Passive current sensors for operation with the IC DRV401

- rated currents from 6 A to 200 A
- peak currents from 85 A to 300 A
- operation with the IC DRV401 (unipolar 5 V - voltage supply, voltage output).
- alternatively precise internal or external reference voltage
- demagnetization
- error - detection
- overcurrent detection
- very good measuring accuracy, minimum DC - offset with very small hysteresis
- negligible interferences, like noise or periodic signals, at the output
- very small temperature dependence and long-time drift of the output signal
- small rise time, wide frequency range
- compact designs
- economical design

The patented VAC - principle of the closed-loop sensor with magnetic probe as zero-field detector is characterised by highest precision of the current measurement. The electronics to the passive VAC current sensors are outside of the sensor module. It is however almost completely concentrated in the new IC DRV401, which was developed together with a leading semiconductor manufacturer.

The advantage of external electronics is among other things the availability of different auxiliary functions of the IC, which are not accessible with the likewise available Typees with integrated electronics. These are the possibility of starting a demagnetization cycle, to further improve the signal offset. Also fault states, like wire interruptions and short-circuits in the sensor module, are recognized and indicated, as well as a too small supply voltage at the IC. An overcurrent detection signals e.g. a short in the primary current circuit, without having to evaluate the output signal.

A further advantage is, to set the ratio output voltage to input current individually.

The datasheets of our passive current sensor modules can be found under: www.vacuumschmelze.de / Products / Cores & Inductive Components / Applications / Current Sensors. Here also our paper applicational hints to the IC DRV401, which contains extensive detailed information, is available for download. The data sheet and further information to the IC DRV401 find you under http://focus.ti.com/docs/prod/folders/print/drv401.html.

Demo boards for own investigations in the customer laboratory are also available. By means of these demo boards the function of the DRV401 in interaction with sensor modules can be tested.

When designing current measuring systems with other circuit topology, e.g. bipolar voltage supply and current output, we ask, to address VAC.

Typical applications for VAC current sensors

- Variable speed drives
- Uninterruptable power supplies
- Welding inverters
- Switched mode power supplies
- Photovoltaics

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## Type series of passive current sensors for operation with the IC DRV401

<table>
<thead>
<tr>
<th>Item no.</th>
<th>Type T60404-M...</th>
<th>Rated current ( I_{\text{PN}} ) @ ( K_n = 1 ) N</th>
<th>Max. meas. range ( I_{\text{P,max.}} ) @ ( V_c = +5 ) V</th>
<th>Ambient temp. range ( T_a )</th>
<th>Turns ratio ( K_n )</th>
<th>Frequency range ( f )</th>
<th>Accuracy ( X @ I_{\text{PN}}, T_a = 25 ) °C</th>
<th>Pins</th>
<th>Primary connection</th>
<th>Secondary conn.</th>
<th>Encapsulated</th>
<th>Dimensional diagram</th>
</tr>
</thead>
<tbody>
<tr>
<td>4645-X600</td>
<td>25</td>
<td>± 85</td>
<td>12.5</td>
<td>+ 85</td>
<td>(1 ... 3): 2000</td>
<td>100</td>
<td>0.5</td>
<td>.</td>
<td>.</td>
<td>.</td>
<td>1</td>
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<tr>
<td>4645-X601</td>
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<td>12.5</td>
<td>+ 85</td>
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<td>0.5</td>
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<td>.</td>
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<td>12.5</td>
<td>+ 85</td>
<td>(1 ... 3): 2000</td>
<td>100</td>
<td>0.5</td>
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<td>.</td>
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<tr>
<td>4645-X010</td>
<td>40</td>
<td>± 55</td>
<td>3.91</td>
<td>+ 85</td>
<td>(1 ... 6): 1000</td>
<td>100</td>
<td>0.5</td>
<td>.</td>
<td>.</td>
<td>.</td>
<td>3</td>
<td></td>
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<tr>
<td>4645-X211</td>
<td>50</td>
<td>± 150</td>
<td>1.25</td>
<td>+ 85</td>
<td>(1 ... 5): 1000</td>
<td>100</td>
<td>0.5</td>
<td>.</td>
<td>.</td>
<td>.</td>
<td>3</td>
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<tr>
<td>4645-X030</td>
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<td>± 125</td>
<td>1.56</td>
<td>+ 85</td>
<td>(1 ... 4): 1000</td>
<td>100</td>
<td>0.5</td>
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<td>4645-X410</td>
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<td>+ 85</td>
<td>(1 ... 3): 1000</td>
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<td>0.5</td>
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<td>4645-X060</td>
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<td>+ 85</td>
<td>1:1000</td>
<td>100</td>
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<td>.</td>
<td>.</td>
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<td>4645-X100</td>
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<td>1.56</td>
<td>+ 85</td>
<td>1:1000</td>
<td>100</td>
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</table>

**Abbreviations and terms**

(1) Reflow – solderable Type

- \( I_{\text{PN}, \text{et}} \) @ \( K_n = 1 \) N [A]
- \( I_{\text{P,max.}} \) @ \( V_c = +5 \) V [A]
- \( T_a \) [°C]
- \( K_n \)
- \( f \) [kHz]
- \( X @ I_{\text{PN}}, T_a = 25 \) °C [%]

- primary rated current
- maximum measuring range
- ambient temperature
- turns ratio
- frequency range
- accuracy
**Dimensional diagrams**

**Diagram No. 1**

<table>
<thead>
<tr>
<th>Type</th>
<th>T60404M-4645-X600</th>
<th>T60404M-4645-X601</th>
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<tbody>
<tr>
<td>Tolerance der Stiftabstände</td>
<td>±0.2 mm</td>
<td>±0.2 mm</td>
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<tr>
<td>(Tolerances grid distance)</td>
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<td></td>
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<tr>
<td>0.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.84</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.54</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td></td>
<td></td>
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</table>

**Diagram No. 2**

<table>
<thead>
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<th>T60404-M4645-X400</th>
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<td>Einheit</td>
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<td>0.7</td>
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<td>DC</td>
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<td>1</td>
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<td>0.5</td>
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<td>33.25</td>
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**Diagram No. 3**

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<tr>
<th>Type</th>
<th>T60404-M4645-X010</th>
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</thead>
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<tr>
<td>Ziffern 1-16 nicht aufgedruckt</td>
<td>0.5</td>
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<tr>
<td>(Numbers 1-16 not imprinted)</td>
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<tr>
<td>DC</td>
<td>1</td>
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<tr>
<td>0.5</td>
<td></td>
</tr>
</tbody>
</table>

* DC = Date Code
  F = Factory

(*) 2.5 mm at X601

Passive current censors for operation with the IC DRV401
Diagram No. 4

Type
T60404-M4645-X211

Diagram No. 5

Type
T60404-M4645-X030
Passive current censors for operation with the IC DRV401

Diagram No. 6

Type
T60404-M4645-X060

Toleranz der Stiftabstände ± 0,2mm
Tolerance of the grid distances

Befestigungsbohrung
Mounting hole
Ø 2,4 / 9,5 tief
2,4 / 9,5 deep
Schraube Ø 2,9x6,5
DIN 7971 empfohlen
screw recommended

Anschlüsse 1,2,3,4
(connections)
0,6x0,88

Diagram No. 7

Type
T60404-M4645-X100

Toleranz der Stiftabstände ± 0,2mm
(Tolerances grid distance)

DC=Date Code
DC=Date Code
F=Factory
F=Factory

≤ 22,5
≤ 31
≤ 20
≤ 40,5
≤ 22,5
≤ 31
≤ 20
≤ 40,5

K= geklebt
(glued)

K= geklebt
(glued)
Diagram No. 8

Type
T60404-M4645-X080

Befestigungsbohrung
Ø 3.2 / 12 tief
Mounting hole Ø 3.2 / 12 deep
Schraube Ø 3.9x9.5
DIN 7971 empfohlen
screw recommended

Toleranz der
Stiftabstände ± 0.2mm
Tolerance of the grid
distances

DC = Date Code
F = Factory
N = neu

Passive current censors for operation with the IC DRV401
Technical appendix

Functional principle of VAC current sensors

Two major advantages of the compensation current sensors are their principle-related high linearity and their excellent dynamic properties. The current $I_p$ to be measured is magnetically coupled to the compensation current through a soft magnetic core. The magnetic flux of this core is measured by a magnetic field detector and controlled to zero by the electronics, generating a compensation current $I_s$ in the compensation winding. This current is proportional to the primary current $I_p$.

Different sensor principles - accuracy of the current capture and quality of the output signal

Open loop Hall effect - sensors without compensation coil. The accuracy of these types of sensors differs from the two other principles. Their error over the whole temperature range is 7.5 % to 12 %. About half of this error is temperature-dependent. The series scattering of the temperature responses of the Hall elements prevent the possibility of compensation. Their output signal also carries a lot of noise interference. Open loop Hall effect sensors can be used for less demanding applications.

Closed loop Hall effect – sensors. They achieve approximately half the accuracy of the VAC sensors, i.e. 2 % to 3 % over the permissible temperature range whereby this is smaller (typically -25 ... 85 °C instead of -40 ... 85 °C). Their output signal is superimposed by noise. This semiconductor noise is broadband and cannot be filtered out.

VAC closed loop sensors with magnetic probe. The sum of all errors (accuracy, linearity and offset) adds up to a value of about 1% to 1.5% over the whole (!) application temperature range of -40 ... 85 °C. This total value is more important than the error value only at room temperature. The quiescent signal of the VAC sensors only has a low level, is high frequency periodic and therefore easy to filter. There is practically no noise.