

* All values are expressed in hexadecimal notation.

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Document release	Release date	Description	HW	SW	Interface
1.0	14.09.2015	First issue	-	-	-
1.1	31.01.2020	General review, new order code	-	-	-

Dispose separately

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