Current Transducer LT 10000-S

I_{PN} = 10000 A

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

5 YEAR WARRANTY by LEM   C E   RoHS

Features

- Bipolar and insulated current measurement
- Current output
- Closed loop (compensated) current transducer using the Hall effect
- Panel mounting.

Advantages

- Excellent accuracy
- Very good linearity
- Low temperature drift
- Optimized delay time
- Wide frequency bandwidth
- No insertion losses
- High immunity to external interference
- Current overload capability.

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.

Standards

- IEC 61010-1: 2016
- EN 61326-1: 2012.

Application Domain

- Industrial.

Safety

Caution

If the device is used in a way that is not specified by the manufacturer, the protection provided by the device may be compromised.
Always inspect the electronics unit and connecting cable before using this product and do not use it if damaged.
Mounting assembly shall guarantee the maximum primary conductor temperature, fulfill clearance and creepage distance, minimize electric and magnetic coupling, and unless otherwise specified can be mounted in any orientation.

Caution, risk of electrical shock

This transducer must be used in limited-energy secondary circuits SELV according to IEC 61010-1, in electric/electronic equipment with respect to applicable standards and safety requirements in accordance with the manufacturer's operating specifications.

Use caution during installation and use of this product; certain parts of the module can carry hazardous voltages and high currents (e.g. power supply, primary conductor).
Ignoring this warning can lead to injury and/or cause serious damage.
De-energize all circuits and hazardous live parts before installing the product.
All installations, maintenance, servicing operations and use must be carried out by trained and qualified personnel practicing applicable safety precautions.

This transducer is a build-in device, whose hazardous live parts must be inaccessible after installation.
This transducer must be mounted in a suitable end-enclosure.
Besides make sure to have a distance of minimum 30 mm between the primary terminals of the transducer and other neighboring components.

Main supply must be able to be disconnected.
Always inspect the current transducer for damage before using this product.
Never connect or disconnect the external power supply while the primary circuit is connected to live parts.
Never connect the output to any equipment with a common mode voltage to earth greater than 30 V.
Always wear protective clothing and gloves if hazardous live parts are present in the installation where the measurement is carried out.
This transducer is a built-in device, not intended to be cleaned with any product. Nevertheless if the user must implement cleaning or washing process, validation of the cleaning program has to be done by himself.

ESD susceptibility
The product is susceptible to be damaged from an ESD event and the personnel should be grounded when handling it.

Do not dispose of this product as unsorted municipal waste. Contact a qualified recycler for disposal.

Absolute maximum ratings

Parameter	Symbol	Unit	Value
Maximum supply voltage (working) (−25 … 70 °C)	$\pm U_{C\,max}$	V	±63
Maximum primary conductor temperature	$T_{B\,max}$	°C	100

Absolute maximum ratings apply at 25 °C unless otherwise noted.
Stresses above these ratings may cause permanent damage.
Exposure to absolute maximum ratings for extended periods may degrade reliability.

Environmental and mechanical characteristics

Parameter	Symbol	Unit	Min	Typ	Max	Comment
Ambient operating temperature	T_A	°C	−25		70	
Ambient storage temperature	$T_{A\,st}$	°C	−40		85	
Relative humidity	RH	%	20		50	non-condensing @ 40 °C
Mass	m	kg		17		
Altitude		m			2000 [1]	

Note: [1] Insulation coordination at 2000 m.

Insulation coordination

Parameter	Symbol	Unit	≤ Value	Comment
RMS voltage for AC insulation test, 50 Hz, 1 min	U_d	kV	10	Between primary and secondary + screen
			1	Between secondary and screen
Clearance (pri. - sec.)	d_{Cl}	mm	81.45	Shortest distance through air
Creepage distance (pri. - sec.)	d_{Cp}	mm	100.8	Shortest path along device body
Case material	-	-	V0	According to UL 94
Comparative tracking index	CTI		100	Material group IIIb
Application example RMS voltage line-to-neutral		V	> 1000	Basic insulation according to IEC 61010-1 CAT III, PD2
Application example RMS voltage line-to-neutral		V	> 1000	Reinforced insulation according to IEC 61010-1 CAT III, PD2

Electrical data

At T_A = 25 °C unless otherwise noted (see Min, Max, typ, definition paragraph).

Parameter	Symbol	Unit	Min	Typ	Max	Comment
Primary nominal AC RMS current (continuous)	I_{PNAC}	A	−10000		10000	$f \le$ 100 Hz
Primary current, measuring range	I_{PM}	A	−12000		12000	With $\pm U_C$ = ±48 V (−5 %), T_A = 70 °C, R_M = 1 Ω; for other conditions, see figure 1
			−15000		15000	With $\pm U_C$ = ±60 V (−5 %), T_A = 70 °C, R_M = 1.5 Ω; duration max 1 s/min for other conditions, see figure 2
Measuring resistance	R_M	Ω	0			see figure 1 & figure 2
Secondary nominal RMS current	I_{SN}	A	−1		1	
Resistance of secondary winding	R_S	Ω	24	24.6	25	@ 25 °C [1]
Number of secondary turns	N_S			10000		
DC supply voltage ⎓	U_C	V	±45.6		±63	
DC current consumption ⎓	I_C	mA	35	$37 + I_S \times N_P / N_S$	40	@ U_C = ±60 V @ 25 °C
Total error	ε_{tot}	%			±0.3	@ 25 °C (@ I_{PN}) see figure 3
Electrical offset current	I_{OE}	mA			±1.5	@ 25 °C (@ I_P = 0)
Temperature variation of I_{OE}	I_{OT}	mA		±0.6	±0.8	referred to 25 °C
Linearity error	ε_L	% of I_{PN}			< 0.1	@ 25 °C, see figure 4
RMS noise 1 Hz … 10 MHz referred to primary	I_{no}	mA		90		
Delay time to 10 % of the final output value I_{PN} step	t_{D10}	µs		< 1		With di/dt > 50 A/µs
Delay time to 90 % of the final output value I_{PN} step	t_{D90}	µs		< 1		With di/dt > 50 A/µs
Frequency bandwidth (−1 dB)	BW	kHz		100		With $\pm U_C$ = ±60 V, T_A = 25 °C

Note: [1] $R_S(T_A) = R_S \times (1 + 0.004 \times (T_A + \Delta \text{Temp} - 25))$ estimated temperature increase @ I_{PN} is ΔTemp = 15 °C.

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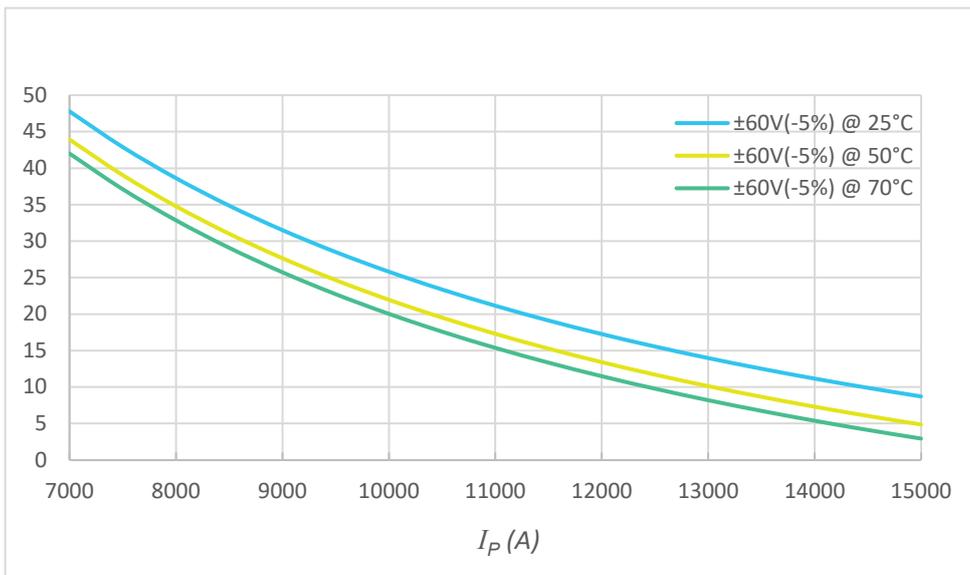
Typical, maximal and minimal values are determined during the initial characterization of the product.

Typical performance characteristics

$$R_{M\,max} = N_S \times \frac{U_{C\,min} - 5\,V}{I_P} - R_{S\,max}$$
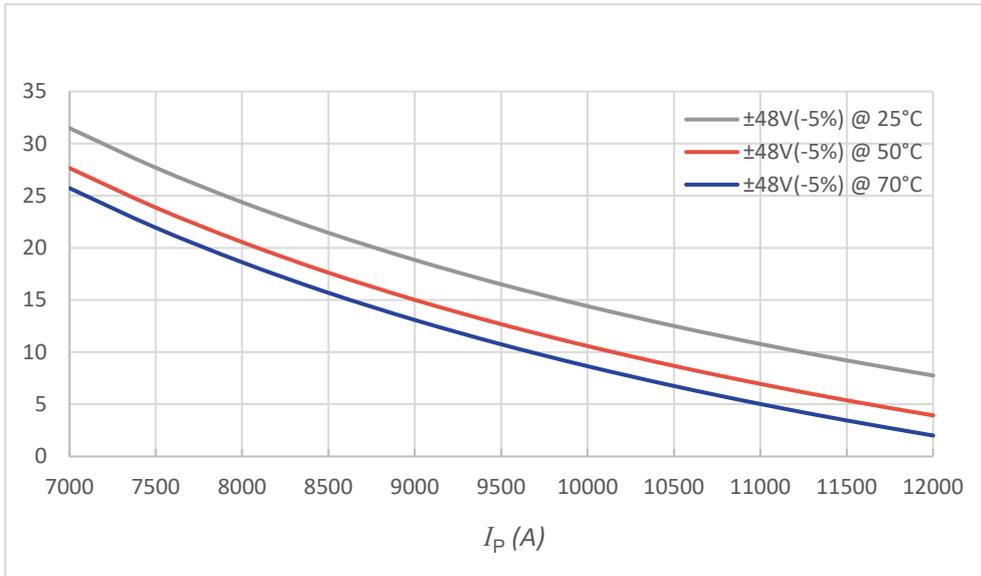
Figure 1: Maximun measuring resistance @ ±48 V

$$R_{M\,max} = N_S \times \frac{U_{C\,min} - 5\,V}{I_P} - R_{S\,max}$$
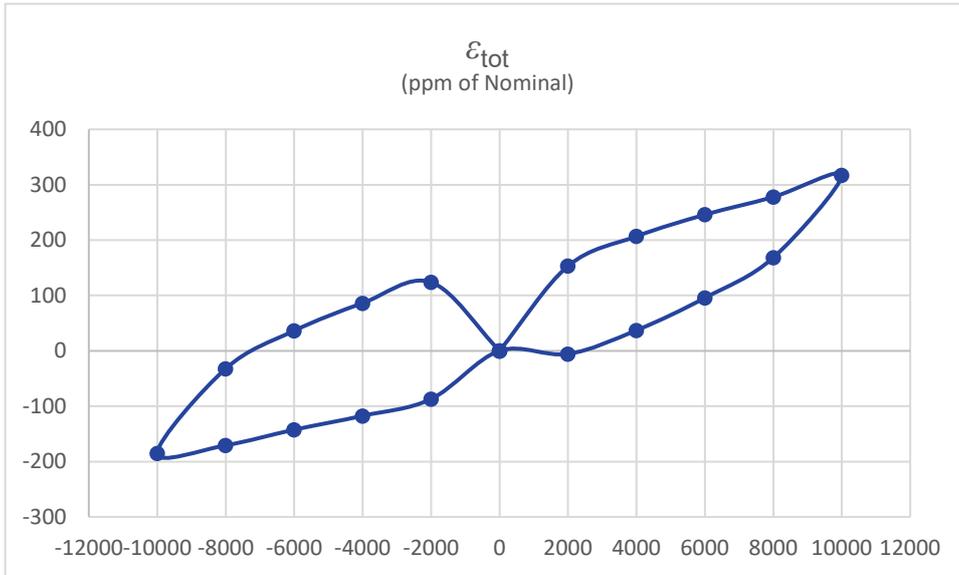
Figure 2: Maximun measuring resistance @ ±60 V

$$\varepsilon_{tot}$$
(ppm of Nominal)

Figure 3: ε_{tot} @ 25 °C, U_C = ±60 V with R_M = 0.1 Ω
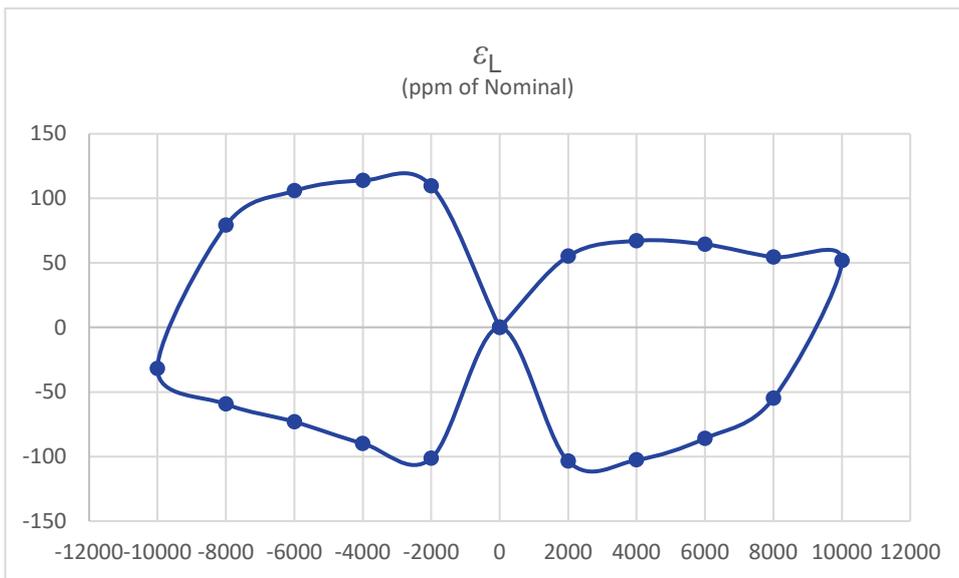
$$\varepsilon_L$$
(ppm of Nominal)

Figure 4: ε_L @ 25 °C, U_C = ±60 V with R_M = 0.1 Ω

Terms and definitions

Ampere-turns and amperes

The transducer is sensitive to the primary current linkage Θ_P (also called ampere-turns).

$$\Theta_P = N_P \cdot I_P$$

Where N_P is the number of primary turn.

Caution: As most applications will use the transducer with only one single primary turn ($N_P = 1$), much of this datasheet is written in terms of primary current instead of current linkages. However, the ampere-turns (A) unit is used to emphasis that current linkages are intended and applicable.

Simplified transducer model

The static model of the transducer with current output at temperature T_A is:

$$I_S = \Theta_P \cdot (1 + \varepsilon)$$

In which (referred to primary):

$$\varepsilon \cdot \Theta_P = I_{O\,E} + I_{O\,T} + \varepsilon_L(\Theta_{P\,max}) \cdot \Theta_{P\,max} + I_{O\,M}$$

$\Theta_P = N_P \cdot I_P$: primary current linkage (A)
$\Theta_{P\,max}$: maximum primary current linkage applied to the transducer
I_S : secondary current (A)
T_A : ambient operating temperature (°C)
$I_{O\,E}$: electrical offset current (A)
$I_{O\,M}$: magnetic offset current (A)
$I_{O\,T}$: temperature variation of $I_{O\,E}$ (A)
$\varepsilon_L(\Theta_{P\,max})$: linearity error for $\Theta_{P\,max}$

This model is valid for primary ampere-turns Θ_P between $-\Theta_{P\,max}$ and $+\Theta_{P\,max}$ only.

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:

$$\varepsilon = \sqrt{\sum_{i=1}^{N} \varepsilon_i^2}$$

Total error referred to primary

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

● the electrical offset $I_{O\,E}$
● the magnetic offset $I_{O\,M}$
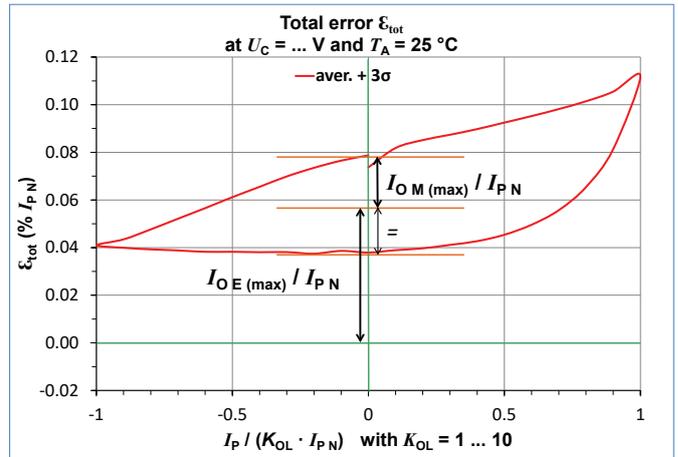● the linearity error ε_L (to $I_{P\,N}$).

Figure 5: Total error ε_{tot}

Electrical offset referred to primary

Using the current cycle shown in figure 6 the electrical offset current $I_{O\,E}$ is the residual output referred to primary when the input current is zero.

$$I_{O\,E} = \frac{I_{P(3)} + I_{P(5)}}{2}$$

The temperature variation $I_{O\,T}$ of the electrical offset current $I_{O\,E}$ is the variation of the electrical offset from 25 °C to the considered temperature.

$$I_{O\,T}(T) = U_{O\,E}(T) - U_{O\,E}(25\ ^\circ C)$$

Magnetic offset referred to primary

The magnetic offset current $I_{O\,M}$ 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. $I_{O\,M}$ depends on the current value $I_P \geq I_{P\,N}$.
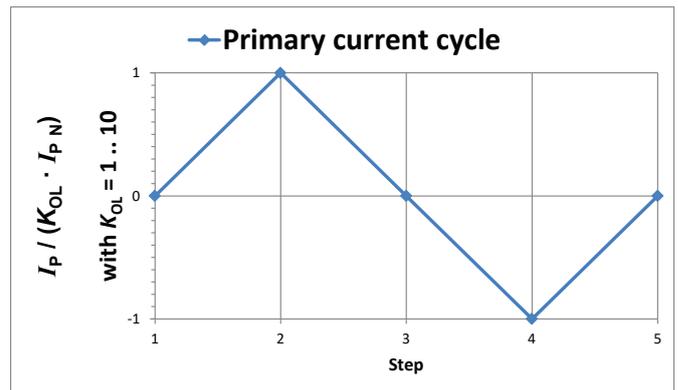K_{OL}: Overload factor

Figure 6: Current cycle used to measure magnetic and electrical offset (transducer supplied)

$$I_{O\,M} = \frac{I_{P(3)} - I_{P(5)}}{2}$$

Sensitivity and linearity

To measure sensitivity and linearity, the primary current (DC) is cycled from 0 to I_P, then to $-I_P$ and back to 0 (equally spaced $I_P/10$ steps). The linearity error ε_L is the maximum positive or negative difference between the measured points and the linear regression line, expressed in % of I_{PN}.

Delay times

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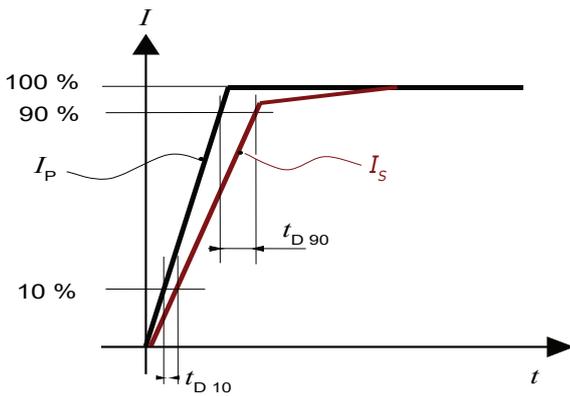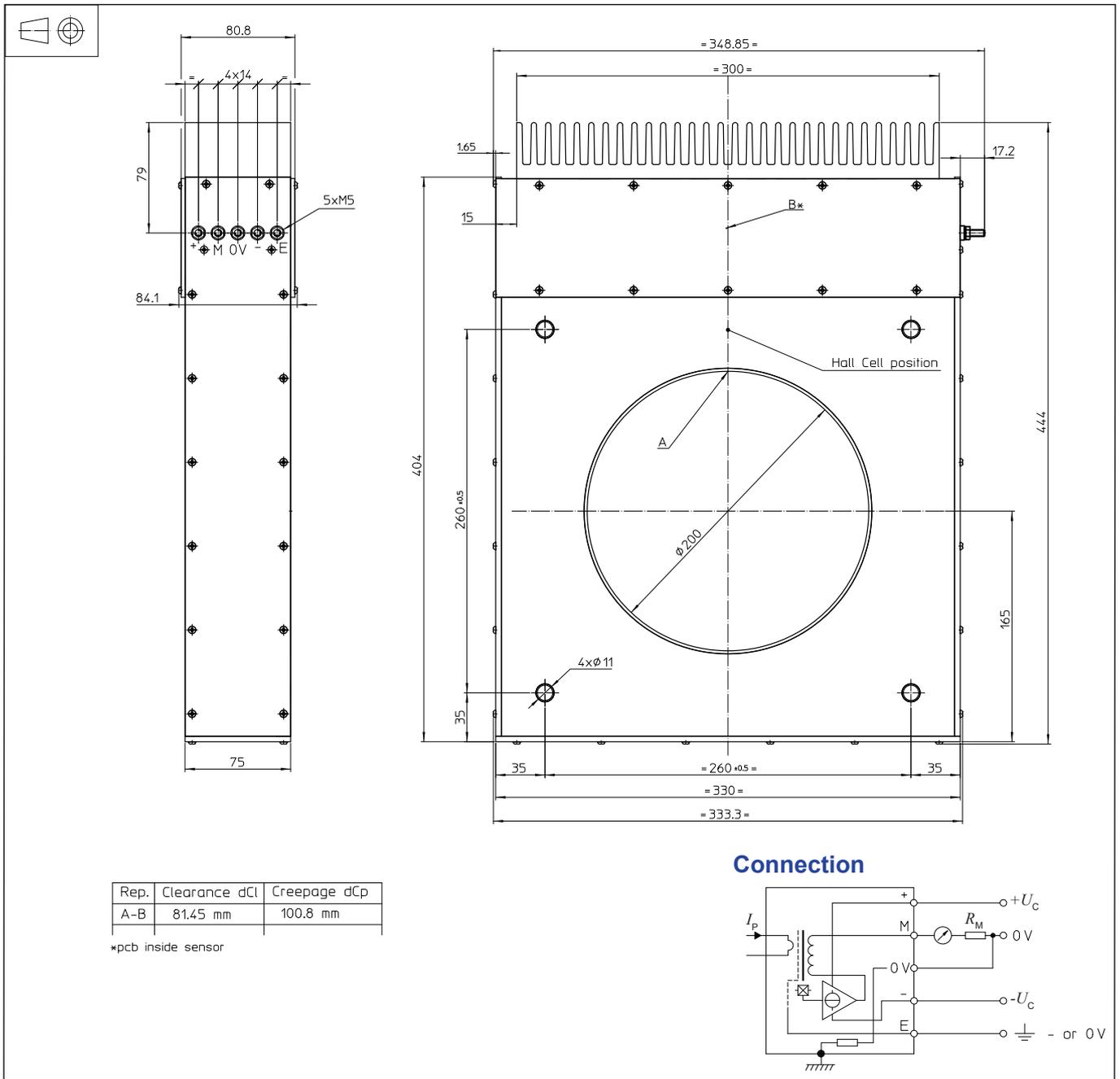They are measured at nominal current.

Figure 7: $t_{D\,10}$ (delay time @ 10 %) and
$t_{D\,90}$ (delay time @ 90 %).

LEM reserves the right to carry out modifications on its transducers,
in order to improve them, without prior notice

Dimensions (in mm)

Rep.	Clearance dCl	Creepage dCp
A–B	81.45 mm	100.8 mm

*pcb inside sensor

Connection

Mechanical characteristics

- General tolerance — ±1 mm
- Transducer fastening — 4 holes Ø 11 mm
  4 × M10 steel screws
  Recommended fastening torque — 17 N·m (±10 %)
- Connection of primary — Ø 200 mm
- Connection of secondary — M5 threaded studs
  Recommended fastening torque — 2.2 N·m (±10 %)

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.
- Dynamics performances "delay time" are best with a single bar completely filling the primary hole.
- 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