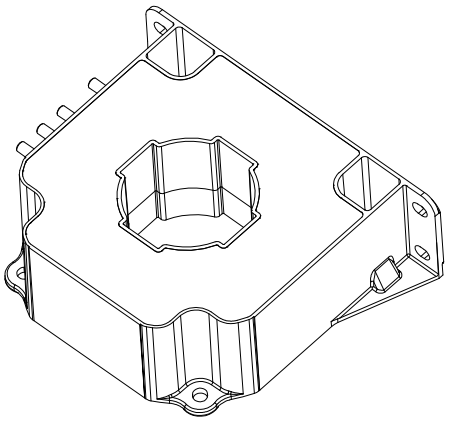
Current transducer LF 2010-S/SP28

I_{PN} = 2000 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 3.5 kA
- Current output
- Closed loop (compensated) current transducer
- Panel mounting.

Special features

- I_{PM} = 0 ... ±3500 A
- U_d = 12 kV
- Shield between primary and secondary
- Connection to secondary on M5 threaded studs.

Advantages

- High accuracy
- Very low offset drift over temperature.

Applications

- Single or three phase inverters
- Propulsion and braking choppers
- Propulsion converters
- High power drives
- Substations.

Standards

- EN 50155: 2021
- EN 50124-1: 2017
- EN 50121-3-2: 2016
- UL 508: 2010.

Application Domain

- Railway (fixed installations and onboard).

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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.
Safe and trouble-free operation of this transducer can only be guaranteed if transport, storage and installation are carried out correctly and are carried out with care.
If not working, the current transducer shall be replaced by an equivalent device.
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.

Underwriters Laboratory Inc. recognized component

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Absolute maximum ratings

Parameter	Symbol	Unit	Value
Maximum supply voltage (working) (−40 … 85 °C)	$\pm U_{C\ max}$	V	±25.2
Primary conductor temperature	T_B	°C	100
Maximum steady state primary current (−40 … 85 °C)	$I_{P\ N\ max}$	A	2000

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

Conditions of acceptability

When installed in the end-use equipment, with primary feedthrough 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.

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Insulation coordination

Parameter	Symbol	Unit	Value	Comment
RMS voltage for AC insulation test, 50 Hz, 1 min	U_d	kV	12 1	Between primary and secondary + shield Between shield and secondary
Impulse withstand voltage 1.2/50 µs	U_{Ni}	kV	23.2	
Partial discharge RMS test voltage (q_m< 10 pC)	U_t	kV	4.8	Test carried out with a non insulated bar, diameter 40 mm, centered in the through-hole
Insulation resistance	R_{INS}	MΩ	200	measured at 500 V DC
Application example Rated insulation voltage RMS voltage	U_{Nm}	V	3700	Reinforced insulation according to IEC 62497-1, CAT III, PD2
Application example Rated insulation voltage RMS voltage	U_{Nm}	V	8000	Basic insulation according to IEC 62497-1, CAT III, PD2
Clearance (pri. - sec.)	d_{Cl}	mm	53.7	Shortest distance through air
Creepage distance (pri. - sec.)	d_{Cp}	mm	53.8	Shortest path along device body
Comparative tracking index	CTI		600	
Case material	-	-	V0	According to UL 94

Environmental and mechanical characteristics

Parameter	Symbol	Unit	Min	Typ	Max	Comment
Ambient operating temperature	T_A	°C	−40		85	
Ambient storage temperature	$T_{A\,st}$	°C	−50		90	
Equipment operating temperature class						EN 50155: OT6
Switch-on extended operating temperature class						EN 50155: ST0
Rapid temperature variation class						EN 50155: H2
Conformal coating type						EN 50155: NA
Mass	m	g		1500		

RAMS data

Parameter	Symbol	Unit	Min	Typ	Max
Useful life class					EN 50155: L4
Mean failure rate	$\bar{\lambda}$	h^{-1}		1/2961551.6	According to IEC 62380: 2004 T_A = 45 °C ON: 20 hrs/day ON/OFF: 320 cycles/year U_C = ±24 V, I_P = 2000 A DC

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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			2000	*	
Primary current, measuring range	I_{PM}	A	−3500		3500	*	
Measuring resistance	R_M	Ω	0			*	Max value of R_M is given in figure 1
Secondary nominal RMS current	I_{SN}	A			0.4	*	
Resistance of secondary winding	R_S	Ω			18.6		$R_S(T_A) = R_S \times (1 + 0.004 \times (T_A + \Delta temp - 25))$ Estimated temperature increase @I_{PN} is $\Delta temp$ = 15 °C
Secondary current	I_S	A	−0.7		0.7	*	
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		42 + I_S 48 + I_S			$\pm U_C$ = ±15 V $\pm U_C$ = ±24 V
Inrush current							NA (EN 50155)
Interruptions on power supply voltage class							NA (EN 50155)
Supply change-over class							NA (EN 50155)
Offset current, referred to primary	I_O	A	−1		1		
Temperature variation of I_O, referred to primary	I_{OT}	A	−1		1	*	
Magnetic offset current, referred to primary	I_{OM}	A		±1			After 3 × I_{PN}
Sensitivity error	ε_S	%	−0.15		0.15	*	
Linearity error	ε_L	% of I_{PN}	−0.1		0.1	*	
Total error	ε_{tot}	% of I_{PN}	−0.2 −0.3		0.2 0.3	 *	25 … 70 … 85 °C −40 … 85 °C
RMS noise current referred to primary	I_{no}	mA		90			1 Hz to 20 kHz (see figure 4)
Delay time to 10 % of the final output value I_{PN} step	t_{D10}	µs		< 0.5			0 to 1 kA, 200 A/µs
Delay time to 90 % of the final output value I_{PN} step	t_{D90}	µs		< 0.5			0 to 1 kA, 200 A/µs
Frequency bandwidth	*BW*	kHz		150			−3 dB, small signal bandwidth

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, minimum and maximum values are determined during the initial characterization of the product.

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Typical performance characteristics

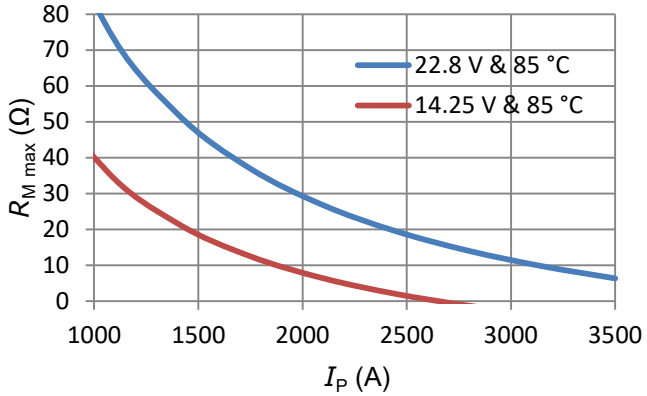

Figure 1: Maximum measuring resistance

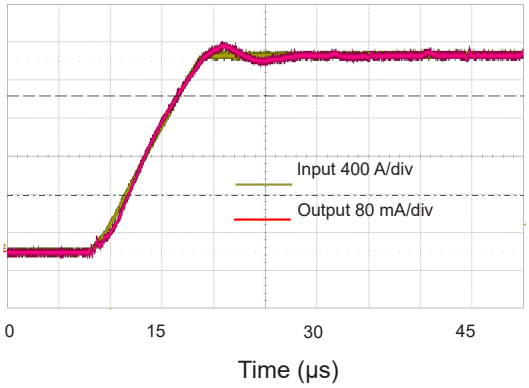

Figure 2: Typical step response (0 to 2 kA, 200 A/µs)

$$R_{M\ max} = N_S \times \frac{U_{C\ min} - 1.3\ V}{I_P} - R_{S\ max}\ \Omega$$

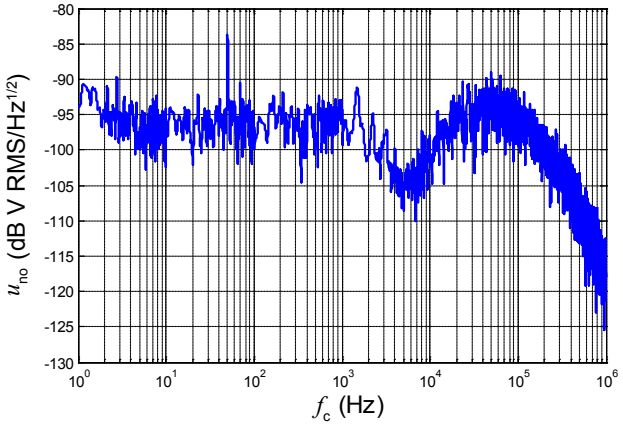

Figure 3: Typical noise voltage density u_{no} with R_M = 100 Ω

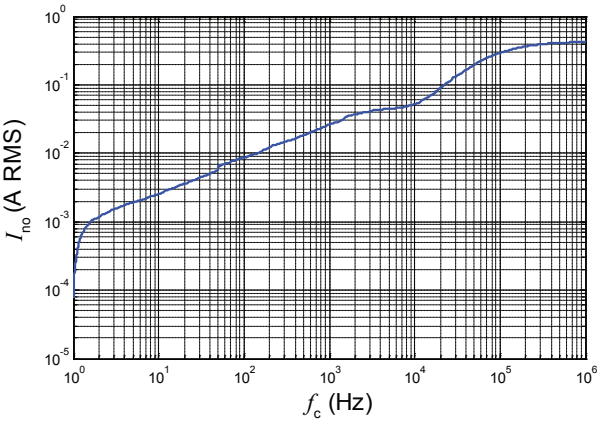

Figure 4: Typical total output current noise with R_M = 100 Ω (primary referred, RMS)

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

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

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) = 0.2 mA and I_{no} (10^6 Hz) = 400 mA.
The output current noise (RMS) is therefore:

$\sqrt{(400 \times 10^{-3})^2 - (0.2 \times 10^{-3})^2}$ = 400 mA referred to primary

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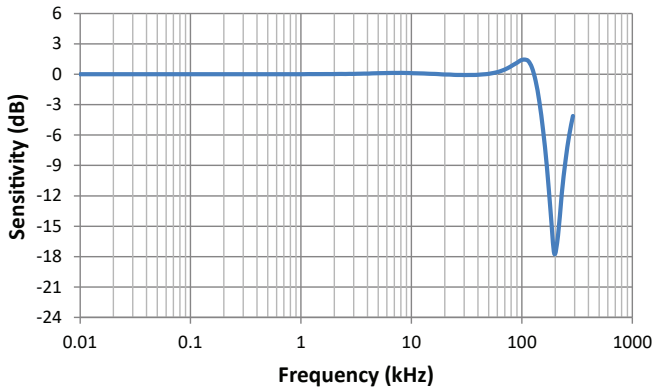
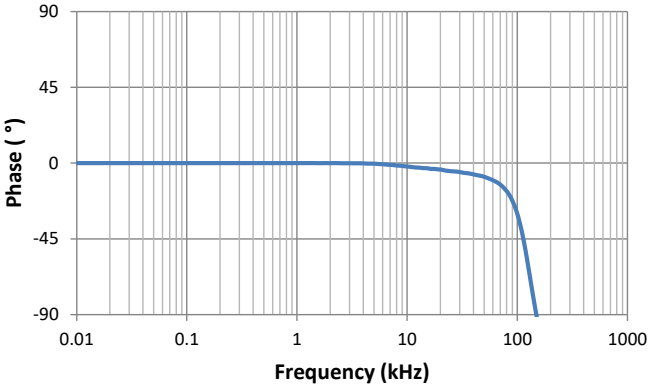
Typical performance characteristics





Figures 5 and 6: 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_{PM}, then to $-I_{PM}$ and back to 0 (equally spaced I_{PM}/10 steps).
The sensitivity S is defined as the slope of the linear regression line for a cycle between $\pm I_{PM}$.
The linearity error ε_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_{OM} 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_{OE} is the residual output current when the input current is zero.

Total error

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

Delay times

The delay time t_{D10} @ 10 % and the delay time t_{D90} @ 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.

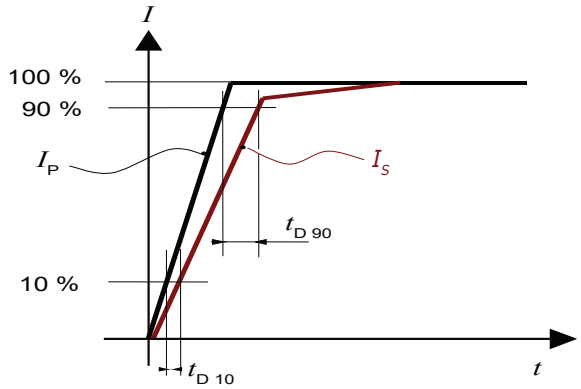


Figure 7: t_{D10} (delay time @ 10 %) and t_{D90} (delay time @ 90 %)

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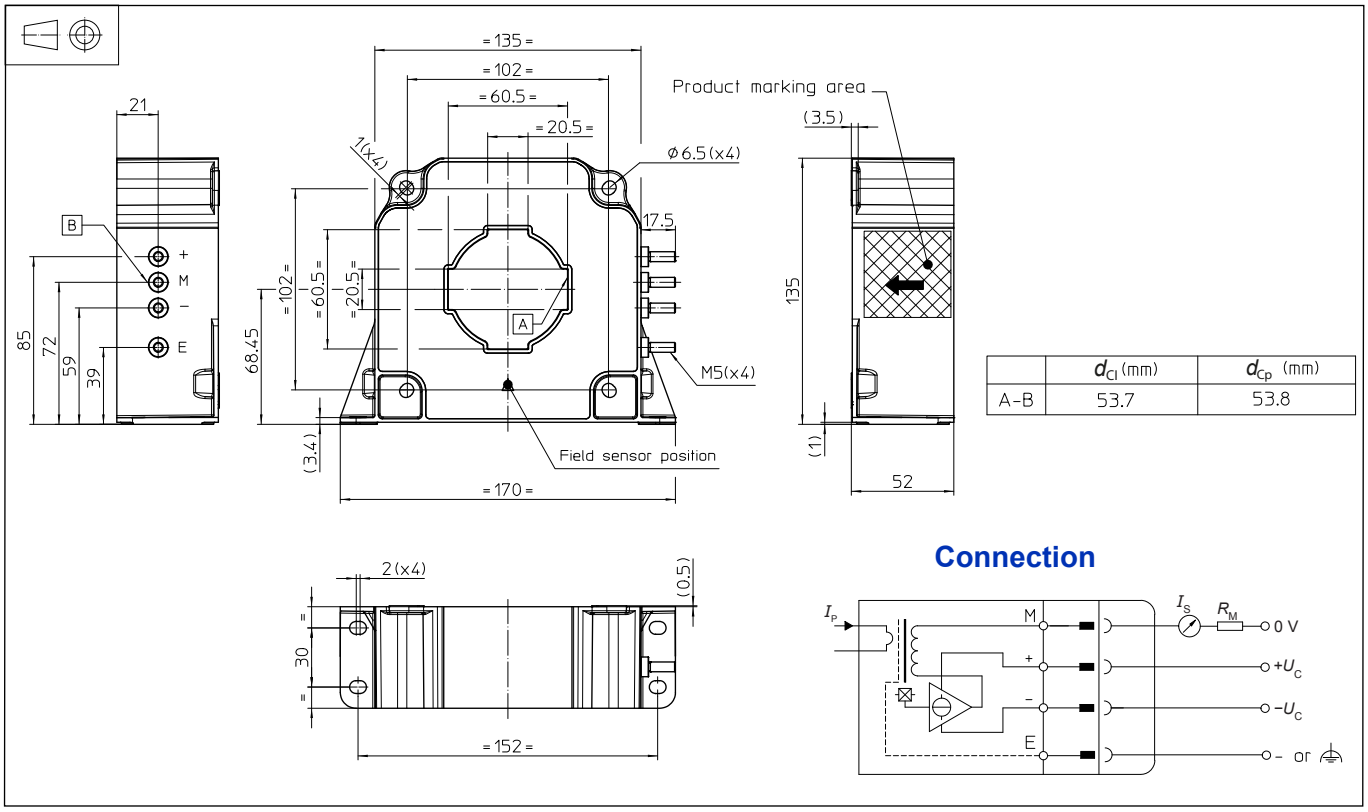
Dimensions (in mm)



	d_{Cl} (mm)	d_{Cp} (mm)
A-B	53.7	53.8

Connection

Mechanical characteristics

• General tolerance	±0.5 mm
• Transducer fastening	
Vertical position	4 slotted holes Ø6.5 mm
	4 M6 steel screws
Recommended fastening torque	5.5 N·m (±10 %)
• Primary through-hole	Ø 57 mm
Or	60 mm × 20 mm
• Transducer fastening	
Horizontal position	4 slotted holes Ø 6.5 mm
	4 M6 steel screws
Recommended fastening torque	5.5 N·m (±10 %)
• Connection of secondary	on 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.
- 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: **https://www.lem.com/en/file/3137/download.**

Note: Additional information avaible on request.

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