

# Operation Manual

## SERIES EMAX

Magnetic Absolute – Length Measuring System with 0.01 mm resolution



- No referencing necessary
- Direct contact free measurement
- The distance between sensor and magnetic tape can be between 0.1 and 0.8mm
- Measuring lengths up to 10 m
- High resolution of 0,01 mm
- Repeat accuracy +/- 0,01 mm
- Insensitive against dirt

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## 1. General Information

### 1.1 Information Operation Manual

The manual contains important information regarding the handling of the controller. Precondition for safe operation is the compliance with the specified safety and handling instructions. Moreover, observe the existing local accident prevention regulation and general safety rules.

Please read the operation manual carefully before starting to work. The manual should be kept accessible at anytime. The illustrations in the manual are for better representation of the facts they are not necessarily to scale and can be slightly different to the actual construction

### 1.2 Explanation of Symbols

#### Warning notices

Warning notices are characterised by symbols in the operation manual. The notes will be introduced by signal words to express the magnitude of the danger.

Follow these advices in order to avoid accidents and injuries to persons and property.



#### **DANGER!**

... adverts to direct dangerous situations that can lead to death or severe injuries.



#### **CAUTION!**

... advices to potentially dangerous situations that can lead to death or severe injuries.



#### **ATTENTION!**

... advices to potentially dangerous situations that can lead to damages on property.

### Hints and Commendations

**ADVERT!**

...highlights helpful hints and recommendations for efficient and failure-free operation.

### Specific Safety Instructions

The following symbols in conjunction with safety instructions are used in order to point out possible hazards:

**DANGER!**

...marks perilous situations by electricity. By non-observance of the safety instructions the possibility of death or severe injuries exists. The operations have to be carried out only by an electrician.

## 1.3 Statement of Warranties

The warranty conditions are in a separate document.

### Guarantee

The producer guarantees the functional capability of the process engineering and the selected parameter. The period of warranty is one year and begins with the date of delivery.

## 1.4 Demounting and Disposal

Unless otherwise authorized, dispose the item considering the safety instructions.

### Before demounting

- Disconnect the power supply
- Secure against re-start
- Disconnect supply lines physically and discharge remaining energy
- Dispose operating supplies with respect to the environment

### Disposal

Recycle the decomposed elements:

- Scrap metal elements
- Recycle plastic parts
- Dispose the rest of the components according to their material consistence



#### **ATTENTION!**

Wrong disposal → damage caused to the environment!

Electronic waste, electronic components, lubricants and operating supplies are liable to treatment of hazardous waste.

Only approved specialized companies should perform disposal.

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

## 2 Safety

### 2.1 General Cause of Risks

This chapter gives an overview about all important safety aspects to guarantee an optimal protection of employees.

Non-observance of the instructions mentioned in this operation manual can result in hazardous situations.

### 2.2 Personal Protective Equipment

Employees should wear protective clothing during installation of the device to minimize the risk of accidents.

Therefore:

Change into protective clothing before beginning the work process. Also observe any labels in the operating area regarding protective clothing.

#### Protective clothing



#### Safety working clothing

- ... is close-fitting
- ... is tear proof
- ... has tight sleeves without distant parts

**Also wear no rings, necklaces or other jewellery.**



#### Protective gloves

- ... for protecting the hands against abrasion and cuts



#### Hardhat

- ... for protection of the head during work

## 2.3 Conventional Use

The ELGO *EMAX* and *EMAX with FW2080* absolute length measuring systems are for the limited purpose as described in this manual:

The *EMAX* and *EMAX with FW2080* absolute length measuring systems are constructed for measuring distances up to 10 meter.



### CAUTION!

Danger through non conventional use!

Non-intended use and non-observance of this operation manual can lead to dangerous situations.

Therefore:

- Use **EMAX/ EMAX** with **FW2080** only as described.
- Strictly follow this manual.

Avoid in particular:

Remodelling, refitting or changing of the device or parts of it with the intention to alter functionality or scope of the *EMAX / EMAX with FW2080*.

ELGO is not liable for any damages resulting from improper use of the product.

## 3 Transport and Storage

### 3.1 Safety Instructions for Transport / Unpacking and Loading



### ATTENTION!

Professional transport only.  
Do not throw, hit or fold the package.

### 3.2 Handling of Packaging Material

Adverts for proper disposal refer to 1.4.

### 3.3 Check of Transport

Examine delivery immediately after receiving for completeness and transport damages.

In case of externally recognizable transport damages:

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

**ADVERT!**

Claim any damages you recognize as soon as possible. The claims for damage must be filed in the lawful reclaim periods.

### 3.4 Storage

Store device only under 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: -20 to +70 °C
- Relative humidity: max. 80%
- Inspect packages regularly if stored for an extensive period of time (> 3 months)



## 4 Product Features

The series **EMAX** is an absolute magnetic length measuring system. The sensor technology and translator are both placed in housing. The magnetic tape of the series EMAB is fixed to a plane base with the provided sticky tape. The **EMAX** can be installed up to a maximum distance of 0.8 mm.

The absolute measuring system offers decisive advantages:

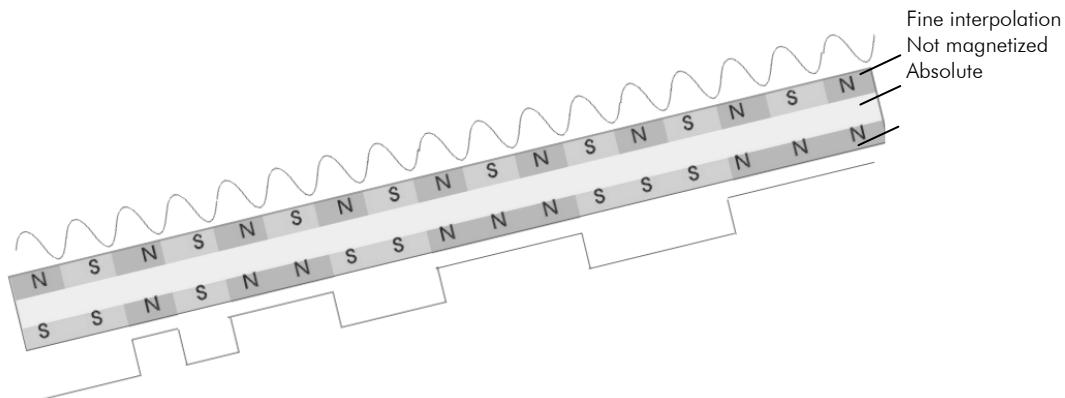
- No referencing necessary
- Direct contactless measurement
- The distance between sensor and measuring tape can vary between 0.1 and 0.8 mm
- Measuring lengths up to 10 m
- High resolution of 0,01 mm
- Repeating accuracy +/- 0,01 mm
- Very robust against pollution

Different interfaces possible: RS422, RS232, SSI, CANopen, profibus with converter PNO1

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

### 4.1 Functional principle

A Hall sensor line and a magneto-resistive resistor measuring bridge element are moved over a magnetic tape written with two tracks. The tracks are a fine interpolation track and an absolute track. The absolute track provides together with the sensor line an absolute value and the fine interpolation track together with the interpolation circuit the high resolution of the measuring system.



Picture 1: Functional principal EMAX

Picture 2 shows the two magnetic tracks with north and south pole magnetization. On the fine interpolation track the north and south poles alternate with a distance of 5 mm. The poles are sampled with resistor measuring bridges and provide a resolution of 0.01 mm. The sensor line with 16 single Hall sensors, which sample the code sequence of the north and south poles, provides the absolute value. The absolute value on the magnetic tape repeats all 10 m.



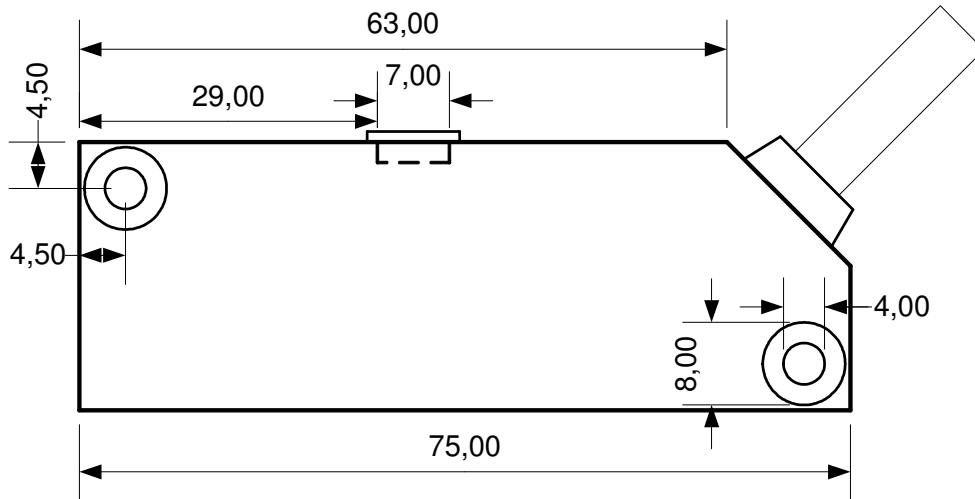
Picture 2: Coding

## 5 Technical specifications

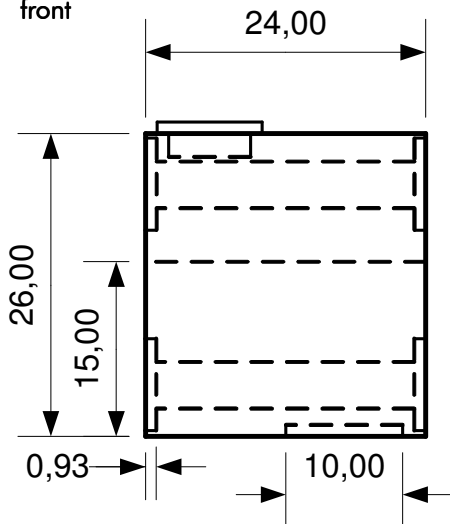
nominal voltage	10-30 VDC ripple < 5%
consumption	max. 150 mA
signal level	5 V TTL at RS422 (standard interface)
resolution	0,01 mm
repeating accuracy	+/- 1 increment
maximum operation speed	4 m/s
interfaces: data and protocol look at 6.3 interfaces	RS422 (standard) RS422 addressable (option A22) SSI (option SSI) CAN open (option CAO)
optional incremental output	track A and B (option I) HTL (10... 30 VDC – Push-Pull), single ended
measuring length*	max. 10 m
distance sensor/tape	max. 0,8 mm
system accuracy in $\mu\text{m}$ at 20°C	+/- (150 + 20 x L) L= measuring length in meters
operation temperature	-10... +70 °C (-25... +85 °C)
storage temperature	-25... +85 °C
humidity	not condensing, max. 80%
protection class	IP43 (standard) IP67 (option V)
dimensions sensor	EMAX: 78 x 24 x 33 mm EMAX with FW2080 : 100 x 48 x 34 (L x W x H)
dimensions guiding rail for EMAX with FW2080	possible length: 1 m, 1,5 m or 2 m.
cable	Tug chain capable Length max. 30.0 m Weight ca. 58.0 g/m 2 x 0.75 mm <sup>2</sup> , 6 x 0.14 mm <sup>2</sup> min. bend radius 60 mm
magnetic tape AB20-50-20-2-R-11	Length Extension coefficient $\alpha = 16 \times 10^{-6} \text{K}^{-1}$ Length extension $\Delta L = L \times \alpha \times \Delta T$ 20 mm x ca. 1.8 mm (W x H) min. bend radius 150 mm

### 5.1 Dimensions EMAX

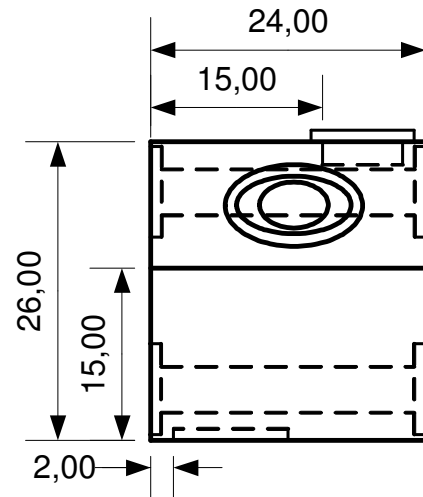
side view



front

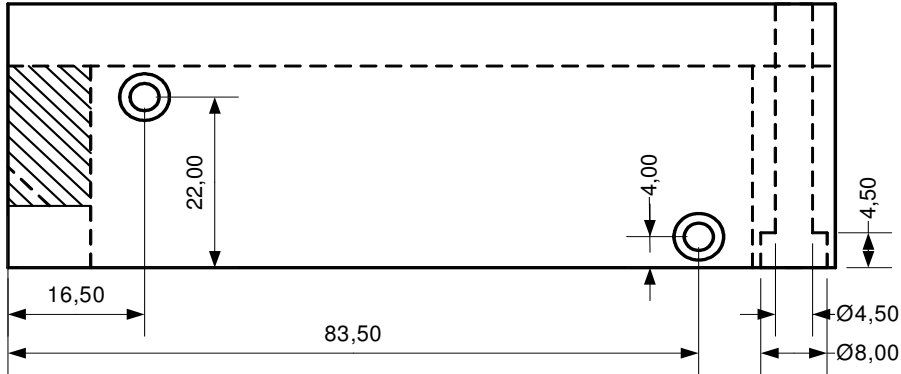


back

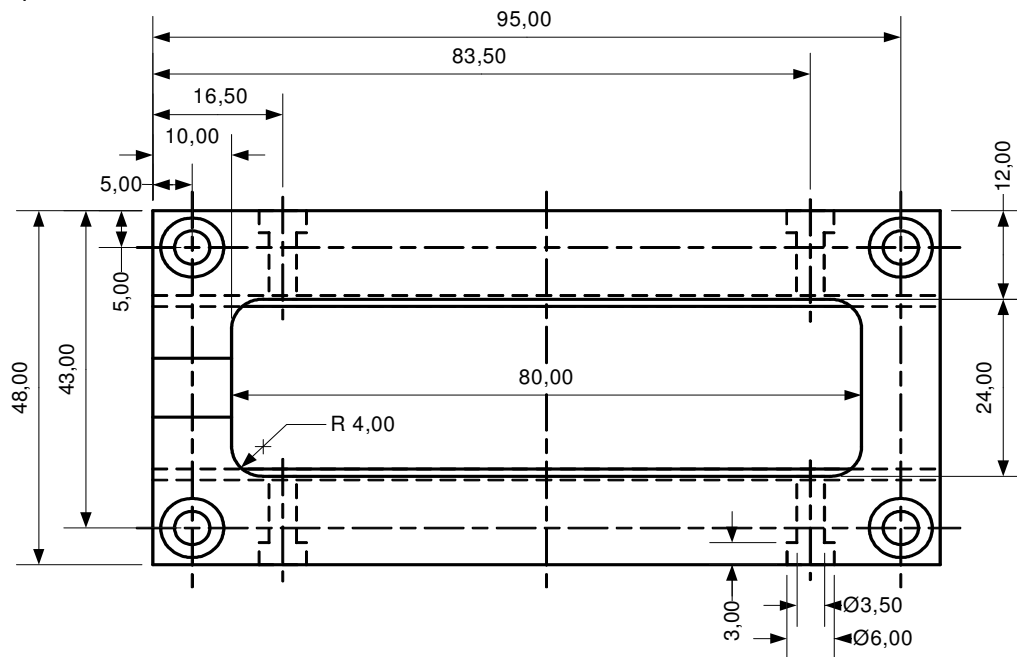


## 5.2 Dimensions EMAX with FW2080

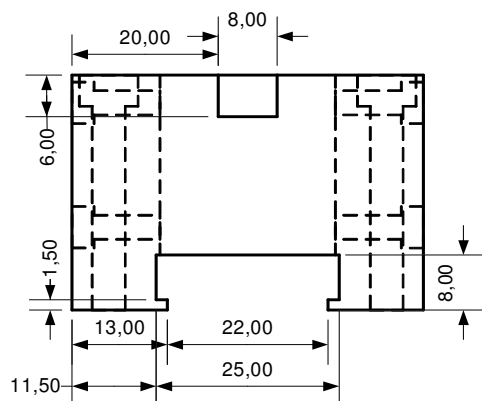
side view



top view



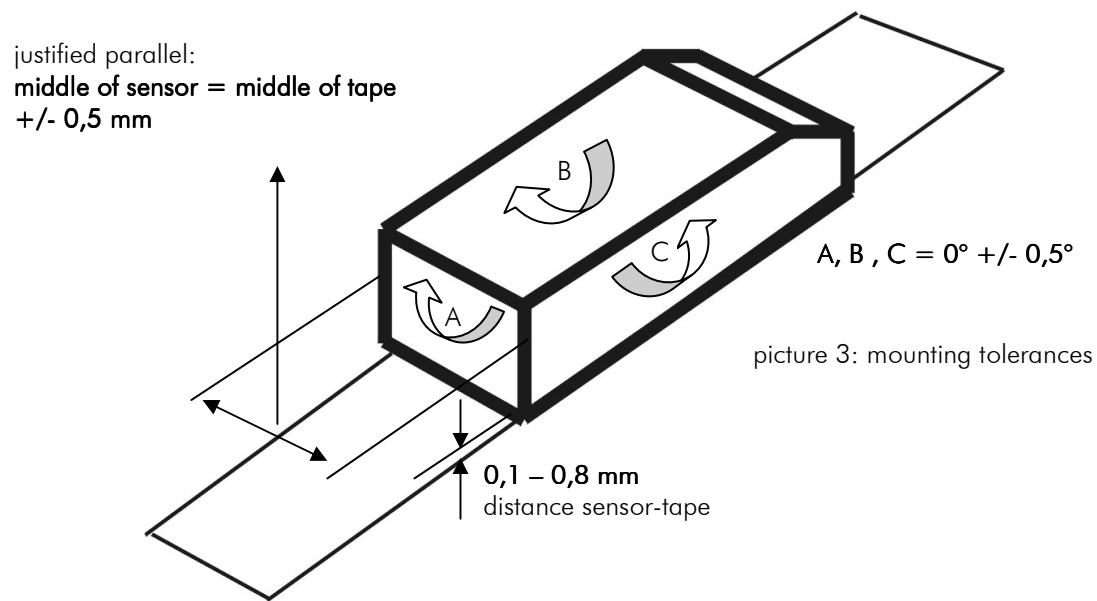
front



## 6 Installation/ Initial start-up

### 6.1 Mounting sensor

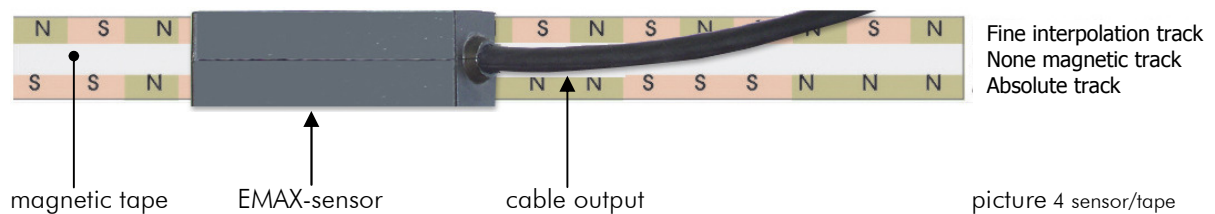
When installing the sensor head use two M3 screws.  
Tolerances for distance and angle must be observed (see picture 3).



Installation direction of the **EMAX** sensor on the magnetic tape:





Sensor and magnetic tape have to be mounted always in the same direction. The pole searcher film (available as an accessory) allows to determine the respective pole separations when lying on the tape. From that the following installation direction results:

:



Marks on tape and sensor indicate additionally the installation direction.

## 6.2 Terminal assignment

cable	function RS422	option RS232	option SSI	option CAN open
white	0 V	0 V	0 V	0 V (GND)
brown	+ 24 V	+ 24 V	+ 24 V	+ 24 VDC
orange	TX -	TX	SSI / TX data inv.	CAN low
yellow	TX	RX	SSI / TX data	CAN high
violet	RX -	-	SSI / CLK Clock inv.	-
green	RX	-	SSI / CLK Clock	-
grey	A channel (at Option I)	A channel (at Option I)	reserved for tests	-
black	B channel (at Option I)	B channel (at Option I)	reserved for tests	-
shielding	PE* 	PE* 	PE* 	PE* 

\*) Connect the shielding only to the machine!

## 6.3 Interfaces

### 6.3.1 RS422 Standard & RS232 (Option 232)

The measuring system EMAX is provided with an interface in the format RS422.  
The data transmission has the following format:

**9600 Baud / 1 Start Bit / 8 Daten Bits / 1 Stop Bit / No Parity**

Data protocol:

The actual value is transferred in the following format with 9600 Bit/s, 8 Data bytes, 1 Stopbit, and no parity bit:

```

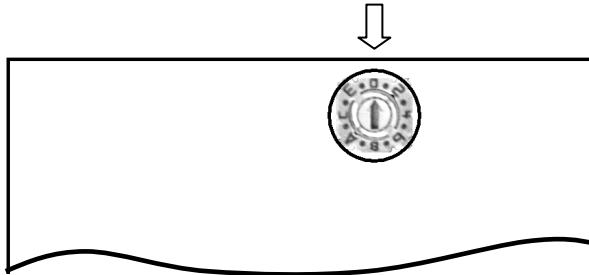
02h  STX
xxh  ABS-Data MSB
xxh  ABS-Data
xxh  ABS-Data LSB
03h  ETX
00h
0Dh
    
```

The measured absolute position is shown with 0.01 mm resolution binary in the 3 ABS data bytes.

### 6.3.2 RS422 addressable version (option A22)

Protocol of addressable *EMAX* Version 1.4

With a switch for coding, installed on the top of the housing, under a protective cap, the device address in the range of 0B ... 1A could be adjusted:



position	address
0	0B
1	0C
2	0D
3	0E
4	0F
5	10
6	11
7	12
8	13
9	14
A	15
B	16
C	17
D	18
E	19
F	1A

**principle format of a message to EMAX:**

<b>0x02</b>	<b>Byte1</b>	<b>Byte2</b>	<b>Byte3</b>	<b>0x03</b>
<b>STX</b>			<b>check</b>	<b>ETX</b>

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

**principle format of a message from EMAX:**

<b>0x02</b>	<b>Byte1</b>	<b>Byte2</b>	<b>Byte3</b>	<b>Byte4</b>
<b>STX</b>				

**Position access of an EMAX with address i:**

Message to the EMAX

<b>0x02</b>	<b>0x04</b>	<b>i</b>	<b>check</b>	<b>0x03</b>
<b>STX</b>			<b>check</b>	<b>ETX</b>

0x04 characterize the message as position query.  
 I is the address of the queried *EMAX* (  $i = 0x0b... 0x7f$  ).

**Response from the queried EMAX:**

<b>0x02</b>	<b>PosHigh</b>	<b>PosMid</b>	<b>PosLow</b>	<b>EMAX- Adresse</b>
-------------	----------------	---------------	---------------	----------------------

The position value consist of 3 bytes:  
 PosLow (bit 0... bit 7), PosMid (bit 8.. bit15), PosHigh (bit16..bit23).  
 Bit 0 has a value of 10  $\mu$ m, position values are always smaller than 0xffff00.  
 Please note that the last byte is no ETX (as other transfers), but the address is *EMAX*

Querying an EMAX address:

Connect only one queried **EMAX**, e.g. with a RS422/RS232 Converter, at the COM Port from a PC.

Message to the EMAX

<b>0x02</b>	<b>0x05</b>	<b>0x05</b>	<b>0x0c</b>	<b>0x03</b>
<b>STX</b>	<b>Adressabfrage</b>		<b>check</b>	<b>ETX</b>

Answer of the EMAX

<b>0x02</b>	<b>0xff</b>	<b>0xff i</b>	<b>0x03</b>
<b>STX</b>		<b>EMAX Adresse</b>	<b>ETX</b>

Note:

The combination 0xff 0xff comes not at Position answer at this point (immediately after STX). Therefore, it is appropriate to mark special responses. In this case (0x0b <=i <= 0x7f) it is the answer of the query of the address.

Negative Answer:

Should one of these actions described for any reason an error, the EMAX display an according coded error message.

Answer from the EMAX

<b>0x02</b>	<b>0xff</b>	<b>0xff</b>	<b>Err</b>	<b>0x03</b>
<b>STX</b>	<b>0xff</b>	<b>0xff</b>	<b>Error-Code</b>	<b>ETX</b>

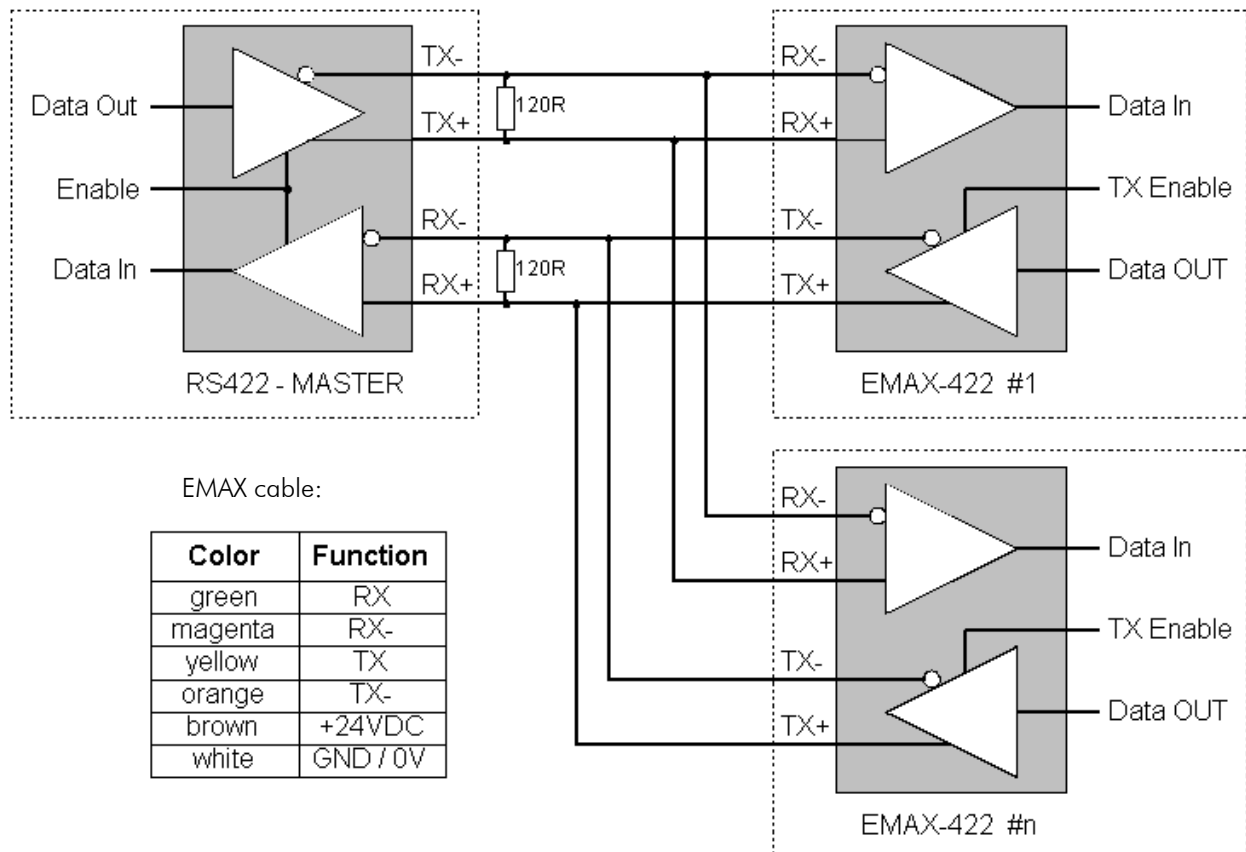
Mit Err = 0x04... 0x0a



Significance of the error messages of an addressable **EMAX**:

Code	Meaning
0x04	Wrong order of bytes to the <b>EMAX</b> been sent, for example, if the 4th Byte after the STX ETX or not the byte after STX not 0x04, 0x05 or 0x06.
0x05	Transmission error / interface error, e.g. wrong in discontinued baud rate etc.
0x06	Invalid EMAX Address: Lights for tests the <b>EMAX</b> an address 0x0b less than or greater than 0x7f assigned.
0x07	Lost <b>EMAX</b> Address: Check the internal redundant address is stored failed. This message is issued immediately after Power supply if an error reading the EEPROM 's is known or the problem is not saved by a redundant address can resolve the issue.
0x08	Internal EEPROM- Memory error.
0x09	Errors in the position calculation (occurs at a great distance to the sensor on the tape or if no defect or a band exists, to)
0x0a	Check-Sum-Error: The check sum which was sent to the <b>EMAX</b> is wrong.

### 6.3.3 Connection to a RS422 Master



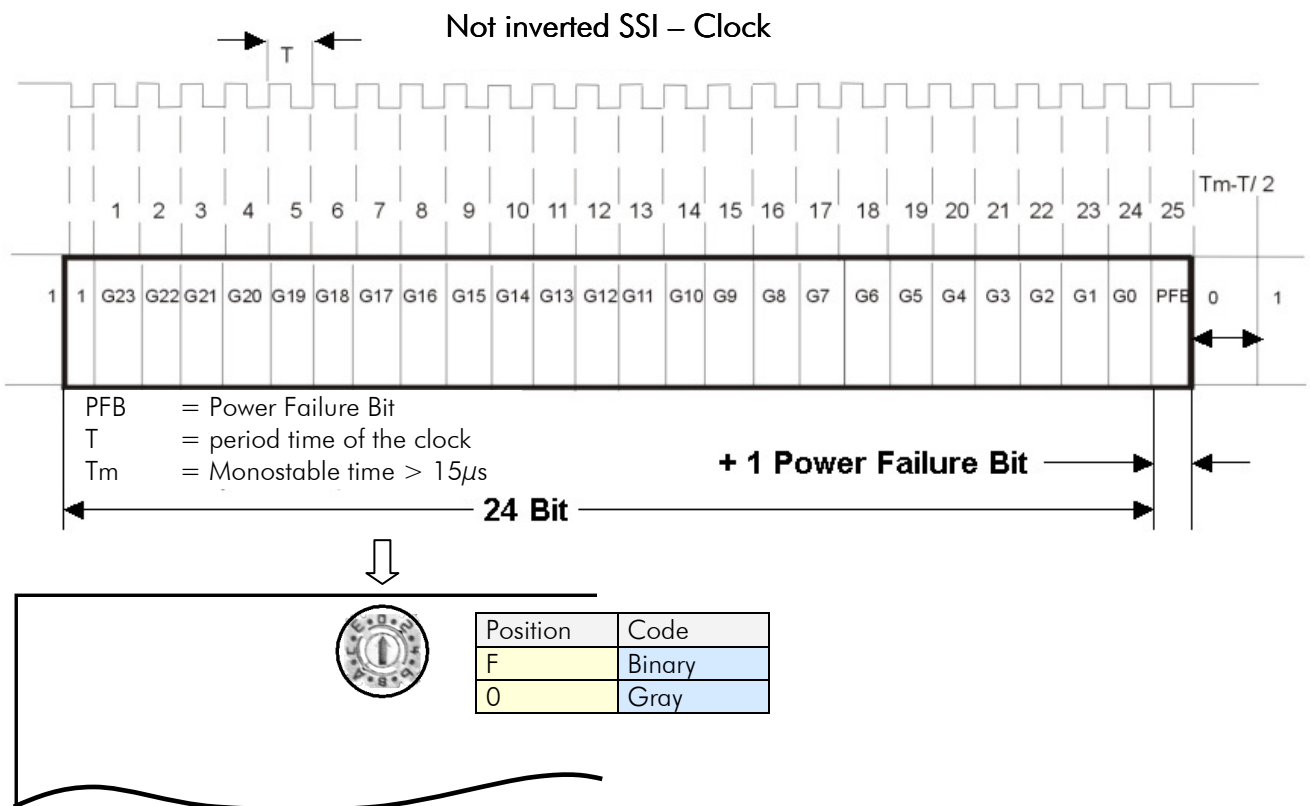
**6.3.4 SSI - (Option SSI)**

Functional Principle: If the clock for the time  $T_m - T / 2$  is interrupted (issue of further 25 cycles), clocking the shift again the same data value out (error detection in the evaluation).

Some encoders have a Power Failure bit (PFB):

At the EMAX the PFB is always „low“.

Readout the data (2 times with 25 pulses)



### 6.3.5 CANopen - (Option CAO)

Interface / Protocol:

The measurement system is equipped with a CAN interface for CANopen standard.

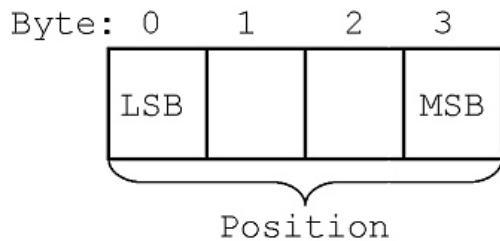
The following are set identifier:

CAN - Identifier

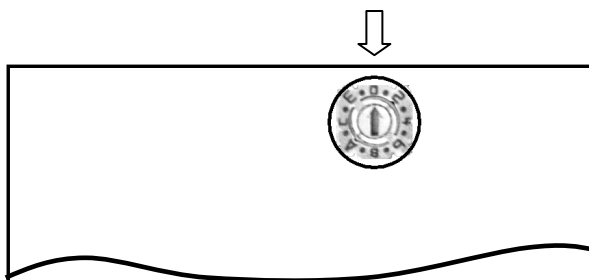
(4 Byte Telegram)

180 (16) = Identifier

First 4 Bytes = Position in mm (Resolution 0,01 mm), Bit rate 250 KB/s



With a rotary encoder switch at the top of the housing (under a protective cap) the CAN identifier could be set in the range of 181 (16) to 18F (16):

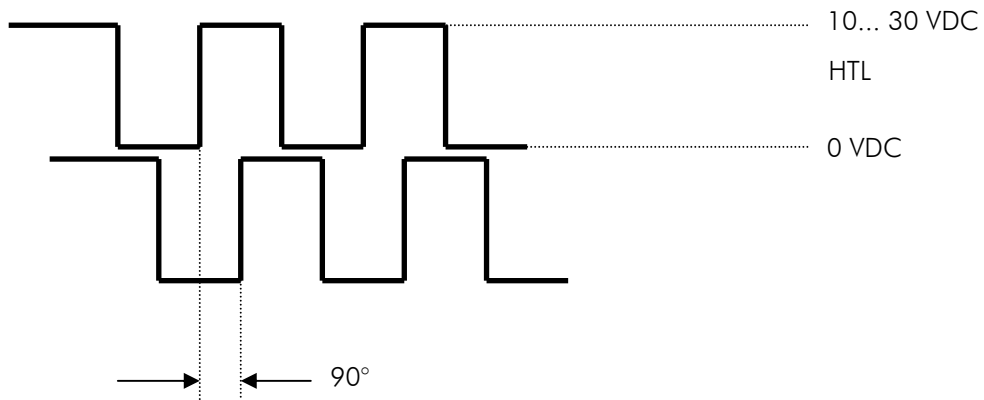


Position	CAN Identifier
0	1fe
1	181
2	182
3	183
4	184
5	185
6	186
7	187
8	188
9	189
A	18A
B	18B
C	18C
D	18D
E	18E
F	18F

### 6.3.6 A/B – Incremental signal (Option I)

As an option, there are two 90 ° phase shifted rectangle signals (compatible to rotary encoders) with HTL output level (push-pull, push / pull).

The system resolution is in the case of four flank evaluation  $= \frac{5 \text{ mm}}{4096}$

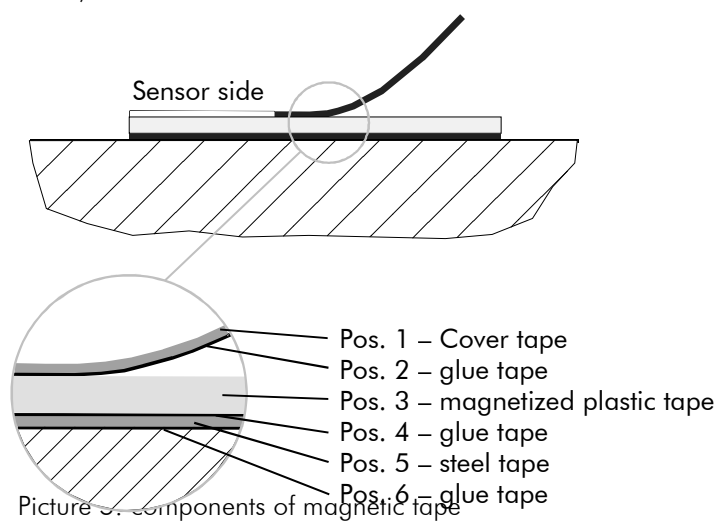


## 7 Option Magnetic tape

### 7.1 Structure of Magnetic tape

The tape consists of 3 components (see Figure 5), a magnetized, flexible plastic band (Item 3), which is connected with a steel band (Item 5) and a masking tape (item 1), which is for protection of the plastic band. The Masking tape have to be glued for the mechanical protection of the magnetic tape. In addition, it protects the magnetic tape from extreme external magnetic influences.

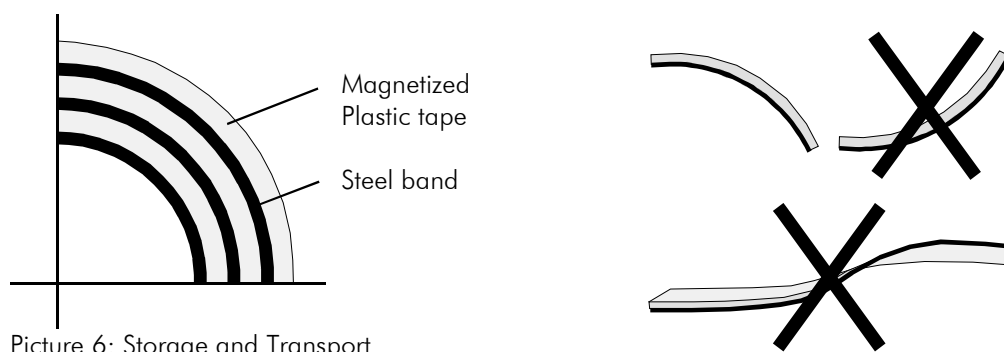
For the complete bonding between the different materials is a special glue tape used (item 2, item 4, and item 6).



Picture 5: components of magnetic tape

### 7.2 Handling

To avoid tension in the tape, it should not be twisted or stored with the magnetized plastic tape to the inside (minimum radius of curvature 150 mm).



Picture 6: Storage and Transport

### 7.3 Processing hint for the sticking of magnetic tapes

**Materials to stick:** The provided sticky tapes stick well on clean, dry and plain surfaces. Typical solvent for cleaning surfaces are a 50/50 mixed isopropyl-alcohol / water mixture or heptane. (Important: Please observe carefully the caution hints of the producer when using the solvent.) The surfaces of materials as copper, brass etc. should be sealed to avoid an oxidation. **Proof:** The stability of the adhesion is directly depending on the contact, which the adhesive develops to the surfaces stuck together. A high proof results in a good surface contact. **Sticking temperature:** The optimal sticking temperature is between + 21° C and 38° C. Avoid colder sticking surfaces than + 10°C, because in this case the adhesive becomes to 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).



**Note for storage:** In order to avoid tensions in the tape, it should be stored in stretched or rolled up condition - with the magnetized plastic tape resp. scanning side outward (see image).

### 7.4 Resistance against chemical influences

#### Chemicals, showing no or only small effects:

- |                    |                 |               |                 |
|--------------------|-----------------|---------------|-----------------|
| - formic acid      | - glycerol 93°C | - linseed oil | - soy beans oil |
| - cotton seed oil  | - N-hexane      | - lactic acid |                 |
| - formaldehyde 40% | - Iso octane    | - petroleum   |                 |

#### Chemicals, showing small to medium effects:

- |             |                   |                                 |                    |
|-------------|-------------------|---------------------------------|--------------------|
| - acetone   | - gasoline        | - acetic acid 30%               | - Olein acid       |
| - acetylene | - steam           | - acetic acid, pure acetic acid | - sea water        |
| - ammonia   | - acetic acid 20% | - isopropyl ether               | -stearic acid 70°C |
| - anhydrous | - kerosene        |                                 |                    |

#### Chemicals, showing strong effects:

- |                   |                               |                               |                   |
|-------------------|-------------------------------|-------------------------------|-------------------|
| - benzene         | - nitric acid 70%             | - nitrobenzene                | - lacquer solvent |
| - turpentine      | - nitric acid, red, vitriolic | - carbon tetrachloride        | - trichloroethane |
| - tetrahydrofuran | - xylene                      | - hydrochloric acid 37%, 93°C |                   |

### 7.3 Stick and Cut

**Note!**

When gluing the magnetic tape is to the markings on magnetic tape and on the sensor head to be respected. Improper installation does not have correct values. A previously sticked tape is destroyed after removal and can not be reused. Also of note is the counting of the measuring system. Before the start of the bonding are magnetic tape and masking tape to the exact length basis.

Length of magnetic tape = Measuring length + Sensor length

At best, the tape stuck in a groove or an edge concern.

Stick in that way:

The tape is already connected to the steel tape. On the carrier side (steel), the attached tape pasted. Now the magnetic tape should be adjusted and glued.

## 8 Operation

### Offset

After assembly and connection of the magnetic tape and measuring system (sensor heads) the value will be transferred over the interface. Because of this not pass with the machine invention of zero should be (adapted to control) an offset deposited.

**NOTE!**

The offset should be arranged at any change from measurement system (sensor head) or magnetic tape



## 9 Interferences

The following chapters describe possible causes for malfunction and the instructions to correct them. If you encounter problems check for proper installation first. Make sure that power is supplied to the system. If you observe recurring errors you might consider electrical interference suppression measures as described in section 7. If errors cannot be corrected with the following instructions please contact the manufacturer (see last page).

### 9.1 Security

#### Basics



#### CAUTION!

##### Risks of injury from improper fault clearances!

Improper fault clearances can cause serious personal or property damage.

Therefore:

- Fault clearance may only be carried out by qualified and instructed personnel
- Prior to the beginning of work provide sufficient room to assemble the equipment
- Please look for cleanliness at the place of installation; loosely around laying parts and tools are sources of accidents

If components have to be replaced:

- Look for correct installation of spare parts
- All mounting elements have to be assembled correctly
- Before resetting please ensure that all covers and protective devices are installed correctly and function properly

To ensure a perfect operation of the controller the following (external) measures have to be taken additionally:

#### Place of installation:

The controller should not be installed near to sources of interference generating strong inductive or capacitive interferences or strong electrostatic fields. Install the external power supply directly beside the controller to avoid long low voltage wires.

## 9.2 Electrical interference suppression



Signal wires should be installed separately from load power lines and with a safe distance of at least 0.5 m to capacitive and inductive interferences such as contactors, relays, motors, switching power supplies, timed controllers.

If interferences occur in spite of applying all above mentioned measures proceed as follows:

1. Add RC elements over contactor coils of AC contactors (for example 0,1  $\mu$ F/100  $\Omega$ )
  2. Add recovery diodes over DC inductances
  3. Add RC elements over each drive phase (in connector box of the drive).
  4. Do not connect the GND potential with PE (earth potential)!
- Install a power filter before the external power supply

## 9.3 Restart after fault clearance

After fault clearance:

1. Reset emergency stop switch.
2. Quit disturbance on controller.
3. Make sure that no person is located in the danger zone.
4. Start operating as explained in the instructions.

## 9.4 EMC information

A trouble-free operation of the control devices of the company ELGO Electric GmbH can only be guaranteed if in assembly, wiring and operating the following basic rules are observed and adhered to:

- use only shielded signal lines with a minimum diameter of 0.15 mm<sup>2</sup>
- to protect against electrical fields, connect the cable shield unilaterally, low resistance and low inductive with the operating lightning protection.
- unused arteries in signal lines should be isolated from each other separately
- isolate signal and power lines separately in long parallel lines (a distance of 300 mm is respected ) therefore, should never be different voltage levels, e.g. 230V/50 Hz power supply and measuring signal 24V DC in one cable together
- low the emission by the Installation of filter networks in plants with frequency. In the operating instructions of the manufacturer FU find the appropriate instructions.
- wireless phones and Walky-talkies should never be used in the immediate vicinity of electronic devices

## 10. Maintenance

The unit works maintenance-free.

## 11. Type Designation EMAX

For orders please use the following order code:

### Sensor Head

EMAX -          -             -             -             -             -            

#### A SN-Number

- 000 ELGO standard
- 001 first special version
- 006 addressable, bus-compatible version

#### B Signal cable length (in XX,X meter)

- 01.5 1,5 m standard length

#### C Resolution

- 2 0,01 mm

#### D Interface

- 232 RS232
- 422 RS422
- SSI SSI via coding switch binary or gray adjustable
- CAN CANopen DS406

#### E Baudrate

- 0 9600 Baud (standard)
- 1 19200 Baud (option on request)
- 2 38400 Baud (option on request)

#### F Option

- V sealed version (IP65)
- I additional incremental output A/B

#### Example:

EMAX - 000 - 01.5 - 2 - 232 - 0 - V  
 A A A - B B . B - C - D D D - E - F

EMAX (ELGO standard) with 1,5 m cable length, with RS232 interface, 9600 Baudrate, sealed version (IP67).

#### Your order:

EMAX -          -             -             -             -             -

**Accessories:****Magnetic tape AB20-50-20-2-R-11:**

- 0,2 m minimum length
- 10,0 m maximum length

Art. No.: 731000110

**Guiding carriage FW2080:**

Art. No.: 734LF0003

**Guiding rail FS-1000 (1 m) / FS1500 (1,5 m) / FS-2000 (2 m) for EMAX with FW2080:**

- *name length of AB20-50-20-2-R-11* for guided version
- the magnetic tape will be glued at one piece in the guiding rail

**SSI/Profibus Converter PNO1:**

- Interface-Converter SSI to Profibus DP

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