

Current Transducer LXS series

$I_{PN} = 6, 15, 25 A$

Ref: LXS 6-NPS, LXS 15-NPS, LXS 25-NPS

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



Features

- Closed loop multi-range current transducer
- Voltage output
- Unipolar supply voltage
- Compact design for PCB mounting.

Advantages

- Very low offset drift
- Very good dv/dt immunity
- LTS footprint compatible
- Extended measuring range for unipolar measurement.

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
- Solar inverters.

Standards

- IEC 61800-1: 1997
- IEC 61800-2: 2015
- IEC 61800-3: 2004
- IEC 61800-5-1: 2007
- IEC 62109-1: 2010
- IEC 62477-1: 2012
- 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	110
Maximum primary current	$I_{P \max}$	A	$20 \times I_{PN}$
Maximum electrostatic discharge voltage	$U_{ESD \max}$	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: 11

Standards

- CSA C22.2 NO. 14-10 INDUSTRIAL CONTROL EQUIPMENT - Date 2011/08/01
- UL 508 STANDARD FOR INDUSTRIAL CONTROL EQUIPMENT - Date 2013

Ratings

Parameter	Symbol	Unit	Value
Primary involved potential		V AC/DC	600
Max surrounding air temperature	T_A	°C	105
Primary current	I_P	A	According to series primary currents
Secondary supply voltage	U_C	V DC	7
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 LES, LESR, LKSR, LPSR, LXS and LXSR Series shall be used in a pollution degree 2 environment or better.
- 4 - 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).
- 5 - These devices are intended to be mounted on the printed wiring board of the end-use equipment (with a minimum CTI of 100).
- 6 - LES, LESR, LKSR and LPSR Series: based on results of temperature tests, in the end-use application, a maximum of 110°C cannot be exceeded on the primary jumper.

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	
Impulse withstand voltage 1.2/50 μ s	\hat{U}_W	kV	8	
Insulation resistance	R_{INS}	G Ω	18	measured at 500 V DC
Partial discharge RMS test voltage ($q_m < 10$ pC)	U_t	kV	1.65	
Clearance (pri. - sec.)	d_{Cl}	mm		See dimensions drawing on page 19
Creepage distance (pri. - sec.)	d_{Cp}			
Case material	-	-	V0 according to UL 94	
Comparative tracking index	CTI		600	
Application example		V	300 V CAT III, PD2	Reinforced insulation, non uniform field according to IEC 61800-5-1
Application example		V	600 V CAT III, PD2	Basic insulation, non uniform field according to IEC 61800-5-1

Environmental and mechanical characteristics

Parameter	Symbol	Unit	Min	Typ	Max	Comment
Ambient operating temperature	T_A	$^{\circ}$ C	-40		105	
Ambient storage temperature	T_S	$^{\circ}$ C	-55		125	
Mass	m	g		10		

Electrical data LXS 6-NPS

At $T_A = 25\text{ °C}$, $U_C = +5\text{ V}$, $N_P = 1\text{ turn}$, $R_L = 10\text{ k}\Omega$ internal reference, unless otherwise noted (see Min, Max, typical definition paragraph in page 18).

Parameter	Symbol	Unit	Min	Typ	Max	Comment
Primary nominal RMS current	I_{PN}	A		6		Apply derating according to fig. 16
Primary current, measuring range	I_{PM}	A	-20		20	
Number of primary turns	N_P			1, 2, 3		
Supply voltage	U_C	V	4.75	5	5.25	
Current consumption	I_C	mA		$17 + \frac{I_p(\text{mA})}{N_s}$	$20 + \frac{I_p(\text{mA})}{N_s}$	$N_S = 2000\text{ turns}$
Output voltage	V_{out}	V	0.25		4.75	with $U_C = +5\text{ V}$
Output voltage @ $I_p = 0\text{ A}$	V_{out}	V		2.5		
Electrical offset voltage	V_{OE}	mV	-15		15	100 % tested $V_{out} - 2.5\text{ V}$
Electrical offset current referred to primary	I_{OE}	mA	-144		144	100 % tested
Temperature coefficient of V_{out} @ $I_p = 0\text{ A}$	TCV_{out}	ppm/K			± 70	ppm/K of 2.5 V -40 °C ... 105 °C
Theoretical sensitivity	G_{th}	mV/A		104.2		625 mV/ I_{PN}
Sensitivity error	ε_G	%	-0.2		0.2	100 % tested
Temperature coefficient of G	TCG	ppm/K			± 45	-40 °C ... 105 °C
Linearity error	ε_L	% of I_{PN}	-0.1		0.1	
Magnetic offset current ($10 \times I_{PN}$) referred to primary	I_{OM}	mA	-25		25	
Output RMS noise current 100 Hz ... 100 kHz	e_{no}	$\mu\text{V}/\text{Hz}^{1/2}$		7		
Output noise voltage DC ... 10 kHz DC ... 100 kHz DC ... 1 MHz	V_{no}	mVpp		11.5 13.6 13.8		
Reaction time @ 10 % of I_{PN}	t_{ra}	μs			0.3	$R_L = 1\text{ k}\Omega$, $di/dt = 50\text{ A}/\mu\text{s}$
Step response time to 90 % of I_{PN}	t_r	μs			0.4	$R_L = 1\text{ k}\Omega$, $di/dt = 50\text{ A}/\mu\text{s}$
Frequency bandwidth ($\pm 3\text{ dB}$)	BW	kHz	300			$R_L = 1\text{ k}\Omega$
Overall accuracy	X_G	% of I_{PN}			2.25	
Overall accuracy @ $T_A = 85\text{ °C}$ (105 °C)	X_G	% of I_{PN}			3.5 (4.2)	
Accuracy	X	% of I_{PN}			0.5	
Accuracy @ $T_A = 85\text{ °C}$ (105 °C)	X	% of I_{PN}			0.8 (1)	

Electrical data LXS 15-NPS

At $T_A = 25\text{ °C}$, $U_C = +5\text{ V}$, $N_P = 1\text{ turn}$, $R_L = 10\text{ k}\Omega$ internal reference, unless otherwise noted (see Min, Max, typical definition paragraph in page 18).

Parameter	Symbol	Unit	Min	Typ	Max	Comment
Primary nominal RMS current	I_{PN}	A		15		Apply derating according to fig. 17
Primary current, measuring range	I_{PM}	A	-51		51	
Number of primary turns	N_P			1, 2, 3		
Supply voltage	U_C	V	4.75	5	5.25	
Current consumption	I_C	mA		$17 + \frac{I_s(\text{mA})}{N_s}$	$20 + \frac{I_s(\text{mA})}{N_s}$	$N_s = 2000\text{ turns}$
Output voltage	V_{out}	V	0.25		4.75	with $U_C = +5\text{ V}$
Output voltage @ $I_P = 0\text{ A}$	V_{out}	V		2.5		
Electrical offset voltage	V_{OE}	mV	-13		13	100 % tested $V_{out} - 2.5\text{ V}$
Electrical offset current referred to primary	I_{OE}	mA	-312		312	100 % tested
Temperature coefficient of V_{out} @ $I_P = 0\text{ A}$	TCV_{out}	ppm/K			± 80	ppm/K of 2.5 V -40 °C ... 105 °C
Theoretical sensitivity	G_{th}	mV/A		41.67		$625\text{ mV}/I_{PN}$
Sensitivity error	ε_G	%	-0.2		0.2	100 % tested
Temperature coefficient of G	TCG	ppm/K			± 45	-40 °C ... 105 °C
Linearity error	ε_L	% of I_{PN}	-0.1		0.1	
Magnetic offset current ($10 \times I_{PN}$) referred to primary	I_{OM}	mA	-45		45	
Output RMS noise current 100 Hz ... 100 kHz	e_{no}	$\mu\text{V}/\text{Hz}^{1/2}$		4		
Output noise voltage DC ... 10 kHz DC ... 100 kHz DC ... 1 MHz	V_{no}	mVpp		5.7 6.3 7.6		
Reaction time @ 10 % of I_{PN}	t_{ra}	μs			0.3	$R_L = 1\text{ k}\Omega$, $di/dt = 50\text{ A}/\mu\text{s}$
Step response time to 90 % of I_{PN}	t_r	μs			0.4	$R_L = 1\text{ k}\Omega$, $di/dt = 50\text{ A}/\mu\text{s}$
Frequency bandwidth ($\pm 3\text{ dB}$)	BW	kHz	300			$R_L = 1\text{ k}\Omega$
Overall accuracy	X_G	% of I_{PN}			1.6	
Overall accuracy @ $T_A = 85\text{ °C}$ (105 °C)	X_G	% of I_{PN}			3 (3.9)	
Accuracy	X	% of I_{PN}			0.5	
Accuracy @ $T_A = 85\text{ °C}$ (105 °C)	X	% of I_{PN}			0.7 (0.75)	

Electrical data LXS 25-NPS

At $T_A = 25\text{ °C}$, $U_C = +5\text{ V}$, $N_P = 1\text{ turn}$, $R_L = 10\text{ k}\Omega$ internal reference, unless otherwise noted (see Min, Max, typical definition paragraph in page 18).

Parameter	Symbol	Unit	Min	Typ	Max	Comment
Primary nominal RMS current	I_{PN}	A		25		Apply derating according to fig. 18
Primary current, measuring range	I_{PM}	A	-85		85	
Number of primary turns	N_P			1, 2, 3		
Supply voltage	U_C	V	4.75	5	5.25	
Current consumption	I_C	mA		$17 + \frac{I_s(\text{mA})}{N_s}$	$20 + \frac{I_s(\text{mA})}{N_s}$	$N_s = 2000\text{ turns}$
Output voltage	V_{out}	V	0.25		4.75	with $U_C = +5\text{ V}$
Output voltage @ $I_P = 0\text{ A}$	V_{out}	V		2.5		
Electrical offset voltage	V_{OE}	mV	-11		11	100 % tested $V_{out} - 2.5\text{ V}$
Electrical offset current referred to primary	I_{OE}	mA	-440		440	100 % tested
Temperature coefficient of V_{out} @ $I_P = 0\text{ A}$	TCV_{out}	ppm/K			± 80	ppm/K of 2.5 V -40 °C ... 105 °C
Theoretical sensitivity	G_{th}	mV/A		25		$625\text{ mV}/I_{PN}$
Sensitivity error	ε_G	%	-0.2		0.2	100 % tested
Temperature coefficient of G	TCG	ppm/K			± 45	-40 °C ... 105 °C
Linearity error	ε_L	% of I_{PN}	-0.1		0.1	
Magnetic offset current ($10 \times I_{PN}$) referred to primary	I_{OM}	mA	-60		60	
Output RMS noise current 100 Hz ... 100 kHz	e_{no}	$\mu\text{V}/\text{Hz}^{1/2}$		3.5		
Output noise voltage DC ... 10 kHz DC ... 100 kHz DC ... 1 MHz	V_{no}	mVpp		2.7 4.5 5.3		
Reaction time @ 10 % of I_{PN}	t_{ra}	μs			0.3	$R_L = 1\text{ k}\Omega$, $di/dt = 50\text{ A}/\mu\text{s}$
Step response time to 90 % of I_{PN}	t_r	μs			0.4	$R_L = 1\text{ k}\Omega$, $di/dt = 50\text{ A}/\mu\text{s}$
Frequency bandwidth ($\pm 3\text{ dB}$)	BW	kHz	300			$R_L = 1\text{ k}\Omega$
Overall accuracy	X_G	% of I_{PN}			1.8	
Overall accuracy @ $T_A = 85\text{ °C}$ (105 °C)	X_G	% of I_{PN}			3 (3.1)	
Accuracy	X	% of I_{PN}			0.5	
Accuracy @ $T_A = 85\text{ °C}$ (105 °C)	X	% of I_{PN}			0.7 (0.75)	

Typical performance characteristics LXS 6-NPS

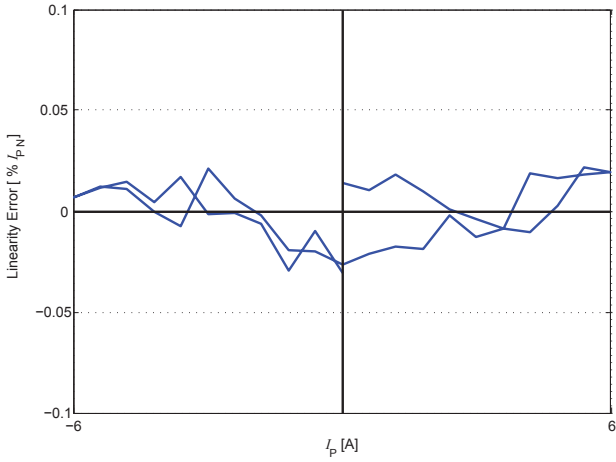


Figure 1: Linearity error

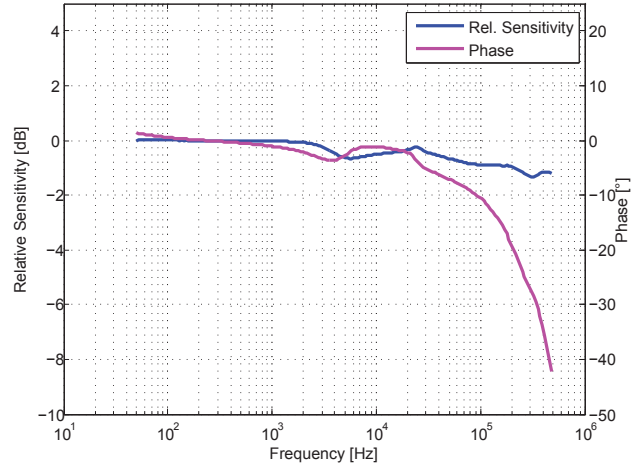


Figure 2: Frequency response

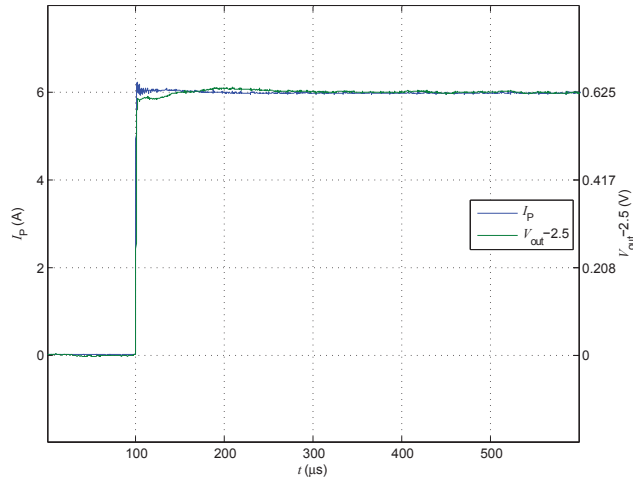


Figure 3: Step response

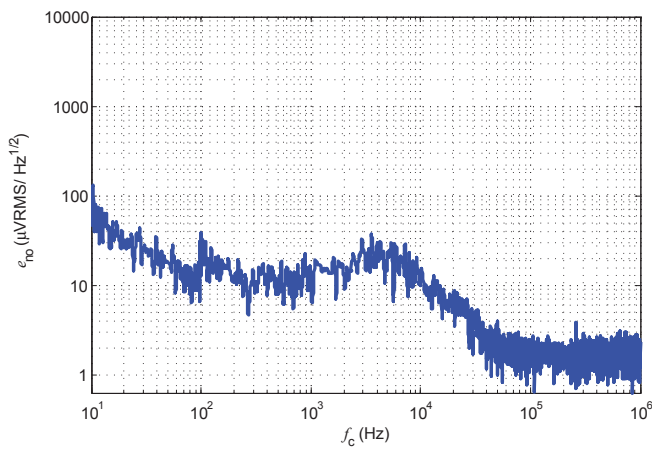


Figure 4: output noise voltage spectral density

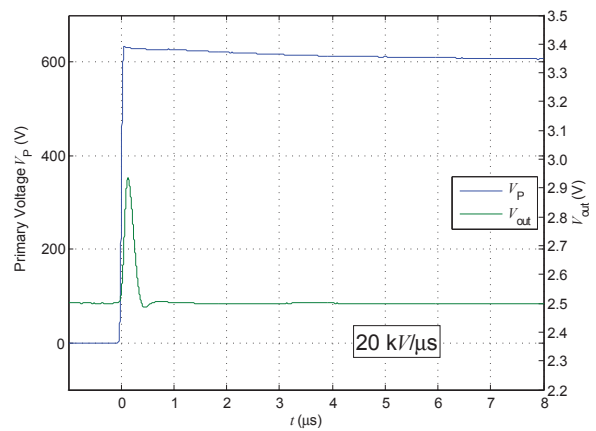


Figure 5: dv/dt

Typical performance characteristics LXS 15-NPS

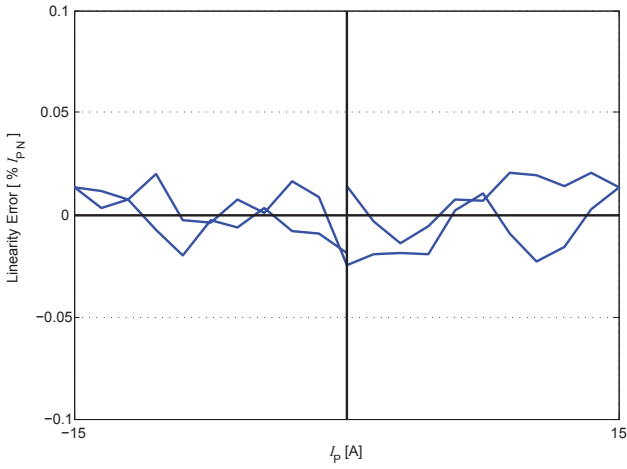


Figure 6: Linearity error

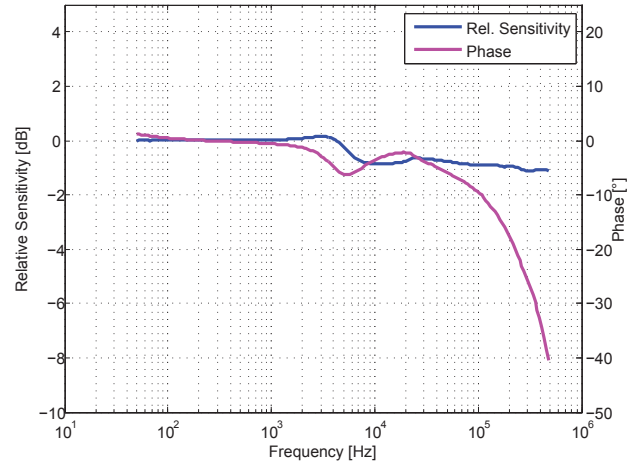


Figure 7: Frequency response

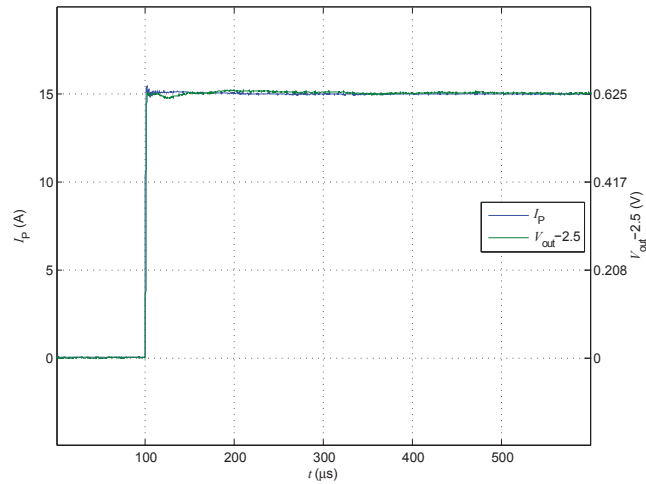


Figure 8: Step response

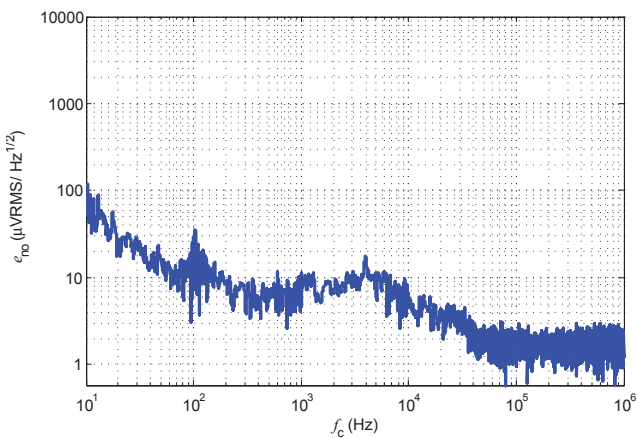


Figure 9: output noise voltage spectral density

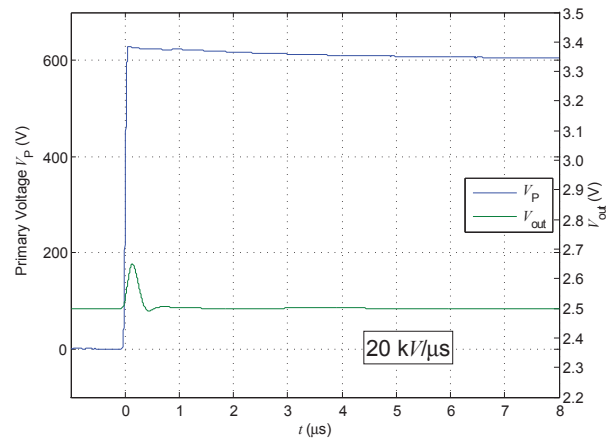


Figure 10: dv/dt

Typical performance characteristics LXS 25-NPS

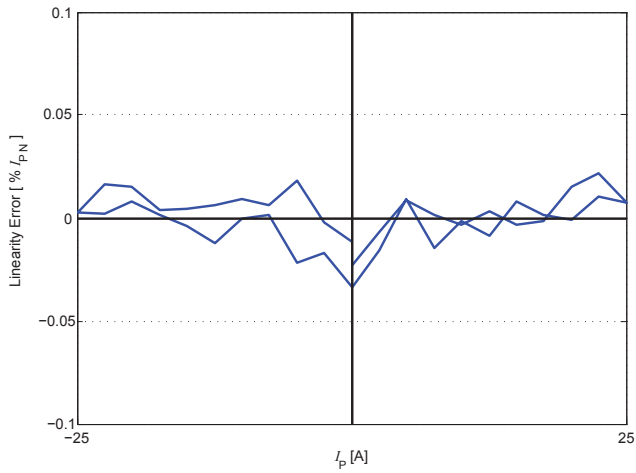


Figure 11: Linearity error

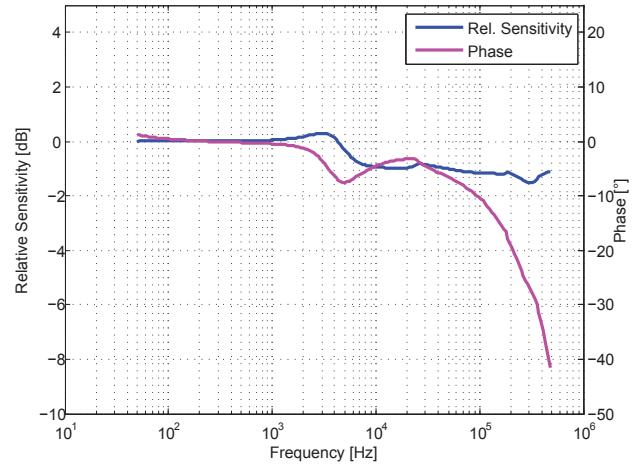


Figure 12: Frequency response

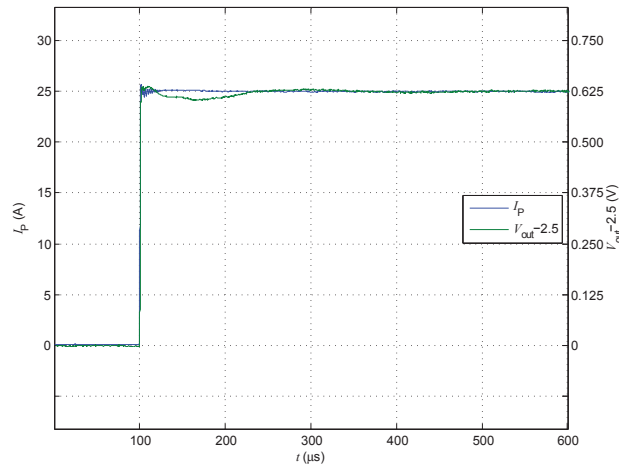


Figure 13: Step response

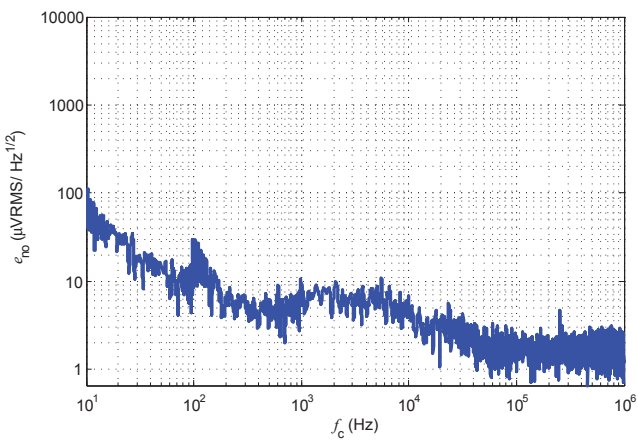


Figure 14: output noise voltage spectral density

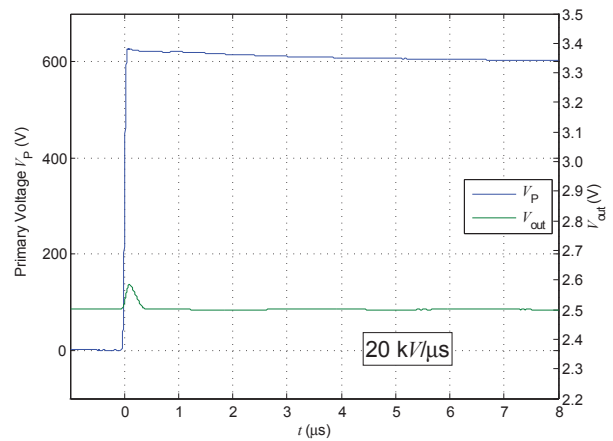


Figure 15: dv/dt

Maximum continuous DC primary current

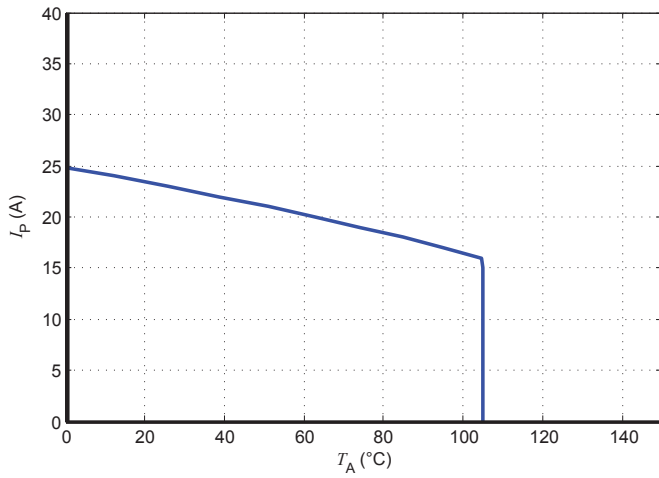


Figure 16: I_p vs T_A for LXS 6-NPS

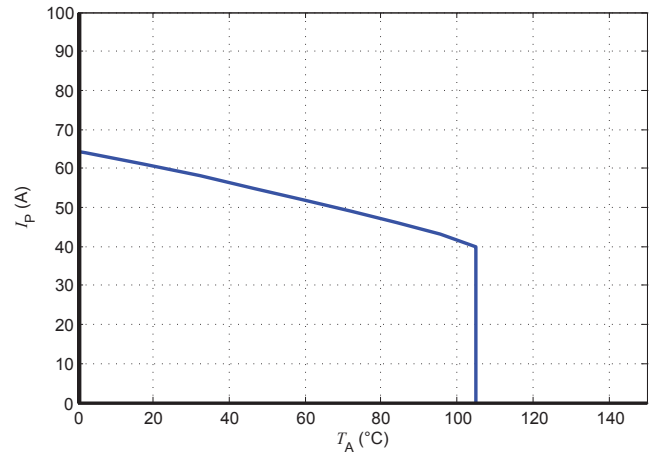


Figure 17: I_p vs T_A for LXS 15-NPS

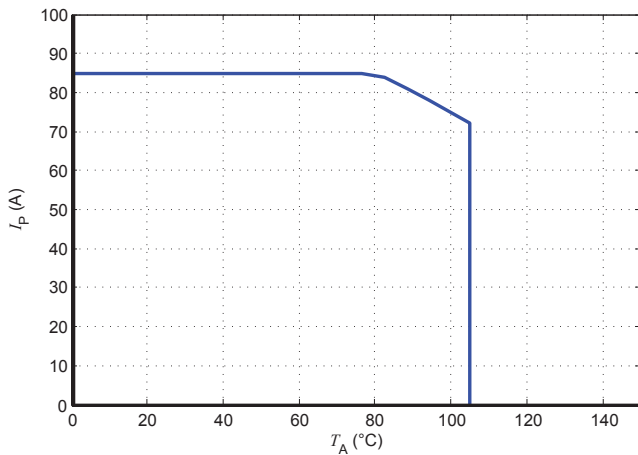


Figure 18: I_p vs T_A for LXS 25-NPS

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

- $I_p < I_{PM}$
- Junction temperature $T_j < 125$ °C
- Primary conductor temperature < 110 °C
- Max power dissipation of internal resistors $< 0.5 \times$ resistors nominal power

Frequency derating

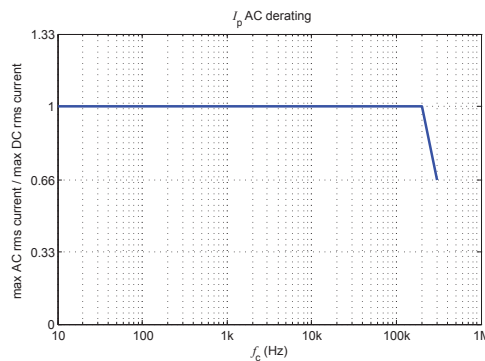


Figure 19: Maximum RMS AC primary current / maximum DC primary current vs frequency

Performance parameters definition

Ampere-turns and amperes

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

$$\theta_p = N_p \cdot I_p \text{ (At)}$$

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 $\varepsilon =$

$$I_{OE} + I_{OT}(T_A) + \varepsilon_G \cdot \theta_p \cdot G + \varepsilon_L(\theta_{Pmax}) \cdot \theta_{Pmax} \cdot G + TCG \cdot (T_A - 25) \cdot \theta_p \cdot G$$

With:

- $\theta_p = N_p \cdot I_p$: primary current linkage (At)
- θ_{Pmax} : max primary current linkage applied to the transducer
- V_{out} : output voltage (V)
- T_A : ambient operating temperature ($^{\circ}\text{C}$)
- I_{OE} : electrical offset current (A)
- $I_{OT}(T_A)$: temperature variation of I_O at temperature T_A ($^{\circ}\text{C}$)
- G : sensitivity of the transducer (A/At)
- TCG : temperature coefficient of G
- ε_G : sensitivity error
- $\varepsilon_L(\theta_{Pmax})$: linearity error for θ_{Pmax}

This model is valid for primary ampere-turns θ_p between $-\theta_{Pmax}$ and $+\theta_{Pmax}$ only.

Sensitivity and linearity

To measure sensitivity and linearity, the primary current (DC) is cycled from 0 to I_{PN} , then to $-I_{PN}$ 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 ferro-magnetic parts). It is measured using the following primary current cycle. I_{OM} depends on the current value I_{P1} ($I_{P1} > I_{PM}$).

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

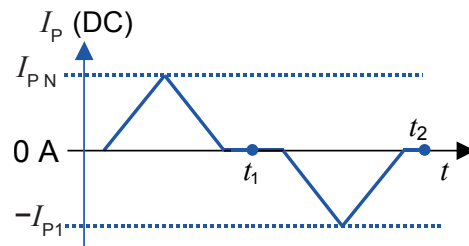


Figure 20: Current cycle used to measure magnetic and electrical offset (transducer supplied)

Performance parameters definition

Electrical offset

The electrical offset voltage V_{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 20.

Using the current cycle shown in figure 20, the electrical offset is:

$$V_{OE} = \frac{V_{out}(t_1) + V_{out}(t_2)}{2}$$

The temperature variation V_{OT} of the electrical offset voltage V_{OE} is the variation of the electrical offset from 25 °C to the considered temperature:

$$V_{OT}(T) = V_{OE}(T) - V_{OE}(25^\circ\text{C})$$

Note: the transducer has to be demagnetized prior to the application of the current cycle (for example with a demagnetization tunnel).

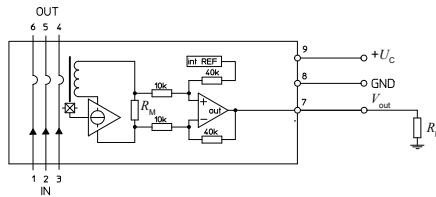


Figure 21: Test connection

Overall accuracy

The overall accuracy at 25 °C X_G is the error in the $-I_{PN} \dots +I_{PN}$ range, relative to the rated value I_{PN} . It includes:

- the electrical offset V_{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 22

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

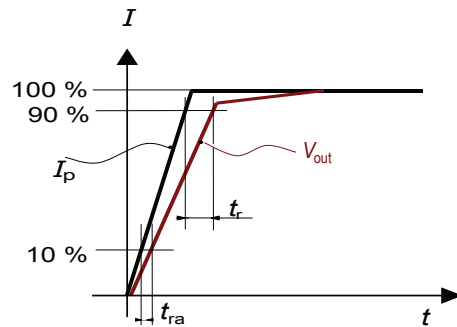


Figure 22: Response time t_r and reaction time t_{ra}

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 V_{out} and reference V_{ref} due to high varying primary current. The transducer power supply rejection ratio is low at high frequency.

Output V_{out}

The output V_{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 R_f of several tenths of Ohms allows much larger capacitive loads C_f (higher than 1 μ F). Empirical evaluation may be necessary to obtain optimum results. The minimum load resistance on V_{out} is 1 kOhm.

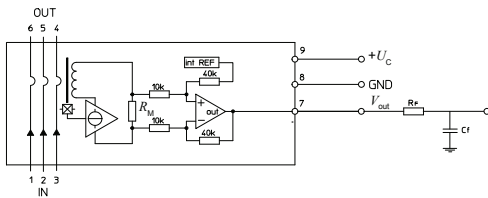
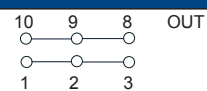
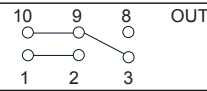
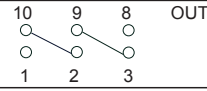


Figure 23: filtered V_{out} connection

Total Primary Resistance

The primary resistance is 0.72 m Ω per conductor.

In the following table, examples of primary resistance according to the number of primary turns.

Number of primary turns	Primary Nominal RMS current	Output voltage V_{out}	Primary resistance R_p [m Ω]	Recommended connections
1	$\pm I_{PN}$	2.5 ± 0.625	0.24	
2	$\pm I_{PN}/2$	2.5 ± 0.625	1.08	
3	$\pm I_{PN}/3$	2.5 ± 0.625	2.16	

Dimensions (in mm)

Connection

Insulation distances

Creepage: 7.7 mm
 Clearance: 7.7 mm
 Clearance between pads on pcb: 6.3mm

Arrow in positive current direction
 Secondary input
 +Uc
 GND
 Vout
 Logo
 Production line
 Model type
 SP Number

Packaging information

Standard delivery in cardboard: L × W × H: 315 × 200 × 120 mm

Each cardboard contains 200 parts, placed into 4 Polystyrene-made trays of 50 parts each one.

Both trays and cardboard are ESD-compliant.

The typical weight of the cardboard is 2.5 Kg.

