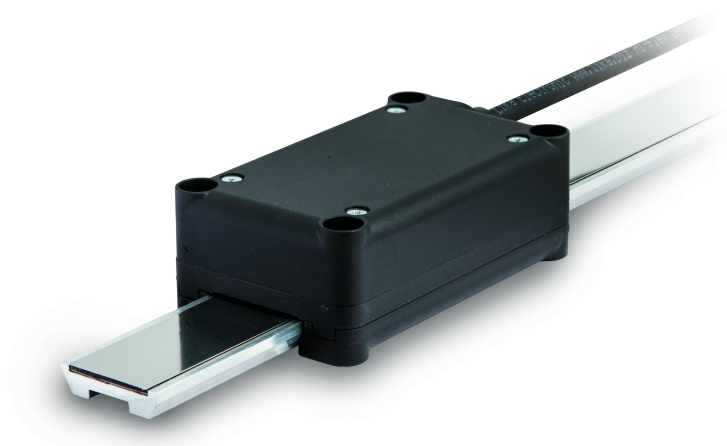


SMAG + MTAG-A301



- SMAG absolute linear encoder
- MTAG-A301 guided profile, insensitive to 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 -GA2-0100-...
- SMAG -GA2-0050-...
- SMAG -GA2-0010-...
- SMAG -GA2-0005-...

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The logo for Lika Electronic s.r.l. features the word "lika" in a bold, lowercase, sans-serif typeface. The letters are black and have a modern, clean appearance.

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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, you will find some icons on the side of the page. These icons are expressly designed to highlight the sections of the text that are of great interest and importance to the user. Sometimes, they serve as warnings about dangers or potential hazards associated with using the device. It is strongly advised to follow the instructions in this guide carefully to ensure user safety and optimal device performance. The following symbols are used in this guide:

	This icon, followed by the word WARNING , is used to highlight sections of the text containing information of critical importance to the user. The user must pay close attention to these section! Instructions must be followed strictly to ensure the user's safety and the proper operation of the device. Failure to heed a warning or comply with instructions may result in personal injury and/or damage to the unit or other equipment.
	This icon, followed by the word NOTE , is used to highlight sections of the text containing important information necessary for the correct and reliable use of the device. Users must pay close attention to these notes! Failure to follow the instructions may result in incorrect device settings, leading to malfunction or improper operation.
	This icon highlights sections of the text containing suggestions to simplify device setup and enhance performance and reliability. Sometimes, this symbol is followed by the word EXAMPLE when parameter-setting instructions are accompanied by examples to clarify the explanation.

Preliminary information

This guide is designed to describe the technical characteristics, installation, and use for the linear encoders with guided profile of the **SMAG series equipped with SSI interface**.

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 while the sensor is kept fixed). Therefore, 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-A301 magnetic tape**. The measuring length is from 115 mm (4.528") to 570 mm (22.441"), see the order code.

For detailed technical specifications, please [refer to the product datasheet](#).

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

In the first section (from chapter 1 to chapter 3), 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-A301 are provided.

In the second section, entitled **SSI Interface** (chapter 4), both general and specific information is given on the SSI interface. In this section, the interface features are fully described.



CAUTION

Keep magnets away from the measuring system, it could be damaged by strong magnetic fields.

1 – Safety summary



1.1 Safety

- Always adhere to the professional safety and accident prevention regulations applicable in your country during device installation and operation.
- Installation and maintenance operations must be carried out only by qualified personnel, with power supply disconnected and mechanical parts stationary.
- The device must be used only for the purpose for which it was designed: using it for any other purposes could result in serious personal injury and/or environment damage.
- High current, voltage, and moving mechanical parts can cause serious or fatal injuries.
- Warning ! Do not use in explosive or flammable areas.
- Failure to comply with these precautions or with specific warnings elsewhere in this manual violates the safety standards of design, manufacture, and intended use of the equipment.
- Lika Electronic accepts 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 it in accordance with the instructions in the "4.1 Electrical connections" section on page 12.
- Connect the Zero Setting input to 0Vdc, if not used; to zero set the encoder, connect the Zero setting input to +Vdc for at least 100 μ s, 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 the 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 the input 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 the input to +Vdc.
- In compliance with the 2014/30/EU directive on electromagnetic compatibility, the following precautions must be taken:
 - Before handling and installing the equipment, discharge any electrical charge from your body and tools that may come into contact with the device.
 - The power supply must be stable and free from noise. Install EMC filters on device's power supply if necessary.
 - Always use shielded cables, preferably 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 necessary.



- To ensure the device functions correctly, avoid using strong magnets on or near the unit.
- Minimize noise by connecting the cable shield or the connector housing to ground. Ensure that ground connection is not affected by noise. The grounding point can be located both on the device side and on user's side. The user should determine the best solution to minimize the interference. Provide the ground connection as close to the unit as possible.
- Do not stretch the cable. Do not pull or carry the encoder by the cable. Do not use the cable as a handle.



1.3 Mechanical safety

- Install the device strictly in accordance with the instructions in the "3 – Mechanical installation" section on page 9.
- Mechanical installation must be carried out with power supply disconnected and mechanical parts stationary.
- 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 specified by the manufacturer.
- We recommend installing the unit providing protective measures against waste, particularly swarf, such as turnings, chips, or filings. If this is not feasible, please ensure that adequate cleaning methods (for example, brushes, scrapers, jets of compressed air, etc.) are implemented to prevent the sensor and the magnetic scale from becoming jammed.



CAUTION

Keep magnets away from the measuring system, it could be damaged by strong magnetic fields.

2 - Identification

The device can be identified by the **order code** and the **serial number** printed on the label attached to its housing. This information is listed also in the delivery document. Please always provide the order code and the serial number when contacting Lika Electronic for purchasing spare parts or requesting assistance. For detailed information on the product's technical characteristics, refer to the technical catalogue.



Warning: devices with order code ending in "/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 only by qualified personnel, with power supply disconnected and mechanical parts compulsorily in stop.

3.1 Overall dimensions (Figure 1)

(values are expressed in mm)

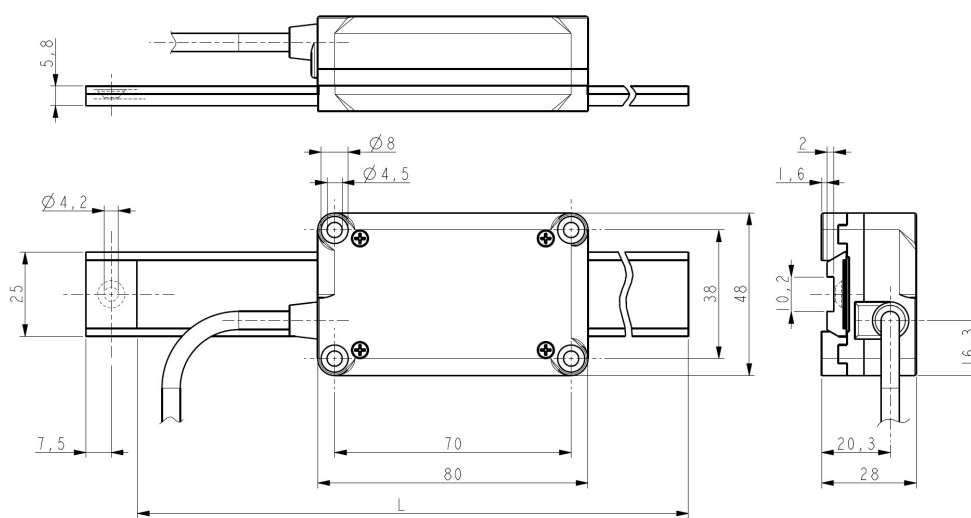


Figure 1

$L = 195 \text{ mm} / 7.677" \div 650 \text{ mm} / 25.59"$ (see the order code of the MTAG-A301 profile)

3.2 Mounting instructions

Install and use the product complying with the protection level for which it was designed.

Protect the unit against knocks, frictions, and solvents and avoid temperatures over the specified range.

Ensure 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 (for example, brushes, scrapers, jets of compressed air, etc.) to prevent the sensor and the magnetic tape from becoming jammed.

The profile of the magnetic tape must be inserted in the track at the bottom of the sensor's housing; the shape of the track is univocal and prevents mounting errors.

Two mounting options are possible:

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

It is the customer's responsibility to assess the type of installation most suitable for their application. In any case, both the sensor and the profile (according to your choice) must be able to slide freely and ensure smooth movement.



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. To any 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 housing. The screws must be 30 mm minimum 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 must be positioned at the base of the sensor case. Ensure that the cable does not obstruct or impede the sensor's movement.

3.4 Profile of the magnetic tape (Figure 2)

It is mandatory to pair the sensor with the **MTAG-A301 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. 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 with the active magnetic surface (black side) facing 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 must be 10 mm minimum 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 installing the sensor on the magnetic tape, a zero setting operation is required. The zero setting operation is also 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 length L of the tape** 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's magnetic surface, the **maximum measuring length ML** is the maximum length of the tape minus the length of the sensor (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 only by qualified personnel, with power supply disconnected and mechanical parts compulsorily in stop.

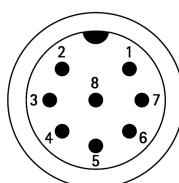
Function	M8 cable	M12 8-pin
0Vdc	Black	1
+10Vdc +30Vdc	Red	2
Clock IN +	Yellow	3
Clock IN -	Blue	4
Data OUT +	Green	5
Data OUT -	Orange	6
Zero setting	White	7
Counting direction	Grey	8
Shielding	Shield	Case

4.1.1 M8 cable specifications

Model:	LIKA HI-FLEX sensor cable type M8
Cross section:	2 x 0.25 mm ² + 6 x 0.14 mm ² (24/26 AWG)
Jacket:	PUR, ether base, halogen free, oil, hydraulic fluid, coolant emulsifier, alkali, and hydrolysis resistant
Shield:	Tinned copper braid, coverage > 85%
Outer diameter:	5.5 mm / 0.216"
Min. bend radius:	Outer diameter x 7.5
Work temperature:	-50°C +90°C / -58°F +194°F, fixed application -40°C +90°C / -40°F +194°F, dynamic application, not for continuous use
Conductor resistance:	<84.7 Ω/Km (0.25 mm ²), <152 Ω/Km (0.14 mm ²)
Speed:	up to 6 m/sec (T° = 20°C)
Acceleration:	up to 10 m/sec ² (T° = 20°C)

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 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. Ensure that ground connection is not affected by noise. The grounding point can be located both on the device side and on the user's side. The user should determine the best solution to minimize the interference. It is recommended to provide the ground connection as close to the device as possible.

4.1.5 Zero setting input

The output value can be set to zero (reset) using an external signal issued by a PLC or another controller device. When the internal microprocessor receives this signal, it resets the position information. This feature is particularly useful for setting the zero position of both the sensor and the machine. If the Zero setting input is not used, connect it to 0Vdc. To zero set the encoder position, connect the input to +Vdc for at least 100 μ s, then disconnect the +Vdc; normally, the voltage should remain at 0Vdc. The zero setting must be performed after configuring the Counting direction. We recommend performing the zero set when the encoder is stationary.



WARNING

You must zero set the sensor after setting a new counting direction.



WARNING

After installing the sensor on the magnetic tape, a zero setting operation is compulsorily required. The zero setting operation is also 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 maximum value (see the table below). If you move the axis before the zero point, the position value will be the maximum number of information – 1 down.



EXAMPLE

Let's suppose we are using the SMAG-GA2-0005-... model. It is paired with the MTAG-A301-...-000650-... profile. If you set the 0 along the path, starting from the 0 point, the output values will be from 0 towards the maximum 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 maximum number of information – 1 (131,071).

...	131.070	131.071	0	1	2	...	114.000
-----	---------	---------	---	---	---	-----	---------

Model	Max. value	Max. number of information
SMAG-GA2-0100-... + MTAG-A301-...-000650	5,700	8,192 (13 bits)
SMAG-GA2-0100-... + MTAG-A301-...-000370	2,900	4,096 (12 bits)
SMAG-GA2-0100-... + MTAG-A301-...-000300	2,200	4,096 (12 bits)
SMAG-GA2-0100-... + MTAG-A301-...-000240	1,600	2,048 (11 bits)
SMAG-GA2-0100-... + MTAG-A301-...-000220	1,400	2,048 (11 bits)
SMAG-GA2-0100-... + MTAG-A301-...-000192	1,150	2,048 (11 bits)

SMAG-GA2-0050-... + MTAG-A301-...-000650	11,400	16,384 (14 bits)
SMAG-GA2-0050-... + MTAG-A301-...-000370	5,800	8,192 (13 bits)
SMAG-GA2-0050-... + MTAG-A301-...-000300	4,400	8,192 (13 bits)
SMAG-GA2-0050-... + MTAG-A301-...-000240	3,200	4,096 (12 bits)
SMAG-GA2-0050-... + MTAG-A301-...-000220	2,800	4,096 (12 bits)
SMAG-GA2-0050-... + MTAG-A301-...-000192	2,300	4,096 (12 bits)

SMAG-GA2-0010-... + MTAG-A301-...-000650	57,000	65,536 (16 bits)
SMAG-GA2-0010-... + MTAG-A301-...-000370	29,000	32,768 (15 bits)
SMAG-GA2-0010-... + MTAG-A301-...-000300	22,000	32,768 (15 bits)
SMAG-GA2-0010-... + MTAG-A301-...-000240	16,000	16,384 (14 bits)
SMAG-GA2-0010-... + MTAG-A301-...-000220	14,000	16,384 (14 bits)
SMAG-GA2-0010-... + MTAG-A301-...-000192	11,500	16,384 (14 bits)

SMAG-GA2-0005-... + MTAG-A301-...-000650	114,000	131,072 (17 bits)
SMAG-GA2-0005-... + MTAG-A301-...-000370	58,000	65,536 (16 bits)
SMAG-GA2-0005-... + MTAG-A301-...-000300	44,000	65,536 (16 bits)
SMAG-GA2-0005-... + MTAG-A301-...-000240	32,000	32,768 (15 bits)
SMAG-GA2-0005-... + MTAG-A301-...-000220	28,000	32,768 (15 bits)
SMAG-GA2-0005-... + MTAG-A301-...-000192	23,000	32,768 (15 bits)

4.1.6 Counting direction input

The **standard counting direction** is to be intended with sensor moving in accordance with the white arrow in Figure 2; or with magnetic profile moving in accordance with the black arrow in Figure 2. The counting direction circuit allows the user to reverse the counting direction. In other words, it enables 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. If the Counting direction input is not used, connect it to 0Vdc. Connect the counting direction input to 0Vdc to get 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 get 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 setting the new counting direction, it is necessary to zero set the sensor.

4.2 SSI (Synchronous Serial Interface)



SSI (an acronym for **Synchronous Serial Interface**) is a synchronous point-to-point serial interface designed for unidirectional data transmission between one Master and one Slave. Developed in the early 1980s, it is based on the RS-422 serial standard. Its most distinctive feature is that data transmission is achieved by synchronising 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 request from the controller. Furthermore, only two pairs of twisted wires are used for data and clock signals, yet a six-wire cable is required.

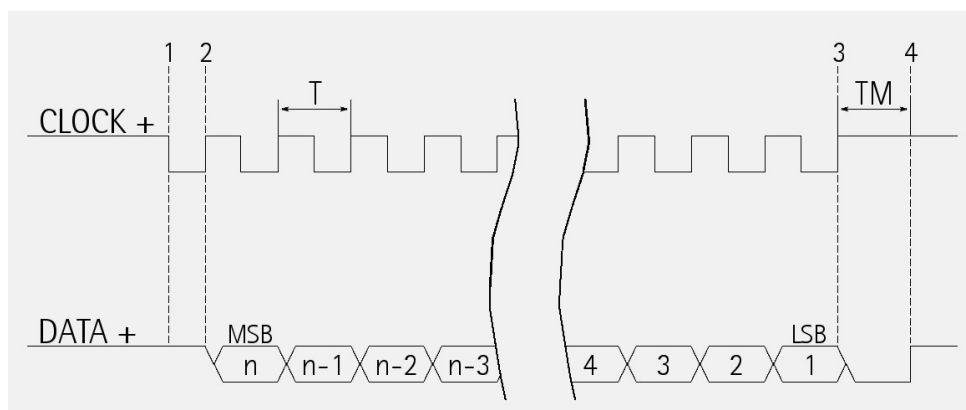
The main advantages compared to parallel or asynchronous data transmissions are:

- Fewer conductors are required for transmission.
- Fewer electronic components.
- Possibility of insulating the circuits galvanically by means of optocouplers.
- High data transmission frequency.
- Hardware interface independent of the resolution of the absolute encoder.

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

Data transmission occurs as follows.

At the first falling edge of the clock signal (**1**, where the logic level changes from high to low), the absolute position value is stored. At the subsequent rising edge (**2**), the transmission of data begins, starting with the most significant bit (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 the least significant bit (LSB), thus 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 signal are required for each data word transmission (where n is the bit resolution); for example, a 13-bit encoder requires 14 clock edges. If the number of clocks exceeds the number of bits in the data word, the system will send a zero (low logic level signal) at each additional clock. These zeros will either lead (LSB ALIGNED protocol), or follow (MSB ALIGNED protocol), or both lead and/or follow (TREE FORMAT protocol) the data word. After the monoflop period T_m , typically lasting 16 μsec and measured from the end of the clock signal transmission, the encoder is then ready for the next transmission, and the data signal is switched high.

The clock signal typically has a logic level of 5V, the same as the output signal, which customarily has a logic level of 5V, in compliance with the RS-422 standard.

4.3 LSB Right Aligned protocol

The "LSB Right Aligned" protocol allows the bits to be right aligned, starting from the most significant bit (MSB) to the least significant bit (LSB); the LSB is then transmitted with the last clock cycle. A total of 25 bits are always transmitted. The sensor uses a variable number of bits depending on the resolution. Unused bits are set to zero and precede the data word.

Model	Information per mm	Resolution	Length of the word	Max. number of information *
SMAG-GA2-0100-...	10	0.1 mm	25 bits	13 bits (8,192)
SMAG-GA2-0050-...	20	0.05 mm	25 bits	14 bits (16,384)
SMAG-GA2-0010-...	100	0.01 mm	25 bits	16 bits (65,536)
SMAG-GA2-0005-...	200	0.005 mm	25 bits	17 bits (131,072)

* When the profile is 650 mm / 25.59 inches long
See also the table on page 14

The output code is the GRAY code.

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

Structure of the transmitted position value:

SMAG-GA2-0100-...	bits	25 ... 14	13	...	1
SMAG-GA2-0050-...	bits	25 ... 15	14	...	1
SMAG-GA2-0010-...	bits	25 ... 17	16	...	1
SMAG-GA2-0005-...	bits	25 ... 18	17	...	1
	value	00 ... 00	MSB *	...	LSB

* When the profile is 650 mm / 25.59 inches long

See also the table on page 14



WARNING

Please note that the position value transmitted by the sensor is expressed in counts. Therefore, you have then to convert the number of counts into a linear measuring unit.

To convert the position value into millimetres (mm) or micrometres (µm), you must multiply the counts by the linear resolution of the encoder, expressed in millimetres or micrometres.



EXAMPLE 1

SMAG-GA2-0050-...

resolution = 50 µm = 0.05 mm

detected counts = 123

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



EXAMPLE 2

SMAG-GA2-0010-...

resolution = 10 µm = 0.01 mm

detected counts = 1569

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

4.4 Recommended transmission rates

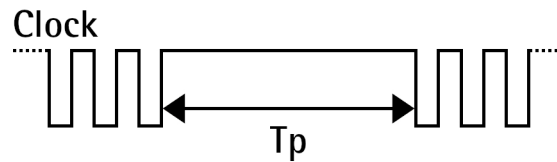
The SSI interface has a frequency of data transmission ranging between 100 kHz and 1.5 MHz.

The CLOCK and DATA signals are transmitted in compliance with the "EIA RS-422" standard.

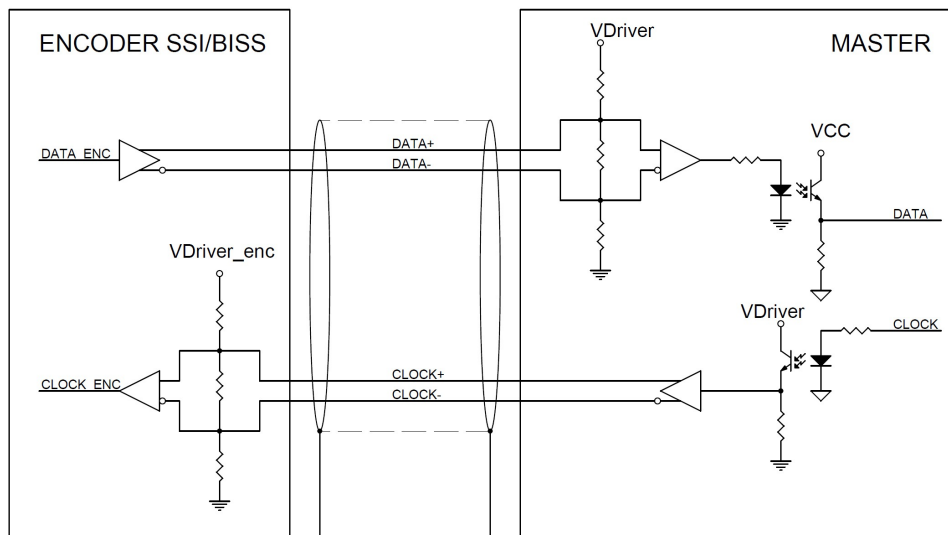
The clock frequency (baud rate) depends on the length of the cables and must comply with the technical information specified in the following table.

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 μ s (T_p = pause time > 30 μ s).



4.5 Recommended SSI circuit



5 - Maintenance

This magnetic measurement system does not require any specific maintenance; however, it must be handled with the utmost care, as it is a delicate electronic equipment. From time to time, we recommend performing the following operations:

- Periodically check the integrity of the structure and ensure that there are no loose screws; tighten them if necessary.
- The surface of the magnetic tape must be cleaned regularly using a soft, clean cloth to remove dust, debris, chips, moisture, and other contaminants.

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	-	-	-
1.4	24.01.2022	Figure 1 updated	-	-	-
1.5	25.08.2026	General review, new order codes	-	-	-



Dispose separately

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