# AC/DC sensitive residual current monitoring module RCMB121-...

for safe charging of electrical vehicles according to IEC 62752 for IC-CPD and UL 2231 for Wall Boxes


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VAC BENDER

# AC/DC sensitive residual current monitoring module RCMB121-...

**for safe charging of electrical vehicles according to IEC 62752 for IC-CPD and UL 2231 for Wall Boxes**


RCMB121-2

## Features

- IEC 62752 and UL 2231 version available
- Frequency range DC to 2 kHz
- Full load current up to 80 A r.m.s. (1-phase) or 3 x 32 A r.m.s. (3-phase)
- Switching output for DC 6 mA/30 mA r.m.s., 5 mA r.m.s./20 mA r.m.s. or DC 6 mA/ 20 mA r.m.s.
- Error output (Integrated self-monitoring and test functions)
- Measurement resolution 0.2 mA
- Variants with feed through opening or with integrated primary conductors
- Residual current range 0…300 mA
- Robust mechanical design suitable for IC-CPD environmental requirements (e. g. drop test)
- Widely usable in harsh electronic environments (e.g. resistant to external fields)
- Total system cost significantly reduced compared to RCD type B

## Certifications

CE cULus LISTED

## Applications and Advantages

To satisfy new standards including IEC 62752 and UL 2231, the charging of electrical vehicles requires residual current sensors to avoid hazardous situations in cases where the vehicle battery (DC) is connected to the home power supply (AC). Generally, AC/DC-sensitive residual current sensors can be used where direct current and alternating current circuits are directly connected and therefore AC/DC leakage currents can occur.

Typically type A residual current circuit breakers (RCCBs) are installed in private households. However, these RCCBs are to identify and deactivate DC fault currents. In order to charge an electric vehicle (EV) from a home power supply, a costly type B RCCB would be required to guarantee safety in the event of a DC fault current.

By using a VAC/Bender DI sensor integrated into an IC-CPD or wall box, customers can save the high costs of installing a type B RCCB to provide all-current sensitivity and electrical safety at low cost.

A single DI sensor simultaneously monitors all currents in phases and neutral conductors sensing AC/DC fault currents. The sensors can activate automatic shut-off in the event of hazardous electrical faults. As the residual currents to be monitored only occur in the event of electrical faults and are extremely low (mA), maximum measurement precision is critical. In addition, a fast response time is required to maintain safety features.

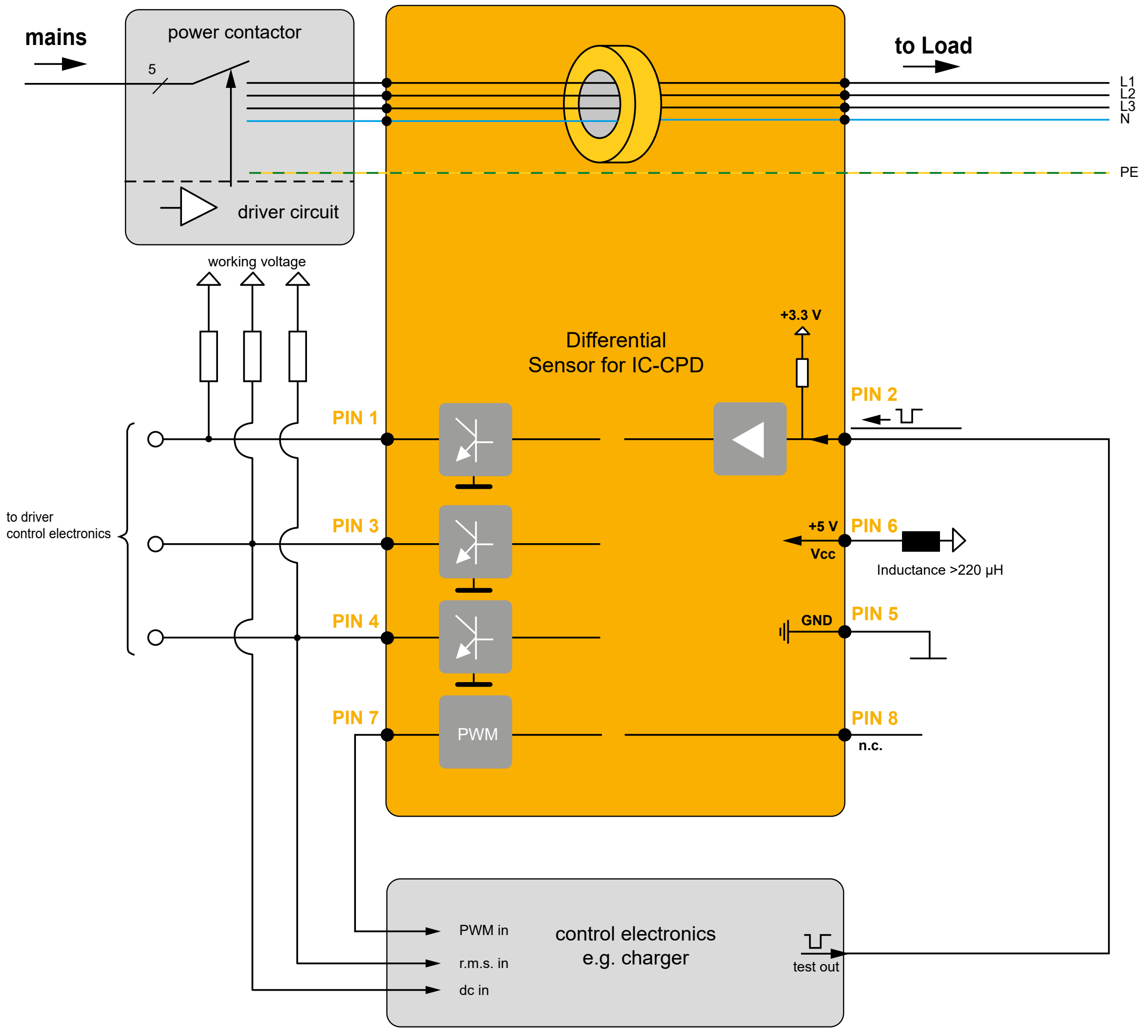
## Standards

Constructed and manufactured and tested in accordance with IEC 61800-5-1, IEC 62752 (In-Cable Control and Protection Device for mode 2 charging of electric road vehicles (IC-CPD)) and UL 2231 (Personnel protection systems for electric vehicle (EV) supply circuits).

## Ordering Information

| Version | Type VAC | Type Bender | Art. No. |
|---|---|---|---|
| AC 30 mA/DC 6 mA | T60404-N4641-X900 | RCMB121-1 | B94042490 |
| 5 mA r.m.s./20 mA r.m.s. | T60404-N4641-X901 | RCMB121-2 | B94042491 |

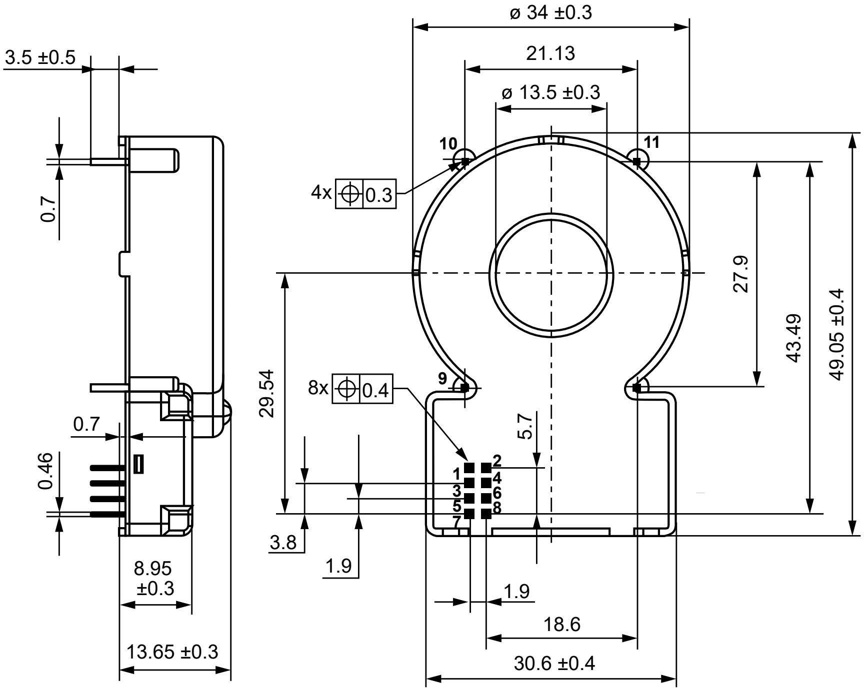
**Schematic output diagram:**



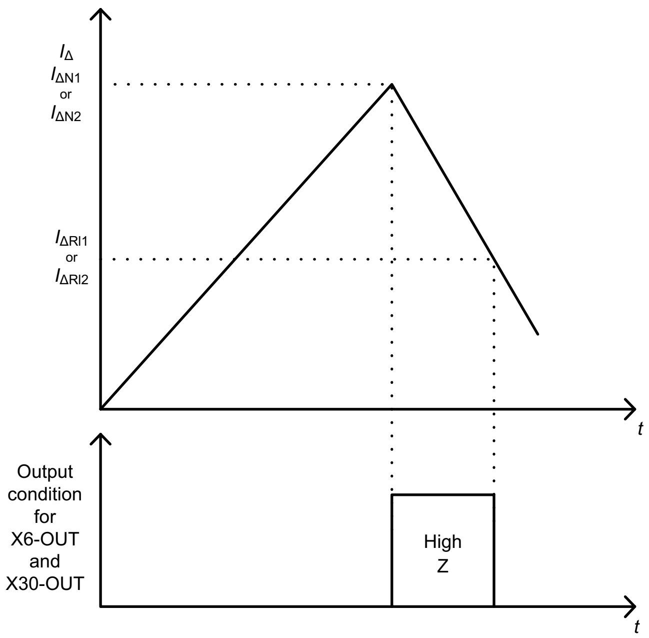

| | |
|---|---|
| PIN 1 - **ERROR-OUT** **(open collector output)** | If no system fault is detected, the output PIN 1 is a low level (GND). If a system fault is detected, PIN 1 is high impedance. In this case, PINs 3 and 4 will be set to a high impedance state. |
| PIN 2 - **TEST-IN** | A function test including an offset measurement (this value is stored in EEPROM for further calculation) is activated if this PIN is connected to GND for a period of 30 ms to 1.2 s. If the PIN is set to GND less than 30 ms or more than 1.2 s, no function test will be performed.<br>**Attention:** During the functional test and offset measurement, no differential current may flow.<br>To ensure high accuracy of the sensor this test should be activated at regular intervals (e.g. at startup, before measuring…). |
| PIN 3 - **X6-OUT** **(open collector output)** | If a push-pull switch is used, the voltage range must be 0…5 V.<br>If the residual current is below DC 6 mA and no system fault occurs the output on PIN 3 is a low level (GND). In any other case output PIN 3 is in a high impedance state. If PIN 4 is high impedance, PIN 3 will also be set to high impedance. |
| PIN 4 - **X30-OUT** **(open collector output)** | If the residual current is below the 30 mA r.m.s. and no system fault occurs the output on PIN 4 is a low level (GND). In any other case PINs 3 and 4 is in a high impedance state. |
| PIN 5 - **GND** | Ground connection |
| PIN 6 - **VCC** | Positive supply voltage |
| PIN 7 - **PWM-OUT** | Acc. to the DC component of residual current a duty-cycle with $f = 8$ kHz is generated. This is for monitoring purposes only and is not safety function!<br>Refer to $S_{PWM\text{-}OUT} = 3.33$ %/mA |
| PIN 8 - **n.c.** | Not connected |

## Dimension diagram

Dimensions in mm



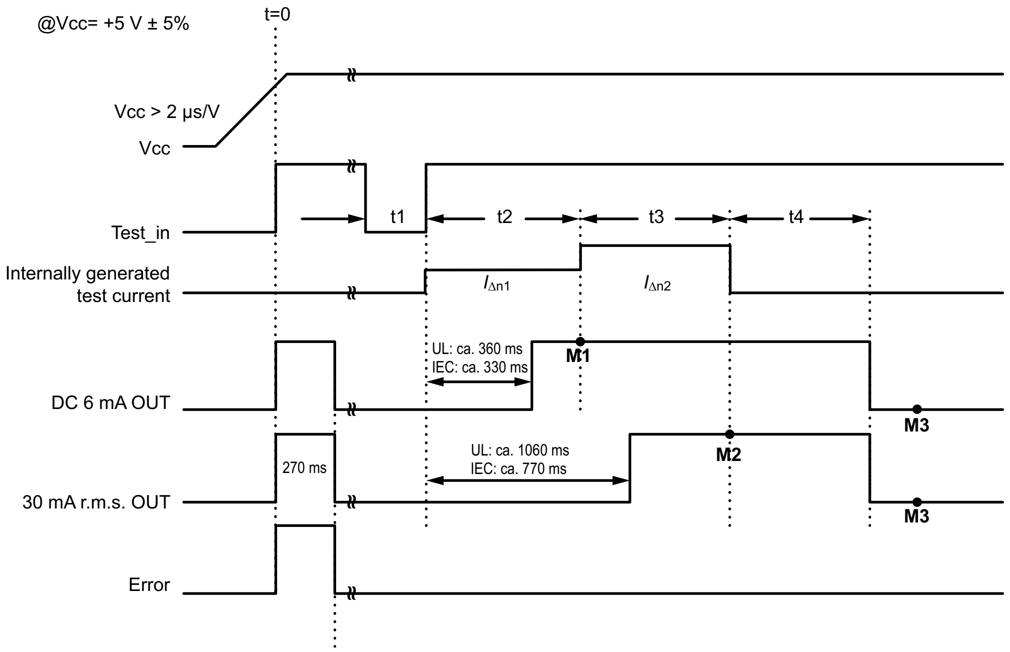

## Meaning of switching recovery level




If the trip-level $I_{\Delta N1}/I_{\Delta N2}$ is accomplished the output X6-OUT/X30-OUT will change it state from low-level (GND) to high impedance.

Depending on the existence of the diffential current $I_{\Delta}$, the outputs X6-OUT/X30-OUT will remain in this state until $I_{\Delta}$ fell below threshold $I_{\Delta RI1}/I_{\Delta RI2}$.

## Power-Up timing diagram




t1 = > 40 ms < 1,2 s
t2 = 700 ms
t3 = 700 ms
t4 = 600 ms

After activating the test sequence, the end product has to monitor the correct state of the switching outputs being used at the following points in time:

M1: check that DC 6 mA OUT is disable (latest time)

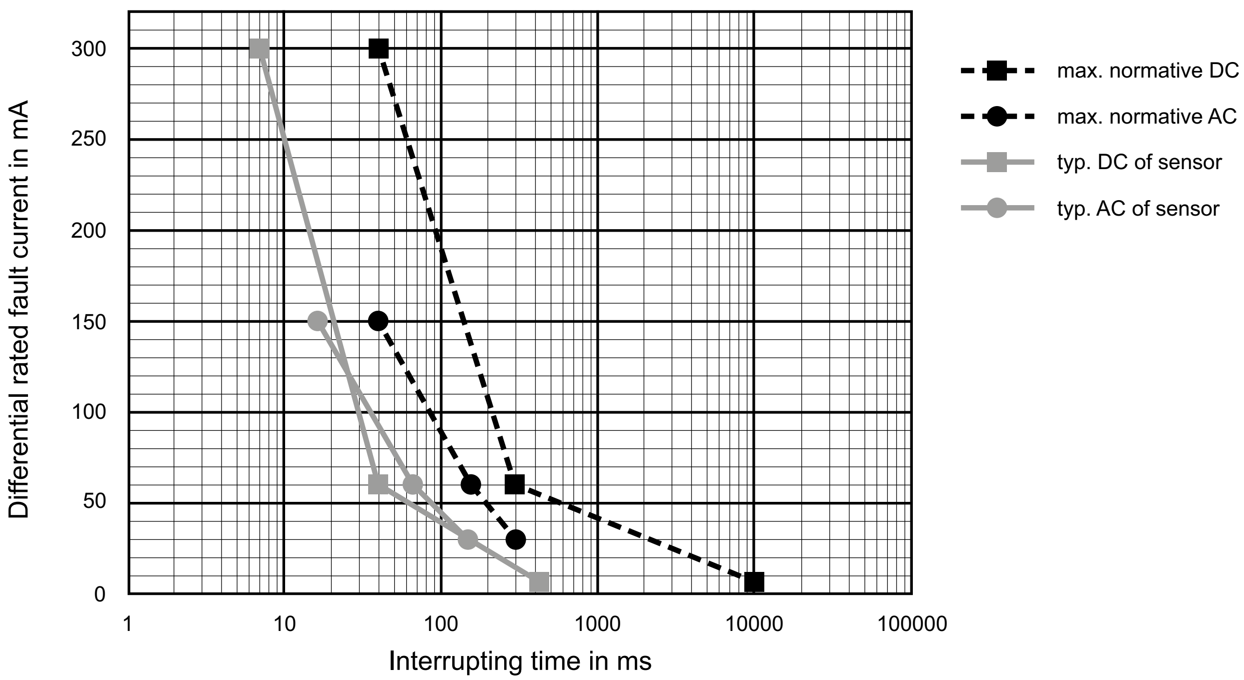
M2: check that 30 mA r.m.s. OUT is disabled

M3: check that 30 mA r.m.s. OUT resp. DC 6 mA out is enabled

Test currents generated during functional test

| Standard | $I_{\Delta n1}$ | $I_{\Delta n2}$ |
|---|---|---|
| IEC 62752 | DC 8.8 mA | DC 55.5 mA |
| UL 2231 | 8.6 mA r.m.s. | 8.0 mA r.m.s. |

## Interrupting Time according to IEC62752 (E)-1:2016 Table 2 + 3 and typical values of sensor



## Technical Data

### Insulation coordination

| | |
|---|---|
| Definitions: | |
| Measuring circuit (primary circuit) (IC1) | 3NAC 230/400 V |
| Supply circuit (IC2) | Pin 5 (GND), Pin 6 (Vcc) |
| Output circuit (IC3) | Pin 1 (Err), Pin 3 (X6), Pin 4 (X30), Pin 7 (PWM) |
| Input circuit (IC4) | Pin 2 (Test) |
| Rated voltage | 300 V |
| Overvoltage category | II |
| Rated impulse voltage | 2,5 kV + altitude factor = 3,225 kV |
| Rated insulation voltage | 250 V |
| Pollution degree | 2 |
| Altitude | ≤ 4000 m |
| Basic insulation, blank conductor IC1/(IC2…IC4) | 250V |
| Reinforced insulation, isolated conductors IC1/(IC2…IC4) | 250V |

### Electrical data – Ratings

| | | |
|---|---|---|
| $I_P$ | Primary nominal r.m.s. current (1 phase/3 phase) | 80/40 A |
| $I_{\Delta N1}$ | Rated residual operating current 1 | DC 5 mA r.m.s. |
| $I_{\Delta N2}$ | Rated residual operating current 2 | 20 mA r.m.s. |
| $I_{\Delta N1, tolerance}$ | Trip tolerance 1 | DC 4…6[1]/12[2] mA r.m.s. |
| $I_{\Delta N2, tolerance}$ | Trip tolerance 2 | 15…20[1]/70[2] mA r.m.s. |
| $S_{PWM\text{-}OUT}$ | Scaling factor of the DC component $I_{\Delta N1}$ **(for monitoring purpose only!)** | 2 %/mA |
| $I_{\Delta RI,1/2}$ | Recovery current level for $I_{\Delta N1}/I_{\Delta N2}$ (absolute value DC/r.m.s.) | 2.5/10 mA |

### Accuracy – Dynamic performance data

| | | |
|---|---|---|
| $I_{\Delta N,max}$ | Max. measuring range (peak) | -300…+300 mA |
| X | Resolution (@ $I_{\Delta N}$, $\Theta_A = 25$ °C) | < 0.2 mA |
| $t_r$ | Response time | $< (20/I_{\Delta})^{1,43}$…10 ms (According to UL2231-2 Ed. 2) |
| $f_{BW}$ | Frequency range | DC 2 kHz |

### General data

| | | |
|---|---|---|
| $\vartheta_A$ | Ambient operation temperature | -40…85 °C |
| $\vartheta_{Storage}$ | Ambient storage temperature[3] | -40…85 °C |
| m | Mass | 21 g |
| $V_{CC}$ | Supply voltage | 4.8…5.2 V |
| $S_{clear}$ | Clearance | not applicable if isolated cable is used[4] |
| $S_{creep}$ | Creepage | not applicable if isolated cable is used[4] |
| FIT | EN/IEC 61709 / SN 29500[5] (MIL-HDBK-217F)[5] | 1529 fit (6349 fit) |

### Absolute maximum Ratings[6]:

| | | |
|---|---|---|
| $V_{CE}$ | Collector-Emitter voltage (PINs 1, 3 and 4) | 40 V |
| $I_C$ | Collector current (PINs 1, 3 and 4) | 50 mA |
| $V_{CC}$ | Maximum supply voltage (without function) | -0.3…7 V |
| $U_{MAX}$ | Maximum rated voltage of primary conductors | 250 V |
| $V_{TEST\text{-}IN, low}$ | TEST-IN Input Voltage, low level | 0…0.6 V |
| $V_{TEST\text{-}IN, high}$ | TEST-IN Input Voltage, high level | 2.5…5 V |

(1) $f$ = DC to 1kHz

(2) $f$ = 1kHz to 2kHz

(3) see VAC M-sheet 3101; storage temperature inside cardboard packaging

(4) Isolated wires are preferred. If isolated primary conductors are used, the isolation coordination is according to: Reinforced insulation, Insulation material group 1, Pollution degree 2, Sea-Level ≤ 4000m and overvoltage category II.

(5) The results are valid under following conditions: 55 °C mean component ambient temperature by continuous operation (8760 h per year); Environment condition: ground mobile, no dust or harmful substances, according to IEC61709; Fit equals one failure per 10^9 component hours.

(6) Stresses above these ratings may cause permanent damage.
Exposure to these conditions for extended periods may degrade device reliability.
Functional operation of the device at these or any other conditions beyond those specified is not supported.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The Power in Electrical Safety©

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