### 1700A Current Sensor
for ±24V supply with a transformation ratio of $K_N=1:5000$

for electric current measurement:
- DC, AC, pulsed, mixed ...
- with a galvanic isolation between primary circuit (high power) and secondary circuit (electronic circuit)

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**Specification**

<table>
<thead>
<tr>
<th>Item no.</th>
<th>T60404-P4640-X256</th>
</tr>
</thead>
<tbody>
<tr>
<td>K-no.</td>
<td>K26928</td>
</tr>
<tr>
<td>Date</td>
<td>08.09.2021</td>
</tr>
</tbody>
</table>

**Customer:** Standard type

**Customers Part no.:** Page 1 von 8

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**Electrical Data – Ratings**

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
<th>min.</th>
<th>typ.</th>
<th>max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$I_{PN}$</td>
<td>Primary nominal r.m.s. current</td>
<td>1700 A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$R_M$</td>
<td>Measuring resistance for $I_{PN, DC} @ 85°C$</td>
<td>0 ... 30 Ω</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$I_{SN}$</td>
<td>Secondary nominal r.m.s. or DC current</td>
<td>340 mA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$K_N$</td>
<td>Turns ratio</td>
<td>(1): 5000</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1) for the max. measuring range depending on $R_M$ please refer to Fig. 2

2) first number in brackets represents the count of primary turns guided through the primary opening of the sensor

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**Accuracy – Dynamic performance data**

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
<th>min.</th>
<th>typ.</th>
<th>max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$I_{P,max}$</td>
<td>measuring range @ $R_M = 1 \Omega$; $\theta_A = 20°C$; $U_C = \pm 24V$</td>
<td>3400 A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$I_{P,min}$</td>
<td>measuring range @ $R_M = 1 \Omega$; $\theta_A = 85°C$; $U_C = \pm 24V$</td>
<td>2750 A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$X$</td>
<td>Accuracy @ $I_{PN}$ for $\theta_A = 25°C$</td>
<td>0.3 %</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$X_{T1}$</td>
<td>Temperature drift of $X @ \theta_A = -40 ... +85°C$ (secondary)</td>
<td>0.1 %</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$X_{EL}$</td>
<td>Linearity</td>
<td>0.1 %</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$I_{SO}$</td>
<td>Offset current (secondary) @ $I_P = 0A$, $\theta_A = 25°C$</td>
<td>0.1 mA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$I_{SMH}$</td>
<td>Hysteresis current (secondary)</td>
<td>0.1 mA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$t_{r}$</td>
<td>Response time @ 90% of $I_{PN}$</td>
<td>&lt; 0.5 μs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\Delta t$</td>
<td>Delay time @ 10% of $I_{PN}$ (at $di/dt = 600A/\mu s$)</td>
<td>0.5 μs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$f_{BW}$</td>
<td>Frequency bandwidth (small signal)</td>
<td>DC...100 kHz</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1) for $I_{P,max}$ see Fig. 1 on Page 2, short term currents with high slew rates can be measured above $I_{r,max}$ (transformer behavior)

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**General data**

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
<th>min.</th>
<th>typ.</th>
<th>max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\theta_A$</td>
<td>Ambient operating temperature</td>
<td>-40 °C</td>
<td>+85 °C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\theta_S$</td>
<td>Ambient storage temperature acc. VAC M3101</td>
<td>-45 °C</td>
<td>+100 °C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$m$</td>
<td>Mass</td>
<td>550 g</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$U_C$</td>
<td>Supply voltage</td>
<td>±22.8 V</td>
<td>±24 V</td>
<td>±25.2 V</td>
<td></td>
</tr>
<tr>
<td>$I_{CO}$</td>
<td>Current consumption for $I_P = 0A$</td>
<td>±31 mA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$I_{CN}$</td>
<td>Current consumption for $I_{PN} = 1500A$</td>
<td>270 310 375 mA</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1) The temperature of the sensor surface at any position must not exceed 105°C

2) Due to the Class-D final stage used for generating the compensation current, the supply current $I_{CN}$ ($I_C @ I_P = I_{PN}$) is lower than $I_{SN}$.

The specified wide range of the supply current is reasoned by dependencies on ambient operating temperature $\theta_A$ and the value of the resistor $R_M$ connected to the sensor output.

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3) The specified wide range of the supply current is reasoned by dependencies on ambient operating temperature $\theta_A$ and the value of the resistor $R_M$ connected to the sensor output.

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- Copying of this document, disclosing it to third parties or using the contents there for any purposes without express written authorization by use illegally forbidden
- Any offenders are liable to pay all relevant damages.

**Date Name Issue Amendment**

<p>| | | | |</p>
<table>
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<tr>
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</tr>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hrsg.: R&amp;D-PD NPI D</td>
<td>Bearb: Ku.</td>
<td>MC-PM: NSch.</td>
<td>freig.: SB</td>
</tr>
<tr>
<td>editor</td>
<td>designer</td>
<td>check</td>
<td>released</td>
</tr>
</tbody>
</table>

---

*V A C U U M S C H M E L Z E for electric current measurement:*
- DC, AC, pulsed, mixed ...
- with a galvanic isolation between primary circuit (high power) and secondary circuit (electronic circuit)

Measurement Range Derating

In addition to the sensor design and construction, following operating parameters have high influence to the measurement range limit \( I_{P\text{max}} \):
- the actual continuous primary current \( I_p \)
- the burden resistor \( R_M \)
- the ambient temperature \( \theta_A \)
- the supply voltage \( \pm U_C \)
- and the busbar temperature.

(following curves are interpolated calculations verified by sample measurements)

### Derating depending on primary current \( I_p \):

\[
I_{P\text{max}(DC)} = f(I_p) \quad \text{condition: } U_C=\pm24,0V \quad R_M=1\Omega
\]

![Graph of \( I_{P\text{max}(DC)} = f(I_p) \)](image1)

**Fig. 1:** measurable current \( I_{P\text{max}} \) depending on the primary continuous current \( I_p \).

### Derating depending on connected burden resistor \( R_M \):

\[
I_{P\text{max}(DC)} = f(R_M) \quad \text{condition: } U_C=\pm24,0V \quad I_p=1700A
\]

![Graph of \( I_{P\text{max}(DC)} = f(R_M) \)](image2)

**Fig. 2:** measurable currents \( I_{P\text{max}} \) depending on the burden resistor \( R_M \).

### Dwell Time Limits For Maximum DC Currents (\( I_{P\text{max}} \))

<table>
<thead>
<tr>
<th>( \theta_A ) (ambient temperature)</th>
<th>85°C</th>
<th>( R_M ) (burden resistor)</th>
<th>( I_{P\text{max}(DC)} ) (max. DC primary current)</th>
<th>( t_{\text{dwell}} ) (Permissible dwell time for ( I_{P\text{max}(DC)} ))</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Ω</td>
<td>2750</td>
<td>5 Ω</td>
<td>2500</td>
<td>&lt; 4 minutes</td>
</tr>
<tr>
<td>10 Ω</td>
<td>2260</td>
<td>20 Ω</td>
<td>2000</td>
<td>&lt; 6 minutes</td>
</tr>
</tbody>
</table>

**Tab.1:** permissible dwell times for measurable DC peak currents at 85°C without degradation of the sensor expected after higher current loads (\( I_p > I_{P\text{max}} \)) recovery times should be taken into account.

### Absolute Maximum Ratings For Continuous Currents

* Exposure to this absolute maximum conditions for extended periods may degrade device reliability and lifetime. Stresses above these ratings may cause permanent damage. These are stress ratings. Functional operation of the device at these or any other conditions beyond those specified is not supported. This conditions don't comply with UL-Certification.

<table>
<thead>
<tr>
<th>( \theta_A ) (ambient temperature)</th>
<th>( R_M ) (burden resistor)</th>
<th>( I_p ) (continuous)</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 85°C</td>
<td>≥ 1 Ω</td>
<td>≤ 1800A DC</td>
</tr>
</tbody>
</table>

**Tab.2:** absolute maximum ratings for continuous currents with not to be excluded degradation and without UL-compliance.
Supply Current Consumption

**Fig. 5:** supply current consumption ($\pm I_C$) at positive and negative supply voltage over primary current

**Background information: “bus pumping effect”**

For DC and low frequency measurements the output current of the sensor (or so called compensation current) is generated by a class D switching amplifier. The advantages of this technology are low power losses, meaning low self-heating of the sensor which makes a continuous measurement of high primary currents possible. Due to the principle of this technology, for $I_P > +300A$ the negative supply current $I_C$ is getting positive and vice versa for $I_P < -300A$ the positive supply current $I_C$ is getting negative as shown in Fig. 5. This effect reaches a maximum/minimum at a certain primary current depending on the operating temperature and the connected burden resistor $R_M$. It decreases by an increase of $R_M$ or the operating temperature.

- reverse supply currents of the sensor can be used supply (partially) other loads connected to the same power supply
- sensors in three phase systems, where all sensors are connected to one power supply, the supply currents of the sensors can compensate each other similar to the behaviour of load currents in the star point of a three phase system (vector addition).
Noise And Offset Ripple Reduction

The offset ripple and noise can be reduced by an external low pass. The simplest solution is a passive low pass filter of 1st order with

\[ f_r = \frac{1}{2\pi \cdot R_M \cdot C_a} \]

In this case the response time is enlarged. It is calculated from:

\[ t'_r \geq t_r + 2.5 R_M C_a \]

Connection diagram

---

Fig. 6: simplified schematic diagram of the sensor
Specification

Item no.: T60404-P4640-X256

K-no.: K26928

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primary circuit (high power) and secondary circuit (electronic circuit)

Date: 08.09.2021

Customer: Standard type

Customer's Part no.: Page 5 von 8

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

Connector:
JST B03B-XASK-1

Pin Assignment:
Pin 1: +Uc
Pin 2: Is
Pin 3: -Uc

Example: Sensor with end number X256
Produced in Slovakia in CW38 2018
Part number: 4640-X256
Factory code: SK
Date code: K38

Marking

Explanation: Item number: see Tab.2 (left column)
F = Factory code
DC = Date code (YWW)

Arrow shows positive current direction

VAC Logo UL Logo (will follow)

Datamatrix Code (for further info please refer to the datamatrix code section)

Quiet zone (white rectangular shape with 1.5mm width around the data area of the code)

Connector Pin description

Example: Sensor with end number X256

4640-X256
SK K38
**Specification**

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**Date:** 08.09.2021

**Customer:** Standard type

**Datamatrix Code specification**

**Code Size:**
- metrical size: 18mm x 18mm
- symbol size: 24 x 24 points

**Code Content:**
- Standard: ANSI MH10.8.2

1T"Batch-no."@1P"Item-no."@2P"datasheet revision"@6D"datecode"@10V"production site"

1T0001234567@1PT60404-P4640-X256@2P81@6DK36@10VSK

**Routine Test**

Measurement after temperature balance of the samples at room temperature; **SC = significant characteristic**

<table>
<thead>
<tr>
<th>$K_N(N_1/N_2)$</th>
<th>$M3011/6$</th>
<th>Transformation ratio ($I_p = 1500, A$, 40-80 Hz)</th>
<th>$1 : 5000 \pm 0.3% , (SC)$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$I_{SO}$</td>
<td>$M3226$</td>
<td>Offset current</td>
<td>$&lt; 0.1 , mA$</td>
</tr>
<tr>
<td>$U_p$</td>
<td>$M3014$</td>
<td>Test voltage (1s)</td>
<td>$2.2 , kV_{RMS}$</td>
</tr>
<tr>
<td>$U_{PDE}$</td>
<td>(AQL 1/S4)</td>
<td>Partial discharge voltage (extinction)</td>
<td>$1500 , V_{RMS}$</td>
</tr>
<tr>
<td>$U_{PDE(mso)}$</td>
<td>$\cdot 1.875$</td>
<td>*acc. table 24</td>
<td>$2813 , V_{RMS}$</td>
</tr>
</tbody>
</table>

**Type Test**

Preconditioning acc. VAC M3236 (Pin 1,3,5 to primary opening)

<table>
<thead>
<tr>
<th>$U_W$</th>
<th>$M3064$</th>
<th>HV transient test ($1.2\mu s / 50\mu s$, 5 pulses $\rightarrow$ polarity $+$, 5 pulses $\rightarrow$ polarity $-$)</th>
<th>12</th>
<th>kV</th>
</tr>
</thead>
<tbody>
<tr>
<td>$U_p$</td>
<td>$M3014$</td>
<td>Test voltage (5s)</td>
<td>4.4</td>
<td>kV$_{RMS}$</td>
</tr>
<tr>
<td>$U_{PDE}$</td>
<td>$M3024$</td>
<td>Partial discharge voltage (extinction)</td>
<td>1500</td>
<td>$V_{RMS}$</td>
</tr>
<tr>
<td>$U_{PDE(mso)}$</td>
<td>$\cdot 1.875$</td>
<td>*acc. table 24</td>
<td>2813</td>
<td>$V_{RMS}$</td>
</tr>
</tbody>
</table>

* IEC61800-5-1:2007

**Applicable documents and standards**

- Constructed, manufactured and tested in accordance with IEC61800-5-1:2007.
- Further standards: UL 508; file E317483, category NMTR2 / NMTR8

**Hrsg.:** R&D-PD NPI D  
**Bearb.:** Ku.  
**MC-PM: NSch.**  
**treig.: SB released**
**Specification**

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for electric current measurement: DC, AC, pulsed, mixed ..., with a galvanic isolation between primary circuit (high power) and secondary circuit (electronic circuit)

**Explanation of the terms used in the datasheet**

- **$I_{SN}$**: Nominal secondary current (secondary current value at $I_{PN}$)

- **$X_{total}(I_{N})$**: The sum of all possible errors over the temperature range by measuring a current $I_{IN}$:

$$X_{total} = 100 \cdot \frac{I_{S}}{K_N \cdot I_{PN}} - 1$$

- **$X$**: Permissible measurement error in the final inspection at RT. $I_{DB}$ is the DC output current for a DC primary current with the same value as the (positive) rated current $I_{IN}$ (with $I_O = 0$)

$$X = 100 \cdot \frac{I_{SB}}{I_{SN}} - 1$$

- **$X_{Ti}$**: Temperature drift of the rated value orientated output term. $I_{IN}$ (cf. Notes on $F_i$) in a specified temperature range:

$$X_{Ti} = 100 \cdot \frac{I_{SB}(\Delta \alpha_A) - I_{SB}(\Delta \alpha_A)}{I_{SN}}$$

- **$\varepsilon_L$**: Linearity fault where $I_p$ is any input DC and $I_{SP}$ the corresponding output term. ($I_O = 0$).

$$\varepsilon_L = 100 \cdot \frac{I_p}{I_{PN}} - \frac{I_{SP}}{I_{SN}}$$

**Offset, hysteresis and drift**

- **$I_{SO}$**: Offset current

- **$I_{SOH}$**: hysteresis offset at $I_P = 0$A, meaning secondary current after overloading the sensor by a direct current of $3 \times I_{IN}$ with $R_M = 100 \Omega$

- **$I_{O}$**: Long term drift of $I_O$ after 100 temperature cycles in the range -40 to 85 °C.

**Dynamic properties**

- **$\Delta t(I_{P, max})$**: delay time between a rectangular primary current and the output current $I_O$ at $I_P = 0.1 \times I_{IN}$

$$\Delta t = t - t_0$$

- **$t_r$**: Response time, measured as a delay time between a rectangular primary current and the output current $I_O$ at $I_P = 0.9 \times I_{IN}$

**Voltage ratings** (according to IEC 61800-5-1:2007)

- **$U_{PD}$**: Rated discharge voltage (recurring peak voltage separated by the insulation)

- **$U_{PN}$**: System voltage: RMS value of rated voltage

- **$U_{AC}$**: Working voltage: RMS voltage which occurs by design in a circuit or across an insulation

- **$U_{ACP}$**: Working voltage: recurring peak voltage acc. IEC 61800-5-1 which occurs by design in a circuit or across insulation.