
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 mobile applications:
- IC-CPD acc. to IEC62752

Electrical data – Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>min.</th>
<th>typ.</th>
<th>max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>( I_p )</td>
<td>32</td>
<td>40</td>
<td></td>
<td>A</td>
</tr>
<tr>
<td>( I_{\Delta N1} )</td>
<td>6</td>
<td></td>
<td>mA</td>
<td>DC</td>
</tr>
<tr>
<td>( I_{\Delta N2} )</td>
<td>30</td>
<td></td>
<td>mA</td>
<td>rms</td>
</tr>
<tr>
<td>( I_{\Delta N1}, \text{tolerance} )</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>mA</td>
</tr>
<tr>
<td>( I_{\Delta N2}, \text{tolerance} )</td>
<td>20</td>
<td>30(^{(1)})</td>
<td>60(^{(2)})</td>
<td>mA</td>
</tr>
<tr>
<td>( S_{\text{PWM-OUT}} )</td>
<td></td>
<td>3.33</td>
<td></td>
<td>%/mA</td>
</tr>
<tr>
<td>( I_{\Delta R1/2} )</td>
<td></td>
<td>2.5</td>
<td>10</td>
<td>mA</td>
</tr>
</tbody>
</table>

Accuracy – Dynamic performance data

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>( I_{\Delta N,max} )</td>
<td>-300</td>
</tr>
<tr>
<td>( X )</td>
<td>&lt; 0.2</td>
</tr>
<tr>
<td>( t_r )</td>
<td>2 kHz</td>
</tr>
</tbody>
</table>

General data

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \theta_A ) Ambient operation temperature</td>
<td>-40</td>
</tr>
<tr>
<td>( \theta_{\text{Storage}} ) Ambient storage temperature(^{(4)})</td>
<td>-40</td>
</tr>
<tr>
<td>( m ) Mass</td>
<td>32</td>
</tr>
<tr>
<td>( V_{\text{CC}} ) Supply voltage</td>
<td>4.8</td>
</tr>
<tr>
<td>( I_{\text{CC}} ) Consumption current</td>
<td>38</td>
</tr>
<tr>
<td>( S_{\text{clear, pp}} ) Clearance (primary to primary)(^{(5)})</td>
<td>4.22</td>
</tr>
<tr>
<td>( S_{\text{creep, pp}} ) Creepage (primary to primary)(^{(5)})</td>
<td>5.65</td>
</tr>
<tr>
<td>( S_{\text{clear, ps}} ) Clearance (primary to secondary)(^{(6)})</td>
<td>6.53</td>
</tr>
<tr>
<td>( S_{\text{creep, ps}} ) Creepage (primary to secondary)(^{(6)})</td>
<td>7.75</td>
</tr>
<tr>
<td>( \text{FIT} )</td>
<td>1529</td>
</tr>
</tbody>
</table>

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 its state from a low level (GND) to high impedance state. In the event of an AC fault current, PINs 3 and 4 will change state from a low level (GND) to a high impedance state.

Error conditions (e.g., an internal error) are signaled by PIN 1 (ERROR-OUT) which changes state to high impedance.
## PIN description:

<table>
<thead>
<tr>
<th>PIN no.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>PIN 1 → ERROR-OUT</td>
<td>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 too (see tab. 1).</td>
</tr>
<tr>
<td>PIN 2 → TEST-IN</td>
<td>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. <strong>Attention:</strong> During the functional test and offset measurement, no differential current shall flow. To ensure high accuracy of the sensor this test shall 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.</td>
</tr>
<tr>
<td>PIN 3 → X6-OUT</td>
<td>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).</td>
</tr>
<tr>
<td>PIN 4 → X30-OUT</td>
<td>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 are in a high impedance state (see tab. 1).</td>
</tr>
<tr>
<td>PIN 5 → GND</td>
<td>Ground connection</td>
</tr>
<tr>
<td>PIN 6 → VCC</td>
<td>Positive supply voltage</td>
</tr>
<tr>
<td>PIN 7 → PWM-OUT</td>
<td>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 )</td>
</tr>
<tr>
<td>PIN 8 → N.C.</td>
<td>Not connected</td>
</tr>
<tr>
<td>PIN 9 – 16</td>
<td>For primary wires connection</td>
</tr>
</tbody>
</table>

**Mechanical outline (mm):** General tolerances DIN ISO 2768-c

**Connections:**
- PIN no. 1-8: 0.46mm x 0.46mm
- PIN no. 9-16: \( \varnothing = 2.5mm \)

**Marking:**
- Content of Data-Matrix-Code: VAC, 4641-X920, F, DC
  - Datecode: Format: [YWW]
  - Example: J04: 2017, Week 4

**Connections:**
- PIN no. 1-8: 0.46mm x 0.46mm
- PIN no. 9-16: \( \varnothing = 2.5mm \)
**Typical application diagram:**

![Application Diagram](image)

**Absolute maximum ratings**\(^{(8)}\):

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Min</th>
<th>Typ.</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>(V_{CE})</td>
<td>Collector-Emitter voltage (PINs 1, 3 and 4)</td>
<td>40 V</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(I_C)</td>
<td>Collector current (PINs 1, 3 and 4)</td>
<td>50 mA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(V_{CC})</td>
<td>Maximum supply voltage (without function)</td>
<td>-0.3 V</td>
<td>7 V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(U_{MAX})</td>
<td>Maximum rated voltage of primary conductors</td>
<td></td>
<td>440 V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(V_{TEST-IN, low})</td>
<td>TEST-IN Input Voltage, low level</td>
<td>0 V</td>
<td>0.6 V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(V_{TEST-IN, high})</td>
<td>TEST-IN Input Voltage, high level</td>
<td>2.5 V</td>
<td>5 V</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\(^{(8)}\) 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.
### Final Tests:
(Measurements after temperature balance of the samples at room temperature, SC=significant characteristic)

<table>
<thead>
<tr>
<th></th>
<th>Min.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vcc</td>
<td>4.9</td>
<td>5.1</td>
<td>V</td>
</tr>
<tr>
<td>Icc</td>
<td>38.0</td>
<td>45.0</td>
<td>mA</td>
</tr>
<tr>
<td>TEST-IN (SC)</td>
<td>TEST-IN voltage</td>
<td>2.8</td>
<td>3.4</td>
</tr>
<tr>
<td>X6-OUT (normal)</td>
<td>X6-OUT voltage</td>
<td>0</td>
<td>0.6</td>
</tr>
<tr>
<td>X30-OUT (normal)</td>
<td>X30-OUT voltage</td>
<td>0</td>
<td>0.6</td>
</tr>
<tr>
<td>ERROR-OUT (normal)</td>
<td>ERROR-OUT voltage</td>
<td>0</td>
<td>0.6</td>
</tr>
<tr>
<td>X6-OUT (activated)</td>
<td>X6-OUT voltage activated @5V, 1kΩ (pull-up)*</td>
<td>4.9</td>
<td>5.1</td>
</tr>
<tr>
<td>X30-OUT (activated)</td>
<td>X30-OUT voltage activated @5V, 1kΩ (pull-up)*</td>
<td>4.9</td>
<td>5.1</td>
</tr>
<tr>
<td>ERROR-OUT (activated)</td>
<td>ERROR-OUT voltage activated @5V, 1kΩ (pull-up)*</td>
<td>4.9</td>
<td>5.1</td>
</tr>
<tr>
<td>TC1</td>
<td>4.1</td>
<td>5.4</td>
<td>mA</td>
</tr>
<tr>
<td>TC2</td>
<td>-5.4</td>
<td>-4.1</td>
<td>mA</td>
</tr>
<tr>
<td>TC3</td>
<td>20</td>
<td>30</td>
<td>mA</td>
</tr>
<tr>
<td>PWM-OUT (frequency)</td>
<td>PWM-OUT frequency</td>
<td>7.8</td>
<td>8.2</td>
</tr>
<tr>
<td>PWM-OUT (duty-cycle)</td>
<td>PWM-OUT duty-cycle @6mA DC</td>
<td>18</td>
<td>22</td>
</tr>
<tr>
<td>LV1</td>
<td>0</td>
<td>700</td>
<td>ms</td>
</tr>
<tr>
<td>LV2</td>
<td>0</td>
<td>500</td>
<td>ms</td>
</tr>
<tr>
<td>LV3</td>
<td>0</td>
<td>300</td>
<td>ms</td>
</tr>
<tr>
<td>LV4</td>
<td>0</td>
<td>40</td>
<td>ms</td>
</tr>
</tbody>
</table>

* 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:
    - 3.4a: Rapid change of temperature for 300 cycles passed
    - 4.5a: Damp heat, steady state. Duration: 1000 h passed

- **PD**
  - 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**
  - CISPR14-1 (Immunity to conducted disturbances), recommend with the use of inductance of >220µH in series of Vcc input.
  - 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.
  - 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 IN or λn
  - passed

- **Impulse test**
  - Monitoring of CS function during the current phase test 100A to 5kA
  - passed
Requalification Tests: (replicated every year, Precondition acc. to M3238)

<table>
<thead>
<tr>
<th>Test Description</th>
<th>Reference</th>
<th>Voltage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Impulse test (1.2µs/50µs waveform) PIN 1-8 vs. PIN 9-14</td>
<td>M3064</td>
<td>5.5 kV</td>
</tr>
<tr>
<td>5 pulse ➔ polarity +, 5 pulse ➔ polarity -</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Impulse test (1.2µs/50µs waveform) PIN 9 vs. PIN 11, PIN 11 vs. PIN 13, PIN 13 vs. PIN 15, PIN 15 vs. PIN 9</td>
<td>M3064</td>
<td>4.0 kV</td>
</tr>
<tr>
<td>5 pulse ➔ polarity +, 5 pulse ➔ polarity -</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Test voltage, 60s PIN 1-8 vs. PIN 9-16</td>
<td>M3014</td>
<td>1.5 kV</td>
</tr>
<tr>
<td>Test voltage between primary conductors, 5s PIN 9 vs. PIN 11,PIN 11 vs. PIN 13, PIN 13 vs. PIN 15, PIN 15 vs. PIN 9</td>
<td>M3014</td>
<td>1.5 kV</td>
</tr>
<tr>
<td>Partial discharge voltage (extinction) PIN 1-8 vs. PIN 9-16</td>
<td>M3024</td>
<td>1.2 kV rms</td>
</tr>
<tr>
<td>*acc. to table 24</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Partial discharge voltage (extinction) PIN 1-8 vs. PIN 9-16</td>
<td>M3024</td>
<td>1.5 kV rms</td>
</tr>
<tr>
<td>*acc. to table 24</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*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.
- Fall- and rise-time of Vcc: t > 10µs/V

Figures:

Fig. 1: Meaning of switching recovery level

If the trip-level $I_{N1}/I_{N2}$ is accomplished the corresponding output X6-OUT/X30-OUT will change its state from low-level (GND) to high impedance. Depending on the existence of the differential current $I_a$, the outputs X6-OUT/X30-OUT will remain in their states until $I_a$ is below the recovery threshold $I_{R1}/I_{R2}$. 
**Fig. 2: Power-Up timing diagram**

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. 3: Interrupting Time according to IEC62752 (E)-1:2016 Table 2 + 3 and typical values of sensor**
**Fig. 4: Response value over frequency**

<table>
<thead>
<tr>
<th>X6-OUT</th>
<th>X30-OUT</th>
<th>ERROR-OUT</th>
<th>State</th>
</tr>
</thead>
<tbody>
<tr>
<td>GND</td>
<td>GND</td>
<td>GND</td>
<td>Normal condition</td>
</tr>
<tr>
<td>High impedance</td>
<td>GND</td>
<td>GND</td>
<td>$I_{AN1} \geq 6,\text{mA}_{\text{DC}}$</td>
</tr>
<tr>
<td>High impedance</td>
<td>High impedance</td>
<td>GND</td>
<td>$I_{AN2} \geq 30,\text{mA}_{\text{rms}}$</td>
</tr>
</tbody>
</table>

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*