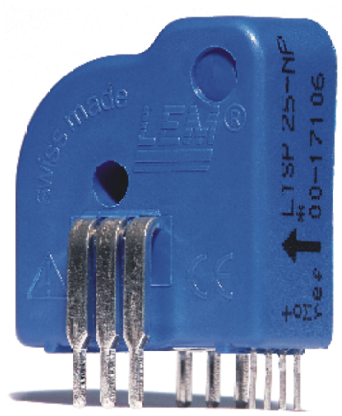
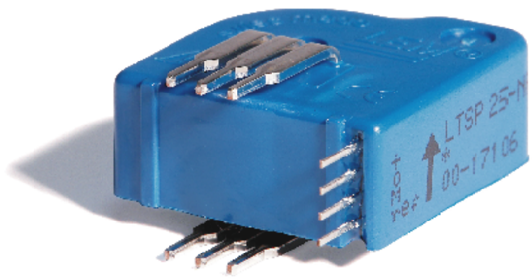
Current Transducer LTSP

I_{PN} = 25 A

Ref: LTSP 25-NP

For the electronic measurement of currents: DC, AC, pulsed .... , with a galvanic isolation between the primary circuit (high power) and the secondary circuit (electronic circuit).





Features

- Closed loop (compensated) multi-range current transducer using the Hall effect
- Current output
- Unipolar supply voltage
- Isolated plastic case recognized according to UL 94-V0
- Compact design for PCB mounting
- Voltage reference readout access.

Advantages

- Excellent accuracy
- Very good linearity
- Very low temperature drift
- Optimized response time
- Wide frequency bandwidth
- No insertion losses
- High immunity to external interference
- Current overload capability.

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.

Standards

- EN 50178
- UL508 - UR marking
- IEC 61010-1-safety.

Application Domain

- Industrial.

Electrical data

At T_A = 25°C, V_C = + 5 V and R_M = 24.3 Ω, N_P = 1 turn, unless otherwise noted.

Parameter	Symbol	Unit	Mini	Typ	Maxi	Conditions
Primary nominal current rms	I_{PN}	At		25		Apply derating according to figure 1
Primary current, measuring range	I_{PM}	At	50			at T_A = 85°C, V_C = + 5 V ± 5 %
Measuring resistance	R_M	Ω	0			I_{PM} = 71.7 At, T_A = 85°C, V_C = + 5 V ± 5 %, see figure 5
					150	I_{PM} = 19.4 At, T_A = 85°C, V_C = + 5 V ± 5 %, see figure 5
Secondary nominal current rms	I_{SN}	mA		12.5		at I_{PN}
Reference voltage	V_{REF}	V	2.475	2.5	2.525	see figure 6
Capacitive loading on V_{REF}	C_L	pF			500	
Supply voltage	V_C	V	4.75		5.25	
Current consumption	I_C	mA		20 + I_S	28 + I_S	
Electrical offset current	I_{OE}	µA	-200	0	+200	
Magnetic offset current	I_{OM}	µA			44	after a cycle to 75 A (see figure 7)
					60	after a cycle to 125 A (see figure 7)
					69	after a cycle to 250 A (see figure 7)
Temperature variation of I_{OE}	I_{OET}	µA			±100	+ 25°C .. + 85°C
					±125	- 40°C .. + 25°C
Temperature coefficient of V_{REF}	TCV_{REF}	ppm/K			50	+ 25°C .. + 85°C
					100	- 40°C .. + 25°C
Sensitivity	G	mA/At		0.5		For K_N, see transducer simplified model page 5
Primary turns	N_P		1		3	
Sensitivity error	ε_G	%	-1.00		1.00	± 25 A range
Linearity error	ε_L	% of I_{PN}			0.10	
Overall accuracy	X_G	%	-2.70		2.70	= $I_{OE} + \varepsilon_G + \varepsilon_L$
Reaction time	t_{ra}	ns			200	I_P = 50 At, dI_P/dt = 100 A/µs
Response time	t_r	ns			150	I_P = 50 At, dI_P/dt = 100 A/µs
di/dt accurately followed	di/dt	A/µs		> 200		
Output current noise rms	I_{no}	µA		72		0.1 Hz < f < 50 Hz, I_P = 0
				1.9		50 Hz < f < 1 kHz, I_P = 0
				7		1 kHz < f < 100 kHz, I_P = 0
Secondary coil resistance	R_S	Ω		45		

Electrical data (continued)

	Symbol	Unit	N_P	Typical	Conditions
Frequency bandwidth at 25 At	BW	kHz	1 turn	> 300	I_P = 25 A, -1 dB
			2 turns	> 300	I_P = 12.5 A, -1 dB
			3 turns	> 300	I_P = 8.3 A, - 1 dB

Absolute maximum ratings

	Symbol	Unit	Conditions
Maximum supply voltage (not operating)	V_C	V	7
Maximum busbar temperature (jumper)		°C	100
Operating ambient temperature range	T_A	°C	- 40 .. + 85
Storage temperature range	T_S	°C	- 40 .. + 90

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

Isolation characteristics

	Symbol	Unit	Value
Rms voltage for AC isolation test, 50 Hz, 1 min, between primary and secondary	V_d	kV	3
Impulse withstand voltage 1.2/50 µs	$\hat{V}_w$	kV	8
Partial discharge extinction voltage rms @ 10pC	V_e	kV	> 1.5
Creepage distance (on case)	dCp	mm	15.35
Clearance distance (on PCB, footprint as figure 9)	dCI	mm	6.2
Comparative Tracking Index	CTI	V	175

Isolation application example

The transducer can be used according to EN 50178 and IEC 61010-1 standards under following conditions (for example):

- Rated isolation voltage: 300 V
- Reinforced isolation
- Over voltage category OV III
- Pollution degree PD2
- Non-uniform field

Typical performance characteristics

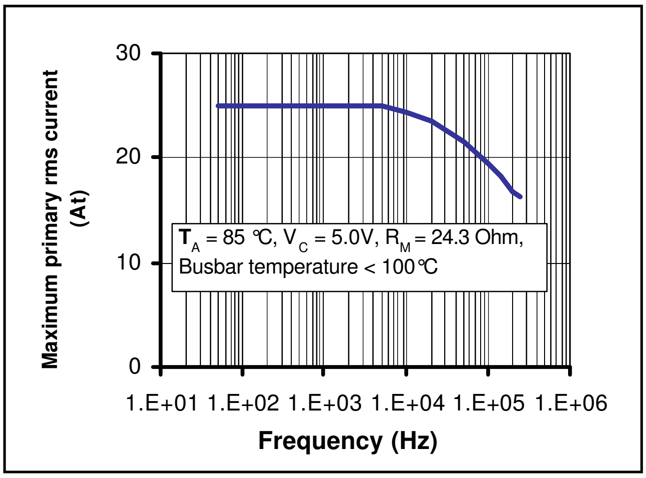


Figure 1: Frequency derating

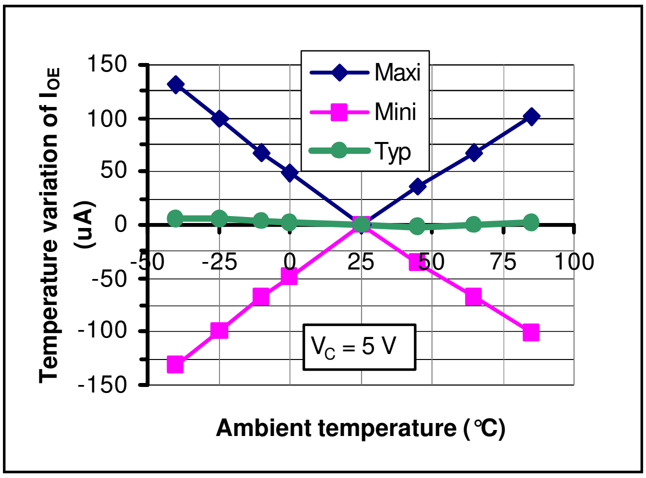


Figure 2: Temperature variation of I_{OE} (I_{OET})

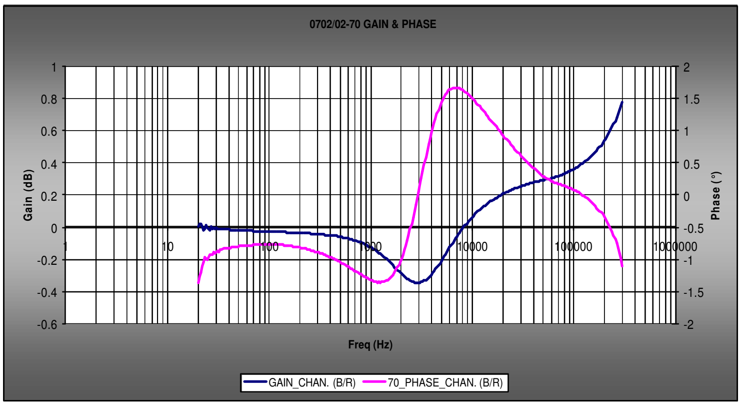


Figure 3: Typical frequency response

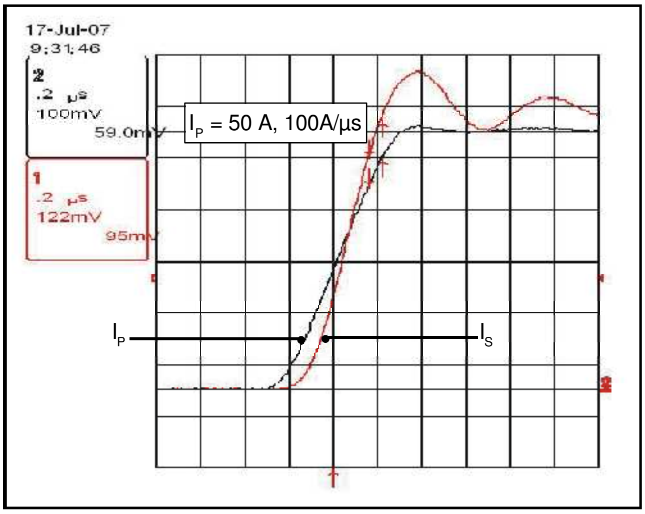


Figure 4: Typical di/dt follow-up

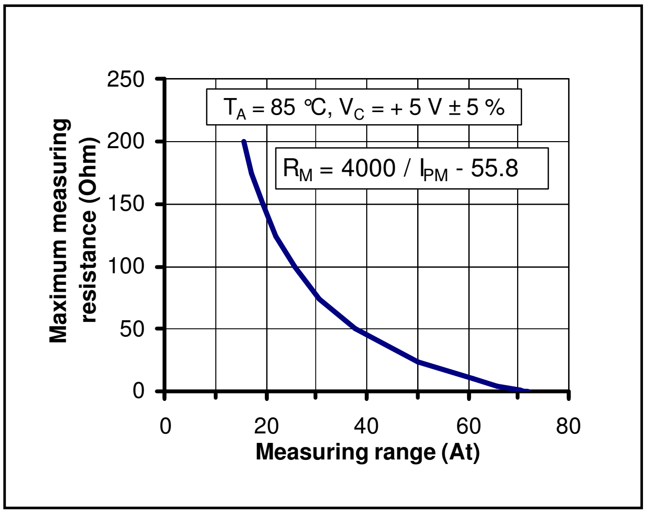


Figure 5: Measuring resistance

Performance parameters definition

Schematic used to measure all electrical parameters
(C = 100 nF, R_M = 24.3 Ω unless otherwise noted):

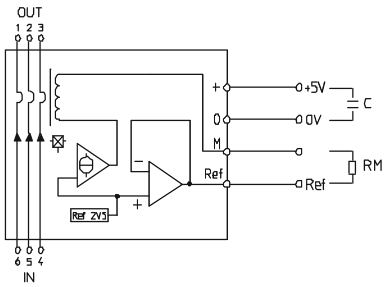


Figure 6: standard characterization schematics

Ampere-turns and amperes

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

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

With N_P the number of primary turn (1, 2 or 3 depending on the connection of the primary jumpers)

Warning : As in most applications the LTSP transducer is used with only one single primary turn (N_P = 1), much of this datasheet is written using primary currents instead of current linkages. The unit is kept as ampere-turn (At) to make clear that ampere-turns are meant.

Transducer simplified model

The static model of the transducer at temperature T_A is:

$$I_S = G\,\Theta_P + \text{error}$$

In which error = $I_{OE} + I_{OET}(T_A) + \varepsilon_G \mathbf{G}\, \Theta_P + \varepsilon_L(\Theta_{Pmaxi})\mathbf{G}\, \Theta_{Pmaxi}$

With :
- $\Theta_P = N_P I_P$: the input ampere-turns (At). Please read above warning.
- Θ_{Pmaxi} : the maxi input ampere-turns that have been applied to the transducer (At)
- I_S : the secondary current (A)
- T_A : the ambient temperature (°C)
- I_{OE} : the electrical offset current (A)
- $I_{OET}(T_A)$: the temperature variation of I_{OE} from 25°C to T_A (A)
- G : the sensitivity of the transducer (A/At) $G = \frac{1}{K_N}$
- ε_G : the sensitivity error
- $\varepsilon_L(\Theta_{Pmaxi})$: the linearity error for Θ_{Pmaxi}

This model is valid for primary ampere-turns Θ_P between $-\Theta_{Pmaxi}$ and $+\Theta_{Pmaxi}$ only.

Example:

Error from - 25°C to +75°C at I_P = 25 A and 1 turn
Error (µA) = 200 + 100 + 0.01 x 25 x 0.5 x 10^3 + 0.001 x 25 x 0.5 x 10^3
Error = 200 + 100 + 125 + 12.5 = 437.5 (µA) worst case

At zero input current, the model for the offset is reduced to:

$$I_S = I_{OE} + I_{OET}(T_A) + I_{OM}(\Theta_{Pmaxi})$$

In which $\mathbf{I}_{OM}(\Theta_{Pmaxi})$ is the magnetic offset current due to the maximum input ampere-turns that have been applied to the transducer.

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 G 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 the maximum measured value.

Magnetic offset

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 included in the linearity figure but can be measured individually.
It is measured using the following primary current cycle.
I_{OM} depends on the current value I_{P1}.

$$I_{OM} = \frac{Is(t_1) - Is(t_2)}{2}$$

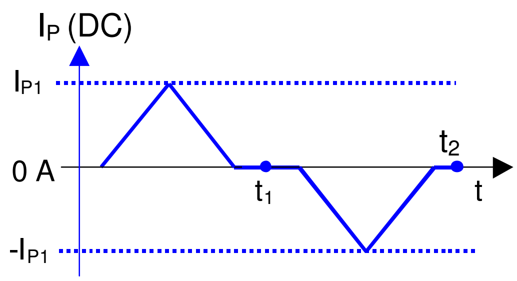


Figure 7: current cycle used to measure magnetic and electrical offset (transducer supplied)

Performance parameters definition (continued)

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 above.

Using the current cycle shown in figure 7, the electrical offset is:

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

The temperature variation I_{OET} of the electrical offset current I_{OE} is the variation of the electrical offset from 25°C to the considered temperature:

$$I_{OET}(T) = I_{OE}(T) - I_{OE}(25°C)$$

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 $-I_{PN} .. +I_{PN}$ 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})

The magnetic offset is part of the overall accuracy. It is taken into account in the linearity error figure provided the transducer has not been magnetized by a current higher than I_{PN}.

Response and reaction times

The response time t_r and the reaction time t_{ra} are shown in the next figure.
Both depend on the primary current di/dt. They are measured at nominal ampere-turns.
The "di/dt accurately followed" mentioned in the electrical data table is defined as the di/dt of the primary current for which the response time is equal to 1 µs.

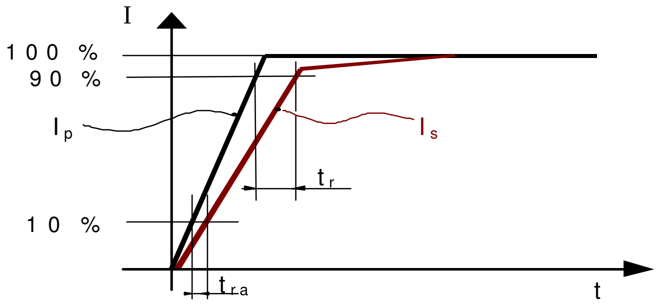
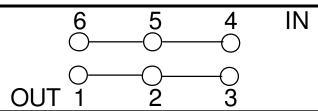
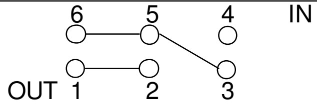
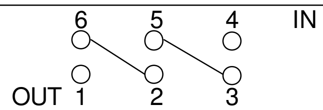


Figure 8: response time t_r and reaction time t_{ra}

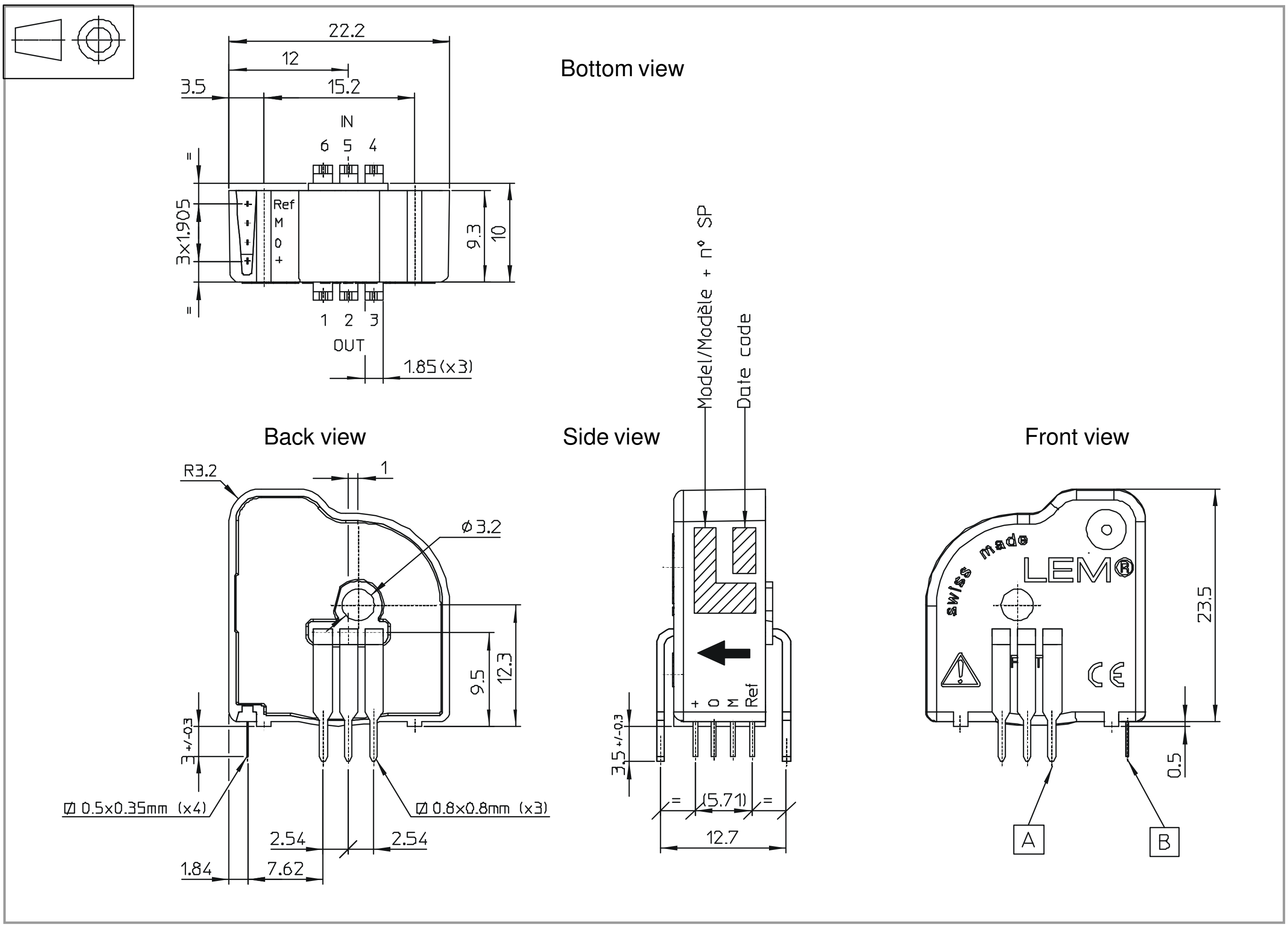
Application data

The LTSP 25-NP has been designed to be used at nominal currents from 8.3 to 25 A. The 3 primary jumpers allow the adaptation of the number of primary turns N_P to the application so as to achieve the best compromise between nominal current, measuring range and secondary current:

Number of primary turns N_P	Primary nominal current rms I_{PN} (A)	Secondary nominal current rms I_{SN} (mA)	Primary coil resistance at 20°C R_P (mΩ)	Primary insertion inductance L_P (µH)	Recommended connections
1	25	12.5	0.18	0.013	
2	12.5	12.5	0.81	0.05	
3	8.33	12.5	1.62	0.12	

See also the paragraph "performance parameters definition: transducer simplified model" for more details about ampere-turns and output current.

Dimensions LTSP 25-NP (in mm. General linear tolerance ± 0.2 mm)



Assembly on PCB

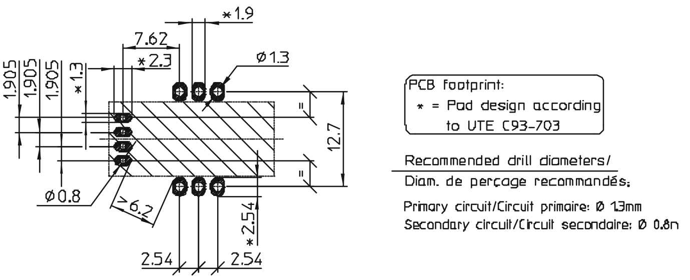


Figure 9: PCB footprint

- Recommended PCB hole diameter 1.3 mm for primary pins
  0.8 mm for secondary pins
- Maximum PCB thickness 1.6 mm
- Solder temperature maximum 270°C for 15 s

Remarks

- I_S is positive (sourcing) when I_P flows in the direction of the arrow
- Mass: 10 g

Safety

This transducer must be used in electric/electronic equipment with respect to applicable standards and safety requirements in accordance with the following 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 built-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.