# Current Transducer LF 1010-S

$I_{PN}$ = 1000 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
- Current output
- Closed loop (compensated) current transducer
- Panel mounting.

## Advantages

- High accuracy
- Very low offset drift over temperature.

## Applications

- Windmill inverters
- Test and measurement
- 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.

## Standards

- IEC 61010-1: 2010
- IEC 61800-5-1: 2007
- IEC 62109-1: 2010
- UL 508: 2013.

## Application Domain

- Industrial.



LEM International SA
Chemin des Aulx 8
1228 PLAN-LES-OUATES Switzerland
www.lem.com

## Absolute maximum ratings

| Parameter | Symbol | Unit | Value |
|---|---|---|---|
| Maximum supply voltage (working) (−40 … 85 °C) | $U_{C\ max}$ | V | ±25.2 |
| Maximum primary conductor temperature | $T_{B\ max}$ | °C | 100 |
| Maximum steady state primary nominal current (−40 … 85 °C) | $I_{P\ N\ max}$ | A | 1000 |

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: 9

### 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.

### Ratings

| Parameter | Symbol | Unit | Value |
|---|---|---|---|
| Primary involved potential | | V AC/DC | 1500 |
| Maximum ambient temperature | $T_A$ | °C | 85 |
| Primary current | $I_P$ | A | 1000 |
| Secondary supply voltage | $U_C$ | V DC | 24 |
| Secondary current | $I_S$ | mA | 200 |

### Conditions of acceptability

When installed in the end-use equipment, with primary feedthrough potential involved of 1500 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.*

*5 - LF 1010-S shall be used in a pollution degree 2.*

### 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.





LEM International SA
Chemin des Aulx 8
1228 PLAN-LES-OUATES Switzerland
www.lem.com

## Insulation coordination

| Parameter | Symbol | Unit | Value | Comment |
|---|---|---|---|---|
| RMS voltage for AC insulation test 50 Hz, 1 min (Type test) | $U_d$ | kV | 3.8 | Between primary and secondary |
| RMS voltage for AC insulation test 50 Hz, 2 sec (Routine test) | $U_d$ | kV | 3 | Between primary and secondary |
| Impulse withstand voltage 1.2/50 µs | $U_{Ni}$ | kV | 15.6 | |
| Clearance (pri. - sec.) | $d_{Cl}$ | mm | 19.0 | Shortest distance through air |
| Creepage distance (pri. - sec.) | $d_{Cp}$ | mm | 20.1 | Shortest path along device body |
| Application example<br>System voltage RMS | | V | 2600 | Basic insulation according to<br>IEC 61800-5-1<br>CAT III, PD2 |
| Application example<br>System voltage RMS | | V | 1000 | Reinforced insulation according to<br>IEC 61800-5-1<br>CAT III, PD2 |
| Application example<br>System voltage DC | | V | 1500 | Reinforced insulation according to<br>IEC 62109-1<br>CAT III, PD2 |
| Case material | - | - | V0 | According to UL 94 |
| Comparative tracking index | *CTI* | | 600 | |

## Environmental and mechanical characteristics

| Parameter | Symbol | Unit | Min | Typ | Max | Comment |
|---|---|---|---|---|---|---|
| Ambient operating temperature | $T_A$ | °C | −40 | | 85 | |
| Ambient storage temperature | $T_S$ | °C | −50 | | 90 | |
| Mass | $m$ | g | | 503 | | |



LEM International SA
Chemin des Aulx 8
1228 PLAN-LES-OUATES Switzerland
www.lem.com

## Electrical data

At $T_A$ = 25 °C, $\pm U_C$ = ±24 V, $R_M$ = 1 Ω, unless otherwise noted.
Lines with a * in the conditions column apply over the −40 … 85 °C ambient temperature range.

| Parameter | Symbol | Unit | Min | Typ | Max | | Conditions |
|---|---|---|---|---|---|---|---|
| Primary nominal RMS current | $I_{PN}$ | A | | | 1000 | * | |
| Primary current, measuring range | $I_{PM}$ | A | −2700 | | 2700 | * | With $U_C$ = ±22.8 V; $T_A$ = +85 °C; $R_M$ = 1 Ω<br>For other conditions, see figure 1 |
| Measuring resistance | $R_M$ | Ω | 0 | | | * | Max value of $R_M$ is given in figure 1 |
| Secondary nominal RMS current | $I_{SN}$ | A | −0.2 | | 0.2 | * | |
| Resistance of secondary winding | $R_S$ | Ω | | | 30.2 | | $R_S(T_A) = R_S \times (1 + 0.004 \times (T_A + \Delta\text{temp}-25))$<br>Estimated temperature increase @$I_{PN}$ is Δtemp = 15 °C |
| Secondary current | $I_S$ | A | −0.54 | | 0.54 | * | |
| Number of secondary turns | $N_S$ | | | 5000 | | | |
| Nominal sensitivity | $S_N$ | mA/A | | 0.2 | | | |
| Supply voltage | $\pm U_C$ | V | ±14.25 | | ±25.2 | * | |
| Current consumption | $I_C$ | mA | | 44 + $I_S$<br>49 + $I_S$ | | | $\pm U_C$ = ±15 V<br>$\pm U_C$ = ±24 V |
| Offset current, referred to primary | $I_O$ | A | −1 | | 1 | | |
| Temperature variation of $I_O$, referred to primary | $I_{OT}$ | A | −0.6 | | 0.6 | * | |
| Magnetic offset current after 3 × $I_{PN}$, referred to primary | $I_{OM}$ | A | | ±1 | | | |
| Sensitivity error | $\varepsilon_S$ | % | −0.15 | | 0.15 | * | |
| Linearity error | $\varepsilon_L$ | % of $I_{PN}$ | −0.15 | | 0.15 | * | |
| Total error at $I_{PN}$ | $\varepsilon_{tot}$ | % of $I_{PN}$ | −0.2<br>−0.4 | | 0.2<br>0.4 | * | 25 ... 70 ... 85 °C<br>−40 … 85 °C |
| RMS noise current, referred to primary | $I_{no}$ | mA | | 50 | | | 1 Hz to 20 kHz (see figure 4) |
| Delay time @ 10 % of $I_{PN}$ | $t_{D\,10}$ | µs | | < 0.5 | | | 0 to 1 kA, 200 A/µs |
| Delay time to 90 % of $I_{PN}$ | $t_{D\,90}$ | µs | | < 0.5 | | | 0 to 1 kA, 200 A/µs |
| Frequency bandwidth | $BW$ | kHz | | 200 | | | −3 dB, small signal bandwidth (see figure 5) |

## 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.

## Typical performance characteristics

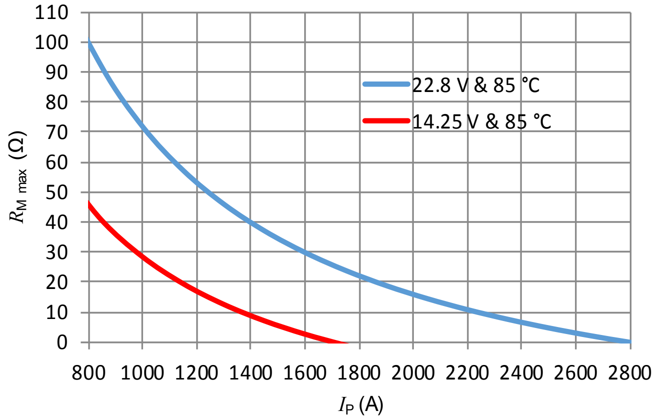



Figure 1: Maximum measuring resistance

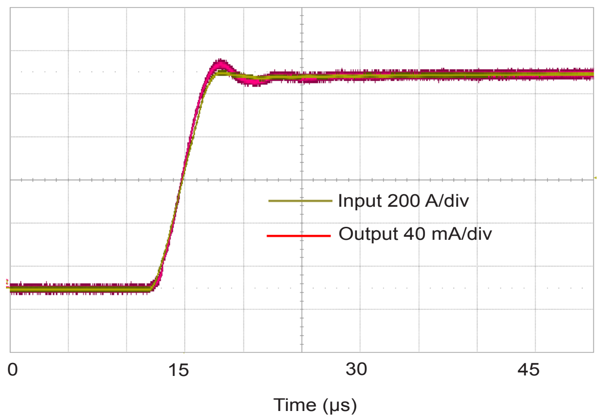



Figure 2: Typical step response (0 to 1 kA, 200 A/μs)

$$R_{M\ max} = N_S \times \frac{U_{C\ min} - 0.5\ V}{I_P} - R_{S\ max} - 0.93\ \Omega$$

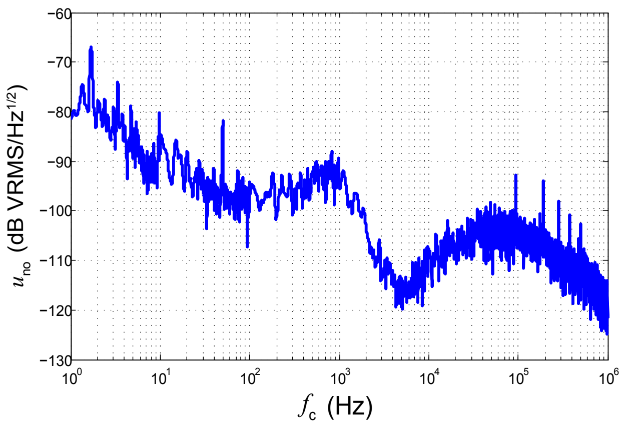



Figure 3: Typical noise voltage spectral density referred to primary $u_{no}$ with $R_M$ = 100 Ω

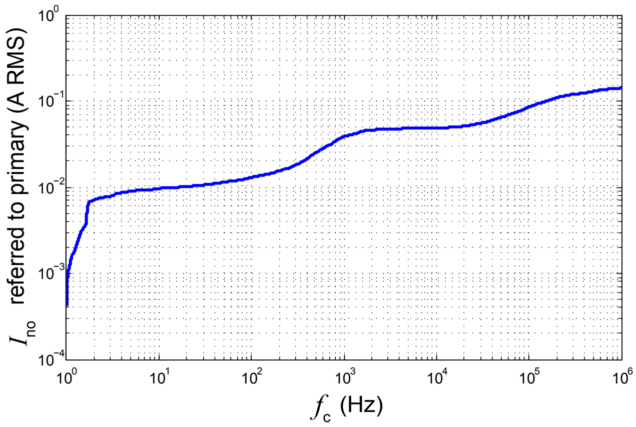



Figure 4: Typical total RMS noise current referred to primary $I_{no}$ with $R_M$ = 100 Ω

To calculate the noise in a frequency band $f_1$ to $f_2$, the formula is:

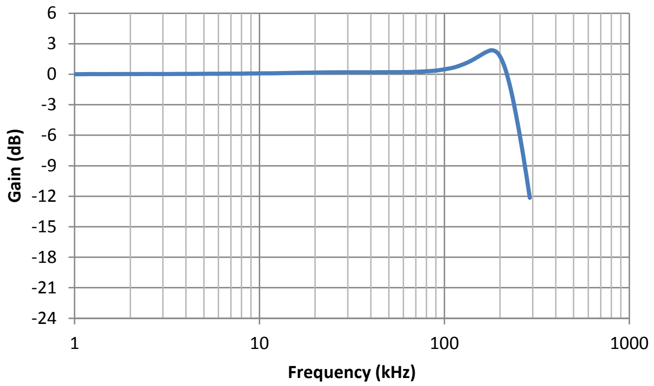
$$I_{no}(f_1 \text{ to } f_2) = \sqrt{I_{no}(f_2)^2 - I_{no}(f_1)^2}$$

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 Hz) = 0.5 mA and $I_{no}$ ($10^6$ Hz) = 199 mA.
The output RMS noise current is therefore:

$$\sqrt{(199 \times 10^{-3})^2 - (0.5 \times 10^{-3})^2} = 199 \text{ mA referred to primary}$$

## Typical performance characteristics continued



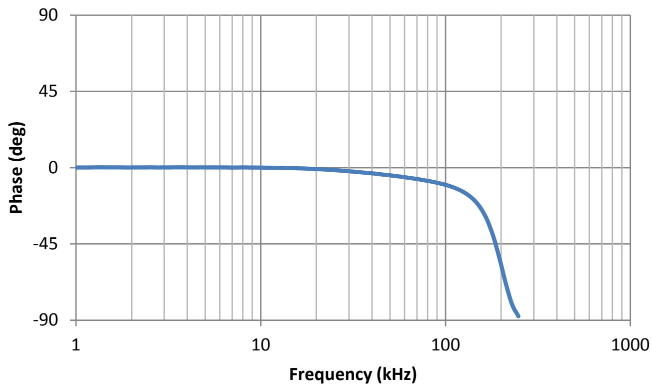




Figure 5: Typical frequency response, small signal bandwidth

## Performance parameters definition

### Sensitivity and linearity

To measure sensitivity and linearity, the primary current (DC) is cycled from 0 to $I_{\mathrm{P\,M}}$, then to $-I_{\mathrm{P\,M}}$ and back to 0 (equally spaced $I_{\mathrm{P\,M}}/10$ steps).
The sensitivity $S$ is defined as the slope of the linear regression line for a cycle between $\pm I_{\mathrm{P\,M}}$.
The linearity error $\varepsilon_{\mathrm{L}}$ 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

The magnetic offset $I_{\mathrm{O\,M}}$ is the change of offset after a given current has been applied to the input. It is included in the linearity error as long as the transducer remains in its measuring range.

### Electrical offset

The electrical offset current $I_{\mathrm{O\,E}}$ is the residual output current when the input current is zero.

### Total error

The total error $\varepsilon_{\mathrm{tot}}$ is the error at $\pm I_{\mathrm{P\,N}}$, relative to the rated value $I_{\mathrm{P\,N}}$.
It includes all errors mentioned above.

### Delay time

The delay time $t_{\mathrm{D\,10}}$ @ 10 % and the delay time $t_{\mathrm{D\,90}}$ @ 90 % with respect to the primary are shown in the next figure.
Both slightly depend on the primary current d$i$/d$t$.
They are measured at nominal current.

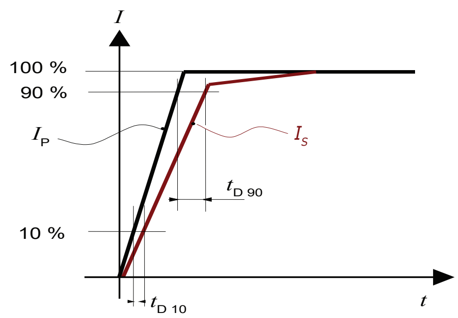



Figure 6: $t_{\mathrm{D\,10}}$ (delay time @ 10 %) and $t_{\mathrm{D\,90}}$ (delay time @ 90 %)

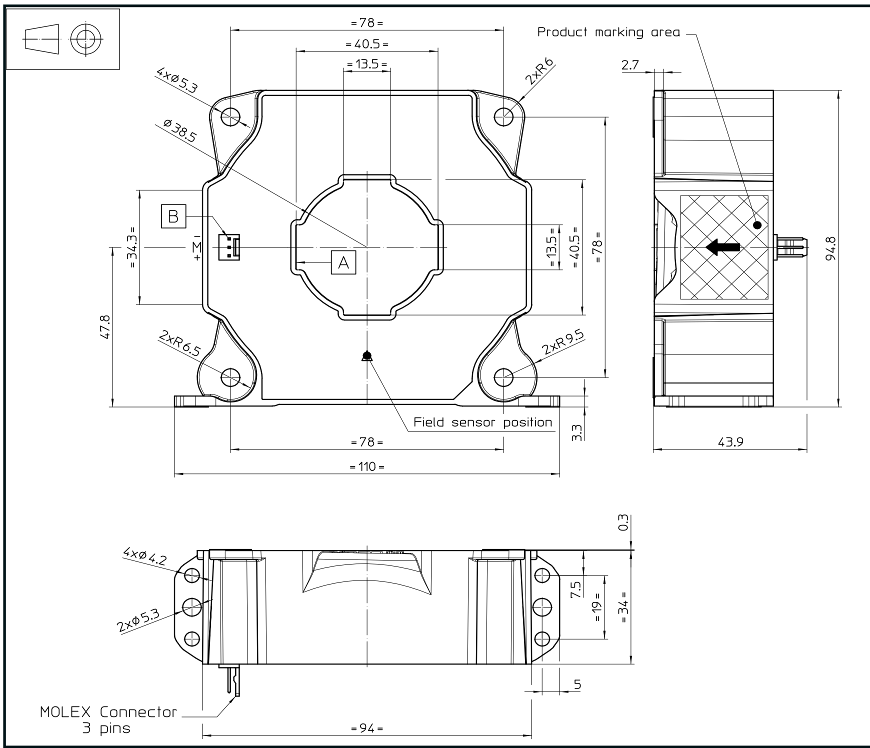






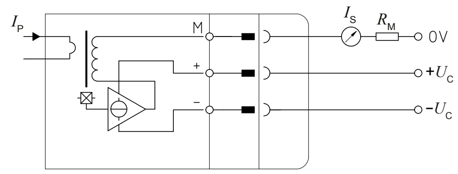
LEM International SA
Chemin des Aulx 8
1228 PLAN-LES-OUATES Switzerland
www.lem.com

## Dimensions (in mm)




| | $d_{Cl}$ (mm) | $d_{Cp}$ (mm) |
|---|---|---|
| A-B | 19.0 | 20.1 |

### Connection




## Mechanical characteristics

- General tolerance ±0.5 mm
- Transducer fastening
  Vertical position 2 holes ⌀ 5.3 mm
  2 M5 steel screws
  Recommended fastening torque 3.2 N·m (±10 %)
  Or 4 holes ⌀ 4.2 mm
  4 M4 steel screws
  Recommended fastening torque 2.1 N·m (±10 %)
- Primary through-hole ⌀ 38 mm
  Or 40 mm × 13 mm
- Transducer fastening
  Horizontal position 4 holes ⌀ 5.3 mm
  4 M5 steel screws
  Recommended fastening torque 3.2 N·m (±10 %)
- Connection of secondary Molex 6410

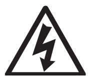
## Remarks

- $I_S$ 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.
- 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: **https://www.lem.com/en/file/3137/download/.**

## Safety

This transducer must be used in limited-energy secondary circuits according toIEC 61010-1 and IEC 61800-5-1..

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 (eg. 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.