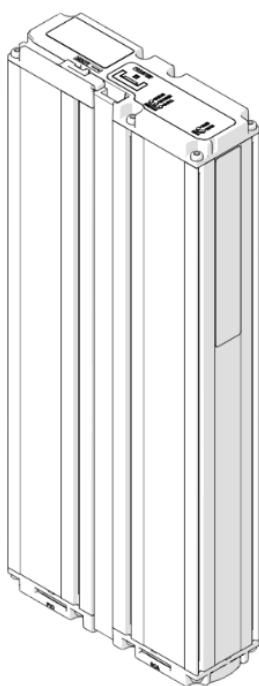


Safety Manual

SERIE LIMAX2R



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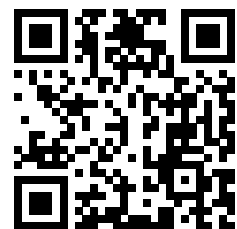
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1 Symbols and References

1.1 Symbols

Explanation of symbols Special notes in this manual are characterized by symbols.
Please follow this advice and act carefully in order to avoid accidents and damage and injuries.

Warning notes:

	WARNING! This symbol in connection with the word „Warning“ means a possibly impending danger for the life and health of persons or damage of property.
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1.2 Related Documents

References:
(DOC 3.4) Marks a reference to chapter 3.4 of the document *DOC* (see table below)

Table 1: Reference to external documents

Reference name	Link
 GeneralInformation	https://support.elgo.li/man/D-108741
 DataSheetMagneticTape	https://support.elgo.li/man/D-102662
 MountingWithSRMS	LIMAX S-RMS: https://support.elgo.li/man/D-100923
	LIMAX S-RMS2: https://support.elgo.li/man/D-100925
	LIMAX S-RMS-WH: https://support.elgo.li/man/D-103858
 MountingOnTheCabin	https://support.elgo.li/man/D-105162 ¹
 Glossary	https://support.elgo.li/man/D-108778

1.3 EN81-versions

The referenced versions in this manual of the EN81 are:

- EN81-20: 2020-06
- EN81-50: 2020-06
- EN81-21: 2022-06

¹ This document shows (among other things) the mounting on the cabin (explicitly) for the LIMAX33CP. The LIMAX2R is mounted in the same way. An optimized document (with focus on the mounting of the housing to the cabin and abstracted from the concrete device type) will be provided later.

2 Overview of the functionality

The following chapter gives an overview of the functional features of LIMAX2R as an introduction.

The device can support the following safe functionality.

Table 2: Overview safety functionality

Safe functionality	SIL	Comment
(safe) RS485 position interface	3	Transmission of the safe positions by a safe protocol via RS485 interface

In addition, the device provides the following non-safety related functions:

Table 3: Overview non-safety functionality

Non safety related functionality	Comment
Door zone/evacuation signaling	Signaling of door zones over a digital output

3 Mechanical Installation

There is a separate mounting instruction for the mechanical installation of the magnetic tape and the LIMAX2R which has to be observed:

-  MountingWithSRMS for the option including the tape presence detector

The tape presence detector must be installed in the electrical wiring. The tape presence detector secures the risk of ripping of the tape: When the tapes rips, there is no tension on the spring, which tightens the tape, anymore. This loss of tension will cause opening a switch wired in the safety circuit. This is done in a mechanical way.

The cables for the supply and communication outputs (refer to Table 4: Pin-assignment of S2) must be laid with mechanical protection.

4 Electrical Installation

For LIMAX2R only one 8 pin connector is available for:

- power supply
- RS485 interface

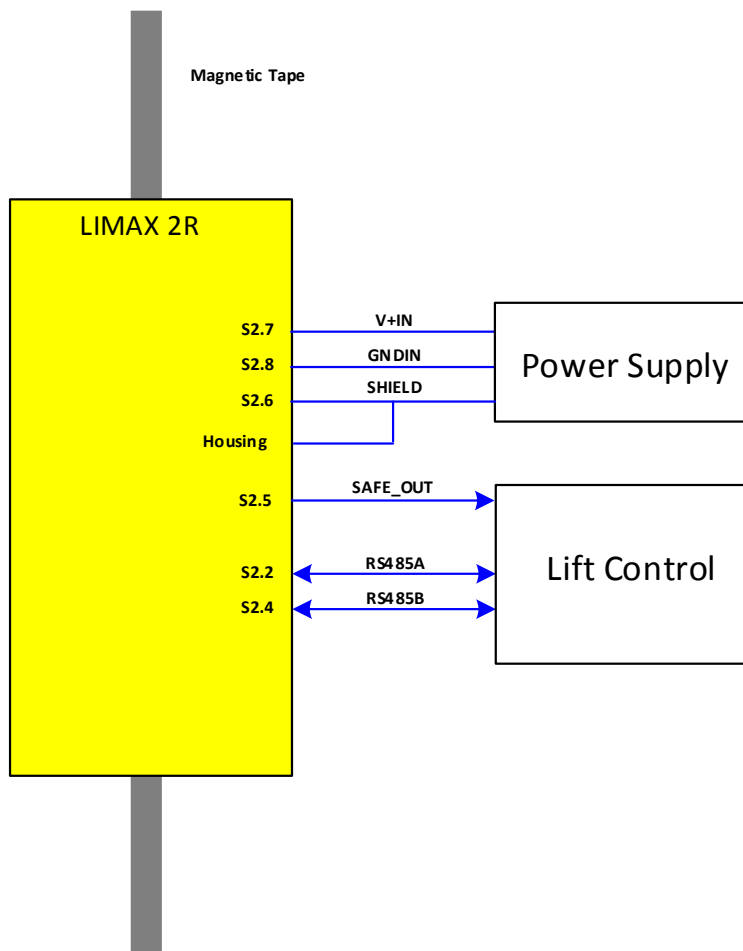
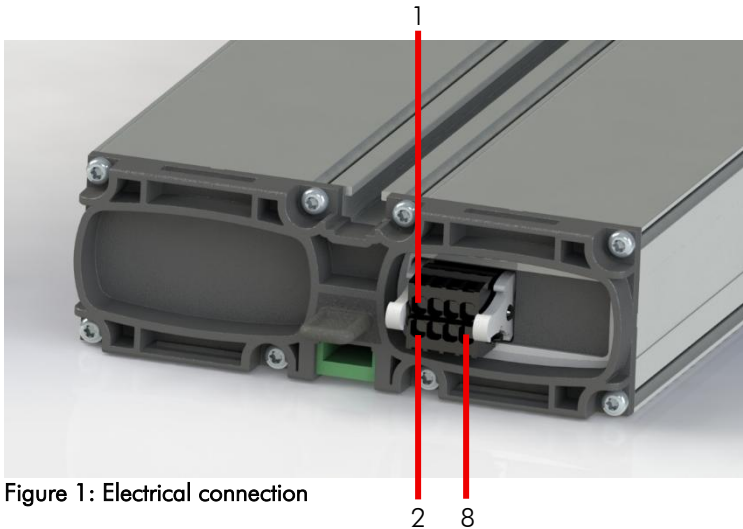


Table 4: Pin-assignment of S2

PIN	Short Name	Description
1	-	NC
2	RS485A	Communication Signal
3	-	NC
4	RS485B	Communication Signal inverted
5	DZO	Door-zone output
6	Earth	Earth
7	V+IN	+24V – supply
8	GND_IN	0V of supply

The Signals listed in the table above must be connected corresponding to the description. A connection of DZO is optional.

Protective earth must be connected to the earthing lug as well.

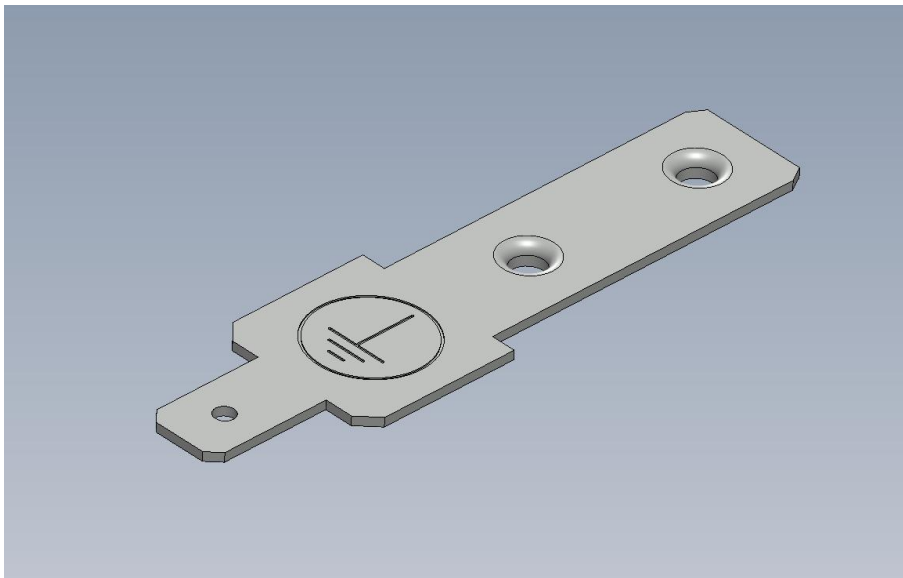


Figure 3: Earthing lug

5 Diagnostics

5.1 Position Diagnosis

LIMAX2R reads the actual position from the coding of the magnetic tape. This is done in two channels. These two channels must align within a certain tolerance otherwise an error will be set. LIMAX2R supervises if the succession of position is plausible. If there are leaps in this succession, an error will be set.

By these measurements all faults concerning electronic for positions determination will be detected. Also, nearly all faults of the tape will be detected: falsified magnetization of the tape will cause leaps in succession of positions and additional the failure will be detected by comparison of the position values of the two channels:

The falsified magnetization will lead to an incorrect position in both channels, but this can be determined by comparing the channels, since the wrong position will very likely be different in both channels.

5.2 Diagnostics of Situation "Tape Ripped"

There is one situation that is not covered by the measures described above:

If e.g. the lower end of the tape is torn from the fixation or the tape rips and then magnetically adheres to the cabin (situation: "rip of the tape"), then the tape would travel with the cabin. The sensors would always read the same spot on the tape and therefore the same position.

To handle this situation safely the use of the tape-mounting set with included (mechanical) tape-detection "S-RMS", offered as an accessory by ELGO, is one way to cover this issue.

5.3 Further Diagnostics

The diagnostic measures in the previous chapters have been described in pretty much details, because the user may do a fault clearance by changing of the external installation/environment in some cases and/or because the diagnostic measures must be customized in order to make them fit to each lift installation. There is more diagnostics where the user has no chance to intervene:

Diagnosis concerning the μ -controller (RAM, ROM, CPU or internal communication between the μ -controllers). If these diagnostic measurements fail, the device must be considered as defective in any case.

6 Additional functions

6.1 Door zone indicator

The Door-zone output (DZO) can be connected e.g. to an (external) optical indicator. This can be used for signaling of floor levels in case of emergency release of people.

Table 5 shows the signalization of door zone indicator.

Table 5: Signalization of door zone indicator

Car State / Position	Signalization
outside the door zone	The output remains low
in door zone	The output remains high

7 Safe Position Sensor

7.1 Use case for LIMAX2R

The LIMAX2R provides safe positions values to an external evaluation unit following a safe protocol via RS-485. The position values can be used for the fulfillment of safety functions by the evaluation unit.

7.2 Bus Timing

For a correct transmission of the data, the RS-485 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

The bus-timing is shown by Figure 4.

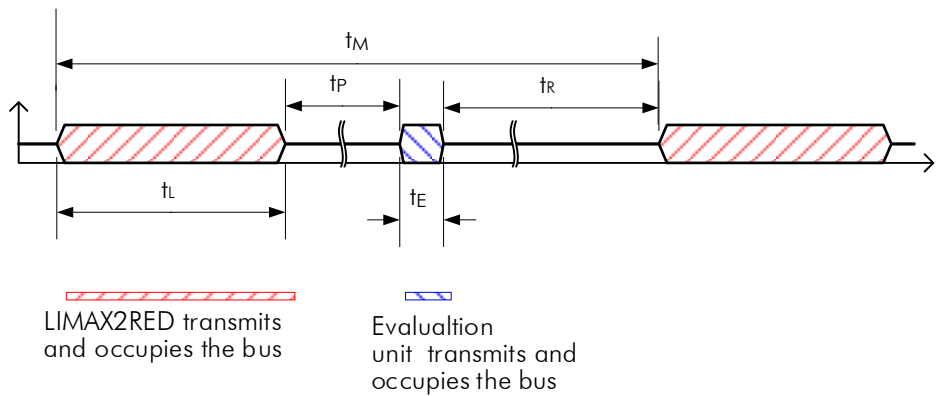


Figure 4: Bus timing on RS485 interface

Table 6: Description of the timing symbols

Symbol	Description	Min.	Typ.	Max.	Unit
t_M	Message transmission interval		4		ms
t_L	Message length of LIMAX2R (from occupation until release of the bus)		970	1040	μs
t_E	Transmission floor information from evaluation unit (optional)		87		μs
t_P	Pause time until the evaluation can put the floor information on the bus ¹ .	150			μs
t_R	Bus release after transmission of evaluation unit (evaluation unit must have released the bus)	10			μs

The LIMAX2R transmits its position message (red segment in Figure 4) in a regularly interval of 4ms. The structure of the position message is described in chapter 7.3.1.

¹ The evaluation unit may only occupy the RS-485 bus after t_P has elapsed because LIMAX2R cannot process the information earlier.

In the pause between two position messages the evaluation unit has the opportunity to transmit information about its floor table to the LIMAX2R. This is done bit by piecemeal, in each pause one byte of the floor table, refer to chapter 7.3.7 . LIMAX2R uses the floor table information to operate the door zone output (DZO).

Transmission of the floor table information from the evaluation unit to LIMAX2R is optional.

7.3 Structure of the Position Message

7.3.1 Overview on the Structure

A position message of LIMAX2R consists of six segments and has an overall effective length of 88 bits. It is divided into 11 symbols of 8 bits each.

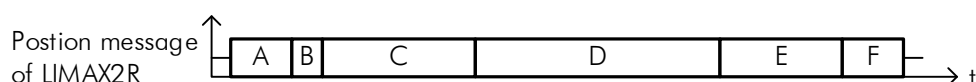


Figure 5: Structure the position message

The different segments carry the information according to the following table. A more detailed description of the content of the segments can be found in the following chapters.

Table 7: Description of the segments of the position 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)

7.3.2 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 (chapter 7.3.6) 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.

7.3.3 Status Bits

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

Table 8: Status Bits

Bit ¹	Meaning of the signaled 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	Signaling faulty tape:

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.

Bit ¹	Meaning of the signaled value
	0 = Tape correct 1 = Tape not present or faulty
6	Signaling unauthorized extrapolation: 0 = Extrapolation active 1 = Extrapolation was deactivated because there were too many reading errors.
7	n.a.

Since the described status bits usually never change, they are dynamized, 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.

7.3.4 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 transmits the correct CRC check sum (refer to chapter 0) and additional conditions do apply (see chapter 7.6).

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 position control by the controller. Segment C is transmitted in the Motorola format.

7.3.5 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.

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:

$D(x) = a_7 + \dots + a_0 + b_4 + \dots + b_0 + c_{19} + \dots + c_0$, with the bits corresponding to the respective segments:

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

$b_4 \dots b_0$: 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.

LIMAX2R 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.

7.3.6 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, refer to chapter 7.3.2. 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 9 describes the content of the additional information depending on the value of the message counter.

Table 9: 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 the sensor, bits 16 ... 31

Counter Reading	Content
3	Serial number of the sensor, bits 0 ... 15
4	Error register channel B*) bits 16 ... 31, see chapter 7.5
5	Error register channel B*) bits 0 ... 15,
6	Error register channel A*) bits 16 ... 31 see chapter 7.5
7	Error register channel A*) bits 0 ... 15
8	Reserved. The transmitted value is always 0.
9	CRC of customization, bits 16 ... 31
10	CRC of customization, bits 0 ... 15
11	CRC of non-safety related software, bits 16 ... 31
12	CRC of non-safety related software, bits 0 ... 15
13	Reserved
14	Reserved
15 ... 127	Reserved. The transmitted value is always 0.
128	Number of stored error codes channel B*)
129	Reserved, always 0
130...163	Stored error codes channel B*), each code represented by 32 bit; cnt = 130: bit 16..31 of last error; cnt = 131: bit 0..15 of last error; cnt = 132: bit 16..31 of last but one error; cnt = 133: bit 0..15 of last but one error and so on...
164..173	Reserved/ Statistical information channel B (for ELGO internal use)
174	Lowest detected power supply voltage, detected by channel B*) (1 LSB $\triangleq$ 67.7 mV)
175	Highest detected power supply voltage, detected by channel B*) (1 LSB $\triangleq$ 67.7 mV)
176...181	Reserved/ Statistical information channel B (for ELGO internal use)
182	Operating time (seconds since restart) channel B*) bits 16 ... 31
183	Operating time (seconds since restart) channel B*)bits 0 ... 15
192	Number of stored error codes channel A*)
193	Reserved, always 0
194...227	Stored error codes channel A*), each code represented by 32 bit; cnt = 194: bit 16..31 of last error; cnt = 195: bit 0..15 of last error; cnt = 196: bit 16..31 of last but one error; cnt = 197: bit 0..15 of last but one error and so on...
228..237	Reserved/ Statistical information channel A (for ELGO internal use)
238	Lowest detected power supply voltage, detected by channel A*) (1 LSB $\triangleq$ 67.7 mV)
239	Highest detected power supply voltage, detected by channel A*) (1 LSB $\triangleq$ 67.7 mV)
240..245	Reserved/ Statistical information channel (for ELGO internal use)
246	Operating time (seconds since restart) channel A*) Bits 16 ... 31
247	Operating time (seconds since restart) channel A*) Bits 0 ... 15
248..255	reserved

*) There are two channels each with one processing unit: A and B

7.3.7 Floor Information

In order for LIMAX2R to operate the door zone output (DZO), 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 (see 7.2) LIMAX2R assigns the received information in relation to the message counter (see 7.3.2) of the message that was just sent.

Table 10: 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 MSB $\triangleq$ 4 mm)
2	Low Byte of the flush position first floor (1 MSB $\triangleq$ 4 mm)
3	High Byte of the flush position first floor (1 MSB $\triangleq$ 4 mm)
...	...
255	High Byte of the flush position 127 th floor (1 LSB $\triangleq$ 1024 mm)

This data is for the transmission of the floor image, so that LIMAX2R can generate the DZO signal. For this purpose, the resolution of 4 mm is sufficient.

If necessary, LIMAX2R 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 LIMAX2R 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.

7.4 Request for Transition into Safe State

If too many leaps are detected in position or other self-diagnostics fail, the LIMAX2R must request a transition to the safe state.

There are basically two kinds¹ of signaling for safe state

- setting the position in Segment C to 0.
- inverting the CRC check sum

There is a distinction between short-term and long-term interference. A short-term interference may disappear after a while. If the short-term interference disappears, also its signaling will disappear. In Table 12 short-term interference are referred to as “self reset” = “yes”.

Concerning a long-term interference, a disappearance of itself is not to be expected. So, the same applies to its signaling. In Table 12 short-term interference are referred to as “self reset”= “no”.

In case of temporary or short-term interference the request for transition into safe state is transmitted with every fourth message. In between the requests, the position is still transmitted to the evaluation unit (a valid position is necessary to allow later recovery of the evaluation unit, see below).

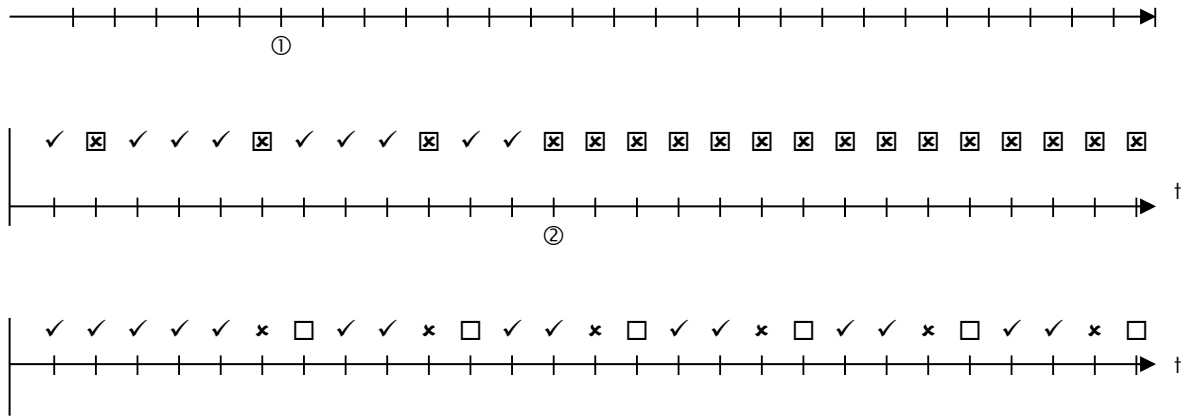
In certain cases, it is possible there are to two requests in a row for safe state (one of them inverted CRC and one of them position = 0), see Figure 6, bottom. The evaluation unit has to tolerate this effect.

In case of long-term interference, the request for transition into safe state is transmitted with every message (Figure 6, center, right side). Often an interference will be signalized as a short-term interference first and after a while the signaling will transit to a long-term interference (it is also shown in Figure 6 center like this).

In case of interference in the position determination (in the narrow sense) 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.

✓ ✓ ✓ ✓ ✓ ☒ ✓ ✓ ✓ ☒ ✓ ✓ ✓ ☒ ✓ ✓ ✓ ☒ ✓ ✓ ✓ ☒ ✓ ✓ ✓ ☒ ✓ ✓ ✓ ☒ ✓ †

¹ The two kinds of signaling are for safety reasons: there are two processing units on LIMAX2R, one of them transmits the position, the other the CRC. By these two kinds of signaling each processing unit is able to signalize request for safe state on its own, independent on the other processing unit.



- ✓ Valid position data
- Request for safe state (position 0)
- x Request for safe state (inverted CRC check sum)
- ⊠ Request for safe state (position 0 and inverted CRC check sum) in the same message

- ① Error occurs, request for safe state is sent immediately after detection.
- ② If the error is present for a certain amount of time, the request for transition into safe state is transmitted with every message.

Figure 6: Examples for a request for transition to safe state

A criterion for the evaluation unit to know that a long-term interference is now present, is that the request for transition into safe state has been received three times in a row.

A distinction between a long-term interference and short-term interference may be important for the reaction of the evaluation unit: In case of a short-term interference the evaluation unit may allow normal operation again (e.g. by closing of the corresponding actuator after the interference disappeared). Disappearance of the signaling of short-term interference is a sign for disappearance of the interference).

At this point, however, only the possibility of recovery is pointed out. Whether this is actually permissible and implemented depends on the functionality of the evaluation unit and its certification.

7.5 Error Register error level and error codes

If a self-diagnostic functions of LIAMX2R detects a malfunction (e.g. failure in position detection or voltage error) an error state is set in order to establish safe state. Concerning LIMAX2CP this is done via the protocol, see 7.4. To each cause of an error a certain error level and an error code is assigned. The error level determines the kind of reaction (if given in an escalated way). The error code identifies the specific cause in order to support troubleshooting.

Table 11 shows the error register, which is communicated in the additional information of the protocol (see chapter 7.3.6). It contains the error level in bit 29..31. The Error level has a value range from 0 to 4.

Table 11: Structure of the register

Bit	Content
0..28	reserved
29..31	Error level

Error level	meaning
0	No Error

Error level	meaning
1	If the cabin is actual in movement => no immediate impact. The error level is increased to 2 as the cabin is in stand still If the cabin is actual in stand still => the error level 2 immediately (error level 1 does not appear in stand still)
2..4	Request for transition to safe state is communicated (see chapter 7.5)

The error code is also communicated in the additional information see chapter 7.3.6. There are error codes indicating a cause which may be fixed by the user. Other error codes indicated that the device itself is defective. In this case the device must be replaced in any case.

An active error is also signaled by the corresponding LED (see chapter 8.1)

The table below shows an overview.

Table 12: Error codes

Error code (hex-value)	Meaning and action	Error level	Self re-set*)
0x00000100... 0x00000106	Position error, check tape. If this does not help exchange the device,	4	no
0x00000110	Position error, check tape. If this does not help exchange the device	1	no
0x00000111	Position error, check tape. If this does not help exchange the device	2	no
0x00000370	Supply Voltage (24V) too high, Exchange the device even after the cause for the overvoltage has been fixed. **)	1	no
0x00000371	Supply Voltage (24V) too low	1	Yes
0xC0000000	No error, sign for boot up	0	n.a.
All other codes	For ELGO internal analysis. Replace the device		

*) If an error is self reset, it will be reset as soon as the cause for the error disappeared. All other errors will stay active until next power cycle.

**) For safety reasons: Even though multiplies measures against device failures at overvoltage are implemented there might be cases where damage occurred on the device.

7.6 Requirements on the Evaluation Unit

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

- The message counter (refer to chapter 7.3.2) has to match the expected value.
- The CRC check sum for segments A to C (refer to chapter 7.3.5) 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.

- 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 (possibly after suitable filtering¹) the evaluation unit has to establish safe state.

The evaluation must also establish safe state if this is demanded explicitly by the concerning signalization in the protocol (see 7.4).

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.

8 Signaling

8.1 LEDs

On the top-side of the housing there are 5 LEDs (see also Figure 7):

- Communication
 - RUN (green)
 - ERR (red)
- System
 - TAPE (yellow)
 - ERROR (red)
 - MODE (green)

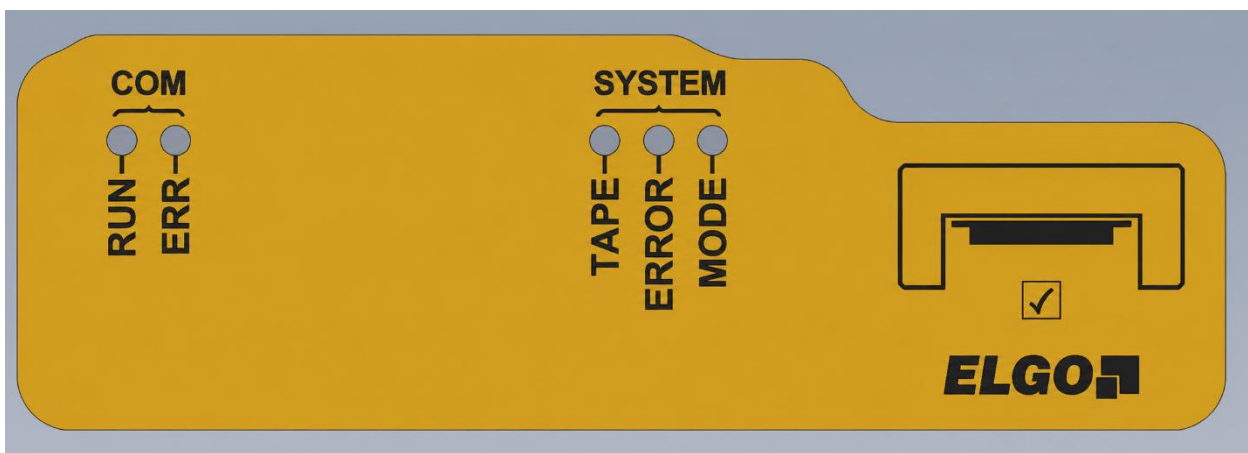


Figure 7: LEDs on the top of the housing

Table 13: Meaning of ERR-LED

ERR-LED (COM) Status	Meaning
ON	(Communication-) error
OFF	No error

Table 14: Meaning of RUN-LED

RUN-LED (COM) Status	Meaning
Flashing at 5Hz	Normal
OFF	No power supply available

Table 15: Meaning of TAPE-LED

TAPE-LED (SYSTEM) Status	Meaning
ON	Tape-Error (Tape missing or damaged)
OFF	No Error and correct magnetic type in the tape guiding

Table 16: Meaning of ERROR-LED

ERROR-LED (SYSTEM) Status	Meaning
ON	Self-diagnostic failure
OFF	Self-diagnostic successful

Table 17: Meaning of MODE-LED

MODE-LED (SYSTEM) Status	Meaning
ON	Elevator within door zone
OFF	Elevator outside door zone

9 Initial and Recurrent Examination

In this chapter is described how the auditor can check LIMAX2R at initial and recurrent examination.



WARNING!

The existing local accident prevention regulations and additional especially the rules of the EN81 must be observed when carrying out the tests for examination.

9.1 System Restart

Some checks concerning self-diagnostics of LIMAX2R are only performed at start-up of the system and can only be triggered by disconnection/reconnection the main power supply.

9.2 Magnetic Tape

Concerning the magnetic tape, the tape guiding and the tape presence sensor the maintenance-hints of the corresponding manuals for the magnetic tape installation kit (📖 MountingWithSRMS) and the sensor mounting instructions (📖 MountingOnTheCabin) should be followed.

In particular, it must be made sure that the tape presence detector is still in its correct position and that the spring is intact and correctly tensioned, refer also to 📖 MountingWithSRMS.

9.3 Software Identification

The LIMAX2R transmits its ROM-CRC via the RS485-interface in the additional information. In this case the CRC may be display in the evaluation unit.

If it is not possible to check the ROM-CRC, the software- version noted on the type label, see chapter 14 should be checked.

10 Maintenance

Apart from the guiding for the tape the LIMAX2R is maintenance-free.

The guiding is a wear part and must be exchanged if necessary. The guiding must be checked for wear in intervals of one year. The first interval after installation can be extended to 2 years.

Figure 8 shows a new guiding. The material thickness under the tape amounts to 3mm.

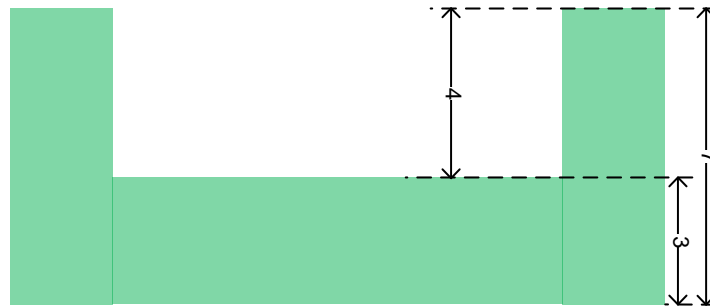


Figure 8: New guiding

Even wear is normal (Figure 9). A minimum of 2mm thickness should remain, otherwise the guiding should be exchanged.

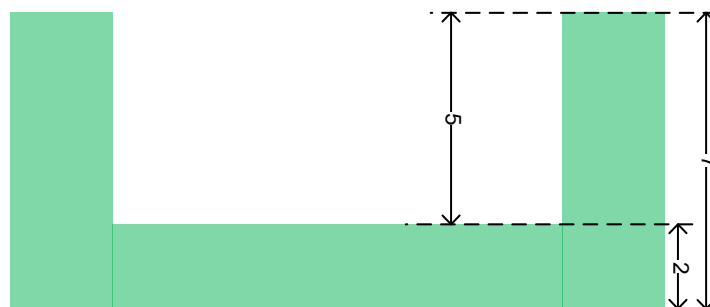


Figure 9: Even wear

Slightly uneven wear is also normal. In this case 2mm should remain at the thinnest spot (Figure 10).

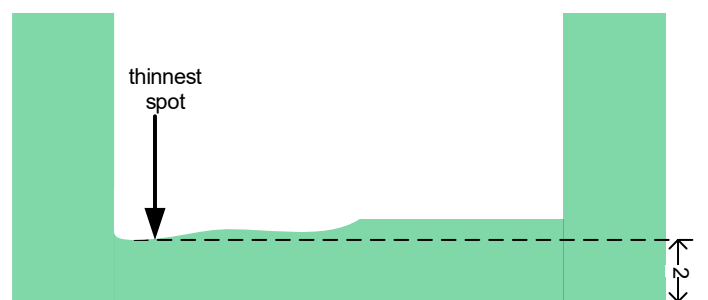


Figure 10: Uneven wear

In the event of very uneven wear, the correct installation of the tape must be checked (📖 MountigOnTheCabin). The tape must run parallel to the guiding, otherwise the mounting must be corrected.

If the edge of the tape has milled a notch into the guide, the assembly must also be corrected. If the notch is deeper than 1 mm, the guiding must be exchanged.

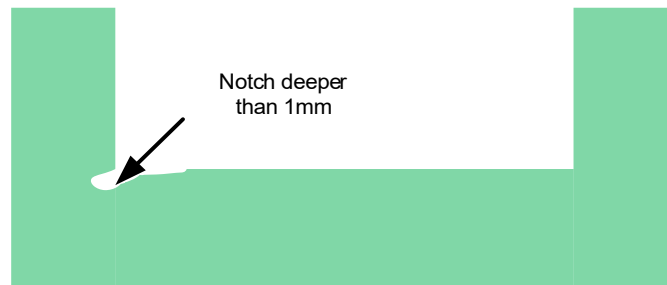


Figure 11: Formation of a notch

11 Technical Data

Table 18: Mechanical data

Designation	Value	Remark
Dimensions	L x B x H = 300 x 120 x 40 mm	Dimensions (without accessories & cable)
Weight	760g	Including cover and earthing lug
Material of housing	Aluminum	

Table 19: Connector types (manufacturer type key)

Designation	Value	Remark
Connector for SCA-Signals	WAGO-713-1424/116-000	6-pole
Earthing lug		

Table 20: Measuring System

Designation	Value	Remark
Magnetic tape	AB20-80-10-1-R-D-15-BK80	
Maximum measuring length	262 m	
Maximum Speed	15 m/s	
Resolution:	See chapter 15 Type Designation	
Repeat accuracy:	±1 Increment	
System accuracy in μm at 20°C:	$\pm (1000 + 100 \times L)$	L = measuring length in meter

Table 21: Electrical Data

Designation	Value	Remark
Supply voltage:	24VDC (10VDC ... 30VDC)	
Residual ripple:	< 100mVpp	
Reverse voltage protection	integrated	
Current consumption	35mA@24V	
Digital outputs	1	DZO-output
Digital output voltage	Vcc - 5V...Vcc	
Digital output current	400mA for a range of the environment temperature up to 40°C 300mA for a range of the environment temperature between 40°C and 70°C	Self limiting

Table 22: Environmental Data

Designation	Value/test conditions	Remark
Storage temperature	-25 °C ... 85 °C	
Operation temperature	-20 °C ... 70 °C	
Humidity	max. 95 %, non-condensing	
Protection class	IP43	
Interference emission / immunity	EN 12015 / EN 12016	

Designation	Value/test conditions	Remark
Vibration / shock resistance	EN 60 068-2-6 EN 60 068-2-27	
Max. operation height above sea level	4000m	

Table 23: Miscellaneous

Designation	Value
Maximum Operation time	20 Years

12 Constraints for Use

**WARNING!**

The following points must be observed; otherwise, functional safety cannot be guaranteed.

1. The technical data (mechanical, electrical and environmental) concerning the LIMAX2R - sensor as defined in chapter 11 are valid for constraints for use.
2. Constraints for Installation of magnetic tape according to its instruction manual must be observed
3. A tape presence detector must be integrated into the safety circuit, in case the risk "tape ripped" is not secured by other means, see chapter 5.2. If the risk "tape ripped" is secured by other means this must be approved by the notified body responsible for the entire elevator.
4. Protection earth must be connected to the corresponding PIN on the LIMAX2R and additionally to the earthing lug, see chapter 4.
5. It is only guaranteed that the safety functions operate in the manner described in this manual, with the functional safety corresponding at least to the specified SIL. The assurance of the functional safety of the overall system including the LIMAX2R is the responsibility of the notified body in charge. Specific instructions for use given in this manual shall be followed unless there is a workaround / equivalent measure available, which shall be accepted by the notified body in charge
6. The evaluation unit must fulfill the requirements defined in chapter 7.6 when evaluating the safe protocol.
7. In case of error state appeared, the error codes must be checked. In case an error indicate overvoltage of the supply (see chapter 7.5) the device must be taken out of operation and send back to ELGO.
8. A SELF or PELV supply must be used for voltage supply of 2RED.
9. The power supply must be capable of delivering at least 1 A¹.

¹ This necessary for safety reasons. The safeguarding for the failure "internal overvoltage of the supply of the processing units" is a safe shut off by blowing internal fuses. The minimum current of 1A ensures that this takes place in an appropriate time.

13 Functional Safety

13.1 Safety Parameters

Table 24: Required and achieved SIL

Safety function	Norm reference	Achieved SIL due to PFHD and SFF	PFHD [FIT] (acc. to FMEDA)	Percentage of required SIL
Safe Position sensor	EN81	SIL3	1.93	1.93%

Table 25: Rate of failures of safe, dangerous and dangerous detected failures; values acc. to FMEDA

Safety function	Failure rate of safe failures λ_s	Failure rate of dangerous failures λ_D	Failure rate of dangerous detected failures $\lambda_{DD} = \lambda_D - \lambda_{DU}$; λ_D see left column, λ_{DU} see Table 24
Safe position sensor	720 FIT	2770 FIT	2768 FIT

Table 26: Safe Failure fraction, HFT and type of the subsystem

Subsystem	HFT	Type	Req. SFF for SIL3	Achieved SFF	Comments
Positions	1	A	> 60%	99.81%	SFF for SIL 3 achieved
EMC of supply (1-channel)	0	A	> 90%	98.41%	SFF for SIL 3 achieved
EMC of supply (2-channel)	1	A	> 60%	97.50%	SFF for SIL 3 achieved
Voltage 3.3V	0	A	> 90%	99.64%	SFF for SIL 3 achieved
Voltage 1.8V	1	A	> 60%	99.91%	SFF for SIL 3 achieved
Crowbar	0	A	> 90%	96.30%	SFF for SIL 3 achieved
μ -controller, A/D-unit, permanent errors	1	B	> 90%	99.90%	SFF for SIL 3 achieved
μ -controller, A/D-unit, soft errors	1	B	> 90%	99.90%	SFF for SIL 3 achieved
μ -controller, CPU, permanent errors	1	B	> 90%	97.76%	SFF for SIL 3 achieved
μ -controller, CPU, soft errors	1	B	> 90%	95.00%	SFF for SIL 3 achieved
μ -controller, RAM, permanent errors	1	B	> 90%	99.95%	SFF for SIL 3 achieved
μ -controller, RAM, soft errors	1	B	> 90%	98.00%	SFF for SIL 3 achieved
μ -controller, ROM, permanent errors	1	B	> 90%	99.95%	SFF for SIL 3 achieved
μ -controller, other peripheral modules, Permanent Errors	1	B	> 90%	95.00%	SFF for SIL 3 achieved
μ -controller, other peripheral modules, soft Errors	1	B	> 90%	95.00%	SFF for SIL 3 achieved
External RESET	0	A	> 90%	96.78%	SFF for SIL 3 achieved
EEPROM	1	B	> 90%	99.01%	SFF for SIL 3 achieved
Voltage Monitoring part 1, one channel	0	A	> 90%	99.58%	SFF for SIL 3 achieved
Voltage Monitoring part 1, two channel	1	A	> 60%	90.00%	SFF for SIL 3 achieved
Voltage Monitoring part 2	1	A	> 60%	99.00%	SFF for SIL 3 achieved
Door zone output	0	A	> 90%	99.90%	SFF for SIL 3 achieved
Miscellaneous	0	A	> 90%	99.79 %	SFF for SIL 3 achieved
RS-485 interface	0	A	> 90%	99.59%	SFF for SIL 3 achieved

Table 27: Diagnostic test intervall

Subsystem	Diagnostic measurement	DTI	Comments
Positions	Plausibility of succession of potions (check on leaps), Comparison with other channel	1ms	
EMC of supply (1-channel)	none		
EMC of supply (2-channel)	none		
Voltage 3.3V	crowbar	continuous	
Voltage 1.8V	Voltage supervision	10ms	
Crowbar	none		
μ -controller, A/D-unit, permanent errors	check on leaps, fail of voltage supervision => safe state	10ms	Used for position determination and for voltage supervision. In both cases the impact of fail of A/D conversion will cause an error to be set (position error or voltage supervision error), furthermore safety is ensured by the 2ns channel
μ -controller, A/D-unit, soft errors	check on leaps, fail of voltage supervision => safe state	10ms	
μ -controller, CPU, permanent errors	CPU-Test/ Comparison with other channel	10ms	
μ -controller, RAM, permanent errors	RAM test/ Comparison with other channel	12.1 days /10ms	
μ -controller, ROM, permanent errors	ROM test (CRC) / Comparison with other channel	25s / 10ms	
μ -controller, other peripheral modules, Permanent Errors	Comparison with other channel	10ms	
μ -controller, RAM, soft errors	2 nd channel	n.a.	Soft-errors (Bit-Flips) only occur temporary. The error disappears when the bit is written again. Until this moment the second channel ensures safety. Particularly critical values like current position or speed are exchange and compared between the channels so that an error will be set if a bit belonging to such a values is affected.
μ -controller, CPU, soft errors	2 nd channel	n.a.	
μ -controller, other peripheral modules, soft Errors	2 nd channel	n.a.	
External RESET	none	none	
EEPROM	CRC, comparison with other channel	See comment	Checked when loaded to the RAM (concerning 2RED not safety relevant)
Voltage Monitoring part 1 and part 2	Compare A/D-converted voltages with expected values	10ms	
Door zone output	none		
Miscellaneous	none		
RS-485 interface	Channel A listens to the messages of channel B. If the number of bytes sent by channel B does not fit, or channel B does not fit at all (time out) channel A sets an error	4 ms	The other diagnostic measures are implemented in the evaluation unit (refer to chapter 7.6)

13.2 Demands of EN 61508-2, Annex D2

Table 28: Demands of 61508-2; D2

Ref. 61508	EN 61508 demand	Value, description or references to other chapters
D2.1 a.)	Functional description	See chapters 2..8
D2.1 b.)	Identification of configuration	There is no condiguration
D2.1 c.)	Constraints for use	Safe chapter 12

Ref. 61508	EN 61508 demand	Value, description or references to other chapters
D2.2 a.)	Kinds of undetected failures	Safe failures: no transmission of messages via RS485 at all; Transmission via RS485 with correct protocol and explicit demand for safe state by position = 0 or inverted CRC (see chapter 7.4); implicit demand for safe state: messages with mismatched CRC; wrong message counter; wrong message length or errors in transmission causing failures on byte-level (like UART-framing)¹ Dangerous failures: Transmission of the correct protocol (all security mechanisms are in order; see Chapter 7.6), but with incorrect position information
D2.2 b.)	Rate of failures dependent on the kind (refer to a.)	Rate of Safe and dangerous failures refer to Table 25
D2.2 c.)	Kinds of failures detected by diagnostics	1. Failure of position (Final safety-related parameter), can be caused by failure of positioning hardware (hall sensors, OP-amps and so on), failures of tape or failures of processing unit. 2. Failure of subsystems which create the prerequisites that positioning hardware and software (processing unit) work. These are mainly the voltages 3. Failures of transmission of positions (mainly detected by the evaluation unit)
D2.2 d.)	Kinds of failures of diagnostics	Position errors are diagnosed directly, both in each individually channel and by comparing the two channels. This diagnostic is software, therefore it can only fail if the processing system fails. Failure of position diagnostic normally leads to safe state because there is always an expectation concerning the positions (They must fit in between a small tolerance between the two channels and there must be no unexpected big leaps in succession of position). Failures in voltages are detected directly (by voltage suppression) and indirectly by the impact of voltage failures on the positions. If the voltage supervision fails there is still diagnostics of positions active.
D2.2 e.)	Rate of failures concerning c.) and d.)	Summarized to one value λ_{DD} (because reaction of the system is the same, see above): $\lambda_{DD} = \lambda_D - \lambda_{DU}$, refer to Table 25.
D2.2 f.)	Diagnostic test interval	See Table 27
D2.2 g.)	Initiated outputs	See chapter 7.4
D2.2 h.)	Regular test and maintenance	See Chapter 9 and 10
D2.2 i.)	External diagnostics	Diagnostic by evaluation unit (see chapter 7.6) Tape presence sensor (see chapter 5.2)
D2.2 j.)	Hardware failure tolerance	See Table 26
D2.2 k.)	Type A / Type B classification	See Table 26

¹ Even if errors at byte level (e.g. UART-Framing) are not evaluated by the evaluation unit, this leads—with nearly 100% certainty—to higher-level error detection mechanisms (CRC, etc.) detecting the error.

14 Identification and Labels

Several labels are placed on the LIMAX2R –housing:

Table 29: Label contents

Name	Example figure	Place	Content
Type label	Table 30	on one of the narrow sides	Type key (see also chapter 15) Version-number (HW/SW) Serial-number ELGO part-number, custom, part-number optional Batch-number Traceability information (QR code) Proper disposal only (pictogram)
Info labels (split into two parts)	Table 31 (part1) Table 32 (part2)	on one of the broad sides	Manufacturer information Certification-Information (EU and more, if given) Customer defined info (e.g. 2D-bar code), if given Conformity information (CE, more later, if given) Arrow for tape direction Tape designation of compatible tape (next to the arrow) Supply and safety circuit ratings Signal assignment of the contactors
Top label	Table 33	On the top-side (where the LEDs are placed)	Repetition of some information from the other labels (for easier identification in the installed state): Certification-Information, Traceability information (QR code)
Designation of the LEDs	See Figure 7, chapter 8.1	On the top-side (where the LEDs are placed)8.1	Designation of the LEDs.

Table 30: Type label

ELGO LIMAXXX-XX-XXX-XXXX-XXXX-X P-XXXX/XXXk/X/X Version: XX.X-XX/xX.XxX-XXX				MADE IN LIECHTENSTEIN
	Serial-No.: XXXXXX	ELGO Part No.: Batch No.:	XXXXXXXXXX XX.XXXX	

The "X" are placeholders so that the pictures of the labels are generally valid for all current and possibly also future versions.

The first two lines: LIMAXXX-XX-XXX-XXXX-XXXX-X and P-XXXX/XXXk/X/X contain the type key resp. type key 2
The 3rd line contains the HW- and SW-Version.

The software version is part of the certificate with its version number and CRC.

The hardware version is also part of the certificate with its board version.

Table 31: Info label, part 1 (subject to changes)

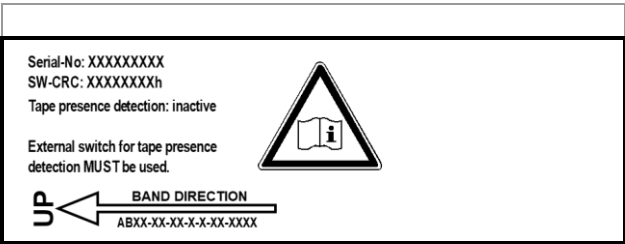


Table 32: Info label, part 2

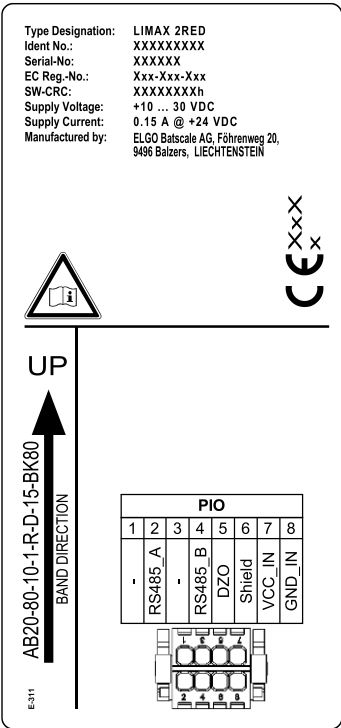


Table 33: Top label



15 Type Designation

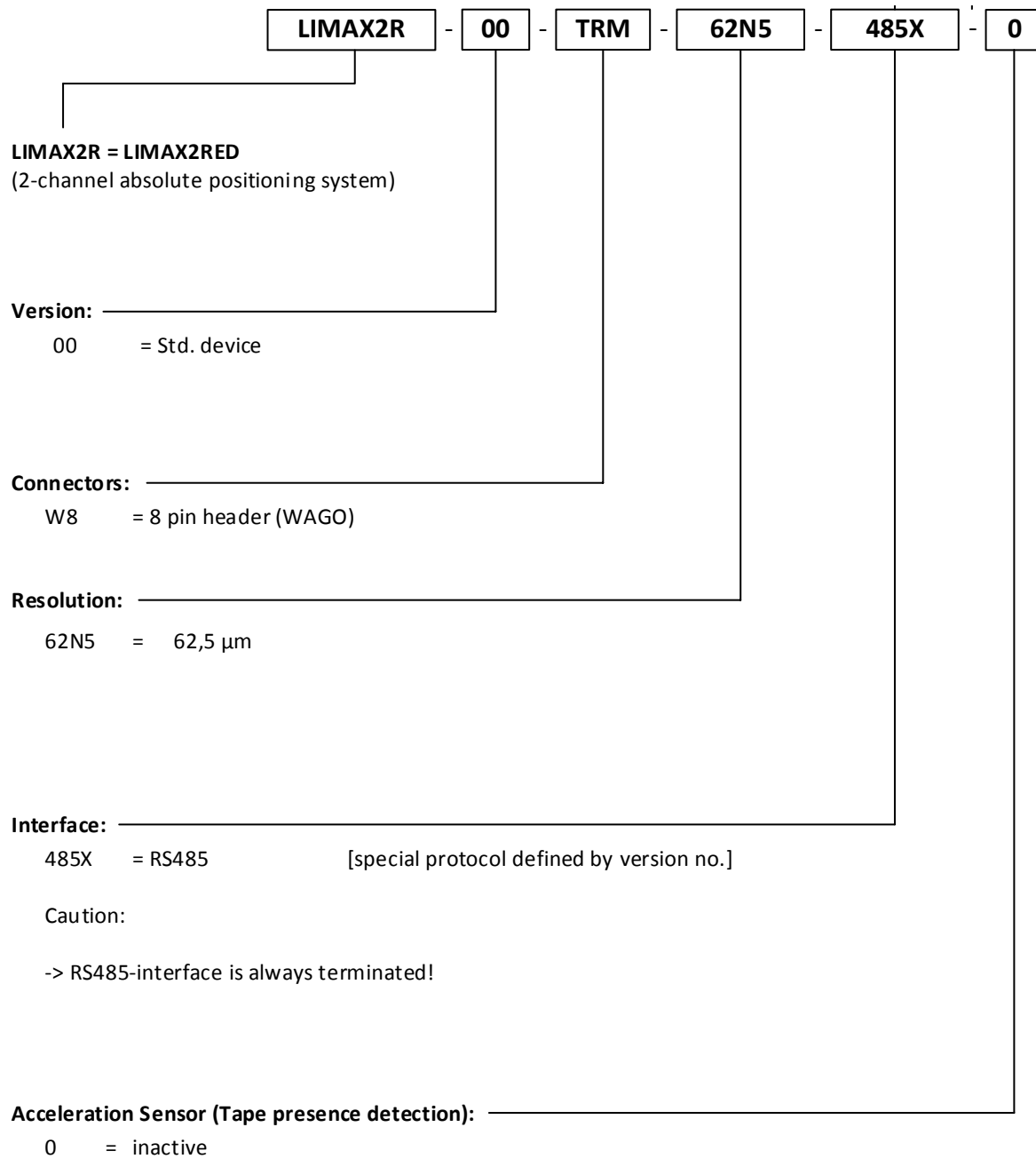


Figure 12: Type Key for LIMAX2R

