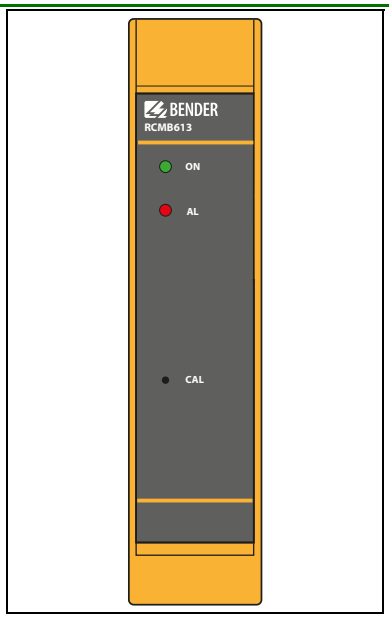
RCMB613

AC/DC sensitive residual current monitoring device



Intended use

The AC/DC sensitive residual current monitor RCMB613 is used for fault current monitoring of charging stations for electric vehicles in which AC or DC fault currents can occur, the amount of which can continuously be greater than zero.
Applicable standards: IEC 61851-1 and UL2231 for CCID20.

Safety

For the use of this device, **specialist knowledge** is required.
It is essential to follow the existing safety regulations!

Part of the device documentation in addition to this manual is the enclosed "Important safety instructions for Bender products".

Function description

Residual current monitoring of the charging station takes place via an externally connected measuring current transformer. If the residual current monitor is set to "UL", it evaluates the r.m.s. value of the fault current. When set to "IEC", the monitoring device determines the r.m.s. value and the DC component of the fault current.
If the response value is exceeded, the switching output switches and thereby interrupts the charging process. In addition, the device is able to detect welded main contacts of an external load switch (relay or contactor). It also monitors the presence of mains voltage (charging voltage).
The response values can be selected according to the standards IEC 61851-1 or UL2231 for CCID20 by means of a button on the front panel of the device.

Device test: During the device test, the device generates a test current. The level of the test current is designed so that when functioning correctly the threshold is exceeded, triggering the switching output.

Charging process: Before each charging process, the external charge controller must initiate the functional test of the RCMB613. Ensure that the charging process is disabled. Regular testing increases the safety of the charging process and prevents long-term drift of the residual current measurement.

System fault: In the event of a device fault or a welded contact of the external load switch, the device disables the connection between the charge controller and the connected vehicle (Control Pilot) and thereby interrupts the charging process. The system fault is additionally reported to the charge controller.

Measuring current transformer: The measuring current transformer is magnetically shielded, so that no external interference can affect the residual current measurement.

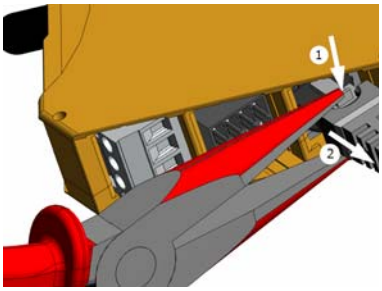
*The RCMB613 can only be put **into operation with a connected measuring current transformer**.*

Unlocking the CT plug

CAUTION

Risk of damage when pulling out the CT plug!
If the CT plug is pulled out using too much force, the enclosure and the internal components may be damaged.
Use needle-nose pliers to unlock the CT plug.

The following illustration shows how to unlock the CT plug:



Device elements

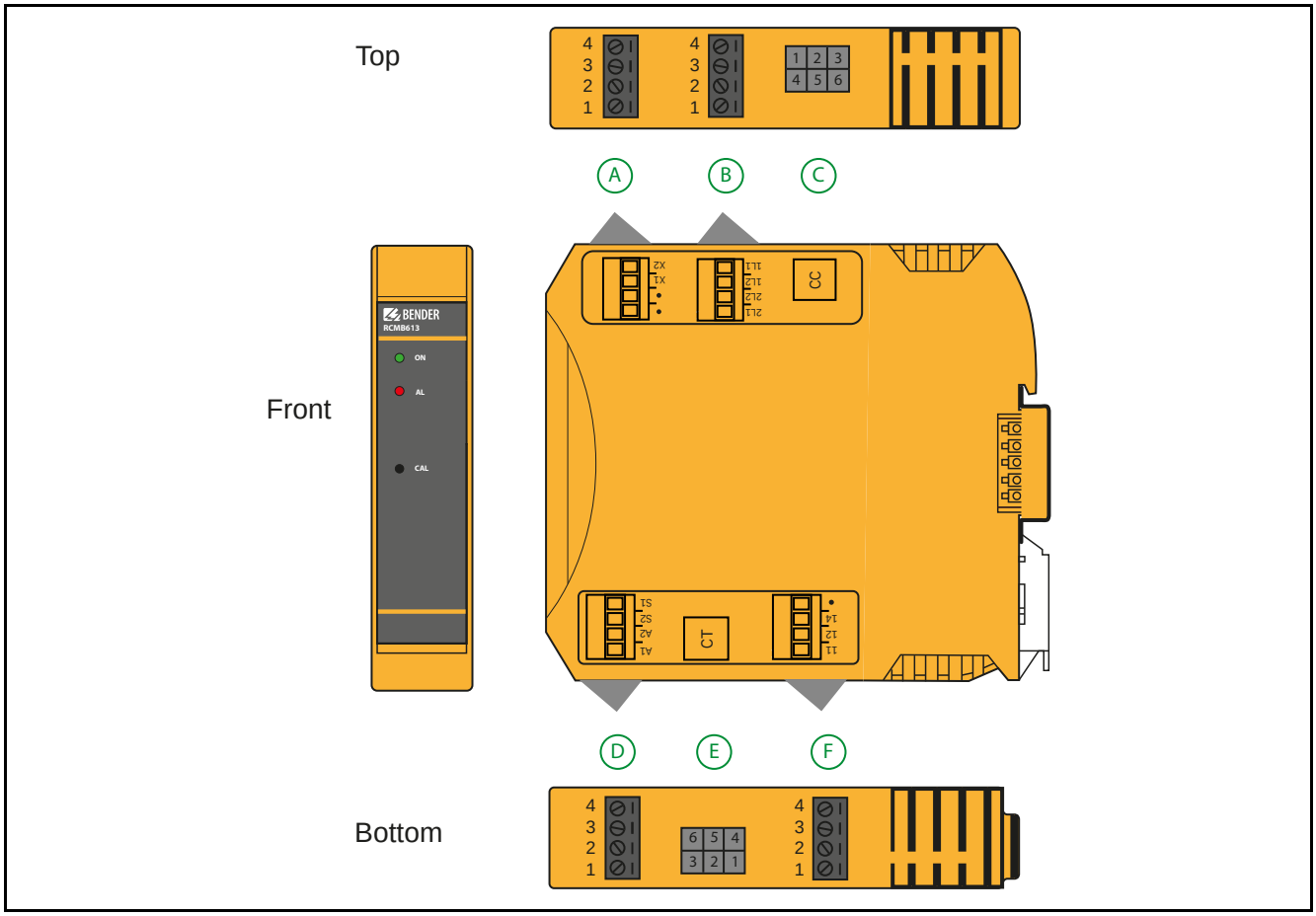


Fig. 1: Device elements RCMB613

Front

Element	Description
ON LED (green)	Power on LED
AL LED (red)	Alarm LED
Changeover switch CAL	Push the button with a pointed object to switch between IEC 61851-1 and UL2231 for CCID20 (for more details, refer to page 7)

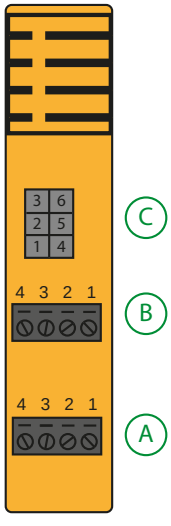
Tab. 1: Device elements (front view)

Description of the LED indication

ON LED	AL LED	Description
●	○	Ready for operation, without fault current
●	●	Response value exceeded
✳	●	System fault (e.g. internal device fault, welded contact, conflict of standards coding terminal (assignment of coding terminal does not suit set standard))

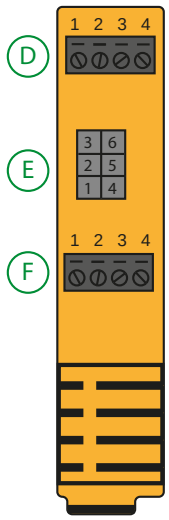
Tab. 2: Description of the LED indication

Top

Element	Description	Pin	Terminal assignment	
C	Interface to charge controller "CC" socket	**1** **2** **3** **4** **5** **6**	T/R GND EN AL ERR VL	
B	Contact monitoring (Weld Check)	**1** **2** **3** **4**	2L1 2L2 1L2 1L1	
A	Coding terminal (select standard)	**1** **2** **3** **4**	• • X1 X2	

Tab. 3: Device elements (top view)

Bottom

Element	Description	Pin	Terminal assignment	
D	Power supply/ Switching output [1)]	**1** **2** **3** **4**	A1 (+12 V) A2 (GND) S2 S1	
E	Measuring current transformer connection "CT" socket			
F	Control Pilot	**1** **2** **3** **4**	11 12 14 •	

Tab. 4: Device elements (bottom view)

• = not connected
[1)] Contacts A2 and S2 must be bridged.

Installation and connection

DANGER

*Ensure that there is **no voltage in the installation area** and follow the rules for working on electrical equipment.*

DIN rail mounting

CAUTION

Risk of injury to fingers!
The mounting clip of the device is sharp edged and pushed upwards by spring force.
When mounting the device, be careful not to get your fingers caught between the mounting clip and the DIN rail.

Pull down the silver mounting clip on the rear side in order to mount the device on the DIN rail. Place the device on the DIN rail and release the mounting clip. The device is installed.

Dimension diagram

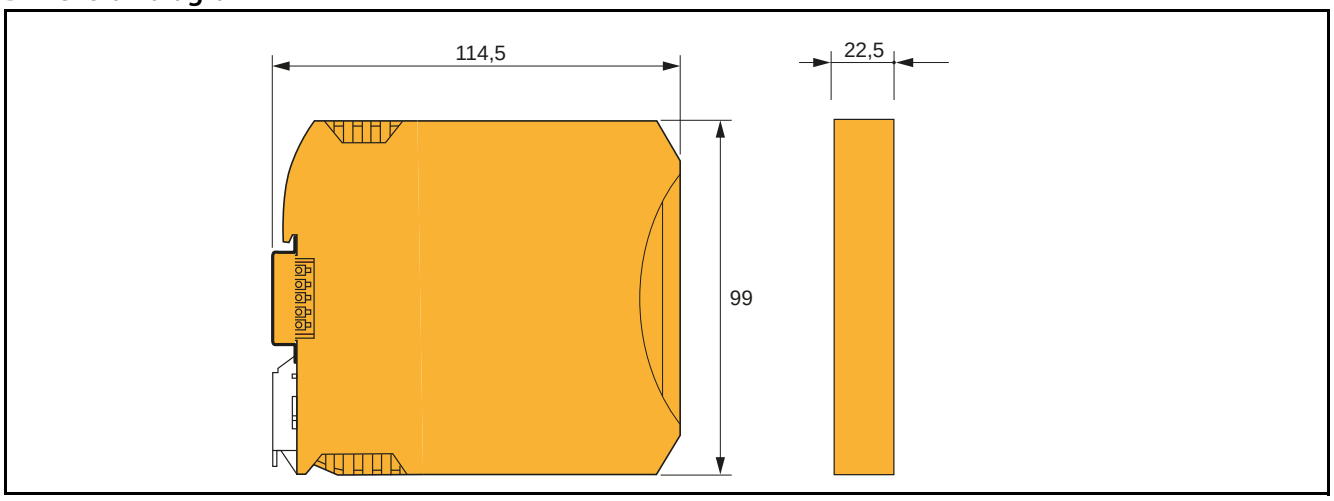


Fig. 2: Dimension diagram

All dimensions in mm.

Wiring diagram

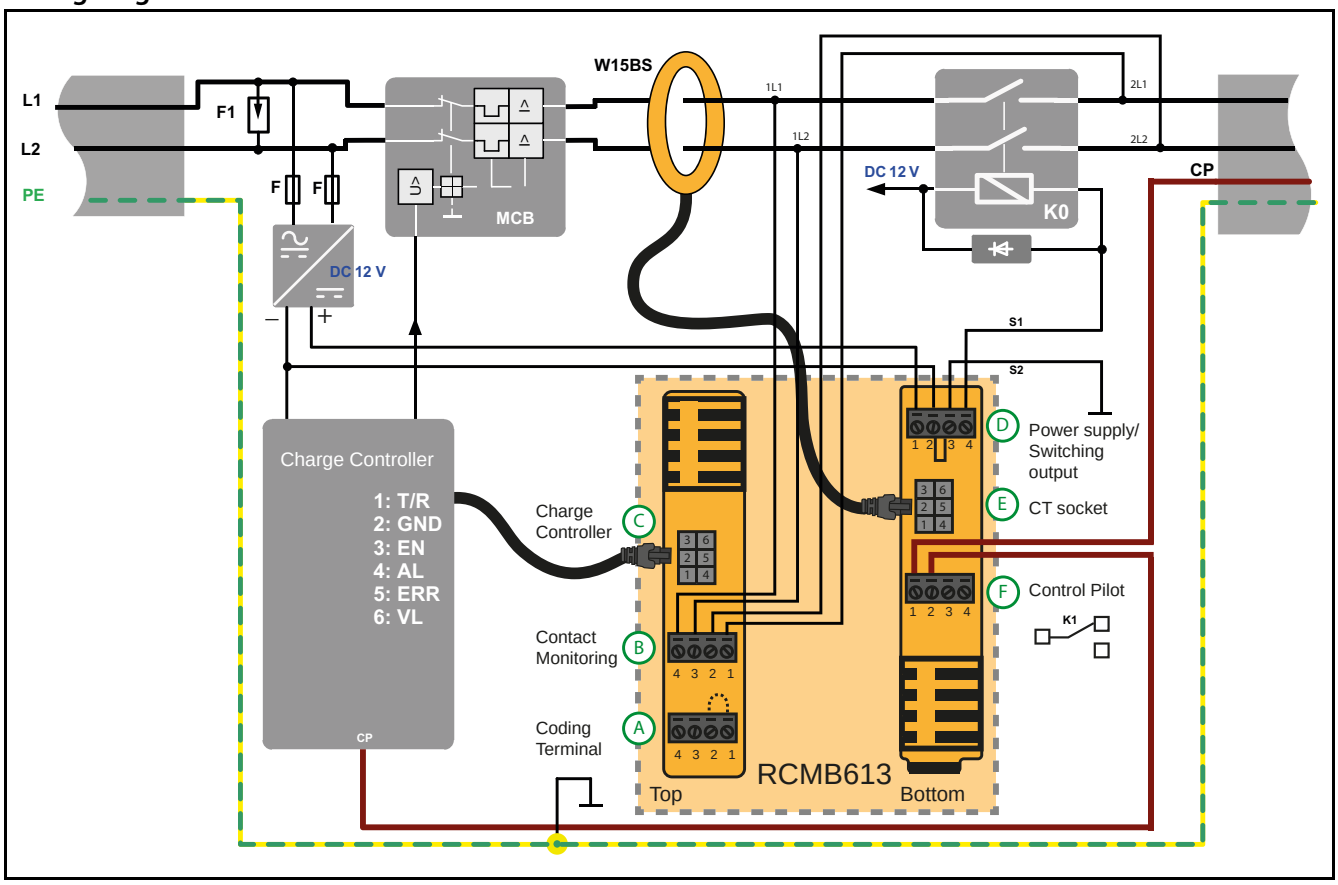


Fig. 3: Wiring diagram RCMB613

Wiring diagram legend

Element	Description
CP	Control Pilot: line between charge controller and vehicle
F	Overcurrent protection (device protection)
F1	Surge protective device
K0	External load contactor
K1	Integrated relay of the CP
Coding terminal	Switchover between UL2231 and IEC 61851-1
Contact monitoring	Check for welded contacts
Charge controller	Charge Controller, CC
MCB	Overcurrent protection
S1	Switching output (Open collector)
W15BS	Measuring current transformer

Tab. 5: Wiring diagram legend

Permissible cable lengths

The following maximum cable lengths may not be exceeded:

Cable to	Length
Measuring current transformer	1,500 mm
Power supply	< 500 mm
Control cable between charge controller and RCMB613	< 500 mm
Contact monitoring	< 500 mm
Control load contactor	< 500 mm

Tab. 6: Permissible cable lengths

Commissioning

Before commissioning, it is required to check that the connections are correct.

DANGER

Risk of electric shock!
The safety of life and limb is only ensured with correct functioning of the monitoring device. Therefore, ***a device test must be made before every charging*** *(by the charge controller)!*

DANGER

Risk of electric shock!
If connections 2L1 and 2L2 of the contact monitoring are ***interchanged****, contact welding* ***will no longer be detected****.*
It is essential to ensure correct wiring!

Standards

IEC/UL switching

The device meets the requirements of UL2231 as well as IEC 61851-1. The respective response values are automatically set when selecting the standard to be applied.
The device is factory-set to UL2231. For this standard, bridging between pins on coding terminal **A** is not required.

To set the RCMB to IEC 61851-1, proceed as follows:

- Switch off the supply voltage of the RCMB613.
- Coding terminal **A**: bridge between pin 3 ("X1") and pin 4 ("X2").
- Push and hold the "CAL" button on the front with a pointed object.
- Switch on the supply voltage of the RCMB613.
- Release "CAL" button.

Comparison of requirements of each standard

Requirement	UL 2231	IEC 61851
Supply voltage U_S	DC 12 V	
Rated voltage U_n	250 V	
Response value $I_{\Delta n}$	rms 20 mA	DC 6 mA rms 30 mA
Measuring range $I_{\Delta\ (sinus)}$	100 mA	
Resolution	0.2 mA	
Frequency range	DC…2 kHz	
Number of measuring channels	1	
Shortest response time t_{an}	10 ms	20 ms
Rated current I_n	48 A	32 A
Operating temperature	–35…70°C	–25…70 °C
Switching capacity	DC 12 V/2 A	
Power consumption Us	< 1.5 W	
Two-pole voltage measurement Output of charging point	120…240 V	230 V
Contact monitoring (Weld Check)	120…240 V	230 V
Accessories	W15BS, W15BS-02, W15BS-03	

Tab. 7: Comparison of requirements of each standard

Checking set standard

The set standard can be checked by means of two different test currents. The following behaviour has to be observed:

	Test current AC 20 mA	Test current DC 6 mA
UL 2231	trip	no trip
IEC 61851	no trip	trip

Operation

DANGER

Risk of electric shock!
*The safety of life and limb is only ensured with correct functioning of the monitoring device. Therefore, **a device test must be made before every charging** (by the charge controller)!*
*During a **device test** it is **absolutely necessary** to ensure that **no residual current flows** through the measuring current transformers. The switching state of the load contactor K0 must be open during the test phase.*

Residual current measurement method

The residual current monitoring module measures both AC and DC currents.

Switching output S1

The switching output S1 is activated by the RCMB613 and controls an external switching element (e.g. load contactor K0). The switching output is triggered under the following conditions:

- When the response value $I_{\Delta n}$ is exceeded by a residual current; the AL output is activated in parallel.
- After performing the test function and the resulting response values have been exceeded.
- Device fault; the ERR output is activated in parallel. Device faults can be:
  - CT connection faults
  - Failure of the supply voltage
  - Values outside the permissible measuring range
  - Incorrect setting at the coding terminal
- Contact monitoring: Detecting welded contacts of the external switching element; the ERR output is activated in parallel.

Device test

The device test is initiated by activating a test sequence at the T/R input. During the device test, the device generates a test current. The level of the test current is designed so that when functioning correctly the threshold is exceeded, triggering the switching output.
In addition, the main contacts of the external switching element (load contactor K0) are checked for welding. The charge controller must activate the test sequence prior to each closing of the external load contactor.
See "Timing diagram TEST successful" on page 11.

Reset function

After disconnecting the charging voltage via the switching output S1/S2 connecting it again is only possible after a previous successful test/reset sequence or after switching off and on the supply voltage. The sequence is to be signalled to the RCMB613 via the T/R input. The number of restarts is therefore controlled by the charge controller.
See: "Timing diagram RESET sequence" on page 13.

StartUp sequence

While connecting the supply voltage, the device runs an internal sensor test with an open switching output S1/S2 (disconnected load contactor K0) without contact monitoring (Weld Check). If, contrary to expectations, the output relay is closed, the voltage detector signals this state to the charge controller. Signalling is done via the VL output.
See: "Timing diagram StartUp sequence" on page 10.

Contact monitoring (Weld Check)

Contact monitoring K0 has two poles. Checking the main contacts of the external load contactor for welding is done by measuring the relay output voltage. If a single contact does not open, this is detected: the RCMB613 disconnects the output relay. Outputs ERR and VL are activated in parallel.

Contact monitoring is only done during the functional test via the T/R input.

Voltage detector

The RCMB613 recognises if voltage has been applied to the output of the external load contactor K0. The voltage detector can be used both in a single-wire and in a two-wire voltage system.

EN function

The external switching element (load contactor K0) can be directly disconnected by the charge controller. After disconnecting via the EN input a functional test of the RCMB613 via the T/R input is required.
Via the EN output it is ensured that the external switching element is disconnected after the charging process.

Switching function Control Pilot ("CP")

An integrated relay (K1) enables switching off the Control Pilot. It is only switched off in the event of a system fault (welded contacts or device faults). A residual current that is too high (that exceeds the response value) does not lead to switching off the Control Pilot.

Hardware interface

The following digital signals for device status detection that are analysed by the charge controller are available at the output:

Signal at output	Meaning	Note
AL	? RCMB613 has triggered ? Device fault	If due to a device fault the AL output is not able to signal a triggering, the external load contactor K0 does not switch off. If due to a device fault the AL output is not able to switch on, the external load contactor K0 does not connect. Such a device fault is detected by the charge controller during the functional test. A service visit is necessary to remove the fault (possibly the device has to be exchanged).
EN	Activation signal of the load contactor via the charge controller	
T/R	Input for activation of a TEST or RESET sequence	The charge controller ensures that a functional test is initiated before each charging process.
ERR	? Status signal for indication of system faults (e.g. measurement technique fault, device fault, welded contacts, etc.) ? Control Pilot interrupted	In case of a device fault, the Control Pilot is interrupted (indication via ERR output) and S1/S2 switches the external load contactor K0 (indication via AL output). The charge controller checks the ERR output of the RCMB613 during each functional test.
VL	Status signal of the output voltage of the load contactor	Indicates whether the load voltage is applied to the output of the load contactor K0.

Tab. 8: Hardware interface signals

Troubleshooting

CAUTION

*Troubleshooting may only be carried out using **measuring and test equipment** that is **suitable** for the applied current and voltage range!*

Technical data

Timing diagrams

StartUp sequence

After connecting the supply voltage (A1, A2) the initialisation phase of the RCMB613 starts. During this phase, the device runs a self test. After approx. 300 ms the RCMB613 unblocks the switching output (AL output). The external load contactor K0 is connected by the charge controller via the EN output.

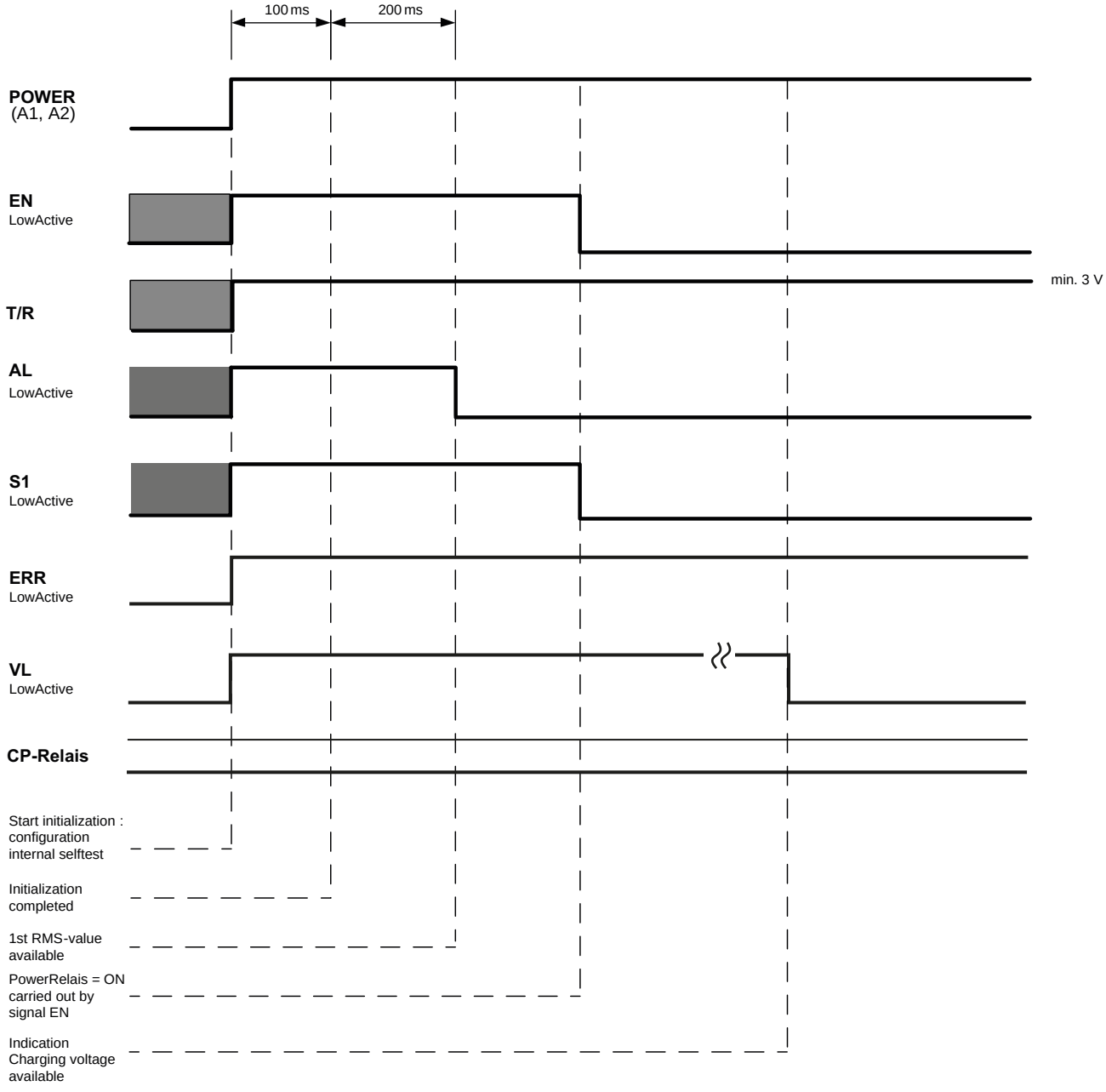


Fig. 4: Timing diagram StartUp sequence

TEST (Timing on T/R input)

The charge controller switches the T/R input for 30 ms…1.2 s to LOW. As soon as the T/R input changes back to HIGH, the RCMB613 starts the test by placing a simulated fault current on the test winding of the measuring current transformer for 1.4 s. Since this simulated fault current is higher than the response value, the external load contactor is disconnected via the switching output S1. The AL output signals a tripping in parallel. Afterwards, the RCMB613 checks the main contacts of the external load contactor (contact monitoring, Weld Check).

A failed functional test is signalled to the charge controller via the ERR output.

Timing diagram TEST successful

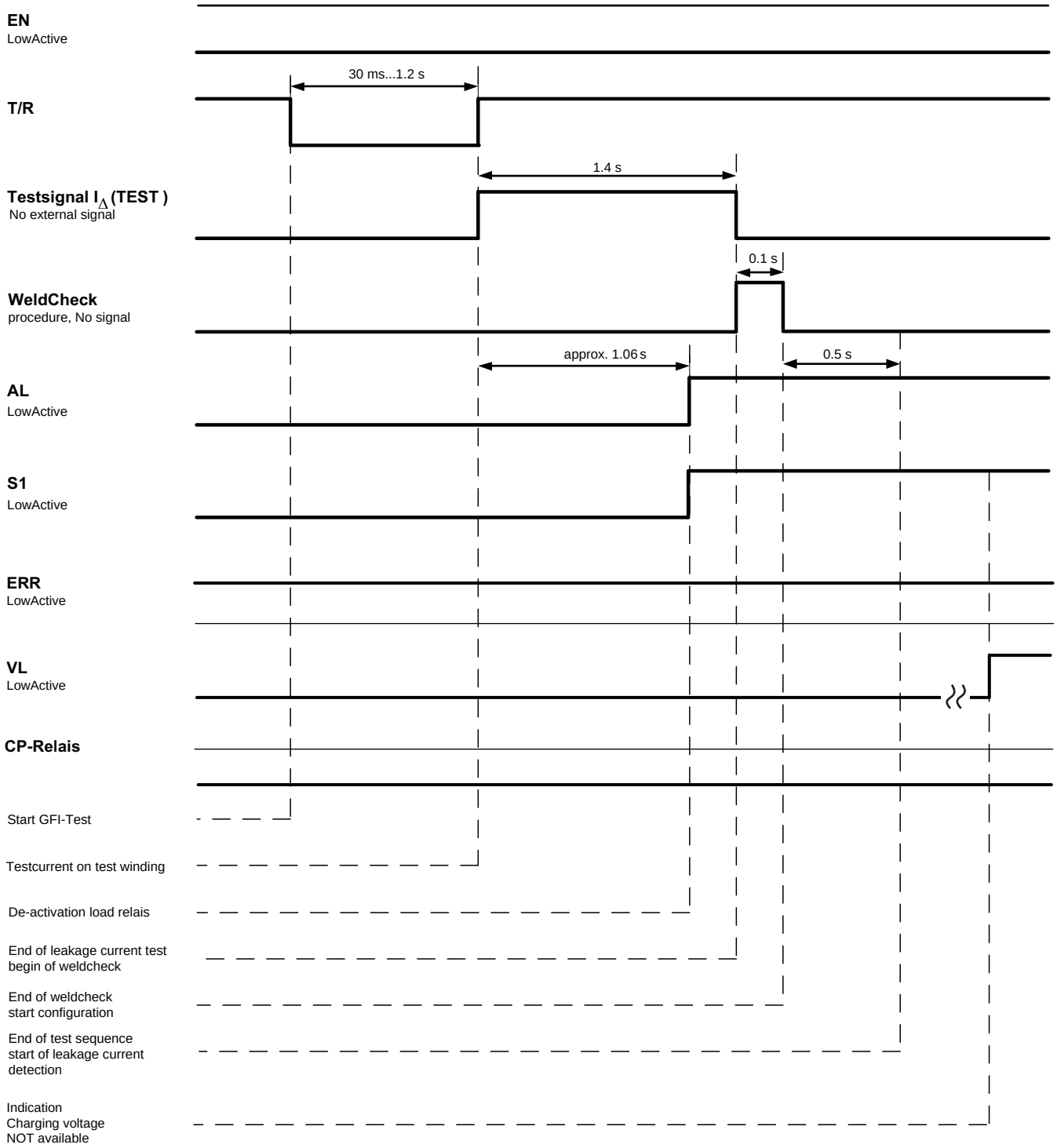


Fig. 5: Timing diagram TEST successful

In the event of a failed functional test (existing fault) the timing diagram looks as follows:

Timing diagram TEST failed

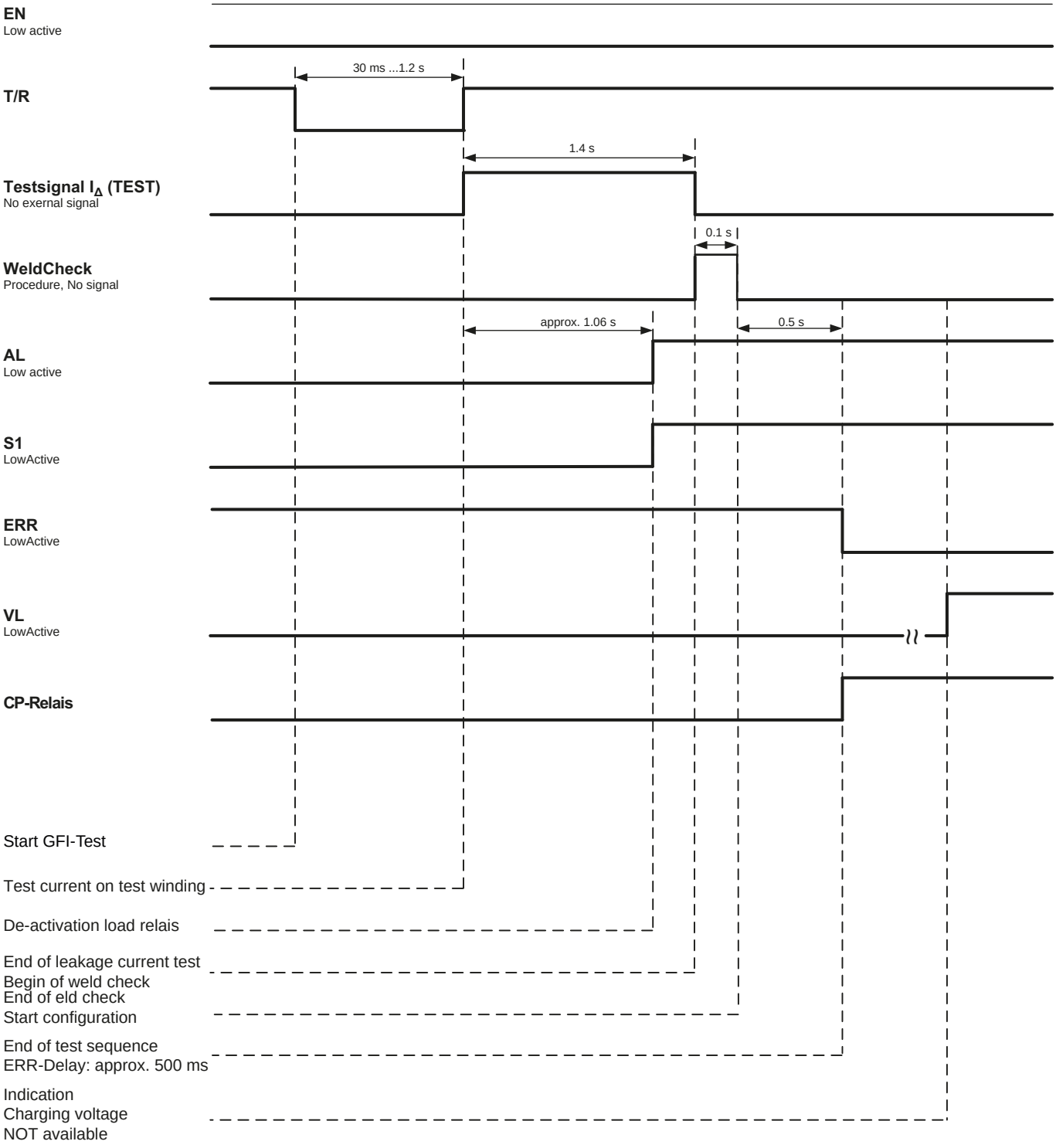


Fig. 6: Timing diagram TEST failed

RESET sequence

The RESET sequence can be initiated in two cases:

1. After disconnecting the external load contactor due to a fault current.
2. After running a functional test which has been initiated via the charge controller (T/R signal).

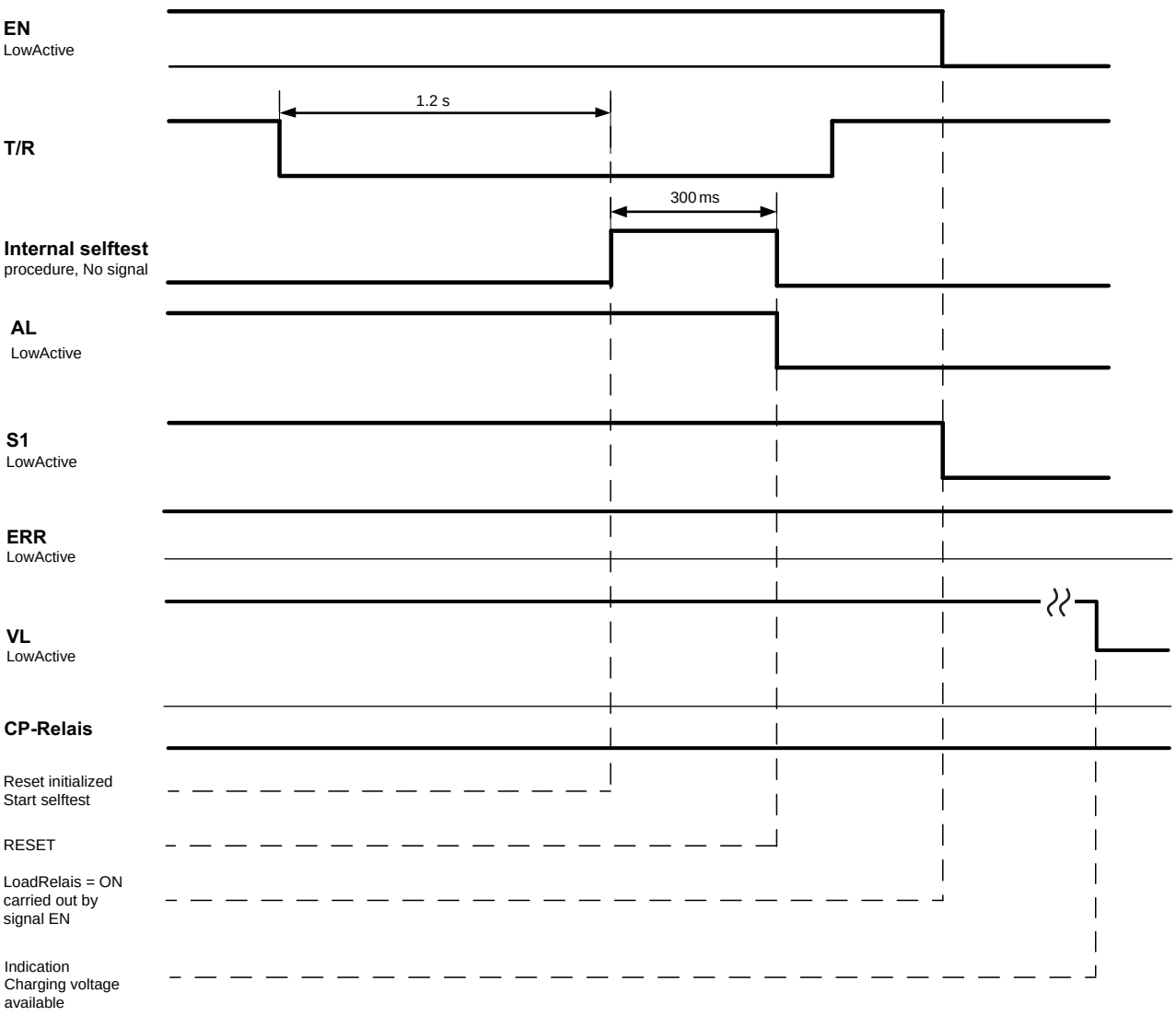


Fig. 7: Timing diagram RESET sequence

New charging process

After interrupting a charging process via the switching output S1 (EN = HIGH) the charge controller starts the TEST sequence. During this time, EN blocks the switching output S1, so that the external load contactor cannot be reconnected. Only after successfully completing a RESET sequence EN releases the switching output and a new charging process can be started.

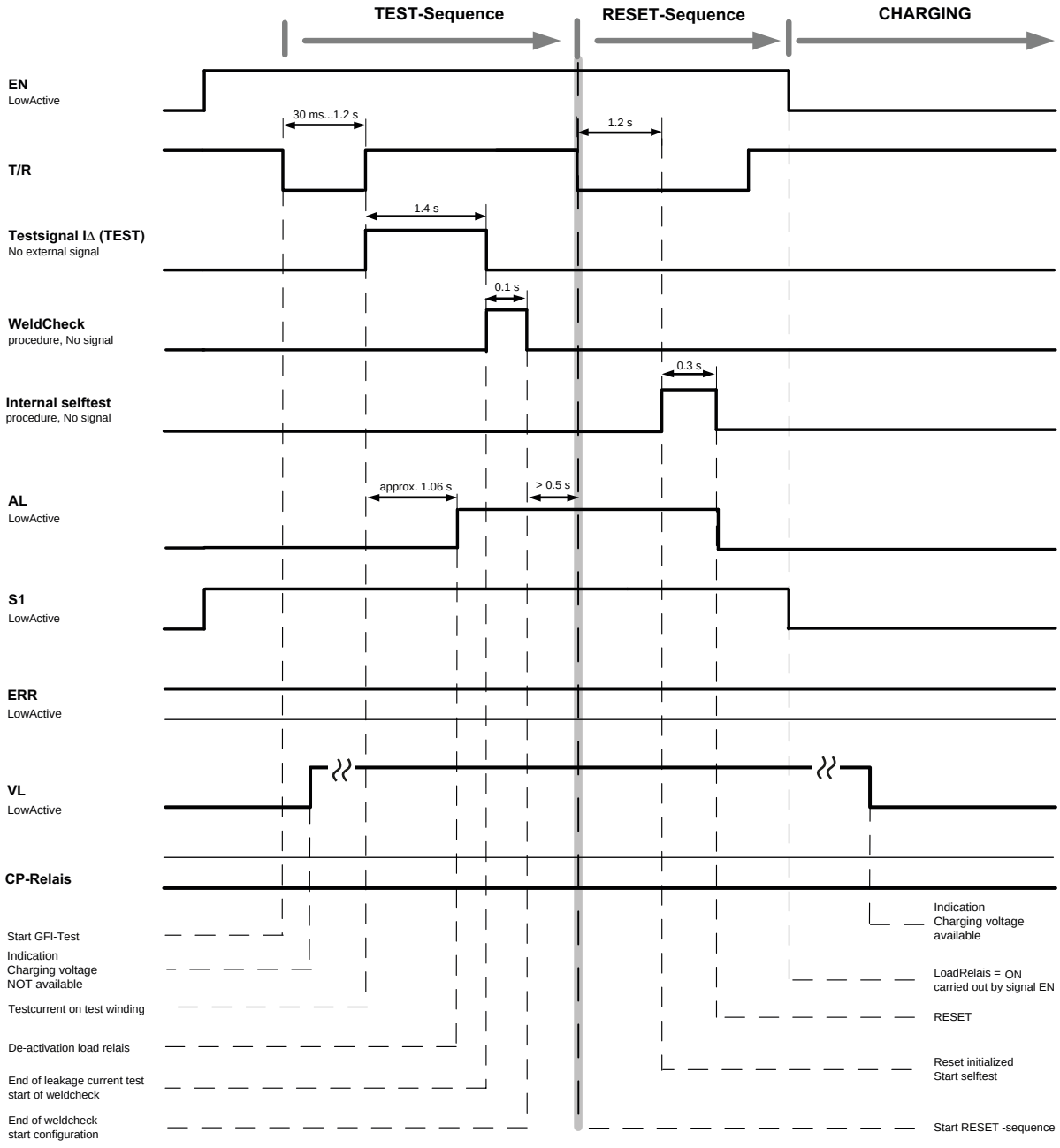


Fig. 8: Timing diagram new charging process

Standards

IEC 61851-1: Electrical equipment of electric vehicles – Electric vehicle conductive charging system – Part 1: General requirements (IEC 61851-1:2010); German version: EN 61851-1:2011
UL2231-1: Standard for safety: Personnel Protection Systems for Electric Vehicle (EV) Supply Circuits: General Requirements UL2231-1, ED 2012
UL2231-2: Standard for safety: Personnel Protection Systems for Electric Vehicle (EV) Supply Circuits: Particular Requirements for Protection Devices for Use in Charging Systems

Tabular data

Insulation coordination according to IEC 60664-1 contact monitoring/voltage detection

Rated insulation voltage ..... 250 V
Overvoltage category/pollution degree II/2
Rated impulse voltage ..... 4 kV
Dielectric strength ..... 3.5 kV/1 minute
Protective separation between the terminals ..... B-A, B-C, B-D, B-E, B-F
Range of use ..... ≤ 2000 m above sea level

Power supply

Nominal supply voltage U_s ..... DC 12 V
Supply voltage range ..... DC 11 . . . 13 V
Ripple ..... 120 mV pp
Power consumption ..... < 1.5 W

Residual current measuring range

Rated frequency ..... 0 . . . 2000 Hz
Measuring range ..... 100 mA
Nominal current single-phase ..... 48 A
Nominal current 3N AC ..... 32 A

Response values

UL2231

Residual current $I_{\Delta n}$ ..... 20 mA
Response range $I_{\Delta n}$ ..... DC . . . 500 Hz: 15 . . . 20 mA
..... 500 . . . 2000 Hz: 15 . . . 50 mA
Response time t_{an} DC ..... (40 x 1.414/$I_{\Delta n}$)^4 - 10 ms
Response time t_{an} AC, AC/DC ..... (20/$I_{\Delta n}$)^{1,43} - 10 ms
The max. tripping times are reduced by the operating time of the switching element of 10 ms to open the switching contacts.

IEC 61851-1

Residual current $I_{\Delta n1}$ ..... 6 mA
Residual current $I_{\Delta n2}$ ..... rms 30 mA
Response range $I_{\Delta n1}$ (DC 6 mA) ..... DC 4 . . . 6 mA
Response range $I_{\Delta n2}$ (rms 30 mA) ..... DC . . . 500 Hz: 24 . . . 30 mA
..... AC 500 . . . 2000 Hz: 25 . . . 50 mA
Response time t_{an1} for $I_{\Delta n1}$ (DC 6 mA) ..... 500 ms
Response time t_{an2} for $I_{\Delta n2}$ (rms 30 mA)
1 x $I_{\Delta n}$ ..... 200 ms
5 x $I_{\Delta n}$ ..... 20 ms

Contact monitoring (Weld check)

Nominal voltage ..... 120 . . . 240 V
Rated insulation voltage ..... 250 V
Leakage current ..... < 50 µA
Power consumption of the contact monitoring ..... < 1.0 W
Status signal **ERR**
Function ..... existing fault?
Fault ..... LOW signal
No fault ..... HIGH signal
Leakage current ..... < 0.5 mA

Voltage detector VL

Nominal voltage ..... 120 . . . 240 V
Rated insulation voltage ..... 250 V
Power consumption of the voltage detector ..... < 1.0 W
Status signal **VL**
Function ..... Charging voltage applied?
Charging voltage applied ..... LOW signal
Charging voltage not applied ..... HIGH signal
Leakage current ..... < 0.5 mA
Tripping time ..... < 5.0 s

Output load contactor control

Execution ..... Open Collector (Connector S1)
Switching capacity ..... permanent switching capacity: 12 V, 2 A
..... Short-time switching capacity: DC 12 V, 4 A
Characteristics ..... storing behaviour
Status signal ..... AL

Switching device Control Pilot

Execution ..... relay 1 x changeover contact
Insulation (functional insulation) ..... 500 V
Switching capacity ..... AC/DC 24 V, 100 mA

Control inputs

Execution ..... LOW: activated state
..... HIGH: deactivated state
Switching thresholds ..... HIGH: < 13 V
..... LOW: < 0.5 V
Loading capacity U_{in}(max) ..... DC 12 V
Input current ..... DC 10 mA
Non-operating state ..... HIGH (input not activated)

Control outputs

Execution ..... OpenCollector or contact
Voltage drop ..... < 1 V under load conditions with 10 mA
Loading capacity ..... DC 12 V, 25 mA
Leakage current ..... < 50 µA

Display and operation

LED ..... green: ON
..... red: alarm
Device-internal button ..... switching between IEC/UL2231*

Environment/EMC

Setting UL2231
Immunity UL2231-2
Interference emission UL2231-2
Setting IEC61851
Immunity ..... IEC 61000-6-1
Interference emission ..... IEC 61000-6-3
Operating temperature ..... –35 . . . +70 °C

Classification of climatic conditions acc. to IEC 60721

Stationary use (IEC 60721-3-3) 3K5
Transport (IEC 60721-3-2) 2K3
Long-term storage (IEC 60271-3-1) 1K4

Classification of mechanical conditions acc. to IEC 60271

Stationary use (IEC 60721-3-3) 3M4
Transport (IEC 60721-3-2) 2M2
Long-term storage (IEC 60271-3-1) 1M3

Connection

Connection type ..... plug-in connector, screw-type terminals
Connection capacity
Rigid /flexible ..... 0.2 . . . 2.5 mm² (AWG 24 . . . 14)
Flexible with ferrule without plastic sleeve ..... 0.25 . . . 2.5 mm² (AWG 24 . . . 14)
Flexible with ferrule with plastic sleeve ..... 0.25 . . . 1.5 mm² (AWG 24 . . . 16)

Limit conditions load contactor K0

Coil voltage ..... DC 12 V
Coil current ..... continuous current < 2 A
Inrush current ..... < 4 A (under worst-case conditions)
Contact opening time ..... < 10 ms (under worst-case conditions)
Overvoltage protection ..... flyback diodes on the coil (see wiring diagram)

Other

Operating mode ..... continuous operation
Service life ..... 10 years at 40 °C
Degree of protection, enclosure ..... IP 30
Degree of protection, terminals ..... IP 20
DIN rail mounting ..... IEC 60715

* = Factory settings

Ordering details

Type	Property	Art. No.
Residual current monitor RCMB613	DC 12 V	B 9404 2461
Transformer W15BS	Diameter 15 mm Connector length 1500 mm	B 9808 0065
Transformer W15BS-02	Diameter 15 mm Connector length 180 mm	B 9808 0067
Transformer W15BS-03	Diameter 15 mm Connector length 250 mm	B 9808 0068

Photos: Bender archives

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