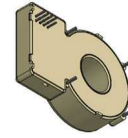


**Differential Current Sensor with tripping characteristic acc. to the partly combined standards IEC62955:2018 and UL2231-2 Ed.2**



Date: 02.06.2022

K-No.:30579

Customer: Standard type

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### Description

- Fluxgate current sensor with toroidal core
- PCB mounting

### Characteristics

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

### Applications

Mainly used for stationary and mobile 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 rated current (1phase / 3phase)			80 / 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
$S_{PWM-OUT}$	Scaling factor of the dc component <b>(for monitoring purpose only!)</b>		3.33		%/mA
$I_{ARI,1/2}$ (Fig.1)	Recovery current level for $I_{\Delta N1}$ or $I_{\Delta N2}$ (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> 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 <sup>(4)</sup>	-40		85	°C
m	Mass		21		g
$V_{CC}$	Supply voltage	4.8	5	5.2	V
$I_{CC}$	Supply current		33		mA rms
$I_{CC,max.}$	Maximal supply current (peak to peak)			200	mA pp
$S_{clear, ps}$	Clearance (primary to secondary)		not applicable if insulated cable is used <sup>(5)</sup>		
$S_{creep, ps}$	Creepage (primary to secondary)		not applicable if insulated cable is used <sup>(5)</sup>		
FIT	EN/IEC 61709 / SN 29500 <sup>(6)</sup>		<2200		fit

<sup>(3)</sup> Switching time of a standard relay (IEC: t = 20ms / UL: t = 10ms) is considered.

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

<sup>(5)</sup> Constructed, manufactured and tested in accordance with IEC60664-1:2020

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, and overvoltage category III.

<sup>(6)</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
02.06.2022	SF	81	Mistake in general description, New state in tab. 1 CN-22-115
Editor.:R&D-PD-NPI D Designer: SF MC-PM: ZB Released by: SB			

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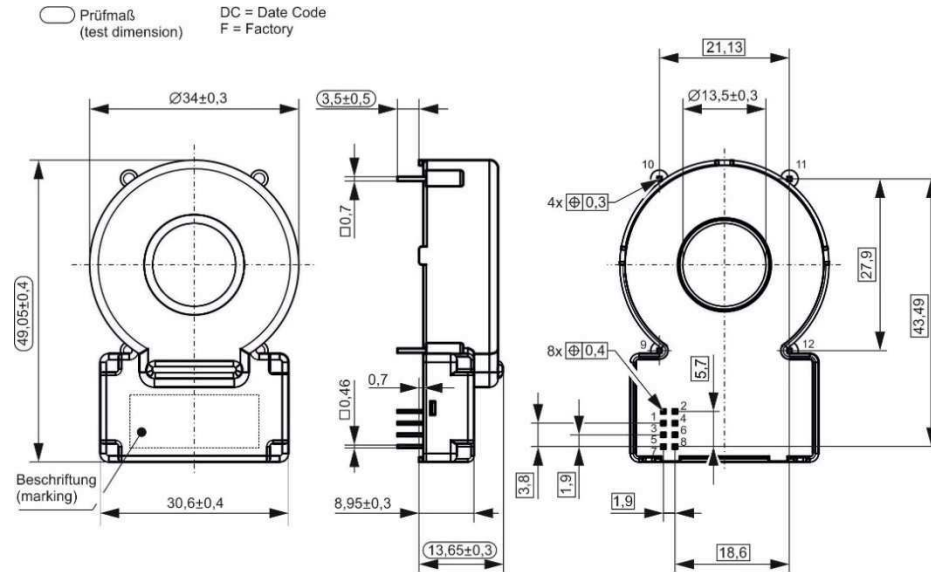
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**Mechanical outline (mm):**

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



Marking:

Benvac  
4641-X804  
F DC



Content of Data-Matrix-Code is: benvac, 4641-X804, 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 at low level (GND). If a system fault is detected, PIN is at high impedance state. 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 40ms to 1.2s. If the PIN is set to GND less than 40ms or more than 1.2s, no function test will be performed. <b>Attention:</b> During the functional test and offset measurement, no differential current shall flow. <b>To ensure high accuracy of the sensor this test shall be activated at regular intervals (e.g. at startup, before measuring...).</b> 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 (see tab. 1).
PIN 4 → X20-OUT (open collector output)	If the residual current is below the 20mA rms and no system fault occurs the output on PIN 4 is a low level (GND). In any other case PIN 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 shall not be used to switch the power relay. Refer to $S_{PWM-OUT} = 3.33\%/mA$
PIN 8 → N.C.	Not connected

Editor.:R&D-PD-NPI D

Designer: SF

MC-PM: ZB

Released by: SB

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

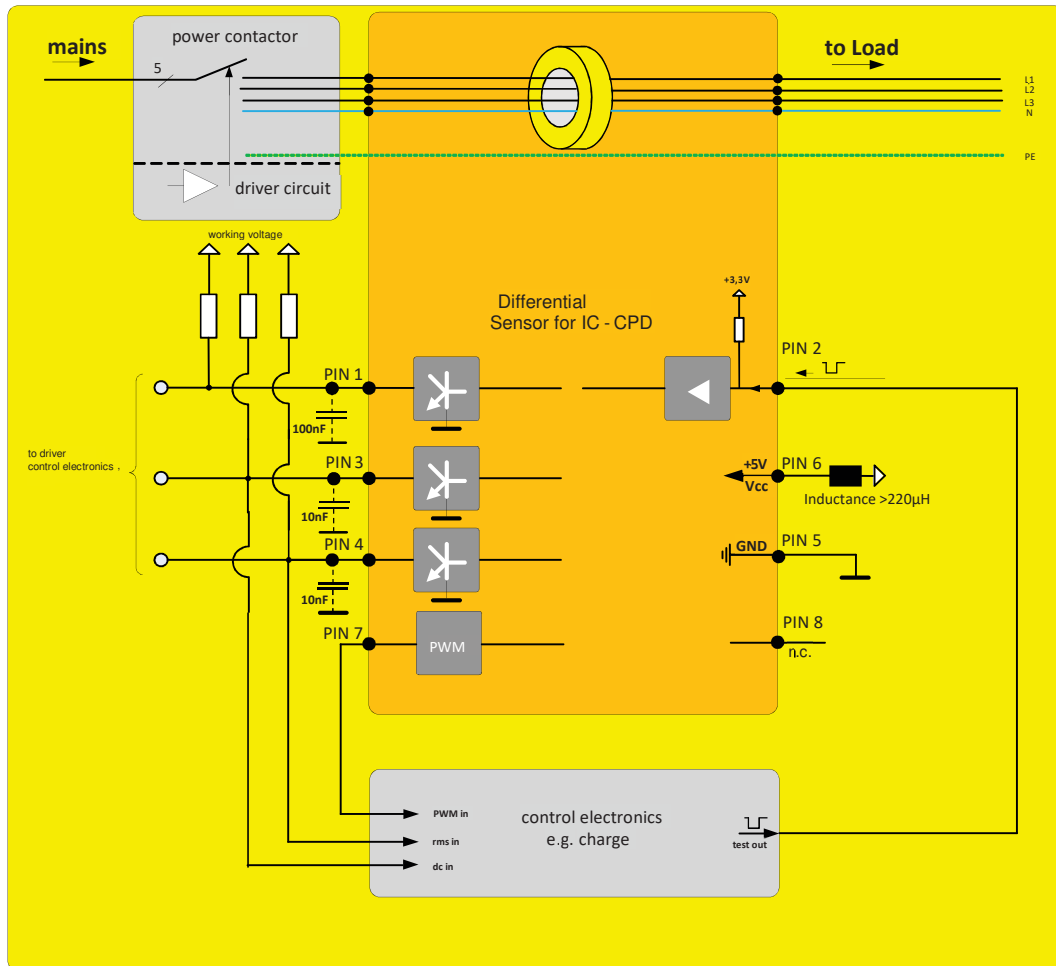
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**Typical application diagram:**



Optional for EMC improvements: Capacitance of 100nF to ground at PIN1 and capacitance of 10nF to ground at PIN3/4.

**Absolute maximung ratings<sup>(6)</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 (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

<sup>(6)</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**

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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	16.0	28.0	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	Trip current 2 – X6	-5.4	-4.5	mA
TC3	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	Limit values of break time – X20-OUT@20mA, 60Hz	0	1000	ms
NTC1	X6-OUT & X20-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

tbd

Following tests differ from M3238:

4.5a: Damp heat, steady state. Duration: 1000h

ESD	Air- and contact discharge; U=±2000V, R=1500Ω, C=100pF acc. to Human Body Model JESD22-A114	±2.0	kV
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**Requalification Tests:** (replicated every year, Precondition acc. to M3238)

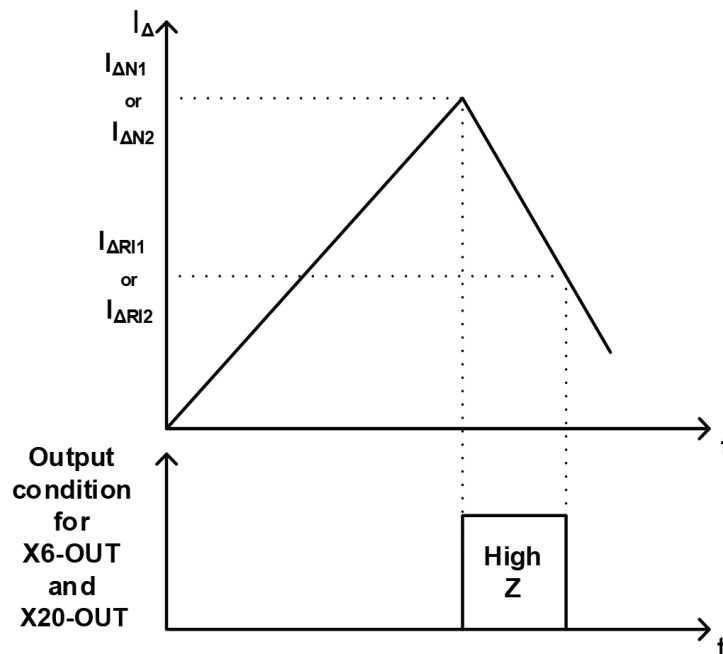
$\hat{U}_{W, \text{prim-sec}}$	M3064	Impulse test (1.2 $\mu$ s/50 $\mu$ s waveform) PIN 1-8 vs. insulated primary wire 5 pulse $\rightarrow$ polarity +, 5 pulse $\rightarrow$ polarity -	5.5	kV
$U_d$	M3014	Test voltage, 60s PIN 1-8 vs. insulated primary wire	1.5	kV rms
$U_{PDE}$	M3024	Partial discharge 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:**

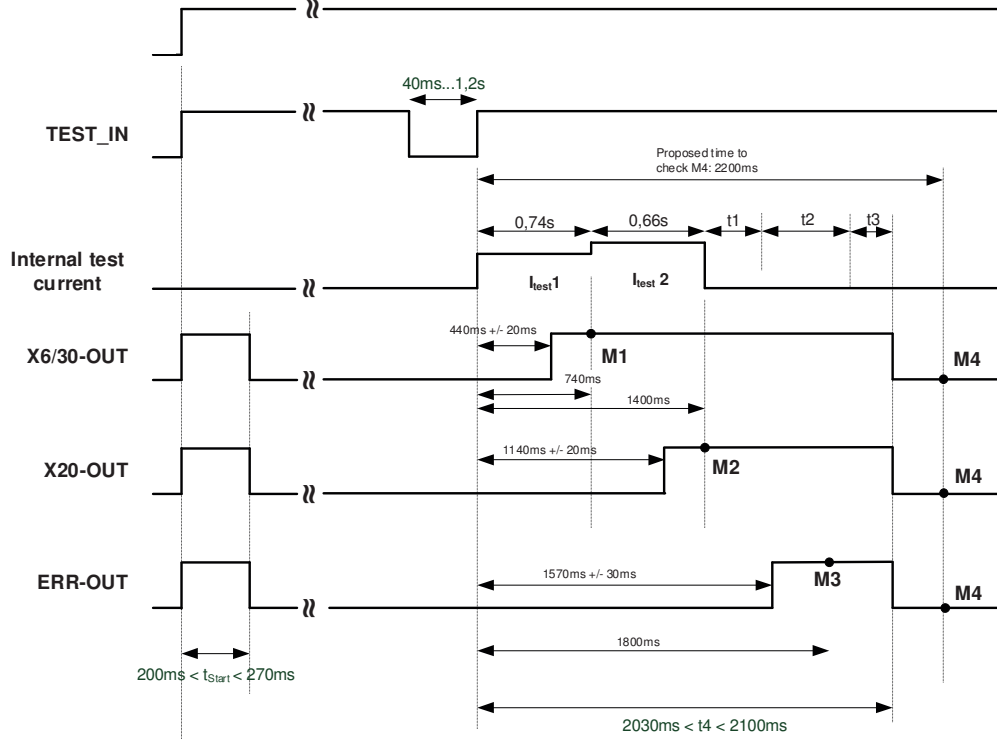
- Temperature of the primary conductor should not exceed 105°C.
- Vcc during Test-IN function test must be in rated range.
- Housing and bobbin material UL-listed, flammability class 94V-0.
- Fall- and rise-time of Vcc:  $t > 20\mu\text{s/V}$
- UL certification is still pending
- Further standards UL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

**Figures:**



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

If the trip-level  $I_{\Delta N1/3}/I_{\Delta N2}$  is accomplished the corresponding output X6-OUT/X20-OUT will change its state from low-level (GND) to high impedance. Depending on the existence of the differential current  $I_{\Delta}$ , the outputs X6-OUT/X20-OUT will remain in their states until  $I_{\Delta}$  is below the recovery threshold  $I_{\Delta R1}/I_{\Delta R2}$ .

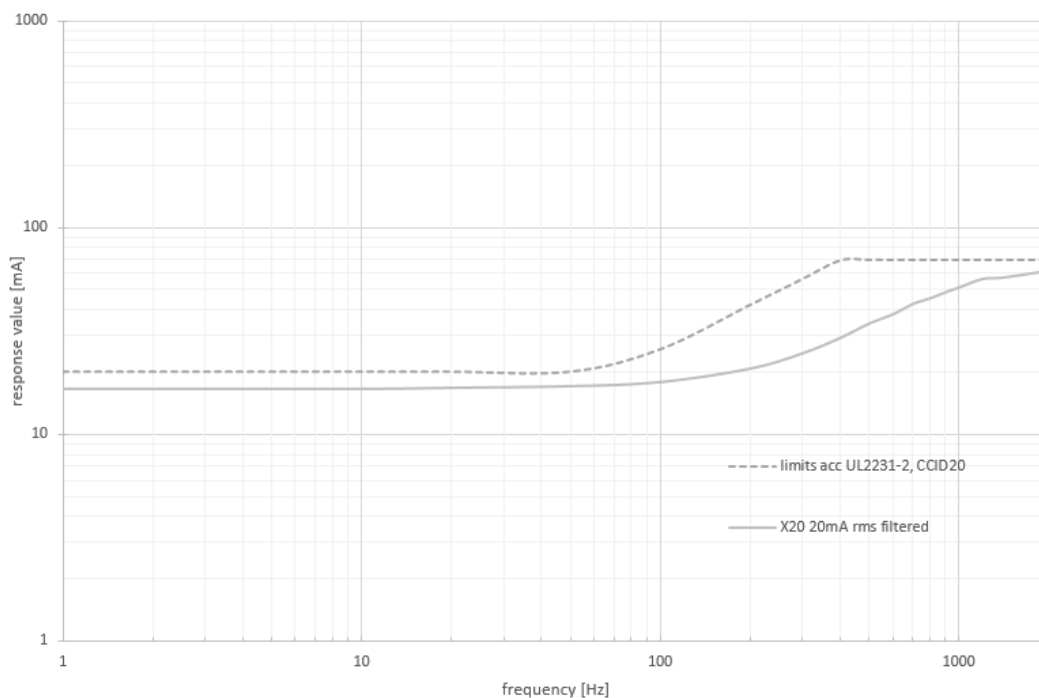


t1 = 120ms  
t2 = 500ms  
t3 = 10ms to 80ms

M1...M4

Check for welded contacts.  
Time for offset calibration.  
Time required to store the offset calibration value. Depends on the difference to the value already stored in memory.  
points in time to check output levels

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



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

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X6-OUT	X20-OUT	ERROR-OUT	State
GND	GND	GND	Normal condition
High impedance	GND	GND	$I_{\Delta} \geq 6\text{mA}_{DC}$
GND	High impedance	GND	$I_{\Delta N2} \geq 20\text{mA}_{rms}$
High impedance	High impedance	GND	$I_{\Delta} \geq 6\text{mA}_{DC}$ AND $I_{\Delta N2} \geq 20\text{mA}_{rms}$
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 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**