LEM

Current Transducer LWSR 250-P

I_{PN} = 250 A

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

5 YEAR WARRANTY by LEM cRUus RoHS

Features

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

Advantages

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

Applications

- Solar inverters
- AC variable speed and servo motor drives
- Battery supplied applications
- Uninterruptible Power Supplies (UPS)
- Switched Mode Power Supplies (SMPS)
- Power supplies for welding applications.

Standards

- IEC 62109-1: 2010
- IEC 61800-5-1: 2007
- IEC 62477-1: 2012
- IEC 61000-6-2: 2016
- IEC 61000-6-3: 2006+A1/2010
- IEC 61800-3: 2017
- UL 508: 2018.

Application Domain

- Industrial.

Safety

![Caution symbol]

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 busbar temperature, fulfill clearance and creepage distance, minimize electric and magnetic coupling, and unless otherwise specified can be mounted in any orientation

![Electrical shock symbol]

Caution, risk of electrical shock

This transducer must be used in limited-energy secondary circuits SELV according to IEC 61800-5-1, in electric/electronic equipment with respect to applicable standards and safety requirements in accordance with the manufacturer's operating specifications.

When operating the transducer, certain parts of the module can carry hazardous voltage (e.g. primary busbar, power supply).
All installations, maintenance, servicing operations and use must be carried out by trained and qualified personnel practicing applicable safety precautions.
If the transducer is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

Ignoring this warning can lead to injury and/or cause serious damage.
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.
Use caution during installation and use of this product; high voltages and currents may be present in circuit under test.

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 symbol]

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.

Although LEM applies utmost care to facilitate compliance of end products with applicable regulations during LEM product design, use of this part may need additional measures on the application side for compliance with regulations regarding EMC and protection against electric shock. Therefore LEM cannot be held liable for any potential hazards, damages, injuries or loss of life resulting from the use of this product.

![cULus symbol]

Underwriters Laboratory Inc. recognized component

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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 # E189713 Volume: 2 Section: 20

Standards

- CSA C22.2 NO. 14-10 INDUSTRIAL CONTROL EQUIPMENT - Edition 11
- UL 508 STANDARD FOR INDUSTRIAL CONTROL EQUIPMENT - Edition 17

Ratings

Parameter	Symbol	Unit	Value
Primary involved potential		V AC/DC	1000
Max surrounding air temperature	T_A	°C	105
Primary current	I_P	A	250
Transducer supply	U_C	V DC	5
Output voltage	U_{out}	V DC	0 to 5

Conditions of acceptability

When installed in the end-use equipment, consideration shall be given to the following:
1 - The secondary circuit pin terminals have not been evaluated for field wiring.
2 - Low voltage control circuit shall be supplied by an isolating 5 V DC supply source.
3 - The product is to be mounted on a printed wiring board.
4 - The product shall be connected at the secondary side of a UL certified surge protective device which has been evaluated with the Standard for Transient Voltage Surge Suppressors, UL 1449 with a maximum clamping voltage of 8 kV.

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.

Insulation coordination

Parameter	Symbol	Unit	Value	Comment
RMS voltage for AC insulation test, 50 Hz, 1 min	U_d	kV	4.3	According to IEC 60664-1
Impulse withstand voltage 1.2/50 µs	U_{Ni}	kV	8	According to IEC 60664-1
Partial discharge RMS test voltage (q_m < 10 pC)	U_t	V	1500	According to IEC 60664-1
Comparative tracking index	CTI	V	600	
Case material	-	-	V0	According to UL 94
Clearance (pri. - sec.)	d_{Cl}	mm	> 14	Shortest distance through air
Creepage distance (pri. - sec.)	d_{Cp}	mm	> 14	Shortest path along device body
Application example System voltage RMS		V	600	Reinforced insulation according to IEC 61800-5-1, IEC 62109-1 CAT III, PD2
Application example System voltage RMS		V	1000	Basic insulation according to IEC 61800-5-1, IEC 62109-1 CAT III, PD2
Application example System voltage DC		V	1000	Reinforced insulation according to IEC 61800-5-1, IEC 62109-1 CAT II, PD2

Environmental and mechanical characteristics

Parameter	Symbol	Unit	Min	Typ	Max	Comment
Ambient operating temperature	T_A	°C	−40		105 [1]	
Ambient storage temperature	$T_{A\,st}$	°C	−55		125	
Mass	m	g		76		

Note: [1] 85 °C and 5 % RH to 95 % RH is applied in LVD certification.

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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 6).
Lines with a * in the comment column apply over the −40 … 105 °C ambient temperature range.

Parameter	Symbol	Unit	Min	Typ	Max		Comment
Primary nominal RMS current	I_{PN}	A		250			see "Maximum continuous DC primary current " on page 6
Primary current, measuring range	I_{PM}	A	−380		380		−40 °C ~ +95 °C
Maximum measured peak overcurrent (transformer effect)	$\hat{I}_{P\,meas}$	A	−650		650		di/dt = 50 A/µs,during time at 650 A is 1000 µs
Supply voltage	U_C	V	4.75	5	5.25	*	
Current consumption	I_C	mA		$18 + \dfrac{I_P(mA)}{N_S}$	$20.5 + \dfrac{I_P(mA)}{N_S}$		N_S = 1600 turns
Reference voltage @ I_P = 0 A	U_{ref}	V	2.485	2.5	2.515		Internal reference
Output voltage @ I_P = 0 A	U_{out}	V		U_{ref}			
Electrical offset voltage	U_{OE}	mV	−1.57		1.57		100 % tested $U_{out} - U_{ref}$
Electrical offset current referred to primary	I_{OE}	mA	−500		500		100 % tested
Temperature coefficient of I_{OE} [1]	TCI_{OE}	ppm/K	−10		10	*	
Temperature coefficient of U_{ref}	TCU_{ref}	ppm/K	−100		100	*	Internal reference
Nominal sensitivity	S_N	mV/A		3.125			781.25 mV/I_{PN}
Sensitivity error	ε_S	% of I_{PN}	−0.8		0.8		100 % tested
Temperature coefficient of S	TCS	ppm/K	−60		60	*	
Linearity error	ε_L	% of I_{PN}	−0.15		0.15		
Magnetic offset current (5 × I_{PN}) referred to primary	I_{OM}	mA	−200		200		
Peak-to-peak noise voltage DC … 10 kHz DC … 100 kHz DC … 1 MHz	$U_{no\,pp}$	mVpp		0.57 1.85 2.55			
Delay time to 10 % of the final output value for I_{PN} step	t_{D10}	µs			1		di/dt = 50 A/µs
Delay time to 90 % of the final output value for I_{PN} step	t_{D90}	µs			2		di/dt = 50 A/µs
Frequency bandwidth (±3 dB)	BW	kHz	200				small signal
Total error	ε_{tot}	% of I_{PN}	−1		1		
Total error @ T_A = 85 °C	$\varepsilon_{tot\,85}$	% of I_{PN}	−1.4		1.4		See formula note [2]
Sum of sensitivity and linearity error	ε_{SL}	% of I_{PN}	−0.83		0.83		
Sum of sensitivity and linearity error at 85° C	$\varepsilon_{SL\,85}$	% of I_{PN}	−1.2		1.2		See formula note [3]

Notes: [1] PPM refers to full-scale which corresponds to a primary nominal RMS current

[2] Total error $\varepsilon_{tot}(T_A) = \varepsilon_{tot\,25} + \dfrac{TCS + TCI_{OE}}{10000} \times |T_A\text{-}25|$

[3] Sum of sensitivity and linearity error $\varepsilon_{SL}(T_A) = \varepsilon_{SL\,25} + \dfrac{TCS + TCI_{OE}}{10000} \times |T_A\text{-}25|$.

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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.

Maximum continuous DC primary current
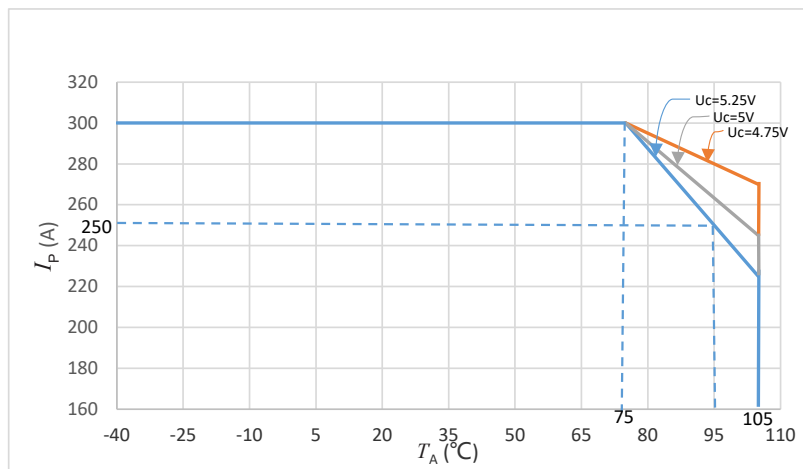
The maximum continuous DC primary current plot shows the boundary of the area for which all the following conditions are true:

● $I_P < I_{P M}$
● Junction temperature T_J < 150 °C
● Primary conductor temperature < 110 °C

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

Simplified transducer model

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

$$U_{out} = S \cdot \Theta_P \cdot (1 + \varepsilon)$$

In which (referred to primary):

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

$\Theta_P = N_P \cdot I_P$: primary current linkage (A)

$\Theta_{P\,max}$: maximum primary current linkage applied to the transducer

I_S : secondary current (A)

U_{out} : output voltage (V)

S : sensitivity of the transducer

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)

ε_S : sensitivity error at 25 °C

$\varepsilon_{S\,T}$: thermal drift of S

$\varepsilon_L(\Theta_{P\,max})$: 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:

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

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 $\pm I_{P\,N}$.

The linearity error ε_L is the maximum positive or negative difference between the measured points and the linear regression line, expressed in % of $I_{P\,N}$.

Performance parameters definition

Magnetic offset referred to primary

The magnetic offset current I_{OM} is the consequence of a current on the primary side ("memory effect" of the transducer's ferro-magnetic parts). It is measured using the following primary current cycle. I_{OM} depends on the current value $I_P \geq I_{PN}$.
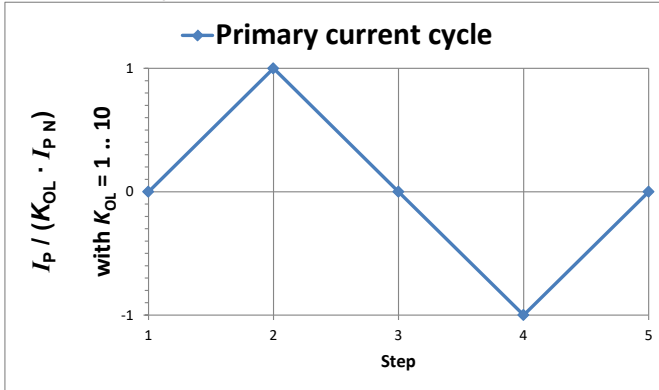
K_{OL}: Overload factor

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

$$I_{OM} = \frac{I_{P(3)} - I_{P(5)}}{2}$$

Electrical offset referred to primary

Using the current cycle shown in figure 3, the electrical offset current I_{OE} is the residual output referred to primary when the input current is zero.

$$I_{OE} = \frac{I_{P(3)} + I_{P(5)}}{2}$$

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.

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

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 di/dt.
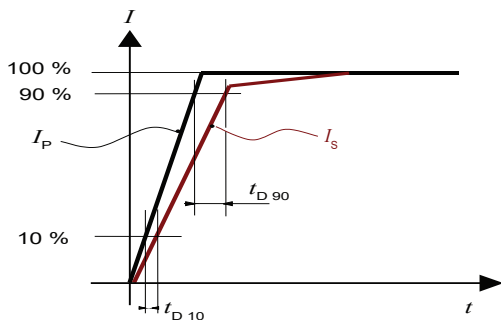They are measured at nominal current.

Figure 2: t_{D10} (delay time @ 10 %) and t_{D90} (delay time @ 90 %)

Total error referred to primary

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
- the electrical offset I_{OE}
- the magnetic offset I_{OM}
- the sensitivity error ε_s
- the linearity error ε_L (to I_{PN}).

Figure 3: Total error ε_{tot}
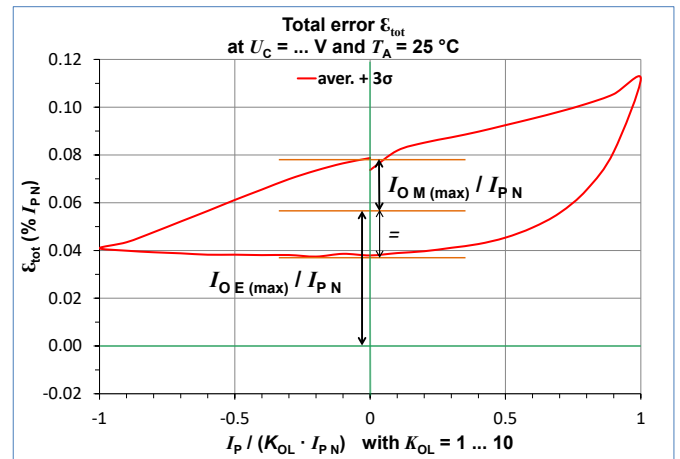
Application information

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.

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External reference voltage

The REF pin can be used either as a reference voltage output or as a reference voltage input.

When used in reference voltage output, the internal reference voltage U_{ref} is used by the transducer as the reference point for bipolar measurements.

The internal reference voltage output accuracy is defined in the electrical parameter data.

When used in reference voltage input, an external reference voltage is connected to the REF pin.

In this case, the maximum allowable reference voltage range is 0.5 V - 2.75 V.

The REF pin must be able to source or sink an input current of 1.5 mA maximum.

If the reference voltage is not used, the REF pin should be left unconnected.

The following graph shows the I_P current versus forced extreme external U_{ref}.
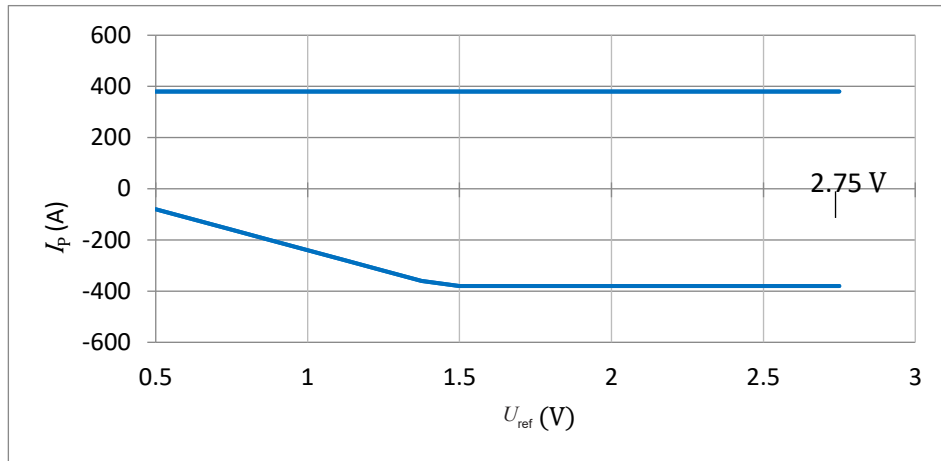
Figure 4: Measuring range versus external U_{ref}

Upper limit: I_P = 380 (U_{ref} = 0.5 V ... 2.75 V)

Lower limit: I_P = −257* U_{ref} + 27 (U_{ref} = 0.5 V ... 1.5 V)
I_P = −380 (U_{ref} = 1.5 V ... 2.75 V)

Example with U_{ref} = 1 V
The transducer has a measuring range from −240 A to +380 A.

Example with U_{ref} = 0.5 V
The transducer has a measuring range from −80 A to +380 A.

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PCB footprint according to the product (in mm)

Recommended drill diameters

Top side view

Assembly on PCB

- Recommended PCB hole diameter   1.2 mm for secondary pin
  3.2 mm for retention pin
- Maximum PCB thickness   2.4 mm
- Wave soldering profile   maximum 260 °C for 10 s
  No clean process only

External Busbar recommendation

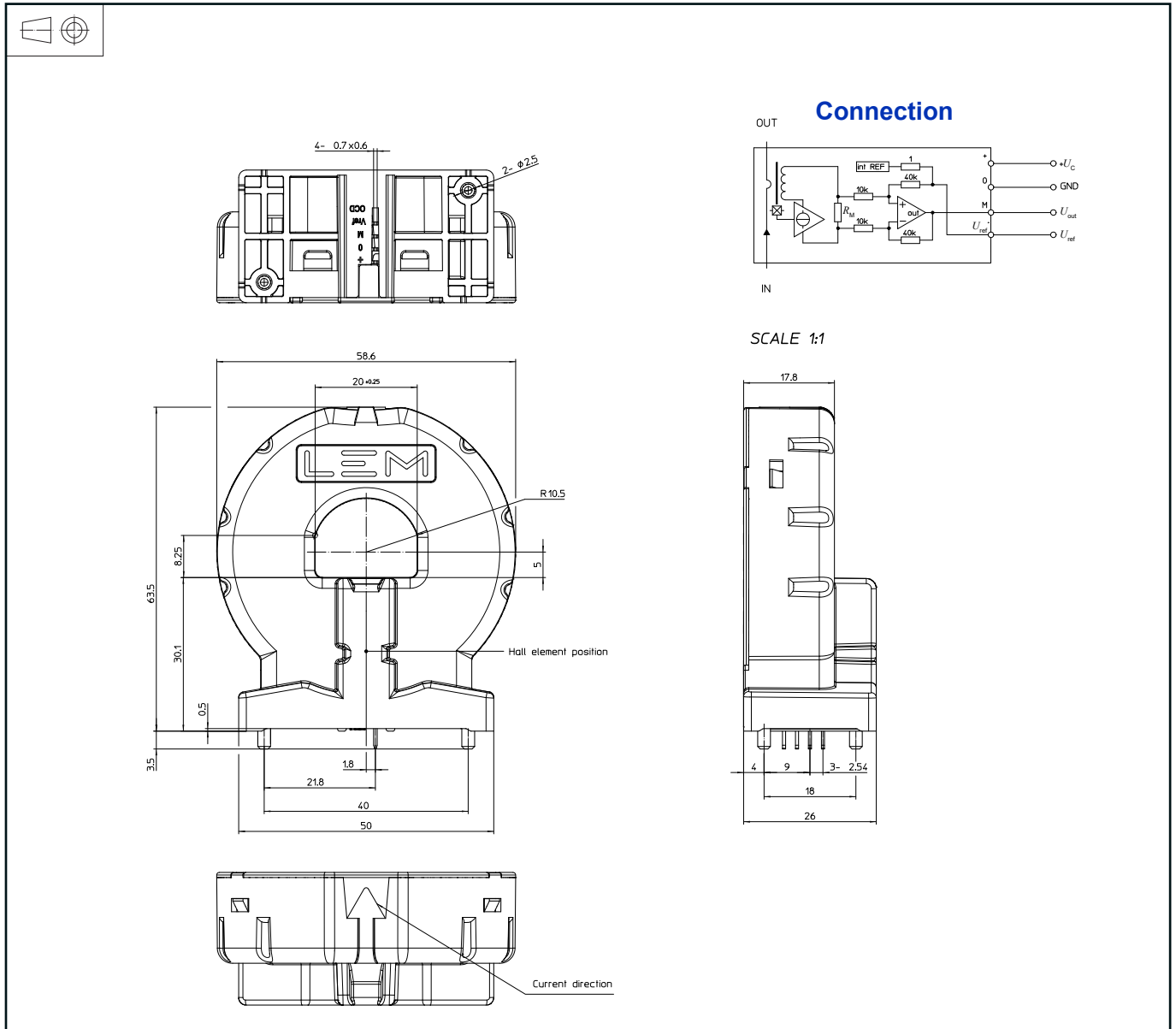| Illustration of External Busbar influence on ε_{tot}							

a (mm)	10	20	50	100	200
ε_{tot} @ Busbar $I_P = +I_{PN}$ (%)	−0.446	−0.374	−0.255	−0.160	−0.090
ε_{tot} @ Busbar $I_P = -I_{PN}$ (%)	0.402	0.330	0.211	0.116	0.046

a (mm)	10	20	50	100	200
ε_{tot} @ Busbar $I_P = +I_{PN}$ (%)	0.480	0.403	0.260	0.156	0.081
ε_{tot} @ Busbar $I_P = -I_{PN}$ (%)	−0.463	−0.391	−0.247	−0.142	−0.067

a (mm)	10	20	50	100	200
ε_{tot} @ Busbar $I_P = +I_{PN}$ (%)	−0.666	−0.525	−0.313	−0.179	−0.095
ε_{tot} @ Busbar $I_P = -I_{PN}$ (%)	0.626	0.485	0.273	0.139	0.055

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Dimensions (in mm)

Connection

OUT

IN

SCALE 1:1

Mechanical characteristic

● General tolerance ±0.6 mm

Remarks

● It is advised to use a primary conductor (busbar) that fills transducer through-hole.
● Be aware of the influence of the external field if nearby transducers are too close (relay, capacitor, choke...).
● 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**.

单击下面可查看定价，库存，交付和生命周期等信息

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