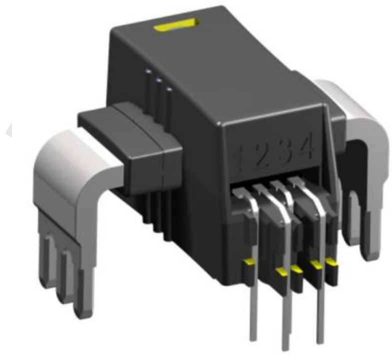
Current Transducer HLSR 120-P/SP59

I_{PN} = 120 A

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



Features

- Open loop multi-range current transducer
- Voltage output
- Single supply +5 V ± 5%
- Galvanic separation between primary and secondary
- Low power consumption
- Compact design for through-hole PCB mounting
- Factory calibrated.

Special features

- 1.6mm busbar.

Advantages

- Small footprint
- Low offset drift
- High bandwidth
- Low response time.

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
- Combiner box
- MPPT.

Standards

- EN IEC 62477-1:2023
- EN IEC 62040-1:2019+A11+A1
- EN 61010-1:2010+A1
- EN IEC 61800-5-1:2023
- EN 62109-1:2010
- IEC 61326-1:2020
- UL508:2010.

Application Domain

- Industrial.

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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 flexible probe 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.
When defining soldering process, please use no cleaning process only.

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.

Underwriters Laboratory Inc. recognized component

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Absolute maximum ratings

Parameter	Symbol	Unit	Value
Supply voltage (not destructive $<$ 1 min)	U_C	V	8
Supply voltage (not entering non standard modes)	U_C	V	6.5
Primary conductor temperature	T_B	°C	120
Electrostatic discharge voltage (HBM - Human Body Model)	$U_{ESD\ HBM}$	kV	2
Electrostatic discharge voltage (CDM – Charged Device Model)	$U_{ESD\ CDM}$	kV	0.5

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 (refer to existing HLSR-P family, the final data is subject to the UL file)

Standards

- CSA C22.2 NO. 14-10 INDUSTRIAL CONTROL EQUIPMENT - Edition 11 - Revision Date 2011/08/01
- UL 508 STANDARD FOR INDUSTRIAL CONTROL EQUIPMENT - Edition 17 - Revision Date 2010/04/15

Ratings

Parameter	Symbol	Unit	Value
Primary involved potential		V AC/DC	600
Ambient operating temperature	T_A	°C	105
Primary current	I_P	A	120
Secondary supply voltage	U_C	V DC	5
Output voltage	U_{out}	V	0 to 5

Conditions of acceptability

1 - These devices have been evaluated for overvoltage category III and for use in pollution degree 2 environment.

2 - A suitable enclosure shall be provided in the end-use application.

3 - The terminals have not been evaluated for field wiring.

4 - These devices are intended to be mounted on a printed wiring board of end use equipment. The suitability of the connections (including spacings) shall be determined in the end-use application.

5 - Primary terminals shall not be straightened since assembly of housing case depends upon bending of the terminals.

6 - Any surface of polymeric housing have not been evaluated as insulating barrier.

7 - Low voltage control circuit shall be supplied by an isolating source (such as a transformer, optical isolator, limiting impedance or electro-mechanical relay).

Marking

Only those products bearing the 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, 50/60 Hz, 1 min	U_d	kV	4.3	
Impulse withstand voltage 1.2/50 µs	U_{Ni}	kV	8	
Clearance (pri. - sec.)	d_{Cl}	mm	> 8	Shortest distance through air
Creepage distance (pri. - sec.)	d_{Cp}	mm	> 8	Shortest path along device body
Clearance (pri. - sec.)	d_{Cl}	mm	8	When mounted on PCB with recommended layout
Case material	-	-	V0	According to UL 94
Comparative tracking index	*CTI*	-	600	
Application example	-	V	300	Reinforced insulation, CAT III, PD 2, non uniform field according to IEC 61010
Application example	-	V	1000	Basic insulation, CAT III, PD 2, non uniform field according to IEC 61010

Environmental and mechanical characteristics

Parameter	Symbol	Unit	Min	Typ	Max	Comment
Ambient operating temperature	T_A	°C	−40		105	
Ambient storage temperature	$T_{A\ st}$	°C	−40		105	
Mass	m	g			7.5	

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Electrical data

At T_A = 25 °C, U_C = +5, R_L = 10 kΩ unless otherwise noted.

Parameter	Symbol	Unit	Min	Typ	Max	Comment
Primary nominal RMS current	I_{PN}	A		120		Normal mode
Primary current, measuring range	I_{PM}	A		300		For U_C > 4.7 V
Supply voltage	U_C	V	4.75	5	5.25	
Current consumption	I_C	mA		10	15	
Reference voltage (output)	U_{ref}	V	2.48	2.5	2.52	Internal reference
Output voltage range @Ipm	U_{out} -U_{ref}	V	-2		2	
Electrical offset voltage @ I_P = 0	U_{OE}	mV	−5		5	$U_{out} - U_{ref}$ @ U_{ref} = 2.5 V
Temperature coefficient of U_{ref}	TCU_{ref}	ppm/K	−100		100	−40 °C … 105 °C
Temperature coefficient of U_{OE}	TCU_{OE}	mV/K	−0.05		0.05	−40 °C … 105 °C
Sensitivity	S_{Th}	mV/A		6.666		800 mV @ I_{PN}
Sensitivity error @ I_{PN} @ T_A = 25 °C	ε_S	%	−0.85		0.85	
Temperature coefficient of S	TCS	ppm/K	−250		250	−40 °C … 105 °C
Linearity error	ε_L	%	−0.5		0.5	
Capacitive loading	C_L	pF		10	10000	For Pin Uout and Uref
Magnetic offset current (@ 10 × I_{PN}) referred to primary	I_{OM}	A	−0.5		0.5	
Noise voltage spectral density 100 Hz… 100 kHz	u_{no}	µV/√Hz		0.159	1	
Noise voltage DC … 10 kHz DC … 100 kHz DC … 1 MHz	U_{no}	mVpp		 1.44 4.6 15		
Delay time @ 10 % of the final output value I_{PN} step	$t_{D\,10}$	µs		0.5	1	@ 30 A/µs
Delay time @ 90 % of the final output value I_{PN} step	$t_{D\,90}$	µs		0.5	1	@ 30 A/µs
Frequency bandwidth (−3 dB)	BW	kHz	200			Loading capacitance of 10pF for Uout
Sum of sensitivity and linearity @ I_{PN} @ T_A = 25 °C	$\varepsilon_{SL\,25}$	% of I_{PN}	−1		1	
Total error @ I_{PN} @ T_A = 25 °C	$\varepsilon_{tot\,25}$	% of I_{PN}	−1.5		1.5	
Sum of sensitivity and linearity @ I_{PN} @ T_A = −30 °C ~ +85 °C	$\varepsilon_{SL\,85}$	% of I_{PN}	−2.1		2.1	
Total error @ I_{PN} @ T_A = −30 °C ~ +85 °C	$\varepsilon_{tot\,85}$	% of I_{PN}	−2.5		2.5	
Sum of sensitivity and linearity @ I_{PN} @ T_A = −40 °C ~ 105 °C	$\varepsilon_{SL\,105}$	% of I_{PN}	−2.6		2.6	
Total error @ I_{PN} @ T_A = −40 °C ~+105 °C	$\varepsilon_{tot\,105}$	% of I_{PN}	−3		3	

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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.

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 *TA* is:

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

In which (referred to primary):

$$\varepsilon \cdot \Theta_P = I_{OE} + I_{OT} + \varepsilon_S \cdot \Theta_P + \varepsilon_{ST} \cdot \Theta_P + \varepsilon_L(\Theta_{P\,max}) \cdot \Theta_{P\,max} + I_{O\,M}$$

$\Theta_P = N_P \cdot I_P$: 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_{OE}	: electrical offset current (A)
I_{OM}	: magnetic offset current (A)
$I_{O\,T}$	: temperature variation of I_{OE}: (A)
ε_S	: sensitivity error at 25 °C
ε_{ST}	: thermal drift of *S*
$\varepsilon_L(\Theta_{P\,max})$	: linearity error for $\Theta_{P\,max}$

This model is valid for primary ampere-turns ΘP between −ΘP max and +ΘP max only.

This is the absolute maximum error. As all errors are independent, a more realistic way to calculate the error would be used in 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 sensitivity error ε_S
- the linearity error ε_L (to $I_{P\,N}$).

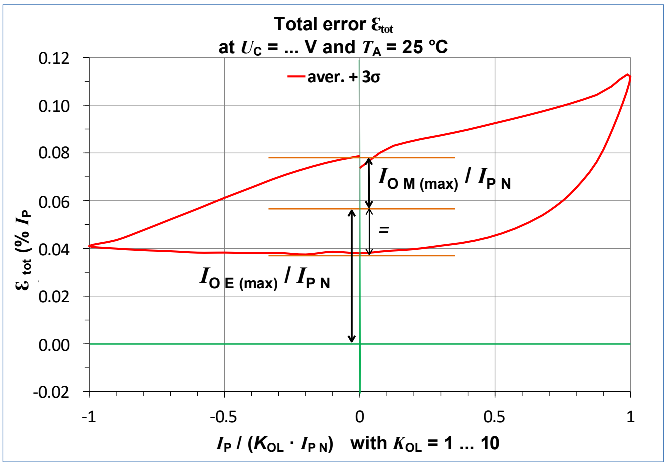

Figure 1: Total error

Electrical offset referred to primary

Using the current cycle shown in figure 2, the electronical offset current $I_{OE}$is the residual output referred to the primary when the input current is zero.

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

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

$$I_{O\,T}(T) = I_{O\,E}(T) - I_{O\,E}(25℃)$$

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 ferromagnetic parts). It is measured using the following primary current cycle. I_{OM} depends on the current value $I_P \geq I_{P\,N}$. K_{OL}: *Overload factor*.

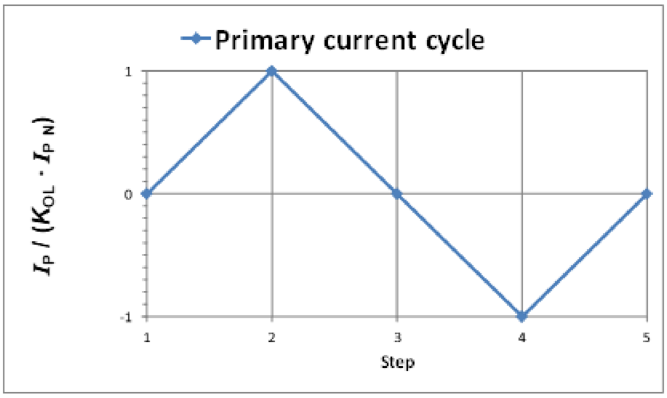

Figure 2: Current cycle used to measure magnetic and electrical offset(transducer supplied)

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

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Performance parameters definition

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 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_{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.

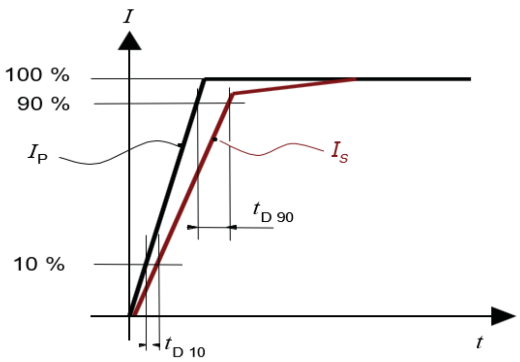

Figure 3: $t_{D\ 10}(delay\ time\ @\ 10\%)\ and$
$t_{D\ 90}(delay\ time\ @\ 10\%)$

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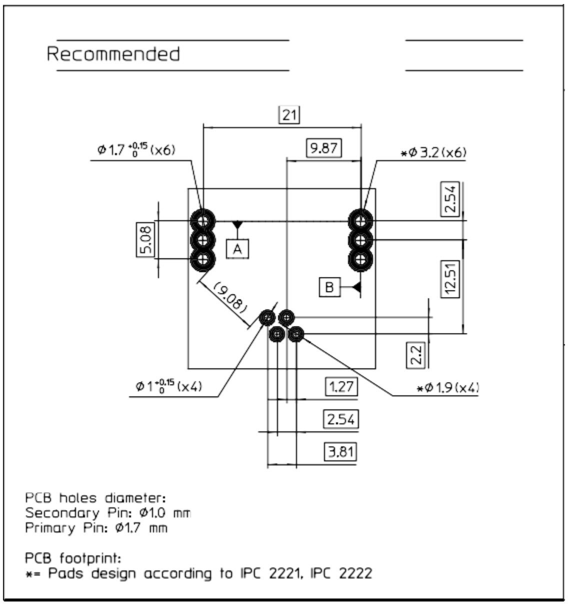
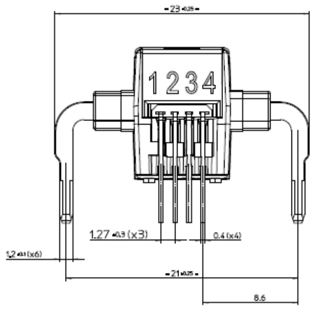
PCB footprint (in mm)

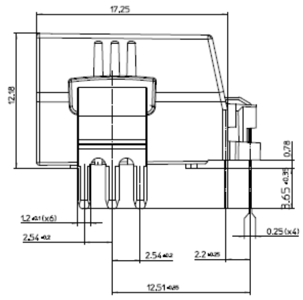


Assembly on PCB

- Recommended PCB hole diameter — 1.7 mm for primary pins; 1 mm for secondary pins
- Maximum PCB thickness — 2.4 mm
- Wave soldering profile — maximum 265 °C for 10 s
  No clean process only.

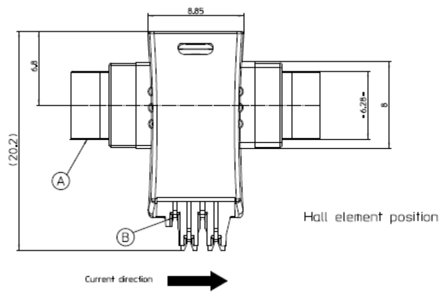
Dimensions (in mm)

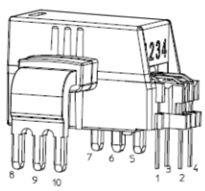




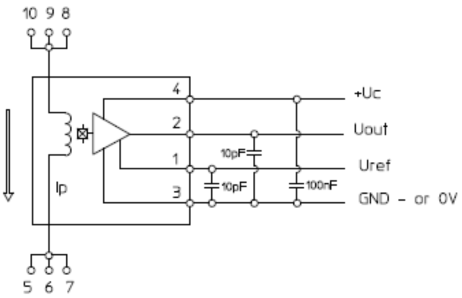
	dCl (mm)	dCp (mm)
A-B	10.2	13

On the customer's PCBA		
	dCl (mm)	dCp (mm)
A-B	9.08	9.08





Connection



Mechanical characteristics

- General tolerance ±0.2mm
- Color Black
- Busbar resistance @ 25 ℃ 0.09mΩ

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 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

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