Current Transducer LTS-PB series I_{PN} = 350,400A

Ref: LTS 350-PB, LTS 400-PB

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

RoHS

Features

- Closed loop(compensated)
- Current transducer using the Hall effect
- Insulating plastic case recognized according to UL 94-V0
- +12V single power supply with 1200A measurement range
- PCB mounting
- Aperture 23.5mm.

Advantages

- Excellent accuracy
- Very good linearity
- Low temperature drift
- Optimized response time
- Wide frequency bandwidth
- High immunity to external interference
- Current overload capability.

Applications

- Motor controller
- Solar inverter
- Uninterruptible Power Supplies (UPS)
- Battery chargers
- Power conversion system (PCS).

Standards

- IEC 62109-1:2010
- IEC 60664-1:2020
- IEC 61800-5-1:2022
- IEC 62447-1:2007.

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.
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.

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.
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, damage, injuries or loss of life resulting from the use of this product.

Absolute maximum ratings

Parameters	Conditions	Unit	Value
Maximum supply voltage	$U_{\text{C max}}$	V	13
Maximum primary current	$I_{\text{P max}}$	A	$10 \times I_{P\ N}$
Maximum primary conductor temperature	$T_{\text{B max}}$	°C	110

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	4.3	
Impulse withstand voltage 1.2/50 µs	U_{IN}	kV	8	
Partial discharge RMS test voltage (qm < 10 pC)	$U_{PD\ 1}$	kV	1.65	
Case material			V-0	According to UL 94
Clearance (pri. - sec.)	d_{CI}	mm	18.5	Shortest distance through air
Creepage distance (pri. - sec.)	d_{CP}	mm	18.5	Shortest path along device body
Comparative tracking index	CTI	V	600	

Environmental and mechanical characteristics

Parameter	Symbol	Unit	Min	Typ	Max	Comment
Ambient operating temperature	T_A	°C	-40		105	
Ambient storage temperature	T_{st}	°C	-50		105	
Relative humidity	RH	%			85	
Mass	m	g		105		

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Electrical data LTS 350-PB

At T_A = 25 °C, U_C = +12 V, R_L=10 kΩ, unless otherwise noted.

Parameter	Symbol	Unit	Min	Typ	Max	Comment
Primary nominal current(continuous)	I_{PN}	A		350		
Primary current, measuring range	I_{PM}	A	-1200		1200	$< 85℃, 12V\ power\ supply$
Supply voltage	U_C	V	11.4	12	12.6	
Current consumption	I_C	mA	$10 + I_P\,(mA)/N_s$			$NS = 2200$
Reference voltage Ip =0	U_{ref}	V	5.85	6	6.15	$Internal\ reference$
Output voltage range	U_{OUT}	V	1.2		10.8	$U_C > 12V$
Electronic offset voltage @ Ip=0	U_{OE}	mV	-4		4	100% $tested$
Electrical offset current@ Ip=0	I_{OE}	A	-1		1	100% $tested$
Temperature coefficient of Ioe refer to primary	TCI_{OE}	mA/K	-15		15	
Nominal Sensitivity	S_N	mV/A		4		$1.4V @ I_{PN}$
Sensitivity error	ε_s	%	-0.8		0.8	100% $tested$
Sensitivity temperature coefficient	TCS	ppm/K	-50		50	
Linearity error	ε_L	%	-0.15		0.15	
Magnetic offset current (referred to primary)	I_{OM}	mA	-250		250	
Response time 10%	$t_{D\ 10}$	μs		1		$di/dt = 50A/us$
Response time 90%	$t_{D\ 90}$	μs		1		$di/dt = 50A/us$
Frequency bandwidth(-3dB)	BW	kHz		200		$Small\ signal$
Rms noise voltage(10kHz)	U_{NO}	mV		2.5		
Accuracy @ Ta=+25 °C	$\varepsilon_{SL\ 25}$	%	-0.8		0.8	100% tested @$I_{P\ N}$
Accuracy @$-40℃\sim105℃$	$\varepsilon_{SL\ TA}$	%	-1		1	@$I_{P\ N}$

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 sample 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.

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Electrical data LTS 400-PB

At T_A = 25 °C, U_C = +12 V, R_L=10 kΩ, unless otherwise noted.

Parameter	Symbol	Unit	Min	Typ	Max	Comment
Primary nominal current(continuous)	$I_{P\,N}$	A		400		
Primary current, measuring range	$I_{P\,M}$	A	-1200		1200	$< 85℃, 12V\ power\ supply$
Supply voltage	U_C	V	11.4	12	12.6	
Current consumption	I_C	mA	$10 + I_P\,(mA)/N_s$			$NS = 2200$
Reference voltage @Ip =0	U_{ref}	V	5.85	6	6.15	$Internal\ reference$
Output voltage range	U_{OUT}	V	1.2		10.8	$U_C > 12V$
Electrical offset voltage @ Ip=0	U_{OE}	mV	-4		4	$100\%\ tested$
Electrical offset Current@ Ip=0	I_{OE}	A	-1		1	$100\%\ tested$
Temperature coefficient of Ioe refer to primary	TCI_{OE}	mA/K	-15		15	
Nominal Sensitivity	S_N	mV/A		4		1.6V@I_{PN}
Sensitivity error	ε_s	%	-0.8		0.8	$100\%\ tested$
Sensitivity temperature coefficient	TCS	ppm/K	-50		50	
Linearity error	ε_L	%	-0.15		0.15	
Magnetic offset current (referred to primary)	I_{OM}	mA	-250		250	
Response time 10%	$t_{D\,10}$	μs		1		$di/dt = 50A/us$
Response time 90%	$t_{D\,90}$	μs		1		$di/dt = 50A/us$
Frequency bandwidth(-3dB)	BW	kHz		200		$Small\ signal$
Rms noise voltage(10kHz)	U_{NO}	mV		2.5		
Accuracy @ Ta=+25 °C	$\varepsilon_{SL\,25}$	%	-0.8		0.8	100% tested @$I_{P\,N}$
Accuracy @$-40℃ \sim 105℃$	$\varepsilon_{SL\,TA}$	%	-1		1	@$I_{P\,N}$

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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 $I_{P\,N}$).

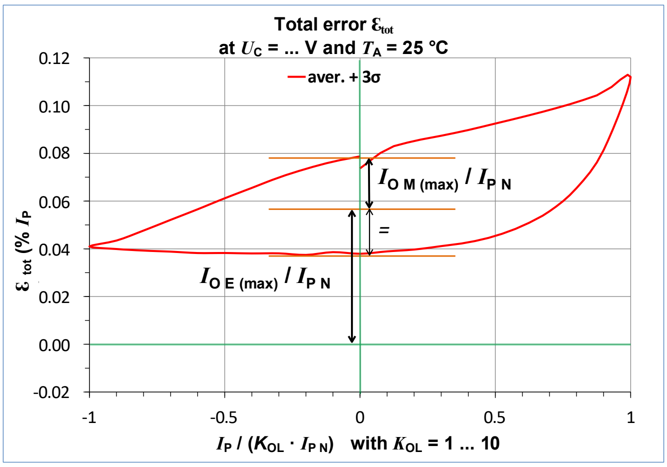

Figure 1: Total error

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*.

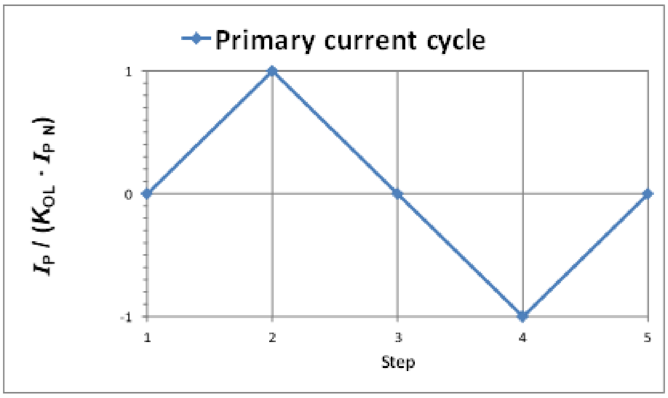

Figure 2: Current cycle used to measure magnetic and electrical offset(transducer supplied)

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

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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 $t_{D\,10}$ @ 10 % and the delay time $t_{D\,90}$ @ 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.

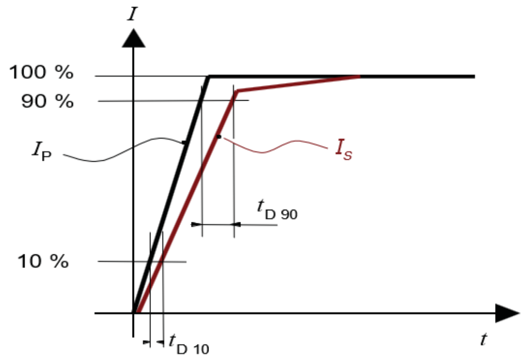

Figure 3: $t_{D\,10}(delay\ time\ @\ 10\%)\ and$
$t_{D\,90}(delay\ time\ @\ 10\%)$

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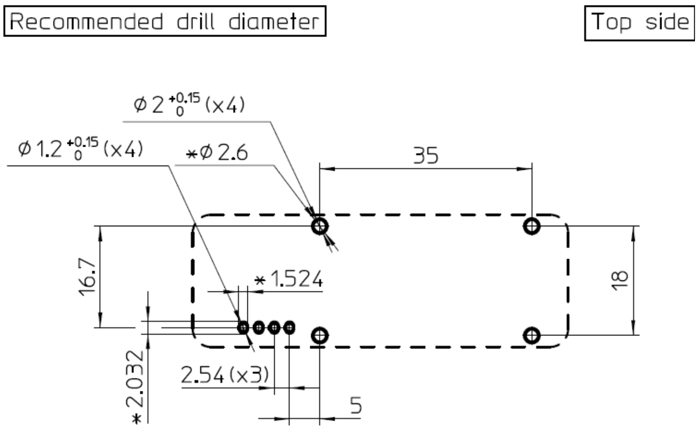
PCB footprint according to the product (in mm)



PCB holes diameter:
Secondary Pins: Ø1.2mm
Retention Pins: Ø2.0mm

*=Pads design according to IPC 2221, IPC 2222

Assembly on PCB

- Recommended PCB hole diameter: 1.2mm for secondary pin; 2mm for retention pin
  Maximum PCB thickness: 2.4mm
- Wave soldering profile: maximum 265 ℃ 10 s

The retention pins inserted into the case of the transducer are electrically isolated by the housing.

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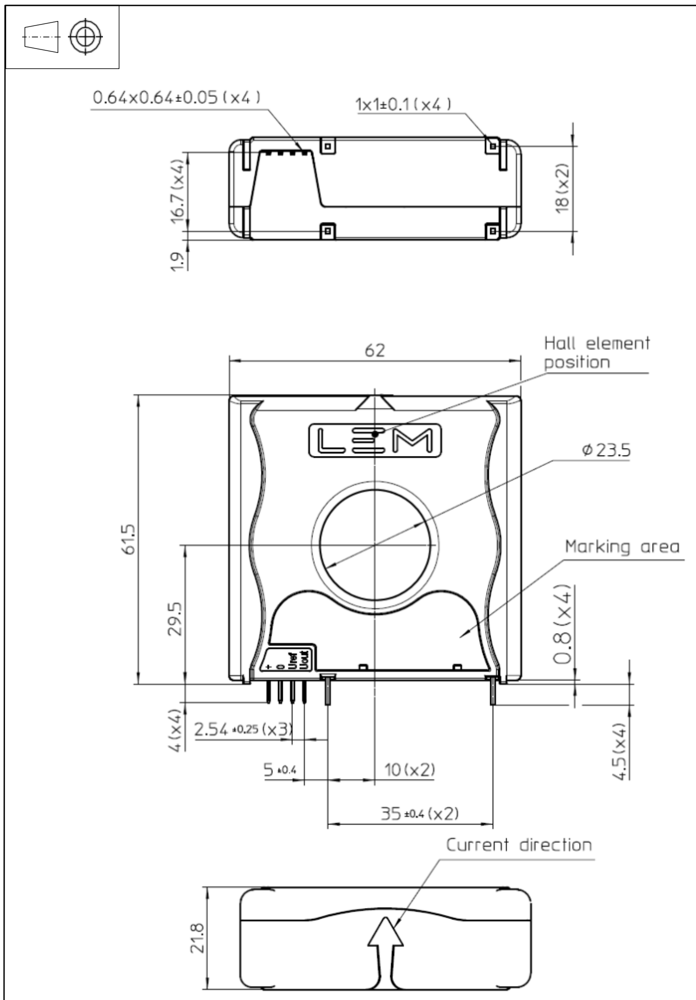
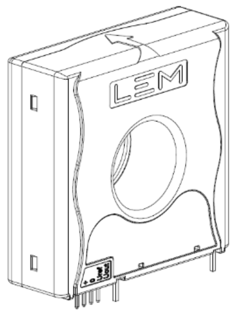
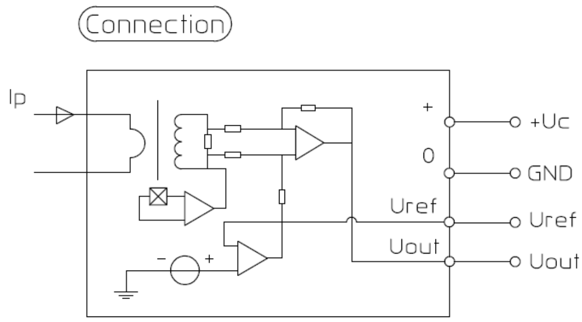




dCl (mm)	dCp (mm)
18.5	18.5

Connection



Mechanical characteristics

- General tolerance ±0.5 mm
- Color black

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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