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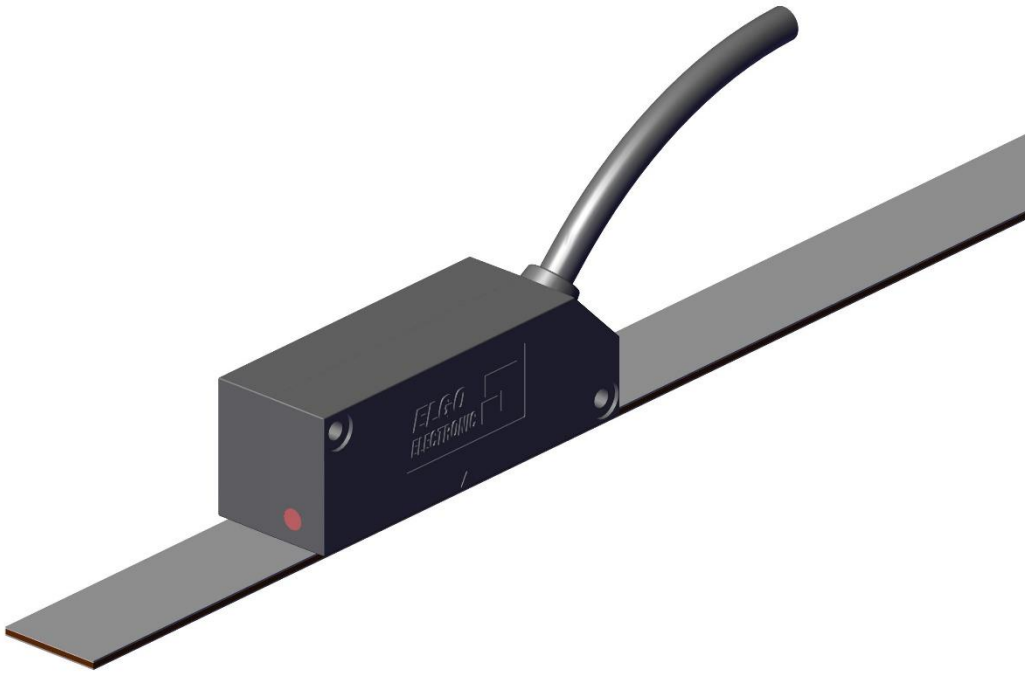
ELGO ELECTRONIC

Operating Manual

SERIES *EMAX*

Magnetic Absolute Linear Encoder with 10 µm resolution



- Absolute encoder with 10 µm resolution
- No referencing required (changes of position are also recognized in the de-energized state)
- Wear free and contactless measurement
- Measuring length up to 10 m
- Too large distances between sensor and magnetic tape are automatically detected and signalized by an LED
- Interface: RS485

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4 General, Safety, Transport and Storage

4.1 Information Operating Manual

This manual contains important information regarding the handling of the device. For your own safety and operational safety, please observe all safety warnings and instructions. Precondition for safe operation is the compliance with the specified safety and handling instructions. Moreover, the existing local accident prevention regulations and the general safety rules at the site of operation have to be observed. Please read the operating manual carefully before starting to work with the device! It is part of the product and should be kept close to the device and accessible for the staff at any time. The illustrations in the manual are for better demonstration of the facts. They are not necessarily to scale and can slightly differ from the actual design.

4.2 Explanation of Symbols

Special notes in this manual are characterized by symbols. The notes are introduced by signal words which express the magnitude of danger. Please follow this advice and act carefully in order to avoid accidents, damage, and injuries.

Warning notes:

	DANGER! This symbol in connection with the signal word "Danger" indicates an immediate danger for the life and health of persons. Failure to heed these instructions can result in serious damage to health and even fatal injury.
	WARNING! This symbol in connection with the word „Warning" means a possibly impending danger for the life and health of persons. Failure to heed these instructions can result in serious damage to health and even fatal injury.
	CAUTION! This symbol in connection with the signal word "Caution" indicates a possibly dangerous situation. Failure to heed these instructions can lead to minor injuries or damage of property.

Special safety instructions:

	DANGER! This symbol in connection with the signal word "Danger" indicates an immediate danger for the life and health of persons due to voltage. Failure to heed these instructions can result in serious damage to health and even fatal injury. The operations may only be carried out by a professional electrician.

Tips and recommendations:

	NOTE! …points out useful tips and recommendations as well as information for an efficient and trouble-free operation.

Reference marks:

☞ Marks a reference to another chapter of this manual.
🕮 Marks a reference to another chapter of another document.

4.3 Statement of Warranties

The producer guarantees the functional capability of the process engineering and the selected parameters.

4.4 Demounting and Disposal

Unless acceptance and disposal of returned goods are agreed upon, demount the device considering the safety instructions of this manual and dispose it with respect to the environment.
Before demounting, disconnect the power supply and secure against re-start. Then disconnect the supply lines physically and discharge remaining energy. Remove operational supplies and other material.
Disposal:
Recycle the decomposed elements: Metal components in scrap metal, Electronic components in electronic scrap, Recycle plastic components, dispose the remaining components according to their material consistence.

	CAUTION! Wrong disposal causes environmental damages! Electronic scrap, electronic components, lubricants and other auxiliary materials are subject to special refuse and can only be disposed by authorized specialists!

Local authorities and waste management facilities provide information about environmentally sound disposal.

Safety

	CAUTION! Please read the operating manual carefully, before using the device! Observe the installation instructions! Only start up the device if you have understood the operating manual. The operating company is obliged to take appropriate safety measure. The initial operation may only be performed by qualified and trained staff. Selection and installation of the devices as well as their embedding into the controlling system require qualified knowledge of the applicable laws and normative requirements on the part of the machine manufacturer.

4.5 General Causes of Risk

This chapter gives an overview of all important safety aspects to guarantee an optimal protection of employees and a safe and trouble-free operation. Non-observance of the instructions mentioned in this operating manual can result in hazardous situations.

4.6 Personal Protective Equipment

Employees have to wear protective clothing during the installation of the device to minimize danger of health.
Therefore: Change into protective clothing before performing the works and wear them throughout the process.
Additionally observe the labels regarding protective clothing in the operating area.

Protective clothing:

	PROTECTIVE CLOTHING … is close-fitting working clothing with light tear strength, tight sleeves and without distant parts. It serves preliminarily for protection against being gripped by flexible machine parts. Do not wear rings, necklaces or other jewellery.
	PROTECTIVE GLOVES …for protecting the hands against abrasion, wear and other injury of the skin.
	PROTECTIVE HELMET …for protection against injuries of the head.

4.7 Conventional Use

The product described in this manual was developed to execute safety-related functions as a part of an entire assembly or machine. The ELGO-device is only conceived for the conventional use described in this manual.
The ELGO EMAX linear encoders only serve to measure lengths.

CAUTION!
Danger through non-conventional use!
Non-intended use and non-observance of this operating manual can lead to dangerous situations.
Therefore:

- Only use the device as described
- Strictly follow the instructions of this manual

Avoid in particular:

- Remodelling, refitting or changing of the construction or single components with the intention to alter the functionality or scope of the device.

Claims resulting from damages due to non-conventional use are not possible.
Only the operator is liable for damages caused by non-conventional use.

4.8 Safety Instructions for Transport, Unpacking and Loading

CAUTION! Transport the package (box, palette etc.) professionally. Do not throw, hit or fold it.

4.9 Handling of Packaging Material

Notes for proper disposal: ☞4.4

4.10 Inspection of Transport

Check the delivery immediately after the receipt for completeness and transport damage.
In case of externally recognizable transport damages:

- Do not accept the delivery or only accept under reserve.
- Note the extent of damages on the transportation documents or delivery note.
- File complaint immediately.

NOTE!
Claim any damage immediately after recognizing it. The claims for damage must be filed in the lawful reclaim periods.

4.11 Storage

Store the device only under the following conditions:

- Do not store outside
- Keep dry and dust-free
- Do not expose to aggressive media
- Protect from direct sun light
- Avoid mechanical shocks
- Storage temperature (☞6) needs to be observed
- Relative humidity (☞6) must not be exceeded
- Inspect packages regularly if stored for an extensive period of time (>3 months)

5 Product Features

The series EMAX is an absolute length measuring system. Sensor and translator and interpolation unit are together in the same compact housing. The magnetic tape of series EMAB is glued up to a plain area. The EMAX encoders can be mounted with a maximum distance of 1.5 mm to the magnetic tape. With a reduced measuring accuracy the sensor distance can be up to 2.0 mm.

Typical applications are handling systems, conveyor and storage technology, hydraulic presses, stamping machines, casting machines, linear slides, linear drives and pick and place systems.

Overview of features:

- no referencing required
- direct wear free and contactless measurement
- allowed distance range between sensor and magnetic tape: 0.1 ... 1.5 mm
  → Distance between magnetic tape and sensor not ok = red LED on
- measuring length up to 10 m
- high resolution 10 µm
- repeat accuracy +/- 1 increment
- very resistant against dirt

5.1 Functional principle

A Hall sensor and a magneto-resistive impedance measuring bridge are guided over a two-track magnetic tape with a fine-interpolation trace and an absolute track. Together with the sensor line the absolute track provides an absolute value and the fine-interpolation trace provides together with the interpolation electronic the measuring systems high resolution.

The fine interpolation track encloses alternately north- and south-pole tracks with a distance of 5 mm. These are scanned with resistance bridges and provide a resolution of 0.01 mm. The absolute value provides the sensor line with 16 single Hall sensors; these sensors are scanning the code sections of the north and south poles. The absolute value on the magnetic tape recurs every 10 m.

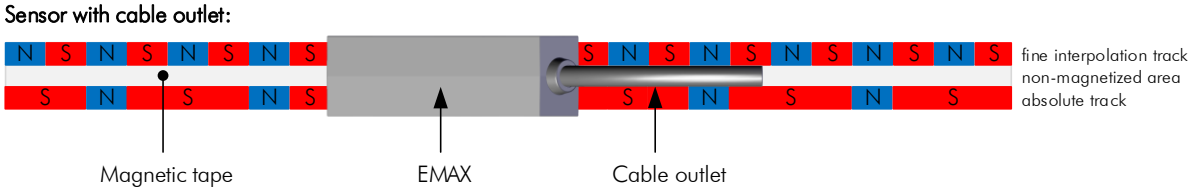


Figure 1: Coding of the magnetic tape

6 Technical Data

6.1 Identification

The type label serves for the identification of the unit. It is located on the housing of the sensor and gives the exact type designation (=order reference, see type designation) with the corresponding part number.
Furthermore, the type label contains a unique, traceable device number.
When corresponding with ELGO always indicate this data.

6.2 Dimensions Sensor

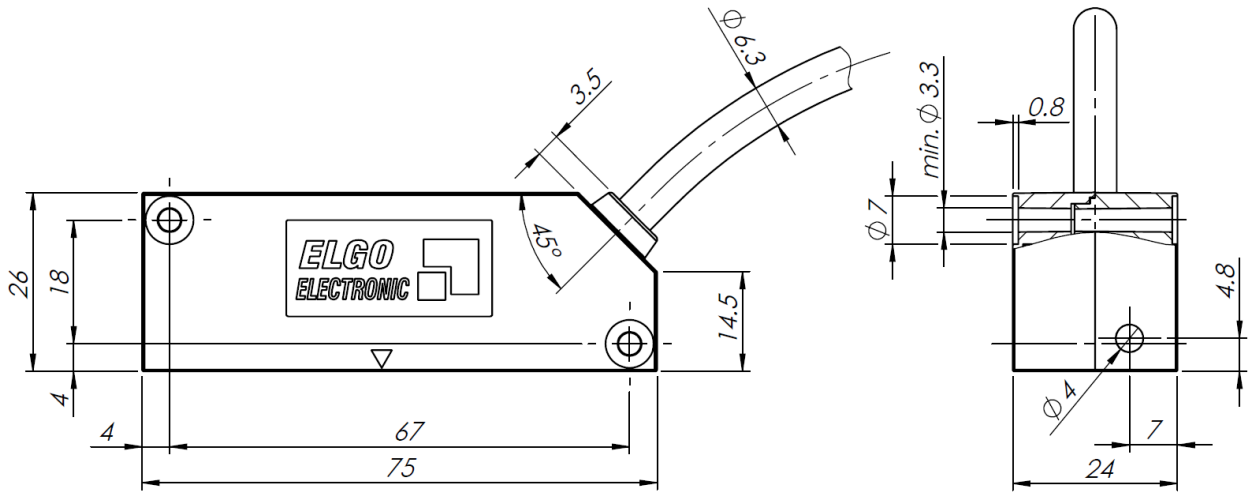


Figure 2: Dimensions of sensor

6.3 Technical Data Sensor

EMAX	
Mechanical Data	
Measuring principle	absolute
Measurement	linear
Repeat accuracy	±1 Increment
System accuracy in µm at 20°C (L = measuring length in meters)	±(150 + 20 x L)
Distance sensor / magnetic tape	max. 1.5 mm (2.0 mm with reduced measuring accuracy)
Basic pole pitch	5 mm
Sensor housing material	zinc die cast
Sensor housing dimensions	W x B x H = 75 x 24 x 26 mm,
Required magnetic tape	AB20-50-20-2-R-11
Maximum measuring length	10 m
Connections	open cable ends
Weight	Sensor approx. 100 g without cable, (cable approx. 60 g/m)
Electrical Data	
Supply voltage	+ 10 … 30 VDC
Residual ripple	10 … 30 V: <10%
Power input	max. 150 mA
Interface	RS485
Resolution	0.01 mm
Speed	max. 4 m/s
Conditions	
Storage temperature	-20 °C … +85 °C
Operation temperature	-10 °C … +70 °C (-25 °C … +85 °C upon request)
Humidity	max. 95 %, not condensing
Protection Class	IP55

6.4 Technical Data Magnetic Tape

The magnetic tape consists of two components:

- The actual magnetic tape which carries the position information
- A mechanical stainless steel back iron

Magnetic Tape AB20-50-20-2-R-11	
Coding	absolute, dual track system
Pole pitch	5 mm
Operation temperature installed	−20 °C … +65 °C (−20°C … +80°C when using without adhesive tape, options „B“ or „D“)
Storage temperature uninstalled	Short-term: −10°C … +60°C Medium-term: 0°…+40°C Long-term: +18°C (−20°C … +80°C when using without adhesive tape, options „B“ or „D“)
Gluing temperature:	+18°C … +30°C
Relative humidity	max. 95 %, non-condensing
System accuracy in µm at 20°C (L = measuring length in meters)	±(150 + 20 x L)
Material carrier tape	Precision Strip Steel 1.4310 / X10CrNi 18-8 (EN 10088-3)
Double-faced adhesive tape	3M-9088 (observe instructions), others on request
Dimensions	20 mm (±0.3 mm) x 1.8 mm (±0.1 mm)
Length expansion coefficient	$\alpha \approx 16 \times 10^{-6}$ 1/K
Thermal length expansion	$\Delta L[m] = L[m] \times \alpha[1/K] \times \Delta\vartheta[K]$ (L = tape length in meters, $\Delta\vartheta$ = relative temperature change)
Available measuring lengths	max. 10 m
Weight magnetic tape	ca. 62 g/m (incl. magnetic tape and cover tape)
Tape imprint	ELGO standard, printing color black, digit height >= 5 mm
Influence of external magnets	External magnetic fields must not exceed 64 mT (640 Oe; 52 kA/m) on the surface of the magnetic tape as this could damage or destroy the code on the tape.
Protection class	IP65

7 Installation and First Start-Up

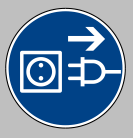
CAUTION
Please read the operating manual carefully before using the device! Strictly observe the Installation instructions! In case of damage caused by failure to observe this operating manual, the warranty expires.

ELGO is not liable for any secondary damage and for damage to persons, property or assets.

The operator is obliged to take appropriate safety measures. The first start-up may only be performed by staff that has been trained and authorized by the operator.

7.1 Operating Area

WARNING!
Do not use the device in explosive or corrosive environments!
The device must not be installed close to sources of strong inductive or capacitive interference or strong electrostatic fields!



CAUTION!
The electrical connections must be made by suitably qualified personnel in accordance with local regulations.

The device may be designed for switchboard mounting. During work on the switchboard, all components must be de-energized if there is a danger of touching the energized parts! (protection against contacts)

Wiring works may only be performed in the de-energized state!

Thin cable strands have to be equipped with end sleeves!

Before switching on the device, connections and plug connectors have to be checked!

The device must be mounted in a way that it is protected against harmful environmental influences such as splashing water, solvents, vibration, shock and severe pollution and the operating temperature must not be exceeded.

7.2 Installation of the Magnetic Tape

NOTE External Magnetic Fields
The magnetic tape must not be influenced by external magnetic fields!
The magnetic tape must not come into direct contact with other magnetic fields (e.g. permanent magnets, magnetic clamps, electromagnets, magnetic stands)! This may cause irreparable damage, which will compromise the measuring accuracy or even the functioning.

7.2.1 Structure of magnetic tape

In the standard case, the magnetic tape is delivered as described
It is installed by gluing it to the respective mounting surface.

The magnetic tape consists of 2 pre-assembled components (Figure 3: Components of the magnetic tape):

- A magnetized, flexible plastic tape (Pos. 3), which is connected with a magnetically conductive steel tape as inference band (Pos. 4) and is supplied with an adhesive tape (Pos. 5).
- A magnetized permeable cover tape (Pos. 1), which serves for the mechanical protection of the plastic tape (not required for the measurement) and is supplied with an adhesive tape (Pos. 2).

Therefore a divergent tape structure and scope of delivery is also possible.
The cover tape is also available separately

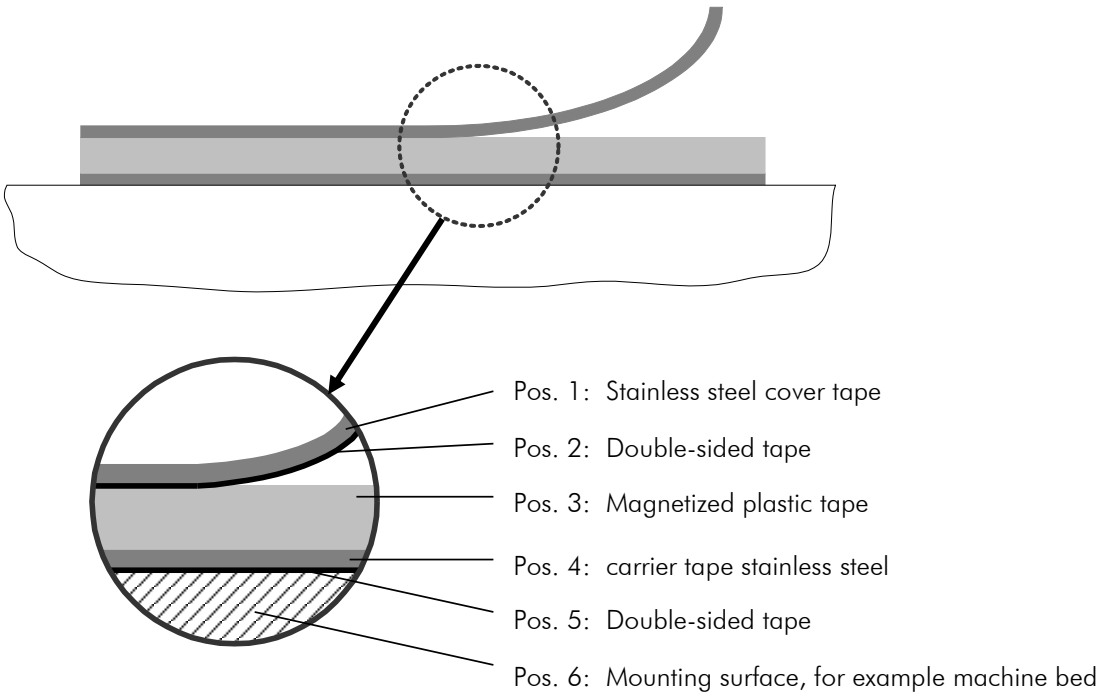


Figure 3: Components of the magnetic tape

7.2.2 Handling

In order to avoid tension in the tape, it must not be stretched, compressed or twisted.
It should be stored with the magnetized plastic tape to the outside, the minimum bending radius must be noted here

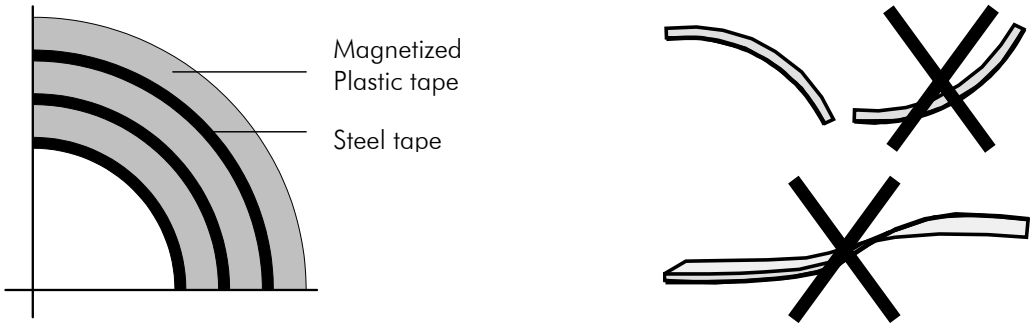


Figure 4: Handling

7.2.3 Processing hint for the gluing of magnetic tapes

Surface-Preparation: In order to guarantee optimal adhesion, all antiadhesive contamination (e.g. oil, grease, dust, separating agents) has to be removed using solvents with residue-free evaporation.
Suitable agents are ketones or alcohols. Typical solvents for cleaning the surface are a 50/50 isopropyl alcohol/water mixture or heptane. Those agents are offered by Loctite and 3M among others as surface cleaners. When using solvents, always observe the manufacturer instructions! If the surface is copper, brass etc., it should be sealed to avoid oxidation.

Contact-Pressure: The strength of the adhesion is directly dependent on the contact the adhesive can form with the surface. Therefore it is important to use as much pressure as possible when gluing the tape, possibly by using aids such as draw rolls. The optimum contact pressure is 4…5 kg/cm^2).

Gluing temperature: The optimal gluing temperature is between + 21 ° C and 38 ° C. Avoid colder sticking surfaces than + 10 °C, because in this case the adhesive becomes too hard and perhaps a sufficient immediate adhesion is hardly to achieve. After proper sticking, the stability of the connection is ensured also when the temperature is below zero. The final tackiness of a sticking is from experience reached after approximately 72 hours (at + 21 °C). For gluing use only the supplied adhesive tape.

7.2.4 Cutting and Gluing

Before starting the gluing process, both the magnetic and the cover tape have to be cut to the required length

Length cover tape = measuring length + sensor length + 50mm (end caps)

NOTE!
When sticking the magnetic tape pay attention to the markings on the tape and the Sensor. Improper installation does not provide the correct values. A already glued magnetic tape is destroyed after the removal, and cannot be used again. Note also the direction of counting of the measuring system

Preferably the magnetic tape should be glued close to an edge or into a groove, which should be deep enough to embed the magnetic tape and the cover tape.

When unprotected, the cover tape may peel off!

Therefore:
Use tape end caps (see chapter 9.2) or let the cover tape overlap* the end of the magnetic tape and fix it with a screw.

The tape must be glued smoothly on the surface. The measuring accuracy decreases if the tape is not even!

Before gluing the magnetic tape and the cover tape onto the surface, they should be left lying on the mounting surface for ca. 30 minutes so that the temperature matches. This prevents strain in the tape due to thermal expansion.

Mounting steps:

1. Thoroughly clean surface (☞7.2.3)
2. Let magnetic tape and cover tape adjust their temperature (acclimatization)
3. Remove protection foil of adhesive tape on magnetic tape
4. Glue the magnetic tape by using great pressure
5. Thoroughly clean the surface of magnetic tape
6. Remove the protection foil of adhesive tape on cover tape
7. Glue the cover tape by using great pressure
8. Safeguard the ends of the cover tape against peeling off (e. g. by using end caps ☞ 13)

7.3 Installation of the Sensor

In order to fasten the sensor head, two M3 must be used.

> **NOTE!**
>
> The correct distance sensor / magnetic tape is monitored and displayed by the LED on the top resp. on the front sensor (depends on design). Distance not correct → **LED lights red**
>
> The mounting tolerances given below are valid for both housing types (standard version with fixed cable outlet or sensor housing with round connector).

7.3.1 Mounting Tolerances

Further, the following tolerances must be observed:

Table 1: Mounting tolerances

Tolerances	
Magnetic tape type	AB20-50-20-2-R-11
Ride height (distance to the tape)	0.1 … 1.5 mm
Pitch	The max. Distance 1.5 mm must not be exceeded at any position
Yaw angle	0 ° ±0.5 °
Roll	The max. Distance 1.5 mm must not be exceeded at any position
Lateral offset	±0.5 mm

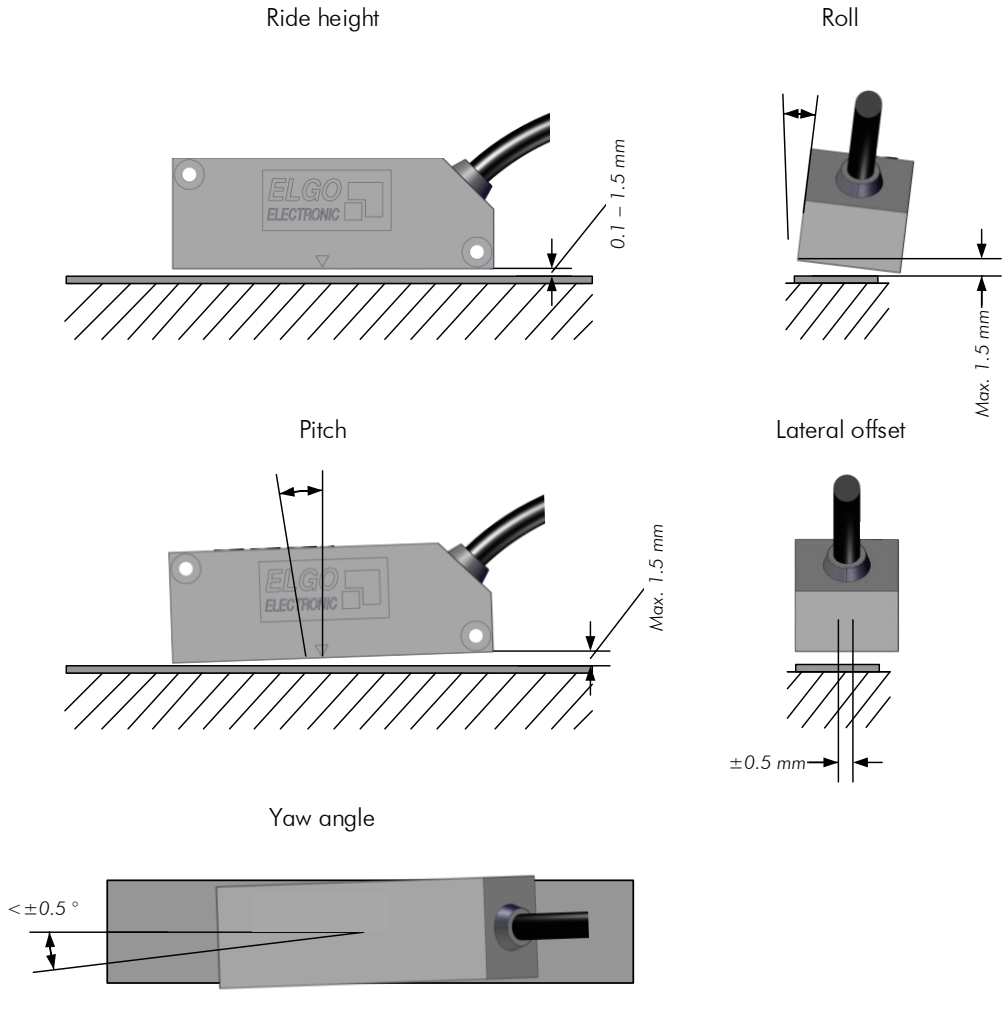


Figure 5: Tolerances

7.3.2 Mounting Direction of the Sensor to Magnetic Tape

Since the magnetic tape has two magnetized tracks, the sensor and magnetic tape must always be mounted in the correct direction in order to obtain correct measurement results.

Marking arrows on the tape and sensor clearly indicate the correct mounting direction.

The pole finder foil, which is available as an accessory (☞ 13) and is placed on the magnetic tape, can also be used to determine the respective pole pitches. The pole pitches result in the following mounting direction:

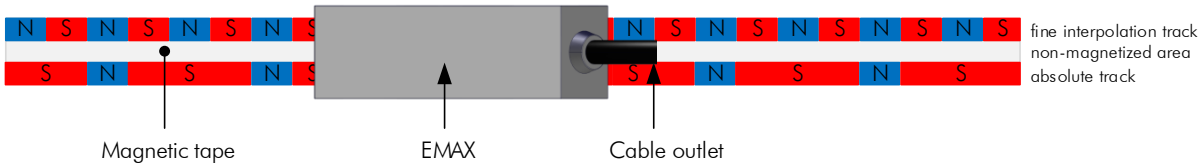


Figure 6: Mounting direction on magnetic tape

- The sensor center must be aligned to the magnetic tape center (±0.5 mm)
- Markers on tape and sensor are additionally indicators for the mounting direction

7.4 Offset Calibration

After the installation of magnetic tape and measuring system (sensor head), a value is transmit via interface. Since this value does not correspond to the machine zero point, it should be possible to store an offset on the control side.

NOTE!

An offset is necessary in each case of a replacement of the EMAX or magnetic tape.

8 Interface

The following chapters give detailed information about the RS485 interface.

8.1 Interface RS485 (Option A850)

The device address and bit rate are set internally. The value of the device address is included in the type designation under point G.

Protocol of an EMAX:

General format of a message **to** the EMAX:				
0x02	Byte1	Byte2	Byte3	0x03
STX			check	ETX

0x02 (STX) starts a message
0x03 (ETX) close the message
Byte3 (check) is the arithmetic sum of 0x02(STX), Byte1 and Byte2.
ETX is not included in the checksum

General format of a message **from** the EMAX:				
0x02	Byte1	Byte2	Byte3	Byte4
STX				

Position-request **from** the EMAX with address i:				
Message to the EMAX				
0x02	0x04	i	check	0x03
STX			check	ETX

0x04 characterizes the message as position-request
i is the address of the requested EMAX (i = 0x0b... 0x7f).

Answer of the requested EMAX:				
0x02	PosHigh	PosMid	PosLow	EMAX address

The position value consists of 3 byte:
PosLow (bit 0… bit 7), PosMid (bit 8… bit15), PosHigh (bit16...bit23).
Bit 0 has the value10 μm. Position-values are always smaller than 0xffff00.
Please note: The last byte is no ETX, like in all the other messages, but the **EMAX** address.

Interrogation of the address of an EMAX:
Connect always only a single EMAX to be interrogated via RS485 converter to COM port of a PC.

Message to the EMAX:				
0x02	0x05	0x05	0x0c	0x03
STX	address request		check	ETX

Answer of the EMAX:			
0x02	0xff	0xff i	0x03
STX		EMAX address	ETX

Note: The combination 0xff 0xff does not appear in normal mode for position answers of EMAX (directly after STX) It is a sign for a special message not a position (in this case with 0x0b <= i <=0x7f it is the answer to the interrogation of the address).

Negative answer: If one of the described operations failed for some reasons, the EMAX encoder will give a negative answer with a concerning error code.

EMAX answers:				
0x02	0xff	0xff	Err	0x03
STX	0xff	0xff	Error Code	ETX

With Err = 0x04… 0x0a

Table 2: Error messages of an addressable EMAX

Code	Description
0x05	Unknown command
0x09	Position invalid (No tape, tape damaged or too big distance)

9 Pin Assignment

9.1 RS485 Interface

Table 3: Connections of the RS485 interface

Color	Function
White	0 V
Brown	+ 10 … 30 VDC
Green	Data (+)
Yellow	Data (−)
Shield	PE* ⏚

*) Connect shield only at the device!

10 Disturbances, Maintenance, Cleaning

This chapter describes possible causes for disturbances and measures for their removal. In case of increased disturbances, please follow the measures for fault clearance in chapter 10.1. In case of disturbances that cannot be eliminated by following the advice and the fault clearance measures given here, please contact the manufacturer (see second page).

10.1 Fault Clearance

CAUTION!
The device, the connection line and the signal cable must not be installed next to sources of interference that emit strong inductive or capacitive interference or strong electrostatic fields.

External perturbations can be avoided thorough suitable cable routing.

The screen of the signal output cable should only be connected to the following circuit on one side. The screens should not be grounded on both sides. Signal cables always have to be routed separately from the load power line. A safety distance of at least 0,5 m has to be kept from inductive and capacitive sources of interference such as contactors, relays, motors, switching power supplies, clocked controllers etc!

If interferences occur in spite of all the items stated above being observed, please proceed as follows:

1. Installation of RC-circuits via contactor coils of AC-contactors (e.g. 0,1 µF / 100 Ω)
2. Installation of recovery diodes via DC-inductors
3. Installation of RC-circuits via the different motor phases (in the terminal box of the motor)
4. Do not connect protective earth and ground
5. Connect a mains filter ahead of the external power pack

10.2 Re-start after Fault Clearance

After the fault clearance:

1. Reset the emergency stop mechanism if necessary
2. Reset the error report at the super-ordinate system if necessary.
3. Ensure that there are no persons in the danger area.
4. Follow the instructions from chapter 7.

WARNING!
Danger of injury through non-conventional fault clearance!

Non-conventional fault clearance can lead to severe injuries and damage of property.

Therefore:

- Any work to clear the faults may only be performed by sufficiently qualified staff
- Arrange enough space before starting the works
- Make sure that the mounting area is clean and tidy. Loose components and tools are sources of accidents.

If components need to be replaced:

- Pay attention to a correct installation of the spare parts.
- Reinstall all the fixing elements properly
- Before turning on the device, ensure that all covers and safety equipment is installed correctly and functions properly

10.3 Maintenance

The device is maintenance-free.

10.4 Cleaning

WARNING!
The device can only be cleaned with a damp cloth, do not use aggressive cleanser!

11 Type Designation

Designation 1: AAAA A - BB - CC.C - DDDD - EE - F

A Series/Type:
EMAX B = Absolute Linear Encoder

B Version:
00 = standard version

C Cable length:
05.0 = 5 m
08.0 = 8 m

D Resolution in µm:
0010 = 10 µm - at system accuracy in µm ±(150 + 20 x L)

E Power supply / output level:
01 = power supply 10-30V DC / output level 5V DC

F Options:
V = sealed version

Designation 2: GGGG - HHHH - IIII - J - K - LLLL

G Basic pole pitch:
5000 = 5 mm

H Interface 1:
A850T = addressable RS485 interface,
standard protocol, terminated (120R)

I Bitrate:
09K6 = 9600 bit/s

J Address:
0 = device address 0
1 = device address 1

K Interface 2:
X = reserved

L Parameter set:
P000 = parameter set 000

12 Available Versions

Designation 1	EMAX B-00-05.0-0010-01-V	EMAX with cable length 5 m, resolution 10 µm, power supply 10-30 VDC, output level 5 VDC, sealed version
Designation 2	-5000-A850T-09K6-1-X-P000	basic pole pitch 5 mm, addressable RS 485 interface, standard protocol, terminated (120R), 9600 bit/s, device address 1, parameter set 000

Designation 1	EMAX B-00-08.0-0010-01-V	EMAX with cable length 8 m, resolution 10 µm, power supply 10-30 VDC, output level 5 VDC, sealed version
Designation 2	-5000-A850T-09K6-0-X-P000	basic pole pitch 5 mm, addressable RS 485 interface, standard protocol, terminated (120R), 9600 bit/s, device address 0, parameter set 000

13 Accessories

Order Designation	Description
AB20-50-20-2-R-11	Magnetic tape for EMAX
Magnetic tape end cap set (20 mm)	2 end caps (20 mm) and two M3 screws; additional fixation in the radial and linear range and protection of the magnetic tape ends
POSU	Pole finder card (85 x 55 mm) for magnetic tape codings

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