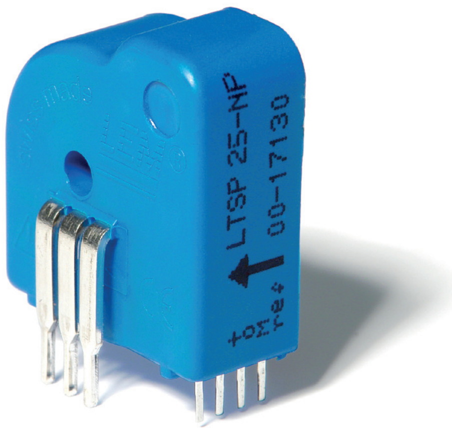
Current Transducer LTSP 25-P

I_{PN} = 25 A

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



Features

- Closed loop (compensated) multi-range current transducer using the Hall effect
- Current output
- Unipolar supply voltage
- Insulated 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
- Renewable Energy (Solar and Wind).

Standards

- EN 50178: 1997
- IEC 61010-1: 2010
- UL 508: 2013.

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

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: 1

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	600
Max surrounding air temperature	T_A	°C	85
Primary current	I_P	A	According to series primary currents
Output voltage	V_{out}	V	0 to 5

Conditions of acceptability

When installed in the end-use equipment, consideration shall be given to the following:

1 - These devices must be mounted in a suitable end-use enclosure.
2 - The terminals have not been evaluated for field wiring.
3 - The LTS, LTSR, LTSP Series are intended to be mounted on the printed wiring board of the end-use equipment (with a minimum CTI of 100).
4 - The LTS, LTSR, LTSP Series shall be used in a pollution degree 2 environment.
5 - Low voltage circuits are intended to be powered by a circuit derived from an isolating source (such as a transformer, optical isolator, limiting impedance or electro-mechanical relay) and having no direct connection back to the primary circuit (other than through the grounding means).
6 - The LTS, LTSR, LTSP Series: based on results of temperature tests, in the end-use application, a maximum of 100°C cannot be exceeded at soldering point between primary coil pin and soldering point or on primary bus bar (corrected to the appropriate evaluated max, surrounding air).
7 - For LTS, LTSR, LTSP Series, the secondary sensing circuit was evaluated as the circuit intended to be supplied from a Limited Voltage/Current circuit defined in UL 508 standard.

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	3	
Impulse withstand voltage 1.2/50 µs	$\hat{U}_W$	kV	8	
Partial discharge extinction RMS voltage @ 10 pC	U_e	kV	> 1.5	
Clearance (pri. - sec.)	d_{Cl}	mm	6.2	Shortest distance through air
Creepage distance (pri. - sec.)	d_{Cp}	mm	15.35	Shortest path along device body
Case material	-	-	V0 according to UL 94	
Comparative tracking index	CTI		175	
Application example		V	300	Reinforced insulation, CAT OV III,PD 2 non uniform field according to EN 50178, IEC 61010-1

Environmental and mechanical characteristics

Parameter	Symbol	Unit	Min	Typ	Max	Comment
Ambient operating temperature	T_A	°C	−40		+85	
Ambient storage temperature	T_S	°C	−40		+90	
Mass	m	g		10		

Electrical data

At T_A = 25 °C, U_C = +5 V and R_M = 24.3 Ω, N_P = 1 turn unless otherwise noted (see Definition of typical paragraph page 8).

Parameter	Symbol	Unit	Min	Typ	Max	Comment
Primary nominal RMS current	I_{PN}	At		25		Apply derating according to figure 1
Primary current, measuring range	I_{PM}	At	50			At T_A = 85 °C, U_C = +5V ±5 %
Measuring resistance	R_M	Ω	0			I_{PM} = 71.7 At, T_A = 85 °C, U_C = +5V ±5 % see figure 5
					150	I_{PM} = 19.4 At, T_A = 85 °C, U_C = +5V ±5 % see figure 5
Secondary nominal RMS current	I_{SN}	mA	12.5			At I_{PN}
Current consumption	I_C	mA		20 + I_S	28 + I_S	
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	U_C	V	4.75		5.25	
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 6
Primary turns	N_P		1		3	
Sensitivity error	ε_G	%	−1		1	±25 A range
Linearity error	ε_L	% of I_{PN}			0.1	
Overall accuracy	X_G	%	−2.7		2.7	= $I_{OE} + \varepsilon_G + \varepsilon_L$
Output RMS noise current	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
Reaction time @ 10 % of I_{PN}	t_{ra}	ns			200	I_P = 50 At, di/dt = 100/Aμs
Step response time to 90 % of I_{PN}	t_r	ns			150	I_P = 50 At, di/dt = 100/Aμs
Secondary coil resistance	R_S	Ω		45		
Frequency bandwidth at 25 At	BW	kHz		> 300		N_P = 1 turn, I_P = 25 A, −1 dB
				> 300		N_P = 2 turns, I_P = 12.5 A, −1 dB
				> 300		N_P = 3 turns, I_P = 8.3 A, −1 dB

Typical performance characteristics

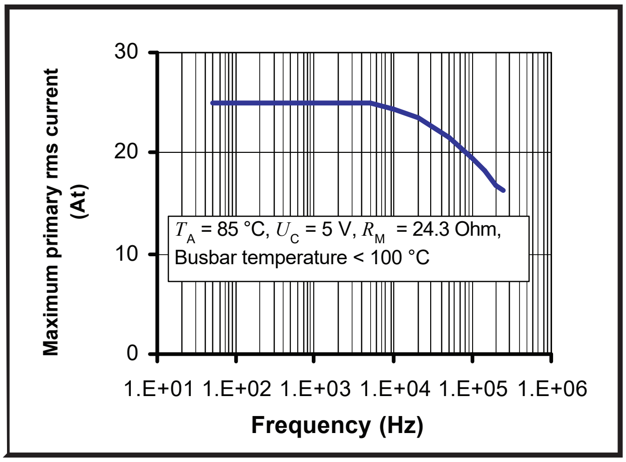


Figure 1: Frequency derating

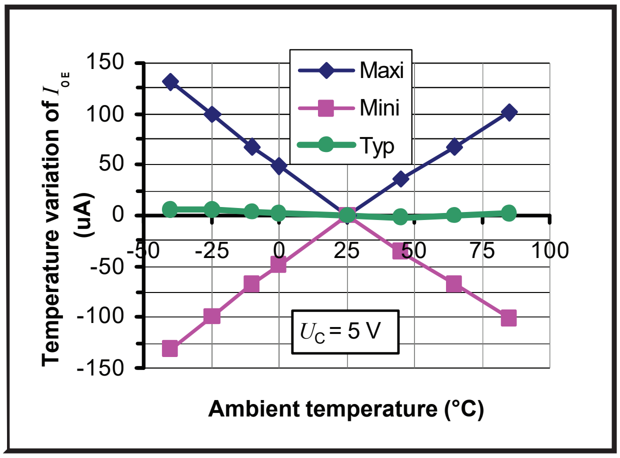


Figure 2: Temperature variation of I_{OE} (I_{OET})

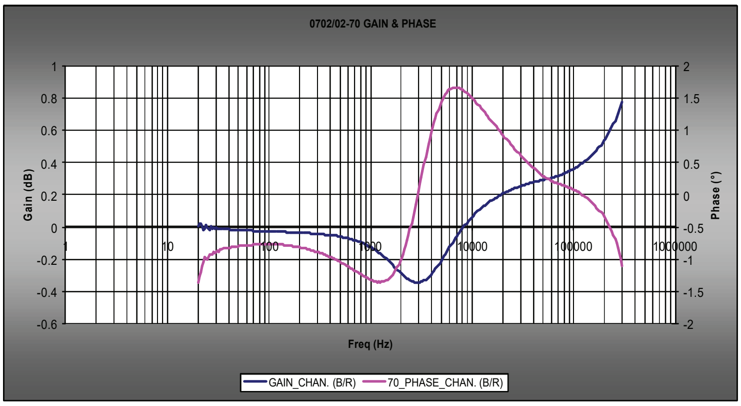


Figure 3: Typical frequency response

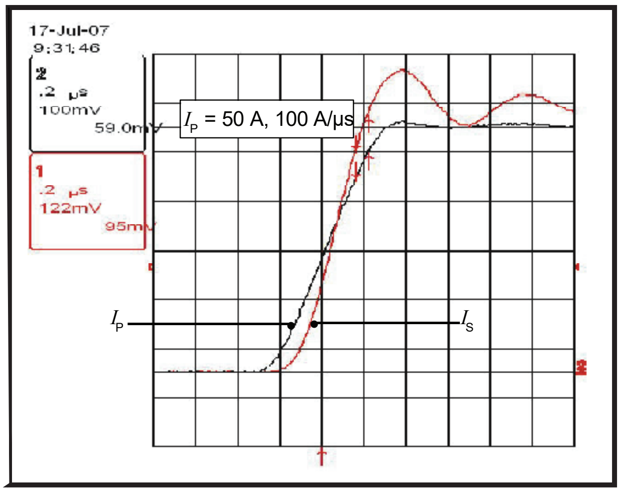


Figure 4: Typical di/dt follow-up

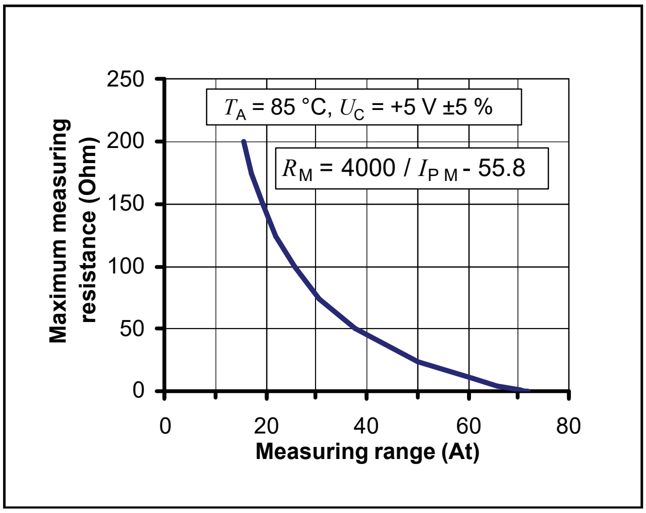


Figure 5: Measuring resistance

Performance parameters definition

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

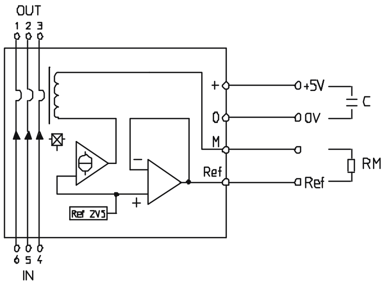


Figure 6: standard characterization schematics

Ampere-turns and amperes

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

$\Theta_P = N_P \cdot I_P$ (At)
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 (At) unit is used to emphasis that current linkages are intended and applicable.

Transducer simplified model

The static model of the transducer at temperature T_A is:

$$I_S = G \cdot \Theta_P + \varepsilon$$

In which ε =

$$I_{OE} + I_{OET}(T_A) + \varepsilon_G \cdot \Theta_P \cdot G + \varepsilon_L(\Theta_{P\,max}) \cdot \Theta_{P\,max} \cdot G\, \Theta_{P\,max}$$

With:
- $\Theta_P = N_P \cdot I_P$: primary current linkage (At)
- $\Theta_{P\,max}$: max primary current linkage applied to the transducer (At)
- I_S : secondary current (A)
- T_A : ambient operating temperature (°C)
- I_{OE} : electrical offset current (A)
- $I_{OET}(T_A)$: temperature variation of I_{OE} from 25 °C at temperature T_A (°C)
- G : sensitivity of the transducer (A/At)
- ε_G : sensitivity error
- $\varepsilon_L(\Theta_{P\,max})$: 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.

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 I_{PN}.

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

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

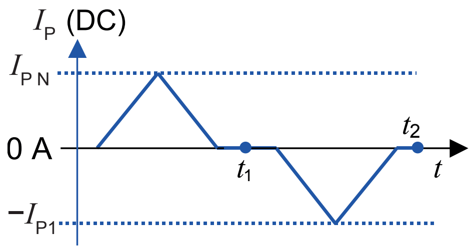


Figure 7: Current cycle used to measure magnetic and electrical offset (transducer supplied)

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 7, the electrical offset is:

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

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})

Response and reaction times

The response time t_r and the reaction time t_{ra} are shown in figure 8.

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

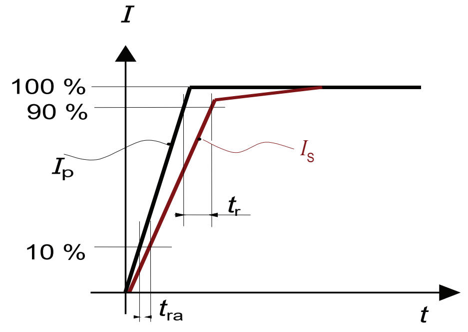
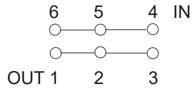
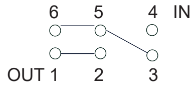
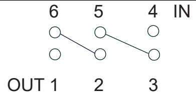


Figure 8: Response time t_r and reaction time t_{ra}

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.

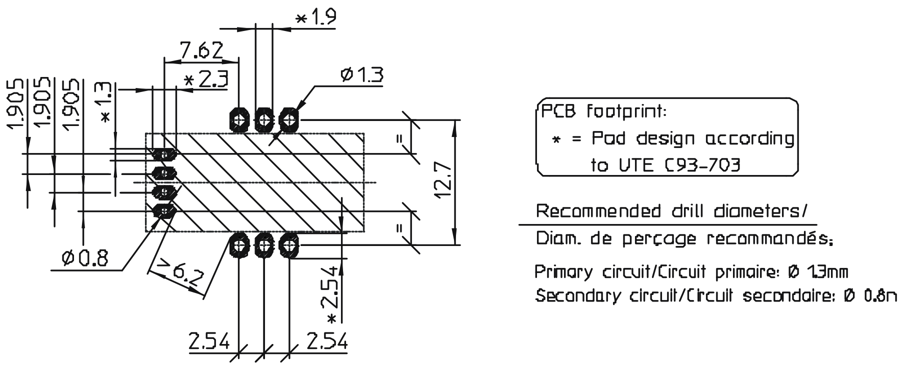
Number of primary turns	Primary nominal RMS current	Secondary nominal current I_S	Primary resistance R_P [mΩ]	Primary insertion inductance L_P [µH]	Recommended connections
1	25	12.5	0.18	0.013	
2	12.5	12.5	0.81	0.05	
3	8.33	12.5	1.62	0.12	

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

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.

PCB footprint



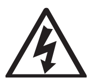
Assembly on PCB

- Recommended PCB hole diameter: Ø 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

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.

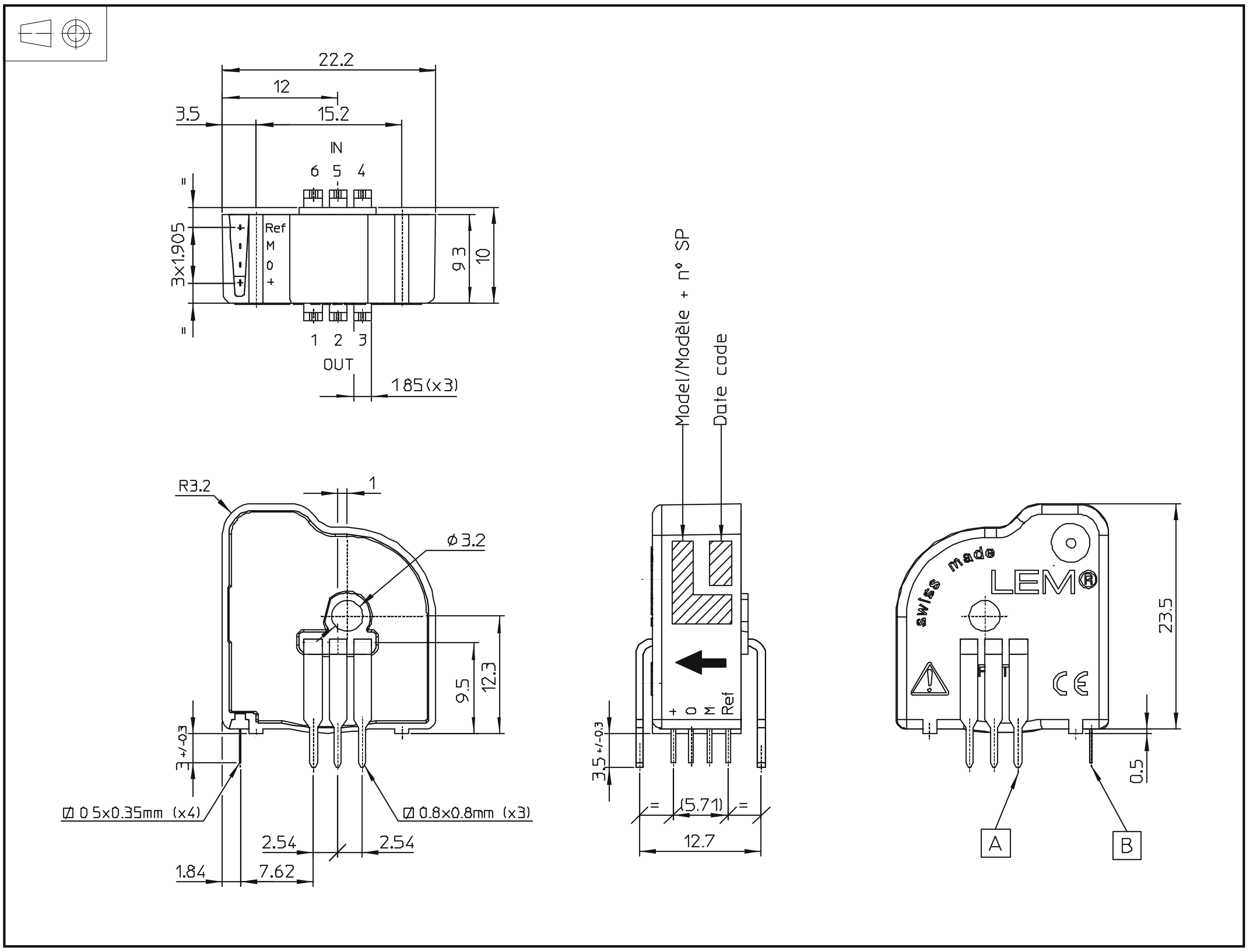


Caution, risk of electrical shock
When operating the transducer, certain parts of the module can carry hazardous voltage (e.g. primary busbar, power supply). Ignoring this warning can lead to injury and/or cause serious damage.
This transducer is a build-in device, whose conducting parts must be inaccessible 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 LTSR 25-NP (in mm)



Remark

I_s is positive (sourcing) when I_P flows in the direction of the arrow.