Current transducer LF 510-S  \( I_{PN} = 500 \, A \)

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

Features
- Bipolar and insulated current measurement up to 0.8 kA
- Current output
- Closed loop (compensated) current transducer
- Panel mounting.

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

Applications
- Windmills inverters
- Test and measurement
- Substations
- AC variable speed and servo motor drives
- Statics converters for DC motors drives
- Battery supplied applications
- Uninterruptible Power Supplies (UPS)
- Switched Mode Power Supplies (SMPS)
- Power supplies for welding applications.

Standard

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>±$U_c$</td>
<td>V</td>
<td>25.2</td>
</tr>
<tr>
<td>Primary conductor temperature</td>
<td>$T_b$</td>
<td>°C</td>
<td>100</td>
</tr>
<tr>
<td>Maximum steady state input current (-40 .. 85 °C)</td>
<td>$I_{pn}$</td>
<td>A</td>
<td>500</td>
</tr>
</tbody>
</table>

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>3.8</td>
<td></td>
</tr>
<tr>
<td>Impulse withstand voltage 1.2/50 µs</td>
<td>$U_{sw}$</td>
<td>kV</td>
<td>12.5</td>
<td></td>
</tr>
<tr>
<td>Insulation resistance</td>
<td>$R_{IS}$</td>
<td>MΩ</td>
<td>200</td>
<td>measured at 500 V DC</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>Clearance and creepage</td>
<td></td>
<td></td>
<td>See dimensions drawing on page 6</td>
<td></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>70</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ambient storage temperature</td>
<td>$T_s$</td>
<td>°C</td>
<td>-45</td>
<td>85</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mass</td>
<td>$m$</td>
<td>g</td>
<td>240</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Electrical data

At $T_a = 25 \degree C$, $\pm U_c = \pm 24 V$, $R_m = 1 \Omega$, unless otherwise noted.

Lines with a * in the conditions column apply over the -40 .. 85 \degree 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>Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary nominal rms current</td>
<td>$I_{PN}$</td>
<td>A</td>
<td>500</td>
<td>*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Primary current, measuring range</td>
<td>$I_{PM}$</td>
<td>A</td>
<td>-800</td>
<td>800</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>Measuring resistance</td>
<td>$R_M$</td>
<td>$\Omega$</td>
<td>0</td>
<td>Max value of $R_m$ is given in figure 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Secondary nominal rms current</td>
<td>$I_{SN}$</td>
<td>A</td>
<td>0.1</td>
<td>*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output range</td>
<td>$I_s$</td>
<td>A</td>
<td>-0.16</td>
<td>0.16</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>Number of secondary turns</td>
<td>$N_s$</td>
<td></td>
<td>5000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Supply voltage</td>
<td>$\pm U_c$</td>
<td>V</td>
<td>$\pm 14.25$</td>
<td>$\pm 25.2$</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>Current consumption</td>
<td>$I_C$</td>
<td>mA</td>
<td>52</td>
<td>58</td>
<td>$I_p = 0$, $\pm U_c = \pm 15 V$ $I_p = 0$, $\pm U_c = \pm 24 V$</td>
<td></td>
</tr>
<tr>
<td>Offset current, referred to primary</td>
<td>$I_O$</td>
<td>A</td>
<td>$\pm 1.3$</td>
<td>*</td>
<td>-40 .. 85 \degree C</td>
<td></td>
</tr>
<tr>
<td>Magnetic offset current, referred to primary</td>
<td>$I_{OM}$</td>
<td>A</td>
<td>$\pm 0.7$</td>
<td>*</td>
<td>After $I_p = \pm 2 kA$</td>
<td></td>
</tr>
<tr>
<td>Sensitivity error</td>
<td>$\epsilon_g$</td>
<td>%</td>
<td>-0.5</td>
<td>0.5</td>
<td>*</td>
<td>-40 .. 85 \degree C</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>-40 .. 85 \degree C</td>
</tr>
<tr>
<td>Overall accuracy at $I_{PN}$</td>
<td>$X_G$</td>
<td>% of $I_{PN}$</td>
<td>-0.6</td>
<td>0.6</td>
<td>*</td>
<td>-40 .. 85 \degree C</td>
</tr>
<tr>
<td>Output rms current noise referred to primary</td>
<td>$I_{no}$</td>
<td>A</td>
<td>0.12</td>
<td>1 Hz to 200 kHz (see figure 4)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reaction time @ 10 % of $I_{PN}$</td>
<td>$t_{ra}$</td>
<td>$\mu s$</td>
<td>&lt;0.5</td>
<td>0 to 500 A, 200 A/\mu s</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Step response time to 90 % of $I_{PN}$</td>
<td>$t_{r}$</td>
<td>$\mu s$</td>
<td>&lt;0.5</td>
<td>0 to 500 A, 200 A/\mu s</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Frequency bandwidth</td>
<td>$BW$</td>
<td>kHz</td>
<td>200</td>
<td>100</td>
<td>-3 dB, small signal bandwidth +3 dB (see figure 5)</td>
<td></td>
</tr>
</tbody>
</table>

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 a product.
**Typical performance characteristics**

**Figure 1:** Maximum measuring resistance ($T_A = -40 \ldots 85 \, ^°C$)

**Figure 2:** Typical step response (0 to 500 A, 200 A/µs)

**Figure 3:** Typical noise voltage density $e_{no}$

**Figure 4:** Typical total output current noise with $R_M = 1 \, \Omega$ (primary referred, rms) with $R_M = 1 \, \Omega$ ($f_c$ is upper cut off frequency of bandpass, low cut off frequency is 1 Hz).

Figure 3 (noise voltage density) shows if there are discrete frequencies in the output. To calculate the noise in a frequency band $f_1$ to $f_2$, the formula is:

$$I_{no} (f_1 \text{ to } f_2) = \sqrt{I_{no} (f_2)^2 - I_{no} (f_1)^2}$$

with $I_{no} (f)$ read from figure 4 (typical, rms value).

**Example:**

What is the noise from 1 to $10^6$ Hz?

Figure 4 gives $I_{no}(1 \, \text{Hz}) = 0.4 \, \text{mA}$ and $I_{no}(10^6 \, \text{Hz}) = 145 \, \text{mA}$. The output current noise (rms) is therefore:

$$\sqrt{(145 \cdot 10^{-3})^2 - (0.4 \cdot 10^{-3})^2} = 145 \, \text{mA referred to primary}$$
Typical performance characteristics continued

![Typical frequency response, small signal bandwidth](image)

**Performance parameters definition**

The schematic used to measure all electrical parameters are:

![Standard characterization schematics for voltage output transducers](image)

**Transducer simplified model**

The static model of the transducer at temperature $T_A$ is:

$$I_s = G \cdot I_p + \text{error}$$

In which:

- $I_s$: secondary current (A)
- $G$: sensitivity of the transducer (A/A)
- $I_p$: primary current (A)
- $I_{PM}$: primary current, measuring range (A)
- $T_A$: ambient operating temperature (°C)
- $I_{OE}$: electrical offset current (A)
- $I_{OM}$: magnetic offset current (A)
- $I_{OT}(T_A)$: temperature variation of $I_O$ at temperature $T_A$ (A)
- $\epsilon_G$: sensitivity error at 25 °C
- $\epsilon_{G1}(T_A)$: thermal drift of sensitivity at temperature $T_A$
- $\epsilon_L$: linearity error

This is the absolute maximum error. As all errors are independent, a more realistic way to calculate the error would be to use the following formula:

$$I_s = G \cdot I_p + \epsilon_G \cdot G \cdot I_p + \epsilon_{G1}(T_A) \cdot G \cdot I_p + \epsilon_L \cdot G \cdot I_{PM} + I_{OM}$$

**Sensitivity and linearity**

To measure sensitivity and linearity, the primary current (DC) is cycled from 0 to $I_{PM}$, then to $-I_{PM}$ and back to 0 (equally spaced $I_{PM}/10$ steps).

The sensitivity $G$ is defined as the slope of the linear regression line for a cycle between $\pm I_{PM}$.

The linearity error $\epsilon_L$ is the maximum positive or negative difference between the measured points and the linear regression line, expressed in % of the maximum measured value.

**Magnetic offset**

Due to its working principle, this type of transducer has no magnetic offset current $I_{OM}$.

**Electrical offset**

The electrical offset current $I_{OE}$ is the residual output current when the input current is zero.

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.

**Overall accuracy**

The overall accuracy $X_G$ is the error at ± $I_{PM}$ relative to the rated value $I_{PN}$. It includes all errors mentioned above.

**Response and reaction times**

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

Both slightly depend on the primary current $dI/dt$. They are measured at nominal current.

![Response time $t_r$ and reaction time $t_{ra}$](image)
**Mechanical characteristics**

- **General tolerance**: ±0.5 mm
- **Transducer fastening**
  - **Vertical position**: 6 holes ø 4.3 mm, 6 M4 steel screws
  - **Recommended fastening torque**: 2.1 N·m (±10 %)
- **Primary through-hole**: ø 30 mm, or 30 × 10 mm
- **Transducer fastening**
  - **Horizontal position**: 4 holes ø 4.3 mm, 4 M4 steel screws
  - **Recommended fastening torque**: 2.1 N·m (±10 %)
- **Connection of secondary**
  - MOLEX 3 pins

**Safety**

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

**Remarks**

- \( I_s \) is positive when \( I_p \) flows in the direction of arrow.
- The secondary cables also have to be routed together all the way.
- Installation of the transducer is to be done without primary current or secondary voltage present.
- Maximum temperature of primary conductor: see page 2.
- 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](http://www.lem.com).

**Caution, risk of electrical shock**

When operating the transducer, certain parts of the module can carry hazardous voltage (e.g. primary connection, 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.