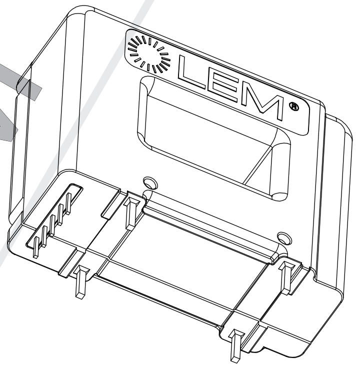
Current Transducer LZSR 100-P

I_{PN} = 100 A

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



Features

- Closed loop multi-range current transducer
- Voltage output
- Unipolar supply voltage.

Special feature

- Very high I_{PM}.

Advantages

- Very low offset drift
- Very good dv/dt immunity.

Applications

- AC variable speed and servo 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
- UL 508: 2013.

Application Domain

- Industrial.

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Absolute maximum ratings

Parameter	Symbol	Unit	Value
Maximum supply voltage	$U_{C\ max}$	V	7
Maximum primary conductor temperature	$T_{B\ max}$	°C	110
Maximum primary current	$I_{P\ max}$	A	$10 \times I_{P\ N}$
Electrostatic discharge voltage (HBM - Human Body Model)	$U_{ESD\ HBM}$	kV	4

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 # .... Volume: ... Section: ...

Standards

- CSA C22.2 NO. 14-10 INDUSTRIAL CONTROL EQUIPMENT - Edition 11 - Revision Date 2011/08/01
- UL 508 STANDARD FOR INDUSTRIAL CONTROL EQUIPMENT - Date 2013

Ratings

Parameter	Symbol	Unit	Value
Primary involved potential		V AC/DC	1000
Max surrounding air temperature	T_A	°C	85
Primary current	I_P	A	According to series primary currents
Secondary supply voltage	U_C	V DC	7
Output voltage	U_{out}	V	0 to 5

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Insulation coordination

Parameter	Symbol	Unit	Value	Comment
RMS voltage for AC insulation test, 50 Hz, 1 min	U_d	kV	3	
Impulse withstand voltage 1.2/50 µs	U_{Ni}	kV	8	
Insulation resistance	R_{INS}	GΩ	> 200	measured at 500 V DC
Partial discharge extinction RMS voltage @ 10 pC	U_e	kV	1650	
Comparative tracking index	CTI		600	
Clearance (pri. - sec.)	d_{Cl}	mm	12.9	Shortest distance through air
Creepage distance (pri. - sec.)	d_{Cp}	mm	12.9	Shortest path along device body
Application example		V	600	Reinforced insulation, non uniform field according to IEC 61800-5-1, CAT III, PD2
Application example		V	1000	Basic insulation, non uniform field according to IEC 61800-5-1, CAT III, PD2
Case material	-	-	V0	According to UL 94
Clearance and creepage	See dimensions drawing on p. 9			

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	−55		125	
Mass	m	g		46		

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Electrical data

At T_A = 25 °C, U_C = +5 V, N_P = 1 turn, R_L = 10 kΩ internal reference unless otherwise noted (see Min, Max, typ. definition paragraph in page 8).

Parameter	Symbol	Unit	Min	Typ	Max	Comment
Primary nominal RMS current	$I_{P N}$	A		100		
Primary current, measuring range	$I_{P M}$	A	−270		270	
Supply voltage	U_C	V	4.75	5	5.25	
Current consumption	I_C	mA		$18 + \frac{I_P(\text{mA})}{N_S}$	$20.5 + \frac{I_P(\text{mA})}{N_S}$	N_S = 2026 turns
Reference voltage @ I_P = 0 A	U_{ref}	V	2.485	2.5	2.515	Internal reference
Output voltage	U_{out}	V	0.25		4.75	with U_C = +5 V
Output voltage @ I_P = 0 A	U_{out}	V		U_{ref}		
Electrical offset voltage	$U_{O E}$	mV	−2.8		2.8	100 % tested $U_{out} - U_{ref}$
Electrical offset current referred to primary	$I_{O E}$	mA	−448		448	100 % tested
Temperature coefficient of U_{ref}	TCU_{ref}	ppm/K			±100	Internal reference
Temperature coefficient of U_{out} @ I_P = 0 A	TCU_{out}	ppm/K			±3	ppm/K of 2.5 V −40 °C … 85 °C (at ±6 Sigma)
Nominal sensitivity	S_N	mV/A		6.25		625 mV/$I_{P N}$
Sensitivity error	ε_S	%	−0.8		0.8	100 % tested (typical value)
Temperature coefficient of S	TCS	ppm/K			75	−40 °C … 85 °C
Linearity error	ε_L	% of $I_{P N}$	−0.1		0.1	
Magnetic offset current (10 × $I_{P N}$) referred to primary	$I_{O M}$	mA	−104		104	
RMS noise voltage spectral density 100 … 100 kHz referred to primary	u_{no}	µV/Hz½		0.95		
RMS noise voltage DC … 10 kHz DC … 100 kHz DC … 1 MHz	U_{no}	mVpp		0.3 0.5 1.5		
Primary current, detection threshold	$I_{P Th}$	A	1.87 × $I_{P N}$	1.93 × $I_{P N}$	1.98 × $I_{P N}$	
Delay time of threshold output for high value	$t_{D H Th}$	µs		1.4	2.2	Overcurrent detection measured over temperature −40 °C … 85 °C
Delay time to 10 % of $I_{P N}$	$t_{D 10}$	µs			1	di/dt = 70 A/µs
Delay time to 80 % of $I_{P N}$	$t_{D 80}$	µs			2	di/dt = 70 A/µs
Frequency bandwidth (±3 dB)	BW	kHz	200			
Total error	ε_{tot}	% of $I_{P N}$			1.1	
Total error @ T_A = 85 °C	ε_{tot}	% of $I_{P N}$			1.4	
Sum of sensitivity and linearity	$\varepsilon_{S L}$	% of $I_{P N}$			0.83	
Sum of sensitivity and linearity @ T_A = 85 °C	$\varepsilon_{S L}$	% of $I_{P N}$			1.2	

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Performance parameters definition

Ampere-turns and amperes

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

$\Theta_P = N_P \cdot I_P$ (At)

Where N_P is the number of primary turn (depending on the connection of the primary jumpers)

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 (At) unit is used to emphasis that current linkages are intended and applicable.

Transducer simplified model

The static model of the transducer at temperature T_A is:

$I_S = S \cdot \Theta_P + \varepsilon$

In which error =

$$\varepsilon(T_A) = U_{OE} + \varepsilon_S \times \Theta_P \times \frac{S}{100} + \varepsilon_L(\Theta_P \max) \times \Theta_P \max \times \frac{S}{100} + TCU_{out} \times (T_A - 25) \times 2.5 \times 10^{-6}$$

$$+ TCS \times (T_A - 25) \times \Theta_P \times S \times 10^{-6}$$

With:

$\Theta_P = N_P \cdot I_P$	: primary current linkage (At) Please read above warning
$\Theta_{P\,max}$	: max primary current linkage applied to the transducer
U_{out}	: output voltage
T_A	: ambient operating temperature (°C)
U_{OE}	: electrical offset voltage (V)
S	: sensitivity of the transducer (A/At)
TCU_{out}	: temperature coefficient of U_{out}
ε_S	: sensitivity error
$\varepsilon_L(\Theta_{P\,max})$	: 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.

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

The sensitivity error ε_S is defined as the error between the measured sensitivity S and the nominal sensitivity S_N, expressed in % of S_N.

The linearity error ε_L is the maximum positive or negative difference between the measured points and the associated linear regression line at a given primary current, expressed in % of I_{PN}.

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} ($I_{P1} > I_{PM}$).

$$I_{OM} = \frac{U_{out}(t_1) - U_{out}(t_2)}{2} \cdot \frac{1}{S_N}$$

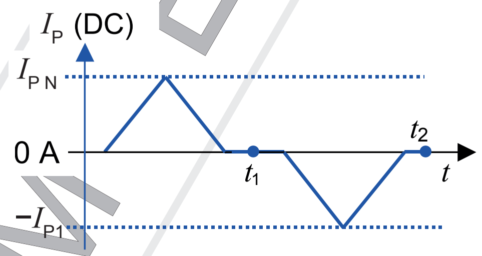

Figure 1: Current cycle used to measure magnetic and electrical offset (transducer supplied)

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Performance parameters definition

Electrical offset

The electrical offset voltage $U_{O E}$ can either be measured when the ferromagnetic 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 1.

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

$$U_{O E} = \frac{U_{out}(t_1) + U_{out}(t_2)}{2}$$

The temperature variation $U_{O T}$ of the electrical offset voltage $U_{O E}$ is the variation of the electrical offset from 25 °C to the considered temperature:

$$U_{O T}(T) = U_{O E}(T) - U_{O E}(25° C)$$

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

Total error

The total error at 25 °C ε_{tot} is the error in the $-I_{P N} \ldots +I_{P N}$ range, relative to the rated value $I_{P N}$.
It includes:

- the electrical offset $U_{O E}$
- the sensitivity error ε_S
- the linearity error ε_L (to $I_{P N}$)

Delay times

The delay time to 10% $t_{D 10}$ and the delay time to 80% $t_{D 80}$ are shown in figure 2.
Both depend on the primary current di/dt. They are measured at nominal ampere-turns.

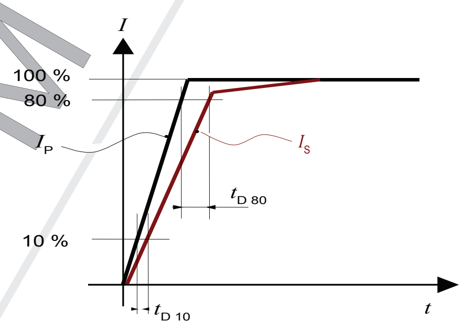

Figure 2: $t_{D 10}$ (delay time to 10 %) and $t_{D 80}$ (delay time to 80%)

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Application information

Filtering and decoupling

Supply voltage U_C

The transducer has internal decoupling capacitors, but in the case of a power supply with high impedance, it is highly recommended to provide local decoupling (100 nF or more, located close to the transducer) as it may reduce disturbance on transducer output U_{out} and reference U_{ref} due to high varying primary current. The transducer power supply rejection ratio is low at high frequency.

Output U_{out}

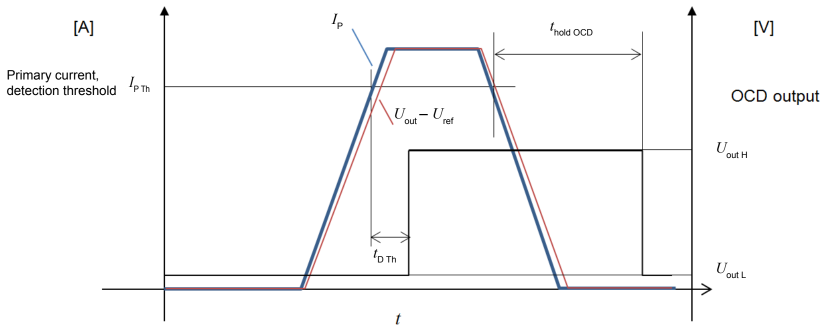
The output U_{out} has a very low output impedance of typically 1 Ohm; it can drive capacitive loads of up to 100 nF directly. Adding series resistance Rf of several tenths of Ohms allows much larger capacitive loads Cf (higher than 1 µF). Empirical evaluation may be necessary to obtain optimum results. The minimum load resistance on U_{out} is 1 kOhm.

Reference U_{ref}

Likewise output U_{out}, the U_{ref} has a very low output impedance of typically 1 Ohm; it can drive capacitive loads of up to 100 nF directly. Adding series resistance Rf of several tenths of Ohms allows much larger capacitive loads Cf (higher than 1 µF). Empirical evaluation may be necessary to obtain optimum results. The minimum load resistance on U_{ref} is 10 kOhms.

Overcurrent detection definition

The overcurrent detection function generates an output signal to the OCD pin whenever the primary current exceeds a pre-programmed threshold value. Once the overcurrent event is detected, the CMOS-type OCD signal changes from low logic (< 30 % U_C) to high logic value(> 70 % U_C). In order to avoid undesirable glitches, the OCD signal is digitally filtered and the OCD signal output is held for 1 ms in high logic value after the last overcurrent event detection.



Parameter	Symbol	Unit	Min	Typ	Max	Comment
High-level output voltage	$U_{out\ H}$	V	3.5			With U_C = +5 V and source current of 3 mA
Low-level output voltage	$U_{out\ L}$	V			1.5	With U_C = +5 V and sink current of 3 mA

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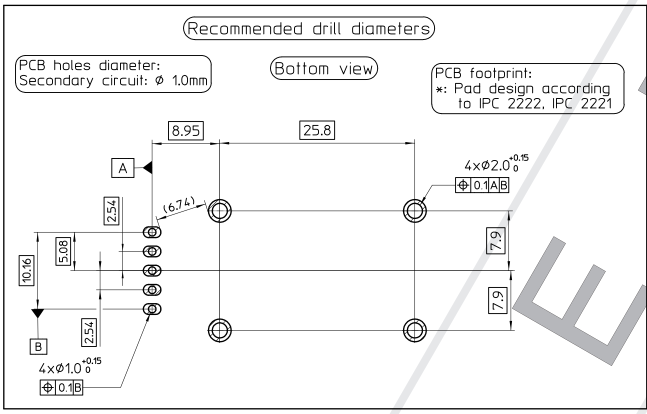
PCB footprint



Assembly on PCB

- Recommended PCB hole diameter — 1 mm for secondary pin; 2 mm for retention pin
- Maximum PCB thickness — 2.4 mm
- Wave soldering profile — maximum 260 °C for 10 s

  No clean process only

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 (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.

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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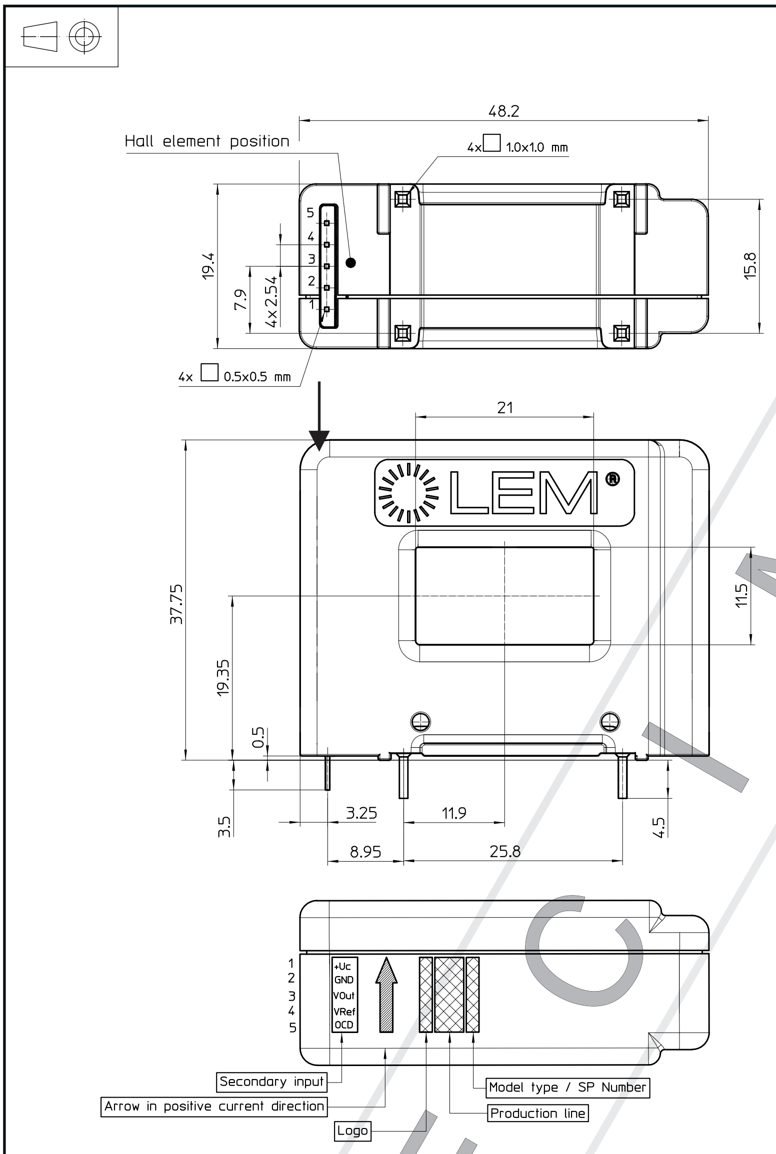
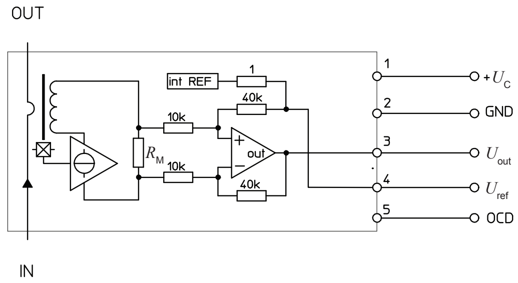
Dimensions (in mm)



Connection



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