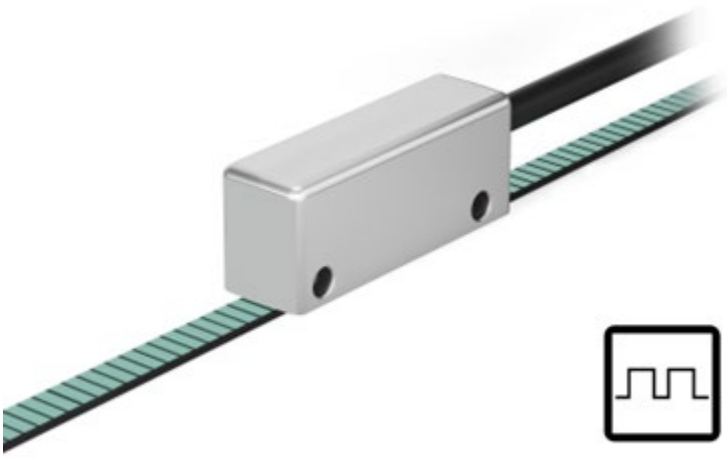
Smart encoders & actuators

User's guide

AME95



- Incremental linear encoder for 5mm pole pitch tapes
- Resolution 10 µm
- Measuring length up to 20m
- IP67 protection rate
- Wide mounting tolerances up to 2.5 mm / 0.098”

Suitable for the following models:

- AME95

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General contents

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 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 **AME95** incremental linear encoders.

The AME95 incremental linear encoders are ideally suited for advanced **motion control needs in linear motors**, servomotors, and various motion control applications with 0.01mm/pulse resolution, and reliable operation even at **fast speeds up to 20 m/s**.
They are compact and rugged, featuring a zinc die-cast housing and an **IP67 protection rating** which enable installation even in harsh industrial environments. The operation is magnetic and contactless, rendering them insensitive to dust, moisture, oil, contaminants, and vibrations.
The reading head can be paired with 10 mm wide ATI magnetic tapes. The tape has alternating magnetic north/south poles that are magnetized at a fixed distance called the pole pitch. The pole pitch is 5 mm for the AME95. The conversion electronics inside the sensor translates the magnetic fields of the tape into electrical signals equivalent to those of a rotary incremental encoder.
These linear encoders can also optionally integrate a sensor for reading the **Reference marks for the homing function**. The reference signal is provided for each pole (the so-called Index signal i.e., every 5 mm for the AME95).
The AME95 encoders offer **AB0 /AB0 quadrature signals** through the **Line Driver RS-422 output** circuit or **Push-Pull output** circuit. The power supply is +5Vdc ±5% and +10Vdc +30Vdc for the AME95 model. They are also equipped with an LED for diagnostic information (position, frequency, and speed error) and a high-flex cable suitable for use in cable drag chains.

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 the power supply before connecting the device;
- connect according to the explanation in the "Electrical connection" section;
- the wires of unused output signals must be cut at different lengths and insulated singularly;
- in compliance with 2014/30/EU norm on electromagnetic compatibility, the 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;
  - system and control cabinet must be connected to the same ground potential;
  - the nominal operating voltage must be observed even if there is a voltage drop along the supply line;
  - 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 cable shield (or the connector housing) and the frame to ground. Make sure that ground is not affected by noise. The connection point to ground can be situated both on the device side and on user's side. The best solution to minimize the interference must be carried out by the user;

• 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 "Mechanical installation" section;
- mechanical installation must 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 fillings; 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.

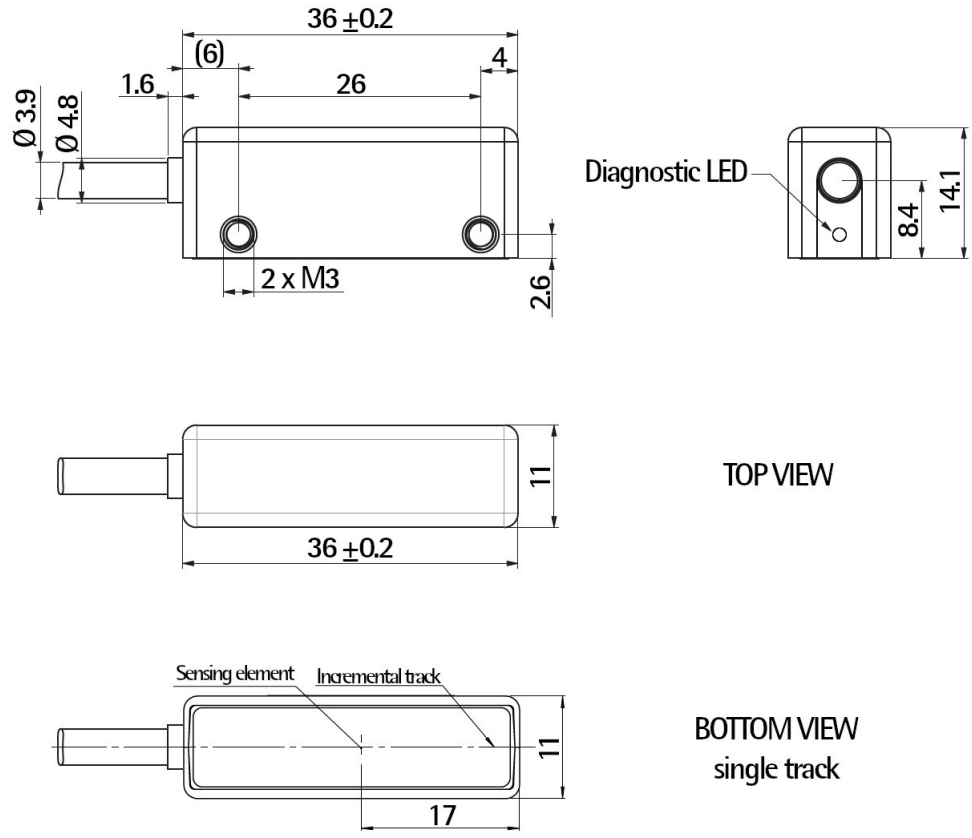
CAUTION
Keep magnets away from the measuring system, it could be damaged by strong magnetic fields.
Use only demagnetized tools for assembly and maintenance.
Improper storage of the magnetic tape rolls can lead to magnetic interaction between the layers and thus to a reduction of the measurement accuracy.

2 Mechanical installation

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

2.1 Overall dimensions

(values are expressed in mm)



2.2 Sensor and scale combination

The sensor has to be compulsorily paired with its specific type of magnetic scale. The AME95 must be paired with the ATI tape.

2.3 Magnetic tape

As stated, each sensor model must be compulsorily paired with its specific type of magnetic scale (see the previous section). For detailed information on the tape and how to mount it properly, please refer to the specific technical documentation.
Make sure that the mechanical installation complies with the system requirements for distance, planarity, and parallelism between the readhead and the scale indicated in Figure 4 all along the entire measuring length.

The ATI magnetic tape is shipped with a cover strip to protect its magnetic surface. The readhead can be mounted in both directions over the tape, see Figure 1 (but you must consider the positive counting direction).

The arrow in Figure 1 indicates the **standard counting direction** (the rising edge of A signal leads the rising edge of B signal) when the sensor moves in the direction indicated by the arrow; further information in the "3.6 Counting direction" section.

2.4 Mounting the sensor

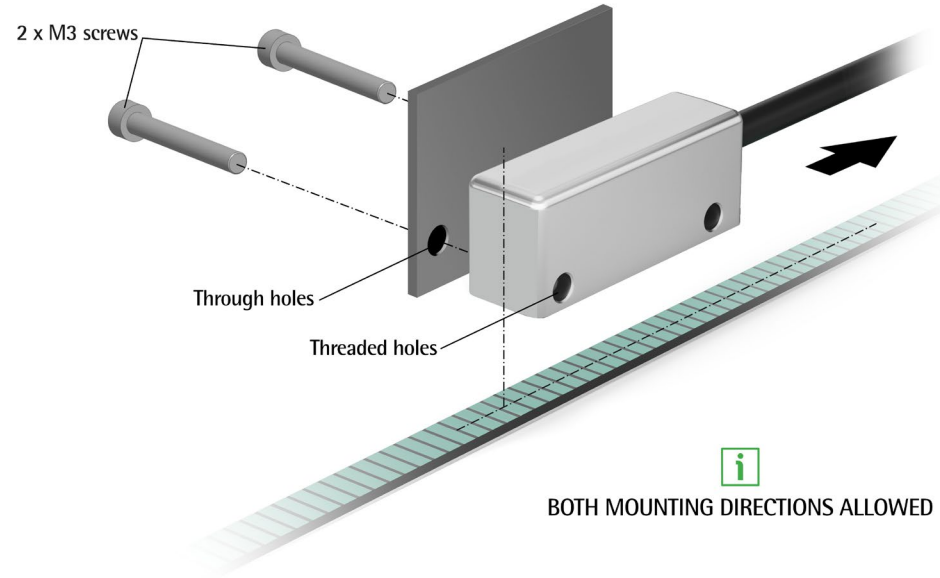


Figure 1 - Mounting the sensor with 10 mm wide single track magnetic tapes

Make sure that the mechanical installation complies with the system requirements concerning distance, planarity, and parallelism between the sensor and the scale as shown in Figure 4. Avoid contact between the parts.
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 scale from jamming.

Fix the sensor by screwing **two M3 screws** into the threaded holes of the reading head.
We recommend the screw to be screwed at least 6 mm into the reading head.
Assuming the mounting support to be 4 mm thick, then the screw will be at least 10 mm long and maximum 15 mm so as not to protrude too much.
Either cylinder head or countersunk head screws can be used.
The recommended tightening torque is **0.4 Nm**.
You must provide through holes for M3 screws (Ø 3.2 … 3.4 mm) in your mounting support.

The recommended **minimum bend radius** of the cable is: **R ≥ 20 mm** (static installation); **R ≥ 40 mm** (dynamic installation).
Install the sensor and the magnetic scale as shown in the Figures. As previously stated, the arrow is intended to indicate the standard counting direction (the rising edge of A signal leads the rising edge of B signal).
Please note that the ATI magnetic scale can be used with the provided cover strip to protect its magnetic surface. Therefore the distance between the sensor and the magnetic scale is different whether the cover strip is applied or not.

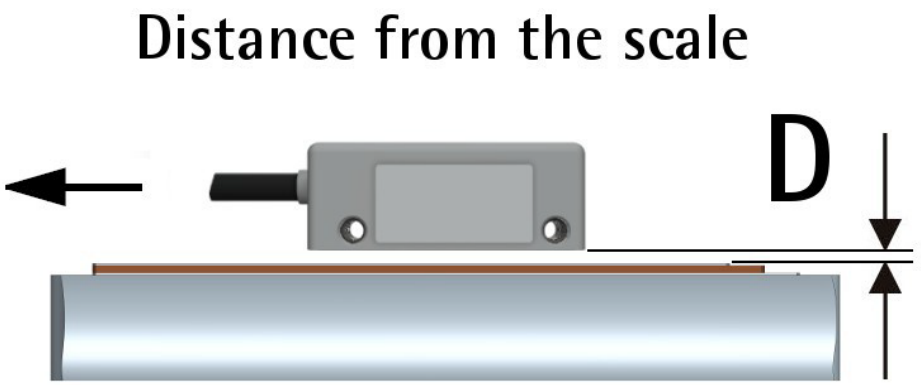


Figure 2 - Distance of the sensor from the magnetic tape

The distance D (see Figure 2) between the bottom of the encoder and the ATI magnetic scale must be as follows:

Sensor	Distance D between sensor and ATI tape	Distance D between sensor and cover strip
AME95	0.1 mm – 2.5 mm 0.004"– 0.098"	0.1 mm – 2.2 mm 0.004" – 0.087"

For better operation we suggest the following distance D:

Sensor	Recommended distance D between sensor and ATI tape
AME95	1.30 mm / 0.051"

WARNING
Make sure that the mechanical installation complies with the system requirements for distance, planarity, and parallelism between the readhead and the scale as shown in Figure 3 all along the entire measuring length.

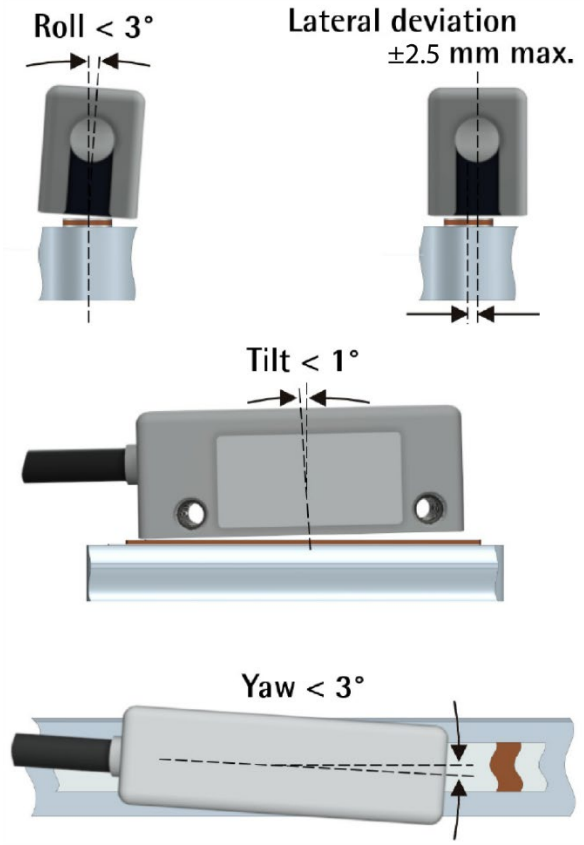


Figure 3 - Encoder / tape mounting tolerances

2.5 Measuring length

The **length of the single-track tape** can be theoretically unlimited. The tape is supplied in rolls up to 20m long.

2.6 Standard counting direction

The positive counting direction (the rising edge of A signal leads the rising edge of B signal) is achieved when the sensor moves on the tape according to the arrow shown in the previous Figures. For further information see the "4.6 Counting direction" section.

3 Electrical connection

WARNING
Electrical connection must 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. Thus they must be cut at different lengths and insulated singularly.

3.1 Cable and connector connections

Function	-L02x Pigtail	M02x M12 8-pin	EC-M12F8-LKM8-xx
0Vdc	Blue	1	Black
+Vdc	Red	2	Red
A	Brown	3	Yellow
/A	Green	4	Blue
B	Grey	5	Green
/B	Yellow	6	Orange
0[1]	Pink	7	White
/0[1]	White	8	Grey
Shielding	Shield	Coupling screw	Shield

EXAMPLE
AME95-L1-... +Vdc = +5Vdc ± 5%
AME95-YC2-... +Vdc = +10Vdc +30Vdc

1 Index "1" (see the "3.7 Index "1"" section) the wires must be cut at different lengths and insulated singularly.

NOTE
All sensors can provide inverted signals.
A = A signal;

/A = inverted A signal (or complementary signal).
All Lika's magnetic sensors can provide AB0, /AB0 output signals. You are advised to always connect the inverted signals if the receiving device will accept them. Otherwise each output should be insulated singularly.

3.2 -L02x Pigtail cable specifications

Model:	22380 – PUR drag chain cable
Cross section:	2 x 0.20 mm^2 + 3 x 2 x 0.055 mm^2 (twisted)
Jacket:	PUR, fleece and aluminium foil wrapped overlaying, surface silk-matt, resistant to acids, alkalis, fuels, coolant liquid, solvents, UV rays
Shield:	Tinned copper braid, coverage > 95%
Outer diameter:	3.9 ±0.10 mm / 0.153" ±0.004"
Min. bend radius:	Outer diameter x 5, fixed application Outer diameter x 10, dynamic application
Work temperature:	-50°C +90°C / -58°F +194°F, fixed application -40°C +90°C / -40°F +194°F, dynamic application
Conductor resistance:	Max. 100 Ω/Km (0.20 mm^2), max. 354 Ω/Km (0.055 mm^2)

The total length of the cable that connects the sensor and the receiving device should not exceed the values stated below as they are specific for each type of output circuit.

We highly recommend the cable lengths reported in the following tables be followed strictly.

Please note that data listed below may vary due to the following factors:

- the supply voltage of the encoder;
- the quality of the cable;
- the electrical noise coming from the ground connection;
- the features of the controller connected to the encoder;
- the ambient temperature.

For the afore-mentioned reasons the recommended cable lengths could be shorter depending on each specific application.

Maximum cable lengths in relation to frequencies:

Output Circuit	Max Cable Length (m / ft)	Max Counting Frequency
YC Push-Pull (AB0, /AB0 signals)	6m / 20ft	2 Mhz
	15m / 50ft	1 Mhz
	60m / 200ft	400 kHz
	120m / 395ft	200 kHz
	180m / 590ft	100 kHz

Output Circuit	Max Cable Length (m / ft)	Max Counting Frequency
L Line Driver (RS422)	10m / 35ft	2 Mhz
	25m / 85ft	1 Mhz
	50m / 165ft	400 kHz
	100m / 330ft	200 kHz
	150m / 495ft	100 kHz

At ambient temperature (23°C)

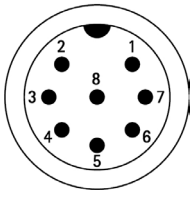
Max. counting frequency = frequency A, B x4

Please note that the higher the resolution and the maximum travel speed of the encoder, the higher the counting frequency.

There is a straight relation between the counting frequency and the signal distortion.

The longer the cable the greater is its capacitance; and the capacitance affects the signal quality causing the higher frequencies to be "filtered" so distorting the signal.

3.3 M12 8-pin connector specifications



Male
Frontal side
A coding

3.4 Ground connection

Always use shielded cables. Connect the cabinet side of the cable shield to protective earth (PE). System and control cabinet must be connected to the same ground potential. The coupling screw of the M12 connector is connected to shield.

3.5 AB0, /AB0 output channels

The sensing head with digital output signals converts the analogue signals into quadrature signals (A/B pulses) and transmits them to the controller. The two digital square wave signals A and B are electrically phase shifted by 90° ±10°.
The sign of the phase shift indicates the direction of movement of the sensing head. Every change of A or B (rise to fall or vice versa) is a count for the increment counter (up/down counter). If the signal A is in advance, then the counter increments. If the signal B is in advance, then the counter decrements. Thus the controller always knows the position of the sensing head without having to query the sensor periodically (real-time capability).
The length of the signal 0 is 90° ±10° electrical.

NOTE
To ensure proper function, the A and B signals have to be evaluated depending on their direction.

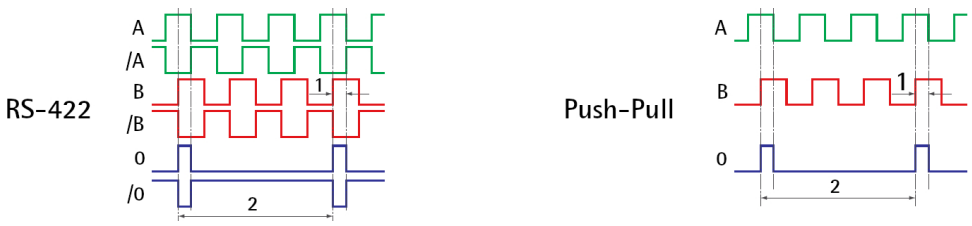


Figure 4 - Output signals scheme

1 Phase shift of A and B signals = 90° ±10° electrical
2 Signal period depending on the Reference track pattern or as a periodic Index according to the pole pitch

If you need to know the interpolation factor, then you have to divide the pole pitch value by the resolution indicated in the order code.

EXAMPLE
Let's suppose we are using the AME95-xxx-**010**-... linear encoder paired with the ATI-0500 magnetic scale; as the pole pitch is 5 mm / 0.1968" long and the resolution is 10 µm = 0.01 mm, this means that the interpolation factor is x500 (5 mm / 0.01 mm).

WARNING
The position value issued by the sensor is expressed in pulses; to convert the pulses into a metric measuring unit you must multiply the number of detected pulses by the resolution expressed in millimetres or micrometres.

EXAMPLE
AME95-xxx-**0010**-...
resolution = 10 µm = 0.01 mm
detected pulses = 71
position value = 71 * 10 = 710 µm = 0.71 mm

NOTE
The **standard counting direction** (the channel A leads the channel B) is to be intended with sensor moving as shown in Figure 2.

3.6 Counting direction

By default the phase relationship between A and B channels is so that the rising edge of A channel leads the rising edge of B channel when the encoder moves in the direction shown by the arrow in Figure 2 (see the "3.5 AB0, /AB0 output channels" section). Thus the counter in the subsequent electronics will get a count up. It cannot be changed.

3.7 Index "I"

Index signals (0, /0) are available with the AME95 encoder read-heads. As shown in Figure 4, the periodic Index pulse is synchronised with A and B channels and is provided once per pole. It is always sent at the same position inside the pole, thus the distance between two index pulses is the pole pitch. It has a duration of 90° ±10° electrical and an amplitude according to the power supply voltage level.

3.8 Diagnostic LED (Figure 5)

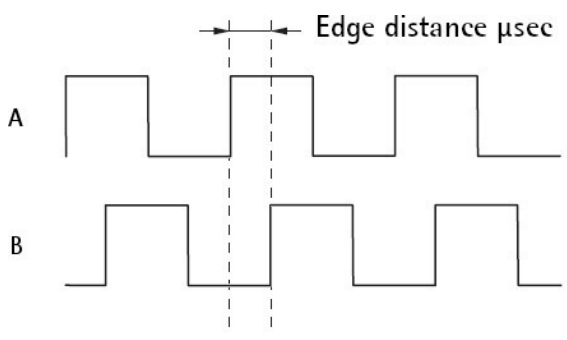
One LED is located on the back side of the encoder enclosure, under the cable, and is intended to show visually the work status of the device and the type of error, should one be active, as explained in the following table.

Figure 5 - Diagnostic LED

LED GREEN (power supply and operation)	Description
OFF	The encoder is off, the power is not supplied.
ON low Green	The encoder is supplied and running properly, the strength of the magnetic field is adequate. No error is active.
ON bright Green	The encoder is supplied and running properly, the strength of the magnetic field is optimal. No error is active.

LED RED (error active)	Description
Flashing Red	It warns of the presence of an error. The number of red flashes of the LED indicates the type of fault, according to following list. Flashes start after a blinking sequence.
1 red flash	The strength of the magnetic field is too high.
2 red flashes	The strength of the magnetic field is too low.
3 red flashes	The range of the magnetic fluctuation is too large.
4 red flashes	The output frequency is too high.
5 red flashes	The movement speed is too high.
6 red flashes	The movement speed is too much high (latched).
7, 8 red flashes	The movement speed is too high for internal signal processing with the current programming (latched).
9, 10, 11 red flashes	Internal error 9, 10, 11 (latched).

3.9 Edge distance



The edge distance feature can be defined as the **minimum spacing time** between two following signal edges at output. The value is 2 µsec and refers to all edges.

When choosing the resolution of the encoder and its related minimum edge distance, consider attentively also both the travel speed of your application and the max. frequency that the subsequent electronics is able to evaluate.
Unexpected situations with high travel speed to be considered are:

- micro-vibrations;
- heavy accelerations and decelerations.

Signals will be output at the highest speed when the sensor comes to a standstill exactly on a graduation mark, resulting in a frequent change of the output signal by +/- 1 increment.

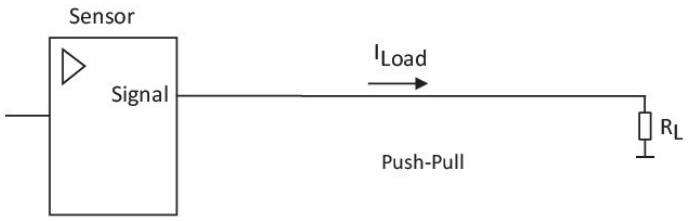
Please note that the minimum edge distance value is in relation with the max. speed value. For slower speeds the effective edge distance is necessarily greater.

Also the **max. mechanical travel speed** indicated in the datasheet has always to be considered attentively. It attests a mechanical permissible limit of the unit.

Edge distance (µsec)	2
Max. counting frequency (kHz)	500
Resolution (µm) at 20 (m/s)	10

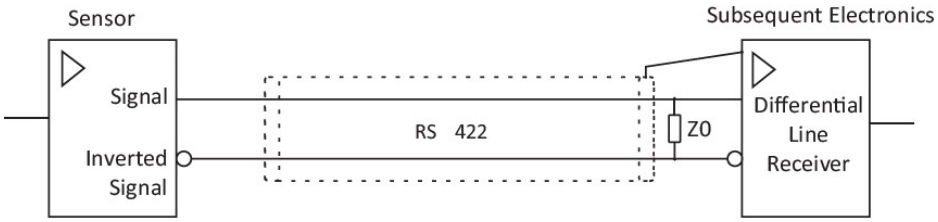
3.10 Recommended output circuit

Push-Pull (YC order code)



Maximum 50 mA per channel when the supply voltage is either +5Vdc or +24Vdc

Line Driver (L order code)



Load resistor Z0 = 120 Ω at receiving end

4 Maintenance and troubleshooting

The magnetic measurement system does not need any particular maintenance; please always consider it is a delicate electronic equipment and therefore it must be handled with care. From time to time we recommend the following operations:

- Check the mounting tolerances between the sensor and the magnetic scale all along the measuring length. Wear of the machine may increase the tolerances.
- The surface of the magnetic scale must be cleaned periodically using a soft cloth to remove dust, chips, moisture etc.

The following list shows some typical faults and errors that may occur during installation and operation of the magnetic measurement system. Refer also to the "3.9 Diagnostic LED (Figure 5)" section.

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

Possible cause:

- The scale or the sensor has been mounted incorrectly (the active part of the scale does not match the active side of the sensor). Check the mounting directions of both the sensing head and the magnetic tape.
- The gap between the sensing head and the magnetic tape is too large or too small. Adjust the mechanical position of the sensing head over the magnetic tape.
- A magnetic piece or an inappropriate strip is in between the sensor and the scale. Only non-magnetic materials are allowed between the sensor and the scale.
- The sensor touches the scale: the mounting tolerances are not met. Adjust the mechanical position of the sensing head over the magnetic tape. Check if the active side of the sensor is damaged.
- The required voltage supply is not provided. Check if the power supply is present and the sensing head is connected properly.
- The voltage is too low or too high. Provide the required operating voltage.
- The cables are not connected properly. Check the connections for compliance with the circuit diagram.
- The sensor has been damaged by a short circuit or a wrong connection. You must replace the sensing head.
- An internal error of the conversion electronics has occurred (interpolator). You could be required to replace the sensing head.

Fault:
The measured values are inaccurate.

Possible cause:

- The mounting tolerances between the sensor and the scale are not met all along the whole measurement length. Adjust the mechanical position of the sensing head over the magnetic tape.
- The connection cable runs near to high voltage cables or the shield is not connected correctly. See the "4 -Electrical connection" section.
- The presence of external noise may cause malfunctioning or a decrease in the quality of the signals. Use shielded cables, ensure proper connections and contacts.
- The max. counting frequency of your receiving device is too low.
- A section of the magnetic scale has been damaged mechanically or magnetically along the measuring length. The magnetic poles of the magnetic tape are damaged in some places.
- The measuring error is caused by torsion of the machine structure. Check parallelism and symmetry of machine movement.

Fault:
The position signal is very noisy.

Possible cause:

- Contacts are poorly shielded. Use shielded cables, ensure proper connections and contacts.

Fault:
The linearity deviation is out of tolerance.

Possible cause:

- The sensing head does not move parallel to the magnetic tape. The gap between the sensing head and the magnetic tape is too large. Adjust the mechanical position of the sensing head over the magnetic tape.
- Thermally induced length variations happen (related to 20°C). Provide electronic temperature compensation in the electronic evaluation unit.

NOTE
If an error occurs switch off and then on again the encoder and check whether the problem is cleared up and the LED turns ON solidly green.

Dispose separately