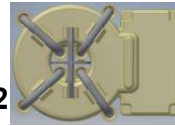


**Differential Current Sensor with tripping characteristic acc. to the partly combined standards IEC62955:2018 and UL2231-2 Ed.2**



Date: 03.12.2024

K-No.: 30578

Customer: Standard type

Page 1 of 7

### Description

- Fluxgate current sensor with toroidal core
- PCB mounting

### Characteristics

- Excellent accuracy
- Switching open-collector outputs
- Compact design

### Applications

- Mainly used for stationary applications:
- Wallbox
  - Personnel Protection Systems for EV acc. to UL2231

Patents: EP2571128 / US9397494 / CN103001175 // EP2813856

### Electrical data – Ratings

|                              |   | min. | typ.     | max.                                  | Unit   |
|------------------------------|---|------|----------|---------------------------------------|--------|
| $I_P$                        | Primary nominal RMS current (1phase / 3phase)   |      | 32       | 40                                    | A      |
| $I_{\Delta N1}$              | Rated residual fault current 1  |      | 6        |                                       | mA DC  |
| $I_{\Delta N2}$              | Rated residual fault current 2  |      | 20       |                                       | mA rms |
| $I_{\Delta N1, tolerance}$   | Trip tolerance 1 (PIN X6-OUT)   | 4    | 5        | 6                                     | mA DC  |
| $I_{\Delta N2, tolerance}$   | Trip tolerance 2 (PIN X20-OUT)  | 15   |          | 20 <sup>(1)</sup> / 70 <sup>(2)</sup> | mA rms |
| SPWM-OUT                     | Scaling factor of the DC component $I_{\Delta N1}$<br><b>(for monitoring purpose only!)</b> |      | 3.33     |                                       | %/mA   |
| $I_{\Delta RI, 1/2}$ (Fig.1) | Recovery current level for $I_{\Delta N1}/I_{\Delta N2}$<br>(absolute value DC/rms)         |      | 2.5 / 10 |                                       | mA     |

(1) f = rated frequency (2) f = 2kHz

### Accuracy – Dynamic performance data

|                     |  |      |       |      |   |
|---------------------|--|------|-------|------|---|
| $I_{\Delta N, max}$ | Measuring range (peak)                                   | -300 |       | +300 | mA  |
| X                   | Resolution (@ $I_{\Delta N}$ , $\Theta_A = 25^\circ C$ ) |      | < 0.2 |      | mA  |
| $t_r$               | Response times   |      |       |      | According to IEC62955:2018 <sup>(3)</sup><br>According to UL2231-2 Ed.2 |
| $f_{BW}$ (Fig.4)    | Frequency range  | DC   |       | 2    | kHz   |

### General data

|                       |   |     |       |        |        |
|-----------------------|---|-----|-------|--------|--------|
| $\vartheta_A$         | Ambient operation temperature                   | -40 |       | 85     | °C     |
| $\vartheta_{Storage}$ | Ambient storage temperature <sup>(4)</sup>      | -40 |       | 85     | °C     |
| m                     | Mass  |     | 32    |        | g      |
| $V_{CC}$              | Supply voltage                                  | 4.8 | 5     | 5.2    | V      |
| $I_{CC}$              | Supply current                                  |     | 33    |        | mA rms |
| $S_{clear, pp}$       | Clearance (primary to primary) <sup>(5)</sup>   |     |       | 4.22mm |        |
| $S_{creep, pp}$       | Creepage (primary to primary) <sup>(5)</sup>    |     |       | 5.65mm |        |
| $S_{clear, ps}$       | Clearance (primary to secondary) <sup>(6)</sup> |     |       | 6.53mm |        |
| $S_{creep, ps}$       | Creepage (primary to secondary) <sup>(6)</sup>  |     |       | 7.75mm |        |
| FIT                   | EN/IEC 61709 / SN 29500 <sup>(7)</sup>          |     | <2200 |        | fit    |

<sup>(3)</sup> Switching time of a standard relay (t = 20ms) is considered.

<sup>(4)</sup> see VAC M-sheet 3101; storage temperature inside cardboard packaging.

<sup>(5)</sup> Can only be achieved with the isolator; all values acc. to applied standards.

<sup>(6)</sup> Designed, manufactured and tested in accordance with IEC60664-1:2020. The isolation coordination is according to: Reinforced insulation, Insulation material group 1, Pollution degree 2, altitude ≤ 5500m and overvoltage category III.

<sup>(7)</sup> The results are valid under following conditions: 55°C mean component ambient temperature by continuous operation (8760h per year); Environment condition: ground mobile, no dust or harmful substances, according to IEC61709; Fit equals one failure per 10<sup>9</sup> component hours.

### General description of sensor function:

The Sensor is sensitive to AC and DC current and can be used for fault current detection in wallbox applications or personnel protection systems for EV. The Sensor detects DC fault current according to IEC62955:2018 and AC fault currents according to UL2231-2 Ed.2 In the event of a DC fault current, PIN 3 will change its state from a low level (GND) to high impedance state. In the event of an AC fault current, PIN 4 will change state from a low level (GND) to a high impedance state, see tab.1. Error conditions (e.g. an internal error) are signaled on PIN 1 (ERROR-OUT).

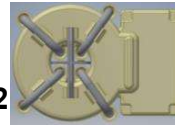
The sensor only fulfills the switch-off characteristic of the IEC62955 standard (monitoring the residual current). An additional driver-circuit must be used for driving RCBO, RCCB or circuit breaker as defined in IEC62955. The sensor's outputs are limited to max. 40V/50mA!

| Datum      | Name | Index | Änderung  |
|------------|------|-------|---|
| 03.12.2024 | SF   | 83    | Update of firmware and UL-Logo added to marking CN-24-66 / CN-24-67 |
| 11.12.2023 | MB   | 82    | Update of firmware. CN23-057  |

|                   |              |           |                 |
|-------------------|--------------|-----------|-----------------|
| Editor.: MC-PD-CS | Designer: SF | MC-PM: BZ | Released by: SB |
|-------------------|--------------|-----------|-----------------|



**Differential Current Sensor with tripping characteristic acc. to the partly combined standards IEC62955:2018 and UL2231-2 Ed.2**



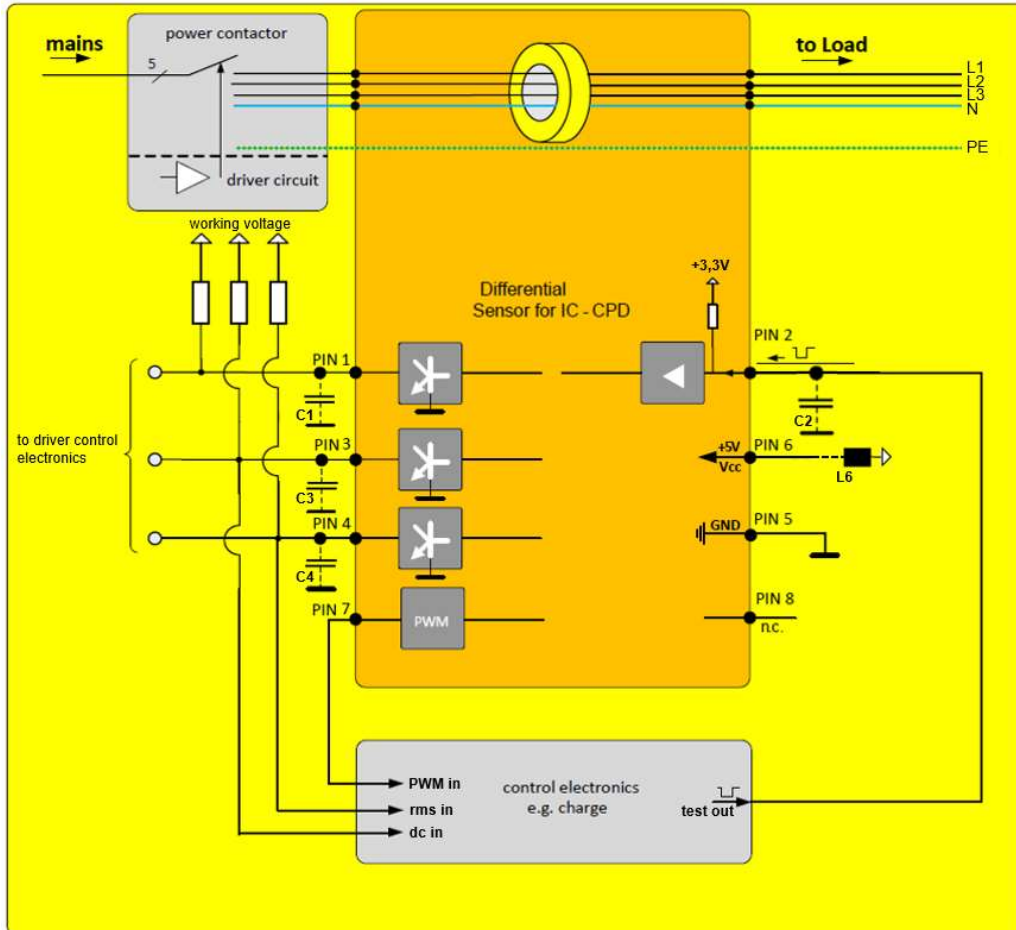
Date: 03.12.2024

K-No.: 30578

Customer: Standard type

Page 3 of 7

**Typical application diagram:**



Recommended: C1, C3, C4 with 100nF to ground and C2 with 10nF to ground as optional EMC improvement. (Components have to be placed close to the device pins)

L6 is not longer recommended for new designs, in existing layouts component L6 should be used with the following parameters:

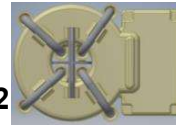
L6: Inductance  $\leq 220 \mu\text{H}$ ; DC Resistance 1 to 5  $\Omega$

**Absolute maximum ratings<sup>(8)</sup>:**

|                     |   | Min  | Typ. | Max | Unit |
|---------------------|---|------|------|-----|------|
| $V_{CE}$            | 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 |      | 6   | V    |
| $U_{MAX}$           | Maximum rated voltage of primary conductors |      |      | 440 | V    |
| $V_{TEST-IN, high}$ | TEST-IN Input Voltage, high level           | 0    |      | 0.6 | V    |
| $V_{TEST-IN, low}$  | TEST-IN Input Voltage, low level            | 2.5  |      | 5   | V    |

<sup>(8)</sup> 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.

**Differential Current Sensor with tripping characteristic acc. to the partly combined standards IEC62955:2018 and UL2231-2 Ed.2**



Date: 03.12.2024

K-No.: 30578

Customer: Standard type

Page 4 of 7

**Final Tests:** (Measurements after temperature balance of the samples at room temperature, SC=significant characteristic)

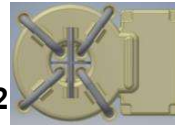
|                       |   | Min. | Max. | Unit |
|-----------------------|---|------|------|------|
| Vcc                   | Supply voltage                                  | 4.9  | 5.1  | V    |
| Icc                   | Supply current                                  | 16   | 28   | mA   |
| TEST-IN               | TEST-IN voltage                                 | 2.8  | 3.4  | V    |
| X6-OUT (normal)       | X6-OUT voltage                                  | 0    | 0.6  | V    |
| X20-OUT (normal)      | X20-OUT voltage                                 | 0    | 0.6  | V    |
| ERROR-OUT (normal)    | ERROR-OUT voltage                               | 0    | 0.6  | V    |
| X6-OUT (activated)    | X6-OUT voltage activated @5V, 1kΩ (pull-up)*    | 4.9  | 5.1  | V    |
| X20-OUT (activated)   | X20-OUT voltage activated @5V, 1kΩ (pull-up)*   | 4.9  | 5.1  | V    |
| ERROR-OUT (activated) | ERROR-OUT voltage activated @5V, 1kΩ (pull-up)* | 4.9  | 5.1  | V    |
| TC1 (SC)              | Trip current 1 – X6                             | 4.5  | 5.4  | mA   |
| TC2 (SC)              | Trip current 2 – X6                             | -5.4 | -4.5 | mA   |
| TC3 (SC)              | Trip current 3 – X20@60Hz                       | 14   | 20   | mA   |
| PWM-OUT (frequency)   | PWM-OUT frequency                               | 7.8  | 8.2  | kHz  |
| PWM-OUT (duty-cycle)  | PWM-OUT duty-cycle @6mA DC                      | 18   | 22   | %    |
| LV1 (SC)              | Limit values of break time - X6-OUT@6mA DC      | 0    | 700  | ms   |
| LV2 (SC)              | Limit values of break time – X20-OUT@20mA, 60Hz | 0    | 1000 | ms   |
| NTC1                  | X6-OUT & X30-OUT@50mA,50Hz                      | 0    | 0,6  | V    |

\* the maximum values of collector-emitter voltage and current see “Absolute maximum ratings”

**Product Tests:** The EMC product standards can only be fulfilled in the complete application system (more EMC test's can be shown if required).

|     |   |         |
|-----|---|---------|
|     | Acc. to VAC sheet M3238   | passed  |
|     | Following tests differ from M3238:  |         |
|     | 4.5a: Damp heat, steady state. Duration: 1000h  |         |
| ESD | Air- and contact discharge;<br>U=±2000V, R=1500Ω, C=100pF<br>Acc. to Human Body Model JESD22-A114 | ±2.0 kV |

**Differential Current Sensor with tripping characteristic acc. to the partly combined standards IEC62955:2018 and UL2231-2 Ed.2**



Date: 03.12.2024

K-No.: 30578

Customer: Standard type

Page 5 of 7

**Requalification Tests:** (replicated every year, Precondition acc. to M3238)

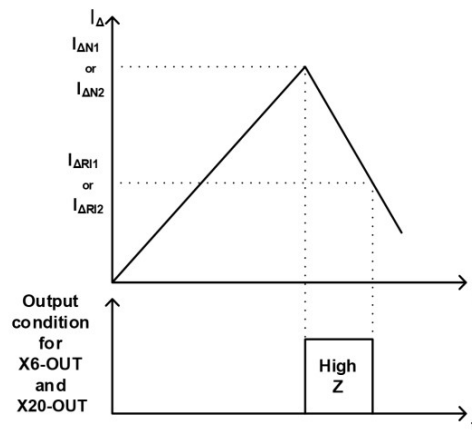
|                                 |       |   |     |        |
|---------------------------------|-------|---|-----|--------|
| $\hat{U}_{W, \text{prim-sec}}$  | M3064 | Impulse test (1.2 $\mu$ s/50 $\mu$ s waveform)<br>PIN 1-8 vs. PIN 9-14<br>5 pulse $\rightarrow$ polarity +, 5 pulse $\rightarrow$ polarity -  | 5.5 | kV rms |
| $\hat{U}_{W, \text{prim-prim}}$ | M3064 | Impulse test (1.2 $\mu$ s/50 $\mu$ s waveform)<br>PIN 9 vs. PIN 11, PIN 11 vs. PIN 13, PIN 13 vs. PIN 15,<br>PIN 15 vs. PIN 9<br>5 pulse $\rightarrow$ polarity +, 5 pulse $\rightarrow$ polarity - | 4.0 | kV rms |
| $U_d$                           | M3014 | Test voltage, 60s<br>PIN 1-8 vs. PIN 9-14   | 1.5 | kV rms |
| $U_{d, \text{prim-prim}}$       | M3014 | Test voltage between primary conductors, 5s<br>PIN 9 vs. PIN 11, PIN 11 vs. PIN 13, PIN 13 vs. PIN 15,<br>PIN 15 vs. PIN 9  | 1.5 | kV rms |
| $U_{PDE}$                       | M3024 | Partial discharge voltage (extinction)<br>PIN 1-8 vs. GND<br>*acc. to table 24  | 1.2 | kV rms |
| $U_{PD} \times 1.875$           | M3024 | Partial discharge voltage (extinction)<br>PIN 1-8 vs. GND<br>*acc. to table 24  | 1.5 | kV rms |

\* IEC 61800-5-1:2007

**Other instructions:**

- Temperature of the primary conductor should not exceed 105°C.
- Vcc during Test-IN function test must be in rated range.
- Housing and bobbin material UL-listed, flammability class 94V-0.
- Fall- and rise-time of Vcc:  $t > 20\mu\text{s/V}$
- UL certification is still pending
- Further standards UL 2231 E-file No. 488116, category FFUQ2 / FFUQ8

**Figures:**



**Fig. 1: Meaning of switching recovery level**

If the trip-level  $I_{\Delta N1}/I_{\Delta N2}$  is accomplished the outputs X6-OUT/X20-OUT will change their state from low-level (GND) to high impedance. Depending on the existence of the residual current  $I_{\Delta}$ , the outputs X6-OUT/X20-OUT will remain in this state until  $I_{\Delta}$  falls below the threshold  $I_{\Delta R11}/I_{\Delta R12}$ .

**Differential Current Sensor with tripping characteristic acc. to the partly combined standards IEC62955:2018 and UL2231-2 Ed.2**

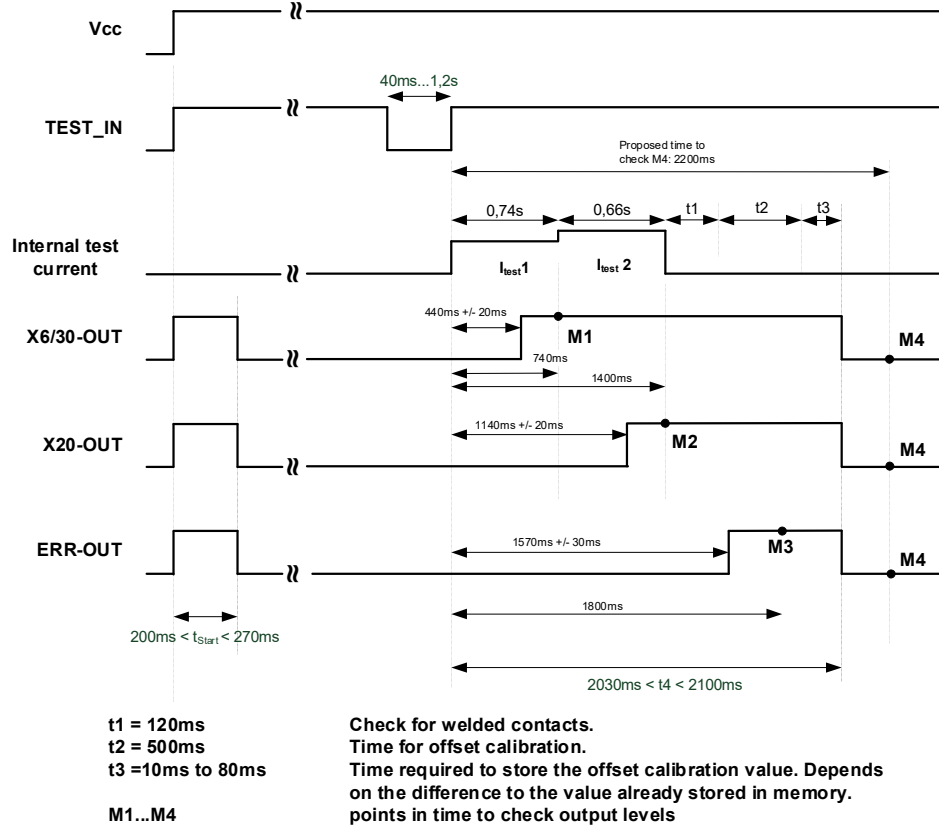


Date: 03.12.2024

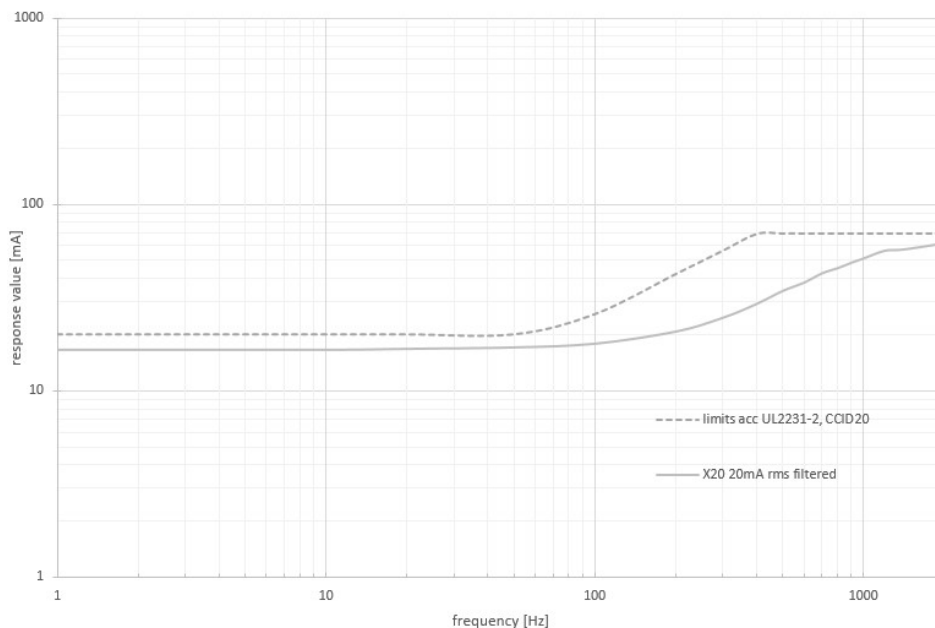
K-No.: 30578

Customer: Standard type

Page 6 of 7

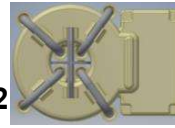


**Fig. 2: Power-Up timing diagram**



**Fig. 3: UL2231 response value over frequency**

**Differential Current Sensor with tripping characteristic acc. to the partly combined standards IEC62955:2018 and UL2231-2 Ed.2**



Date: 03.12.2024

K-No.: 30578

Customer: Standard type

Page 7 of 7

| X6-OUT         | X20-OUT        | ERROR-OUT      | State  |
|----------------|----------------|----------------|--|
| GND            | GND            | GND            | Normal condition   |
| High impedance | GND            | GND            | $I_{\Delta} \geq 6mA_{DC}$                                     |
| GND            | High impedance | GND            | $I_{\Delta N2} \geq 20mA_{rms}$                                |
| High impedance | High impedance | GND            | $I_{\Delta} \geq 6mA_{DC}$ AND $I_{\Delta N2} \geq 20mA_{rms}$ |
| High impedance | High impedance | High impedance | Error, system fault  |

All other conditions not mentioned in the table are not possible. If these conditions occur, the sensor is in unknown state and describes an Error.

**Table 1: Possible output states**

|                                       | 6mA   | 60mA  | 200mA  |
|---------------------------------------|-------|-------|--------|
| Standard values acc. to IEC62955:2018 | 10s   | 0.3s  | 0.1s   |
| Typical values of sensor              | 0.45s | 0.06s | 0.035s |

**Table 2: Maximum and typical values of break time for residual direct currents**