

## SMAG + MTAG



- SMAG absolute linear encoder
- MTAG guided profile unaffected by dust and liquids
- Measuring length from 115 to 570 mm
- Resolution range from 0.1 mm to 0.005 mm
- SSI interface, LSB Right Aligned protocol

#### Suitable for the following models:

- SMAG -GA-100-...
- SMAG -GA-50-...
- SMAG -GA-10-...
- SMAG -GA-5-...

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The logo for Lika Electronic s.r.l. consists of the word "lika" in a bold, lowercase, sans-serif font. The letter "i" has a dot above it. The logo is positioned in the bottom right corner of the page.

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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 the device and the 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 <b>WARNING</b> , 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 <b>NOTE</b> , 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 <b>EXAMPLE</b> when instructions for setting parameters are accompanied by examples to clarify the explanation.

# Preliminary information

This guide is designed to provide the most complete information the operator needs to correctly and safely install and operate the linear encoders with guided profile of the **SMAG series** that provide **SSI interface** and Gray output code.

The SMAG sensors are engineered to measure linear displacements in industrial machines and automation lines.

The measuring system consists of a magnetic tape mounted on a rigid profile and a magnetic sensor. The tape has a coded sequence of poles; the distance between two poles is referred to as "pole pitch". The sensor moves along the magnetic tape (or, on the contrary, the magnetic tape is moved under the sensor), thus the sensor detects the displacement and issues an output signal equivalent to the one generated by an absolute encoder or an optical linear scale.

The sensor must be compulsorily paired with the **MTAG magnetic tape**. The measuring length is from 115 mm (4.528") to 570 mm (22.441"), see the order code.

For technical specifications please refer to the product datasheet.

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

In the first section (from chapter 1 to chapter 3) 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 SMAG linear encoder + MTAG are provided.

In the second section, entitled **SSI Interface** (chapter 4), you can find detailed information on the SSI interface.

## 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 devices;
- 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 the power supply before connecting the device;
- connect according to the explanation in the "4.1 Electrical connections" section on page 12;
- connect Zero Setting input to 0Vdc, if not used; to zero set the encoder, connect Zero setting input to +Vdc for 100  $\mu$ s at least, then disconnect +Vdc; normally voltage must be at 0Vdc; zero set must be performed after Counting direction setting; we suggest performing the zero set when the encoder is in stop;
- connect Counting direction input to 0Vdc, if not used; to have count up information when the measuring system moves as shown in Figure 2 (see the arrows) = connect to 0Vdc; to have count up information when the measuring system moves in the direction opposite to the movement shown in Figure 2 (see the arrows) = 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 or the connector housing 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 – Mechanical installation" section on page 9;
- mechanical installation has to be carried out with stationary mechanical devices;
- do not disassemble the unit;
- do not tool the unit;
- delicate electronic equipment: handle with care; do not subject the unit to knocks or shocks;
- protect the unit against acid solutions or chemicals that may damage it;
- respect the environmental characteristics declared by manufacturer;
- 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 scale from jamming.

## 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 catalogue.



**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 – Mechanical installation



#### WARNING

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

#### 3.1 Overall dimensions (Figure 1)

(values are expressed in mm)

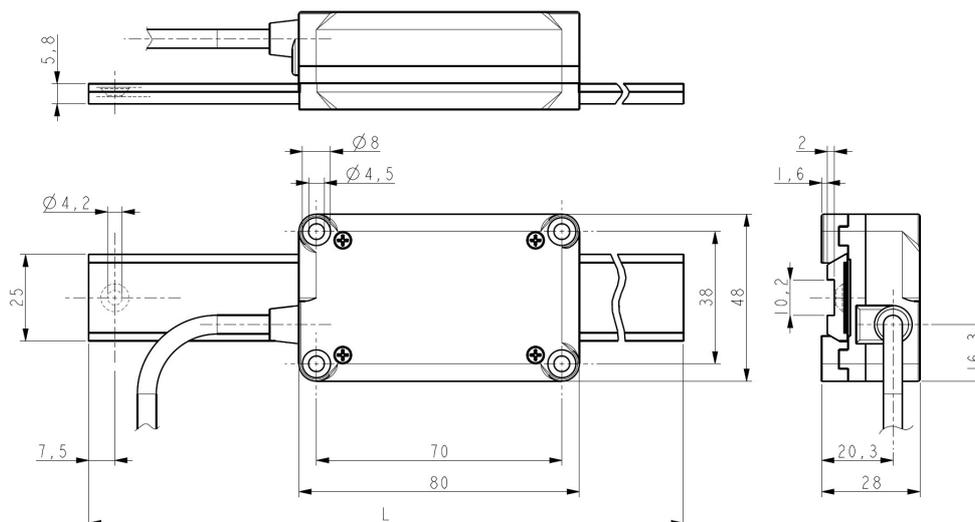


Figure 1

$L = 195 \text{ mm} / 7.677'' \div 650 \text{ mm} / 25.59''$  (see the order code of the MTAG profile)

#### 3.2 Mounting instructions

Install and use the product in conformance with the protection level it has been designed to. Protect the unit against knocks, frictions and solvents and avoid temperatures over the allowed range.

Make sure the unit is mounted where hard or sharp objects (e.g. turnings, chips or filings) do not come into contact with the magnetic tape and the bottom of the sensor head. If these conditions cannot be avoided provide adequate cleaning measures (as for instance brushes, scrapers, jets of compressed air, etc.) in order to prevent the sensor and the magnetic tape from jamming.

The profile of the magnetic tape must be inserted in the track at the bottom of the sensor enclosure; the shape of the track is univocal in order to prevent mounting errors.

Two mounting options are allowed:

1. you can fasten the profile of the magnetic tape to a fixed support and move the sensor;

2. or, on the contrary, you can fasten the sensor to a fixed support and move the profile of the magnetic tape.

It is customer's duty to evaluate the type of installation that is most suitable for his application. Anyway both the sensor and the profile (according to your choice) must be able to slide freely and accomplish a smooth linear travel.



Figure 2

### 3.3 Sensor (Figure 2)

The sensor can be secured:

1. to a sliding carriage;
2. to an actuator;
3. to a mobile support;
4. or to a fixed support.

Use **four TCEI M4 UNI 5931 type cylinder head screws** inserted from the top in the holes provided at the four angles of the enclosure. The screws must be 30 mm min. long (see Figure 1). **The maximum tightening torque is 1.2 Nm.** We suggest adding a few drops of threadlocker of medium bond strength.

The fixing support will be placed at the bottom of the sensor case. Make sure the cable does not block or hamper the movement of the sensor.

### 3.4 Profile of the magnetic tape (Figure 2)

It is mandatory to pair the sensor with the **MTAG type magnetic tape**.

The profile of the magnetic tape can be secured:

1. to a sliding device driven manually, pneumatically or by a motor; in this first case the tape will move back and forth while the sensor will be mounted in a fixed position;
2. or to a fixed support: in this case, the tape will be mounted in a fixed position while the sensor will move back and forth.

The profile must be installed so that the active magnetic surface (black side) is turned towards the active surface of the sensor (electronic card).

Use **one TSP M4 UNI 7688 type countersunk head screw** to secure the profile of the magnetic tape; insert the screw in the hole provided at one end of the profile. The screw is 10 mm min. long. **The maximum tightening torque is 2.5 Nm.**

The length of the profile ranges between 195 mm / 7.677" and 650 mm / 25.59".



#### WARNING

Do not expose the sensor and the magnetic tape to magnetic fields. Avoid any possible interference of the unit with magnetic fields.



#### WARNING

After having installed the sensor on the magnetic tape a zero setting operation is compulsorily required. The zero setting operation is further required every time either the sensor or the tape is replaced. For any information on the zero setting operation please refer to the "4.1.5 Zero setting input" section on page 13.

### 3.5 Measuring length (Figure 1)

The **maximum tape length L** is between 195 mm / 7.677" and 650 mm / 25.59" (for further information refer the order code in the product datasheet). As the sensor area has always to be fully within the limits of the tape magnetic surface, then the **maximum measuring length ML** is the maximum tape length minus the sensor length (see the Figure 1) =  $L - 80 \text{ mm} / 3.149" (115 \text{ mm} / 4.528" \div 570 \text{ mm} / 22.441")$ .

### 3.6 Standard counting direction (Figure 2)

The positive counting direction (count up information) is achieved when the sensor moves on the tape according to the white arrow shown in Figure 2; or, on the contrary, when the tape moves according to the black arrow shown in Figure 2. For further information see the "4.1.6 Counting direction input" section on page 14.

4 – SSI interface

4.1 Electrical connections



**WARNING**

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

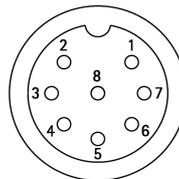
Function	M8 cable	M12 8-pin
0Vdc	Black	1
+10Vdc +30Vdc	Red	2
Clock IN +	Yellow	3
Clock IN -	Blue	4
Data OUT +	Green	5
Data OUT -	Orange	6
Zero setting	White	7
Counting direction	Grey	8
Shielding	Shield	Case

4.1.1 M8 cable specifications

- Model : LIKA HI-FLEX sensor cable type M8
- Wires : 2 x 0.22 mm<sup>2</sup> + 6 x 0.14 mm<sup>2</sup> (24/26 AWG)
- Jacket : Matt Polyurethane (TPU) halogen free, oil, hydrolysis, abrasion resistant
- Screening : tinned copper braid, coverage ≥ 85%
- Outer diameter : 5.3 mm ÷ 5.6 mm (0.209" ± 0.220")
- Min. bending 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

4.1.2 M12 8-pin connector specifications

Male  
Frontal side  
A coding



**4.1.3 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.

**4.1.4 Ground connection**

Minimize noise by connecting the shield or the connector housing 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.

**4.1.5 Zero setting input**

The output value can be set to zero (reset) via an external signal issued by a PLC or other controller device. When the internal microprocessor receives the signal it resets the output information. This can be very useful for setting the zero position of both the sensor and the machine. To zero set the encoder position, connect Zero setting input to +Vdc for 100 μs at least, then disconnect +Vdc; normally voltage must be at 0Vdc; zero set must be performed after Counting direction setting; we suggest performing the zero set when the encoder is in stop. Connect to 0Vdc if not used.



**WARNING**

It is necessary to zero set the sensor after having set a new counting direction.



**WARNING**

After having installed the sensor on the magnetic tape a zero setting operation is compulsorily required. The zero setting operation is further required every time either the sensor or the tape is replaced.



**NOTE**

Please note that, after setting the zero point, the positive counting will be from 0 towards the max. value (see the table below); if you move the axis before the 0 point, the detected value will be the max. number of information - 1 down.



**EXAMPLE**

Let's suppose we are using the SMAG-GA-5-... model, it is paired with the MTAG-650-... profile. If you set the 0 along the path, starting from the 0 point, the output values will be from 0 towards the max. value (114,000, see the table below) when the measuring system moves according to the arrows shown in Figure 2; when the system moves back, the value immediately after 0 will be the max. number of information - 1 (131,071).

...	131.070	131.071	0	1	2	...	114.000
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Model	Max. value	Max. number of information
SMAG-GA-100-... + MTAG-650	5,700	8,192 (13 bits)
SMAG-GA-100-... + MTAG-370	2,900	4,096 (12 bits)
SMAG-GA-100-... + MTAG-300	2,200	4,096 (12 bits)
SMAG-GA-100-... + MTAG-240	1,600	2,048 (11 bits)
SMAG-GA-100-... + MTAG-220	1,400	2,048 (11 bits)
SMAG-GA-100-... + MTAG-192	1,150	2,048 (11 bits)
SMAG-GA-50-... + MTAG-650	11,400	16,384 (14 bits)
SMAG-GA-50-... + MTAG-370	5,800	8,192 (13 bits)
SMAG-GA-50-... + MTAG-300	4,400	8,192 (13 bits)
SMAG-GA-50-... + MTAG-240	3,200	4,096 (12 bits)
SMAG-GA-50-... + MTAG-220	2,800	4,096 (12 bits)
SMAG-GA-50-... + MTAG-192	2,300	4,096 (12 bits)
SMAG-GA-10-... + MTAG-650	57,000	65,536 (16 bits)
SMAG-GA-10-... + MTAG-370	29,000	32,768 (15 bits)
SMAG-GA-10-... + MTAG-300	22,000	32,768 (15 bits)
SMAG-GA-10-... + MTAG-240	16,000	16,384 (14 bits)
SMAG-GA-10-... + MTAG-220	14,000	16,384 (14 bits)
SMAG-GA-10-... + MTAG-192	11,500	16,384 (14 bits)
SMAG-GA-5-... + MTAG-650	114,000	131,072 (17 bits)
SMAG-GA-5-... + MTAG-370	58,000	65,536 (16 bits)
SMAG-GA-5-... + MTAG-300	44,000	65,536 (16 bits)
SMAG-GA-5-... + MTAG-240	32,000	32,768 (15 bits)
SMAG-GA-5-... + MTAG-220	28,000	32,768 (15 bits)
SMAG-GA-5-... + MTAG-192	23,000	32,768 (15 bits)

#### 4.1.6 Counting direction input

The **standard counting direction** is to be intended with sensor moving according to the white arrow in Figure 2; or with magnetic profile moving according to the black arrow in Figure 2. The counting direction circuit allows to reverse the counting direction. In other words it allows the count up when the sensor (or the profile) moves in reverse of the standard direction, i.e. in the direction opposite to the movement shown by the arrows in Figure 2. Connect

the Counting direction input to 0Vdc if not used. Connect the counting direction input to 0Vdc to have the count up information when the sensor moves as shown by the white arrow in Figure 2 (or when the profile moves as shown by the black arrow in Figure 2); connect the counting direction input to +Vdc to have the count up information when the sensor moves in reverse of the standard direction, i.e. in the direction opposite to the movement shown by the white arrow in Figure 2 (or when the profile moves in reverse of the standard direction, i.e. in the direction opposite to the movement shown by the black arrow in Figure 2).



#### WARNING

After having set the new counting direction it is necessary to zero set the sensor.

### 4.2 SSI (Synchronous Serial Interface)



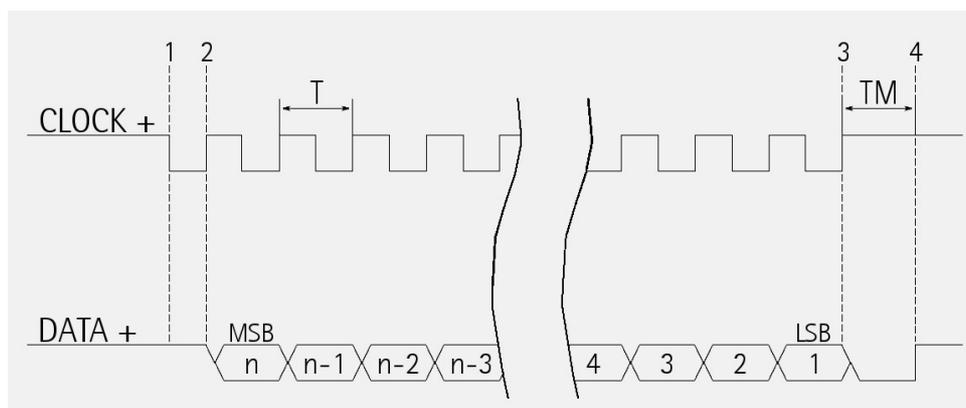
SSI (the acronym for **Synchronous Serial Interface**) is a synchronous point-to-point serial interface engineered for unidirectional data transmission between one Master and one Slave. Developed in the first eighties, it is based on the RS-422 serial standard. Its most peculiar feature is that data 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 insulating 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  $T_m$  monoflop time, having a typical duration of 16  $\mu$ sec, 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.

### 4.3 LSB Right Aligned protocol

"LSB right aligned" protocol allows to right align the bits, beginning from MSB (most significant bit) to LSB (least significant bit); LSB is then sent at the last clock cycle. Transmitted bits are always 25, the sensor uses a variable number of bits according to resolution. Unused bits are set to 0 (zero) and lead the data word:

Model	Information per mm	Resolution	Length of the word	Max. number of information
SMAG-GA-100-...	10	0.1 mm	25 bits	13 bits (8,192)
SMAG-GA-50-...	20	0.05 mm	25 bits	14 bits (16,384)
SMAG-GA-10-...	100	0.01 mm	25 bits	16 bits (65,536)
SMAG-GA-5-...	200	0.005 mm	25 bits	17 bits (131,072)

\* When the profile is 650 mm / 25.59" long

See also the table on page 14

The output code is GRAY.

The measuring step is equal to the resolution (0.1 mm ... 0.005 mm).

Structure of the transmitted position value:

SMAG-GA-100-...	bits	25 ... 14	13	...	1
SMAG-GA-50-...	bits	25 ... 15	14	...	1
SMAG-GA-10-...	bits	25 ... 17	16	...	1
SMAG-GA-5-...	bits	25 ... 18	17	...	1
	value	00 ... 00	MSB	...	LSB

\* When the profile is 650 mm / 25.59" long

See also the table on page 14



**WARNING**

Please note that the position value issued by the sensor is expressed in pulses; thus you have then to convert the number of pulses into a linear measuring unit.

To convert the position value into millimetres (mm) or micrometres (µm) you have to multiply the pulses by the linear resolution of the encoder expressed in millimetres or micrometres.



**EXAMPLE 1**

SMAG-GA-50-...

resolution = 50 µm = 0.05 mm

detected pulses = 123

position value = 123 \* 50 = 6150 µm = 6.15 mm



**EXAMPLE 2**

SMAG-GA-10-...

resolution = 10 µm = 0.01 mm

detected pulses = 1569

position value = 1569 \* 10 = 15690 µm = 15.69 mm

#### 4.4 Recommended transmission rates

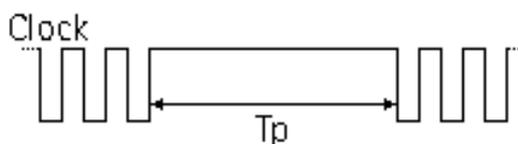
The SSI interface has a frequency of data transmission ranging between 100 kHz and 1.5 MHz.

The CLOCK signals and the DATA signals are transmitted according to the "EIA RS-422" standard.

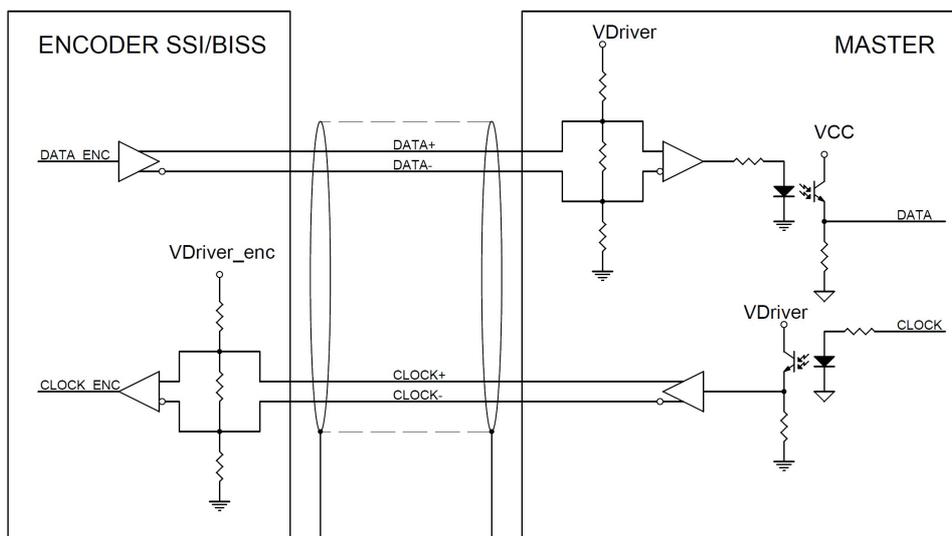
The clock frequency (baud rate) depends on the length of the cables and must comply with the technical information reported in the following table.

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 consecutive Clock sequence transmissions must be at least 30  $\mu$ s ( $T_p$  = pause time > 30  $\mu$ s).



#### 4.5 Recommended SSI circuit



## 5 - Maintenance

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

- periodically check the soundness of the structure and make sure that there are no loose screws; tighten them if necessary;
- the surface of the magnetic tape has to be cleaned regularly using a soft and clean cloth to remove dust, chips, moisture etc.

Document release	Release date	Description	HW	SW	Installation file version
1.0	15.09.2011	First issue	-	-	-
1.1	11.01.2012	General review, English translation	-	-	-
1.2	18.05.2015	General review, "3 - Mechanical installation" section updated	-	-	-
1.3	24.01.2017	General review, Italian and English versions separated, mounting instructions updated			



Dispose separately

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