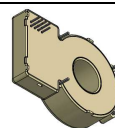


Differential Current Sensor for IC-CPD acc. to the standard IEC62752-2016



Date: 23.01.2020

K-No.: 26574

Customer: Standard type

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Description

- Fluxgate current sensor with toroidal core
- PCB mounting

Characteristics

- Excellent accuracy
- AEC-Q qualified components
- Switching open-collector outputs
- Compact design

Applications

- Mainly used for stationary and mobile applications:
- IC-CPD
 - Wallbox

Electrical data – Ratings

| | | min. | typ. | max. | Unit |
|------------------------------|---|------|----------|---------------------------------------|--------|
| I_P | Primary nominal RMS current (1phase / 3phase) | | | 80 / 40 | A |
| $I_{\Delta N1}$ | Rated residual operating current 1 | | 6 | | mA DC |
| $I_{\Delta N2}$ | Rated residual operating current 2 | | 30 | | mA rms |
| $I_{\Delta N1, tolerance}$ | Trip tolerance 1 | 4 | 5 | 6 | mA DC |
| $I_{\Delta N2, tolerance}$ | Trip tolerance 2 | 20 | | 30 ⁽¹⁾ / 60 ⁽²⁾ | mA rms |
| SPWM-OUT | Scaling factor of the DC component $I_{\Delta N1}$ (for monitoring purpose only!) | | 3.33 | | %/mA |
| $I_{\Delta RI, 1/2}$ (Fig.1) | Recovery current level for $I_{\Delta N1}/I_{\Delta N2}$ (absolute value DC/rms) | | 2.5 / 10 | | mA |

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

Accuracy – Dynamic performance data

| | | | | | |
|---------------------|--|------|---|------|-----|
| $I_{\Delta N, max}$ | Max. measuring range (peak) | -300 | | +300 | mA |
| X | Resolution (@ $I_{\Delta N}$, $\Theta_A = 25^\circ\text{C}$) | | < 0.2 | | mA |
| t_r (Fig.3) | Response time | | According to IEC62752:2016 ⁽³⁾ | | |
| f_{BW} (Fig.4) | Frequency range | DC | | 2 | kHz |

General data

| | | | | | |
|-----------------------|--|---|----------------|-----|-----|
| ϑ_A | Ambient operation temperature | -40 | | 85 | °C |
| $\vartheta_{Storage}$ | Ambient storage temperature ⁽⁴⁾ | -40 | | 85 | °C |
| m | Mass | | 21 | | g |
| V_{CC} | Supply voltage | 4.8 | 5 | 5.2 | V |
| I_{CC} | Consumption current | 38 | | 45 | mA |
| $S_{clear, ps}$ | Clearance (primary to secondary) | not applicable if isolated cable is used ⁽⁵⁾ | | | |
| $S_{creep, ps}$ | Creepage (primary to secondary) | not applicable if isolated cable is used ⁽⁵⁾ | | | |
| FIT | EN/IEC 61709 / SN 29500 ⁽⁶⁾ (MIL-HDBK-217F) ⁽⁶⁾ | | 1529 (6349) | | fit |

⁽³⁾ Switching time of a standard relay ($t = 20\text{ms}$) is considered.

⁽⁴⁾ see VAC M-sheet 3101; storage temperature inside cardboard packaging

⁽⁵⁾ Constructed, manufactured and tested in accordance with IEC60664-1:2007

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, altitude $\leq 4000\text{m}$ and overvoltage category II.

⁽⁶⁾ 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 10^9 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 IC-CPD applications. The Sensor detects AC and DC fault currents according to IEC62752:2016. In the event of a DC fault current, PIN 3 will change it's state from a low level (GND) to high impedance level. In event of an AC current fault, PINs 3 and 4 will change state from a low level (GND) to a high impedance level. Error conditions (e.g. an internal error) are signaled on PIN 1 (ERROR-OUT).

| Datum | Name | Index | Änderung |
|----------|------|-------|--|
| 23.01.20 | BZ | 84 | Sheet 1, Sclear, pp and Screep, pp (Clearance, unisolated primary to primary) deleted. Minor change. |
| 16.01.20 | BZ | 84 | Sheet 4, final test: TC1 and TC2 changed. LV2 and LV4 deleted (see changes in red). CN-20-003 |

Editor.: R&D-PD-NPI D Designer: MB MC-PM: BZ Released by: SB

**Differential Current Sensor for IC-CPD
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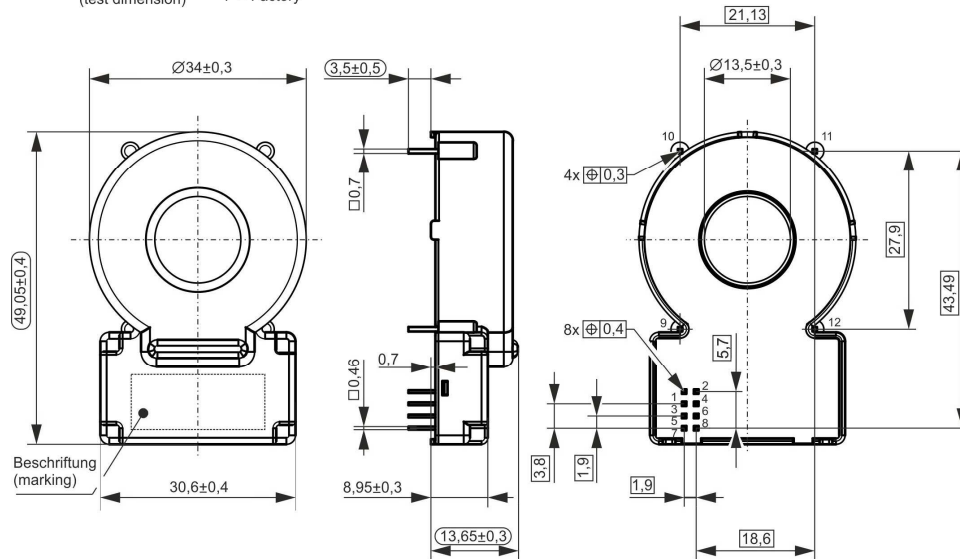
Mechanical outline (mm):

General tolerances DIN ISO 2768-c

Connections:

PIN no. 1-8: 0.46mm x 0.46mm
PIN no. 9-12: 0.7mm x 0.7mm

○ Prüfmaß (test dimension) DC = Date Code
F = Factory



Marking:

benvac
4641-X900
F DC

Content of Data-Matrix-Code is: benvac, 4641-X900, F, DC

Datecode Format:
[YWW]
Example: J04: 2017, Week 4

PIN description:

| PIN no. | Description |
|---|--|
| 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 (see tab. 1). |
| PIN 2 → TEST-IN (refer to Fig. 2) | 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 30ms to 1.2s. If the PIN is set to GND less than 30ms or more than 1.2s, no function test will be performed. Attention: During the functional test and offset measurement, no differential current may flow. To ensure high accuracy of the sensor this test should be activated at regular intervals (e.g. at startup, before measuring...) If a push-pull switch is used, the voltage range must be 0V...5V. |
| PIN 3 → X6-OUT (open collector output) | If the residual current is below 6mA dc 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 (see tab. 1). |
| PIN 4 → X30-OUT (open collector output) | If the residual current is below the 30mA rms 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 (see tab. 1). |
| 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=8kHz is generated. This is for monitoring purposes only and is not safety function! Refer to $S_{PWM-OUT} = 3.33\%/mA$ |
| PIN 8 → N.C. | Not connected |

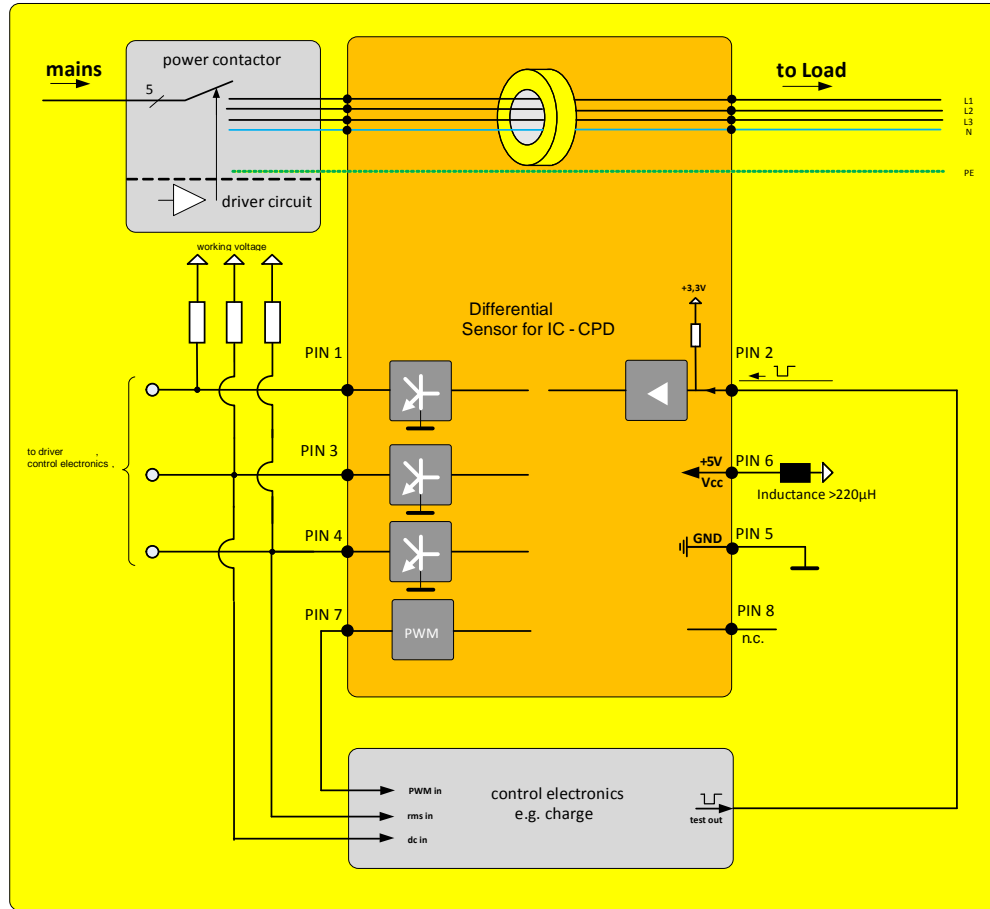
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Designer: MB

MC-PM: BZ

Released by: SB

Typical application diagram:



Absolute maximum Ratings⁽⁶⁾:

| | | 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 | | 7 | V |
| U_{MAX} | Maximum rated voltage of primary conductors (AC rms) | | | 250 | V |
| $V_{TEST-IN, low}$ | TEST-IN Input Voltage, low level | 0 | | 0.6 | V |
| $V_{TEST-IN, high}$ | TEST-IN Input Voltage, high level | 2.5 | | 5 | V |

⁽⁵⁾ 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 for IC-CPD acc. to the standard IEC62752-2016

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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 | 38.0 | 45.0 | mA |
| TEST-IN (SC) | TEST-IN voltage | 2.8 | 3.3 | V |
| X6-OUT (normal) | X6-OUT voltage | 0 | 0.6 | V |
| X30-OUT (normal) | X30-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 |
| X30-OUT (activated) | X30-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 | Trip current 1 – X6 | 4.5 | 5.4 | mA |
| TC2 | Trip current 2 – X6 | -5.4 | -4.5 | mA |
| TC3 | Trip current 3 – X30@50Hz | 20 | 30 | 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 | Limit values of break time - X6-OUT@6mA DC | 0 | 700 | ms |
| LV3 | Limit values of break time - X30-OUT@30mA, 50Hz | 0 | 300 | ms |

* the maximum values of collector-emitter voltage and current see "Absolute maximum ratings"

Product Tests:

| | | |
|--------------|--|-----------------------------------|
| | Acc. to VAC sheet M3238 Following tests differ from M3238: | passed |
| PD | 4.5a: Damp heat, steady state. Duration: 1000 h IEC61000-4-1, EN60270, M3024 UPDE M3024, Partial discharge voltage (extinction) *acc. to table 24 | 1.5 kV rms |
| ESD | Air- and contact discharge; U=±2000V, R=1500Ω, C=100pF Acc. to Human Body Model JESD22-A114 | ±2.0 kV |
| EMC | IEC61000-4-3 (Radiated, radio-frequency, electromagnetic field immunity) 20V/m 80MHz – 1GHz 80%AM 1kHz, recommend with the use of inductance of >220μH in series of Vcc input. | passed |
| | IEC61000-4-6 (Immunity to conducted disturbances), recommend with the use of inductance of >220μH in series of Vcc input. | passed |
| | IEC61000-6-4 (Emission standard for industrial environments, conducted disturbances) | Should be done in end application |
| A(f), Φ(f) | Amplitude and phase response over frequency 1% of I _{PN} or I _{Δn} | passed |
| Impulse test | Monitoring of CS function during the current phase test 100A to 5kA | passed |

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

| | | | | |
|--------------------------------|-------|--|-----|--------|
| $\hat{U}_{W, \text{prim-sec}}$ | M3064 | Impulse test (1.2 μ s/50 μ s waveform) PIN 1-8 vs. insulated primary wire 5 pulse \rightarrow polarity +, 5 pulse \rightarrow polarity - | 5.5 | kV rms |
| U_d | M3014 | Test voltage, 60s PIN 1-8 vs. insulated primary wire | 1.5 | kV rms |
| U_{PDE} | M3024 | Partial discharge voltage (extinction) PIN 1-8 vs. insulated primary wire *acc. to table 24 | 1.2 | kV rms |
| $U_{PD} \times 1.875$ | M3024 | Partial discharge voltage (extinction) PIN 1-8 vs. insulated primary wire *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 at least 4.8V
- Fall- and rise-time of Vcc 2...50 μ s/V

Figures:

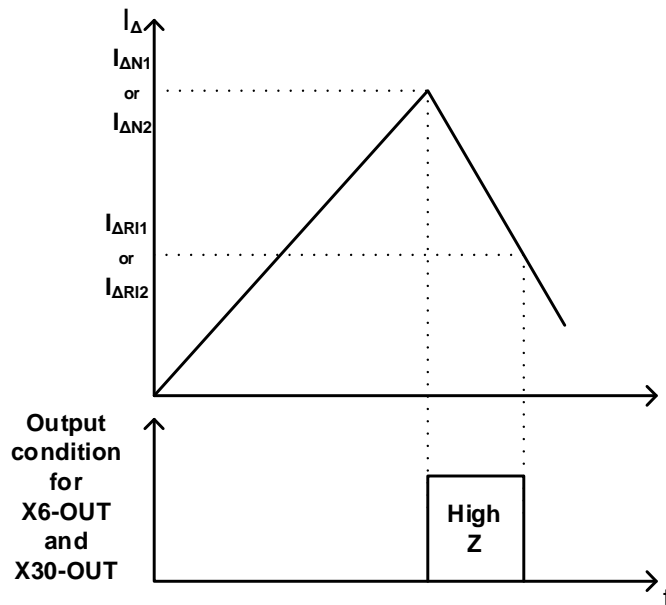
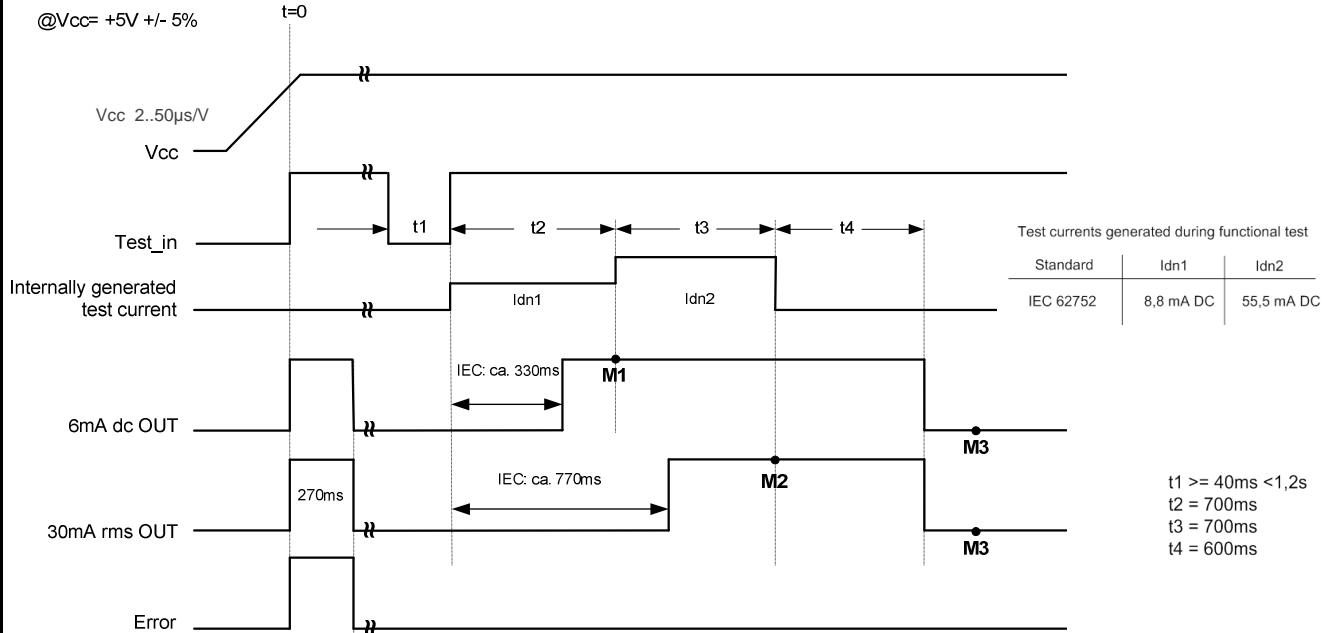


Fig. 1: Meaning of switching recovery level

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 differential current I_{Δ} , the outputs X6-OUT/X30-OUT will remain in this state until I_{Δ} fell below recovery threshold $I_{\Delta RH1}/I_{\Delta RI2}$.



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 6mA dc OUT is disabled (latest time)
- M2: check that 30mA rms OUT is disabled
- M3: check that 30mA rms OUT resp. 6mA dc out is enabled

Fig. 2: Power-Up timing diagram

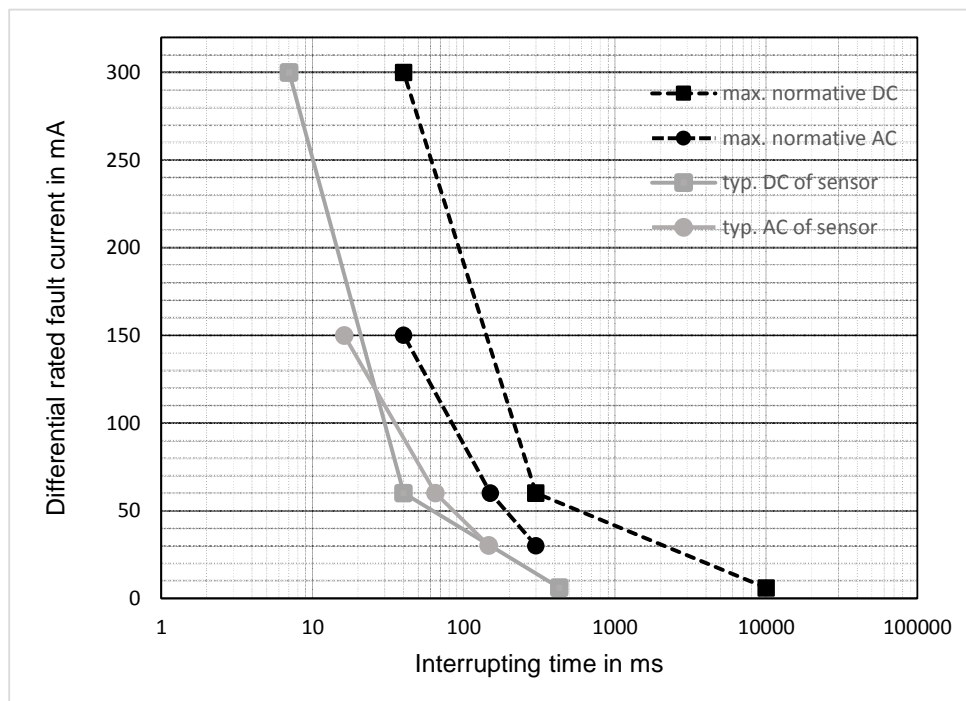


Fig. 3: Interrupting Time according to IEC62752 (E)-1:2016 Table 2 + 3 and typical values of sensor

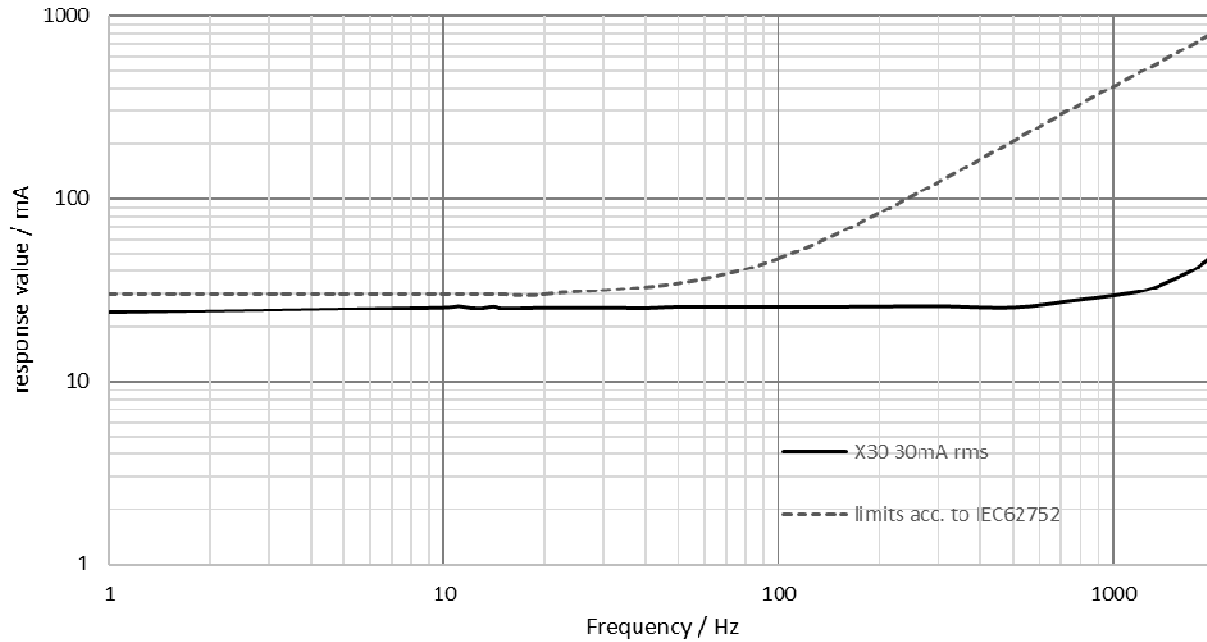


Fig. 4: Response value over frequency

| X6-OUT | X30-OUT | ERROR-OUT | State |
|----------------|----------------|----------------|--|
| GND | GND | GND | Normal condition |
| High impedance | GND | GND | $I_{\Delta N1} \geq 6\text{mA}_{DC}$ |
| High impedance | High impedance | GND | $I_{\Delta N2} \geq 30\text{mA}_{rms}$ |
| 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 an unknown state and describes an Error.

Table 1: Possible output states