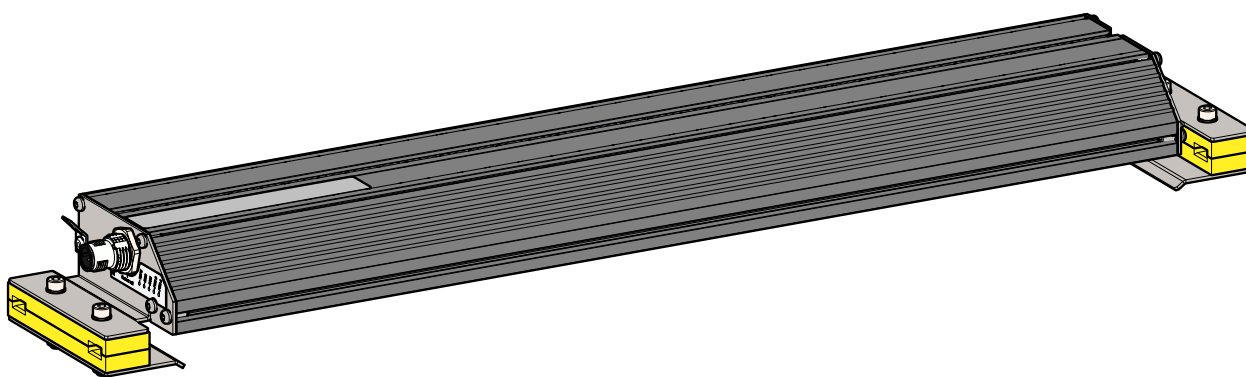


Operating Manual

LIMAX44 RED

Safe Magnetic Absolute Shaft Information System
(Translation of the original operating manual)



Registration No.:
968/FSP 1850.00/19

- Redundant sensor with integrated monitoring
- TÜV certified according to SIL 3 in compliance with EN 61508
- Absolute position always directly available – no reference journey even after long power failures
- RS-485 Interface
- Easy and flexible installation
- Silent measuring principle
- Immune to dirt, smoke and moisture
- Door zone indication for up to 127 floors
- Speeds up to 16 m/s

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2 General

2.1 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.




2.2 Terms and Abbreviations

Abbreviation/ Term	Explanation
Verified position	See <i>safe position data</i>
CPU	Central Processing Unit
CRC	Cyclic Redundancy Check
EEPROM	Electrically Erasable Programmable Read-Only Memory (is used as non-volatile data memory)
FS	Functional Safety
LSB	Least Significant Bit
Motorola format	When transmitting a value, the most significant byte is transmitted first. For a 32-bit value it is for example bit 24 ... bit 31
MSB	Most Significant Bit
MW	Mounting angle
RAM	Random Access Memory (main memory)
ROM	Read-Only Memory (program memory)
S-RMS	Mounting kit for rail mounting of the magnetic tape for safe sensors (Safe Rail Mounting Set), can be used for the semi-guided variant.
Safe evaluation unit	Device that receives the safe position data of the sensor and cuts the safety circuit in case of a disturbance. A safe position controller can fulfil the function of a safe evaluation unit.
Safe position data	This position information may be used for safety functions.
Unsafe position data	Position information that may not be used for safety function due to missing redundancy.
Safe state	In this mode the danger for passenger and environment is minimized. In the elevator industry, safe state means that the safety circuit of the elevator is opened and the cabin is stopped. Since LIMAX44 RED has no direct connection, it has to be connected to the safety circuit via the safe evaluation unit.


2.3 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 and damage and injuries.


Warning notes:

	<p>DANGER!</p> <p>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.</p>
	<p>WARNING!</p> <p>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.</p>
	<p>CAUTION!</p> <p>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.</p>

Special safety instructions:

	<p>DANGER!</p> <p>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.</p>
---	--

Tips and recommendations:

	<p>NOTE!</p> <p>... points out useful tips and recommendations as well as information for an efficient and trouble-free operation.</p>
---	---

References:

- (🔍 1.2) Marks a reference to chapter 1.2 of this manual.
- (📖 DOC 3.4) Marks a reference to chapter 3.4 of the document *DOC*.

2.4 Referenced Documents

Designation Type Article. No.	Description Download URL
LIMAX S-RMS-WH Mounting Instructions 799 000 670	Magnetic tape installation kit with tape detection and tension weight for high rise elevators https://support.elgo.li/man/D-103858
LIMAX S-RMS-H Mounting Instructions 799 000 971	Magnetic tape installation kit with tape detection and tension spring for high rise elevators https://support.elgo.li/man/D-103932
LIMAX44 RED Operating Manual 799 000 968	Original Operating Manual (German) https://support.elgo.li/man/D-101872

2.5 Statement of Warranties

The statement of warranties is enclosed separately in the sales documents.

Guarantee

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

2.6 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.

2.7 RoHS Conformity

LIMAX44 RED complies to the EU Directive on the restriction of the use of certain hazardous substances in electrical and electronic equipment (RoHS) 2011/65/EU and its amendment from EU Directive 2017/2102 of 15 November 2017.

3 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.

3.1 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.

3.2 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.

3.3 Conventional Use

The product described in this manual was developed to execute safety-related functions as a part of an entire assembly or machine. It is the responsibility of the manufacturer of a machine or installation to ensure the proper functioning of the system. The ELGO-device is only conceived for the conventional use described in this manual.

The LIMAX44 RED - ELGO- length measuring system only serves 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 Transport and Storage

4.1 Safety Instructions for Transport, Unpacking and Loading

**CAUTION!**

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

4.2 Handling of Packaging Material

Notes for proper disposal: ☞ 2.6

4.3 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.

4.4 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 Technical Data) needs to be observed
- Relative humidity (☞ 6 Technical Data) must not be exceeded
- Inspect packages regularly if stored for an extensive period of time (>3 months)

5 Product Features

LIMAX44 RED is an absolute shaft information system which is used for the positioning of elevator cabins. It is available in two different versions. In the unguided version, the measuring system consists of two components: Magnetic tape and sensor. The semi-guided version requires an additional presence detector to monitor the correct tape position.

The tape carries the unique position information as a magnetic code. In the unguided version, it is glued directly onto the guide rail of the elevator. In the semi-guided version, it is mounted freely suspended in the shaft and is guided along the sensor with a plastic guiding rail. The measurement is always contact free. The guiding only serves to keep the tape within a defined distance from the sensor.

The sensor reads the magnetic code from the tape and then provides the evaluation unit connected downstream with the position information.

The presence detector makes sure that the magnetic tape is in the intended position and remains there – after all, various safety functions depend on the position derived from the tape.

In the case of unguided installation, this monitoring can be omitted, as it can be assumed that the magnetic tape does not shift in its position.

According to EN 81-20/50 and previously EN 81-1/2 the use of programmable electronic systems in safety-relevant applications for lifts (PESSRAL) is allowed. LIMAX44 RED is designed and certified for those applications. The sensor is designed to be used as a safe sensor together with a safe evaluation unit (like for example in ELGO's LIMAX44 Safe) or directly with a safe controller unit. Together, the entire system is able to fulfil the safety functions in the elevator according to EN 81-20 and EN 81-21. The product is compatible to the previous norm EN 81-1/2 and may be used as modernization solution or as measuring range extension in existing installations. Fig. 1 shows the use in the two possible areas of operation as unguided variant, Fig. 2 as semi-guided variant.

The magnetic measuring principle is distinguished by its extremely high robustness. Dust, dirt and moisture do not affect the measurement in any way. Furthermore, as smoke and increased temperatures do not have any impact on the measurement, LIMAX44 RED is especially suitable for firemen's lifts. Thanks to its material composition, the tape itself is resistant enough to the rough conditions during the installation and operation of elevators.

Another advantage of the system is in its easy and flexible mounting. The installation itself can be carried out by an expert in just a few minutes. Depending on the space available, the system can be installed almost anywhere in the shaft. Since it requires little space, LIMAX44 RED is also suitable without restrictions for retrofitting and modernizations.

The LIMAX44 RED is able to cover lifting heights of up to 786 meters and speeds up to 16 m/s.

Overview of features:

- Robust measuring principle for rough conditions
- Easy and flexible mounting
- High accuracy and repeatability
- No slip
- Absolute position always directly available – no reference journey even after long power failures
- Compatible with many established position controllers with absolute encoder interface.
- High speeds possible

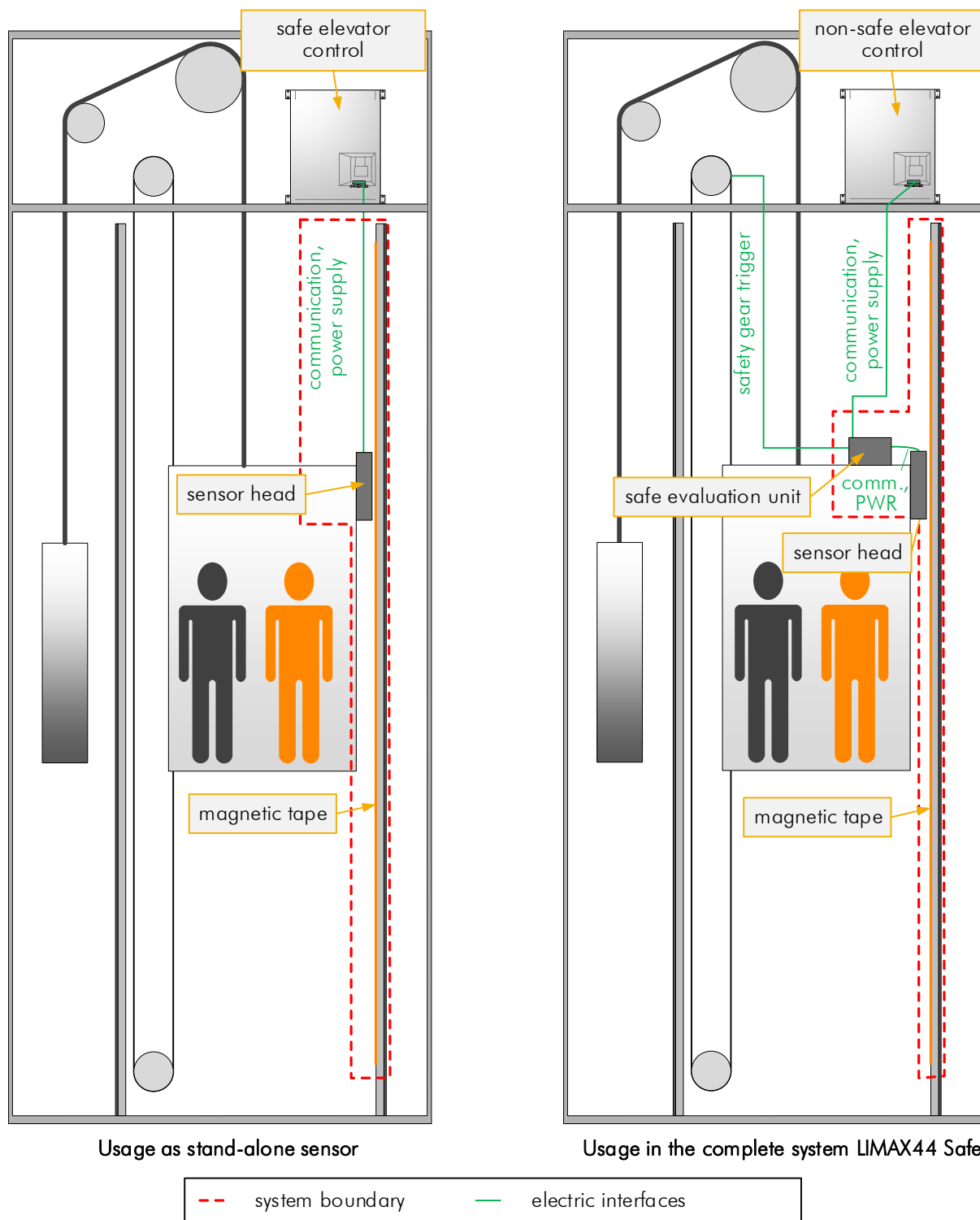


Fig. 1: LIMAX44 RED as unguided variant in combination with a safe controller (left) or in combination with the safe evaluation unit Safe Box as the complete system LIMAX44 Safe (right)

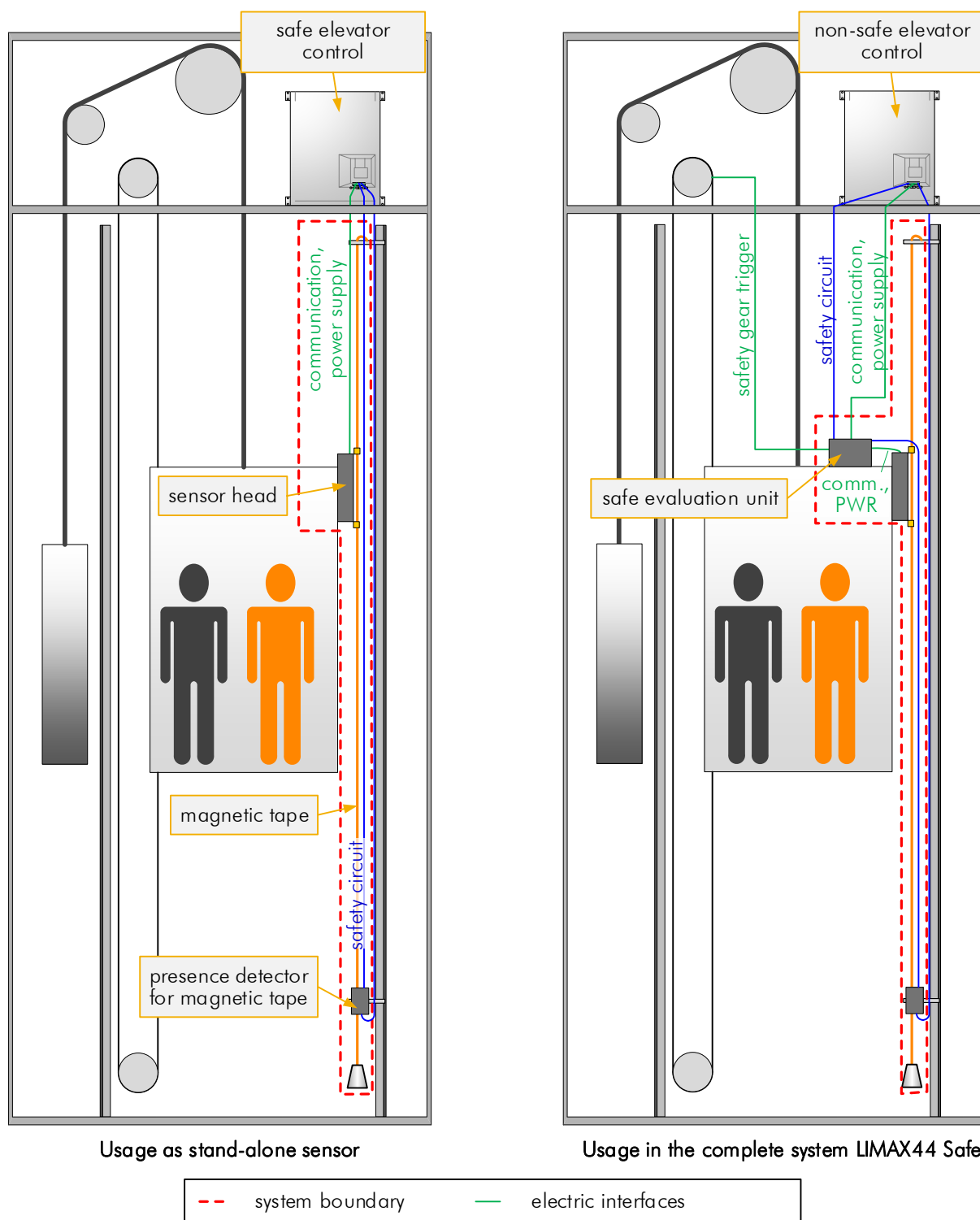


Fig. 2: LIMAX44 RED as semi-guided variant in combination with a safe controller (left) or in combination with the safe evaluation unit Safe Box as the complete system LIMAX44 Safe (right)

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, chapter 7) with the corresponding part number. Furthermore, the type label contains a unique, traceable device number, the production date as well as the hardware and software versions.

When corresponding with ELGO always indicate this data.



Fig. 3: Type label for identification of the sensor

Also, there is an info label on the sensor that gives the following additional information on the sensor: manufacturer, supply voltage, power consumption, CRC check sum of the software and the registration number of the certificate.

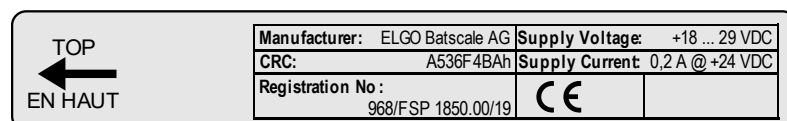


Fig. 4: Info label with additional information

6.2 Safety Parameters

Designation	Value	Remark
Safety Integrity Level	SIL 3	
PFH [1/h]	2.2 E-9	2.2 % of SIL 3
PFD _{avg}	1.9 E-4	19 % of SIL 3
Proof Test Interval T ₁	20 years	

6.3 Technical Data Magnetic Tape and Presence Detector

Schmersal ZS 236-02ZR-1519

Regulations:	IEC/EN 60947-5-1 BG-GS-ET-15
Operating temperature:	-30 °C ... +80 °C
Dimensions (without cable):	L x B x H = 58.5 x 30 x 30 mm
Protection class:	IP67
Usage category:	AC-15; DC-13
I _e /U _e	4 A / 230 VAC; 1 A / 24 VDC
Short-circuit protection:	6 A gL/gG D-fuse
Terminal cross-section:	min. 1.5 mm ² ; max. 2.5 mm ² (incl. cable end sleeves)
Min. movement for triggering:	2.5 mm
Min. actuating force for triggering:	4.5 N

Bernstein IN62-SA2ZB SK

Regulations:	IEC/EN 60947-5-1
Operating temperature:	-30 °C ... +75 °C
Dimensions (without cable):	L x B x H = 62 x 31 x 30.3 mm
Protection class:	IP67
Usage category:	AC-15; DC-13
I _e /U _e	3 A / 240 VAC; 1,5 A / 24 VDC
Short-circuit protection:	4 A gG fuse
Terminal cross-section:	min. 0.34 mm ² ; max. 1.5 mm ² (incl. cable end sleeves)
Min. movement for triggering:	2.5 mm
Min. actuating force for triggering:	5 N

6.4 Dimensions Sensor

6.4.1 Unguided variant

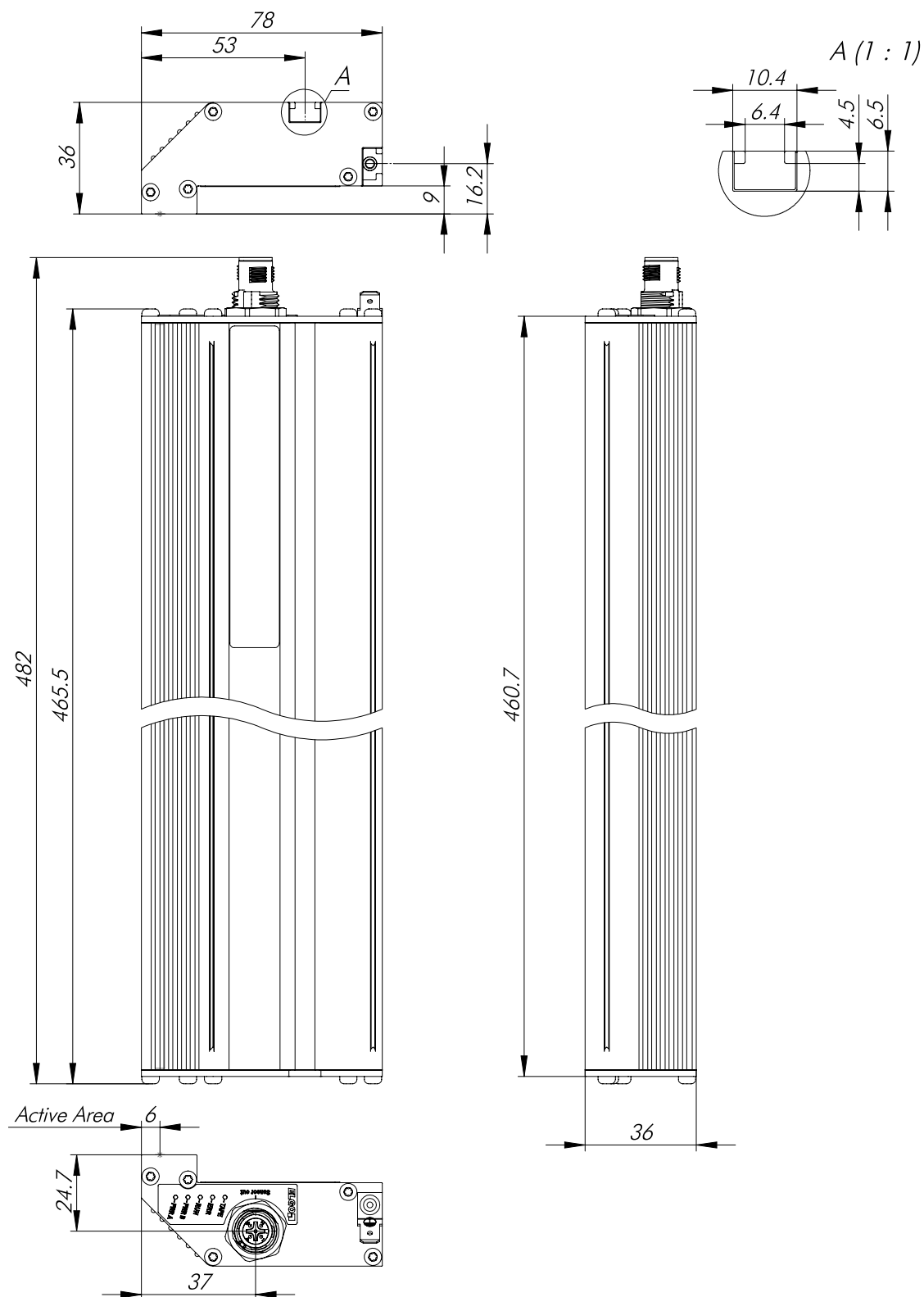


Fig. 5: Dimensions LIMAX44 RED variant unguided

6.4.2 Semi-guided variant

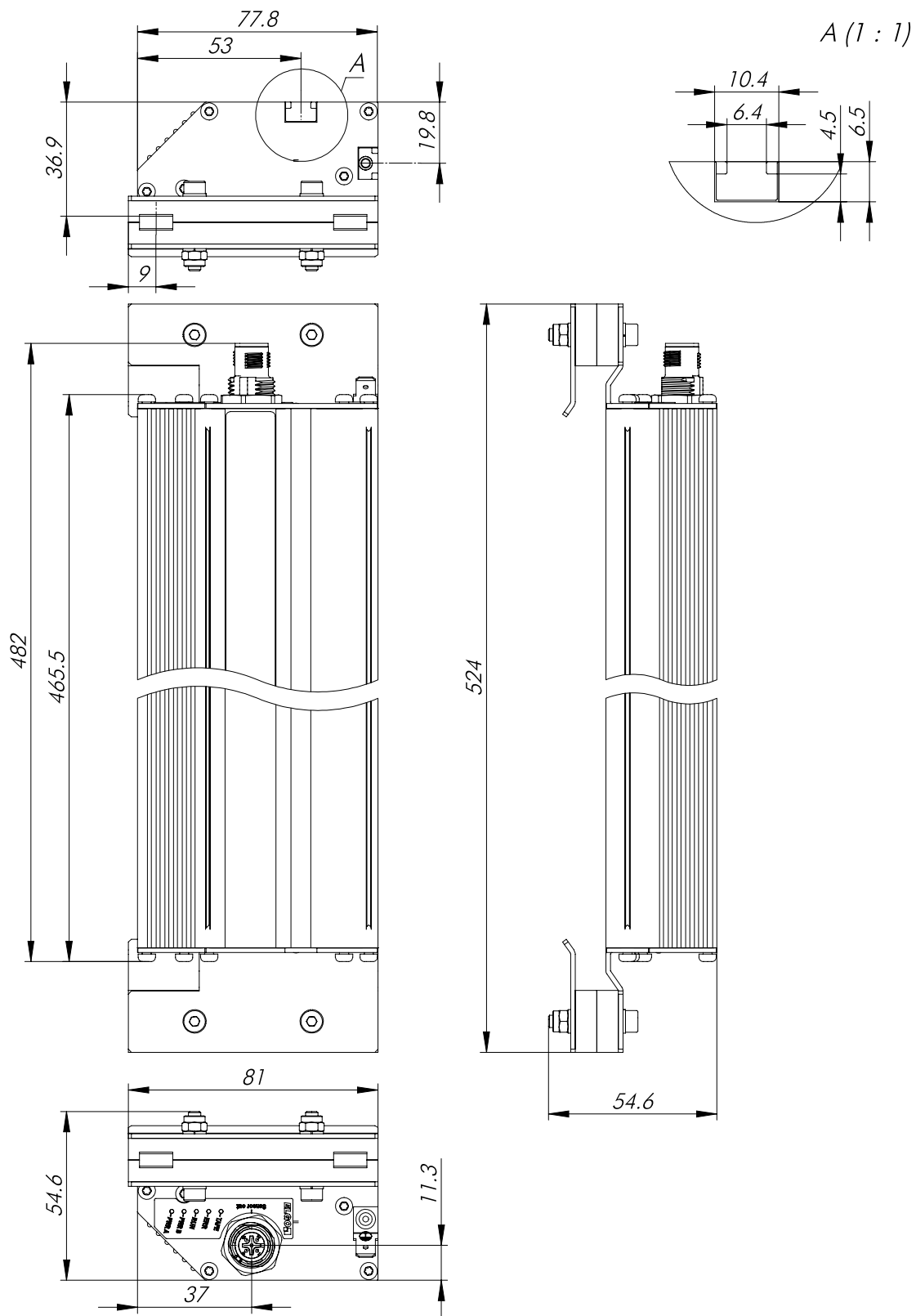


Fig. 6: Dimensions LIMAX44 RED variant semi-guided

6.5 Technical Data Sensor

LIMAX44 RED (Standard version)

Mechanical Data

Measuring principle:	absolute
Measurement:	linear
Maximum measuring length	786 m
Speed:	max. 16 m/s
Resolution:	☞ 7 Type Designation
Repeat accuracy:	+/- 1 Increment
System accuracy at 20°C:	+/- (1000 µm + 100 µm x L[m]) L = measuring length in meter
Distance from sensor to magnetic tape	4.5 mm (semi-guided variant) max. 8 mm (unguided variant)
Dimensions (without cable):	semi-guided variant: L x W x H = 524 x 81 x 55 mm unguided variant: L x W x H = 482 x 78 x 36 mm
Housing material:	aluminium
Connection:	circular plug 5-pole M12 (more options as cable ☞ 11.4 Connection Cable)
Weight without cable:	approx. 1030 g (semi-guided) / 820 g (unguided)

Magnetic tape

Necessary type:	semi-guided variant: AB20-80-120-10-1-R-D-16-BK80 unguided variant: AB20-120-20-1-R1-C-16A-4943F (0 m ... 285 m) AB20-120-20-1-R1-C-16B-4943F (285 m ... 570 m) AB20-120-20-1-R1-C-16C-4943F (570 m ... 786 m)
-----------------	---

Conditions

Storage temperature:	-20 °C ... +85 °C
Operation temperature:	-10 °C ... +70 °C
Humidity:	max. 95 %, non-condensing
Protection class:	IP54 (according to EN 60529)
Operation height:	max. 2000 absolute altitude
EMC transient emission/immunity:	according to EN 12015 / EN 12016
Vibration/shock resistance:	according to EN 60068-2-6 / EN 60068-2-27

Electrical Data

Supply voltage:	+ 18 ... 29 VDC (stabilized) in dual-channel operation (☞ 9.2.1) + 10 ... 18 VDC (stabilized) in single-channel operation (☞ 9.2.2) You must use a power supply with Safety Extra Low Voltage (SELV) or Protective Extra Low Voltage (PELV).
Residual ripple:	< 100 mVpp
Reverse voltage protection:	integrated
Power input:	max. 200 mA @ 24 VDC without loading the output for the door zone indication
Interfaces:	RS-485
Protection of the outputs/ interfaces:	RS-485 output: short-circuit-proof output door zone indication: short-circuit-proof to GND, but not to

	+24V
Cable length:	according to EIA RS-485 specifications
Maximum operating time ¹⁾	20 years

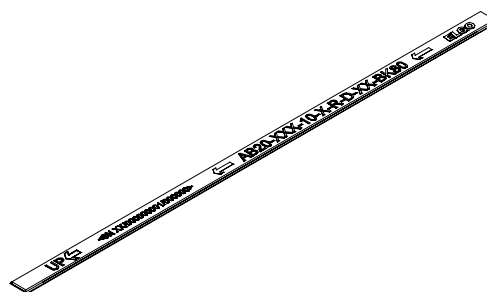
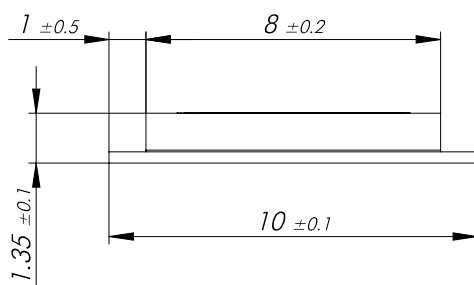
¹⁾ After this time the device must be replaced.

6.6 Technical Data Magnetic Tape

The magnetic tape consists of two components:

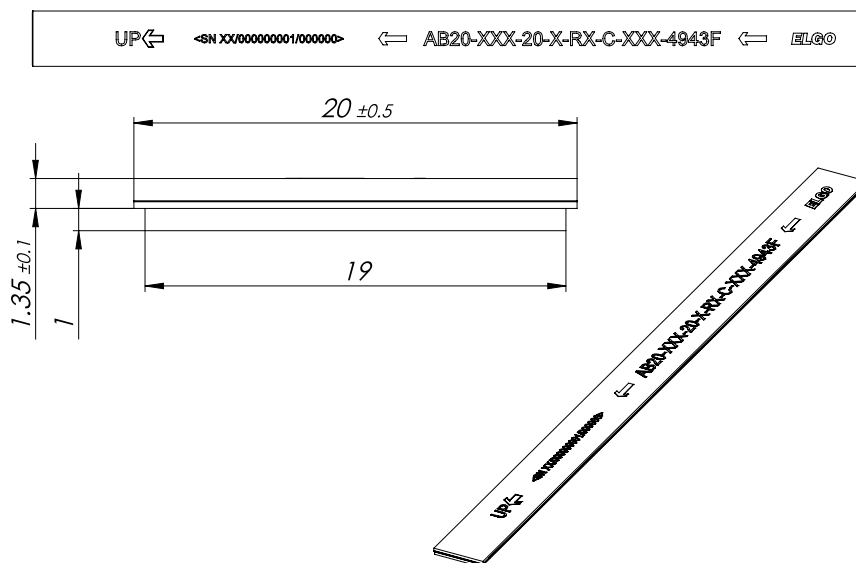
- The actual magnetic tape which carries the position information
- A mechanical stainless steel back iron

UP	<SN XX/000000001/000000>	AB20-XXX-10-X-R-D-XX-BK80	ELGO
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Magnetic Tape AB20-120-10-1-R-D-16-BK80 (for semi-guided variant)

Coding:	absolute, ELGO 16 Bit
Basic pole pitch:	12 mm (± 0.05 mm)
Maximum tape length:	up to 300 m per role available, other lengths up to 786 m on request
Maximum length error:	± 200 µm/m
Operation temperature:	-20 °C ... +70 °C
Storage temperature:	short-run: -40 °C ... +85 °C medium-run: -20 °C ... +70 °C
Relative humidity:	max. 95 %, non-condensing
Dimensions:	B / B1 x H = 10 mm (± 0.1) / 8 mm (± 0.2) x 1.35 mm (± 0.1)
Linear expansion coefficient:	$\alpha \approx 16 \times 10^{-6} \text{ 1/K}$
Linear thermal expansion:	$\Delta L[\text{m}] = L[\text{m}] \times \alpha[1/\text{K}] \times \Delta \vartheta[\text{K}]$ (L = tape length in meter, $\Delta \vartheta$ = relative change in temperature)
Bend radius:	min. 150 mm
Weight of magnetic tape	ca. 52 g/m
Tape imprint	ELGO Standard, colour black, front size ≥ 5 mm
External magnet:	External magnetic fields shall not exceed 64 mT (640 Oe; 52 kA/m), otherwise the magnetic coding will be damaged or destroyed.
Protection:	Back iron stainless steel (1.4310)


Magnetic Tape AB20-120-20-1-R1-C-16x-4943F (for unguided variant)

Coding:	absolute, ELGO 16 Bit
Basic pole pitch:	12 mm (± 0.05 mm)
Maximum tape length:	300 m per role / tape section longer tapes must be composed of several segments of 285 m each.
Maximum length error:	$\pm 200 \mu\text{m/m}$
Operation temperature:	$-10\text{ }^{\circ}\text{C} \dots +70\text{ }^{\circ}\text{C}$
Storage temperature:	short-run: $-10\text{ }^{\circ}\text{C} \dots +60\text{ }^{\circ}\text{C}$ medium-run: $+50\text{ }^{\circ}\text{C}$ at 50% RH
Relative humidity:	max. 95 %, non-condensing
Dimensions:	$B \times H = 20\text{ mm } (\pm 0.1) \times 2.45\text{ mm } (\pm 0.1)$
Linear expansion coefficient:	$\alpha \approx 11 \times 10^{-6} \text{ 1/K}$
Linear thermal expansion:	$\Delta L[\text{m}] = L[\text{m}] \times \alpha[1/\text{K}] \times \Delta\vartheta[\text{K}]$ (L = tape length in meter, $\Delta\vartheta$ = relative change in temperature)
Bend radius:	min. 150 mm
Weight of magnetic tape	ca. 140 g/m (incl. adhesive tape and carrier)
Tape imprint	ELGO Standard, colour black, front size ≥ 6 mm
External magnet:	External magnetic fields shall not exceed 64 mT (640 Oe; 52 kA/m), otherwise the magnetic coding will be damaged or destroyed.
Protection:	Back iron stainless steel (1.1248)
Adhesive tape:	3M 4943F

7 Type Designation

Example: LIMAX4R - 02 - CON - 62N5 - 485X - M12M

Device designation:

LIMAX4R = LIMAX44 RED (2-channel)

Version:

02 = semi-guided variant

52 = unguided variant

Cable length:

CON = no cable, direct attached connector

Resolution:

62N5 = $62.5 \mu\text{m}$ = 0.0625 mm

Interface:

485X = RS485 [special protocol, separately defined via the special version number]

NOTE:

→ RS485-Interface is always terminated!


Connector-Options:

M12M = 5-pin M12-circular plug

[Number of pins/pin assignment depending on the chosen interface]

7.1 Available Versions

Order Reference	Description
LIMAX4R-02-CON-62N5-485X-M12M	RS-485 Interface; Resolution $62.5 \mu\text{m}$; 5-pin circular plug M12; semi-guided variant
LIMAX4R-52-CON-62N5-485X-M12M	RS-485 Interface; Resolution $62.5 \mu\text{m}$; 5-pin circular plug M12; unguided variant

Cables for connecting the sensor can be found under  11.4 Connection Cable

8 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.

On the installation of the LIMAX44 RED system, the national regulations and as far as applicable the EN 81-20 (previously EN 81-1/2) are to be considered.

8.1 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.

8.2 General Information

When observing some principles during the installation, LIMAX44 RED requires minimal effort during installation and operation and has a long operating life.

One basic principle is the protection of the magnetic tape against mechanical wear. This can be achieved through correct mounting.

Before starting with the installation in the shaft, please carefully read the chapters concerning the mounting of the magnetic tape (☞ 8.3) and the sensor (☞ 8.5) in order to get an idea of the mounting possibilities and get an idea of the critical points.

8.3 Mounting of the Magnetic Tape

8.3.1 Unguided variant

In the unguided version, the magnetic tape is glued in the groove of the elevator rail or on an additional carrier tape with the supplied adhesive tape. The installation is dependent on and different parameters, which are dependent on the manufacturer of the complete lift. ELGO cannot provide exact installation instructions for this.



NOTE!

When mounting the magnetic tape, the points concerning the alignment of the sensor to the magnetic tape and the bonding (☞ 8.6.2) must be taken into account.



WARNING!

The magnetic tape must be mounted in such a way that it cannot move out of its original position by more than a certain amount during normal operation under consideration of environmental conditions (e.g. temperature fluctuations) or that the tape position at any point of the magnetic tape does not move away from its original position by more than this amount.

In order to guarantee this, either an appropriate mechanical construction is necessary or the position of the magnetic tape must be monitored with a presence detector (equivalent type as defined in ☞ 6.3). As soon as the position exceeds a critical value, the safety circuit must be opened immediately, as the positions read in by the sensor are no longer correct in this case.

8.3.2 Semi-guided variant

The tape is mounted freely suspended in the shaft.

- Mounting of the Tape along the Guiding Rail with Tension Weight (☞ 8.3.2.1)

This way of mounting prevents extreme misalignments of the tape and simplifies the installation.

In principle the tape can be mounted vertically. However, experience has shown that this kind of mounting is not absolutely suitable for the elevator. Therefore we recommend a slight horizontal offset between the tape and the sensor. Due to this pre-tension, the steel side of the tape will always be slightly pushed against the plastic guiding rails and optimal functioning is ensured. Fig. 10 on page 28 and Fig. 14 on page 31 show the correct installation position of the sensor in relation to the magnetic tape.

ELGO offers mounting kits for the fixation of the magnetic tape:

- LIMAX S-RMS-WH: Mounting kit for the fixation on the rail with tension weight

- LIMAX S-RMS-H: Mounting kit for the fixation on the rail with tension springs

**NOTE!**

Other types of mounting for the magnetic tape used for the LIMAX series such as mounting the tape with dowel and tension spring on the shaft ceiling are not certified and must **not** be used!

Further information on the ELGO mounting kits can be found in the chapter Accessories on page 53.

8.3.2.1 Mounting of the Tape along the Guiding Rail with Tension Weight

The magnetic tape is attached with a mounting kit at the top and the bottom of the shaft on a guiding rail. The lower tape fixation prevents the tape from swing back and forth in the shaft and for mounting the presence detector.

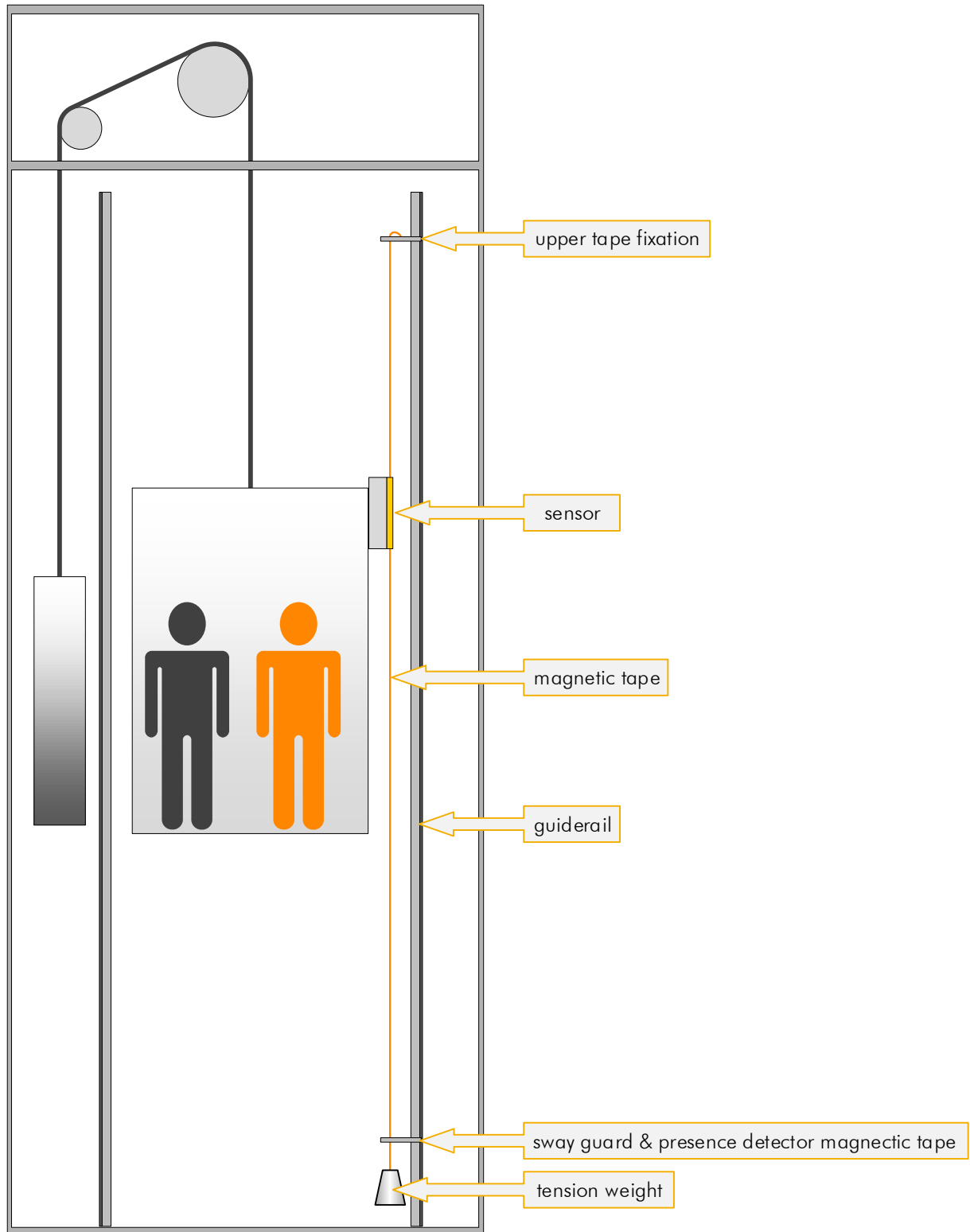


Fig. 7: Mounting of the tape on the guiding rail with tensions weight

ELGO offers the LIMAX S-RMS-WH mounting kit (☞ 11.1) for the fixation of the guiding rail.

8.3.2.2 Mounting of the Tape along the Guiding Rail with tension spring

The magnetic tape is attached to a guide rail at the top and bottom of the shaft using a mounting kit. At the lower attachment, pre-tensioned springs provide the necessary stability for the hanging magnetic tape and ensure that it does not begin to oscillate uncontrolled in the shaft. In addition, a presence detector ensures that the lift can only move if the magnetic tape is in the correct position.

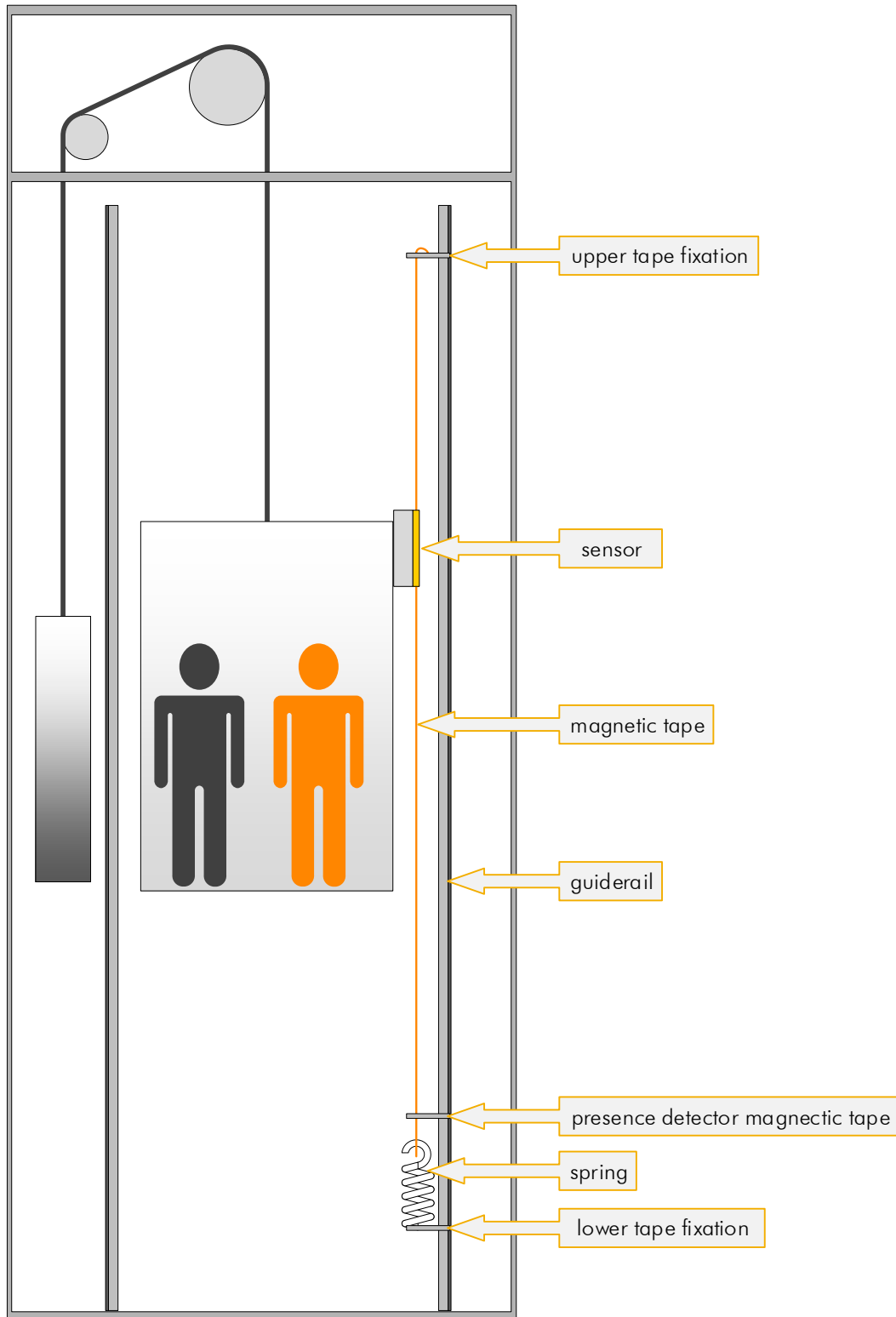


Fig. 8: Mounting of the tape on the guiding rail with tensions spring

ELGO offers the LIMAX S-RMS-H mounting kit (☞ 11.1) for the fixation of the guiding rail.

8.4 Mounting of the Magnetic Tape Presence Detector

This subchapter concerns only the semi-guided variant.

The normally closed contact of the presence detector has to be integrated into the safety circuit at a non over-bridgeable place before the main contactors. It is mechanically mounted with the fixture that is contained in the mounting kit S-RMS-WH (☞ 10.1).

8.5 Mounting of the Sensor

The sensor is mounted on the cabin or the cabin frame. The mounting position is generally predetermined by the situation on site

The integrated mounting grooves on the housing of the measuring system enable a very easy and self-explanatory mounting on three sides. Any M6 hexagon screws (according to DIN933) or M6 square nuts (according to DIN562) can be inserted in order to attach the system at the desired position.

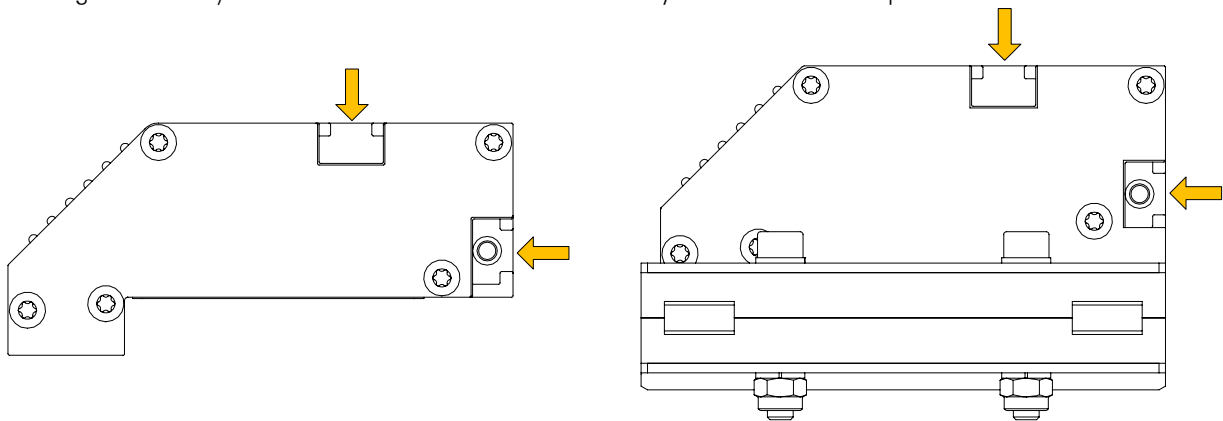


Fig. 9: Mounting grooves on the sensor in the unguided variant (left) and the semi-guided variant (right)

ELGO offers the LIMAX44 RED mounting angle (☞ 11.2) for the mounting of the sensor on the cabin roof.



NOTE!

When mounting the sensor or inserting the magnetic tape into the guiding rail, the arrows on the tape and the sensor need to be observed.

A wrong orientation does not provide the correct position!

The arrows on the magnetic tape and the sensor point towards the positive counting direction and must point in the direction of the shaft head!

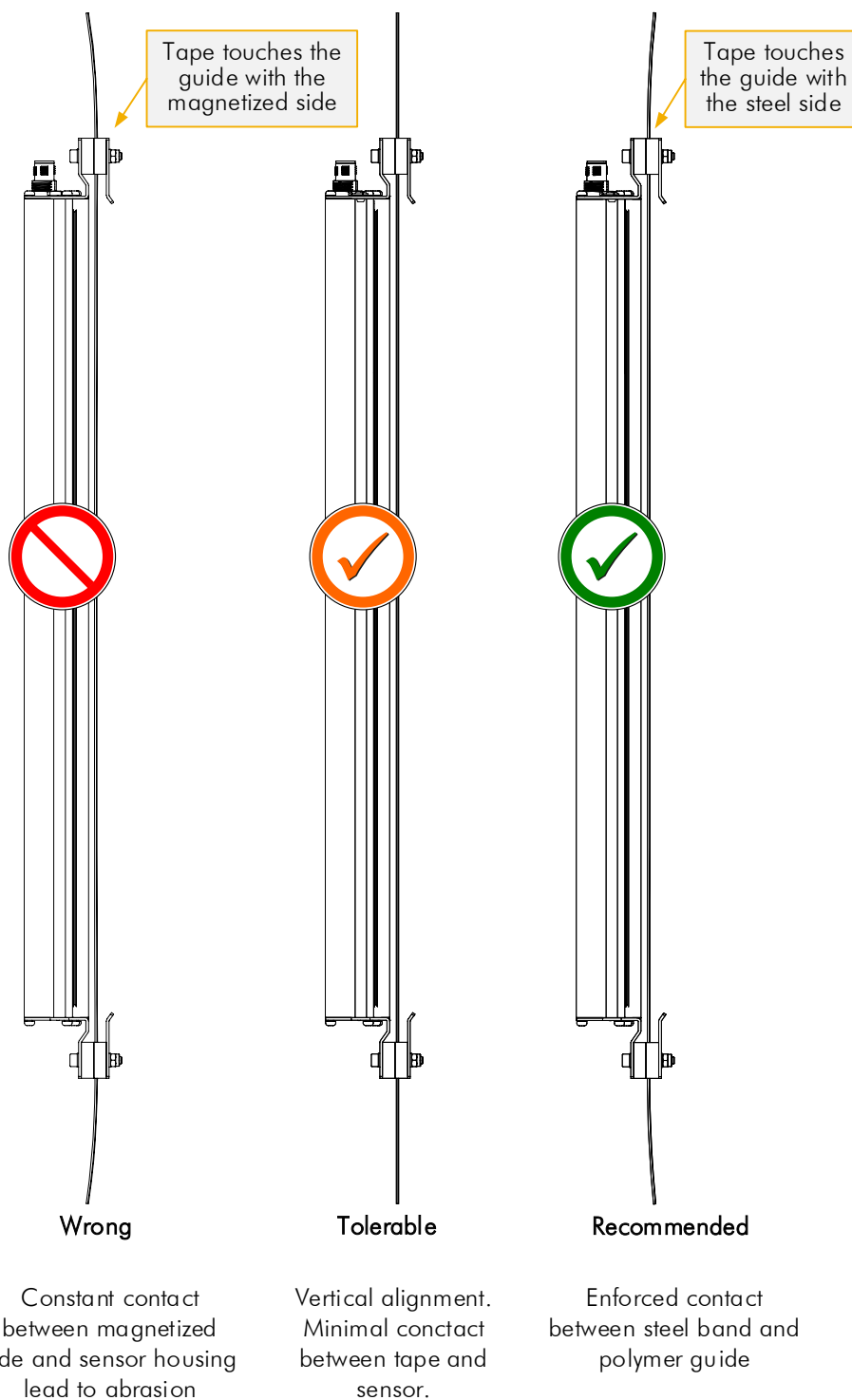


Fig. 10: Assessment of the pretention of the magnetic tape



NOTE!

The magnetic side of the tape is not designed for permanent mechanical wear in form of friction. Therefore the mounting in the lift needs to be done in such way that the contact primarily exists between the steel tape and the plastic guiding rail of the sensor. These two materials are intended for such operation.

8.6 Installation Procedure

The installation differs between unguided and semi-guided variants. The following two subchapters deal with the installation details of the respective variant.

8.6.1 Semi-Guided Variant

The semi-guided LIMAX44 RED can generally be mounted in any position in the shaft. This makes for maximum flexibility for retrofitting and modernizations.

1. Attach the top end of the tape in the shaft head using an ELGO mounting kit. Check for correct orientation. The imprinted arrows must point towards the shaft head.
Please see the details of the mounting in the manual for the mounting of the magnetic tape (§ 2.4).



Fig. 11: Correct orientation of the magnetic tape

2. The printed side of the tape (magnetic side) faces towards the sensor. The steel side therefore normally faces towards the wall of the shaft.
3. Drive down the shaft in inspection mode and unroll the tape in the process. The carton packaging of the tape is designed so that the tape can be unrolled directly out of the package and therefore always is ideally protected. It is therefore not necessary to open the packaging.
4. For the next step in the installation, you have to enter the shaft pit. Strictly observe the applicable safety regulations when doing so. For the electrical installation of the magnetic tape presence detector, de-energize the safety circuit.
Fasten the bottom end of the magnetic tape in the shaft pit using the mounting kit and connect the magnetic tape presence detector at a non-overbridgeable place in the safety circuit. To do this, the safety circuit is cut in a suitable way at a non-overbridgeable place before the main contactors. The cut safety circuit is closed again via the normally closed contact (contact pair 21-22) of the position switch. The normally open contact must **not** be used.
Please see the details of the mounting in the manual for the mounting of the magnetic tape (§ 2.4).



NOTE!

Make sure that the tape is really installed vertically. Tighten the spring as described in the manual of the magnetic tape mounting kit. A slightly higher pre-tension is also acceptable. However, do not tighten the spring less than what is stated in the manual. Especially in higher buildings, the tension can be increased in order to prevent the tape from moving during operation.

5. Drive the cabin to the middle of the shaft.
6. Attach the sensor on the cabin with the plug connection facing upwards.
7. Adjust the position of the sensor using the tape as a reference. First align the sensor and magnetic tape on their centerline. (Step 7 in Fig. 12).

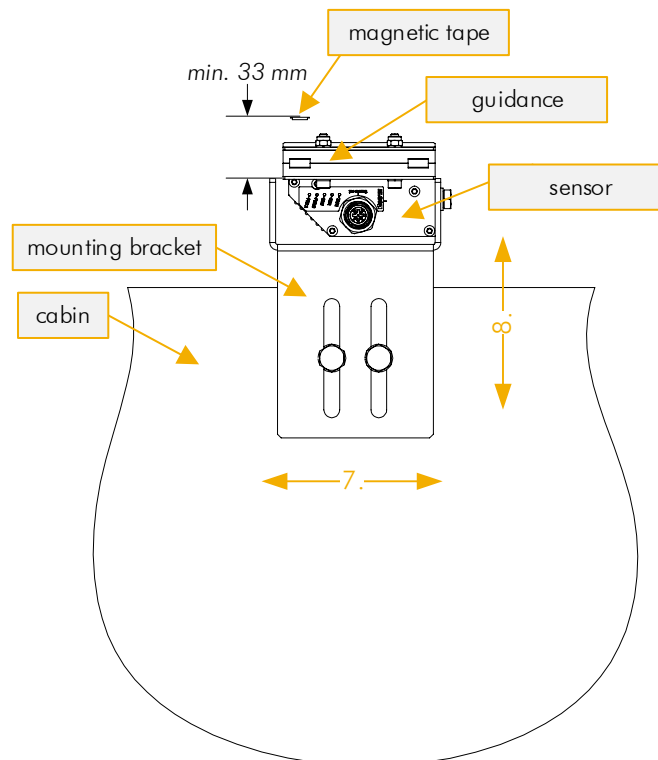


Fig. 12: Distance and orientation of the magnetic tape in relation to the sensor.

8. Now adjust the distance between the tape and the sensor. For lifting heights up to 50 m we recommend a distance of minimum 33 mm. This offset will ensure that the tape is correctly guided along the steel side during operation. The distance can be increased later if it turns out that the tape still rubs against the sensor with the magnetic side. In higher lifts, the distance can already be increased up to 5 cm at the initial mounting. Make sure that the sensor is installed vertically. Misalignment will lead to an increased wear.
9. Now pass the tape through the sensor. Loosen the screws (Fig. 20 on page 39) to fix the polymer guides and remove them. Then remount them with the tape in between.
10. Check for correct mounting. Any irregularities and angular offsets have to be corrected!

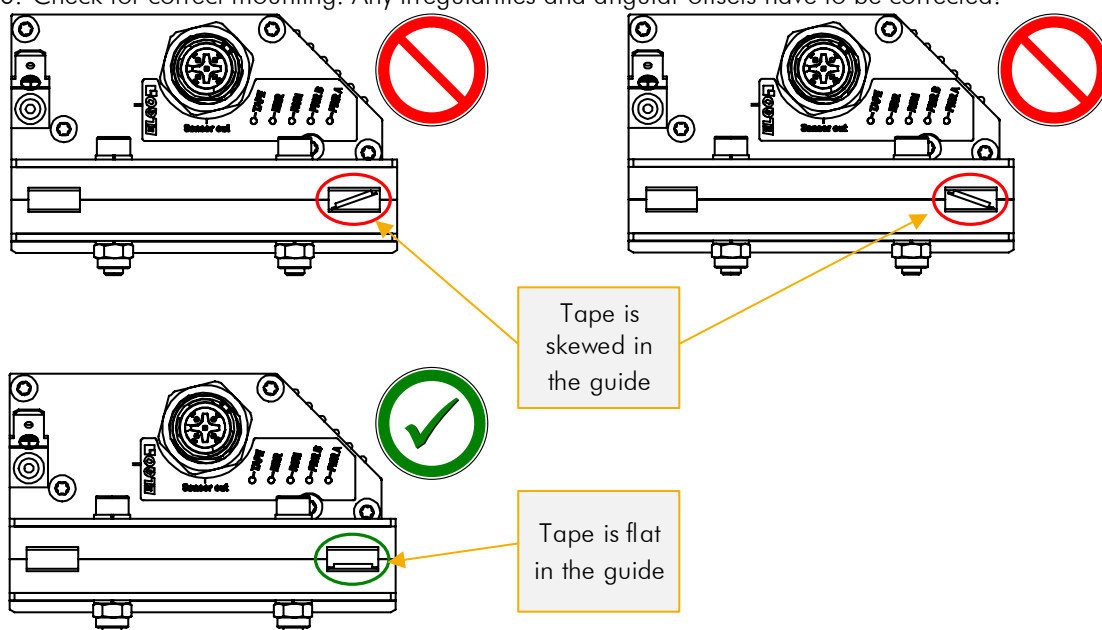


Fig. 13: Assessment of the guiding rail of the tape in the sensor – twisted magnetic tape

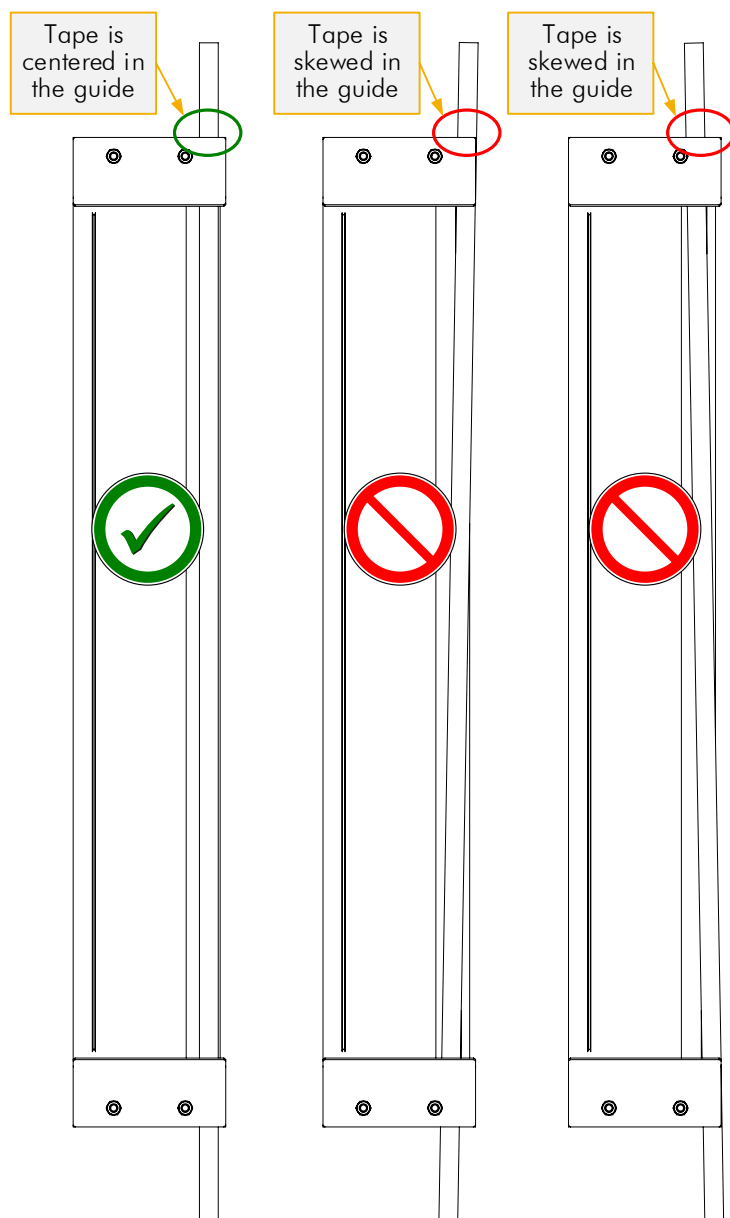


Fig. 14: Assessment of the guiding rail of the tape in the sensor – skewed mounting of the magnetic tape

11. IMPORTANT: Installation check!

The tape tension and the offset of the sensor are recommended values based on experience. **What is essential, however, is that the tape does not constantly rub on the sensor with the magnetic side during operation.** Occasional contact due to movement of the tape is not critical. Therefore, run an inspection travel along the complete lifting height and control the distance between the tape and the guiding rail. If the steel side is slightly pressed against the plastic guide the whole time, the mounting is ideal. Also check the bottom side of the sensor at some points. If the sensor is slightly tilted, it is possible that the tape slides perfectly into the guiding at the upper end but still touches the sensor with the magnetic side at the lower end.

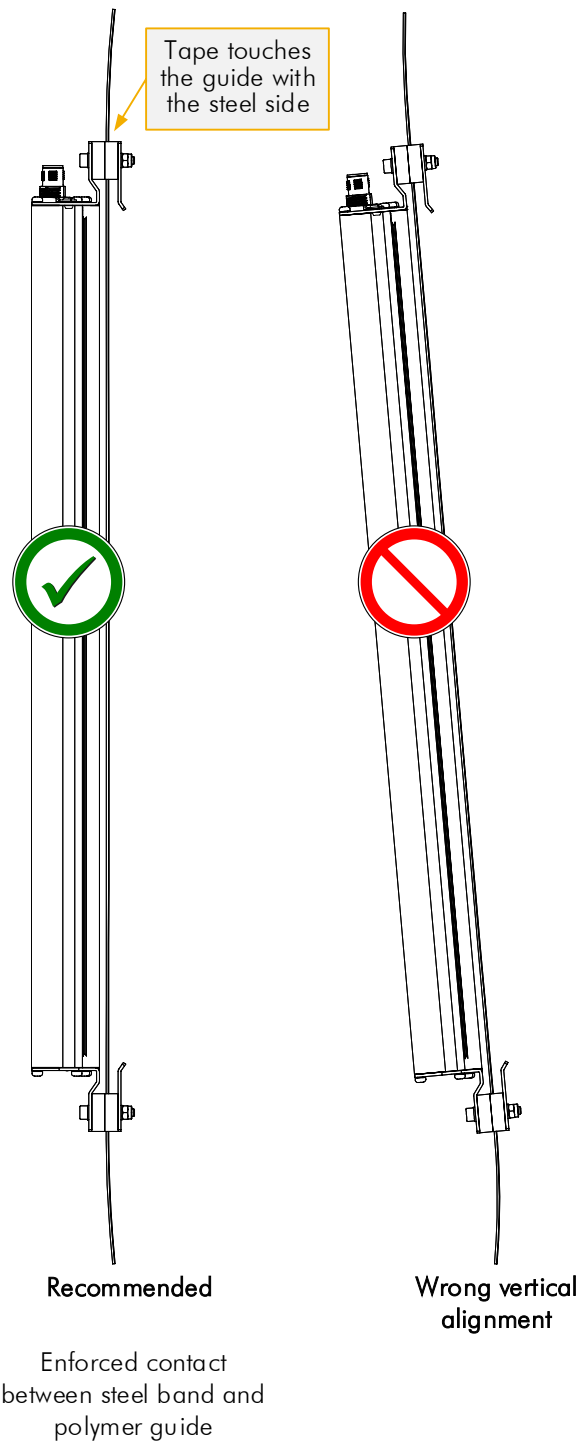






Fig. 15: Assessment of the vertical alignment of the sensor

12. If the installation check shows that the magnetic side of the tape rubs against the sensor, first increase the offset between the sensor and the tape. Up to 5 cm are acceptable without problems. If this measure is not successful, it is probable that the tape is not suspended straight in the shaft. You can easily check that by taking the tape out of the guiding rail and performing an inspection travel along the lifting height. While doing this, observe the distance between the tape and the sensor. Also make sure that the tension of the tape is sufficient. If the tape is fixated too loosely, this complicates correct guiding and a high offset between the tape and the sensor is necessary.
13. **After completion of the installation clean the tape.** Beginning at the top of the shaft drive down the complete travel distance pulling the magnet tape through a dry clean cloth.

	<p>NOTE!</p> <p>Be specifically alert if steel construction work is taking place in the shaft. Steel particles released by grinding, welding or such work will adhere to the magnetic tape. The tape is insensitive to fine metal dust. However, <u>coarser</u> metal chips can cause problems. Clean this debris off instantly.</p>
	<p>DO NOT USE A MAGNET FOR CLEANING!</p> <p><u>Never</u> use a magnet to remove metal chips from the magnetic tape. This will destroy the magnetic code and thus the magnetic tape.</p>
	<p>PROTECTIVE GLOVES!</p> <p>Always wear protective gloves when cleaning the magnetic tape.</p>

14. Repeat the cleaning process before setting the elevator into operation.
15. Check the function of the magnetic tape presence detector. To do this, pull the tape about 60 mm upwards until the bolt of the position switch is actuated. Leave the shaft pit and make sure that all doors are closed. Try to move the cabin electronically. This must not be possible. Go back to the shaft pit and make sure that the tape clamp with the spring is set back into the correct vertical position in relation to the position switch and the crossbeam and reset the bolt into the original position with a screw driver. Leave the shaft pit and make sure that all doors are closed. Try again to move the cabin electronically. This must now be possible.

	<p>WARNING!</p> <p>Observe the applicable safety requirements for entering the shaft pit during this step.</p>
---	---

8.6.2 Unguided Variant

The unguided LIMAX44 RED is mounted on a guide rail or other support. Since the mounting is strongly dependent on the environment, the details cannot be dealt with in this chapter. It is the user's responsibility to ensure that the system is properly installed in accordance with the instructions given in this chapter.

1. Fasten the tape in the shaft so that the position is continuous upwards.

Clean the surface so that it is free of dust, grease, oil or other separating agents and allow the surface to dry if necessary.

Before mounting, check the correct order of the tape segments (A bottom, B centre, C top) and their orientation. The printed arrows must point to the head of the shaft.

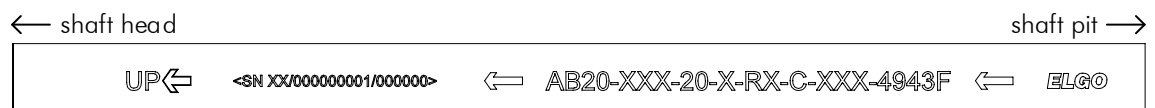
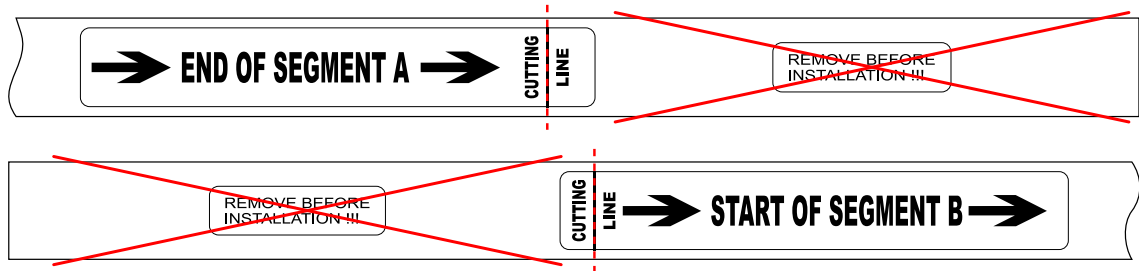
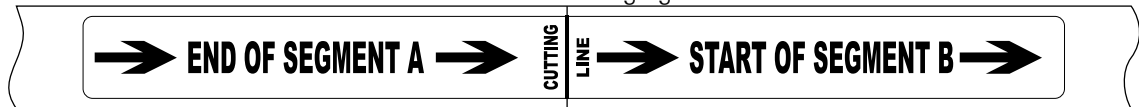


Fig 16: Correct direction of magnetic tape

At the transition points between two tape segments, disconnect the protective pole at the marked point before sticking the magnetic tape. The optimum contact pressure is 4 - 5 kg/cm².



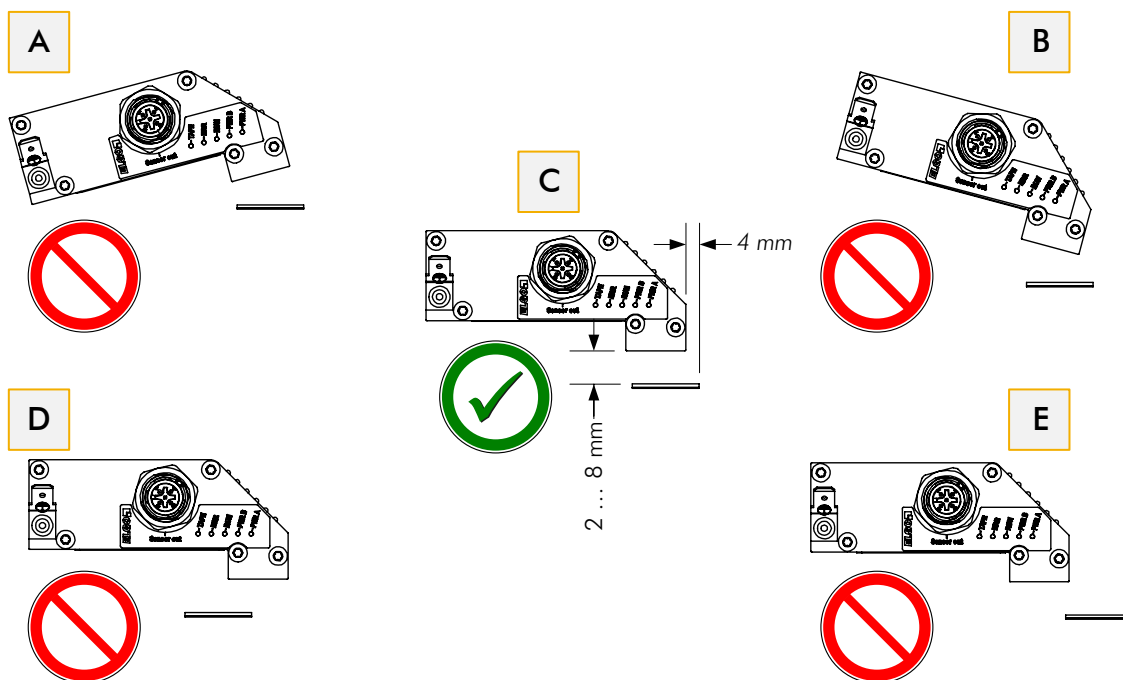
In the case of longer measuring ranges consisting of more than one tape segment, care must be taken to ensure that the segments are not laterally offset at the transition between the two segments and are close to each other at the ends as shown in the following figure.



NOTE!

Ensure a proper vertical tape mounting.
If the order of the tape segments is wrong, a wrong position will be read during the transition from one segment to the next and the sensor will go into the error state.

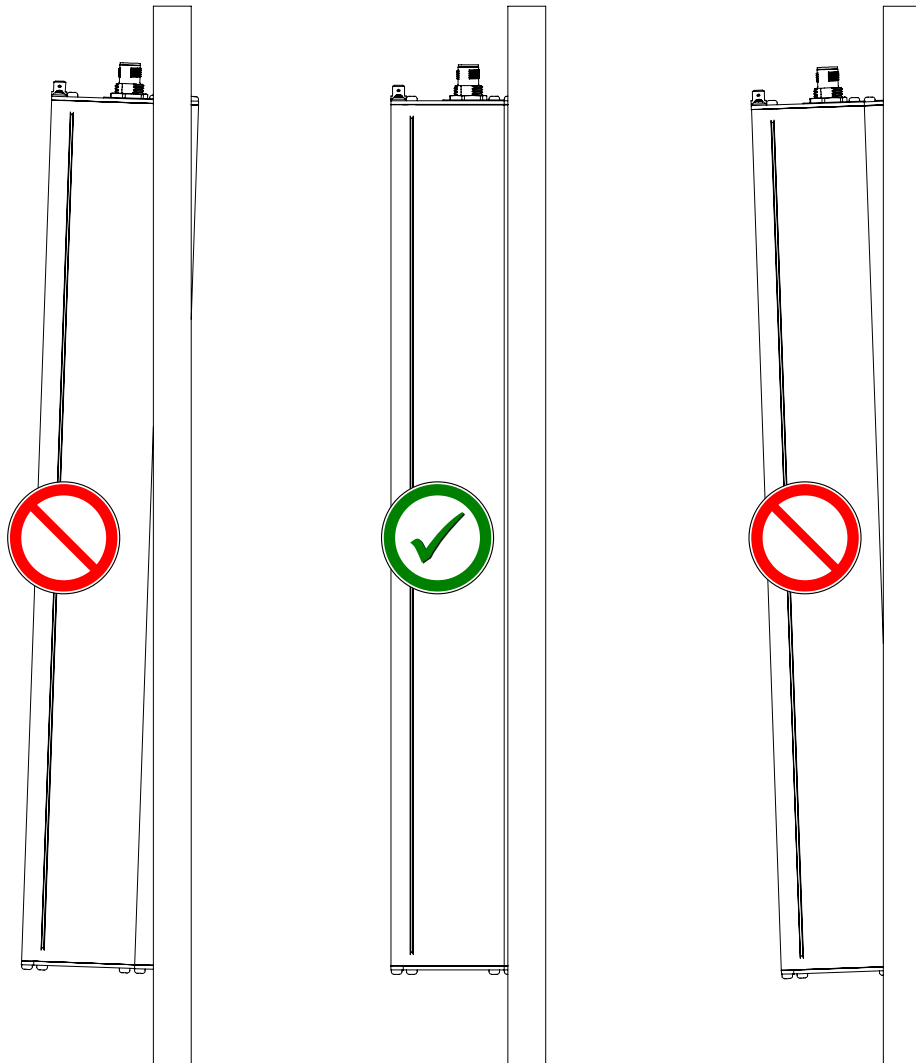
2. Mount the sensor with the plug connection pointing upwards on the cabin.
3. Align the sensor. Use the tape as a reference. First align the sensor in the middle with a lateral offset of 4 mm to the side edge of the magnetic tape (point C in Fig 17).
4. Now set the distance between the tape and the sensor. The maximum reading distance between the sensor housing and the surface of the magnetic tape must not exceed 8 mm. Make sure that the sensor head is mounted vertically.
5. Check the correct mounting. Deviations and angular misalignments must be corrected!



General remarks:

- **Figure A/B:** The sensor surface must be installed parallel to the magnetic tape without twisting
- **Figure C:** The sensor must maintain a lateral offset of 4 mm over the entire measuring distance
- **Figure D/E:** A lateral offset outside this dimension is not permitted and leads to measurement errors, which in turn entails the request for the safe state.

Fig 17: Evaluation of the tape alignment to the sensor - Rotation and misalignment of the magnetic tape



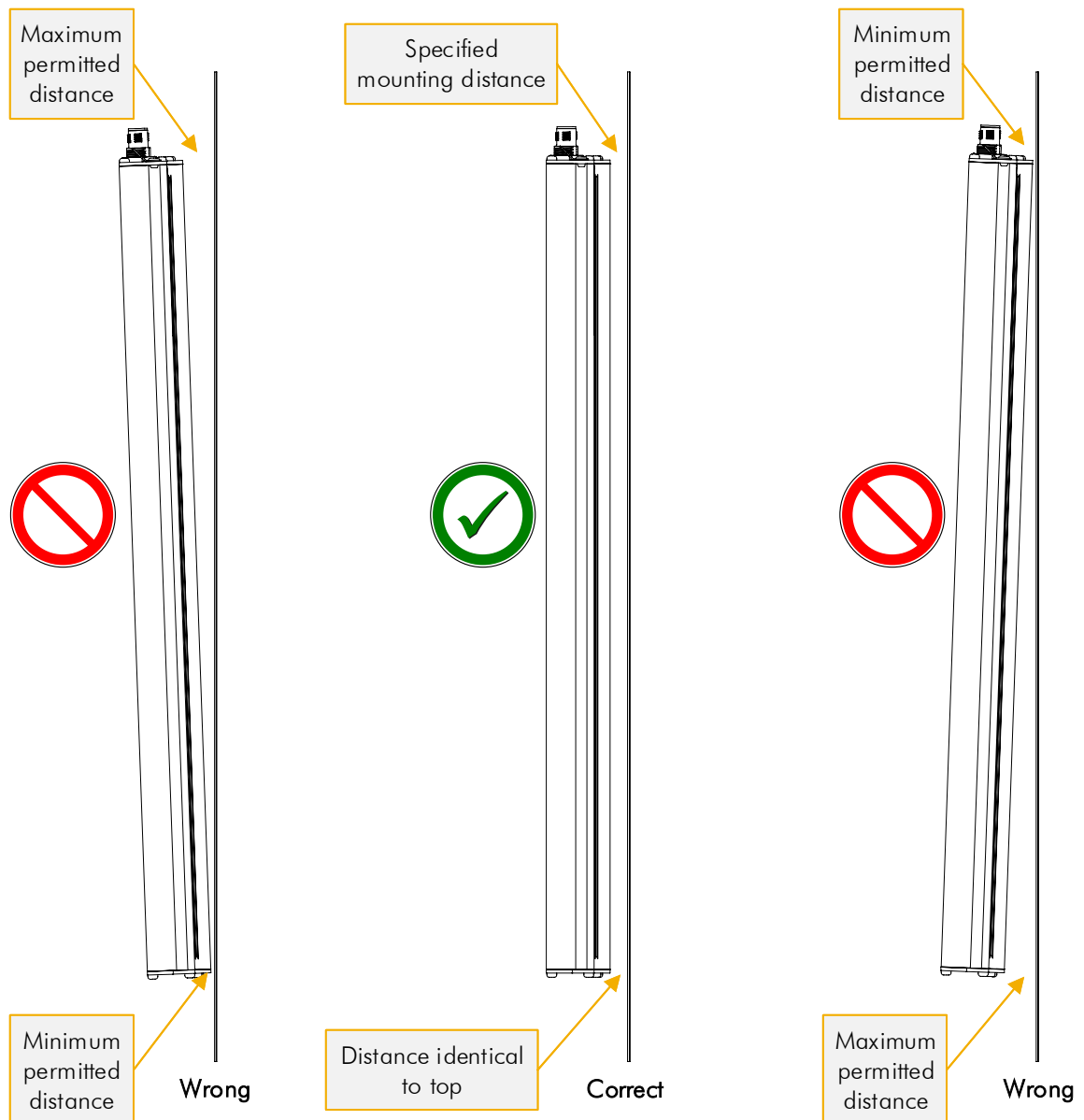
General remarks:

- The sensor scanning surface must be kept parallel to the tape over the entire measuring distance
- A twist as shown in the left or right illustration leads to incorrect measurement results, which in turn entails the request for the safe state.

Fig 18: Evaluation of the magnetic tape to the sensor - inclined mounting of the sensor

6. IMPORTANT: Assembly Check!

To prevent damage, the sensor must not rub against the surface of the magnetic tape. However, occasional contact due to movement of the sensor is not critical. Therefore, make an inspection run over the entire lifting height and check the distances between the belt and the sensor. Also check the underside of the sensor at some points. If this is slightly inclined – the sensor can be perfectly aligned at the top, but still come into contact with the magnetic tape at the bottom – the sensor may rub at the surface of the magnetic tape.






General remarks:

- Over its entire length the sensor must be kept parallel and within the specified distance to the magnetic tape
- Contact between the magnetic tape and the sensor housing must be avoided, as this leads to unwanted abrasion.

Fig 19: Evaluation of the vertical alignment of the sensor

7. If the check shows that the tape nevertheless rubs against the sensor with the magnetic side, it can be assumed that the tape is not mounted on a vertical surface in the shaft.
8. **After completion of the installation clean the tape.** Beginning at the top of the shaft drive down the complete travel distance pulling the magnet tape through a dry clean cloth.

Please follow the instructions on the next page.

	<p>NOTE!</p> <p>Be specifically alert if steel construction work is taking place in the shaft. Steel particles released by grinding, welding or such work will adhere to the magnetic tape. The tape is insensitive to fine metal dust. However, <u>coarser</u> metal chips can cause problems. Clean this debris off instantly.</p>
	<p>DO NOT USE A MAGNET FOR CLEANING!</p> <p><u>Never</u> use a magnet to remove metal chips from the magnetic tape. This will destroy the magnetic code and thus the magnetic tape.</p>
	<p>PROTECTIVE GLOVES!</p> <p>Always wear protective gloves when cleaning the magnetic tape.</p>

9. Repeat this cleaning procedure before putting the elevator into operation.

9 Design and Functions

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9.1 Sensor Design

The sensor consists of:

- Sensor housing with integrated LEDs (for signaling of various status options), fixed connector for power supply and for communication with the safe evaluation unit.
- Guide rail which holds the magnetic tape at a defined distance from the evaluation electronics (only semi-guided version)
- Ground connector to improve EMC characteristics (connection not mandatory)

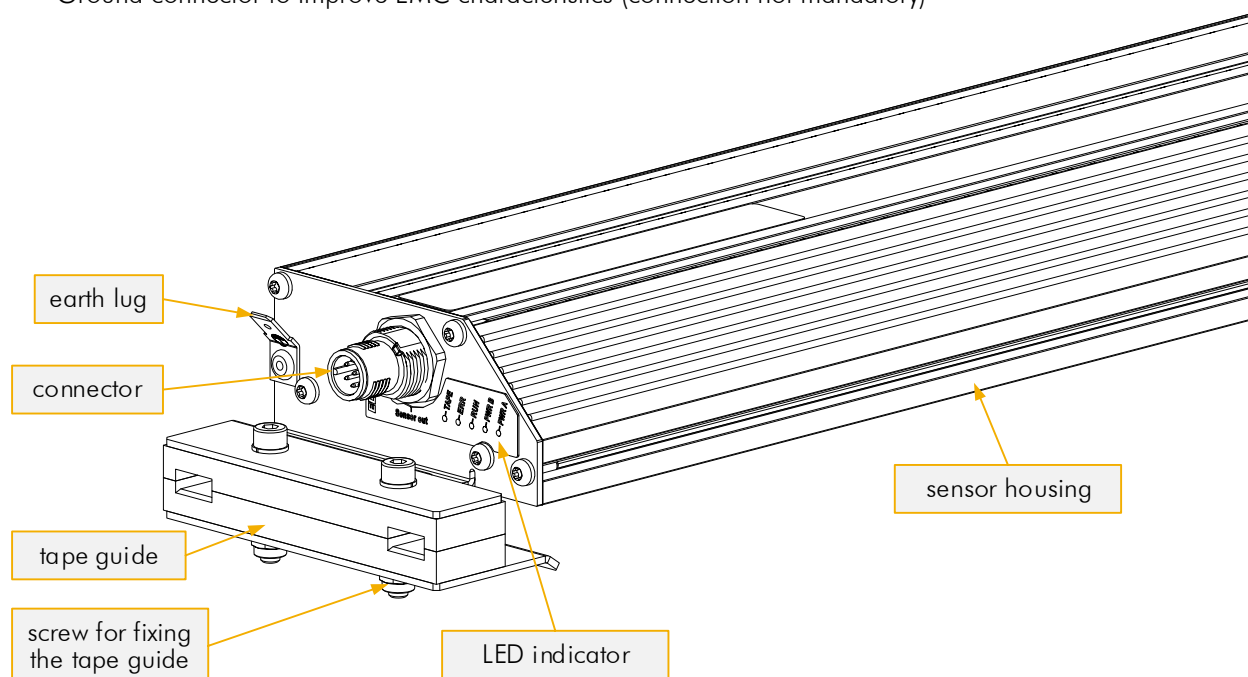


Fig. 20: Components of the sensor (semi-guided variant)

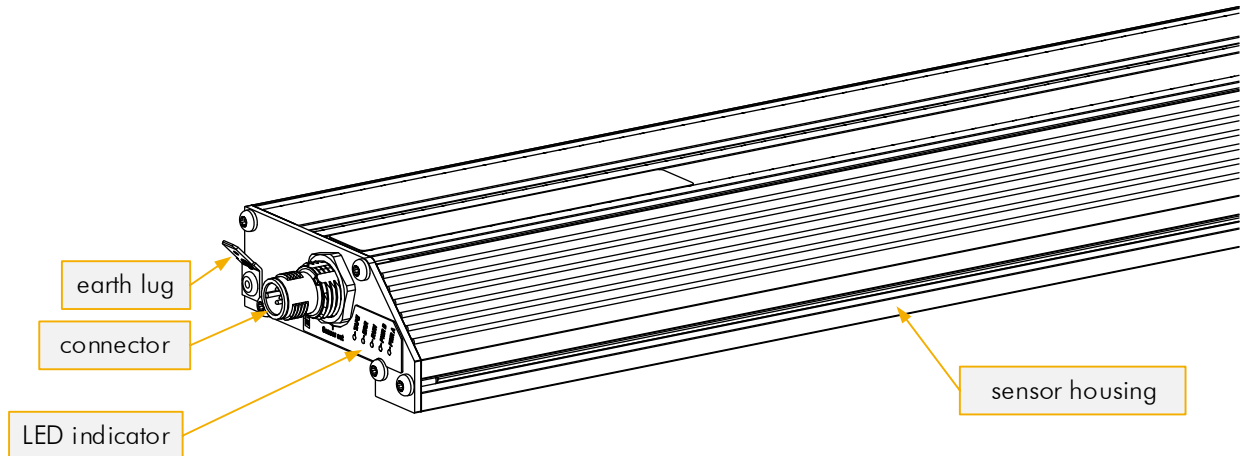


Fig. 21: Components of the sensor (unguided variant)

The electronic part of the sensor is basically done in a two-channel design. For safety reasons the communication interface is operated by both channels together. Each of the two channels contributes their part of the position information transmission. In case of an error, each channel is able to signal the request for transition into safe state independently from the other channel.

Further information:

- Transmission of position information ☞ 9.5.4

9.2 Operating Modes

The sensor can be operated in two different modes:

- Safe dual-channel operation
- Non-safe single-channel operation (energy saving mode)

Switching between modes happens automatically, depending on the supply voltage.

9.2.1 Dual-Channel Operation

Usually, the sensor works in dual-channel operation. In this mode, both channels are fully functional and determine the position independently of each other. After determining the position, the position results of the two channels are compared and then transmitted to the safe evaluation unit via a safe interface. If an internal error is detected or if the position results of the two channels do not match, the sensor sends a request for transition into safe state to the evaluation unit. The evaluation unit has to make sure that the safety circuit is opened.

Further information:

- Overview of error status and possible errors: ☞ 12.6
- Protocol description of the safe position information transmission ☞ 9.5.4

9.2.2 Single-Channel Operation

In order to keep the door zone indication functioning in case of loss of the regular power supply (24V operating voltage), the sensor can be operated with an external 12V back-up battery or an emergency power supply. To maximise the durability of the back-up battery, one channel is switched off. All position comparisons between the two channels are terminated in such a case and the sensor communicates only the non-safe position result of one channel to the evaluation unit. If the evaluation unit is still in operation at that time, it can further process this position information for non safety related functions. The evaluation unit absolutely has to switch into safe state. Further information:

- Possible additional circuit for automatic switch to single-channel operation ☞ 9.5.1
- Protocol description of the position information transmission ☞ 9.5.4

9.3 LED Signals

The LEDs at the upper side of the sensor (shown in Fig. 22) signal the operating status or possible errors:

- PWR A: Supply voltage channel A
- PWR B: Supply voltage channel B
- RUN: Operating status
- ERR: Signalling of an error
- TAPE: Magnetic tape status

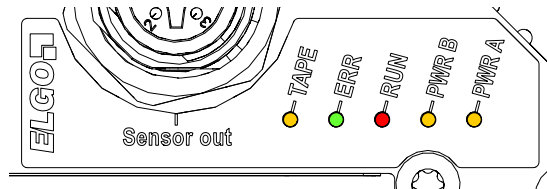


Fig. 22: LED signals on the upper side of the sensor

The LEDs *PWR A*, *PWR B* signal the status in a static manner. They are either turned on or off. The LED *RUN* flashes, with the frequency depending on the operating status. The LED *ERR* has three possible states: Off, regular flashing and irregular flashing. The LED *TAPE* also knows three possible states: off, on and irregular flashing.

Each state has a meaning regarding whether an error occurred and how serious the error is.

The following table shows what states can be signaled by the five LEDs:

Table 1: Meaning of LED signals

LED	Colour	Status ¹	Meaning
PWR A	yellow	ON	Supply voltage channel A available
		OFF	Supply voltage channel A not available
PWR B	yellow	ON	Supply voltage channel B available
		OFF	Supply voltage channel B not available. The sensor head is in the energy saving mode because of low voltage supply or there is no power supply at all.
RUN	green	Flashing 5 Hz	Safe position data is transmitted via the interface
		Flashing 1 ² / ₃ Hz	The sensor head is operating in single-channel mode. Non-safe position information is transmitted via the interface.
		Static light on	The sensor has been blocked intentionally. Also see: LED <i>ERR</i> .
ERR	red	OFF	No error
		Flashing 1 Hz	At least one error has been detected, but it is not classified as a severe error. Find more information on the problem in the Error Register (§ 12.2.3) The exact cause is transmitted via the interface to the evaluation unit as long as the sensor is in dual-channel operation (§ 9.5.4) In single-channel operation; no detailed error diagnosis is possible. Further information on error clearance: § 12.6
		Flashing irregular frequency	The sensor had has blocked itself due to a severe error. The unit should be replaced. The exact cause is communicated via a flashing code of the LED <i>ERR</i> (§ 9.3.1).
TAPE	yellow	ON	Magnetic tape cannot be detected or is damaged
		OFF	Magnetic tape is detected
		Flashing irregular frequency	The sensor had has blocked itself due to a severe error. The unit should be replaced. The exact cause is communicated via a flashing code of the LED <i>ERR</i> (§ 9.3.1).

¹ The status in bold define the faultless normal operation

9.3.1 Signalling Severe Errors

If a severe error (see 12.3) occurs, the sensor head is intentionally blocked. All communication via the interface is shut down. Such errors will be signalled by the LED ERR (channel A) and LED TAPE (channel B) to the user via a sequence of 8 flashing impulses (short or long). A short flash impulse stands for a zero, a long flash impulse stands for a one. The first impulse corresponds to the MSB, the last impulse corresponds to the LSB. The sequence is repeated after a 4 second break. You can find an example of such a sequence in Fig. 23.

If such a severe error occurs, the sensor has to be replaced. The flashing sequence codes support ELGO in finding the exact cause for an error in case of necessary repairs.

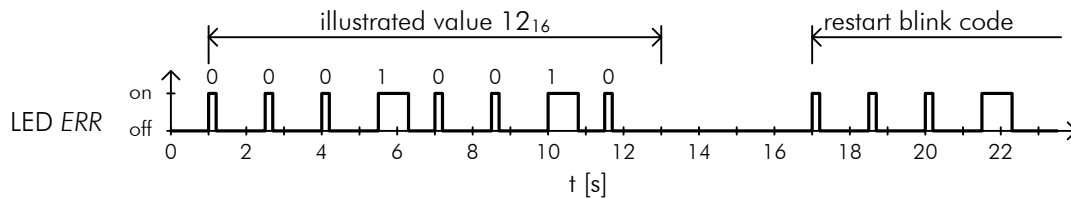


Fig. 23: Illustrated example of an LED ERR flashing sequence, signalling a severe error

Table 2: Meaning of flashing codes due to severe errors

Flashing code	Meaning
01h 02h 03h 04h	RAM test failed
05h	ROM test failed
06h	CRC check sum of code memory is not the same in both channels
07h	Stack test failed
08h	Undefined case in a multiple branch
09h	Test of CRC hardware failed
0Ah	Communication test between channels failed
0Ch	CPU test failed
0Dh 0Eh	Defective program sequence
10h	Channel assignment not unambiguous
11h	Position outside the allowed range
12h	Synchronization failed
20h 21h	Timeout during memory test
22h	Error in timer for timeout detection
40h	UART error
41h 42h	Invalid parameter
43h	Undefined exception
44h 45h 46h	Faulty position determination
47h	Parameter outside the allowed range

9.4 Door Zone Indication

LIMAX44 RED provides a function to indicate the door zones. This function shows whether an elevator is positioned within the door zone, even during a power failure. The location of the door zones is derived from the flush positions of the different floors. These positions must be determined during the initial reference journey for the evaluation unit. The positions of the floor levels are saved permanently and are available even after a power failure.



NOTE!

In order to keep the indication of the door zones active for an evacuation during a loss of the regular power supply, an emergency power supply or a back-up battery is necessary to supply the sensor with energy.

The position of the floors must be transmitted from the evaluation unit to the sensor. Also, the evaluation unit has to signal changes in the position of the floors to the sensor.

After the sensor is switched on, the door zone output is briefly switched to active. This enables a function check of the downstream indicator lamp.

Further information:

- Technical data of output → 6.5
- Protocol for alignment of floor positions → 9.5.4, in the section on *floor information* under the respective interface

9.5 Connections and Interfaces

The following chapters will give you detailed information on the connections and interfaces

9.5.1 Power Supply

Normally, LIMAX44 RED is supplied with 24 VDC. In order to guarantee the functioning of the door zone indication for evacuation in case of a power failure, an external 12 V battery can be connected. Switching between the two supply voltages has to take place outside the sensor and can be realized for example with the following diode circuit:

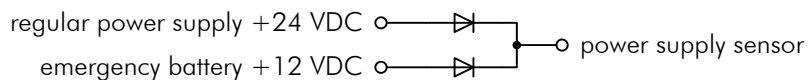


Fig. 24: Possible circuit for supply by emergency battery in case of power failure

The sensor switches automatically between the two operating modes (→ 9.2) based on the applied supply voltage.

The pin assignment depends on the connection option and is documented in chapter → 9.5.3.

9.5.2 Door Zone Indication

For the indication of the door zones, a PNP-output is integrated in the sensor. It can be directly connected to a light bulb or an LED for indicating the status.

The output is short-circuit-proof against GND (but not against +24 V) and can be operated with max. 200 mA.

9.5.3 Pin Assignment

9.5.3.1 RS-485 Interface

The internal termination resistor of the RS-485 bus is assembled in all sensors with RS-485 interface, even when it is not explicitly stated in the interface options (☞ 7 Type Designation). The bus must be terminated also on the side of the evaluation unit.



WARNING!

In order not to jeopardize the safe communication between the sensor and the evaluation unit, the RS-485 connection has to be realized as a point-to-point connection. Apart from the sensor and the evaluation unit, no other devices shall be connected to the bus!

Table 3: Pin Assignment RS-485 Interface

Connection Type	Connection option acc. to type designation	Drawing	Assignment
Circular plug M12 A-Coded	M12M		1 +24 VDC 2 0 V 3 RS-485+ 4 RS-485- 5 Output door zone indication

9.5.4 Protocol Descriptions

9.5.4.1 RS-485 Interface

The communication between the sensor and the evaluation unit is bidirectional. The sensor sends the position information and receives the floor information.

9.5.4.1.1 Interface Parameters

For a correct transmission of the data, the interface in the evaluation unit must be set to the following parameters:

- 115200 bps
- 8 data bits
- No parity bit
- 1 stop bit
- No flow control

9.5.4.1.2 Structure of a Message

A message consists of six segments and has an overall effective length of 88 bits. It is divided into 11 symbols of 8 bits each. The first three segments A to C are sent by channel A, the other three segments D to F by channel B.

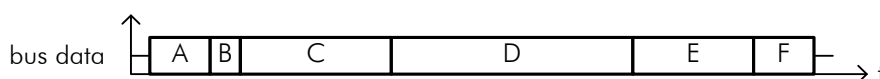


Fig. 25: Structure of a RS-485 message

The different segments carry the information according to the following table. You can find a more detailed description of the content of the segments in the following chapters. Segments A to D contain the safety-relevant information.

Table 4: Description of the segments in an RS-485 message

Segment	Length in bits	Content
A	8	Message counter
B	4	Status bits
C	20	Verified position, coarse resolution (1 LSB \triangleq 1 mm)
D	32	CRC check sum for segments A to C
E	16	Additional information
F	8	Non-verified, high-resolution position offset (1 LSB \triangleq 62.5 μ m)



NOTE!

In single-channel operation, channel B is switched off and segments D-F are not transmitted. This corresponds to a non-verified position transmission.

9.5.4.1.3 Message Counter

The message counter identifies the correct message sequence and is raised by one with every message. It is according to this index that the additional information (9.5.4.1.7) is attributed.

The range of values for the message counter is from 0 to 255. When the counter has reached the maximum value, there will be an overflow and with the following message, counting starts again from 0.

9.5.4.1.4 Status Bits

The status bits provide additional information to the position. They always refer to the position with which they are transmitted.

Table 5: Meaning of the status bits in an RS-485 message

Bit ¹	Meaning of the signalled value
4	Warning – extrapolated position: 0 = Position was determined normally in both channels 1 = Due to a reading error in one of the channels, the position was extrapolated
5	Signalling faulty tape: 0 = Tape correct 1 = Tape not present or faulty
6	Signalling unauthorized extrapolation: 0 = Extrapolation active 1 = Extrapolation was deactivated because there were too many reading errors. Further operation is not allowed. (12.1)
7	Single-channel operation 0 = Sensor is in dual-channel operation 1 = Due to under voltage, the sensor is in single-channel operation. Caution: only segments A to C are transmitted!

Since the described status bits usually never change, they are dynamised, i.e. they change their status depending on the message counter. If the LSB of the message counter is set (odd counter value), all four status bits are inverted bitwise before transmission; if the LSB is cleared (even counter value), the transmitted value matches the signalled value.

¹ Please note that the status bits do not require an entire byte for themselves. The bit position stated here corresponds to the actual position in the second byte of the message.



NOTE!

If the position is extrapolated due to reading errors unusually often, this might point to an extremely dirty or damaged magnetic tape. In this case, proceed as is described in chapter 13 Maintenance.

9.5.4.1.5 Position

The position is transmitted in two parts. Segment C contains the *verified position*, which has to be used in the evaluation unit for safety functions. This position only counts as verified when the sensor is in dual-channel operation and transmits the correct CRC check sum (10.2 Software Requirements). When in single-channel operation, the second part of the message is missing and the position cannot be sufficiently verified. This is called a *non-verified position* or *unsafe position data*.

The position in this segment has a resolution of 1 mm. In order to reach a higher resolution, the position offset from segment F can be used. Since this information only provides an insignificantly small contribution to the overall position, it is not additionally verified. However, it can be used for a better quality of the safety functions, if this cannot cause dangerous situations.

The use of the high-resolution position for position control by the controller is not restricted.

Segment C is transmitted in the Motorola format.

9.5.4.1.6 CRC Check Sum

For use in safety functions, the position, the message counter and the status bits are verified with a CRC32 check sum. The data may only be used if the CRC check sum is correct (10.2 Software Requirements).

The polynomial $G(x) = x^{32} + x^{26} + x^{23} + x^{22} + x^{16} + x^{12} + x^{11} + x^{10} + x^8 + x^7 + x^5 + x^4 + x^2 + x + 1$ is used for calculation. This is the same polynomial that is used in Ethernet.

The data stream $D(x) = x^{31} + \dots + x^0$ is composed from the segment data as follows:

$D(x) = a_7 + \dots + a_0 + b_3 + \dots + b_0 + c_{19} + \dots + c_0$, with the bits corresponding to the respective segments:

$a_7 \dots a_0$: Segment A (message counter)

$b_3 \dots b_0$: Segment B (status bits)

$c_{19} \dots c_0$: Segment C (coarse-resolution position)

The initialization value for the calculation of the CRC check sum is FFFFFFFFh.

LIMAX44 RED calculates the CRC check sum in reverse bit order, which causes the calculated CRC check sum to be transmitted backwards. The calculated CRC check sum is inverted bitwise before the transmission. The transmission is in the Motorola format.

9.5.4.1.7 Additional Information

The additional information in segment E only has an informative character and is meant primarily for finding errors. The content of this segment varies depending on the value of the message counter (9.5.4.1.3 Message Counter). One complete transmission cycle lasts about one second (256 x 4 ms); this is sufficient for the purely informative use. The additional information is transmitted in the Motorola format.

Table 6 describes the content of the additional information depending on the value of the message counter.

Table 6: Additional information as a function of the value of the message counter

Counter Reading	Content
0	CRC check sum program memory, bits 16 ... 31
1	CRC check sum program memory, bits 0 ... 15
2	Serial number of sensor, bits 16 ... 31
3	Serial number of sensor, bits 0 ... 15
4	Error register channel A, bits 16 ... 31 (☞ 12.2.3)
5	Error register channel A, bits 0 ... 15 (☞ 12.2.3)
6	Error register channel B, bits 16 ... 31 (☞ 12.2.3)
7	Error register channel B, bits 0 ... 15 (☞ 12.2.3)
8	Resolution of the floor table. Specifies by how many bits the position (in mm) is shifted to the right (this value is fixed to 4, which corresponds to a resolution of 16 mm).
9 ... 127	Reserved. The transmitted value is always 0.
128 ... 191	Statistical information channel A
174	Lowest detected power supply voltage channel A (1 LSB \triangleq 67.7 mV)
175	Highest detected power supply voltage channel A (1 LSB \triangleq 67.7 mV)
180	Errors set in error register channel A since restart, bits 16 ... 31 (☞ 12.2.3)
181	Errors set in error register channel A since restart, bits 0 ... 15 (☞ 12.2.3)
182	Operating time (seconds since restart) channel A bits 16 ... 31
183	Operating time (seconds since restart) channel A bits 0 ... 15
192 ... 255	Statistical information channel B
238	Lowest detected power supply voltage channel B (1 LSB \triangleq 67.7 mV)
239	Highest detected power supply voltage channel B (1 LSB \triangleq 67.7 mV)
244	Errors set in error register channel B since restart, bits 16 ... 31 (☞ 12.2.3)
245	Errors set in error register channel B since restart, bits 0 ... 15 (☞ 12.2.3)
246	Operating time (seconds since restart) channel B Bits 16 ... 31
247	Operating time (seconds since restart) channel B Bits 0 ... 15


NOTE!

The operating time is transmitted in two messages, separated into high-word and low-word. If the overflow in low-word (carry-over to high-word) happens between the transmission from low-word to high-word, it is possible that the combined time temporarily displays an inconsistent value.

9.5.4.1.8 Floor Information

In order for LIMAX44 RED to operate the door zone indication, the evaluation unit has to transmit the floor information to the sensor. In the interval between two telegrams the evaluation unit has time for this. (☞ 9.5.4.1.10 Bus Timing). LIMAX44 RED assigns the received information in relation to the message counter (☞ 9.5.4.1.3) of the message that was just sent.

Table 7: Floor information as a function of the value of message counter

Counter reading	Content
0	Number of floors
1	Size of door zone (0 ... 1020 mm; 1 LSB \triangleq 4 mm)
2	LSB of the flush position first floor (1 LSB \triangleq 16 mm)
3	MSB of the flush position first floor (1 LSB \triangleq 16 mm)
...	...
255	MSB of the flush position 127 th floor (1 LSB \triangleq 16 mm)

This data is for the transmission of the floor image, so that LIMAX44 RED can generate the door zone signal as return motion information. For this purpose, the resolution of 16 mm is sufficient.

If necessary, LIMAX44 RED will update the stored floor image based on the received data. In order to avoid non-recurring transmission errors having an influence on the floor image, the floor table is only changed when the information is transmitted a second time, i.e. is confirmed. Depending on the value of the message counter, it therefore can take up to two seconds before LIMAX44 RED takes over the new floor information and saves it permanently.

Flush positions of floors with a floor number higher than the number of floors are ignored.

LIMAX44 RED only evaluates the floor information in dual-channel operation (☞ 9.2.1) since a valid test drive requires that both channels are activated anyway.

9.5.4.1.9 Request for Transition into Safe State

If one of the two channels detects that something is out of order by comparing the position with the other channel or during the periodic self-diagnostics, a request for transition into safe state is transmitted to the evaluation unit.

Both channels can request the safe state of the evaluation unit independently of one another. Channel A does this by setting the position in Segment C to 0. Channel B does this by inverting the CRC check sum.

The frequency of the request for safe state depends on how long the error has been present. There is a distinction between short-term and long-term interference.

In case of temporary or short-term interference (☞ 12.2.1), the request for transition into safe state is transmitted with every fourth message (Fig. 26, top). In between the requests, the position is still transmitted to the evaluation unit.

In certain cases it is possible that channel B detects interference while channel A is already sending. In this case, channel B sends the request for safe state one transmission period earlier than channel A (Fig. 26, bottom). This can lead to two requests in a row for safe state. The evaluation unit has to tolerate this effect.

In case of **long-term interference** (☞ 12.2.2), the request for transition into safe state is transmitted with every message (Fig. 26, centre). A criterion for permanent deactivation is met when the request for transition into safe state is sent three times in a row.

In case of **interference in the position determination** (☞ 12.1), the status of short-term interference is not applicable. With these errors, position 0 or the inverted CRC check sum respectively are sent with every message.

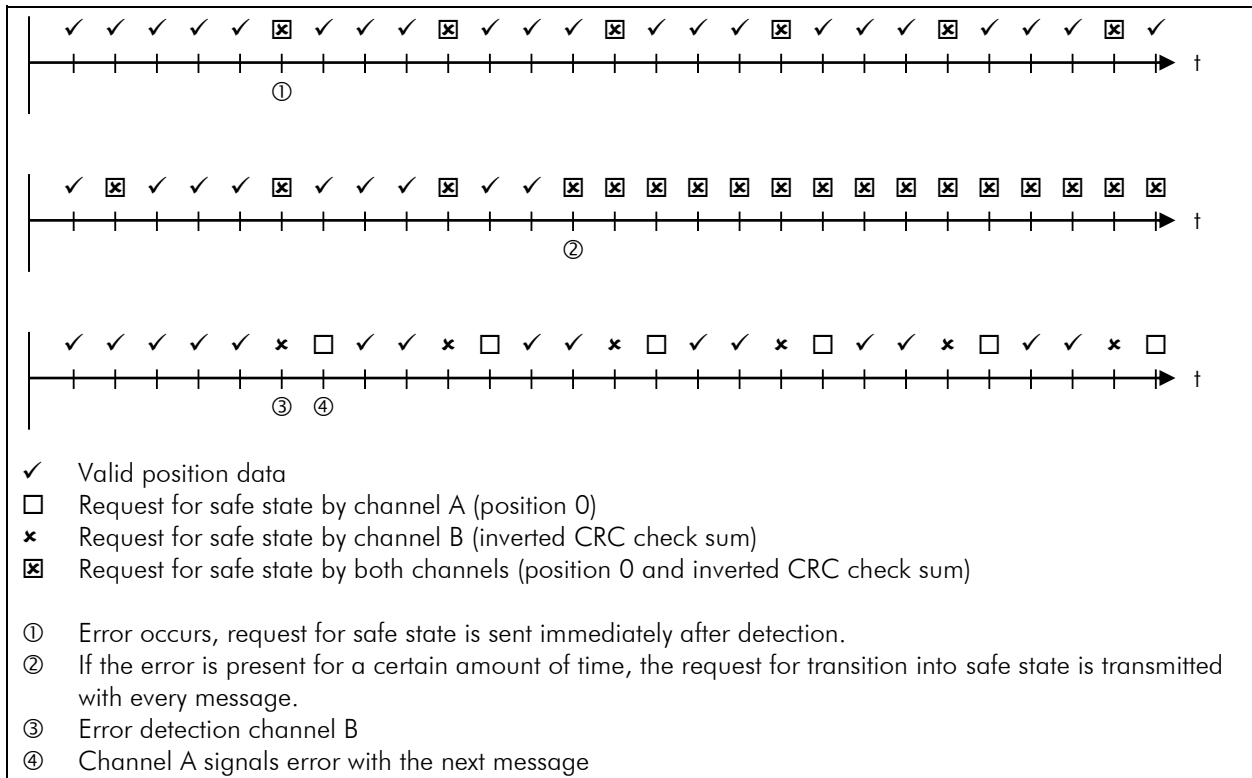


Fig. 26: Example of a request of the evaluation unit for transition into safe state. Temporary signalling (top), transition from temporary to permanent signalling (centre), and staggered signalling of the two channels (bottom).



NOTE!

The gradual request for transition into safe state allows the evaluation unit to react more smoothly in case of a temporary interference which may be the result of a temporary, very strong electromagnetic interference. For example, the evaluation unit can close the safety circuit autonomously after a temporary interference has disappeared, while it makes sense to set an error in case of a persisting interference.

The described behaviour is just an example. The actual behaviour depends on the evaluation unit and has to be defined and evaluated during its development.

Further information:

- Requirements for evaluation unit: 10.2
- Non-severe interference: 12.2

9.5.4.1.10 Bus Timing

LIMAX44 RED divides the transmitted messages into two packets. The first data packet, consisting of segments A to C (9.5.4.1.2 Structure of a Message), is sent by channel A; the second data packet, consisting of segments D to F, is transmitted by channel B. After the end of this transmission the evaluation unit has time to put the floor information to the bus byte wise. Since the sensor is not directly ready to receive data after release of the RS-485 bus, it is imperative that the time t_P (see Fig. 27 and Table 8) is allowed to elapse before the evaluation unit puts data on the bus.

The interface parameters for the structure of the symbols are described in 9.5.4.1.1.

When changing from dual-channel operation to single-channel operation and back, the message-sending-interval is shortened/lengthened by the time t_C once because there are no internal comparisons in single-channel operation.

Fig. 27 shows an overview of the bidirectional bus timing. The details, especially the time of the bus take-over and release, are shown in Fig. 28. A more detailed description of the time symbols and the specific limit values are listed in Table 8.

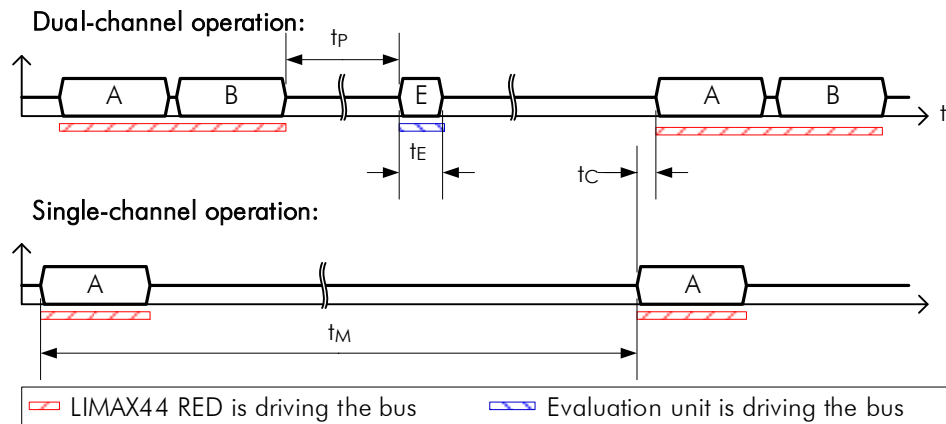


Fig. 27: Overview of the bus timing. A = transmission data channel A; B = transmission data channel B; E = floor information of evaluation unit.

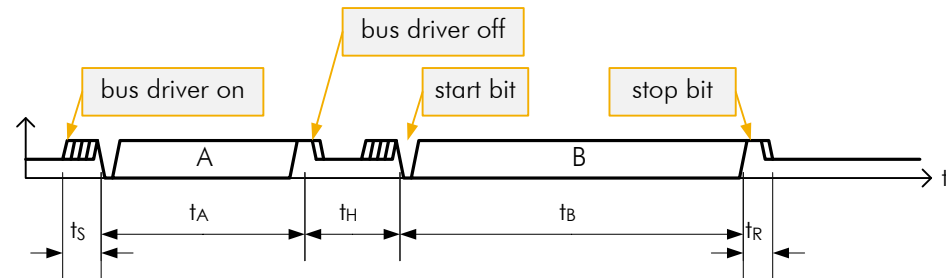


Fig. 28: Bus Timing Details (not to scale)

Table 8: Description of the timing symbols (at 25°C, if not stated otherwise)


Symbol	Description	Min	Typ	Max	Unit
t_M	Message transmission interval		4		ms
t_A	Transmission segment A ... C by channel A		347		μs
t_B	Transmission segment D ... F by channel B		608		μs
t_E	Transmission floor information from evaluation unit		87		μs
t_P	Pause time until the evaluation can put the floor information on the bus ¹ .	150 (at 70°C)			μs
t_C	Time shift due to omitted comparison between the channels in single-channel mode.		276		μs
t_S	Lag between take-over of the RS-485 bus and start bit of the first data bit channel A.	2		12	μs
t_H	Time to hand-over the bus from channel A to channel B (from stop bit of last symbol of channel A until start bit of first symbol of channel B).	55		75	μs
t_R	Delay bus release (from stop bit of the last symbol until bus driver is switched to high impedance).	7		9	μs

9.5.5 Presence Detector Magnetic Tape (only semi-guided variant)

The presence detector serves to assure that the magnetic tape is in the correct position and stays there. Using the appropriate mechanics it is possible to detect the following faults:

¹ The evaluation unit may only occupy the RS-485 bus after t_P has elapsed because LIMAX44 RED cannot process the information earlier.

- Tape rupture above the cabin / above the sensor
- Tape rupture below the cabin / below the sensor
- Loosening of the tape fixation in the shaft head
- Magnetic tape getting stuck in the sensor

In order for the sensor to fulfil its task, it has to be regularly serviced and tested. Further information:  13 Maintenance.

10 Requirements for Evaluation Unit

10.1 Hardware Requirements

The design and the structure of the input circuit of the evaluation unit are generally subject to the specifications of the evaluation unit. When working with a multi-channel structure, the data has to be transmitted to all channels.

If all errors stated in 10.2 can be detected, the bus drivers (transceiver) and protective circuit may also be realised in a single-channel structure.

10.2 Software Requirements

10.2.1 Requirements for RS-485 Interface

The evaluation unit has to perform at least the following checks on the received data:

- The message counter has to match the expected value.
- The CRC check sum for segments A to C (☞ 9.5.4.1.2) calculated in the evaluation unit has to match the CRC check sum received in segment D or its value that has been inverted bitwise (request for transition into safe state by channel B)
- The timing has to be maintained. Two consecutive message packets have to have an interval of 4ms with a max. tolerance of $\pm 20\%$. This implicitly includes detection of a time-out when the sensor is not transmitting anymore.
- The number of the received bytes has to be exactly 11. In single-channel operation (☞ 9.2.2), the sensor will not send a verified position. Such a data packet may not be used for safety functions.
- Errors in the transmission of symbols (framing errors) have to be detected.
- The position has to be valid. The position 0 is the request for transition into safe state by channel A.

If an **error is detected** in one of the points stated above after suitable filtering¹, the evaluation unit has to **assume the safe state**.

10.2.2 General Requirements

The following measures are not compulsory but recommended:

- Repeated check for implausible jumps
- Exchange of the received positions between the channels and comparison with the position of the other channels. If this comparison is not performed, at least the process factors or states derived from the position information must be compared with each other.



NOTE!

Even when working with two synchronized processors, there is no guarantee that the data received from the sensor regarding channel 1 and channel 2 are always 100 % consistent. Due to slight delay differences, it is possible that for example channel 1 has already received a new data packet while channel 2 is still working with the data from the previous packet. The software of the evaluation unit should take this effect into account in order to avoid availability problems.

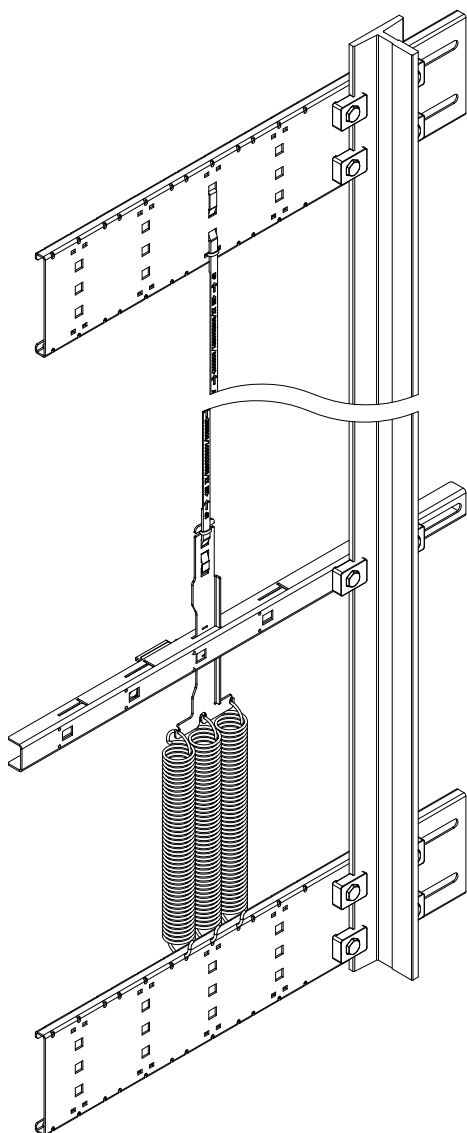
¹ The type of filtering is not specified and depends on the design of the evaluation unit. The filtering parameters are basically determined based on the reaction time for opening the safety circuit.

11 Accessories

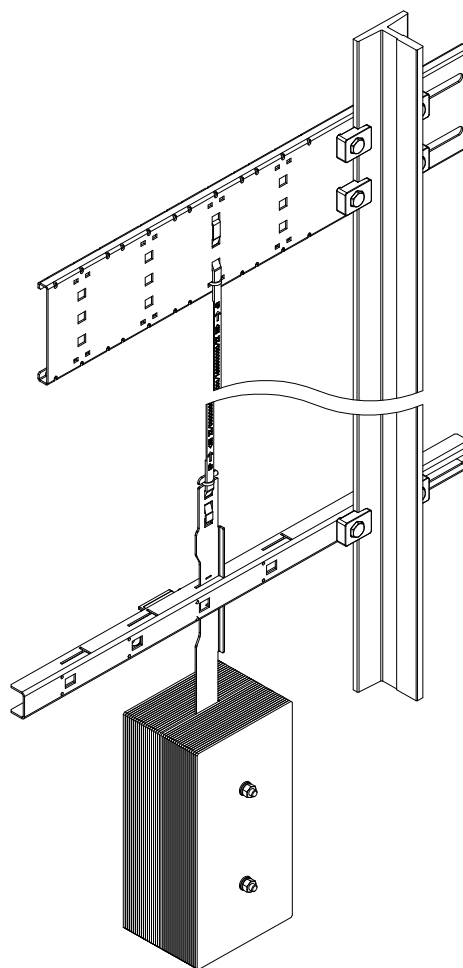
11.1 Mounting Kit Magnetic Tape (only semi-guided variant)

ELGO offers the following mounting kits for fixing the magnetic tape.

LIMAX S-RMS-H



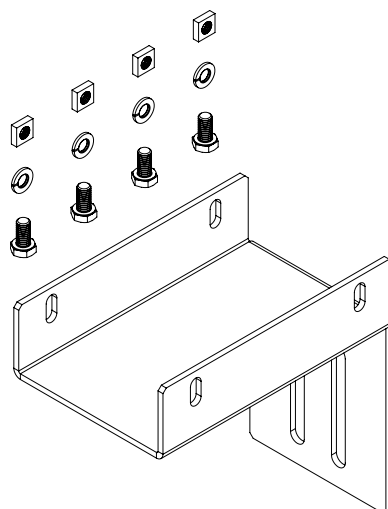
LIMAX S-RMS-WH



Order designation	Description
LIMAX S-RMS-H	Magnetic tape installation kit with tape detection and tension spring for high rise elevators
LIMAX S-RMS-WH	Magnetic tape installation kit with tape detection and tension weight for high rise elevators

11.2 Mounting Aid Sensor

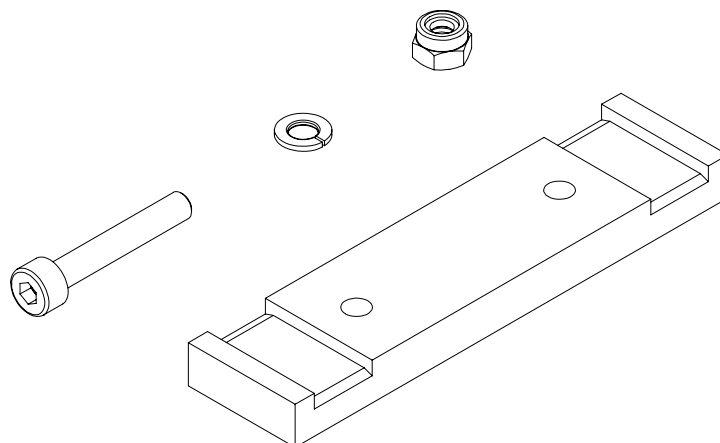
LIMAX3 MW SET



Order designation	Description
LIMAX3 MW SET	Mounting angle for LIMAX33/LIMAX44 RED with four each of screws, nuts and washers for mounting the sensor

11.3 Spare Material Sensor

LIMAX4R Service Set



Order designation	Description
LIMAX4R Service Set	Spare part set consisting of each four guide rails, screws, nuts and eight washers

11.4 Connection Cable

Order designation	Description
CABLE-LIMAX4R-M12MS-M12FS-05.0	Connection cable 5 m, 5-pin, M12 (1:1 extension cable)

12 Disturbances

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 12.5.

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).

12.1 Error in Position Determination

If no tape is present or if the magnetic information on the tape cannot be read unambiguously and consistently, the sensor switches into error mode. No valid position information is transmitted anymore; instead, a request for transition into safe state is transmitted and the corresponding status information is set in the status bits.

This state is not reset even if the tape is detected again later on and the position sequence is correct again. This mode is only reset after a complete re-start (incl. battery voltage).

Further information:

- Requirements specific to the protocol for transition into safe state: ☞ 9.5.4

12.2 Non-severe Errors

If an error is detected that does not jeopardize the internal programme sequence, the error is transmitted to the evaluation unit via external interface. The transmission happens in two steps.

12.2.1 Step 1 – Short-Term Interference

During the first step it is assumed that the interference is only a short-term one. In this stage, the request for transition into safe state is transmitted via external interface. The type of signalling is described in the chapter *Request for Transition into Safe State* (☞ 9.5.4) of the interface in question. In order not to lengthen the reaction time, the request is first sent immediately after the error occurred.

12.2.2 Step 2 – Long-Term Interference

If the error is still present after 15 seconds, it is safe to assume that there is a serious interference whose causes should be checked and evaluated by an expert. In this case, the request for transition into safe state is transmitted permanently. This type of error signalling requests the evaluation unit to sustain the safe state until it has been analyzed and if necessary acknowledged by an expert.

If the error disappears again, the sensor will again begin to send valid position data, no matter if it was a long-term or a short-term interference.

12.2.3 Error Register

Each of the two sensor channels contains an error register that simplifies the error search. The content of the error register is transmitted outside via the interface (↗ 9.5.4 Protocol Descriptions).

Table 9: Content Error Register

Bit	Problem	Error requires safe state
0	Overvoltage or undervoltage in general	Yes
1 ... 6	Error in voltage monitoring	Yes
7	Error position interpolation	Yes
8 ... 12	Internal communication error	Yes
13 ... 14	Synchronisation error	Yes
15	EEPROM error	No ¹
16	Not used	-
17	Comparing of position between the two channels failed	Yes
18	Communication test failed	Yes
19	Extrapolation not allowed anymore. Too many position jumps occurred	Yes
20	Timeout in the non-safety-relevant processing	No
21	Overvoltage 24V	Yes
22	Undervoltage 24V	Yes ²
23 ... 31	Not used	-

12.3 Severe Errors

If one channel detects a severe fault in the processor system (memory error, CPU-error, no communication with the other channel), its firmware goes into a separate emergency loop and the processors are therefore purposefully blocked. The external interface is not served anymore in this case. This mode is never reset if a voltage is applied, no matter if normal or battery supply.

There is one exception for channel A to the reaction described above: when there is no communication with the other channel and the normal supply voltage has a strong undervoltage and therefore channel A is in single-channel operation. This means that channel B is deliberately switched off (↗ 9.2.2 Single-Channel Operation). Under this condition, channel A continues to send its positions and sets the relevant status bit (section *Status Bits* in the chapter of the relevant interface ↗ 9.5.4). When the voltage returns and all error detection measures operate in their entirety in both channels, LIMAX44 RED returns to normal operation (↗ 9.2.1).

12.4 Informative Errors (not Safety-Relevant)

The two chapters 12.2 and 12.3 mainly treated errors in the safety-relevant processing which require the transition into safe state; either explicitly by sending the request for transition into safe state or implicitly due to missing messages which cause a timeout in the evaluation unit.

In order to avoid non-safety-relevant operational elements influencing this behaviour, some information of a purely informative character are exempted from the request for transition into safe state. Those errors can only be identified over the error register (↗ 12.2.3. Informative errors are also signalled via the error LED. Namely these are errors in the EEPROM and timeout in the non-safety-relevant processing.

¹ The EEPROM only contains the non-safety-relevant floor table for the indication of the door zones.

² An undervoltage of the 24 V implicitly requests a transition into the safe state because in this case the second channel is switched off in order to save energy and only a non-safe position is transmitted.


NOTE!

As long as there is “only” an informative error the sensor still transmits valid position data. However, it is possible that the door zone indication is not working as desired. The sensor should be replaced.

12.5 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. $0.1 \mu\text{F} / 100 \Omega$)
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
6. Connect the ground connector to ground

12.6 Possible Errors and their Clearance

12.6.1 General interferences

The following table shows possible interferences and their clearance.

Table 10: General interference clearance

Pos	Problem	Possible cause	Necessary action
(1)	The sensor does not transmit position data	The sensor is not supplied with energy	Proceed with pos (7)
		A severe error occurred. The LED <i>ERR</i> reports the error through a blinking code (☞ 9.3.1).	Replace the sensor.
(2)	The sensor does not send safe positions/ incomplete messages	see pos (5)	See pos (5)
(3)	The sensor is constantly sending position 0	There is no magnetic tape or it is strongly polluted or damaged.	Check the magnetic tape.
		The sensor has detected an interference	Read out the error register of the two channels and proceed as described in ☞ 12.6.2 under the corresponding bit
(4)	None of the LED light up	The sensor is not supplied with energy	Proceed with pos (7)
(5)	The LED <i>PWR B</i> doesn't light up	There is an undervoltage and the sensor therefore is in single-channel operation.	Check the regular power supply (see also ☞ 9.5.1)
(6)	Only the LEDs <i>PWR A</i> and <i>PWR B</i> light up	The sensor is operated without the magnetic tape, which means that the initialization cannot be completed.	Check the magnetic tape.
		A severe error occurred in the early phase of the initialization.	Replace the sensor.
(7)	The sensor is not supplied with energy	Blackout of the supply or interruption of the supply line	Check if the energy supply is working correctly and the sensor is correctly connected to it.
		The energy supply is not connected correctly	Check if the supply line 0 V and +24 V are connected with the correct pole orientation. Exchange both connections if necessary. If the problem still remains, replace the sensor.

12.6.2 Non-severe Errors

The following table refers to the bits in the error register. (☞ 12.2.3).

Table 11: Non-severe errors and their clearance

Bit	Problem	Possible cause	Necessary action
0	General over- or undervoltage	Overvoltage of the external supply	Check the supply and exchange if necessary.
		Defective hardware	Replace the sensor.
1 ... 6	Error in the monitoring of the voltage.	Defective hardware	Replace the sensor.
7	Interpolation error	Defective hardware	Replace the sensor.
8 ... 12	Internal communication error	Massive electromagnetic interference	Perform the fault clearance according to ☞ 12.5 if necessary
		Defective hardware	Replace the sensor.
13	Synchronization error when switching between single and dual channel operation	Strong electromagnetic interference	Perform the fault clearance according to ☞ 12.5 if necessary
		Defective hardware	Replace the sensor.
14	Synchronization error	Strong electromagnetic interference	Perform the fault clearance according to ☞ 12.5 if necessary

Bit	Problem	Possible cause	Necessary action
		Defective hardware	Replace the sensor.
15	Memory error EEPROM	Defective hardware	Replace the sensor.
16	not used	Error while writing the EEPROM	Switch the sensor off and on again.
17	Failure of the comparison of the position between the two channels	Strong electromagnetic interference	Perform the fault clearance according to ☞ 12.5 if necessary
		Defective hardware	Replace the sensor.
		Strongly polluted magnetic tape	Clean the magnetic tape (☞ 13 Maintenance)
		Damaged magnetic tape	Replace the magnetic tape. Attention: after replacement, a reference journey has to be performed!
18	Failure of the communication test	Strong electromagnetic interference	Perform the fault clearance according to ☞ 12.5 if necessary
		Defective hardware	Replace the sensor.
19	Inadmissible extrapolation. Too many position jumps occurred.	Strongly polluted magnetic tape	Clean the magnetic tape (☞ 13 Maintenance)
		Defective hardware	Replace the sensor.
		Damaged magnetic tape	Replace the magnetic tape. Attention: after replacement, a reference journey has to be performed!
20	Timeout in non safety relevant processing	Defective hardware	Replace the sensor.
21	Overvoltage 24 V	Overvoltage of the external supply	Check the power supply.
		Defective hardware	Replace the sensor.
22	Undervoltage 24 V	Undervoltage of the external supply	Check the supply. See pos. (5) in ☞ 12.6.1
		Defective hardware	Replace the sensor.
23 ... 31	Not used		

12.6.3 Severe Errors

A severe error (☞ 12.3) is signalled with the blinking of the LED *ERR* (☞ 9.3.1). If such an error occurs, the sensor will be set out of service. The communication is stopped completely. The sensor needs to be replaced in such a case.

12.7 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 8.



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

13 Maintenance

The LIMAX44 RED shaft information system requires minimal maintenance.

	<p>WARNING! Danger through non-conventional maintenance!</p> <p>Non-conventional maintenance can lead to severe injuries and damage of property.</p> <p>Therefore: Maintenance works may only be completed by staff that has been authorized and trained by the operator.</p>
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The maintenance of the LIMAX44 RED should be done in the course of the regular servicing of the elevator. The maintenance work consists of the following:

- Optical inspection of the magnetic tape. Pay attention to wear and other mechanical damages. Small mechanical damages (scratches, dents or even small chips) mostly don't interfere with the measuring. A heavily damaged tape, however, is much more sensitive for further abrasion when incorrectly guided.
- Clean the tape after the mounting. Use a clean and dry cloth. Start at the shaft head and go down the complete height with inspection travel pulling the magnet tape through the cloth with a slight pressure.

Additional points to check for the **semi-guided** variant:

- Optical inspection of the position of the tape in the sensor guiding rail. Worn-off material on the magnetic side indicates that the tape is guided incorrectly. Check for proper guiding of the tape along the complete lifting height with an inspection travel. If necessary correct the alignment following the criteria from the chapter Installation and First Start-Up starting on page 23.
- Check for proper tension of the tape. Since the tape has been mounted with a spring, the tension can decrease over time. If necessary re-adjust the tension.
You can find details on the correct tension of the magnetic tape in the mounting instructions for the magnetic tape (☞ 2.4).
- Optical inspection of the plastic guiding. Clean the guiding and remove dirt and other material. The plastic guiding is a wear part. Replace if necessary.
- Test the functioning of the magnetic tape presence detector as described under point 15 in the installation procedure (☞ 8.6).

14 Cleaning

	<p>WARNING! The device can only be cleaned with a damp cloth, do not use aggressive cleanser!</p>
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Notes:

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