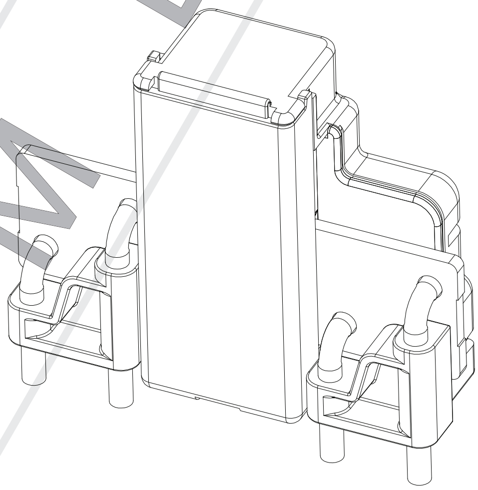
Current Transducer LDSR 0.3-TP/SP1 I_{PRN} = 300 mA

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



Features

- Closed loop (compensated) current transducer
- Voltage output
- Single supply voltage
- PCB mounting.

Special feature

- Dedicated primary PCB.

Advantages

- High accuracy
- Very low offset drift temperature coefficient
- High overload capability
- High insulation capability
- Reference pin with two modes, Ref IN and Ref OUT
- Test winding.

Applications

- Leakage current measurement in transformerless PV inverters
- First human contact protection of PV arrays
- Failure detection in power sources
- Symmetrical fault detection
- Current leakage detection in stacked DC sources
- Single phase nominal current measurement up to ±35 A per wire (DC or AC).

Standards

- EN 61800-1: 1997
- EN 61800-2: 2015
- EN 61800-3: 2004
- UL 62109-1: 2010
- IEC 61010-1: 2010.

Application Domain

- Industrial.

Absolute maximum ratings

Parameter	Symbol	Unit	Value
Maximum supply voltage	$U_{C\ max}$	V	7
Maximum primary conductor temperature	$T_{B\ max}$	°C	100
Overload capability	$\hat{I}_P$		3300

Stresses above these ratings may cause permanent damage. Exposure to absolute maximum ratings for extended periods may degrade reliability.

Insulation coordination

Parameter	Symbol	Unit	Value	Comment
RMS voltage for AC insulation test, 50 Hz, 1 min	U_d	kV	1.71	According to 62109-1
Impulse withstand voltage 1.2/50 µs	$\hat{U}_W$	kV	4	
Partial discharge extinction RMS voltage @ 10 pC	U_e	V	TBD	
Clearance (pri. - sec.)	d_{Cl}	mm	See outline drawing in page 9	
Creepage distance (pri. - sec.)	d_{Cp}	mm	See outline drawing in page 9	
Case material	-	-	V0	According to UL 94
Comparative tracking index	CTI	9	600	

Environmental and mechanical characteristics

Parameter	Symbol	Unit	Min	Typ	Max	Comment
Ambient operating temperature	T_A	°C	−40		105	
Ambient storage temperature	T_S	°C	−50		105	
Mass	m	g		25		

Electrical data

At T_A = 25 °C, U_C = +5 V, unless otherwise noted (lines with * in the condition column apply over the ambient temperature range).
See Min, Max, typ. definition paragraph in page 6.

Parameter	Symbol	Unit	Min	Typ	Max	*	Comment
Primary nominal residual RMS current	I_{PRN}	mA		300		*	
Primary residual current, measuring range	I_{PRM}	mA	−900		900	*	
Supply voltage	U_C	V	4.75	5	5.25	*	
Current consumption	I_C	mA		32.5	47.5		$+I_P$ (mA)/N_S with N_S = 40 turns
Internal voltage reference	$V_{I\ ref}$	V	2.485	2.5	2.515		
Internal voltage source current reference	$I_{I\ ref}$	µA			400		
External voltage reference	$V_{E\ ref}$	V	2.25		2.75		
Current to force a voltage external reference	-	mA			1.5		
Electrical offset current referred to primary	I_{OE}	mA	−40		40		
Temperature coefficient of I_{OE} @ I_P = 0 A	TCI_{OE}	mA/°C	−0.40	±0.17	0.40		
Magnetic offset after 1000 × I_{PN}	I_{OM}	mA		8			
Theoretical sensitivity	G_{th}	V/A		2.22			
Sensitivity error	ε_G	%	−2		2		For R_L > 500 kΩ
Temperature coefficient of G	TCG	ppm/K			±250		
Linearity error	ε_L	% of I_{PRN}	−3		3		
Output RMS noise current 1 Hz … 2 kHz referred to primary	I_{no}	mA		7.5			
Reaction time @ 10 % of I_{PN}	t_{ra}	µs		TBD			For R_L > 500 kΩ; di/dt > 5 A/µs
Step response time to 90 % of I_{PN}	t_r	µs		175			For R_L > 500 kΩ; di/dt > 5 A/µs
Start-up time	t_{start}	ms		220			
Frequency bandwidth (−3 dB)	BW	kHz		2			For R_L > 500 kΩ
Accuracy	X	mA	−40		40	*	Without initial offset
Accuracy @ 30 mA	X	mA	−8		8		For ±30 mA instantaneous DC jump
Accuracy @ 60 mA	X	mA	−12		12		For ±60 mA instantaneous DC jump
Accuracy @ 150 mA	X	mA	−20		20		For ±150 mA instantaneous DC jump
Degauss time		ms		120			
Degauss pin going voltage	IN Low	V			1.62		
	IN High	V	3.42				
	Pulse duration	ms	0.6				

Performance parameters definition

Transducer simplified model

The static model of the transducer at temperature T_A is:

$V_{out} = G \cdot I_P + \varepsilon$

In which ε =

$V_{OE} + V_{OT}(T_A) + \varepsilon_G \cdot I_P \cdot G + \varepsilon_L (I_{PRM}) \cdot I_{PRM} \cdot G + TCG \cdot (T_A - 25) \cdot I_P \cdot G$

With:

$I_{PRM\,max}$	: max primary residual measuring range applied to the transducer
V_{out}	: output voltage (V)
T_A	: ambient operating temperature (°C)
V_{OE}	: electrical offset voltage (V)
$V_{OT}(T_A)$	: temperature variation of V_O at temperature T_A (°C)
G	: sensitivity of the transducer (V/At)
TCG	: temperature coefficient of G
ε_G	: sensitivity error
$\varepsilon_L(I_{PRM})$	: linearity error for $I_{PRM\,max}$

This model is valid for primary ampere-turns I_P between $-I_{PRM}$ and $+I_{PRM}$ only.

Sensitivity and linearity

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

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_{PRM}.

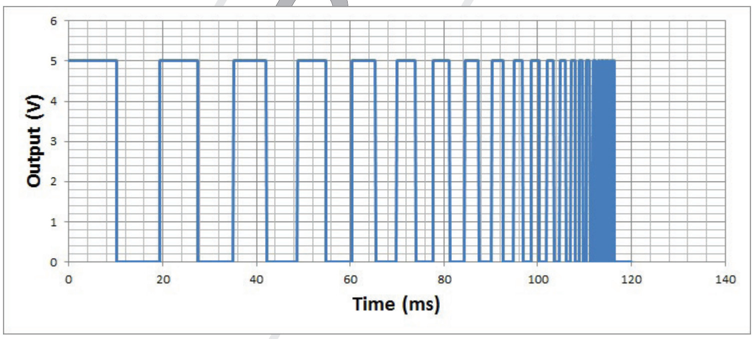
Degauss

A rising edge on the "Degauss" pin will initiate the degauss procedure. During the procedure the output V_{out} does not carry relevant information.

Notes: 1) a degauss procedure is automatically initiated at power up

2) the "Degauss" pin is provided with a 10 kΩ pull down resistor and can be left unconnected.

The figure below describes the expected output during a degauss session.



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

$$I_{OM} = \frac{I_S(t_1) - I_S(t_2)}{2} \cdot \frac{1}{G_{th}}$$

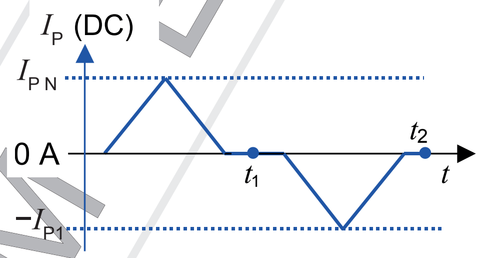


Figure 1: Current cycle used to measure magnetic and electrical offset (transducer supplied)

Performance parameters definition

Electrical offset

The electrical offset current I_{OE} can either be measured when the ferro-magnetic 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 number.

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

$$I_{OE} = \frac{I_{out}(t_1) + I_{out}(t_2)}{2}$$

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:

$$I_{OT}(T) = I_{OE}(T) - I_{OE}(25°\,C)$$

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

Overall accuracy

The overall accuracy at 25 °C X_G is the error in the $-I_{PN} \ldots +I_{PN}$ range, relative to the rated value I_{PN}.
It includes:

- the electrical offset I_{OE}
- the sensitivity error ε_G
- the linearity error ε_L (to I_{PN})

Response and reaction times

The response time t_r and the reaction time t_{ra} are shown in figure 2.

Both depend on the primary current di/dt. They are measured at nominal ampere-turns.

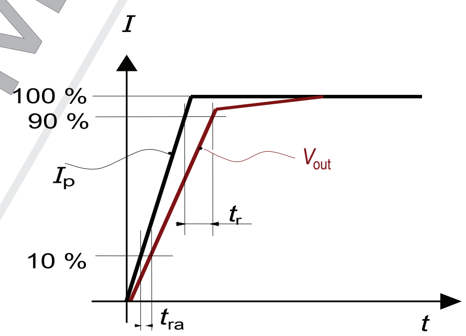


Figure 2: Response time t_r and reaction time t_{ra}

Application information

Decoupling supply voltage U_C (5 V):

RCM transducers are already provided with internal decoupling capacitors.
Depending on the design it is advisable to add an external decoupling: 1 µF or more.
If fast differential current surges are to be expected the decoupling capacitor should be increased in order to absorb the energy from internal protection diodes.
In this case the capacitor should be increased to more than 10 µF.

Load on V_{out}:

The maximum V_{out} is 10 mA. The load on this output should be adapted to not exceed this current.

Decoupling reference V_{ref}:

The maximum decoupling capacitor value is 47 nF.

Output V_{out} properties:

The output is a direct Opamp output. The output current is limited to 10 mA.

Using an external reference voltage:

If the V_{ref} pin of the transducer is not used it could be either left unconnected or filtered according to the previous paragraph "Reference V_{ref}".
If an external voltage reference is used its source capability must be at least 1.5 mA.

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.

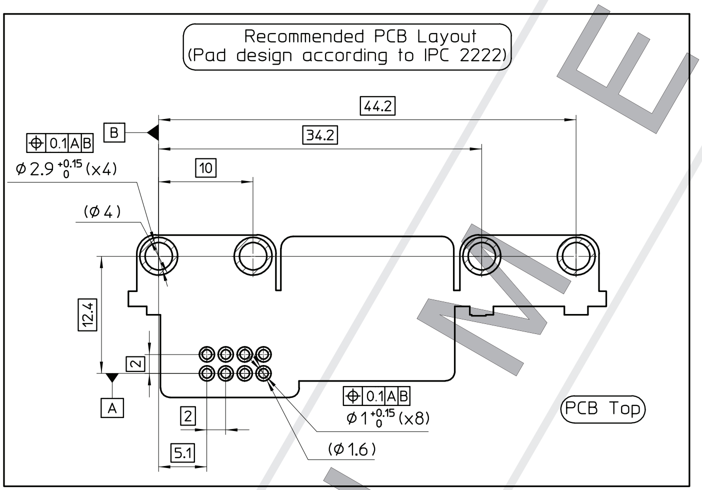
Primary nominal residual current and primary nominal current

The primary nominal residual current is the sum of the instantaneous values of all currents flowing through the primary circuit of the transducer.
The presence of a primary nominal current DC or AC may lead to an additional uncertainty.
For example, with a primary nominal current of 35 A the uncertainty is typically 1.2 % of the primary nominal residual current (1.2 % of 300 mA giving 3.6 mA).

Test LDSR transducer

Twenty turns are available on the magnetic core in order to perform tests. The current is limited to 50 mA.

PCB footprint according to the product



Note: the dimension of customer PCB tracks (width & thickness) and the LEM transducer's primary PCB are linked and can influence on each other temperature heating.

Assembly on PCB

• Recommended PCB hole diameter	Ø 2.9 mm for primary pin Ø 1 mm for secondary pin
• Maximum PCB thickness	2.4 mm
• Wave soldering profile No clean process only	maximum 260 °C, 10 s

Safety

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

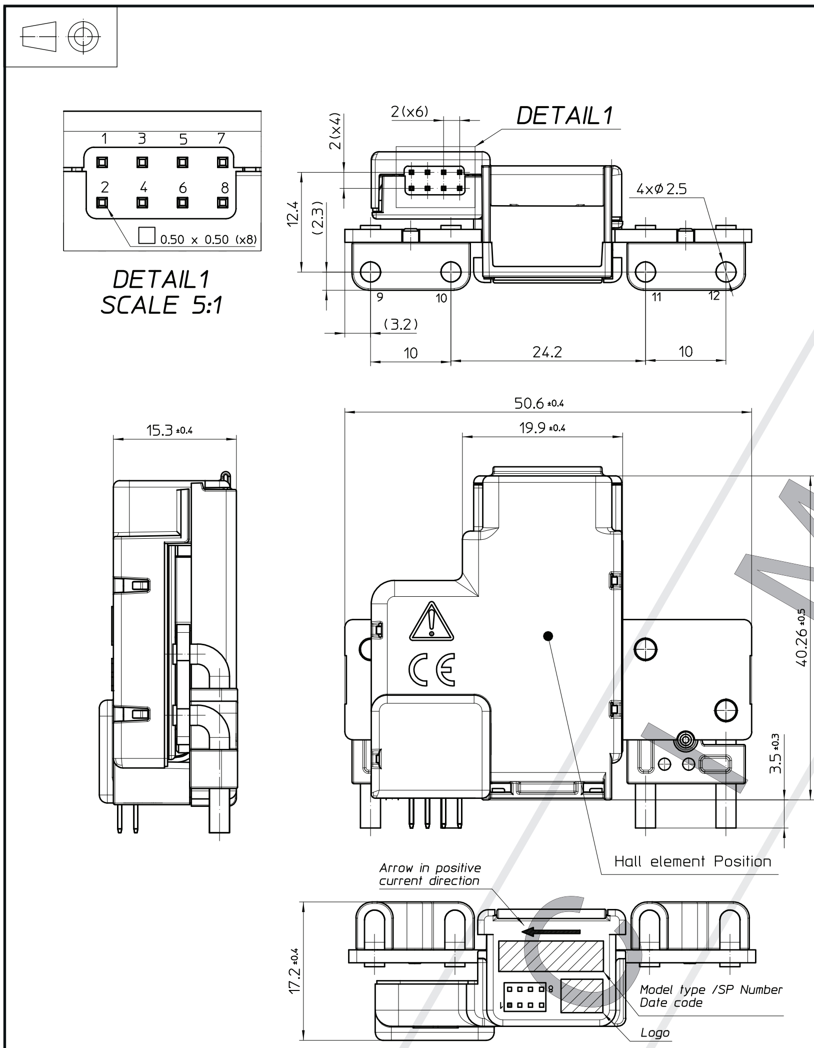
This transducer must be used in electric/electronic equipment with respect to applicable standards and safety requirements in accordance with the manufacturer's operating instructions.

Caution, risk of electrical shock
When operating the transducer, certain parts of the module can carry hazardous voltage (e.g. 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.

Remark

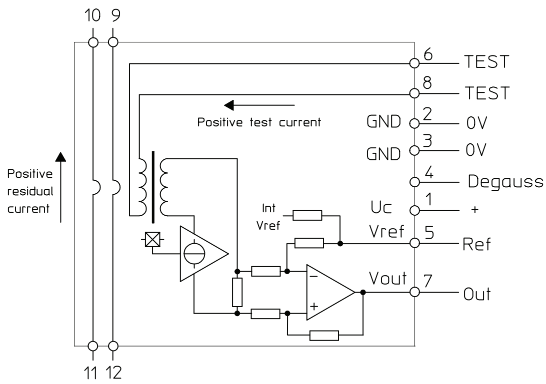
Installation of the transducer must be done unless otherwise specified on the datasheet, according to LEM Transducer Generic Mounting Rules. Please refer to LEM document N°ANE120504 available on our Web site: **Products/Product Documentation.**

Dimensions (in mm)



	d_{Cl}	d_{Cp}
Between primary and secondary terminals	8.90	8.90
Between primary and secondary inside transducer	7.10	7.10

Connection



Creepage and Clearance