Current Transducer LH 50-P

For the electronic measurement of current: DC, AC, pulsed..., with galvanic separation between the primary and the secondary circuit.

Features

- Closed loop (compensated) current transducer
- PCB mounting
- Current output.

Advantages

- High accuracy
- Very low offset
- Very low offset drift over temperature.

Applications

- AC variable speed and servo motor drives
- Static converters for DC motor drives
- Battery supplied applications
- Uninterruptible Power Supplies (UPS)
- Switched Mode Power Supplies (SMPS)
- Power supplies for welding applications
- Solar inverters.

Standards

- IEC 61800-1: 1997
- IEC 61800-2: 2015
- IEC 61800-3: 2004
- IEC 61800-5-1: 2007
- IEC 62109-1: 2010
- IEC 62477-1: 2012

Application Domain

- Industrial.
Absolute maximum ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Unit</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum supply voltage (working) (−40 ... 85 °C)</td>
<td>$U_{C \text{ max}}$</td>
<td>V</td>
<td>±15.75</td>
</tr>
<tr>
<td>Maximum primary conductor temperature</td>
<td>$T_{B \text{ max}}$</td>
<td>°C</td>
<td>100</td>
</tr>
<tr>
<td>Maximum steady state primary current (−40 ... 85 °C)</td>
<td>$I_{P \text{ N \ max}}$</td>
<td>A</td>
<td>50</td>
</tr>
</tbody>
</table>

Stresses above these ratings may cause permanent damage. Exposure to absolute maximum ratings for extended periods may degrade reliability.

UL 508: Ratings and assumptions of certification

File # E189713 Volume: 2 Section: 10

Standards

● USR indicates investigation to the Standard for Industrial Control Equipment UL 508.
● CNR indicates investigation to the Canadian standard for Industrial Control Equipment CSA C22.2 No. 14-13

Conditions of acceptability

When installed in the end-use equipment, with primary feed through potential involved of 600 V AC/DC, consideration shall be given to the following:

1. These products must be mounted in a suitable end-use enclosure.
2. The secondary pin terminals have not been evaluated for field wiring.
3. Low voltage control circuit shall be supplied by an isolating source (such as transformer, optical isolator, limiting impedance or electro-mechanical relay).
4. Based on the temperature test performed on all series, the primary bar or conductor shall not exceed 100 °C in the end use application.

Marking

Only those products bearing the UL or UR Mark should be considered to be Listed or Recognized and covered under UL’s Follow-Up Service. Always look for the Mark on the product.
## Insulation coordination

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Unit</th>
<th>Value</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>RMS voltage for AC insulation test, 50 Hz, 1 min</td>
<td>$U_d$</td>
<td>kV</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Impulse withstand voltage 1.2/50 μs</td>
<td>$U_{w}$</td>
<td>kV</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>Insulation resistance</td>
<td>$R_{INS}$</td>
<td>GΩ</td>
<td>≥ 1</td>
<td>measured at 500 V DC</td>
</tr>
<tr>
<td>Partial discharge extinction RMS voltage @ 10 pC</td>
<td>$U_e$</td>
<td>kV</td>
<td>&gt; 2</td>
<td></td>
</tr>
<tr>
<td>Clearance (pri. - sec.)</td>
<td>$d_{CI}$</td>
<td>mm</td>
<td></td>
<td>See dimensions drawing on page 11</td>
</tr>
<tr>
<td>Creepage distance (pri. - sec.)</td>
<td>$d_{CP}$</td>
<td>mm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Case material</td>
<td>-</td>
<td>-</td>
<td>V0 according to UL 94</td>
<td></td>
</tr>
<tr>
<td>Comparative tracking index</td>
<td>$CTI$</td>
<td></td>
<td>600</td>
<td></td>
</tr>
<tr>
<td>Application example</td>
<td>V</td>
<td>600</td>
<td></td>
<td>Reinforced insulation, CAT III, PD 2 non uniform field according to IEC 61800-5-1</td>
</tr>
<tr>
<td>Application example</td>
<td>V</td>
<td>1000</td>
<td></td>
<td>Basic insulation, CAT III, PD 2 non uniform field according to IEC 61800-5-1</td>
</tr>
</tbody>
</table>

## Environmental and mechanical characteristics

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Unit</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ambient operating temperature</td>
<td>$T_A$</td>
<td>°C</td>
<td>-40</td>
<td></td>
<td>85</td>
<td></td>
</tr>
<tr>
<td>Ambient storage temperature</td>
<td>$T_S$</td>
<td>°C</td>
<td>-50</td>
<td></td>
<td>90</td>
<td></td>
</tr>
<tr>
<td>Mass</td>
<td>$m$</td>
<td>g</td>
<td>23</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Electrical data

At $T_A = 25 \, ^\circ\text{C}$, $\pm U_C = \pm 15 \, \text{V}$, $R_M = 1 \, \Omega$, unless otherwise noted. Lines with a * in the conditions column apply over the $-40 \ldots 85 \, ^\circ\text{C}$ ambient temperature range.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Unit</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary nominal RMS current</td>
<td>$I_{PN}$</td>
<td>A</td>
<td>50</td>
<td>*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Primary current, measuring range</td>
<td>$I_{PM}$</td>
<td>A</td>
<td>$-110$</td>
<td>$110$</td>
<td>*</td>
<td>With $R_M \leq 110 , \Omega$ with $U_C = \pm 15 , \text{V}$</td>
</tr>
<tr>
<td>Measuring resistance</td>
<td>$R_M$</td>
<td>$\Omega$</td>
<td>0</td>
<td>*</td>
<td></td>
<td>Measuring resistance range is defined in figure 1, 2</td>
</tr>
<tr>
<td>Secondary nominal RMS current</td>
<td>$I_{SN}$</td>
<td>mA</td>
<td>25</td>
<td>*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Resistance of secondary winding</td>
<td>$R_S$</td>
<td>$\Omega$</td>
<td>94</td>
<td></td>
<td></td>
<td>$R_S(T_A) = R_S \times (1 + 0.004 \times (T_A + \Delta\text{temp} - 25))$ Estimated temperature increase @ $I_{PN}$ is $\Delta\text{temp} = 15 , ^\circ\text{C}$</td>
</tr>
<tr>
<td>Secondary current</td>
<td>$I_S$</td>
<td>mA</td>
<td>$-55$</td>
<td>$55$</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>Number of secondary turns</td>
<td>$N_S$</td>
<td></td>
<td>2000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Theoretical sensitivity</td>
<td>$G_{th}$</td>
<td>mA/A</td>
<td>0.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Supply voltage</td>
<td>$\pm U_C$</td>
<td>V</td>
<td>$\pm 11.4$</td>
<td>$\pm 15.75$</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>Current consumption</td>
<td>$I_C$</td>
<td>mA</td>
<td>20</td>
<td>21</td>
<td>$\pm U_C = \pm 12 , \text{V}$ $\pm U_C = \pm 15 , \text{V}$</td>
<td></td>
</tr>
<tr>
<td>Offset current referred to primary</td>
<td>$I_O$</td>
<td>A</td>
<td>$-0.12$</td>
<td>$0.12$</td>
<td>$\pm U_C = \pm 12 , \text{V}$ $\pm U_C = \pm 15 , \text{V}$</td>
<td></td>
</tr>
<tr>
<td>Offset current referred to secondary</td>
<td>mA</td>
<td>$-0.060$</td>
<td>$0.060$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overall $I_O$ at $-40 \ldots 85^\circ\text{C}$, referred to primary</td>
<td>$I_{O,ov}$</td>
<td>A</td>
<td>$-0.18$</td>
<td>$0.18$</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>Overall $I_O$ at $-40 \ldots 85^\circ\text{C}$, referred to secondary</td>
<td>mA</td>
<td>$-0.09$</td>
<td>$0.09$</td>
<td>*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Temperature coefficient of $I_{OE}$</td>
<td>$TC_{I_{OE}}$</td>
<td>$\mu\text{A/K}$</td>
<td>$-400$</td>
<td>$400$</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>Magnetic offset current, after overload referred to secondary</td>
<td>$I_{OM}$</td>
<td>mA</td>
<td>$\pm 0.04$</td>
<td></td>
<td>After $5 \times I_{PN}$</td>
<td></td>
</tr>
<tr>
<td>Sensitivity error</td>
<td>$\epsilon_G$</td>
<td>%</td>
<td>$-0.2$</td>
<td>$0.2$</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>Temperature coefficient of $G$</td>
<td>$TC_G$</td>
<td>ppm/K</td>
<td>$-30$</td>
<td>$30$</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>Linearity error</td>
<td>$\epsilon_L$</td>
<td>% of $I_{PN}$</td>
<td>$-0.1$</td>
<td>$0.1$</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>Overall accuracy at $I_{PN}$</td>
<td>$\chi_G$</td>
<td>%</td>
<td>$0.4$</td>
<td>*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Accuracy at $I_{PN}$</td>
<td>$X$</td>
<td>%</td>
<td>$0.2$</td>
<td>*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output RMS noise current referred to primary</td>
<td>$I_{no}$</td>
<td>mA</td>
<td>18</td>
<td></td>
<td>1 Hz to 100 kHz (see figure 4)</td>
<td></td>
</tr>
<tr>
<td>Reaction time @ 10 % of $I_{PN}$</td>
<td>$t_{ra}$</td>
<td>ns</td>
<td>200</td>
<td></td>
<td>$0 , \text{to} , 50 , \text{A}, , 50 , \text{A/}\mu\text{s}$ $R_M = 10 , \Omega$</td>
<td></td>
</tr>
<tr>
<td>Step response time to 90 % of $I_{PN}$</td>
<td>$t_s$</td>
<td>ns</td>
<td>500</td>
<td></td>
<td>$0 , \text{to} , 50 , \text{A}, , 50 , \text{A/}\mu\text{s}, , R_M = 10 , \Omega$ (figure 3); PCB design defined in fig. 7</td>
<td></td>
</tr>
<tr>
<td>Step response time to 90 % of $I_{PN}$</td>
<td>$t_r$</td>
<td>ns</td>
<td>100</td>
<td></td>
<td>$0 , \text{to} , 50 , \text{A}, , 50 , \text{A/}\mu\text{s}, , R_M = 10 , \Omega$; PCB design defined in fig. 6</td>
<td></td>
</tr>
<tr>
<td>Frequency bandwidth</td>
<td>$BW$</td>
<td>kHz</td>
<td>200</td>
<td></td>
<td>$R_d = 10 , \Omega; , -3 , \text{dB}$</td>
<td></td>
</tr>
</tbody>
</table>

Note: 1) With $\pm 15 \, \text{V} \pm 5 \%$ as power supply, $T_A = 85 \, ^\circ\text{C}$ and $I_{PN}$ (DC value). Other values of minimum values according to conditions of use are given in Figure 1, 2.
**Typical performance characteristics**

**Definition of typical, minimum and maximum values**

Minimum and maximum values for specified limiting and safety conditions have to be understood as such as well as values shown in "typical" graphs.

On the other hand, measured values are part of a statistical distribution that can be specified by an interval with upper and lower limits and a probability for measured values to lie within this interval.

Unless otherwise stated (e.g. “100 % tested”), the LEM definition for such intervals designated with "min" and “max” is that the probability for values of samples to lie in this interval is 99.73 %.

For a normal (Gaussian) distribution, this corresponds to an interval between −3 sigma and +3 sigma. If “typical” values are not obviously mean or average values, those values are defined to delimit intervals with a probability of 68.27 %, corresponding to an interval between −sigma and +sigma for a normal distribution.

Typical, maximal and minimal values are determined during the initial characterization of the product.

![Graph 1: Maximum measuring resistance @ 70 °C in DC](image1)

![Graph 2: Maximum measuring resistance @ 85 °C in DC](image2)

The measuring resistance \( R_{M\text{ max}} \) has to be properly defined in order to guarantee the optimal transducer performance.

Maximum measuring resistance \( R_{M\text{ max}} \) is based on the maximum current that must be measured by the transducer.

The simple formula \( R_{M\text{ max}} \) is shown above.

Minimum measuring resistance \( R_{M\text{ min}} \) is based on the maximum heat dissipation capacity of the transducer.

It depends on the following working conditions: supply voltage \( U_C \), ambient temperature \( T_A \) and the primary nominal RMS current \( I_{P\text{ N}} \).

Minimum \( R_{M\text{ min}} \) value can be as low as 0 Ω, and this is normally the case when the transducer is supplied with a low supply voltage \( U_C = \pm 12 \text{ V} \).

In figure 1 the minimum \( R_{M\text{ min}} \) value data is omitted whenever it is equal to 0 Ω.
Typical performance characteristics continued

Figure 3: Typical step response (0 to 50 A, 50 A/µs) with $R_{M} = 10 \, \Omega$

Figure 4: Typical total output RMS noise current (primary referred) with $R_{M} = 10 \, \Omega$

Figure 5: Typical output noise voltage spectral density $e_{no}$ with $R_{M} = 10 \, \Omega$
High and low speed PCB designs

The PCB design is very important to achieve good response to high-frequency primary current in terms of accuracy and bandwidth. High speed PCB design, as the one shown here below, allows the transducer to obtain lower response times to high varying primary current. In order to achieve the highest bandwidth possible the loop of the primary current traces at the transducer back should be as tight as possible.

On the other hand, high speed PCB design requires more PCB area for the primary current traces compared to low speed PCB design. The customer must define the optimal PCB design according to the application specifications.

Figure 6: High speed PCB design

Figure 7: Low speed PCB design
Magnetic offset

The magnetic offset current $I_{OM}$ is the consequence of a current on the primary side (“memory effect” of the transducer’s ferromagnetic parts). It is measured using the following primary current cycle. $I_{OM}$ depends on the current value $I_{P1}$ ($I_{P1} > I_{PM}$).

\[
I_{OM} = \frac{I_{S}(t_1) - I_{S}(t_2)}{2} \cdot \frac{1}{G_{th}}
\]

Figure 8: Current cycle used to measure magnetic and electrical offset (transducer supplied)
Performance parameters definition

Electrical offset

The electrical offset current $I_{OE}$ can either be measured when the ferro-magnetic parts of the transducer are:

- completely demagnetized, which is difficult to realize,
- or in a known magnetization state, like in the current cycle shown in figure 8.

Using the current cycle shown in figure 8, the electrical offset is:

$$I_{OE} = \frac{I_0(t_1) + I_0(t_2)}{2}$$

The temperature variation $I_{OT}$ of the electrical offset current $I_{OE}$ is the variation of the electrical offset from 25 °C to the considered temperature:

$$I_{OT}(T) = I_{OE}(T) - I_{OE}(25°C)$$

Note: the transducer has to be demagnetized prior to the application of the current cycle (for example with a demagnetization tunnel).

Overall accuracy

The overall accuracy $X_G$ is the error at $I_{PN}$, relative to the rated value $I_{PN}$.

The overall accuracy $X_G$ at 25 °C includes the electrical offset, the magnetic offset, the sensitivity error and the linearity error, expressed in % of $I_{PN}$.

The formula for accuracy $X_G$ is:

$$X_G = \left( \frac{I_{out} at I_P - I_{PN}}{I_{PN}} \right) \times 100 \text{ [in % of } I_{PN}]$$

Accuracy

The accuracy $X$ is defined as the global error for each measured point at a given primary current without taking into account the electrical offset, expressed in % of $I_{PN}$.

The formula for accuracy $X$ is:

$$X = X_G at I_P - I_{OE} \text{ referred to primary [in % of } I_{PN}]$$

Response and reaction times

The response time $t_r$ and the reaction time $t_{ra}$ are shown in figure 9.

Both depend on the primary current $d/dt$. They are measured at nominal ampere-turns.

Figure 9: Response time $t_r$ and reaction time $t_{ra}$
Safety

This transducer must be used in limited-energy secondary circuits according to IEC 61010-1.

⚠️

This transducer must be used in electric/electronic equipment with respect to applicable standards and safety requirements in accordance with the manufacturer’s operating instructions.

⚡️

Caution, risk of electrical shock

When operating the transducer, certain parts of the module can carry hazardous voltage (e.g. primary busbar, power supply). Ignoring this warning can lead to injury and/or cause serious damage.

This transducer is a build-in device, whose conducting parts must be inaccessible after installation.

A protective housing or additional shield could be used. Main supply must be able to be disconnected.
### Mechanical characteristics

- General tolerance: ±0.2 mm
- Fastening & connection of primary:
  - 6 pins 1.4 × 1 mm
  - 2 mm
- Fastening & connection of secondary:
  - 3 pins 0.7 × 0.6 mm
  - 1.2 mm

### Remarks

- $I_p$ is positive when $I_p$ flows from terminals (IN) to terminals (OUT).
- The jumper temperature and PCB should not exceed 100 °C.
- This is a standard model. For different versions (supply voltages, turns ratios, unidirectional measurements...), please contact us.
- Installation of the transducer must be done unless otherwise specified on the datasheet, according to LEM Transducer Generic Mounting Rules. Please refer to LEM document N'ANE120504 available on our Web site: Products/Product Documentation.