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ELGO

Safety Manual

LIMAX1CP/1RED Series

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Contents

1 Symbols and References

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.

DANGER!
This symbol in connection with the signal word "Danger" indicates an immediate danger for the life and health of persons due to voltage.

Tips and recommendations:

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

References:

(🕮 DOC 3.4) Marks a reference to chapter 3.4 of the document *DOC* (see following chapter).

1.1 Related Documents

Reference name	Link
🕮 CANopen-specs	https://support.elgo.li/man/D-106614
🕮 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
🕮 MountingWithRMS	https://support.elgo.li/man/D-100924
🕮 MountingOnTheCabin	https://support.elgo.li/man/D-105162 [1]
🕮 ConfigurationProcess	https://support.elgo.li/man/D-108775
🕮 Glossary	https://support.elgo.li/man/D-108778

[1] This document shows (among other things) the mounting on the cabin (explicitly) for the LIMAX33CP. The LIMAX1CP 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.

1.2 EN81-versions

The referenced versions in this manual of the EN81 are:

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

2 General

This manual contains important information regarding the handling of the LIMAX1CP/1RED.

The LIMAX1CP is a safety device with actuators intended to be wired in the safety circuit. The LIMAX1CP fulfills several safety functions (refer to chapter 6). The switching state of the actuators depends on the safety functions and on further conditions.

⚠	WARNING! For your own safety and for functional safety the manual "General information manual for ELGO-Lift-Systems" must be observed: 🕮 GeneralInformation.

In that Manual will also be found:

- conditions for warranty
- conditions for transport and storage
- conditions for demounting and disposal
- possible causes and clearances of disturbances
- hints for maintenance and cleaning
- hints concerning general safety during mounting and maintenance of the system
- available accessories

The LIMAX1CP/1RED is a based on magnetic length measuring technology. The scale for LIMAX1CP/1RED is the magnetic tape AB20-80-10-1-R-D-15-BK80, see 🕮 DataSheetMagneticTape.

In that manual can be found

- the technical data of the magnetic tape
- general properties of the measuring system
- general risks relating to functional safety with focus on the tape and measures to avoid those risks

Closely related to the 🕮 DataSheetMagneticTape is the corresponding mounting instruction 🕮 MountingWithSRMS or alternatively 🕮 MountingWithRMS.

There are two variants of the device:

- a safety device with actuators (OC, SR), which are able to interrupt the safety circuit in order to establish safe state if necessary. This variant is called LIMAX1CP. The communication interface of this variant is CANopen.
- a safe position sensor, which transmits its position to an (external, safe) evaluation unit. The communication interface is RS485 with a safe protocol. This variant is called LIMAX1RED.

In the first case (safety device with actuators) chapter 9 and chapter 17.3 of this manual does not apply.

In the second case (safe position sensor) chapters 5, 6, 7, 8.1, 8.5, 8.6, 8.7 , 13 (with exception of 13.1.4.1), 14.4, 14.5, 14.6 and 17.2 do not apply.

For LIMAX1CP-devices with CAN-interface following CANopen-standards please observe also to the 🕮 CANopen-specs.

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 followed.

Please read the safety manual and the related documents (refer to links) 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.

3 Mechanical Installation

There is a separate mounting instruction for the mechanical installation of the magnetic tape and the LIMAX1CP/1RED which has to be observed:

- 🕮 MountingWithSRMS for the option including the tape presence detector
- 🕮 MountingWithRMS for the option without the tape presence detector

If the option including the tape presence detector is chosen, the tape presence detector must also be installed in the electrical way. In this case the use of the acceleration sensor may be disabled in the configuration (refer to 13.1.4.1). This option is intended to be used mainly in earth quake areas, where there is a risk that false triggering will occur when monitoring the tearing of the magnetic tape with the acceleration sensor.

The acceleration sensor secures the risk that the magnetic tape rips off from its fixation:

In this case, for example, the lower end of the tape can attach itself magnetically to the cabin and the tape would be taken along by the sensor guide when the cabin moves. The sensor would therefore always detect the same stationary position, even if the cabin was moving.

When using the acceleration sensor, the fault would be revealed when comparing the data from the acceleration sensor and the tape position.

Therefore, there is no need to install a tape presence sensor if the use of the acceleration sensor is enabled in the configuration, provided the demands defined in chapter 8.4 are observed.

The tape presence detector secures the risk of ripping of the tape directly: 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 as well as for the safety circuit and the actuators (to SCA-connector, refer to Figure 2, Table 3) must be laid with mechanical protection.

4 Electrical Installation

4.1 Installation in the Safety Circuit

On the bottom side (when installed) of LIMAX1CP there are two connections: "SCA" and "PIO". On the LIMAX1RED there is only the PIO-connector. Figure 1 shows an example how the single signals of "SCA" and "PIO" can be integrated in the electrical installation.

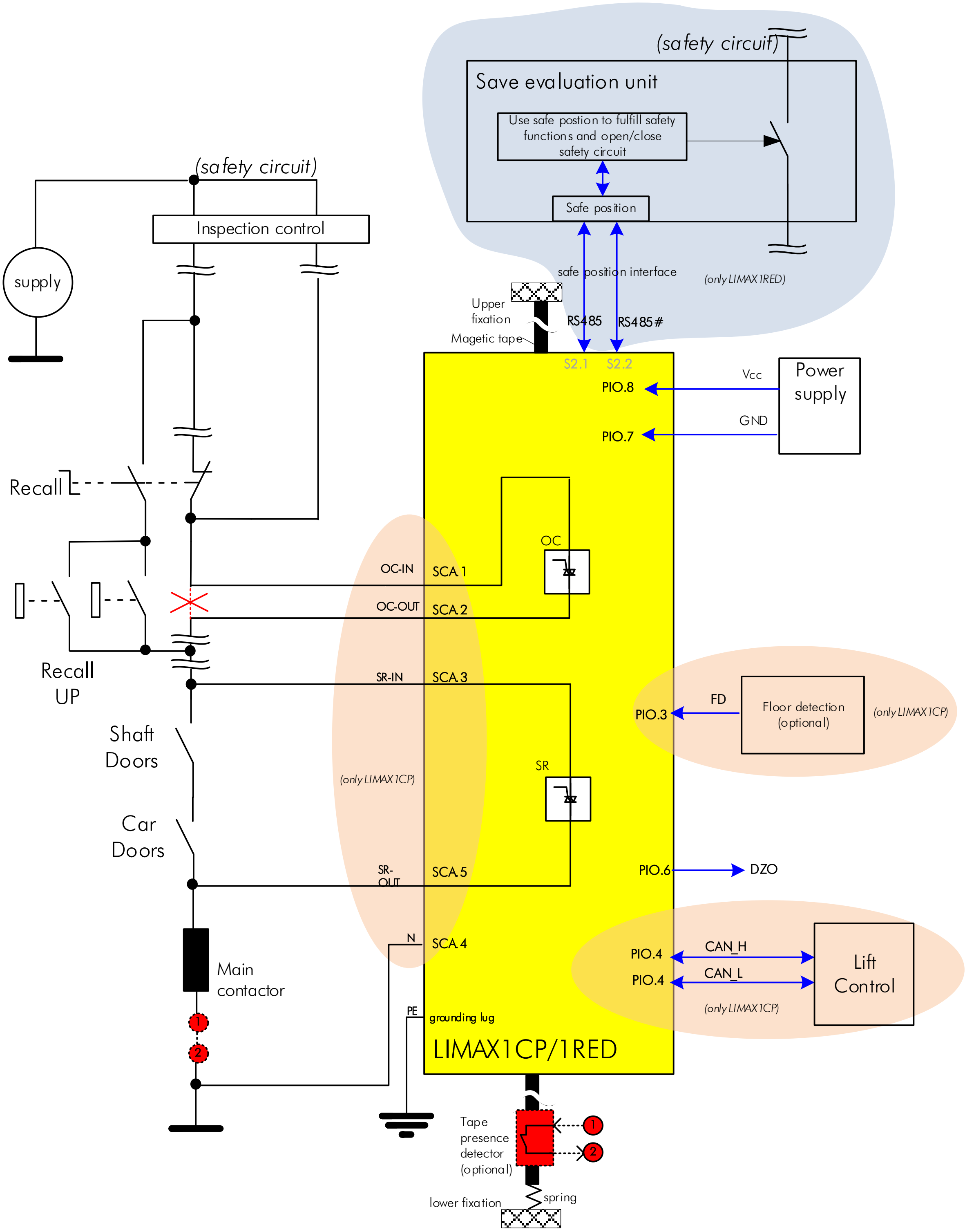


Figure 1: electrical installation (example)

Dependent on the configuration of the LIMAX1CP- device (refer to chapter 13.1) there may be actuator connections to the safety circuit which are not needed. In this case it is not necessary to install them.

For the LIMAX1RED version there are no actuators anyway: calculation of safety functions and operation of actuator(s) is performed on the safe evaluation unit (based on the safe position, received from LIMAX1RED). Safety functions and actuators are out of scope in this case. Only certain boundary- conditions (refer to chapter 9) must be observed.

Connections of floor detection (refer to chapter 12) and DZO (refer to chapter 11.2) are optional.

The floor detection is not used for LIMAX1RED-version.

The following tables describe the signals on the connectors concerning function and manner of connection to the lift installation.

Table 1: Explanation of signals of SCA connector

Signal	Description
OC_IN OC_OUT	The OC-actuator can close/open (dependent on its state) the connection between OC_IN and OC_OUT. OC_IN and OC_OUT will be wired in the safety circuit in such a way that the OC-actuator may open the safety circuit on a spot which can be bridged by recall control.
SR_IN SR_OUT	The SR-actuator) can close/open (dependent on its state) the connection between SR_IN and SR_OUT. SR_IN/SR_OUT is wired in parallel to the door contacts.
N	To be connected to the neutral wire of safety circuit supply

Table 2: Pin-assignment of PIO connector

Signal	Description
Vcc	Normal supply for LIMAX1CP/1RED (rated voltage +24V)
GND	Common reference potential for normal supply
CAN-H CAN-L	Connection to CAN-Bus
RS485 RS485#	RS485 safe position interface
FD	Floor detection
DZO	Door-zone output, to be connected e.g. to an (external) optical indicator. Used for signaling of floor levels in case of emergency release of people.

The electrical data concerning the signals on the PIO-connector as well as the electrical data concerning the safety circuit signals on the SCA-connector can be found in chapter 16.2 .

The earthling lug (designated with PE) must be connected to protection earth.

DANGER!
The connection of PE serves the protection from electric shock in case of LIMAX1CP. Therefore, the installation is mandatory in case of LIMAX1CP

The connection of PE serves the protection from electric shock and the improvement of EMC characteristics. Protection from electric shock is only necessary in case of LIMAX1CP.

Concerning LIMAX1RED connection of PE only serves (possibly) as improvement of EMC characteristics.

The connection of PE is mandatory.

4.2 Suppression of electric Interferences

Dependent on the electric load suitable component(s) for interference suppression is/are recommended (e.g. a corresponding varistor switched over the coil of a main contactor at the end of the safety circuit).

4.3 Connectors and Pin-assignments

The SCA connection is designed as a terminal, for the PIO connection there are 2 versions: as RJ45 (Figure 2) and as a terminal (Figure 3).

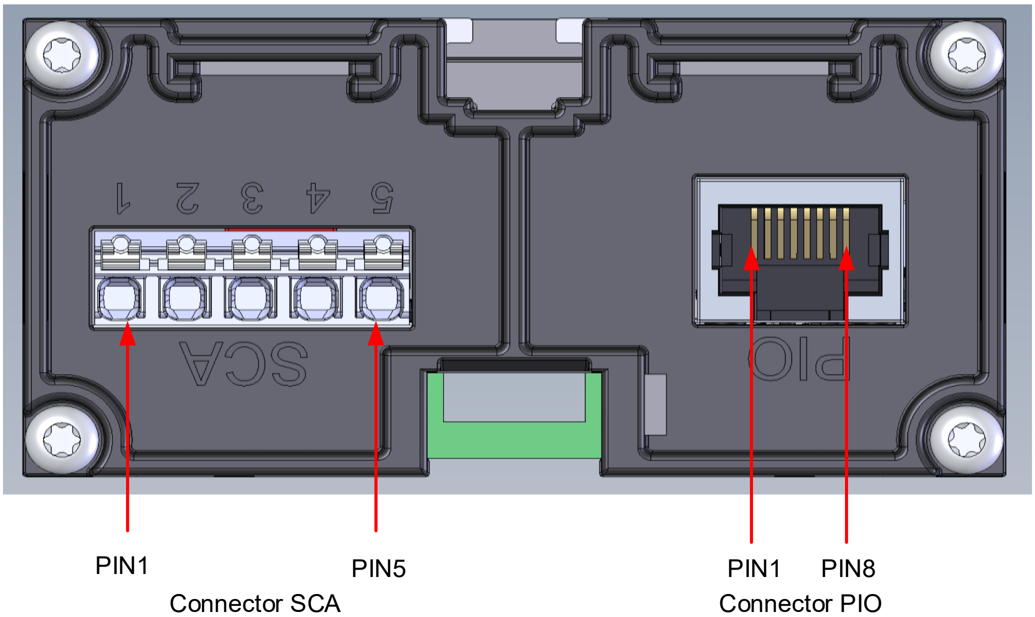


Figure 2: Connectors on bottom side of LIMAX1CP (Version RJ45 for PIO-connector)

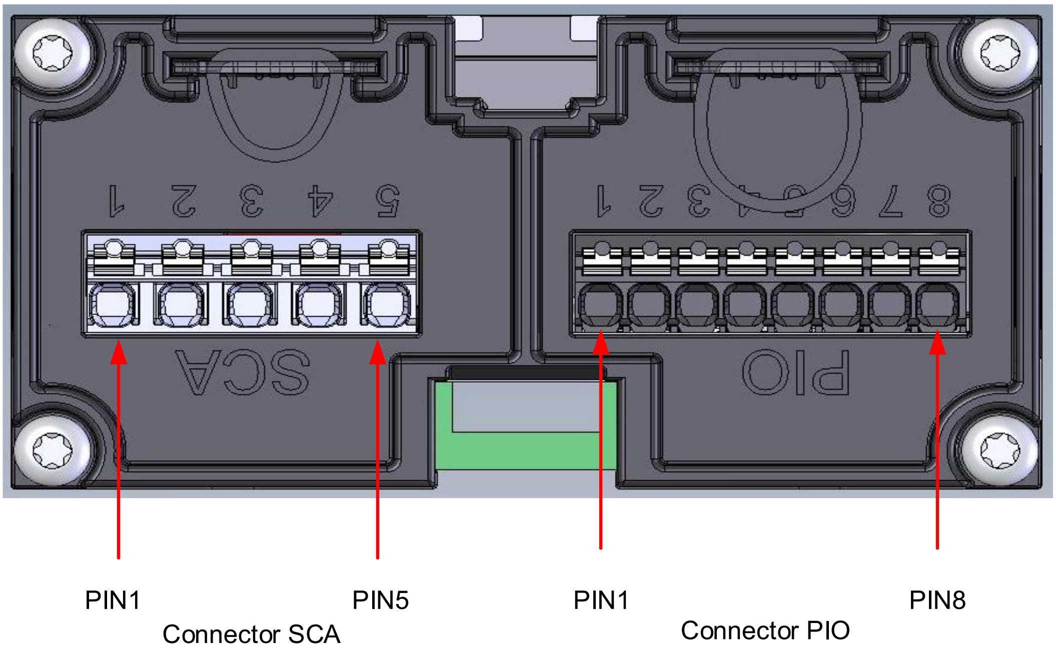


Figure 3: Connectors on bottom side of LIMAX1CP (Version Terminal for PIO-connector)

⚠	DANGER! The SCA terminal is connected to the signal from the safety circuit. There are normally 230VAC. Before installation, the safety circuit must be disconnected from the power supply.

For assembly of the "PIO" and "SCA" (assembled according to the type of connection: RJ45 or terminal) at first the cover must be removed (the cover is optional for the LIMAX1RED and may not be available).

The wires have to be connected to the corresponding terminal connections according to Table 3 and Table 4 or, if necessary, the RJ45 plug is to be inserted. The strain relief must be installed

Afterwards the cover must be put on again.

The signals of connector “SCA” (refer to Table 3) are connected to several spots in the safety circuit (refer to Figure 1).

Table 3: Connector “SCA”

Pin	1	2	3	4	5
Signal	OC_IN	OC_OUT	SR_IN	N	SR_OUT

Connector “PIO” (refer to Table 4) contains power-supply, CAN-connection (LIMAX1CP), RS485-interface for safe position-protocol (LIMAX1RED), a digital input for purpose of floor detection and the door zone output.

It can also be seen in Figure 1 how these signals are connected.

Table 4: Connector PIO

Pin	1	2	3	4	5	6	7	8
Signal	CAN_H	CAN_L	FS	RS485	RS485#	DZO	GND	Vcc

5 Operation Modes and Commissioning

5.1 Overview about Modes and Transitions

The following operation modes are available:

- Pre-commissioning mode
- Teach mode
- Normal mode
- Test mode
- Settings mode

Test mode and teach mode provide additional sub-modes.

In normal lift operation, the LIMAX1CP is always in normal mode. In this mode the LIMAX1CP fulfills the safety functions for the normal operation of the lift:

Table 5: Safety functions in normal mode

Safety function	Refer to chapter	Needs information about floor positions	Need information about special reference positions[1]
Overspeed (pre-tripping)	6.1	-	-
Final limit switches	6.2	-	X
ETSL	6.3	-	X
Door bridging	6.4	X	-
UCM	6.5	X	-

The other modes are used for commissioning (pre-commissioning and teach mode), change of special parameter (settings mode) and test (test mode).

Commissioning will be done after mechanical and electrical installation. There are safety functions which are only active in pre-commissioning and teach mode in order to secure the process of commissioning (refer to chapters 6.6)

The purpose of commissioning is to provide the 1CP with information about the shaft in which it is installed in. This information is needed for some safety functions, see Table 5.

Before LIMAX1CP can operate in normal mode, the shaft construction must be learned in teach mode, if necessary (refer to chapter 5.2).

There are two types of shaft information:

1. The floor table (number and position of floors and possibly side of the floors), needed for door bridging and UCM
2. The reference positions, needed for final limit switches, and for deceleration control

The mode in which LIMAX1CP starts (at power up or system reset, refer to chapter 6.6) depends on the shaft-information which the LIMAX1CP knows, and the shaft-information, LIMAX1CP needs (acc. to Table 5).

LIMAX1CP/1RED will start up in

[1] These „reference-positions“ are normally the ends aft the shaft (where the cabin, resp. the counterweight sits on the buffer surface)

- Normal mode, if all needed shaft information is available at start up
- Teach mode, if the reference positions are already available, but the needed floor table is not available.
- Pre-commissioning mode in all other cases

At delivery LIMAX1CP/1RED must be in pre-commissioning mode: The floor table is empty and no reference positions are available.

Examples for commissioning- (teach-) procedure can be found in A.3

⚠	WARNING! Directly after electrical installation the mode must be pre-commissioning[1]. If this is not the case a transition to pre-commissioning mode must be performed before commissioning is continued.

⚠	WARNING! After commissioning the safety functions must be tested. The test mode provides assistance for testing certain safety functions that would otherwise be difficult to test, refer to chapter 5.4.

Also, after commissioning minor changes of floor positions and changes of some parameters of safety functions may be necessary. These changes can be done in settings mode, refer to chapter 5.3.

Figure 4 shows an overview of the operation modes and the transitions between them. The transitions (except those at startup) are demanded by CANopen (🕮 CANopen-specs).

The CANopen command to change a mode will normally be sent by lift control. It must be triggered by the intention of a competent user, e.g. via control panel of lift control.

Mode transitions are only accepted in stand still.

[1] By transition to pre-commissioning mode floor positions and reference positions which may be already available are erased.

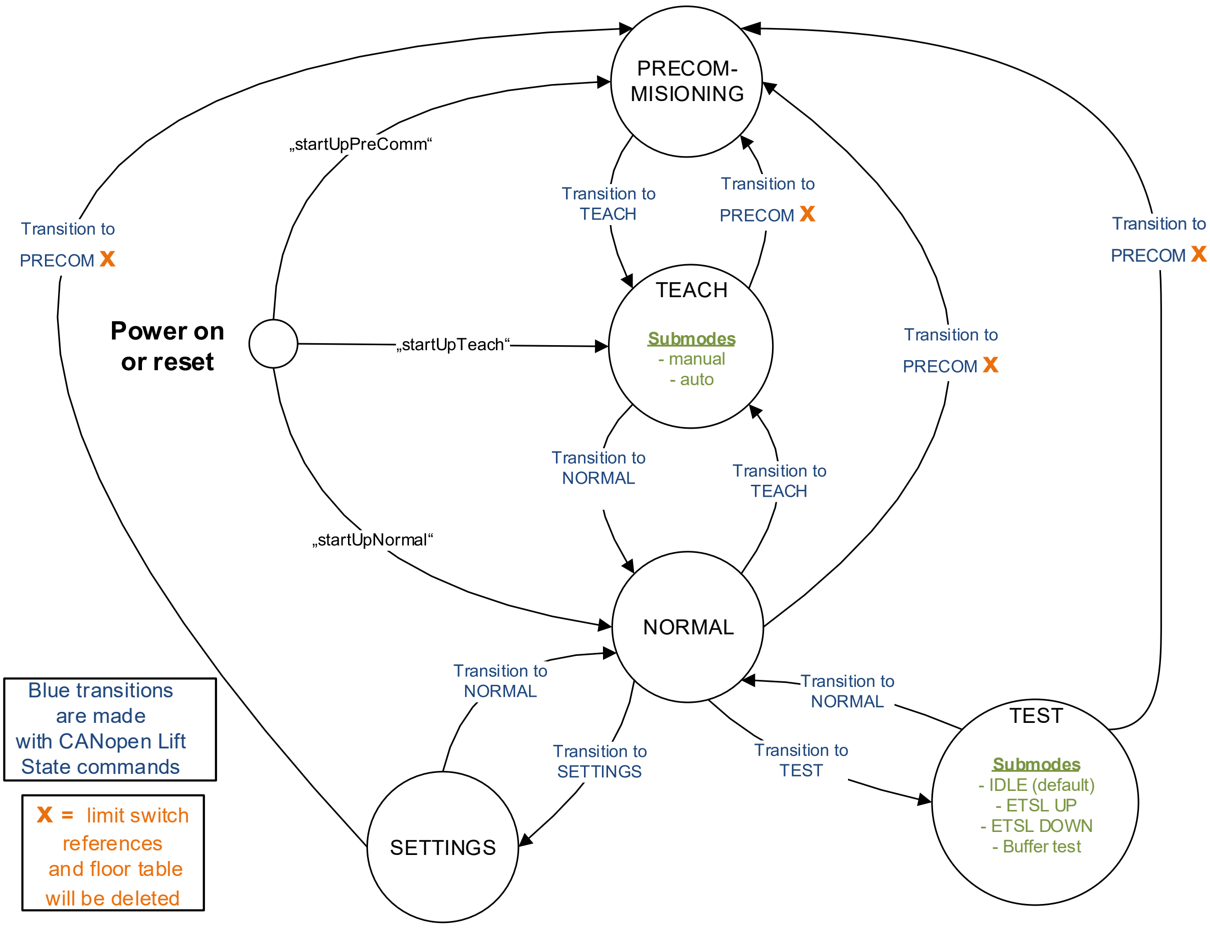


Figure 4: Operation modes overview.

The safe state (error-state, see chapter 8.6) can be reached form each mode shown in Figure 4.

In general, the safe state can only be exited via a reset or a power cycle. However, there are exceptions where the error resets itself - and thus the safe state is exited again - as soon as it has disappeared again.
The exceptions are also described in chapter 8.6.

5.2 Teach Mode

5.2.1 Entering of Teach Mode and its Sub-mode

In teach mode floors and reference positions can be learned.

When LIMAX1CP is in pre-commissioning or in normal mode, the teach mode can be entered by the corresponding CANopen command 🕮 CANopen-specs).

- When teach mode is entered from pre-commissioning mode, no information about floor table and reference position is available.
- When teach mode is entered from normal mode a valid floor table and/or valid reference positions are already available after entering (floor table and reference positions from normal mode will not be erased but kept).
- Teach mode is entered immediately after power up resp. system reset, if reference positions are already available but no floor table.
- Teach mode contains two sub-modes: "manual" and "auto". The sub-mode can be changed by CANopen (🕮 CANopen-specs) from "manual" to "auto" and vice versa.
- If the configuration feature "automatic teach" is not enabled in the configuration (see chapter 13.1.4.2) entering of teach, sub-mode auto will be refused.
- When teach mode is entered, the sub-mode will be "manual"

Reference positions will always be learned by CANopen-command (🕮 CANopen-specs), refer to chapter 5.2.4.

Concerning floor positions there are two possibilities:

1. Teach by CANopen (in sub-mode "manual"), refer to chapter 5.2.2
2. Teach by usage of a floor-sensor (in sub-mode "auto"), refer to chapter 5.2.3.1

In order to learn the floors - be it in the teach mode auto or in the teach mode manual - it is necessary to move the car. The safety function "ETSL" is not active in teach mode (see chapter 6.3). As a substitute LIMAX1CP/1RED provided the possibility to limit the speed in teach mode be safety function "over speed teach pre-tripping" (see chapter 6.6).

⚠	WARNING! If the user wants to secure persons or material during teach mode by safety function "over speed teach pre-tripping", he must take care of a suitable setting of the tripping for over speed teach, e.g. by defining the tripping speed of "over speed teach pre-tripping" not greater than the nominal speed of the buffers.

5.2.2 Learning of Floor Positions in Sub-mode „manual"

Manual teach of floor positions is only accepted by LIMAX1CP in teach sub-mode "manual"

In order to learn a floor position the cabin is normally moved to the corresponding floor.

When the level of the floor ground and the cabin are flush, the CANopen command to learn the actual position as a floor position (🕮 CANopen-specs) can be sent to LIMAX1CP. When doing this the number of the floor and the side (first side, second side or both sides) is also included in the CANopen command.

A demand to learn a floor position is only accepted in stand still.

This proceeding is repeated until all floors are learned.

There are also other commands for manipulation of the floor table (📖 CANopen-specs). But the proceeding corresponding to the steps as described above is the recommended, because the compliance with the exact floor positions is automatically guaranteed.

If floor table is not needed in order to fulfill the respective enabled subset of safety functions the LIMAX1CP will refuse a demand to learn a floor position.

5.2.3 Automatic Learning and Adjustment of Floor Positions

Using a floor sensor an automatic learn trip is possible. Automatic teach of floor positions is only accepted by LIMAX1CP in teach sub-mode "auto".

Because for LIMAX1CP the connection for only one floor sensor is available, only floors on the 1st side can be learned in teach sub-mode "auto": Floors learned by floor detection are always first side at 1CP (by definition). Floor sensors and floor-magnets can be ordered as accessories from ELGO. The user may also connect his own floor-sensor system to the designated input "FD". The floor sensor is mounted at the cabin so that its sensitive area passes by the floor magnets, mounted at the floor positions.

By passing by the floor magnets a certain signal has to appear at the input "FS", refer to chapter 12.

When this signal does appear and some additional conditions do apply (refer to A.2) the position in the "center of the signal" is learned as a floor level (refer to chapter 12).

Dependent on the mode LIMAX1CP will proceed with the detected floor as described in the following sub-chapters.

5.2.3.1 Floor detected in Teach, Sub-mode Auto

When a floor is detected by floor sensor and the actual mode is teach, sub-mode auto the following will apply:

- If the distance to the closest adjacent floors, which are already present in the table, is bigger than the "door-minimum-distance" the floor position is learned as a new floor. The "door-minimum-distance" is a settable parameter, refer to chapter 13.2.
- If the distance to the closest adjacent floors is smaller than the "door-minimum-distance" and the closest floor includes first side (is first side or both sides[1]), the already present floor position will be substituted by the new detected floor position
- If the distance to the closest adjacent floors is smaller than the "door-minimum-distance" and the closest floor includes is only second side[1], the first-side-information will be supplemented and the already present floor-position-information will be substituted by the new detected floor position[2]

If the floor position is learned as a new floor, the floor is inserted automatically at the correct position (floor number) in the floor table to keep ascending order. The floor numbers of already present higher floors are shifted if necessary. Therefore, a wrong numbering of the floors or "gaps" in the floor table cannot appear (in contrast to manual teach).

The conditions for auto-teach are also illustrated in Annex A.1.

5.2.3.2 Floor detected in Teach, Sub-mode Manual

When a floor is detected by floor sensor and the actual mode is teach, sub-mode manual, nothing will happen.

5.2.3.3 Floor detected in Normal-, Settings- and Test-mode

When a floor-position is detected by floor sensor and the actual mode is normal-, settings- or test mode, a floor in the floor table nearby the detected floor position will be adjusted if the following conditions do apply:

[1] Although only a connection for 1st-side floor sensor is available there may be floors of 2nd side in the floor table if they have been learned before by teach-manual.
[2] In contrast to adjustments (refer to chapter 5.2.3.3) this affects the original floor position

1. Automatic adjust must be enabled in the configuration (refer to chapter 13.1.4.2)
2. The distance between the position of the actual detected floor and nearest floor already stored in the floor table is smaller than 50mm
3. The new position (after adjustment) of the floor already stored in the floor table must be within ±100 mm related to its original position (position where the floor was first learned)
4. The distance of the actual position to nearest floor position in the floor table on the corresponding side is bigger than ±5 mm.
5. The adjustment must not change the ascending floor ordering.

If all conditions above apply, the actual position of the floor will be adjusted: The detected floor position will be stored as the new position of the corresponding floor in the floor table by storing an offset to the original position. This prevents shifting for more than 100mm from the position where it has been originally learned, even not by succeeding adjustments (see also bullet-point 2. above).

If the conditions 1. or 5. above do not apply, the detected floor is ignored and floor table will not be changed.

In the Annex A.2 these conditions are also illustrated.

5.2.4 Learning of Reference Positions

In teach mode the reference positions can be learned regardless of the sub-mode.

The technician moves the car to the lowest possible position (normally this is the position where the car is on the buffer). He signals to the control that the current position has to be learned as the reference position bottom. The control passes on this signal via CANopen to LIMAX1CP 🕮 CANopen-specs). For this purpose, the cabin must be in stand still.

The technician moves the car to the highest possible position (normally this is the position where the counterweight is on the buffer). He signals to the control that the current position has to be learned as the reference position top. The control passes on this signal via CANopen to the LIMAX1CP 🕮 CANopen-specs). For this purpose, the cabin must be in stand still.

If the technician tries to learn a reference top on a position below the reference bottom, this command will be refused. The same applies if he tries to learn a reference bottom on a position higher than the reference top.
If the technician gives a CANopen-command to learn a reference position which is already available, it will be overwritten.

NOTE!

- If reference positions are not needed in order to fulfill the respective enabled subset of safety functions the LIMAX1CP will refuse a demand to learn reference positions.
- The reference bottom can be learned before the reference top or vice versa.
- It is also possible to learn one reference first, then learn the floor table and at last learn the 2nd reference. This may make the teach procedure more time effective.
- Refer also to annex A.3 for an example sequence.

5.2.5 Leaving Teach Mode

Teach mode can be left to normal mode by CANopen command 🕮 CANopen-specs).

LIMAX1CP will refuse a demand to enter normal mode and will stay in teach mode if:

1. The floor table is needed, and no floor or only one floor has been learned,
2. The position of the single floors is not increasing with an increasing index

3. all entries in the table, starting from index 1 up to the highest floors must be filled → corresponding floors have been learned.
4. No reference position or only one of them has been learned although they are needed

ℹ	NOTE! The situation that the position of the single floors is not increasing with increasing index (bullet-point 2. Above), or that there are empty spaces in between the floor table (bullet-point 2. above) can only appear in teach sub-mode "manual". If the floors have been learned in teach, sub-mode "auto" this cannot happen, because during automatic teach the LIMAX1CP determines the correct order of the floors be itself.

If the teach process was successful LIMAX1CP will accept the demand to enter normal mode and the floor table will be stored in a non-volatile way (additional to the already stored reference positions).

Afterwards the mode changes to "normal".

Teach mode can also be left to pre-commissioning mode by CANopen command 🕮 CANopen-specs). In this case an existing floor table will be erased. Reference positions which may have been already available in teach mode, are also erased in this case.

5.2.6 Power-cycle and System Reset during Teach

If a power cycle occurs during teach mode or if a system reset command by CANopen (refer to 🕮 CANopen-specs) was given, all floor positions learned up to that moment will get lost.

In contrast to this, reference positions will be kept in case of power cycle or reset - provided both of them are available (they are stored in a non-volatile way as soon as both reference positions have been learned).

So, if both reference position have been learned in teach mode, a power cycle in teach mode will cause immediate re-entering of teach mode or direct entering of normal mode if no floor table is needed due to the configured safety function.

5.3 Settings Mode

The parameters which are settable by CANopen, can be changed in settings mode, refer to chapter 13.2.

In settings mode also adjustments of floor positions by CANopen can be done 🕮 CANopen-specs).

Settings mode can only be entered from normal mode. This is done by the corresponding CANopen command 🕮 CANopen-specs).

Settings mode can only be left with transition to normal mode or to pre-commissioning mode. By leaving to pre-commissioning mode the information about the shaft (floor table and reference positions) are erased. Leaving of settings mode is done by the corresponding CANopen command 🕮 CANopen-specs).

Settings mode is also left at a system reset or power cycle. In this case the LIMAX1CP starts up according to the conditions for power up as specified in chapter 5.1.

The behavior of the safety functions in settings-mode is identical to normal mode.

5.4 Test Mode

Test mode can only be entered from normal mode. This is done by the corresponding CANopen command (🕮 CANopen-specs).

The test mode provides the following sub-modes:

- Idle

- ETSL-UP
- ETSL-DOWN
- Buffer test

Immediately after entering test mode the sub-mode “idle” is activated. In sub-mode idle, the behavior of the safety functions is the same like in normal mode.

Concerning the other sub-modes, the behavior of each one safety function is changed for test purposes. The changed behavior in test mode is also described directly in the subchapter of the corresponding safety function.

Table 6: sub-modes of test mode

Submode	Safety function to be tested	Refer to chapter
IDLE	–	
ETSL - UP	ETSL	6.3
ETSL - DOWN	ETSL	6.3
Buffer test	No safety function of LIMAX1CP is tested, but it makes it possible to travel towards the buffers for test purpose	5.4.1

It can be switched between the individual sub-modes at will.

Test mode can only be left (from each arbitrary sub-mode) with transition to normal mode or to pre-commissioning mode. By leaving to pre-commissioning mode the information about the shaft (floor table and reference positions) are erased. Leaving of teach mode is done by the corresponding CANopen command 🕮 CANopen-specs).

Test mode is also left at a system reset or power cycle. In this case the LIMAX1CP starts up according to the conditions for power up as specified in chapter 5.1.

5.4.1 Buffer Test Mode

Sub-mode “buffer test” can be entered by the CANopen command (🕮 CANopen-specs), as long as the device is in test mode.

Final limit switches are not active (do not open) in buffer test mode so that the car can hit the buffer with rated speed for test purpose.

ETSL is also not active in buffer test mode so that the car can hit the buffer with a sufficient speed.

The pre-tripping speed is reduced to the “pre-tripping speed in buffer test mode”, which is a configuration parameter (refer to chapter 13.1.3). This is a substitute for the disabled ETSL-functions.

The “pre-tripping speed in buffer test mode” should be just as great, so that the buffer test can be performed with the scheduled speed.

Concerning sub-mode ‘Buffer-test’ there is also a special condition: It is only allowed to be in this sub-mode for a maximum time of 10 min. After this time elapsed and the device is still in test-mode, the sub-mode will change to “idle”.

> **NOTE!**
> Buffer test is not for testing of LIMAX1CP - safety functions, but only an auxiliary functionality which helps testing something out of scope of LIMAX1CP (a buffer travel), therefore it is not listed (as a subchapter) in chapter 14.6.

5.4.2 ETSL-UP

The behavior is also illustrated in the annex A.5 , Figure 33:
The ETSL-curve is modified in such a way than ETSL already trips when approaching the middle of the shaft. Starting from a position in the lower half in upwards direction.

So, it is possible to test the ETSL-safety function in a simply way, without changing software of the lift control (beside implementation of the corresponding CANopen-command) and without risk for man or material.

5.4.3 ETSL-DOWN

Corresponding to ETSL-UP.

6 Safety Functions

One of the main tasks of the LIMAX1CP is to fulfill the safety functions defined for this device. They are specified in the following sub-sections.

If a safety function trips, the actuator defined for this function opens unconditional. After the safety functions tripped it will be reset under certain condition (dependent on the kind of safety function):

- Automatic, if a certain reset-condition appears (automatic reset condition in general depended on position and/or speed and may be time). The automatic reset conditions are defined in the following subchapters for each safety function.
- Manual, by a special CANopen-command (additional to other conditions), refer to chapter 6.7.

After reset of a safety function, the corresponding actuator will close, but only if there are no other conditions to the contrary, refer to chapter 7.

6.1 Safety Function: Overspeed Pre-Tripping

Reference to EN-81; SIL:

EN81-20 §5.6.2.2.1.6 a); SIL2 (due to EN81-20, ANNEX A, Table A.1)

Condition for tripping and reset:

This safety function trips, if the actual speed exceeds the pre-tripping speed. This state is only cleared by manual reset, refer to chapter 6.7. The pre-tripping speed depends on the configuration, refer to chapter 13.1.3.

Actuator and Braking element:

The OC is the actuator for this safety function (opens when safety function trips). It is integrated in the safety circuit, refer to chapter 4.

Therefore, the machine brake is normally the braking element.

Concerning reaction of SR refer to chapter 6.4.1.

Activity:

This safety function is active in all operation modes.

In test mode, sub-mode buffer-test, the pre-tripping speed is (normally) reduced:

The safety function trips, if the actual speed exceeds the "pre-tripping speed in buffer test", which is normally smaller than pre-tripping speed. "Pre-tripping speed in buffer test" must be less than or equal to "pre-tripping speed".

6.2 Safety Function: Final Limit Switches

Reference to EN-81; SIL:

EN81-20 §5.12.2.3.1 b); SIL1 (due to EN81-20, ANNEX A, Table A.1)

Condition for tripping and reset:

This safety function trips, if car position is higher than final limit switch top or car position is lower than final limit switch bottom. Safety function "final limit switches" is reset if the car position is back in the area between final limit switch top and final limit switch bottom therefore OC closes automatically.

The position of final limit switch top is calculated as
"reference position top" - "offset final limit switch top"

The position of final limit switch bottom is calculated as
"reference position bottom" + "offset final limit switch bottom"

Reference positions have been learned in teach mode, refer also to chapter 5.2.4, Offsets of final limit switch top/bottom depend on the settings, refer also to chapter 13.2.

Actuator and Braking element:

The OC is the actuator for this safety function (opens when safety function trips). It is integrated in the safety circuit, refer to chapter 4.

Therefore, the machine brake is normally the braking element.

Concerning reaction of SR refer to chapter 6.4.1.

Activity:

This safety function is active in normal, test mode and settings mode. Additional this safety function is active in teach mode, but only on condition that both (top and bottom) reference position have already been learned.

In teach mode – and no reference position or only one reference position learned, this safety function is not active. This safety function will never trip under these conditions.

The same applies to pre-commissioning mode

6.3 Safety Function: Deceleration Control (ETSL)

Reference to EN-81; SIL:

EN81-20 §5.12.1.3; SIL3 (due to EN81-20, ANNEX A, Table A.1)

Condition for tripping and reset:

This safety function trips, if the permitted ETSL-speed is exceeded. The "tripped" state will be kept until stand still is reached and held for 1s. After this time the safety function resets automatically.

The formula for the permitted ETSL-speed (absolute value) is:

$$v_{ETSL} = \begin{cases} MAX\left(\sqrt{2 \cdot a_{ETSL} \cdot s + v_{BUFFER}^2 + a_{ETSL}^2 \cdot t_{del}^2} - a \cdot t_{del}\ ;\ v_{Buffer}\right), & s \geq 0 \\ v_{Buffer}, & s < 0 \end{cases}$$

Table 7 defines how the distance "s" in the formula above is determined.

Table 7: Distance to "assumptive" buffer dependent on moving direction and mode

	Moving UP	Moving DOWN
Normal mode	s = $Pos_{reference\_top}$ - $Offset_{ETSL\_top}$ - Pos_{car}	s = Pos_{car} - $Pos_{reference\_bottom}$ - $Offset_{ETSL\_bottom}$
ETSL test mode up	s = ($Pos_{reference\_top}$ + $Pos_{reference\_bottom}$ - $Offset_{ETSL\_top}$ + $Offset_{ETSL\_bottom}$) / 2 - Pos_{car}	s = Pos_{car} - $Pos_{reference\_bottom}$ - $Offset_{ETSL\_bottom}$
ETSL test mode down	s = $Pos_{reference\_top}$ - $Offset_{ETSL\_top}$ - Pos_{car}	s = Pos_{car} - ($Pos_{reference\_top}$ + $Pos_{reference\_bottom}$ - $Offset_{ETSL\_top}$ + $Offset_{ETSL\_bottom}$) / 2

The parameter a_{ETSL}, t_{del}, V_{Buffer}, $Offset_{ETSL\_top}$, $Offset_{ETSL\_botom}$ depend on the configuration, refer to chapter 13.1.3.

In test mode, the "assumptive" buffer position in, figuratively speaking, at the midpoint between the upper and lower ETSL reference positions. $Offset_{ETSL\_bottom}$ is *added* as absolute value, because the bottom ETSL reference position is *above* the bottom reference position. $Offset_{ETSL\_top}$ is *subtracted* as absolute value, because the top ETSL reference position is *below* the top reference position. Both are shifted toward the center of the shaft.

Actuator and Braking element:

The OC is the actuator for this safety function (opens when safety function trips). It is integrated in the safety circuit, refer to chapter 4.

Therefore, the machine brake is normally the braking element.

Activity:

This safety function is active in normal mode, and in settings mode.

In test mode, sub-mode Test-ETSL-UP and moving direction up, the distance to the assumptive buffer "s" is shifted to the middle of the shaft for test purpose. In test mode, sub-mode Test-ETSL-DOWN and moving direction down, the distance to the assumptive buffer "s" is shifted to the middle of the shaft for test purpose, refer also to Table 7.

In test mode, sub-mode buffer-test, ETSL is not active (will never trip), refer also to 5.4.1.

In all other sub-modes of test mode, the safety function behaves like in normal mode.

In pre-commissioning and in teach mode the safety function is not active (will never trip).

6.4 Safety Function: Door Bridging

Reference to EN-81; SIL:

EN81-20 §5.12.1.4; SIL2 (due to EN81-20, ANNEX A, Table 1A1)

Condition for bridging and release of bridging:

There are two kinds of door bridging: "door bridging levelling", "door bridging re-levelling" and preliminary operations.

If the conditions for "door bridging levelling", "door bridging re-levelling" or for "preliminary operations" are fulfilled, SR closes (door circuit is bridged). If neither the conditions for "door bridging levelling" nor for "door bridging re-levelling" nor for "preliminary operations" are fulfilled, SR opens (door circuit is not bridged any longer).

The conditions for door bridging levelling are:

1. A valid door bridging command for levelling has been given by CANopen (🕮 CANopen-specs).
2. Actual position is in the door zone for levelling of that floor, the door bridging levelling has been enabled for.
   The door zone extends from the "flush position of the relevant floor" MINUS "door zone size for levelling" to "flush position of the relevant floor" PLUS "door zone size for levelling". "Door zone size for levelling" depends on the settings, refer also to chapter 13.2.
   The "flush position of the relevant floor" is taken from the CANopen command and not from the floor table.
3. *Actual speed < 0.8 m/s*

If all three conditions listed above are fulfilled, SR closes due to door bridging levelling.

The conditions for door bridging re-levelling are:

1. A valid door bridging command for re-levelling has been given by CANopen (🕮 CANopen-specs).
2. Actual position is in the door zone for re-levelling of that floor, the door bridging levelling has been enabled for.
   The door zone extends from the "flush position of the relevant floor" MINUS "door zone size for re-levelling" to "flush position of the relevant floor" PLUS "door zone size for re-levelling" Door zone size for re-levelling" depends on the settings, refer also to chapter 13.2
   The "flush position of the relevant floor" is taken from the CANopen command and not from the floor table.
3. *Actual speed < 0.3 m/s*

If all three conditions listed above are fulfilled, SR closes due to door bridging re-levelling.

The conditions for door bridging preliminary operations are:

1. A valid door bridging command for preliminary operations has been given by CANopen (📖 CAN-open-specs).
2. The door zone extends from the "flush position of the relevant floor" MINUS 20mm to "flush position of the relevant floor" PLUS 20mm.

If all three conditions listed above are fulfilled, SR closes due to door bridging preliminary operations.

Actuator and braking element:

The SR is the actuator for "door bridging".

The SR is integrated in the safety circuit, refer to chapter 4.

In contrast to the other safety functions, this safety function may release the braking element (normally the motor brake), although doors contacts are open.

Activity:

This safety function is active in normal mode, settings mode and in test mode. In pre-commissioned and in teach mode this safety function is not active: In pre-commissioned and in teach mode SR will never close and therefore never release the braking element.

6.4.1 Further Conditions for Activity of Door Bridging and Reactions of SR

Even if the conditions for door bridging are fulfilled, there may be further conditions which prevent the SR from closing:

1. In teach and in pre-commissioning mode SR will never close, because door bridging is not active in these modes.
2. If there is no voltage at the input of the SR-actuator (SR_IN), which is the same as the output of the OC-actuator (OC_OUT), a closed SR will open. The reason is to ensure a proper diagnosis of the SR-actuator, refer also to chapter 8.1.2. This means that tripping of other safety functions acting on the OC (like final limit switches) will indirectly also cause an open SR. But an active door bridging will not be disabled. This means, that SR will close again in this case, if voltage returns at OC_OUT (e.g. because of a recall travel), provided the zone-condition and speed condition are fulfilled further on.
3. If an error state is present with a level for which an open SR is required, SR will be open.

6.5 Safety Function: Unintended Car Movement, part1 (UCM, part1)

Reference to EN-81; SIL:

EN81-20 §5.6.7.7; SIL2 (due to EN81-20, ANNEX A, Table A.1)

Condition for tripping and reset:

Three conditions must be fulfilled for causing door over-bridging (SR close), refer to 6.4:

1. Door over-bridging (for levelling or re-levelling) must be enabled by CAN: "CAN-condition" (📖 CANopen-specs)
2. Speed must be below 0.8 m/s for levelling resp. 0.3 m/s for re-levelling: "speed-condition"
3. Position must be in the levelling resp. re-levelling zone of the correct floor: "zone-condition"

Otherwise, OC and SR open.

If "CAN-condition", "speed"-condition" and "zone-condition" are all fulfilled (and therefore SR is closed) and then "speed"-condition" or "zone-condition" is hurt (levelling resp. re-levelling speed exceeded or levelling resp. re-levelling- zone is left) unintended car movement (UCM) trips.

An illustration of these conditions can be found in annex A.4.

After UCM tripped this state is only cleared by manual reset, refer to chapter 6.7.

Actuator and Braking element:

If the machine brake built due to EN81-20 §5.9.2.2.2, the machine brake may be the braking element for UCM

Activity:

This safety function is active in normal mode, settings mode and in test mode.

6.6 Safety Function: Overspeed Teach Pre-Tripping

Reference to EN-81; SIL:

No reference to EN81, Substitute for ETSL, which is not carried out in teach mode. (Because reference potions are possibly not known), Therefore it is SIL3.

Condition for tripping and reset:

This safety function trips, if the actual speed exceeds the pre-tripping speed teach. This safety function is reset in case standstill is reached and hold for 1s.

The pre-tripping speed teach depends on the configuration, refer to chapter 13.1.3.

Actuator and Braking element:

The OC is the actuator for this safety function (opens when safety function trips). It is integrated in the safety circuit, refer to chapter 4.

Therefore, the machine brake is normally the braking element.

Remark: SR is already open, refer to chapter 6.4.1.

Activity:

This safety function is active only in teach- and in pre-commissioning mode.

6.7 Reset of Safety Functions

Some safety functions keep their tripped state until a manual reset[1].

There are two kinds of reset:

- A system reset, implying a restart of the system
- A reset without restart (fault reset)

The reset must be initiated by a human operator, e.g. by entering a corresponding command to lift control.

The lift control in turn sends the reset request to the LIMAX as the CANopen command defined for this purpose.

Both kinds of reset (system reset or fault reset) can be demanded by CANopen command (📖 CANopen-specs).

In general, a reset is only accepted in standstill.

Concerning "UCM, part1" (refer to chapter 6.5) an additional condition for the acceptance of a reset without restart is, that the door bridging is disabled by CANopen. Reset of UCM by system reset will be accepted anyway in standstill (door bridging will be disabled caused by restart).

[1] A power cycle will not reset these safety functions

7 Conditions for Actuators

The safety functions (chapter 6) cause an open actuator (OC and/or SR) when they trip. Beside the safety functions there are further conditions for an open actuator:

- Direct actuator access (CANopen command to open an actuator)
- Error level > 1; resp. >2 (an error has been set due to fail of diagnostics)
- Demand to open OC for test purpose
- There is no voltage at the input of the actuator

(Refer also to Figure 5)

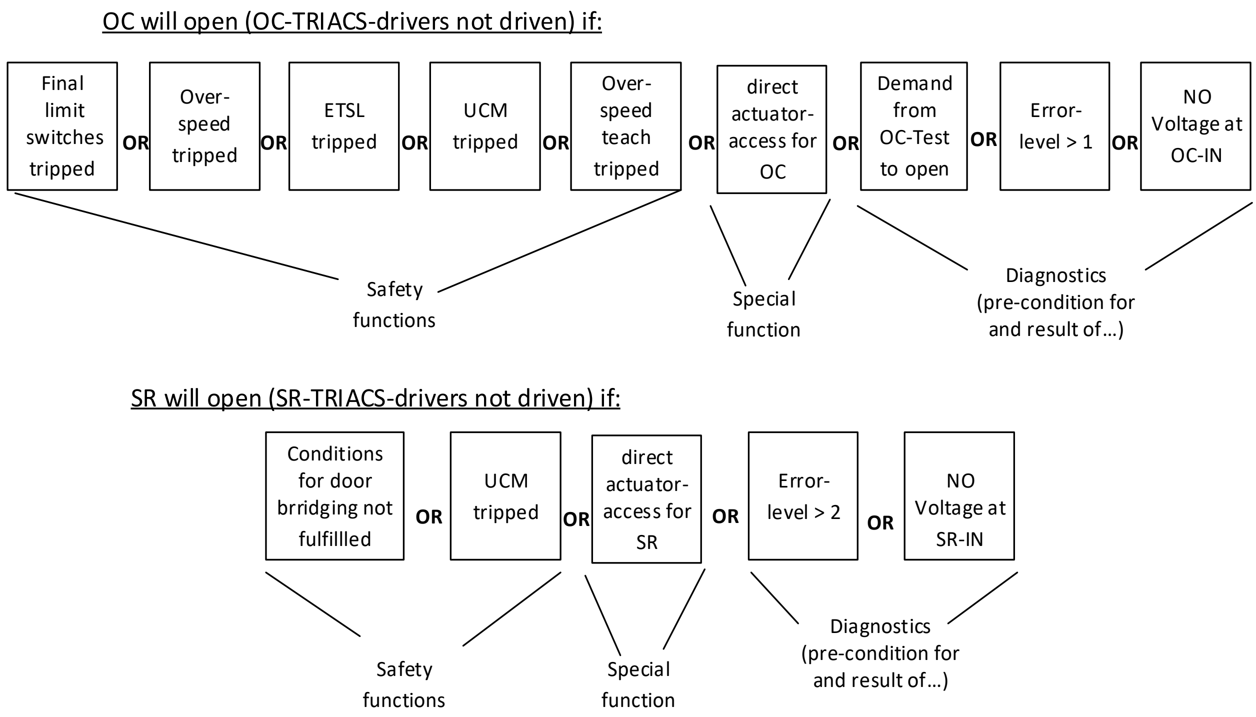


Figure 5: Conditions concerning actuators (OC and SR)

All these conditions are already known from the predecessor system, the LIMAX33CP by ELGO, except the condition “There is no voltage at the input of the actuator”. The need for this condition is mainly caused by the implementation of the actuators by TRIACs:

For diagnostic purpose it must be checked by diagnostic function, if an actuator is able to open (to interrupt the safety circuit).

In contrast to safety devices with safety relays for LIMAX1CP (with TRIACs as actuators), this actuator diagnostic is only possible in an indirect way by checking the voltages switched by the actuator:

If the actuator is open, there must be “no voltage” at the output of the actuator (e.g. at OC_OUT). But this only proves that the actuator is able to open, if there is voltage at the input of the actuator (e.g. at OC_IN).

If there is no voltage at the input of the actuator, no statement can be made. Therefore, an actuator is always opened by the software is there is no voltage at its input. For the safety circuit it makes no difference if the actuator is open or closed in this case (there is no voltage before the actuator anyway). But this additional condition makes diagnostics of the actuators (refer to chapter 8.1) simpler and safer.

Figure 6 shows the situation concerning an intact OC-actuator (as an example). A closed actuator means here: the TRIAC driven by its driver.

In situation 1.) it is proofed the diagnostic circuit of OC_OUT is able to indicate “voltage” (diagnostic still works). This is the normal situation during normal operation. As this situation may last for several weeks or month without changing of the states, the OC-actuator is opened in regular intervals in order to test its function (refer to chapter 8.1).

In situation 2.) it is proofed by checking of OC_IN, OC_OUT and the demanded state of the OC-actuator, that the actuator is able to open resp. is not bridged externally in a forbidden way and OC_OUT-diagnostics works correct: There cannot be voltage at OC_OUT if the device works correct and is installed correct, because there is voltage at OC, which means that the lift is not switched to recall and so not voltage can be fed to OC_OUT via the normal (allowed) way via the recall branch (symbolized by the UP/DOWN-switch)

Situation 3.) is forbidden, because will always open if there is no voltage at OC_IN (as already mentioned above)

In situation 4.) no statement can be made: OC is demanded to be open (no voltage at OC_IN); in this situation it is allowed that voltage is fed via the recall-branch to OC_OUT, so may be voltage or no voltage even for a correct working and correct installed device.

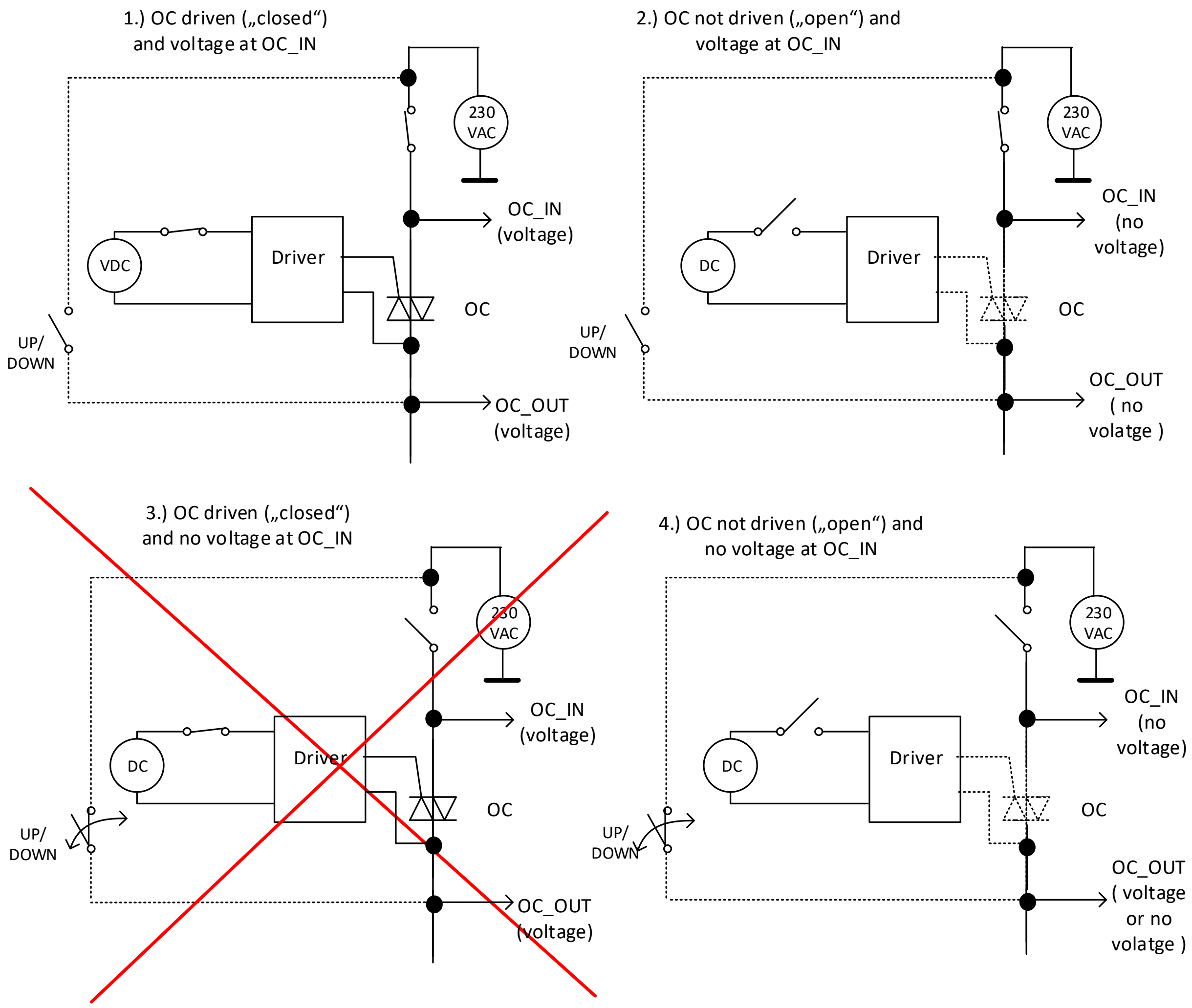


Figure 6: Situations concerning actuators (OC as an example)

Remark: In Figure 6 only one “switch” (TRIAC-driver combination) is shown. This is for simplification in order to explain the basic principle of TRIAC-diagnostic by checking the voltages before and behind the TRIAC.
In reality there are two TRIAC-switches for safety reasons.
More details about TRIAC-diagnostics and also in consideration of the 2-channel-structure of the actuators, can be seen in chapter 8.1

8 Diagnostic

8.1 Safety Circuit Diagnostics

The diagnosis of the functionality of the actuators is a central point of the safety concept.

With electronic switches as actuators (with the LIMAX1CP these are TRIACs), their functionality can only be checked indirectly:

At a defined spot the state relating to the voltage (present/not present) is checked and it is checked whether this state corresponds to the respective expected value depending on the switching state of the actuator and any other external circumstances.

These conditions are defined in such a way that the integration of the actuators into the safety circuit in the intended manner (see Figure 1) is taken into account.

These conditions are documented below so that the user can assess whether different installations would lead to problems concerning reliability or safety.

8.1.1 OC - Diagnostic

LIMAX1CP performs OC-diagnostics by checking the voltage behind the OC-actuator (at OC_OUT), refer to

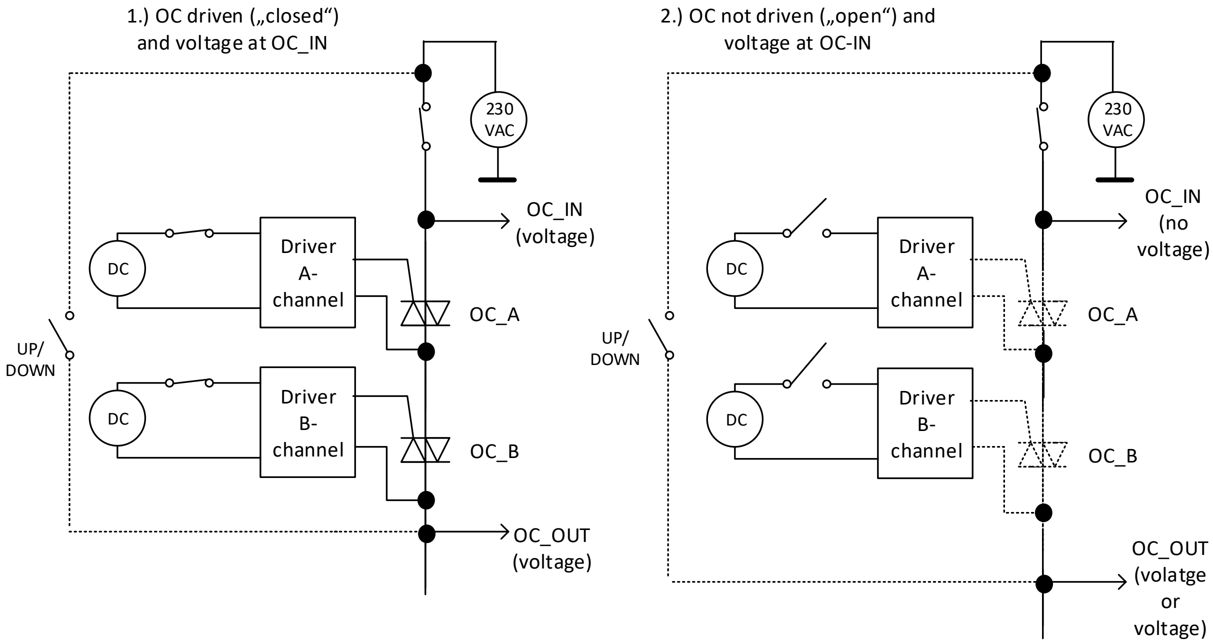


Figure 7. The following conditions are checked:

1. If OC is closed there must be voltage at OC_OUT (a closed OC implies that there is voltage at OC_IN, see chapter 7)
2. If OC is open and there is voltage at OC_IN, there must be no voltage at OC_OUT.
3. Provided OC is closed, a special OC-test (see below) is started in a regularly time interval

OC-Test:

During OC-test it is proofed that both channels are fully functional. The OC-test is normally triggered by lift control, by CANopen-command (🕮 CANopen-specs). If this command is not received for more than 24h (and OC was closed all the time) LIMAX1CP will start the test on its own if there is actual stand still (speed < 50mm/s), otherwise at next stand still.

If there is not stand still detected for further 12 hours (this is normally not possible) an error is set.

Furthermore, the OC test is performed every time, voltage returns at OC_IN, causing the OC-actuator to close.

OC tests lasts for 300ms. This means that OC will open for 300ms during OC-test, resp. OC will close with a delay of 300ms if voltage returns at OC_IN.

If one of the checks mentioned above fails, an error is set (refer to chapter 8.6) and safe state is established.

If all checks succeeded; it is proofed that the OC-actuator is fully functional and additional the voltage detection at OC_OUT is also functional (bullet-point 1. above): A defective voltage detection (as part of diagnostics) may also be dangerous, because a defective TRIAC may not be detected safely in this case.

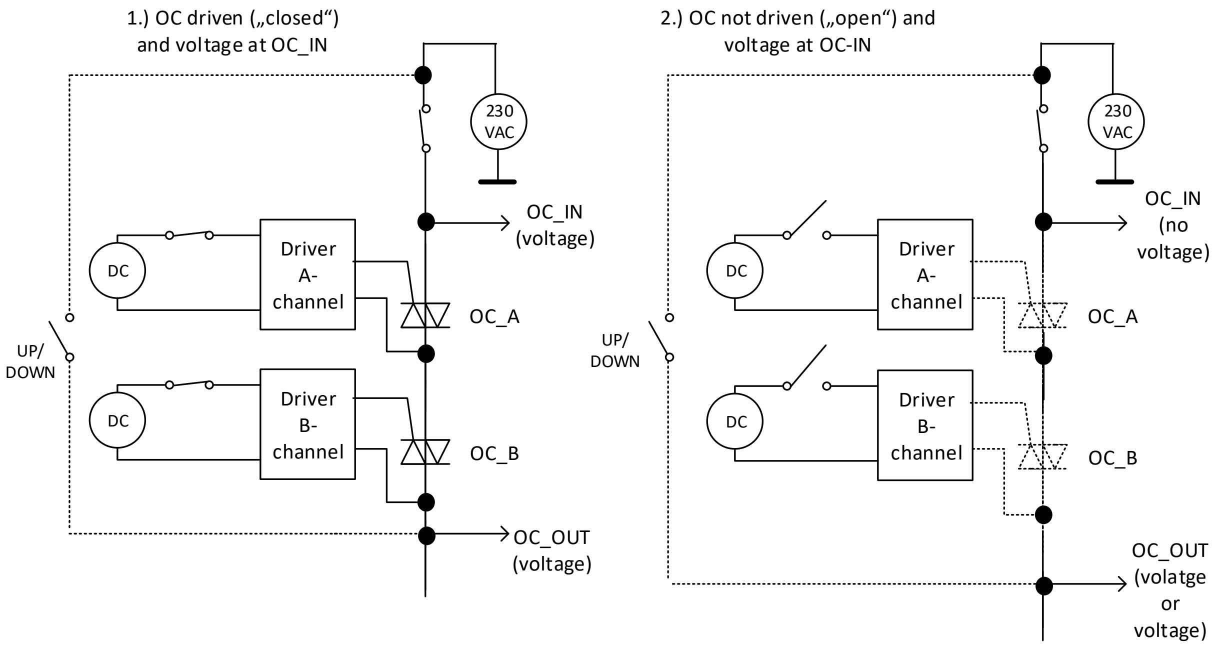


Figure 7: OC-diagnostic

8.1.2 SR - Diagnostic

In contrast to OC-diagnostic, LMAX1CP performs SR-diagnostics by checking the voltage between the two SR-switches (of channel A and channel B). This spot is called "SR-DIAG", refer to Figure 8. The user has no direct access to this spot. The following conditions are checked:

1. If SR is closed there must be voltage at SR-DIAG
2. If SR is open there must be no voltage at SR-DIAG

Remarks:

- Situation 1. (above) implies that there will be voltage at SR-IN (see chapter 7).
- The check in situation 2. (above) does not check directly in each situation that SR_A as well as SR_B are still able to open. But during each normal travel of the car this is checked: During a normal travel there is voltage at SR_IN and door contacts are closed. It can easily be seen, that in this situation there is only "no voltage" at SR_DIAG if SR_A as well as SR_B are open.

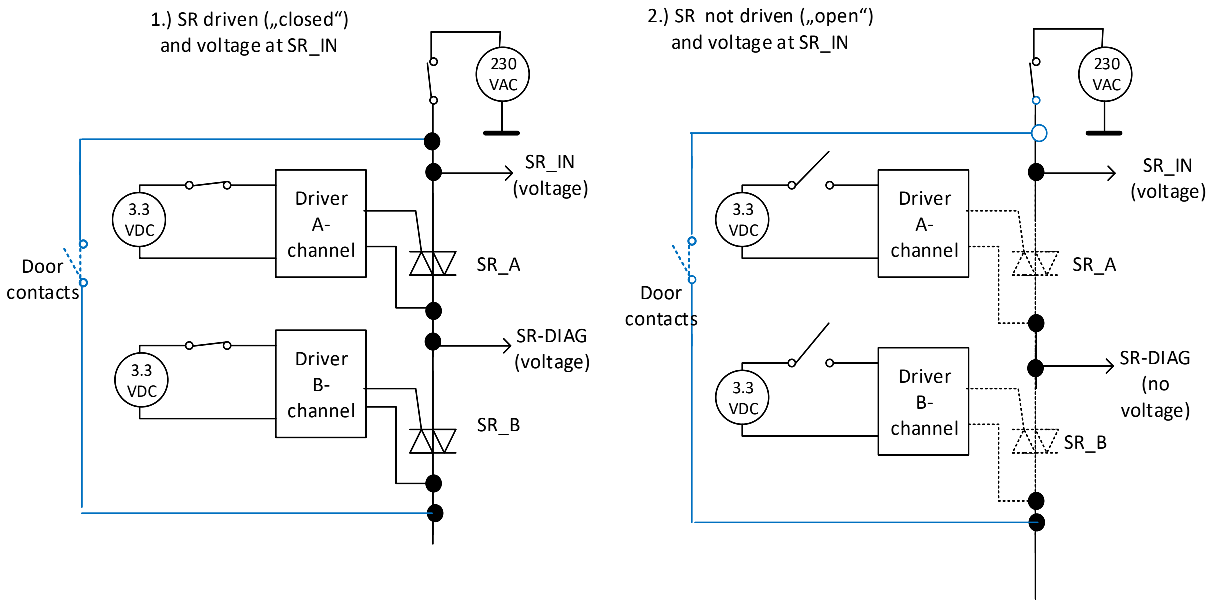


Figure 8: SR-diagnostics

8.1.3 Check of Safety Circuit Diagnostics

The software performs a window-counter for each diagnostic spot (OC_IN, OC_OUT, SR_IN and SR_OUT - see Figure 1), counting how often the instantaneous safety circuit-voltage exceeded the voltage-threshold in certain time window.

The window counter thus gives a measure of the magnitude of the voltage applied to the relevant diagnostic spot (a sinusoidal waveform provided).

Dependent on the size of the window counter the software takes the decision if voltage is present or not.

The software takes the decision that there is actual voltage if the window counter exceeds a certain threshold. Otherwise, the software takes the decision that there is no voltage.

The value of the threshold can also be read via CANopen.

If there is voltage on a diagnostic spot the corresponding counter values (of A- and B-channel) should exceed the counter-threshold clearly.

If there is no voltage on a diagnostic spot the corresponding counter values (of A- and B-channel) should normally be 0.

> NOTE!
> It is recommended to check if the counter values exceed / fall below the threshold clearly enough.
>
> This check should be done for OC_IN, OC_OUT and SR_OUT.

If the counter value is not big enough for the situation “voltage present” the cause may be:

- The supply voltage of the safety circuit is too small
- The hardware is defect

If the counter value is not small enough for the situation “voltage not present” the cause may be:

- There is a capacitive coupling of voltage from adjacent wires

- The hardware is defect

In the following situation the check of the counters for the situation “voltage present” can be done for OC_IN, OC_OUT and SR_OUT at the same time:

- safety circuit is powered
- lift is in normal mode, neither “recall” nor “inspection” is active
- OC is closed
- there is an electric connection between OC_OUT and SR_IN

In the following situation the check of the counters for the situation “voltage not present” can be done for OC_IN, OC_OUT and SR_OUT at the same time:

- safety circuit is powered
- lift is switched to “recall” or to “inspection” and no recall- resp. inspection-direction button is pushed at the moment

ℹ	NOTE! It is not sufficient just to switch the safety circuit off when the check of the counters for the situation “voltage not present” is done: When the safety circuit is switched completely off, it cannot be checked if there is a too big capacitive coupling from adjacent wires.

ℹ	NOTE! The check of safety circuit diagnostic by window counters as described above is for reliability reasons. If there is for example a voltage detected by fail (e.g. caused by capacitive coupling) the corresponding actuator test would fail LIMAX1CP/1RED would establish safe state.

8.2 Position Diagnostics

LIMAX1CP/1RED reads the actual position form the coding of the magnetic tape LIMAX1CP/1RED supervises also if the succession of position is plausible. If there are leaps in this succession, an error will be set.

By the properties of the code, it is ensured, that a failure in position detection – no matter if caused by electronics or caused by a magnetic failure of the tape – will always result in a big leap in succession of positions. This can be detected by the firmware of LIMAX1CP/1RED.

Only the first position immediately after start-up of LIMAX1CP/1RED is not confirmed. Latest after a movement of 24mm the position can be considered secured (confirmed by the succession of positions).

Considering the set of safety functions implemented in LIMAX1CP it is no problem of safety, that the position immediately after power up is not secured:

- Considering overspeed pre-tripping immediately after power up there will be stand still → overspeed will never trip. If the LIMAX1CP was powered up on a fail position, a start of movement would immediately cause a leap in position (which would be detected by diagnostics) and additional this leap in position would cause a very big speed-value, so that overspeed safety function would trip.
- Considering ETSL similar words as for overspeed pre-tripping do apply.
- Considering final limit switches: If LIMAX1CP is powered up on a position outside the area between the final limit switches, OC should be open. If LIMAX1CP nevertheless assumes that it powered up between the final limit switches, OC will be closed by fault. But this is no big problem of safety: As soon as a movement starts there will be a leap in position and the fault will be detected. Anyway, safety function “final limit switches” is quite tolerant concerning the tripping point.
- Considering door bridging: If LIMAX1CP is powered up on a fail position, doors are not be bridged, because the number of the floor (and the position of the floor for DS417) in the door bridging message from the lift control (🕮 CANopen-specs) would not fit. In addition, the LIMAX1CP would have to know floor whose door zone covers the detected (incorrect) position. The information in the bridging message should in turn match this floor. It is extremely unlikely, that all this happens at one time. An in addition

the same words as for the safety functions above do apply: As soon as a little movement starts, the fault is detected.

- Considering UCM: The same words as for door bridging do apply (if the doors are not bridged, the UCM-functionality – as defined for LIMAX1CP – is never active)

8.3 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.

One possibility to secure this situation is the use of the tape-mounting set with included (mechanical) tape-detection "S-SRMS", offered as an accessory by ELGO.

Another possibility is to secure this situation by other measures. These measures may be for example:

- Organizational measures
- Additional mechanical protection
- Plausibility checks with integrated acceleration sensor (see chapter 8.4)
- Plausibility checks with external information (like motor encoder)

This alternative securing of the situation "rip of the tape" will be judged in a separate document. As soon as the document is released by the notified body it will be published by ELGO. From this moment the customer will be able to choose the alternative securing.

As long as the released document is not available, the mechanical tape-detection "S-SRMS" or an equivalent device must be used.

8.4 Boundary Conditions for Securing the Tape Break by Acceleration Sensor

For detection of the situation "tape ripped" (see chapter 8.3) by acceleration sensor the following boundary conditions are valid:

- The higher the acceleration, the faster the detection of the failure (And as a result of this the setting of the error)
- The detection requires at least 36 ms
- Accelerations below 100 mm/s² cannot be detected
- If the acceleration is 200 mm/s² the detection takes 131ms

(The values above do apply under the condition, that the position determination detects stand still.)

The user (integrator) must perform an analysis adapted to the conditions of his installation, in order to judge if the situation "tape ripped" can be detected under the conditions defined above, so that it makes sense to use the acceleration sensor as an additional measure for securing the situation "tape ripped".

In addition, the user must analyze whether the use of the acceleration sensor is robust enough against false tripping. Both the typical motion conditions of the lift and the conditions of the environment (e.g. the risk of earthquakes) must be taken into account.

It is possible to disable the crosscheck acceleration-values ⇔ position values in the configuration, refer to chapter 13.1.4.1.

The crosscheck acceleration-values ⇔ position will normally be disabled if:

- the user comes to the conclusion that the increase in safety by used of the acceleration sensor is small
- the risk for false tripping is high
- the user wants to use the S-RMS (or an equivalent device) either way.

8.5 Further Diagnostics

The diagnostic measures in the previous chapters have been described in quite details, because the user may do a fault clearance be 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) and concerning the digital inputs. If these diagnostic measurements fail, the device must be considered as defective in any case.

The user can know which kind of diagnosis failed by the error-code, resp. the corresponding plain text output via CANopen (🕮 CANopen-specs).

8.6 Error State due to Fail of Diagnostics

LIMAX1CP has a variety of self-diagnostic functions to ensure functional safety. When the self-diagnostic function detects a defect, a unique error code identifying the specific error and its corresponding error level is set. The error-level determines the reaction of the LIMAX1CP.

Table 8 table describes the graduated response of the device and gives examples. It is only valid for the CP[1].

[1] Nevertheless, there is a relation between signaling of safe state by RS485 protocol for the LIMAX1RED (see chapter 9.4) and the error handling of LIMAX1CP as described in this chapter: If the error level is 1, no error is signaled. LIMAX1RED will signalize a short-term error if the error level is bigger than 1 and smaller than 4 and the error is automatically resettable (see chapter 8.7). Otherwise, the LIMAX1RED will signalize a long-term error. Not all errors of LIMAX1CP are applicable for LIMAX1RED.

Table 8: Error-level

Error-Level	Reaction	Consequences	Examples
0	No system fault detected → no reaction	No consequences	
1	If the car moves there is at first no reaction. As soon as the car comes to stand still the error level is incremented to level 2	Lift will be set out of service by an open safety circuit at next stand still. It is likely that no passages will be trapped.	Error-code:0x242 plain text: "Nonvolat (write)", "Nonvolatile memory error (sync write timeout)"
2	OC is opened at once	Lift will be set out of service by an open safety circuit. If lift moved when the failure appeared, passengers may be trapped in the cabin. They can easily be released by a recall travel, if it is not possible to reset the error[1]. Even if doors are open and the cabin is in a door zone, the cabin may be moved by recall, because door bridging is accepted under the normal conditions[2] . This may help to release handicapped or elderly passengers.	Error-code:0x344 plain text; "Can't close OC", "Actuator test: Can't close the OC."
3	OC and SR are opened	Lift will be set out of service by an open safety circuit. If lift moved when the failure appeared, passengers may be trapped in the cabin. If it is not possible to reset the error, the passengers can easily be released by a recall travel, but only if all door contacts are closed.	Error-code:0x391 plain text: "Actuator > 100°C", "Actuator: Temperature Error > 100 °C"
4	Like error level 2[3]	Like error level 2	Error-code:0x342, plain text: "Can't open OC (A)", "Actuator test: Can't open OC (channel A)."
5	Like error level 3[4]	Like error level 3	Error-code:0x348, plain text: "SR open, voltage on SR-OC", Actuator test (SR open, voltage on SR-OC)"

The error codes are also stored in the logs of the two processing units.

If an error occurs, the technician reads all error codes which appeared since last lift operation without error via CANopen.

[1] The preferred method is the reset of the error by power cycle or system reset, refer to chapter 6.7 . If the reset is successful, the actuators will close again. But in many cases the reset will not be successful because the failure that caused the error state is still present.
[2] At first SR will stay open even if the conditions for door bringing are fulfilled, because there is no voltage at OC_OUT due to the open OC. But as soon as the open OC is bridged by the recall control, there will be voltage at OC_OUT and SR will close.
[3] For LIMAX2CP and LIMAX3CP also SGC will open
[4] For LIMAX2CP and LIMAX3CP also SGC will open

Furthermore, it is possible to read the meanings of these error code in plain text via CANopen refer to (📖 CAN-open-specs). Therefore, an explanation of the single error codes is not necessary in this manual.

Table 8 gives examples in the last column. Concerning the plain text, there are two versions: one detail description and one short description, because not all lift controls are able to show the longer text of the detailed description on the display.

8.7 Reset of Errors

A power cycle or a system reset (📖 CANopen-specs) will reset the currently active error-level, provided the error does not appear immediately again after the restart. Some errors will also reset automatically as soon as the error disappears.

These errors are:

Table 9 Errors which can reset automatically

Error code	Meaning (plain text message)	comment
0x340	Actuator test was not triggered (so it is done automatically)	This error is only set for information. There is no need for further activity, except perhaps to check whether it would not be better to have the actuator test triggered by the lift controller (see chapter 8.1.1)
0x371	Undervoltage supply	This error will disappear as soon as the supply voltage exceeds 9V. Please check the supply voltage. A value of 24V is recommended.
0x240	Nonvolatile memory error (sync error)	These errors are unlikely, but it may occur if the system is disturbed by special influences like EMC. There is no need for further activity. The error is set only for information.
0x241	Nonvolatile memory error (sync mirror error)	
0x242	Nonvolatile memory error (sync write timeout)	
0x142	The device is not correctly aligned	Align the device vertically and the error will disappear
0x390	Actuator: Temperature Error > 95°C	These errors will normally disappear by themselves, because when the error is set the actuator(s) open(s) (immediately or at the next stop). This prevents heat input via the TRIACs. However, the error will then often occur again as soon as the actuators close again. In this case, if possible, reduce the temperature in the shaft (e.g. through better ventilation) and/or the heat input through the TRIACs by using a load that consumes less power.
0x391	Actuator: Temperature Error > 100 °C.	
0x392	Actuator: Temperature Error > 105 °C.	
0x394	CPU: Overtemperature (> 95°C).	
0x395	CPU: Overtemperature (> 100°C).	

9 Safe Position Sensor

(This chapter is only applicable to LIMAX1RED and not for LIMAX1CP)

9.1 Use case for LIMAX1RED

The LIMAX1RED provides safe positions values to an external evaluation unit (refer to Figure 1) following a safe protocol. The position values can be used for the fulfillment of safety functions by the evaluation unit.

9.2 Bus Timing

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

The bus-timing is shown by Figure 9.

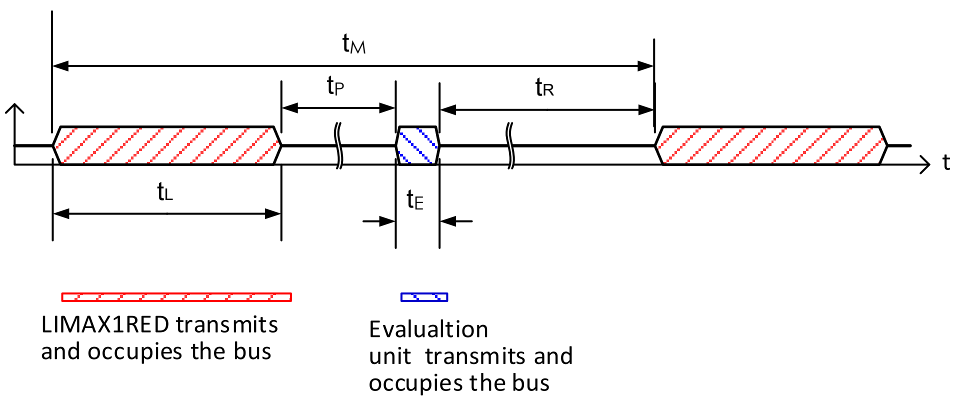


Figure 9: Bus timing on RS485 interface

Table 10: Description of the timing symbols

Symbol	Description	Min.	Typ.	Max.	Unit
t_M	Message transmission interval		4		ms
t_L	Message length of LIMAX1RED (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 LIMAX1RED transmits its position message (red segment in Figure 9) in a regularly interval of 4ms. The structure of the position message is described in chapter 9.3.1.

In the pause between two position messages the evaluation unit has the opportunity to transmit information about its floor table to the LIMAX1RED. This is done bit by piecemeal, in each pause one byte of the floor table, refer to chapter 9.3.7 . LIMAX1RED uses the floor table information to operate the door zone output (DZO).

Transmission of the floor table information from the evaluation unit to LIMAX1RED is optional.

9.3 Structure of the Position Message

9.3.1 Overview on the Structure

A position message of LIMAX1RED consists of six segments and has an overall effective length of 88 bits. It is divided into 11 symbols of 8 bits each.

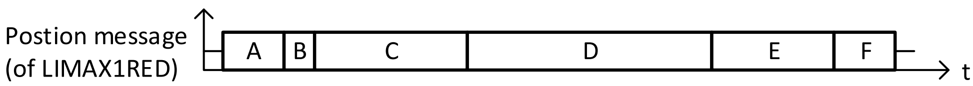


Figure 10: Structure the position message

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 11: 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 ≙ 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 ≙ 62.5 µm)

[1] The evaluation unit may only occupy the RS-485 bus after t_P has elapsed because LIMAX1RED cannot process the information earlier.

9.3.2 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 9.3.6) 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.

9.3.3 Status Bits

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

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: 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.

9.3.4 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 9.6).
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 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.

9.3.5 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 (see chapter 9.6).

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.

[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.

The data stream $D(x)=x^{31}+\ldots+x^{0}$ is composed from the segment data as follows:
$D(x)=a_7+\ldots+a_0+b_4+\ldots+b_0+c_{19}+\ldots+c_0$, with the bits corresponding to the respective segments:

$a_7\ldots a_0$: Segment A (message counter)
$b_4\ldots b_0$: Segment B (status bits)
$c_{19}\ldots c_0$: Segment C (coarse-resolution position)

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

LIMAX1 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.

9.3.6 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 9.3.2. 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 12 describes the content of the additional information depending on the value of the message counter.

Table 12: 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
3	Serial number of the sensor, bits 0 … 15
4	Error register, PU1*), bits 16 … 31 (chapter 9.5)
5	Error register, PU1*), bits 0 … 15 (chapter 9.5)
6	Error register, PU2*), bits 16 … 31 (chapter 9.5)
7	Error register, PU2*), bits 0 … 15 (chapter 9.5)
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	CRC of configuration, bits 16..31
14	CRC of configuration, bits 0..15
15	Bit 0: tape detection (with acceleration sensor) 0=deactivated; 1 = activated Bit 1..15 reserved (for future use)
16 … 127	Reserved. The transmitted value is always 0.
128 … 191	Statistical information PU1*)
174	Lowest detected power supply voltage, detected by PU1*) (1 LSB ≙ 67.7 mV)
175	Highest detected power supply voltage, detected by PU1*) (1 LSB ≙ 67.7 mV
180	Errors set in error register PU1*) since restart, bits 16 … 31 (chapter 9.5))
181	Errors set in error register PU1*) since restart, bits 0 … 15 (chapter 9.5))
182	Operating time (seconds since restart) PU1 bits 16 … 31
183	Operating time (seconds since restart) PU1*) bits 0 … 15
192 … 255	Statistical information PU2*)
238	Lowest detected power supply voltage, detected by PU2*) (1 LSB ≙ 67.7 mV)

Counter Reading	Content
239	Highest detected power supply voltage, detected by PU2*) (1 LSB ≙ 67.7 mV)
244	Errors set in error register PU2*) since restart, bits 16 … 31
245	Errors set in error register PU2*) since restart, bits 0 … 15
246	Operating time (seconds since restart) PU2*) Bits 16 … 31
247	Operating time (seconds since restart) PU2*) Bits 0 … 15

*) There are two processing units PU1 and PU2

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 of low-word and high-word, it is possible that the combined time temporarily displays an inconsistent value.

9.3.7 Floor Information

In order for LIMAX1RED 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 9.2) LIMAX1RED assigns the received information in relation to the message counter (see 9.3.2) of the message that was just sent.

Table 13: 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 ≙ 4 mm)
2	Low Byte of the flush position first floor (1 MSB ≙ 4 mm)
3	High Byte of the flush position first floor (1 MSB ≙ 4 mm)
…	…
255	High Byte of the flush position 127th floor (1 LSB ≙ 1024 mm)

This data is for the transmission of the floor image, so that LIMAX1RED can generate the DZO. For this purpose, the resolution of 4 mm is sufficient.
If necessary, LIMAX1RED 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 LIMAX1RED takes over the new floor information and safes it permanently.

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

9.4 Request for Transition into Safe State

If too many leaps are detected in position or other self-diagnostics fail, the LIMAX1RED must request a transition to the safe state.

There are basically two kinds[1] of signaling for safe state

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

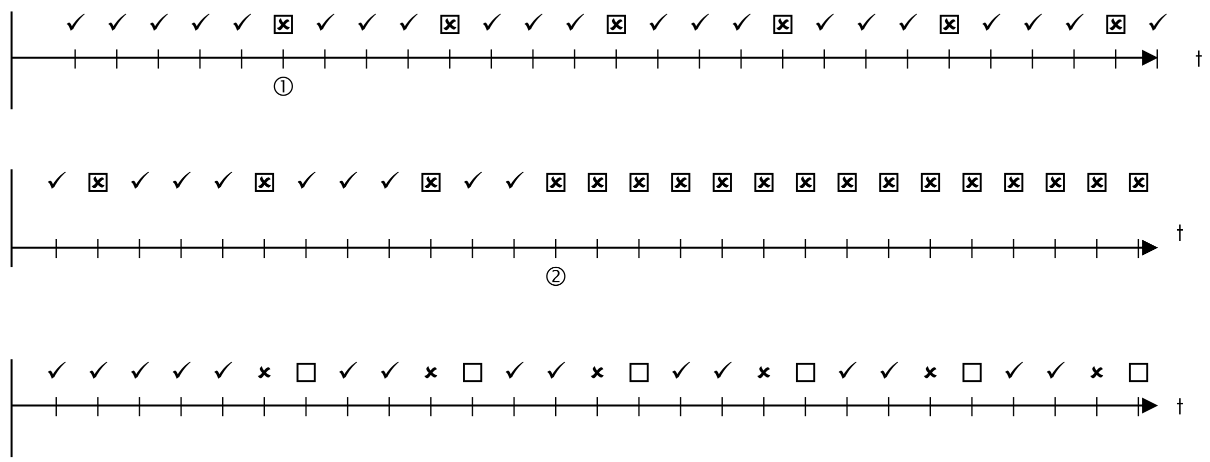
There is a distinction between short-term and long-term interference. A short-term interference may disappear after a while. If the short-term interference disappears, also its signaling will disappear.

Concerning a long-term interference, a disappearance of itself is not to be expected. So, the same applies to its signaling.

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 11, 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 11, 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 11 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.



✓ Valid position data
☐ Request for safe state (position 0)
× 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 11: 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.

[1] The two kinds of signaling are for safety reasons: there are two processing units on LIMAX1RED, 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 sate on its own, independent on the other processing unit.

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.

9.5 Error Register

Each of the two processing units contains an error register that simplifies the error search. The content of the error register is transmitted outside via the interface.

Table 14: Content Error Register

Bit	Problem
0	Overvoltage or undervoltage in general**)
1 ..2	Error in voltage monitoring*)
3..5	Error in temperature
7	Error position interpolation***)
8 … 11	Internal communication error*)
12	Memory compare error*)
13 … 14	Synchronization error*)
15	EEPROM error*)
16	Acceleration sensor error (check orientation)
17	Tape detection (acceleration sensor)
18	Communication test failed*)
19	Extrapolation not allowed anymore. Too many position leaps occurred***)
20	Timeout in the non-safety-relevant processing*)
21	Overvoltage 24V**)
22	Undervoltage 24V**)
23	Configuration error*)
24	General EPROM-data-error*)
25 … 27	Not used
28	reserved
29..31	Error level

*) for ELGO internal analysis
**) The customer should check the supply voltage. If this does not help
***) The customer should check the tape and the mounting of tape and sensor, if this does not help, he should check: does the error always occur on the same position on the tape, he should exchange the tape. Does the error occur at any position on the tape, he should exchange the LIMAX1RED.

9.6 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 9.3.2) has to match the expected value.
- The CRC check sum for segments A to C (refer to chapter 9.3.5) 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 ±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 PU1.

If an error is detected in one of the points stated above (possibly after suitable filtering[1]) 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 9.4).

9.7 Position Immediately after Power Up

WARNING!
Immediately after from start-up / reset the position – value is not safe. Safe operation (according to SIL3) only after travelling 24 mm away from start-up / reset – position. This must be considered at definition for the functionality if the evaluation unit.

When assessing the safety of the functions to be implemented concerning the limited safety of the position immediately after power up, the analysis of the safety functions implemented in the LIMAX1CP (refer to chapter 8.2) can provide orientation.

[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.

10 Dual CAN Devices

This chapter does apply to LIMAX 1RED and LIMAX 1CP with dual CAN configuration, which is defined by type key.

10.1 Use case for dual CAN devices

The LIMAX 1RED or LIMAX 1CP provides a separated CAN hardware channel to be able to satisfy CSA B44.1/ASME A17.1 requirements in combination with an appropriate evaluation unit where useful and required.

10.2 Variants

There are two different types of devices offering dual CAN interface options

- LIMAX 1CP
- LIMAX 1RED

10.3 Principle

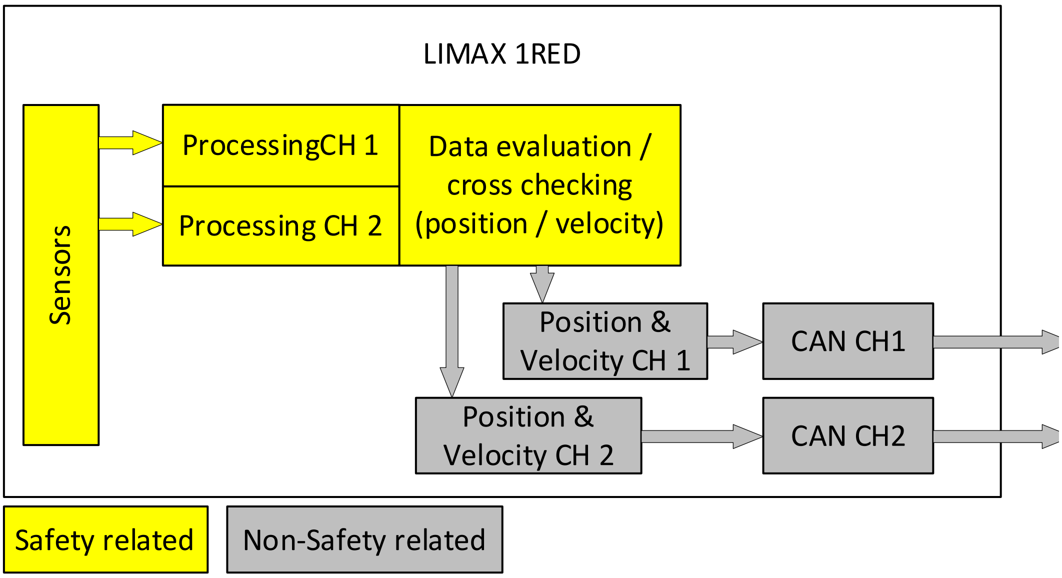


Figure 12: Principle LIMAX 1RED dual CAN variant

All LIMAX 1RED devices with dual CAN interface follow the scheme depicted in Figure 12. Although the device is designed and considered according to IEC 61508, it does not fulfill safety related functions concerning the communication to an evaluation unit when using the CAN device types. Therefore, any functionality built up on this principle has to be safeguarded according to specific national law to comply with all country and application-specific regulations.

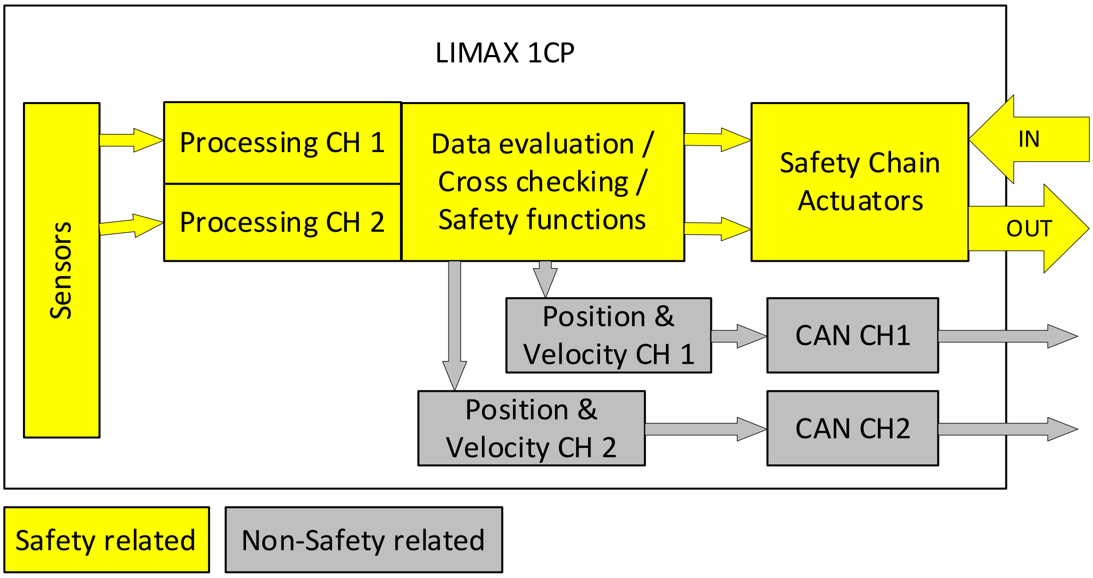


Figure 13: Principle LIMAX 1CP single/dual CAN variants

All LIMAX 1CP devices with dual CAN interface follow the scheme depicted in Figure 13Figure 12. The LIMAX 1CP with dual CAN(open) interface does not provide additional functions but a second CAN(-open) interface to satisfy ASME A17.1 requirements where needed or/and for backwards compatibility reasons.
Therefore, any functionality built up on this principle has to be safeguarded according to specific national law to comply with all country and application-specific regulations.

10.4 Interfaces

The interfaces, except default CANopen devices, are customer specific proprietary CAN interfaces and are not subject of this documentation. These are defined in individual documents and not disclosed.

For default CANopen devices please refer to LIMAX 1CP / 1RED CANopen specifications linked in 1.1 Related Documents.

10.5 Additional Information CANopen Interface

The LIMAX 1CP and LIMAX 1RED are available as dual CANopen devices, where an additional CAN hardware channel is provided with reduced CANopen functionalities. In fact, this additional node behaves like a regular CANopen node, but does not provide a memory function to store its own parameters. All objects defined can be used for temporary parameter configuration at runtime. After a system restart, the changed parameters are re-stored to default.

11 Signaling

11.1 LEDs

On the top-side of the housing there are 3 LEDs (see also Figure 14):

- TAPE (yellow)
- ERR (red)
- RUN (green)

The "TAPE"-LED is lit when there is no or no correct magnetic tape in the tape guiding, otherwise it is off.
The "ERR"-LED has different meanings:

Table 15: Meaning of ERR- LED

ERR-LED Status	Meaning
ON	Error
Flashing 10 Hz	No configuration (only LIMAX1CP)
OFF	No error and configuration available

The "RUN"-LED has also different meanings:

Table 16: Meaning of RUN-LED

RUN-LED Status	Meaning
Single flash	Normal
Double flash	Teach (manual and auto) (only LIMAX1CP)
Triple flash	Settings (only LIMAX1CP)
Quadruple flash	Test (only LIMAX1CP)
Continuous flashing 2.5Hz	Pre-commissioning mode (only LIMAX1CP)

Flashes of the Run-LED each have a duration of 200ms. Between the single-, double-, triple and quadruple-flash clusters there is a pause auf 1s. In between the clusters, there is a pause of 200ms.

The meaning of the LEDs is the same for LMAX1CP and LIMAX1RED. Concerning LIMAX1RED only the normal mode exists. So, the RUN-LED is always flashing single for LIMAX1RED.

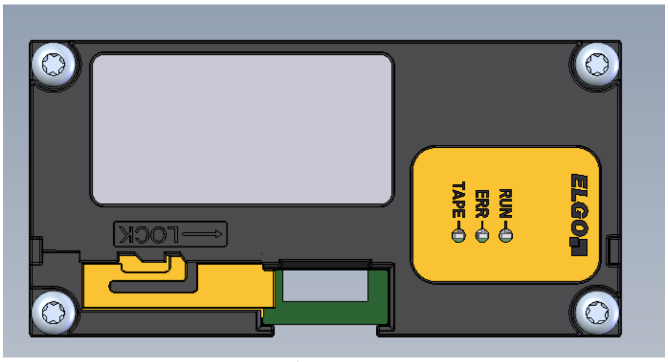


Figure 14: LEDs on the top of the housing

11.2 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: The DZO-output is high if the car is in a levelling door zone.

12 Floor detection

The Floor detection input (FD) can be connected e.g. to an external floor detection.

The floor detection combined with floor magnets can be used for an automatic learn trip when commissioning the LIMAX1CP and/or for automatic adjustment of floor positions during normal operation.

The use and connection of a floor detection is optional. In case is not connected, the learn trip has to be carried out manually (refer to chapter 5.2.2).

If the device is used as a safe measuring system (LIMAX1RED), the floor detection does not need to be connected (because the device does not actively learn the floor positions in this case).

Floor detection sensors can be ordered as an accessory at ELGO or the customer may connect his own floor detection. In the second case the electrical specification of the floor detection input must be observed (refer to chapter 16.2.1)

Furthermore, the detection-mechanism must be observed:

When the floor sensor passes by a floor-magnet the signal on FD-input must change from LOW to HIGH and then to LOW again. If the speed when passing by the magnet is below 1m/s and there is no stand still or changing of the moving direction while the FD-Signal is HIGH, the middle of the position where the positive edge was detected and the position where the negative edge was detected, is evaluated as a (detected) floor position:

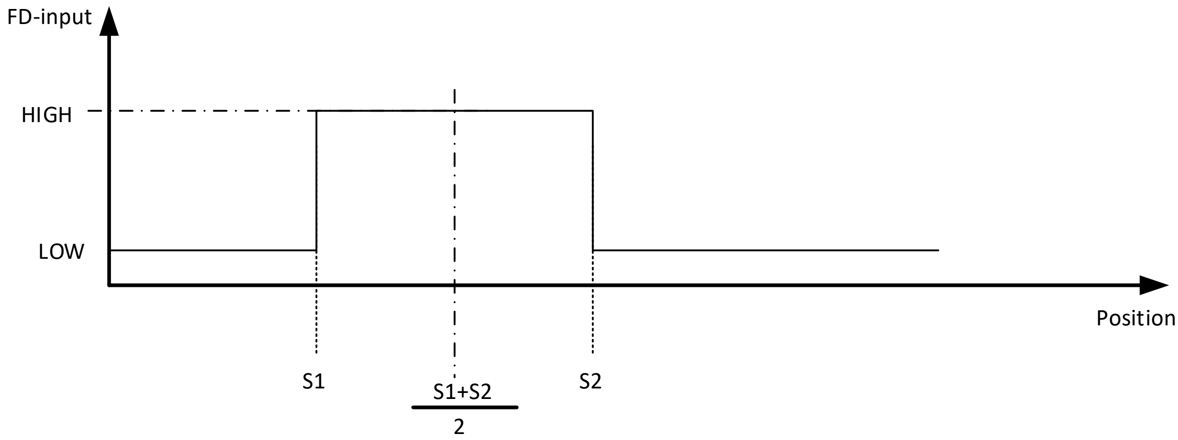


Figure 15: Signal on FD-input when passing by a floor magnet

If a detected floor has an impact on the floor table (learn or adjust floors) depends on further circumstances, refer to chapter 5.2.3.

13 Configuration and Settings

(This chapter is only applicable to LIMAX1CP and not for LIMAX1RED)

Most of the safety functions depend on parameters/features, which are either configured in the LIMAX1CP or settable/changeable by CANopen during operation.

⚠	WARNING! It obligates the user to ensure that the configuration of the device fits the lift, where it will be installed. The hints given in this chapter must be observed.

13.1 Configuration

The configuration defines the behavior of the device, mainly concerning the safety functions, but also concerning some other special features (refer to the next sub-chapters).

The configuration cannot be changed during normal operation. An already present configuration must be erased, before a new configuration can be loaded to the device. An already present configuration can only be erased in pre-commissioning mode.

In this chapter only configurable parameters and features are documented, because they are specific for the device.

The general process of configuration is all the same for several ELGO-devices. Therefore, this is documented in 🕮 ConfigurationProcess. If the user is not still familiar with the configuration process (e.g. from LIMAX33CP) he should also take this document into account.

13.1.1 Configured Safety Functions

Each safety functions can be enabled /disabled individually.

It depends on the enabled safety functions, which information must be learned in teach mode in order to be able to set the LIMAX1CP into normal operation (normal mode), refer also to Table 17.

Table 17: configuration features for Safety functions

Feature	Selection	Information to be learned in teach mode	Explanation
Overspeed (pre-tripping)	enable/ disable	–	If the user wants to take care about overspeed (pre-tripping) on his own, a LIMAX1CP with disabled safety function "overspeed (pre-tripping)" can be used
Overspeed Teach (pre-tripping)	enable/ disable	–	Overspeed teach (pre-tripping) is a substitute for ETSL in teach mode. It may be disabled for example if no ETSL is needed. Please observe also the hint for definition of pre-tripping speed above.
Deceleration control (ETSL)	enable/ disable	Reference positions	If the lift installation has no reduced buffers ETSL is not needed. In this case or if the user wants to take care about ETSL on his own, a LIMAX1CP with disabled safety function "ETSL" can be used.

Feature	Selection	Information to be learned in teach mode	Explanation
Final Limit switch	enable/ disable	Reference positions	In case the user wants to take care about the final limit switches on his own, a LIMAX1CP with disabled safety function "final limit switches" can be used
Doors	enable/ disable	Floor table	In case the user does not need any door bridging for his lift installation, he may set the value "disable". In this case also UCM is disabled. So, the feature doors enables/disables always door bridging and UCM together.

A certain configuration of the safety function determines which actuators must be available on the LIMAX1CP. They must be also enabled in the configuration (refer to chapter 13.1.2) and connected according to chapter 4.

13.1.2 Configuration of Enabled Actuators

Enabling/disabling of actuators are also configuration features. Additional to the safety functions the needed actuators must be enabled. An actuator which is physical available on the device but not enabled will always stay open.

Table 18 shows an overview about the actuators which must be enabled depended on the safety functions/features

Table 18: dependency "enabled safety functions" => needed actuators/relay contacts

Feature	OC	SR
ETSL	enabled	don't care
Final limit switch	enabled	don't care
Overspeed (pre tripping)	enabled	don't care
Overspeed Teach (pre tripping)	enabled	don't care
Doors (door bridging + UCM)	enabled	enabled

13.1.3 Configuration Parameters

The configuration parameters concerning speeds are listed in the following table. It depends on the enabled safety functions, which parameters are needed. The values of the parameters which are not needed will be ignored by LIMAX1CP.

Table 19: configuration parameter concerning speeds

Parameter	Value range	Unit	Explanation
Rated speed	0 … 13000	mm/s	Rated speed of the lift, the device is installed in. This parameter has no influence on any safety function
Pre-tripping speed	0 … 13000	mm/s	Tripping speed for safety function overspeed (pre-tripping)
Pre-tripping speed in buffer test mode	0… 13000	mm/s	Tripping speed for buffer test mode
Pre-tripping speed teach	0 … 3000	mm/s	Tripping speed for safety function overspeed teach (pre-tripping). Refer to the following hints.

Hint for definition of pre-tripping speed teach:

In teach mode safety function ETSL is not active. The safety function "overspeed pre-tripping teach" is a suitable substitute for ETSL in teach mode. The function protects a technician in the cabin during teach mode. It prevents hitting the buffers with a speed higher than the speed the buffers are designed for. This speed must therefore be at most as the speed for which the buffers are designed. This condition may only be hurt in case the customer either ensures safety of a person travelling in the car by other means or prohibits travelling in the car during commissioning.

The speed configuration is only valid, when the pre-tripping speed is greater than the rated speed.

The ETSL-curve hast to be parameterized with the following parameters:

Table 20: configuration parameter for ETSL-curve

Parameter	Value range	Unit	Explanation
a	0 … 10000	mm/s²	Deceleration of the elevator brake
t_{del}	0 … 500	ms	Delay of the functional chain: from detecting ETSL-event by LIMAX1CP until start of deceleration of the car.
V_{Buf}	0 … 2500	mm/s	It is sufficient to reduce the speed to that speed the buffers are designed for. This value gives the remaining speed when the car hits the buffers provided the car retards due to deceleration curve defined in the concerning chapter.
$Offset_{ETSL\_UP}$	0 … 1000mm	mm	The distance s to the assumptive buffer (when moving up) is reduced by this offset
$Offset_{ETSL\_down}$	0 … 1000mm	mm	The distance s to the assumptive buffer (when moving down) is reduced by this offset

13.1.4 Special Features

13.1.4.1 Acceleration Sensor/ Tape-detection

As already explained in chapter 8.2, the risk of ripping of the tape must be secured. This can be done with the integrated acceleration sensors. But in earth quake regions diagnosis with acceleration sensors may cause a shutdown of the elevator by fail (caused by an earth quake). Therefore, the detection can be disabled in the configuration.

DANGER!
If diagnosis by acceleration sensor is disabled, the risk ripping of tape must be secured by other means, e.g. by a tape detection.

13.1.4.2 Configuration concerning Teach and Adjustment

Enabling and disabling of auto-teach and auto-adjust are configuration features.
Entering sub-mode auto teach of teach mode (refer to chapter 5.2.1 and 5.2.3.1) is only possible if "auto-teach" is enabled in the configuration.
Enabling the automatic adjustment in the configuration is one condition (beside several more conditions) that a floor-position will be adjusted automatically by floor detection, refer to chapter 5.2.3.3.

13.2 Settable Parameters

Some parameter can be changed by CANopen even without resetting the LIMAX1CP to pre-commissioned mode. But this is only possible within a defined range in accordance with the EN81-20.

Table 21: Settable parameters

Parameter	Value range	Default	Unit	Explanation
Offset final limit switch top ($Offset_{final\_limit\_top}$)	10 … 30000*	500	mm	Determines the position of the final limit switch top as an offset to the reference position top: $Pos_{final\_limit\_top} = Pos_{reference\_top} - Offset_{final\_limit\_top}$
Offset final limit switch bottom ($Offset_{final\_limit\_bottom}$)	10 … 30000*	500	mm	Determines the position of final limit switch bottom as an offset to the reference position bottom: $Pos_{final\_limit\_bottom} = Pos_{reference\_bottom} + Offset_{final\_limit\_bottom}$
Door zone size levelling	20 … 350	200	mm	Determines the area of the door zone for levelling around the flush floor position. The door zone for levelling reaches from: flush_floor_position – door_zone_size_levelling … to … flush_floor_position + door_zone_size_levelling
Door zone size re-levelling	20 … 200	140	mm	Determines the area of the door zone for relevelling around the flush floor position. The door zone for relevelling reaches from: flush_floor_position – door_zone_size_relevelling … to … flush_floor_position + door_zone_size_relevelling

NOTE!
Changing of the settable parameters is only possible in “settings mode” (refer also to 🕮 CANopen-specs). The LIMAX1CP will keep changes of these parameters even after power cycle.

14 Initial and Recurrent Examination

In this chapter is described how the auditor can check LIMAX1CP/1RED 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.

14.1 System Restart

Some checks concerning self-diagnostics of LIMAX1CP/1RED are only performed at start-up of the system.

Therefore, it is mandatory to restart the LIMAX1CP/1RED at recurrent examination[1]. This can either be done by RESET-button, by reset-command given by CAN or by disconnection/reconnection the main power supply (the only option for LIMAX1RED).

14.2 Magnetic Tape

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

In particular, it should 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.

14.3 Software Identification

It is possible to read the ROM-CRC[2] of the LIMAX1CP software by CANopen. Refer to 🕮 CANopen-specs.

The lift control or alternatively a corresponding auxiliary tool (e.g. a notebook with CAN-adapter and suitable software) must be able to display the ROM-CRC. It must be the same as the respective CRC noted in the certificate.

The LIMAX1RED version 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 19 should be checked.

14.4 Set of Configuration

Compliance with the organizational processes (🕮 ConfigurationProcess) ensures that the correct configuration is on the device.

The configurable parameters/features/CRC of LIMAX1CP are noted on the info-sheet (normally in the documentation of the lift). They must fit the conditions of the lift. This must be checked.

[1] A recurrent examination by notified body is normally mandatory in a one-year period. The time between initial examination and first recurrent examination may be extended to two years.
[2] This is the CRC of the software (firmware). It depends only on the software-version. Please do not confuse this with the configuration CRC.

The CRC must fit with the CRC noted on the sticker on the info-label (see chapter 19 and see 🕮 ConfigurationProcess).

In addition, this can be checked by reading out the configuration data (parameters / features / CRC) of the LIMAX1CP via CANopen (see 🕮 CANopen-specs). For this purpose, the elevator controller or alternatively a corresponding auxiliary tool (e.g. a notebook with CAN adapter and suitable software) can be used to display the corresponding configuration information. This must also match the information on the info sheet.

Concerning 1RED there is only one relevant feature: acceleration sensor enabled or disabled. This information can be read from the type-label according to the type designation (chapter 20) or it can be read via RS485. This feature must be in compliancy with the mounting option of the tape (with or without tape presence sensor, refer also to 13.1.4.1).

14.5 Verification of the Floor Table

The floor table as it is stored in LIMAX1CP must be verified. A verification is mandatory before the lift goes to public service.

For example, this is possible by the following procedure:

- Send the car from one floor to the other. Normally this will be done by car call. All floors stored in the control have to be approached, lift control should perform pre-opening of the doors approaching the single floors. For pre-opening of the doors, door bridging must be enabled. Otherwise, the open door-circuit would cause an emergency stop. So, if pre-opening of the doors works without emergency stop it is proved that the floor number and the position of the floor, where the lift control wants to land the car, is the same as in LIMAX1CP: position and number of the target floor are communicated via CANopen to LIMAX1CP. The device will only close the SR actuator if these information fit.
- Check if the car and landing thresholds are flush at each floor.
- Read the total number of floors stored in LIMAX1CP and compare it with the number of floors stored in the lift control. This is done in order to ensure, that LIMAX1CP has not stored any additional floor at a position where actually is no floor.

> NOTE!
> This procedure is only possible if door bridging is performed. But that is no restriction because for a lift without door bridging it is not necessary to learn the floor table.
>
> If lift control does not support pre-opening it is also possible to carry out the check with the re-levelling functionally: Load/unload the cabin at a floor and watch if the cabin relevels.

14.6 Check of Safety Functions

It obligates to the notified body to judge, if it is necessary to carry out all of the following tests concerning the safety functions periodically or if it is sufficient to carry out some of them only at initial examination. The concrete proceeding concerning the tests should be looked at as a proposal. The user and/or notified body may find other ways to test the safety functions.

14.6.1 Final Limit Switches

The correct position of the final limit switches should be tested.

- The auditor calculates the position of the final limit switches (top and bottom) from the reference positions and the offsets of the final limit switches.

- Now, the auditor takes the elevator to the top floor by car call. From here, he begins to move the cabin slowly upwards (generally this will be done by using the recall panel) until a point just under the final limit switch top.
- Then he switches off "recall" so that by measuring the voltage behind OC he can determine if the contact is open. Here, the normal safety circuit voltage must exist (OC closed).
- The auditor now over travels the position of the final limit switch top (by recall panel) by the shortest possible distance and switches off recall.
- Now he checks again the voltage behind OC. There must not be any voltage as OC must be open. The auditor measures the voltage before OC as to crosscheck.

The normal safety circuit voltage must exist.

The final limit switch bottom can be tested by the corresponding procedure.

14.6.2 ETSL

ETSL in upwards rep. downwards direction can be tested in test mode, sub-mode "ETSL up" (see chapter 5.4.2), resp. ETSL down (see chapter 5.4.3):

Starting a trip from the bottom of the shaft upwards in sub-mode "ETSL up", resp. from the top of the shaft downwards in sub-mode "ETSL down", will cause an (intended) emergency stop cause by the (test-) tripping of ETSL. The car will come to standstill somewhere near the position of the "assumptive buffer" in the middle of the shaft. From the position where the car came to standstill, it is possible to judge if the reaction of the functional chain (LIMAX1CP → Safety circuit → motor / brake) fulfils EN81-20 §5.12.1.3.

14.6.3 Overspeed Pre-tripping

The auditor adjusts lift control/inverter in such a way that overspeed can be reached. He performs a travel, each in upwards and in downwards direction and with a speed just above the pre-tripping speed.

Check: OC opens when pre-tripping speed is reached and the machine brake stops the lift.

14.6.4 Door Bridging

Door bridging has been already checked in combination with the verification of the floor table.

14.6.5 UCM

The car is on a floor, door circuit is bridged (enabled by CANopen). Now start a travel without disabling the door bridging.
UCM must trip latest as soon as the door zone is left.

ℹ	NOTE! Starting a travel without disabled door bridging is normally only possible if this is implemented as a special (test-) feature in the lift control. If this is not the case, the car may be moved by recall control while door bridging is enabled. Alternatively, the car may be moved by hand wheel.

14.7 Check of actuators

14.7.1 Check of OC-actuator

In the initial situation OC is closed. The OC test is requested via CANopen (see chapter 8.1.1.; 🕮 CANopen-specs)

After the OC test has been performed, it must be checked that no error is set (the query of the error level via CANopen must result in an in an error level of 0, the error LED must be off).

14.7.2 Check of SR-actuator

In the initial situation SR is closed. The door circuit is also closed.
It is checked via CANopen (see 🕮 CANopen-specs), if the SR_OC-diagnostic-spot indicates “voltage”.
If opening of SR is requested (e.g. be disabling of the door bridging). It is checked if the voltage on SR_OC-diagnostic-spot changes from “voltage” to “no “voltage” as a consequence from opening of the SR-actuator.

15 Maintenance

Apart from the guiding for the tape the LIMAX1CP/1RED 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 16 shows a new guiding. The material thickness under the tape amounts to 3mm. Even wear is normal (Figure 17). A minimum of 2mm thickness should remain, otherwise the guiding should be exchanged.

Slightly uneven wear is also normal. In this case 2mm should remain at the thinnest spot (Figure 18).

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 1mm, the guiding must be exchanged.

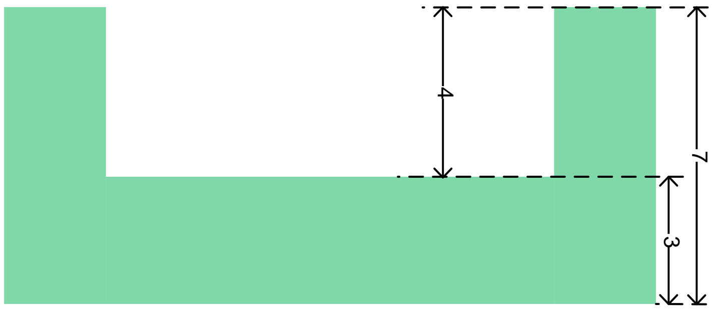


Figure 16: New guiding

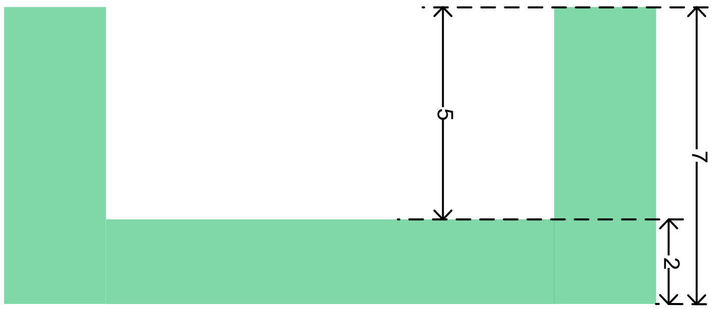


Figure 17: Even wear

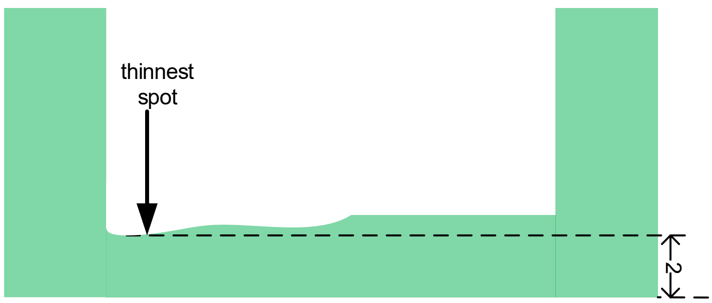


Figure 18: Uneven wear

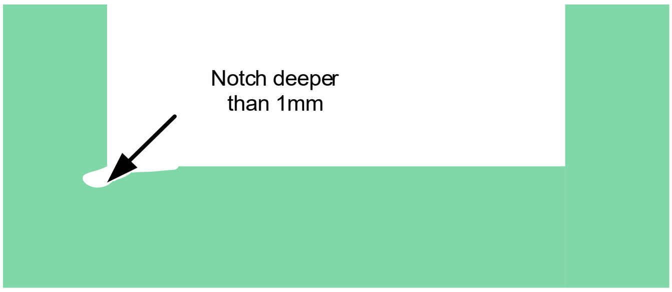


Figure 19: Formation of a notch

16 Technical Data

16.1 Mechanical Data

Table 22: Mechanical data

Designation	Value	Remark
Dimensions	L x B x H = 291 x 75 x 37.5 mm	With cover, see Annex B
Weight	1CP without accessories: 455 g 1RED 1CP without accessories: 430 g Cover: 23 g Strain relief: 1g	
Material of housing	Aluminum	
Maximum measuring length	262 m	
Maximum Speed	15 m/s	
Resolution:	See 20 Type Designation	
Repeat accuracy:	±1 Increment	
System accuracy in µm at 20°C:	± (1000 + 100 x L)	L = measuring length in meter

Table 23: Connector types (manufacturer type key)

Designation	Value	Remark
Connector for SCA-Signals	PHÖNIX-SPT-SMD1,5/5-H5,0	5-pole Terminal
Connector for PIO-signals	WÜRTH-634108185421 OR PHÖNIX-SPT-SMD1,5/8-H3,5	RJ45-connector or alternatively 8-pole Terminal
Earthing lug		

16.2 Electrical Data

16.2.1 Extra low-voltage (Supply, Digital Signals and Communication)

Table 24: extra-LOW-voltage-signals and supply

Designation	Value	Remark
Supply voltage (nominal)	24VDC	
Residual ripple	<100mV$_{pp}$	
Supply voltage range	10VDC … 30VDC	
Current consumption (1CP)	100mA max. (OC und SR closed)	arithmetic mean @24VDC
Current consumption (1RED)	60mA	arithmetic mean @24VDC
Safety of power supply	SELF/PELV	
Connection for floor sensor	18 … 30 VDC for high level; open or <1V for low level	
DZO-Rating	+24V – 20%, max. current 200mA	

Table 25: extra-LOW-voltage-signals (communication)

Designation	Protocol	Remark
CAN	Galvanically isolated CAN interface, CANopen DS406 or DS417	

Designation	Protocol	Remark
RS485	Safe protocol, see chapter 9	Concerning the evaluation unit there are special requirements, which must be observed

16.2.2 Low-voltage (Safety Circuit)

Table 26: Safety circuit supply (general)

Designation	Value/required properties	Remark
Rated voltage, RMS	230 VAC (A1 and A2) 110 VAC (A2) 48 VAC (A3)	There is a 230VAC (A1) and a 110VAC-Variant (A2) (see chapter 20); Also, chapter 17.2, topic 3 must be observed.
Voltage (absolute maximum rating) , RMS	255VAC (for variant A1) 125VAC (for variant A2) 60 VAC (for variant A3)	(apart of transient EMC-influences)
Voltage (minimum), RMS	100V (for variant A1) 50V (for variant A2) 48V (for variant A3)	A lower voltage bears the risk of decreased reliability
Frequency	50/60Hz	
Current., RMS	1A permanent @ environmental temperature up to 40°C	Dependency temperature vs. current see Figure 20
	0.15A permanent @ environmental temperature up to 70°C	
	8A short-term (max. 1.4s)	A short-term inrush current may appear when the safety circuit is switched on
Fusing	The safety circuit must be fused by a circuit breaker (recommended) with 2.5 A C-characteristics or a 4 A B-characteristics or another fuse with at least equivalent characteristics	
Waveform	sinusoidal or trapezoidal	In case of a trapezoidal waveform certain other specifications do apply, refer to section below. An UPS (used as emergency-supply for the safety circuit) often provides a trapezoidal waveform

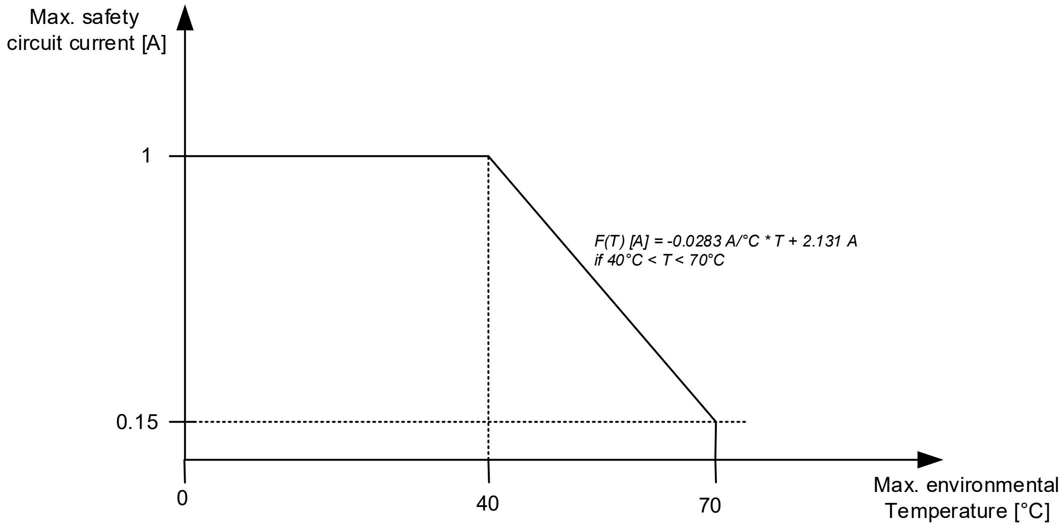


Figure 20: Maximal safety circuit current vs. maximum environmental temperature

A UPS (used as emergency-supply for the safety circuit) often provides a trapezoidal waveform. Following the specifications concerning a trapezoidal waveform. These are specified here for safety, then normally these specifications are met anyway in terms of size and shape of the clamping and operating time. Therefore, these are generally no restrictions.

Table 27: Safety circuit supply (in case of trapezoidal waveform)

Designation	Value	Remark
Recommended min. duty cycle	38%	A smaller duty cycle bears the risk of decreased reliability
Recommended max. duty cycle	60%	With a duty cycle more than 60% the ability for second level diagnostics[1] is strongly limited. This is surely no problem for a limited period of time, but for continuous operation also second level diagnostics should work for optimization of safety
Recommended Supply duration (without sinusoidal supply in between)	< 12h	In case of a trapezoidal waveform the ability for second level diagnostics is limited (see also above). Therefore, the duration of operation with trapezoidal waveform should be limited, especially if a duty cycle of more the 60% is expected.
"Plateau – voltage" of the trapeze (minimum)	± 140V	A lower voltage bears the risk of decreased reliability
"Plateau – voltage" of the trapeze (minimum)	± 360V	A higher voltage bears the risk of short circuit of the safety circuit caused by break down of the protection elements

16.3 Environmental Data

Designation	Value/test conditions	Remark
Storage temperature	-25 °C … 80 °C	

[1] Diagnostics of diagnostics

Designation	Value/test conditions	Remark
Operation temperature	-15 °C … 70° C (EN81 certified) -20° C…70° C (GB7588 certified)	(Under constraints, see also row "Current, RMS" in Table 26). concerning 70°C as maximum temperature: 70°C is only valid if the current in the safety circuit does not exceed 0.15 A. Concerning LIMAX1RED a maximum temperature of 70°C is valid because there is no safety circuit in LIMAX1RED.
Humidity	max. 95 %, non-condensing	
Protection class	IP43	
Interference emission / immunity	EN 12015 / EN 12016	
Vibration / shock resistance	EN 60 068-2-6 EN 60 068-2-27	
Max. operation height above sea level	3000m	

16.4 Miscellaneous

Designation	Value
Maximum Operation time	20 Years
Reaction time (worst case) for safety-functions only dependent on positions (final limit switches, UCM-zone-condition)	30ms
Reaction time (worst case) for safety-functions (also) dependent on velocity (over-speed, ETSL, UCM-speed-condition)	50ms

17 Constraints for Use

17.1 General Constraints Concerning both, LIMAX1CP and LIMAX1RED

This sub-chapter deals with the constraints applicable for both, LIMAX1CP and LIMAX1RED. The following sub-chapter deals with the constraints applicable only for LIMAX1CP resp. for LIMAX1RED.

1. The technical data (mechanical, electrical and environmental) concerning the LIMAX1CP/1RED - sensor as defined in chapter 15 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 - see also the installation scheme Figure 1: electrical installation (example)- in case the risk “tape ripped” is not secured by other means, e.g. the integrated acceleration sensor, see 8.3 .
4. The earthing lug on the LIMAX1CP/1RED must be connected to protection earth in order to protect the user from electric shock. In case of LIMAX1CP/1RED a connected to protection earth is recommended in order to make the system more robust against interferences.
5. The shield of the PIO cable must be connected to the protection earth on the LIMAX1CP/1RED side and additionally on the control side.
6. The safety functions ETSL must fulfill SIL 3 and therefore the PFHD of the whole functional chain must be smaller than 100 FIT. Concerning the PFHD capability of the LIMAX1CP/1RED , see chapter 18.1.
7. 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 LIMAX1CP/1RED 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.

17.2 Constraints Concerning LIMAX1CP-Version

17.2.1 List of constraints concerning LIMAX1CP-Version

The constraints in this chapter only do apply for LIMAX1CP-Version.

1. Configuration of LIMAX1CP and the elevator (where it is installed) must fit. The configuration is noted on the info sheet, 🕮 ConfigurationProcess. The following topics must be taken into consideration when defining the configuration:
   a. All actuators (OC and SR) necessary for the safety functions which are enabled, must be enabled in the configuration and connected to the safety circuit following Figure 1. The OC actuator must be enabled in any case.
   b. In case safety function “ETSL” = DISABLED, it must be ensured that
      i. either ETSL is not needed because the buffers are designed for nominal speed of the lift
      ii. or safety function ETSL is implemented by other means outside of the LIMAX1CP scope.
   c. The Parameter “a”, “v_{buf}”, “t_{del}” and “offset” must be adjusted in such a way, that – in case ETSL trips – the car hits the buffer surface with a speed not greater than the buffers are designed for.
   d. In case the safety function “final limit switches” is DISABLED, it must be ensured that safety function “final limit switches” is implemented by other means outside of the scope of LIMAX1CP.
   e. Safety function “door bridging” and “UCM” can only be disabled in combination. If “door bridging” / “UCM” is DISABLED, neither door bridging nor UCM will be performed by LIMAX1CP.
   f. The rated speed of the LIMAX1CP must fit with the rated speed of the lift.

g. Safety function "overspeed teach pre-tripping" is intended to be used as a substitute for ETSL (deceleration control) during teach mode. If this safety function is not needed, it may be disabled. If it is needed, the tripping speed for "overspeed teach pre-tripping" should not be greater than the buffer speed.

2. The technical data (mechanical, electrical and environmental) concerning the LIMAX1CP - sensor as defined in chapter 16 are valid for constraints for use. This applies in particular for the voltage and current-specification and the specification for fusing, refer to chapter 16.2.2. In particular it is safety relevant that the voltage is not DC, but AC (50 or 60 Hz).
3. Concerning the 230VAC-variant (A1 in the type key, see Figure 22) the following must be ensured:

   The "must drop-out voltage" according to datasheet of the final element[1] amounts $60V_{eff}$ or higher. In case the chosen final element does not fulfill the requirement from above for a 230V safety circuit, the 110V variant (see below) may be chosen even for a 230V safety circuit[2].
4. Concerning the 110VAC-variant (A2 in the type key, see Figure 22) the following must be ensured:

   The "must drop-out voltage" according to datasheet of the final element amounts $28V_{eff}$ or higher
5. Concerning 230VAC-variant and 110V variant chapter 17.2.2 must be observed.
6. Concerning the 48 VAC-variant (A3 in the type key, see Figure 22) the following must be ensured: The "must drop-out voltage" according to datasheet of the final element amounts 4.7 V_{eff} or higher.
7. Concerning the 48VAC -variant it must also be ensured that the power consumption at the end of the safety circuit amounts to at least 2.5W @ $48V_{eff}$.
8. If the fuse of the safety circuit was blown and replaced, the actuators must be checked (refer to 14.7) before normal lift operation continues.
9. The OC-actuator must always be integrated in the safety circuit, see Figure 1.
10. Disabled actuators must not be integrated in safety relevant circuits.
11. The CAN bus is not intended to be used for safety relevant purposes.
12. After commission, the floor table must be checked before the lift is allowed to be released for public use.
13. A power cycle or a reset must be applied to the LIMAX1CP at least once per year.
14. The safety function "UCM" is only fulfilled by LIMAX1CP if the machine is built according to EN81-20 §5.9.2.2.2.

17.2.2 Risk of loss of the neutral conductor

The problem of the loss of the neutral conductor can lead to dangerous changes in the circuit topology, e.g. circuit parts being connected in parallel. In worst case this can lead to a dangerous situation:

The final element (main contactor or safe torque off) of the safety circuit can close or not drop unexpected although the OC is open.

[1] Element at the end of the safety circuit switching off the torque of the machine and acting the motor brake. Normally a kind of electromechanical element: contactor or safety relays for safe torque off.

[2] The 230V variant and the 110V variant only differ in the voltage threshold for the safety circuit detection. This threshold must fit voltage necessary to make the actuator close

Figure 21[1] shows the problem of loss of the neutral conductor: At both ends of the OC-conductor (at OC_IN and OC_OUT) there is each a RC-network-connection to neutral. The purpose of this network is to give a certain load to the safety circuit to suppress impact of capacitive coupling by the external wiring to the diagnostic voltage measuring circuits on OC_IN and OC_OUT.

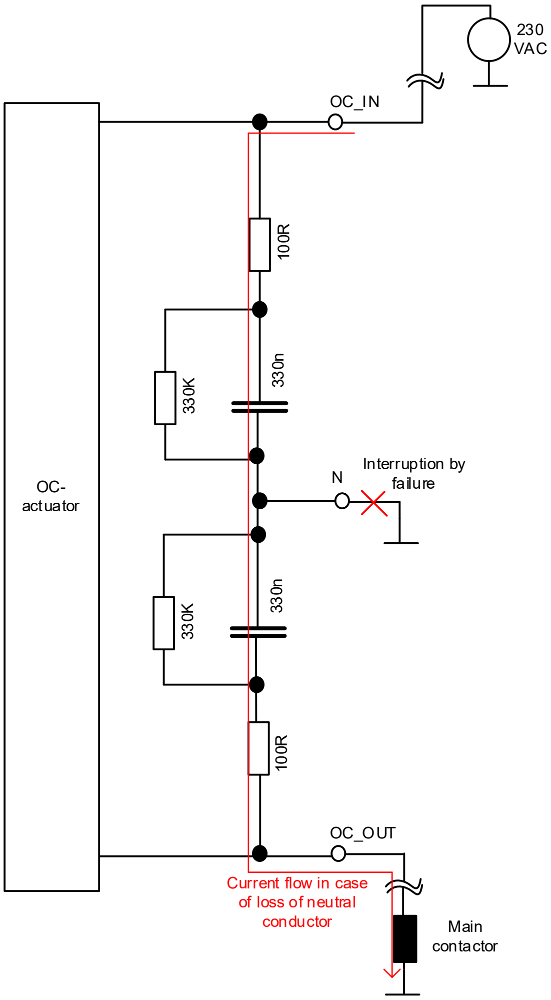


Figure 21: Loss of neutral conductor

The problem on which this chapter focuses is the fault if the neutral conductor is disconnected for some reason. In this case (if the safety circuit is not interrupted before or after OC) some current will flow between OC_IN and OC_OUT even if OC is open.

This current flow must not lead to the situation that the main contactor closes.

This can easily be tested: disconnect the neutral conductor while the OC is closed. After this give a demand to open the OC (e.g. by “direct actuator access” or by over traveling of the final limit switch) and the final element must drop.

Additional the voltage which falls over the final element in the situation (with neutral conductor is disconnected) must be measured.

[1] The value of 330nF for the capacitors does only apply for the 230V variant (A1) and for the 110V variant (A2). Concerning the 48V-variant (A3) the value is much smaller.

This voltage must have a sufficiently large safety margin to the "must drop-out voltage" of the final element (see chapter 17.2. topic 3 resp.4 resp. 6)

Hint:
If for practical reasons the neutral conductor is not disconnected from the LIMAX1CP directly but from another sport in the safety circuit the following must be considered:

There may be more component (e.g. the lift control) which may have internal circuits in parallel to the open OC if the neutral conductor is disconnected. This depends on the topology of the safety circuit especially of the connections of the neutral conductor. Dependent on this a suitable spot to disconnect the neutral for test purpose must be figured out.

17.2.3 Hints for the notified body concerning required properties of the final element, tests to be carried out and resulting SIL

The drop out voltage of the final element (e.g. contactor or safe torque off relays) should be known in order to be able to check if chapter 17.2, point 3 resp. 4 resp. 6 and the requirements of chapter 17.2.2 are fulfilled.

These checks may be done with information from the datasheet, if necessary, also in combinations with calculations or/and by practical trials.

In the case of deviating safety concepts (e.g. AC safety circuit supply => rectifier => DC torque-off relay, or AC safety circuit supply => transformer => rectifier => DC torque-off relay), the defined tests may need to be modified accordingly.

Some checks described above may be only necessary for a type examination for a sample elevator according to the relevant standards and directives (e.g. in Germany the lift directive appendix 5). Some checks are necessary at every recurring inspection. This does especially apply to the variant A1 and A2:

There are electronic components (in the LIMAX1CP) which, under certain failure conditions, can exacerbate the fault of losing the neutral conductor, because the residual current flowing (and therefore the residual voltage on the final element) is increased by the combination of the two faults. For the 48V variant (A3) it has been checked during certification if a combination of a failure of an electronic components and the loss of neutral can lead to a dangerous situation (too high residual voltage at the final element). This is not the case, provide the constraints concerning drop out voltage (item 6 in chapter 17.2.1) and the power dissipation (item 7 in chapter 17.2.1) are fulfilled. Nevertheless, it is recommended to carry out the test according to chapter 17.2.2 (check disconnection of neutral conductor) at least at initial examination of a lift.

For the 230V - variant and the 110V - variant (A1 and A2) an analysis concerning failure combinations of internal components has not been performed. The case of neutral conductor loss is covered here by means of intensified testing: at least at every recurring inspection of the lift. The assessment of whether this is sufficient is entrusted to the notified body of the entire lift system, because this depends on how high the SIL level is that must be achieved (based on the activated safety functions). To do this, the sum of the component failure probabilities that lead to an exacerbation of the problem of neutral conductor loss must also be known. This was determined in a FMEDA. It amounts to 25.2 FIT.

17.3 Constraints concerning LIMAX1 RED - Version

The constraints in this chapter only do apply for LIMAX1RED-Version.

1. Immediately after start-up / reset the position-value is not safe. Safe operation (according to SIL3) only after travelling 24 mm away from start-up / reset-position.
2. The evaluation unit must fulfill the requirements defined in chapter 9.6 when evaluating the safe protocol.
3. The technical data (mechanical, electrical and environmental) concerning the LIMAX1RED- sensor as defined in chapter 15 are valid for constraints for use.

18 Functional Safety

18.1 Safety Parameters

The values in the following tables have been calculated in the FMEDA based SN29500. The values in the following tables have been calculated in the FMEDA based SN29500. The environmental conditions for the calculations are assumed as follows:

It is assumed to be 30°C as a conservative estimation of the average temperature in the shafts were the LIMAX1CP/1RED systems are installed in.

Closer explanations concerning average temperature:

Here, the average is calculated over all times of day, seasons and positions in the shaft (top or bottom and so on).

Since safety parameters are statistical values, the average is also calculated all climatic zones in which the LIMAX is likely to be used and all possible conditions of the building (lift shaft inside the core of the building ⇔ glass – shaft outside the building).

In addition to the statistic values, the maximum ratings regarding temperature/current must of course be consistently met for each elevator.

Table 28: Required and achieved SIL-rate, values according to FMEDA

Safety function	Norm reference	Required SIL due to EN81 (or due to risk analysis, refer to comments)	Achieved SIL due to PFHD and SFF	PFH_D [FIT] (corresponds to λ_{DU})	Percentage of required SIL	Comments
Overspeed, pre-tipping	EN81-20 § 5.6.2.2.1.6 a.)	SIL2	SIL3	33.2 FIT	3.3%	
Overspeed teach pre-tipping	Not named in EN81	SIL3	SIL3	33.2 FIT	33.2%	The safety function overspeed teach pre-tripping is a substitute for ETSL, which cannot be carried out in teach mode. Because ETSL is SIL 3 according to EN81-20, Annex A, overspeed teach pre- tripping is also SIL3.
Final limit switches	EN81-20 §5.12.2.3.1 b.)	SIL1	SIL3	33.2 FIT	0.3%	
ETSL	EN81-20 §5.12.1.3	SIL3	SIL3	33.2 FIT	33.2%	
Door bridging	EN81-20 §5.12.1.4	SIL2	SIL3	33.2 FIT	3.3%	
UCM	EN81-20 §5.6.7.7	SIL2	SIL3	33.3 FIT	3.3%	
Safe position sensor (LIMAX1RED RS485)	EN81	SIL3	SIL3	30.2 FIT	30.2%	LIMAX 1RED RS485 is SIL3 by specification
Redundant position sensor (LIMAX1RED – DUAL CAN)	n.a.	n.a.	n.a.	n.a.	n.a.	LIMAX 1RED dual CAN versions have no SIL rating which is dept. on implementation of communication protocol

Constraints for use (see chapter 15) must be observed. Other the values named in the table above cannot be guaranteed.

Table 29: 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 $\lambda_{DD}=\lambda_D-\lambda_{DU}$; λ_D see left column, λ_{DU} see Table 28
Overspeed, pre-tipping	2188 (2173) FIT[1]	4578 (4635) FIT	4545 (4601) FIT
Overspeed teach pre-tipping	2188 (2173) FIT	4578 (4635) FIT	4545 (4601) FIT
Final limit switches	2188 (2173) FIT	4578 (4635) FIT	4545 (4601) FIT
ETSL	2188 (2173) FIT	4578 (4635) FIT	4545 (4601) FIT
Door bridging	2188 (2173) FIT	4578 (4635) FIT	4545 (4601) FIT
UCM	2218 (2202) FIT	4636 (4693) FIT	4603 (4660) FIT
Safe position sensor (LMAX1RED)	2028 FIT	4270 FIT	4240 FIT

Table 30: Safe Failure fraction, HFT and type of the subsystem

Subsystem	HFT	Type	Req. SFF for SIL3	Achieved SFF	Comments
Position (1-channel-part)	0	A	>90%	99.00%	SFF for SIL 3 achieved
Position (2-channel-part)	1	A	>60%	99.90%	SFF for SIL 3 achieved
Acceleration sensor	0	B	>99%	99.07%	SFF for SIL 3 achieved
EMC of supply (1-channel)	0	A	>90%	98.36%	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%	99.46%	SFF for SIL 3 achieved
Voltage 1.8V	0	A	>90%	99.06%	SFF for SIL 3 achieved
Voltage 5V	0	A	>90%	99.48%	SFF for SIL 3 achieved
Crowbar	0	A	>90%	94.62%	SFF for SIL 3 achieved
OC	1	A	>60%	99.34%	SFF for SIL 3 achieved
SR	1	A	>60%	99.34%	SFF for SIL 3 achieved
OC_IN-DIAG	0	A	>90%	99.88% (99.97%)	SFF for SIL 3 achieved
OC_OUT-DIAG	0	A	>90%	98.83% (99.36%)	SFF for SIL 3 achieved
SR_IN-DIAG	0	A	>90%	99.88% (99.97%)	SFF for SIL 3 achieved
SR_OC-DIAG	0	A	>90%	99.83% (99.36%)	SFF for SIL 3 achieved
TRIAC-protection	0	A	>90%	90.09%	SFF for SIL 3 achieved
µ-controller, CPU, permanent errors	1	B	>90%	96.89%	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, 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, 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%	96.73%	SFF for SIL 3 achieved
EEPROM	0	B	>99%	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

[1] The values without brackets refer to variant A1 and A2 (“230V” and “110V”), the values in brackets refer to variant A3 (48V) if they differ

Subsystem	HFT	Type	Req. SFF for SIL3	Achieved SFF	Comments
Voltage Monitoring part 2	1	A	>60%	99.00%	SFF for SIL 3 achieved
External watchdog	1	A	>60%	72.83%	SFF for SIL 3 achieved
Temperature sensor	1	A	>60%	95.08%	SFF for SIL 3 achieved
Door zone output	0	A	>90%	99.96%	SFF for SIL 3 achieved
Floor sensor input	0	A	>90%	99.00%	SFF for SIL 3 achieved
Miscellaneous	0	A	>90%	98.51 %	SFF for SIL 3 achieved
CAN-Interface	1	B	>90%	91.11%	SFF for SIL 3 achieved
RS-485 interface	0	A	>90%	98.57%	SFF for SIL 3 achieved

Table 31: Diagnostic Test-interval, of the single subsystems

Subsystem	Diagnostic measurement	DTI	Comments
Position (1-channel-part)	Plausibility of succession of potions (check on leaps)	1ms	
Position (2-channel-part)	Comparison with other channel	1ms	
Acceleration sensor	Compare with succession of positions	10ms	
EMC of supply	none	none	
Voltage 3.3V	crowbar	continuous	
Voltage 1.8V	Voltage supervision	10ms	
Voltage 5V	crowbar	continuous	
Crowbar	none	none	
OC	Check of safety circuit diagnostic spots	10ms/24h	For actuators and their diagnostics to be checked, certain conditions must be met. In chapter 8.1 . It is shown that dangerous situations are detected nevertheless.
SR	Check of safety circuit diagnostic spots	10ms	
OC_IN-DIAG	Checked in one go with actuator	10ms	
OC_OUT-DIAG	Checked in one go with actuator	10ms	
SR_IN-DIAG	Checked in one go with actuator	10ms	
SR_OC-DIAG	Checked in one go with actuator	10ms	
TRIAC-protection	none	none	
μ-controller, CPU, permanent errors	CPU-Test	10ms	
μ-controller, RAM, permanent, errors	RAM-test (during operation)	12.1 days	
μ-controller, RAM, permanent, errors	RAM-test (complete at start up)	n.a.	All actuators will stay open until this test is completed
μ-controller, RAM	Parity check	Instantaneous at every access to the corresponding memory cells	
μ-controller, RAM	Internal safeguarding of the data which remain unchanged in the RAM for a loner time	10ms	The floor table is an example for such data. It is secured by added redundancy and by comparison with the other channel.
μ-controller, ROM, permanent, errors	ROM-CRC, safety relevant part	25s	
μ-controller, ROM, permanent, errors	ROM-CRC, (complete at start up)	n.a.	All actuators will stay open until this test is completed
μ-controller, A/D-unit, permanent errors	Comparison with other channel	10ms	
μ-controller, other peripheral modules, permanent errors	Comparison with other channel	10ms	

Subsystem	Diagnostic measurement	DTI	Comments
μ-controller, CPU, soft errors	2nd channel	n.a.	Soft errors occur only briefly. During this time the other channel ensures the safety. Before the error is detected, it has normally already disappeared again.
μ-controller, RAM, soft errors	2nd channel	n.a.	
μ-controller, A/D-unit, soft errors	2nd channel	n.a	
μ-controller, other peripheral modules, soft errors	2nd channel	n.a.	
External RESET	none	none	
EEPROM	CRC over the values in the EEPROM	See comment	Checked when loaded to the RAM
Voltage Monitoring (part 1 and part 2)	Compare A/D-converted voltages with expected values	10ms	
External watchdog	Complete check at startup	Only at start-up	
Temperature sensor	Comparison with other channel	10ms	
Door zone output	none	none	
Floor sensor input	none	none	Floor table is checked by the user after commissioning
Miscellaneous	none	none	
CAN-Interface	none	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 9.6)

The diagnostic test interval of RAM and ROM is much longer than the system response time.
This is acceptable since this is a 2-channel system. The probability that a dangerous error occurs in both channels before it is noticed by the diagnostics was calculated in the FMEDA and assessed as sufficiently low. Furthermore, there are additional measurements securing the RAM-data with a short DTI: parity check and internal safeguarding of certain RAM-data (see table above).

The external watchdog is even tested only once a year. This is acceptable, because this is the diagnosis of the diagnosis. A complete failure of the external watchdog on both channels would not yet lead to an immediately dangerous situation.

18.2 Demands of EN 61508-2, Annex D2

Table 32: Demands of EN61508-2, Annex D2

Ref. 61508	EN 61508 demand	Value, description or references to other chapters
D2.1 a.)	Functional description	See chapters 5, 6, 7, 9, 10 and 13
D2.1 b.)	Identification of configuration	See chapter 20
D2.1 c.)	Constraints for use	See chapter 17
D2.2 a.)	Kinds of undetected failures	Safe failures (actuator open by fail) Dangerous failures (relays closed by fail)
D2.2 b.)	Rate of failures dependent on the kind (refer to D2.2 a.)	Safe failures: refer to Table 29 Dangerous failures: refer to Table 29
D2.2 c.)	Kinds of failures detected by diagnostics	Safe failure (relays open by fail)
D2.2 d.)	Kinds of failures of diagnostics	Safe failure (relays open by fail)
D2.2 e.)	Rate of failures concerning c.) and d.)	Summarized to one value λ_{DD} (because reaction of the system is the same): $\lambda_{DD} = \lambda_{DD} - \lambda_{DU}$, refer to Table 29.

Ref. 61508	EN 61508 demand	Value, description or references to other chapters
D2.2 f.)	Diagnostic test interval	Refer to Table 31
D2.2 g.)	Initiated outputs	Refer to chapter 8.6.
D2.2 h.)	Regular test and maintenance	Refer to chapter 14
D2.2 i.)	External diagnostics	Refer to chapter 9.6
D2.2 j.)	Hardware failure tolerance	Refer Table 30
D2.2 k.)	Type A / Type B classification	Refer Table 30

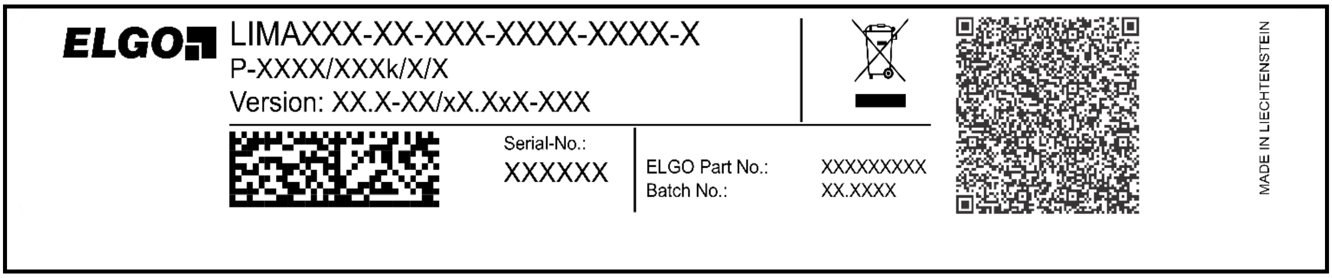
19 Identification and Labels

Several labels are placed on the LIMAX1CP/1RED –housing:

Table 33: Label contents

Name	Example figure	Place	Content
Type label	Table 34	on one of the narrow sides	Type key (see also chapter 20)
			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 35 (part1) Table 36 (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
			Configuration information (see 🕮 ConfigurationProcess)
			Signal assignment of the contactors
Top label	Table 37	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 14, chapter 11.1	On the top-side (where the LEDs are placed)11.1	Designation of the LEDs.

Table 34: Type label



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 actual version number is v3.1rx-xxx.
The “x” are placeholders. The first “x”: v3.1r**x**-xxx identifies the “not safety related” part of the software. If this “not safety related” part changes an update of the certificate is not necessary. The “xxx” at the end: v3.1rx-**xxx**

identify the customization. With the customization an adaption to special wishes of the customer is possible. Here the same words are valid as for the not safety related part of the software are valid.

The hardware version is also part of the certificate with its board version. The actual version number is 01.3-xx-xxx-x.
Here also the "x" are placeholders which identify special assembly versions of the board, for instance "CP" or "RED"-version or the kind of connector which is assembled. These assembly versions are all covered by the certificate.

The corresponding process to generate software versions differing in the "not safety related" and different assembly versions of the board was already part of the certification.

The versions mentioned above are state of June 2023. May be certificate-updates with higher versions than v3.1 / 01.3 will follow in future. In this case the manual will only be updated if necessary (to be decided at certificate update). If an update is not necessary, this version of the manual will be valid further on.

Later versions of the manual may also follow without an update of hardware/software: changes of this manual may also be caused by mistakes (typos or factual mistakes) which will be discovered in future, or optimizations in comprehensibility.

Table 35: Info label, part 1 (subject to changes)

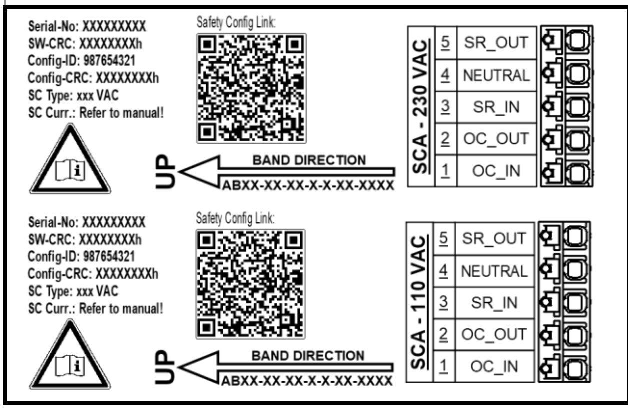
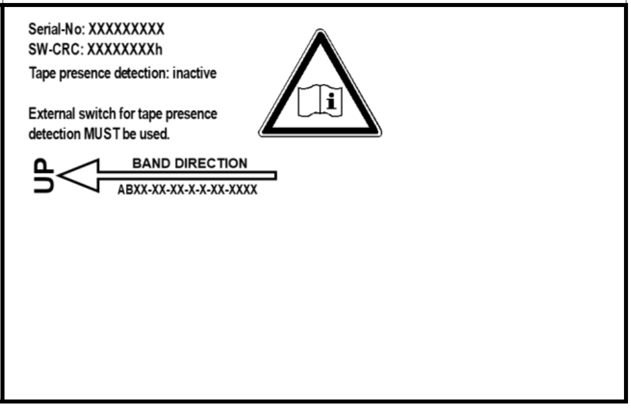
For LIMAX1CP	For LIMAX1RED
	

Table 36: Info label, part 2

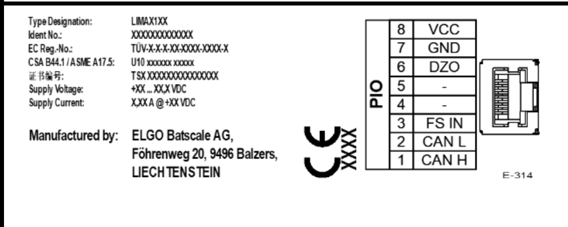
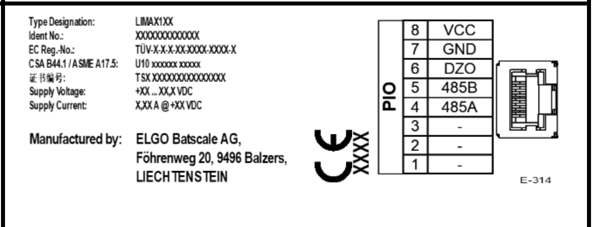
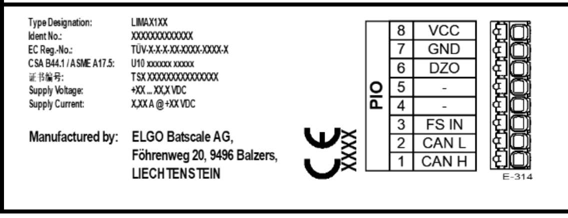
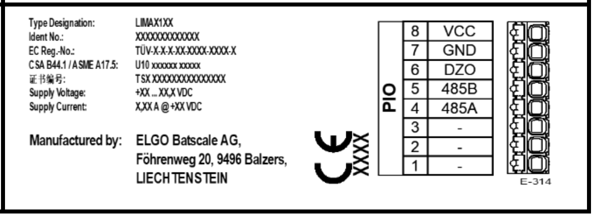
	For LIMAX1CP	For LIMAX1RED
RJ45		
Ter-minal		

Table 37: Top label

20 Type Designation

Designation 1: (example) LIMAX1CP - 00 - CON - 1000 - CO0T - A1

Series / Type:

LIMAX1CP = LIMAX1 CP (2-channel safety system)

Version:

00 = Standard version
01 = 1. special version
...

Connection:

TRM = Push-In terminal
CON = RJ45 connector
... = further options on request

Resolution:

1000 = 1000 µm = 1.00 mm at delivery state*
* CANopen devices configurable according to CiA 406 / CiA 417

Interface:

CO0T	= CANopen	[Encoder Profile DS406]
CO1T	= CANopen	[Elevator Profile DS417]
CO2T	= Dual CANopen	[Encoder Profile DS406; on Request]
CO3T	= Dual CANopen	[Elevator Profile DS417]
CNXT	= CAN	[special protocol separately defined by version number, on request]

NOTE:
The CAN interface is always terminated with 120R (T). Other configurations on request.

Type safety circuit:

A1 = 230 VAC
A2 = 110 VAC
A3 = 48 VAC
... = further variants on request

Figure 22: Type Key for LIMAX1CP

Designation 2 (example): ID-X / 250k / XX / 1

Configuration ID:
ID-X = Parameter set (will be defined by the customer)

CAN Bitrate:
125k = 125 kbps
250k = 250 kbps (default)
500k = 500 kbps

CANopen Node-ID:
XX = Default (DS406: 01h / DS417: 04h)
01 .. 7F = Differing Node-ID in hexadecimal representation

Remark Dual CANopen:
The Node-ID of the additional channel (CH0) is assigned as main channel (CH1) Node-ID + 1, therefore the main channel Node-ID is limited to 7E (CH1: 01h → CH0: 02h / CH1: 04h → CH0: 05h)

Electronic SR – relay pairs:
1 = 1 eSR - pair

Figure 23: Type Key 2 for LIMAX1CP

Remark: there is no Type Key 2 for LIMAX 1RED

Designation 1:
(example)

LIMAX1R - 00 - CON - 62N5 - 485X - 1

Series / Type:

LIMAX1R = LIMAX1 RED
(2-channel absolute positioning system)

Version:

00 = Std. device

Connection:

CON = RJ45 connector
TRM = Push-In terminal

Resolution:

62N5 = 62,5 µm = 0,0625 mm
0125* = 125 µm = 0,125 mm
0250* = 250 µm = 0,25 mm
0500* = 500 µm = 0,50 mm
1000* = 1000 µm = 1,00 mm
*On Request

Interface:

485X = RS485 [special protocol defined by version no.]
CO2T = Dual CANopen [Encoder Profile DS406; on Request]
CO3T = Dual CANopen [Elevator Profile DS417]
CNX = CAN [special protocol defined by version no.]

Caution:
-> Assemlby of CAN-termination resistor can be configurated on request (see table below)
-> RS485-interface is always terminated!

CAN(open)- Interface		**Galvanic isolation**
		Non isolated
Bus-termination 120R	**Non terminated**	xxx
	terminated	xxxT

xxx = acronym from above

Acceleration Sensor (Tape presence detection):

0 = inactive
1 = active

Figure 24: Type Key for LIMAX1RED

A Closer Explanations, Illustrations and Examples

A.1 Illustration of Conditions for Learning in Teach-mode Manual

Figure 25 shows an example for the contents of the floor table – as learned in teach-mode-manual – which will be accepted (all floor positions in a rising order corresponding to their floor numbers and no "gaps" in the row of index´). And it shows examples for floor tables – as learned in teach-mode-manual – which will not be accepted:

- Because floor positions are not in a rising order corresponding to their floor number
- Or because there is a "gap" in the row of index'.

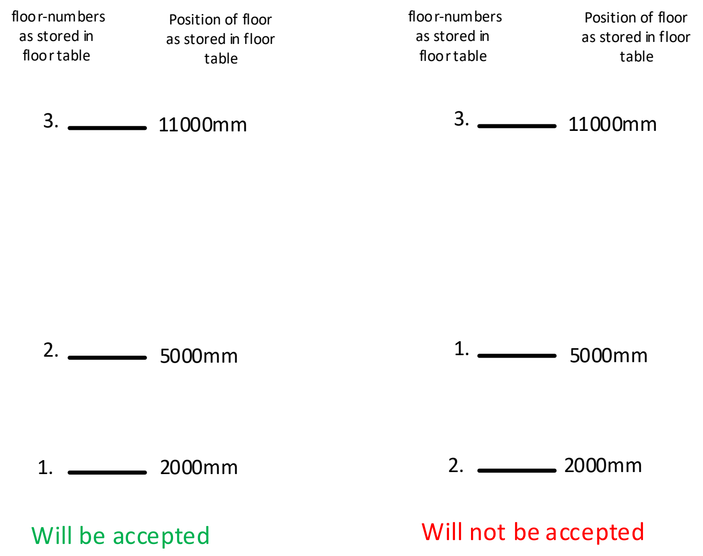


Figure 25: Examples for contents of floor table which will be accepted and for contents which will be not accepted

A.2 Illustration of Conditions for Auto-test and Auto-adjust

Figure 26 and Figure 27 illustrate the auto-teach-process. As one can see, the floors are re-ordered depending the position of the new detected floor.

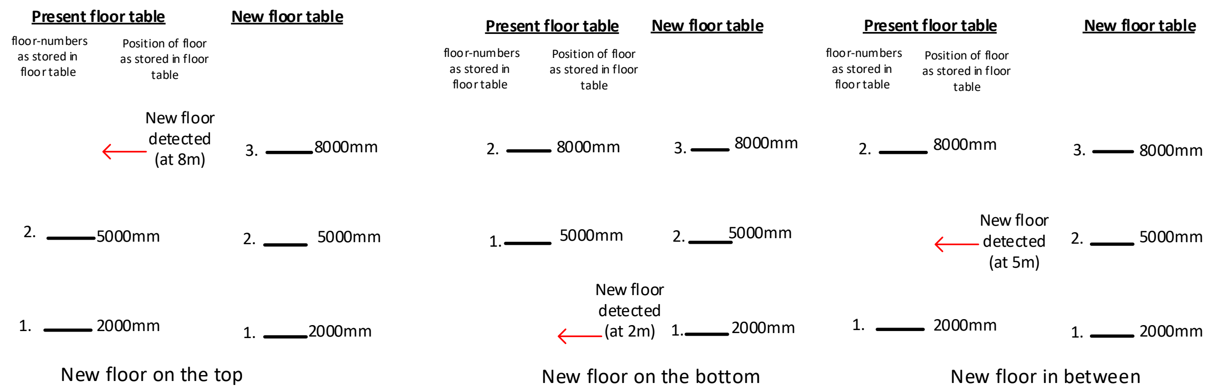


Figure 26: Auto-teach with automatic assignment of floor numbers

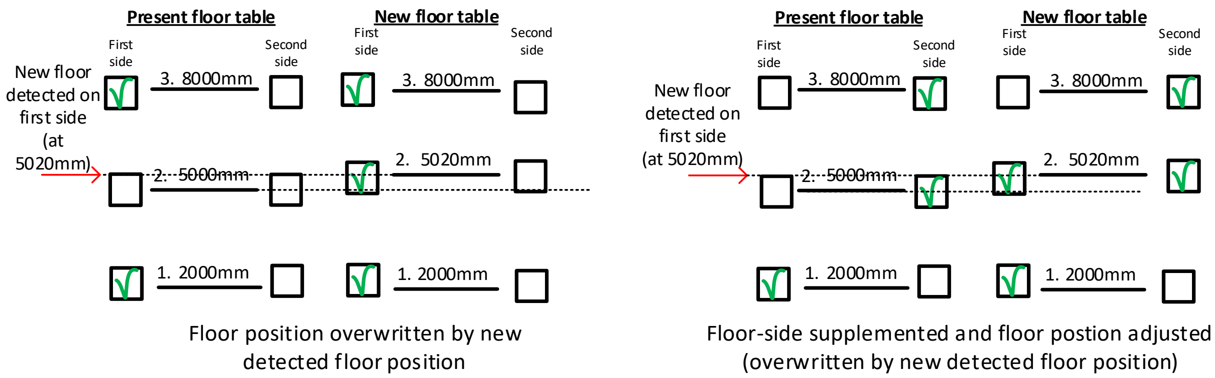


Figure 27: Auto-teach with floor sensor with overwriting of already stored floors.

Figure 28 and Figure 29 show examples for the conditions concerning the distances for auto-adjust:
The adjustment in Figure 28 fails, because the distance to the actual floor position is bigger than 50mm.
The (continued) adjustment in Figure 29 succeeds two times, continued one after the other (distance to the actual floor position is each smaller than 50mm). At third adjustment the distance to the actual floor position is also smaller than 50mm, but nevertheless the adjustment fails, because the distance to the original floor position is more than 100mm.

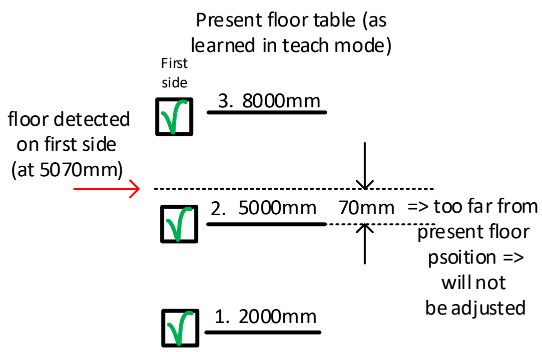


Figure 28: Auto adjust failed because distance to present floor position is too big.

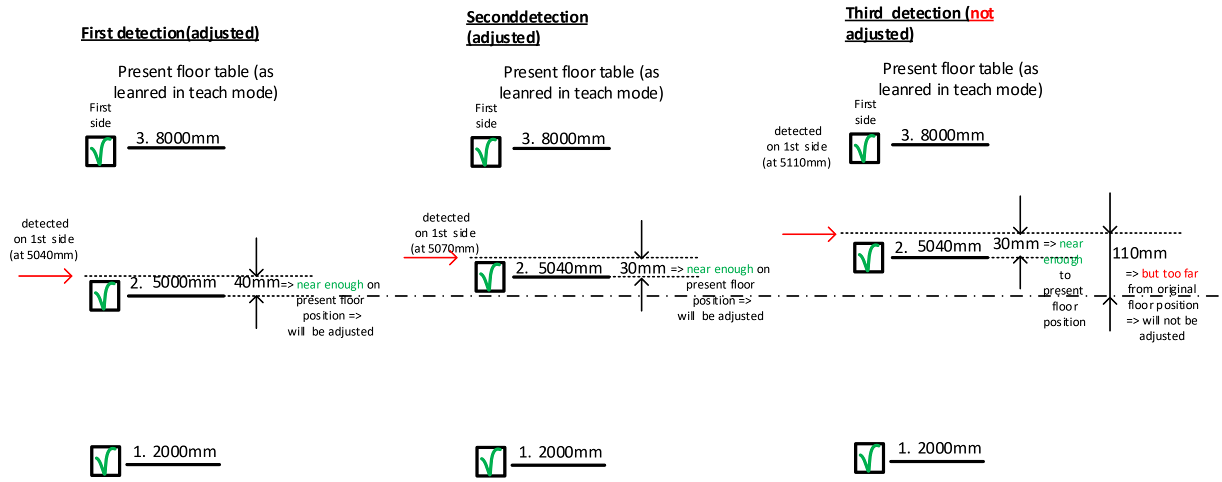


Figure 29: Continued Auto adjust (finally) fails because distance to original floor position too big

A.3 Example for Teach Procedure

The following figure shows an overview of the flow of events for commissioning of the LIMAX1CP/1RED in teach mode (here for teach mode manual).

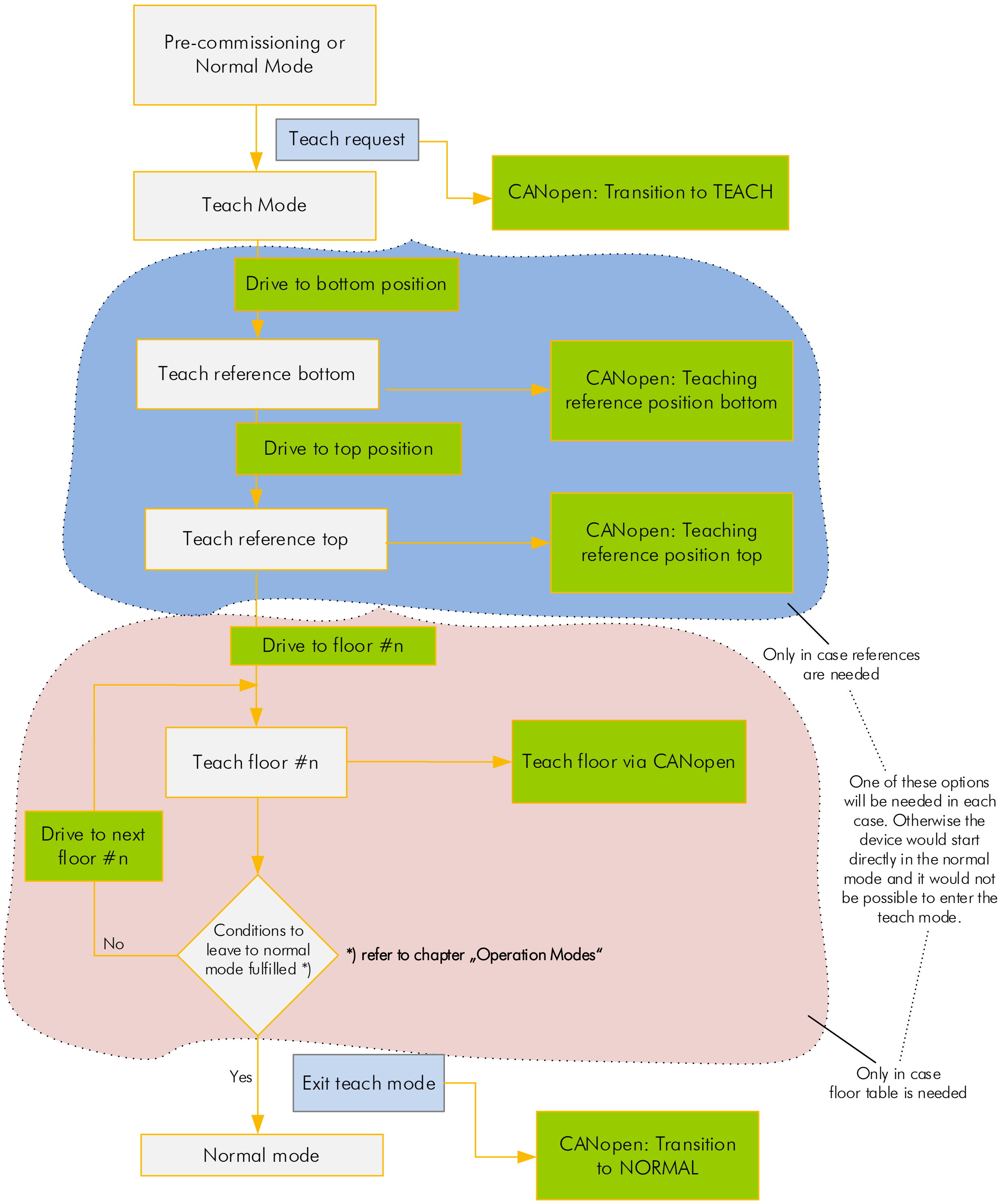


Figure 30: Flow of events in teach mode

The cabin can be moved in normal lift operation with limited speed. So, it is possible to move the cabin to each position to be learned as a position of a floor or as a reference position. At the moment when LIMAX1CP receives the corresponding CANopen-command it learns the actual position as the position of floor #n resp. top or bottom reference position (depending on the CANopen command).

The order of learning is absolutely arbitrary – not only concerning the single floors, but also the order of learning of the reference positions and the floors. So, it is possible to save time by optimizing the order of events:

For example, if

- first one of the reference positions is learned,

- after this, one floor after the other is learned on the way to the other side of the shaft
- and then the other reference position is learned,

the time for one travel through the whole shaft can be saved compared to the procedure, when both references are learned before the "first" floor.

Figure 31 shows such a time-saving sequence of events as an example (here for teach mode auto):

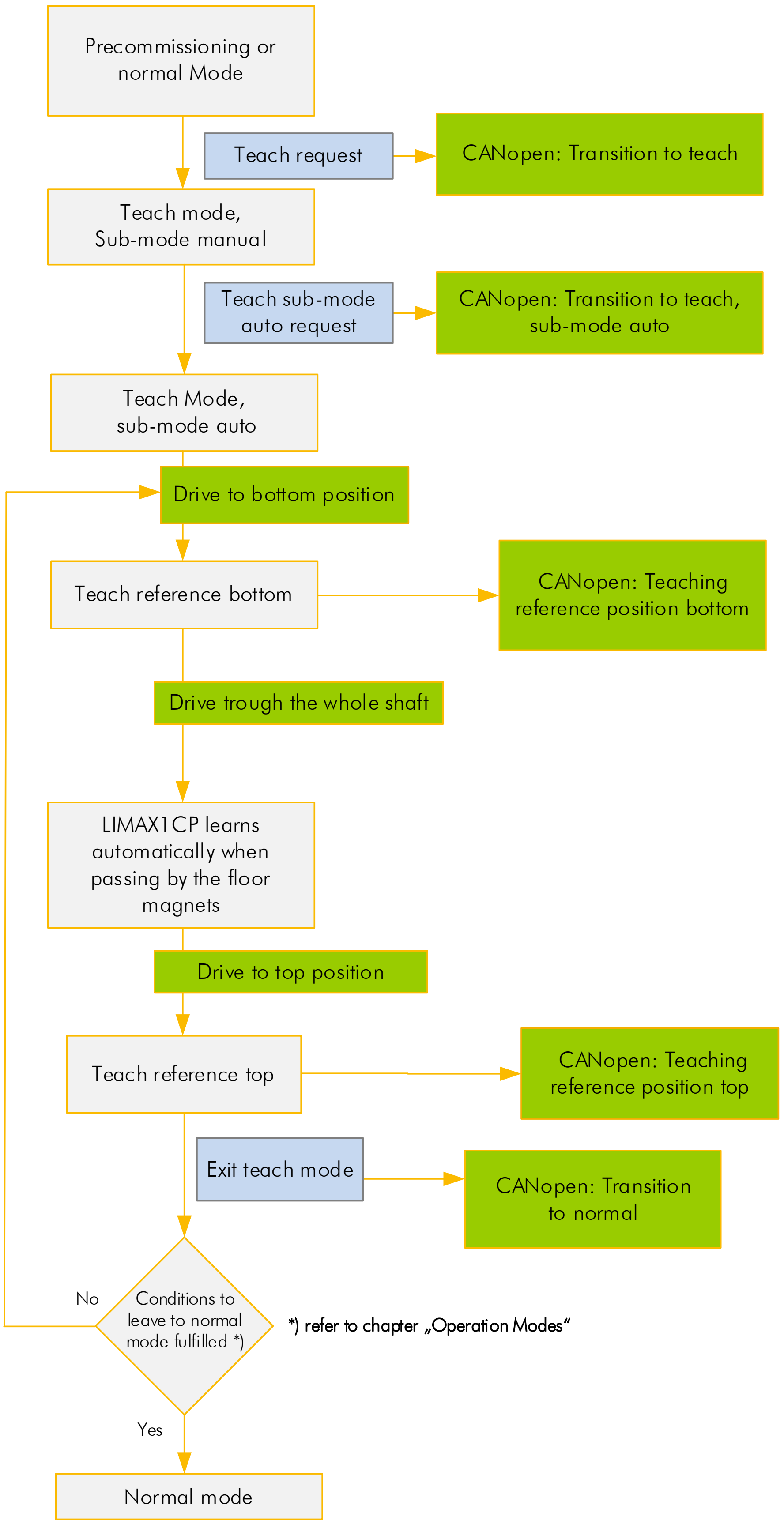


Figure 31: Time-saving flow of events in teach mode auto

A.4 Closer Explanation concerning UCM, part1

If the car is on a floor level with doors bridged (SR closed) lift control must always disable door bridging by CANopen, before a new travel can start. Otherwise UCM would be triggered. Refer also to Figure 32.

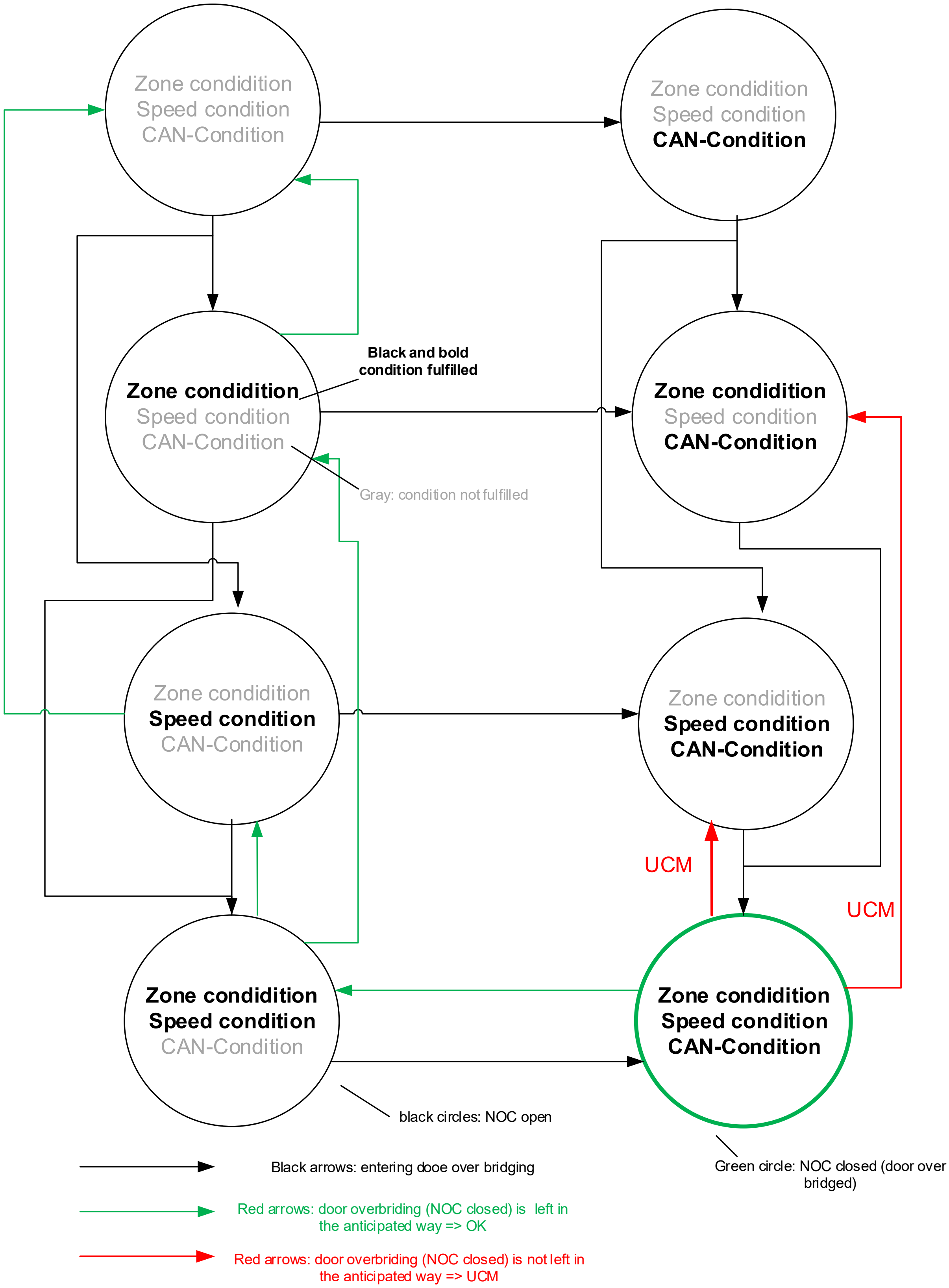


Figure 32: Conditions for door bridging and UCM

A.5 Closer Explanations concerning ETSL

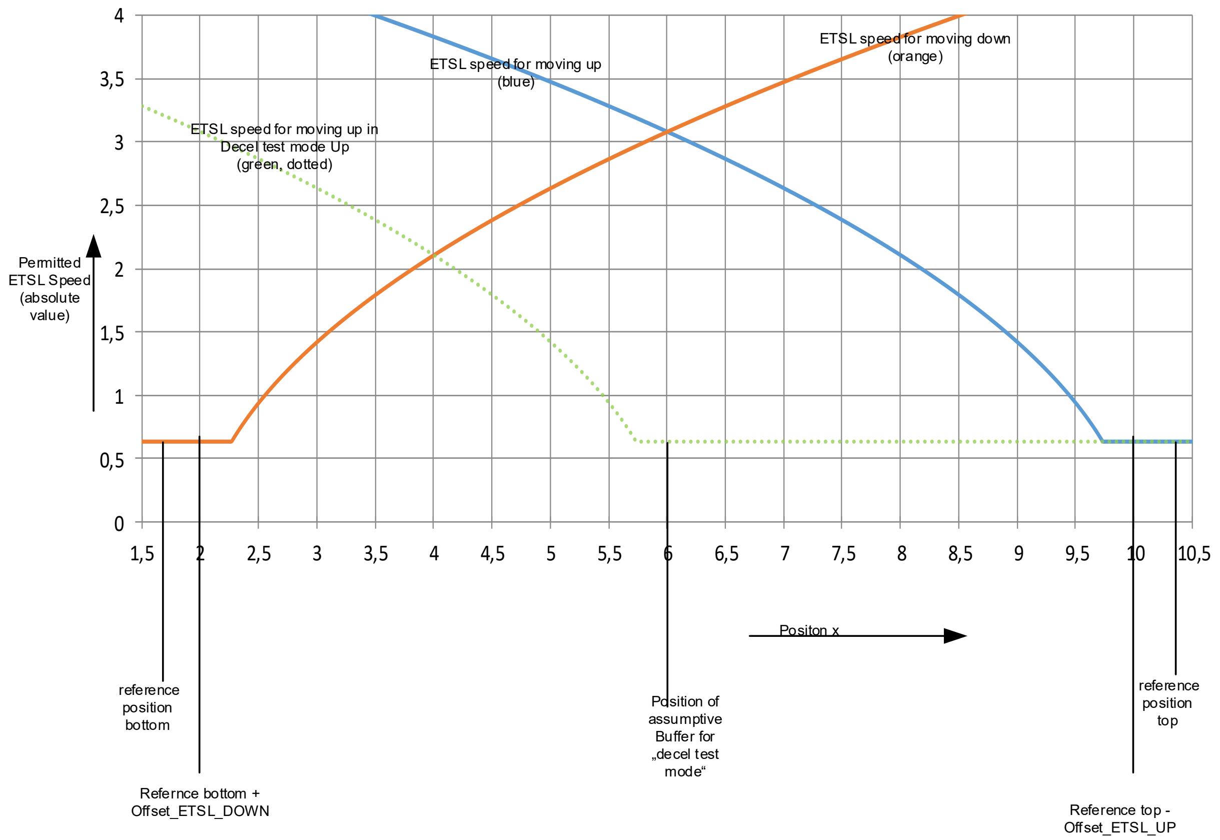


Figure 33: Behavior of ETSL in normal and in test mode

B Overview of the mechanical Structure and Dimensions

Figure 34 shows the structure and the dimensions of the housing. It consists of:

- an aluminum profile (235mm long) with inserted electronics PCB
- Plastics lids screwed on the top and on the bottom of the profile (length over profile including top and bottom lid: 256mm)
- A cover with cable ducting slipped over the lower lid (overall length, including cover: 291mm)

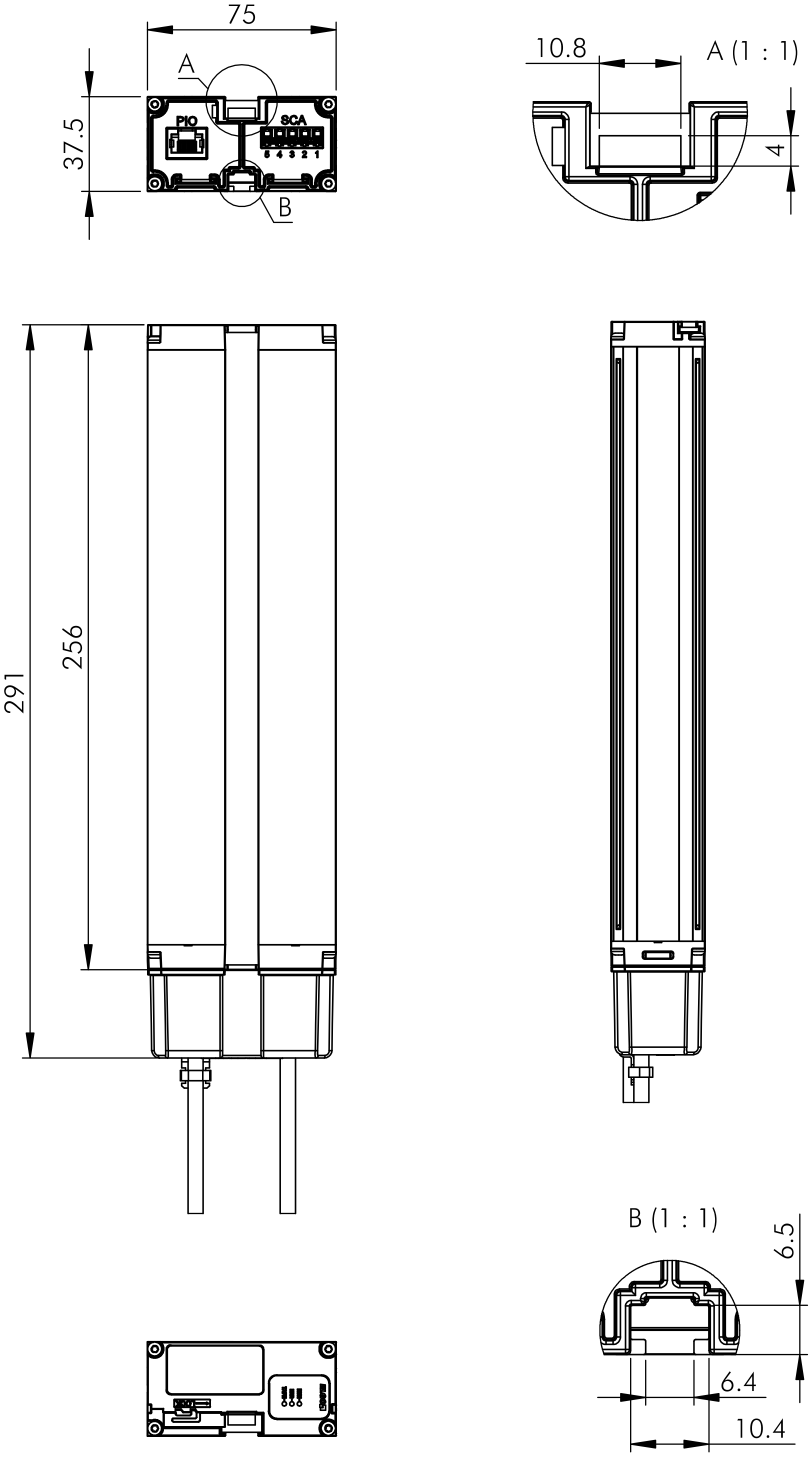


Figure 34: Mechanical dimensions und structure

C Change History

Date	Revision	Changes
2023-07-06	6	First version when the certificate was granted.
2023-07-21	7	• Chapter "Initial and annual examination" substituted by "Initial and periodic examination". Also, in the text of this chapter "annual" substituted by "periodic" • New chapter 14: Maintenance • Correction of spellings • Chapter " Extra low-voltage (Supply, Digital Signals and Communication)": residual ripple for supply voltage added and • DZO rating added • small corrections in Spelling, footnote in chapter 13.1 added (acc. to review of previous changes) • Chapter 13: "periodic" changed to "recurrent" • Chapter 13: spot of the footnote reference changed • Change log added
2023-07-26	8	Change log modified
2024-01-24	9	• Chapter 19: “Type key” extended by 110VAC – variant • Chapter 19: “Type key” Mistakes concerning type key corrected • Table 25: “Safety circuit supply” extended by 110VAC – variant • Chapter 16.2: “Constraints for LIMAX1CP” extended by specification of voltage at which the main contactor must drop at latest • Chapter 15.3: “Environmental data” hint concerning extended temperature range added • Chapter 15.3: “Environmental data” temperature range certified acc. to GB7588 added
2024-11-28	10	• Adaptions to new temperature thresholds: Table 8; Table in chapter 8.7; Table25; new figure 18
2024-12-04	11	• Chapter 16.2, point 3 supplemented • Chapter 16.2.1 and 16.2.2 added (concerning problem “loss of neutral”) • chapter 9.3.3: dynamization of the status bits added • chapter 9.3.5, table 11: wrong assignments PU1/PU2 fixed; channel B => PU2 • table 34: “(Subject to changes)” added
2024-12-09/ 2024-12-13	12	• Info-Label Design Figures updated to Versions E-314 V43 R0 / E-329 V15 R0 / E-337 V7 R0 • Minor syntax and/or semantic corrections • Not defined footnote links removed
2024-12-15	13	• Use of the word ‘DANGER!’ instead of ‘WARNING!’ in the boxes with the lightning bolt. • Fix empty footnote 3 in Table 8. • Chapter 8.7. Added caption to the table. • Figure 18: Base point corrected 0.125 A-> 0.15 A. • Chapter 15.3: Maximum current at 70°C is 0.15A not 0.25A • Chapter 16.1, Point 7: Changed formulation from “specific instructions for use given in this manual serve only as an example” to “instructions shall be followed unless there is a workaround / equivalent measure available, which shall be accepted by the notified body in charge.” • Main contactor. Change “pick” to “close”.
2025-08-18	14	• Typekey corrected and updated

Date	Revision	Changes
		• QR-code added • Dual-CAN added • Interface parameter corrected
2025-11-26	15	• Calculation of ETSL-Distance corrected • Mechanical Data added
2025-12-11	16	• Constraints for use, topics concerning "must-drop-out-voltages" and minimum power dissipation added/updated • Chapters concerning "risk of loss of neutral" "hints for the notified body" Hints for the notified body concerning required properties of the final element, tests to be carried out and resulting SIL" added • Table concerning safety circuit supply: Variant A3 added, rated voltages/maximum ratings and minimum voltages updated • Typekey: variant A3 (48V safety circuit voltage added) • Typekey: Tolerances for safety circuit voltages removed • Safety Parameter corrected (acc. to corrected FMEDA) • Resivion 14 and 15 in the history (this table) added (forgotten before)
2026-02-17	17	• Safety parameter in Table 28 and Table 29 corrected (acc. to latest revision of FMEDA) • (internal) link corrected • Corrections in Table 30

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