AUTOMOTIVE CURRENT TRANSDUCER OPEN LOOP TECHNOLOGY
DHAB S/24

Introduction

The DHAB family is best suited for DC, AC, or pulsed currents measurement in high power and low voltage automotive applications. It features galvanic isolation between the primary circuit (high power) and the secondary circuit (electronic circuit).

The DHAB family gives you a choice of having different current measuring ranges in the same housing (from ± 20 up to ± 600 A).

Features

- Open Loop transducer using the Hall effect sensor
- Low voltage application
- Unipolar + 5 V DC power supply
- Primary current measuring range up to ± 75 A for channel 1 and ± 500 A for channel 2
- Maximum RMS primary admissible limited by the busbar, the magnetic core or the ASIC temperature T° < + 150 °C
- Operating temperature range: - 40 °C < T° < + 125 °C
- Output voltage: fully ratiometric (in sensitivity and offset) 2 measuring ranges to have a better accuracy.

Advantages

- Excellent accuracy
- Very good linearity
- Very low thermal offset drift
- Very low thermal sensitivity drift
- Hermetic package.

Automotive applications

- Battery Pack Monitoring
- Hybrid Vehicles
- EV and Utility Vehicles.

Principle of DHAB Family

The open loop transducers uses a Hall effect integrated circuit. The magnetic flux density B, contributing to the rise of the Hall voltage, is generated by the primary current I_P to be measured. The current to be measured I_P is supplied by a current source i.e. battery or generator (Figure 1).
Within the linear region of the hysteresis cycle, B is proportional to:

$$B\ (I_P) = \text{constant (a)} \times I_P$$

The Hall voltage is thus expressed by:

$$V_H = (R_H/d) \times I \times \text{constant (a)} \times I_P$$

Except for I_P, all terms of this equation are constant. Therefore:

$$V_H = \text{constant (b)} \times I_P$$

The measurement signal V_H amplified to supply the user output voltage or current.

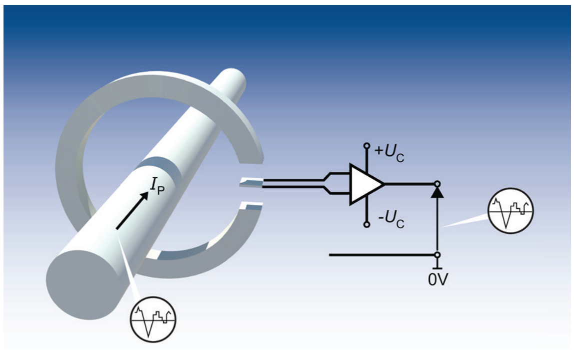
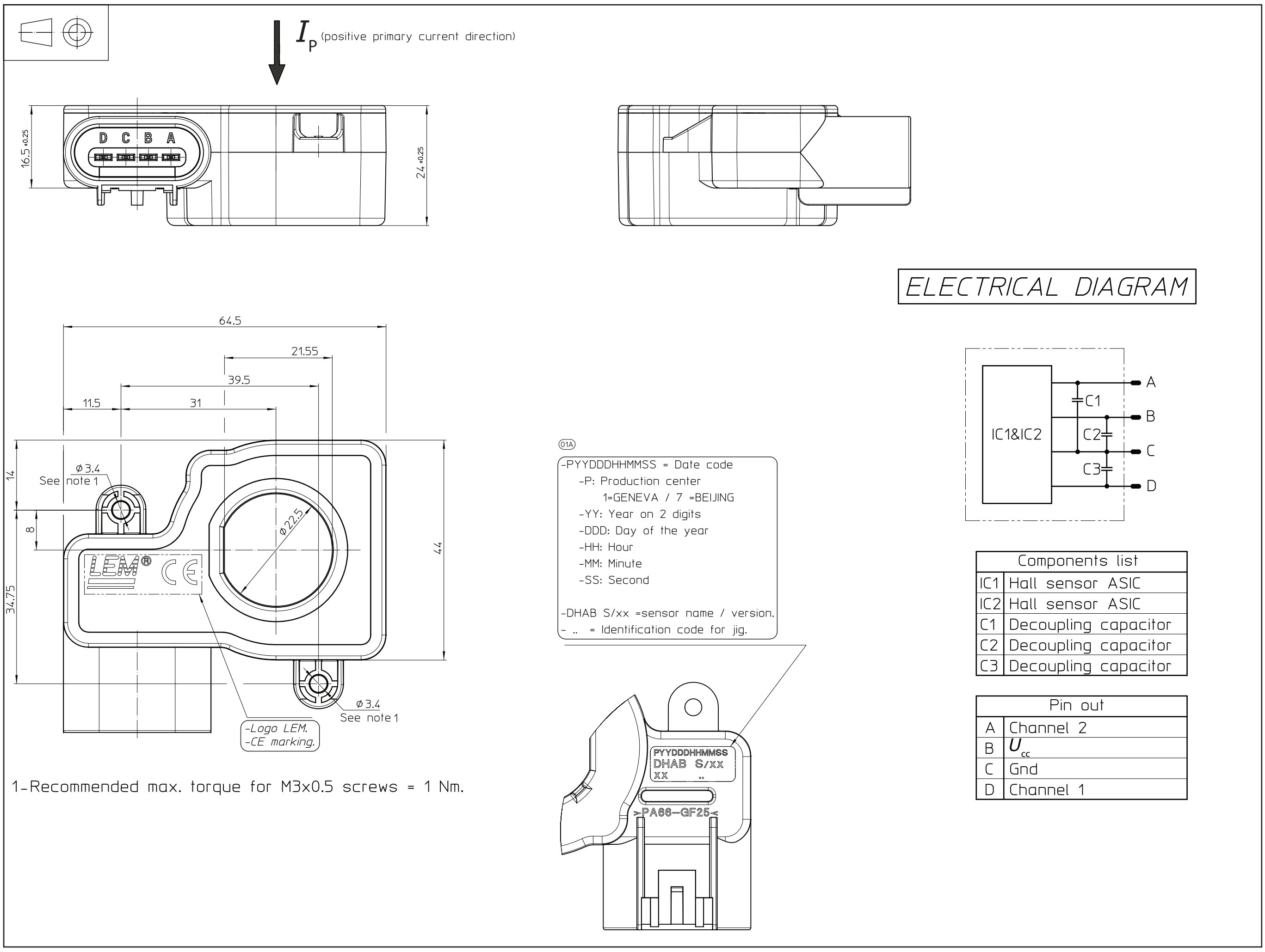


Fig. 1: Principle of the open loop transducer

Dimensions (in mm)



Components list	
IC1	Hall sensor ASIC
IC2	Hall sensor ASIC
C1	Decoupling capacitor
C2	Decoupling capacitor
C3	Decoupling capacitor

Pin out	
A	Channel 2
B	U_{cc}
C	Gnd
D	Channel 1

Mechanical characteristics

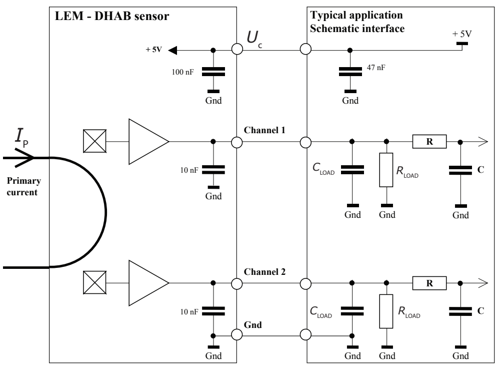
- Plastic case — >PA66-GF25<
- Magnetic core — Channel1:FeNi alloy
  Channel 2: FeSi alloy
- Mass — 69.5 g
- Pins — Brass tin plated

Remarks

$$I_P = \left(\frac{5}{U_C}\cdot V_{out} - V_O\right)\cdot\frac{1}{G} \quad \text{with } G \text{ in (V/A)}$$

- $V_{out} > V_o$ when I_P flows in the positive direction (see arrow on drawing).

System Architecture



R_L > 10 kΩ optional resistor for signal line diagnosis
C_L < 100 nF EMC protection
R_C Low pass filter EMC protection (optional)

DHAB S/24

Absolute ratings (not operating)

Parameter	Symbol	Unit	Specification Min	Specification Typical	Specification Max	Conditions
Maximun supply voltage	U_C	V			8.5	
Maximun over voltage	U_C	V			14	1 min
Maximun reverse voltage	U_C	V	- 14			1 min @ T_A = 25 °C
Ambient storage temperature	T_S	°C	- 40		125	
Continuous output current	I_{out}	mA	- 10		10	
Maximum output voltage (Analog)	V_{out}	V			8.5	
Maximum output over voltage (Analog)	V_{out}	V			14	1 min @ T_A = 25 °C
Maximum Output short circuit duration	t_c	min			2	

Operating characteristics in nominal range (I_{PN})

Parameter	Symbol	Unit	Specification Min	Specification Typical	Specification Max	Conditions
Electrical Data						
Supply voltage	U_C	V	4.5	5	5.5	
Ambient operating temperature	T_A	°C	- 10		65	High accuracy
			- 40		125	Reduced accuracy
output current	I_{out}	mA	- 1		1	
Current consumption	I_C	mA		15	20	
Power up inrush current	I_C	mA			40	@ U_C < 3.5 V
Load resistance	R_L	KΩ	10			
Capacitive loading	C_L	nF	1		100	
Performance Data Channel 1						
Primary current	$I_{P\ channel\ 1}$	A	- 75		75	
Calibration current	I_{CAL}		60		60	@ T_A = 25 °C
Offset voltage [1]	V_O	V		2.5		@ U_C = 5 V
Sensitivity [1]	G	mV/A		26.7		@ U_C = 5 V
Resolution		mV		2.5		@ U_C = 5 V
Output clamping voltage min [1]	V_{SZ}	V	0.24	0.25	0.26	@ U_C = 5 V
Output clamping voltage max [1]	V_{SZ}	V	4.74	4.75	4.76	@ U_C = 5 V
Output internal resistance	R_{OUT}	Ω		1	10	
Frequency bandwidth	BW	Hz		80		@ - 3 dB
Power up time		ms		25	120	
Setting time after over load		ms			25	
Performance Data Channel 2						
Primary current	$I_{P\ channel\ 2}$	A	- 500		500	
Calibration current	I_{CAL}		- 500		500	@ T_A = 25 °C
Offset voltage [1]	V_O	V		2.5		@ U_C = 5 V
Sensitivity [1]	G	mV/A		4		@ U_C = 5 V
Resolution		mV		2.5		@ U_C = 5 V
Output clamping voltage min [1]	V_{SZ}	V	0.24	0.25	0.26	@ U_C = 5 V
Output clamping voltage max [1]	V_{SZ}	V	4.74	4.75	4.76	@ U_C = 5 V
Output internal resistance	R_{OUT}	Ω		1	10	
Frequency bandwidth	BW	Hz		80		@ - 3 dB
Power up time		ms		25	120	
Setting time after over load		ms			25	

Notes: [1] The output voltage V_{out} is fully ratiometric. The offset and sensitivity are dependent on the supply voltage U_C relative to the following formula::

$$I_P = \left(\frac{5}{U_C} \cdot V_{out} - V_O\right) \cdot \frac{1}{G} \quad \text{with } G \text{ in (V/A)}$$

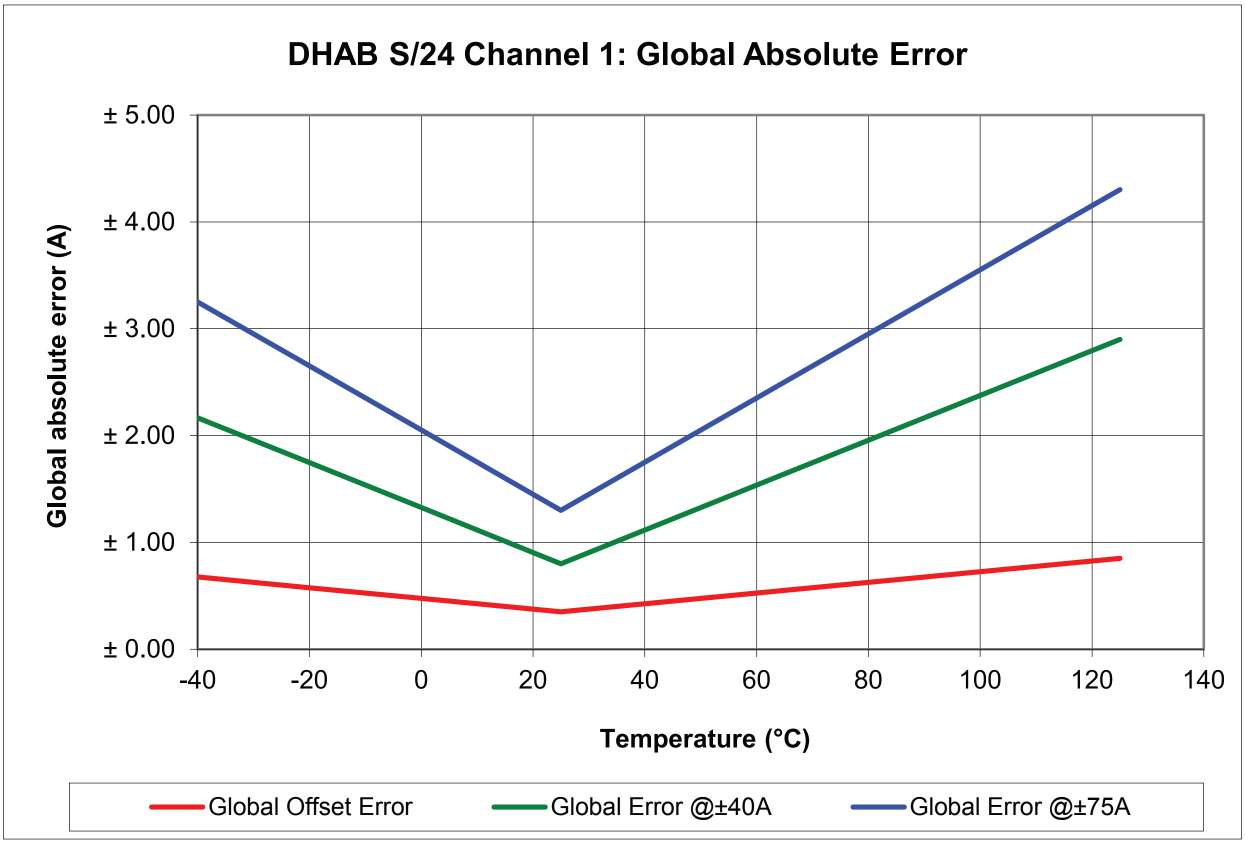
ACCURACY

Channel 1

Parameter	Symbol	Unit	Specification Min	Typical	Max	Conditions
Electrical offset current	$I_{OE\ Channel\ 1}$	mA		± 100		@ T_A = 25 °C
Magnetic offset current	$I_{OM\ Channel\ 1}$	mA		± 100		@ T_A = 25 °C
Global offset current	$I_{O\ Channel\ 1}$	mA	- 350		350	@ T_A = 25 °C
			- 550		550	@ - 10 °C < T° < 65 °C
			- 850		850	@ - 40 °C < T° < 125 °C
Sensitivity error	ε_G	%		± 0.5		@ T_A = 25 °C
				± 2		@ - 10 °C < T° < 65 °C
				± 3.5		@ - 40 °C < T° < 125 °C
Linearity error	ε_L	%		± 0.5		off full range

Global Absolute Error (A)

Channel 1	Global Absolute Error (A)					
Temperature	- 40	- 20	0	25	65	125
Global offset error	± 0.68	± 0.58	± 0.48	± 0.35	± 0.55	± 0.85
Global offset error @ ± 10 A	± 2.17	± 1.75	± 1.33	± 0.80	± 1.64	± 2.90
Global offset error @ ± 20 A	± 3.25	± 2.65	± 2.05	± 1.30	± 2.50	± 4.30

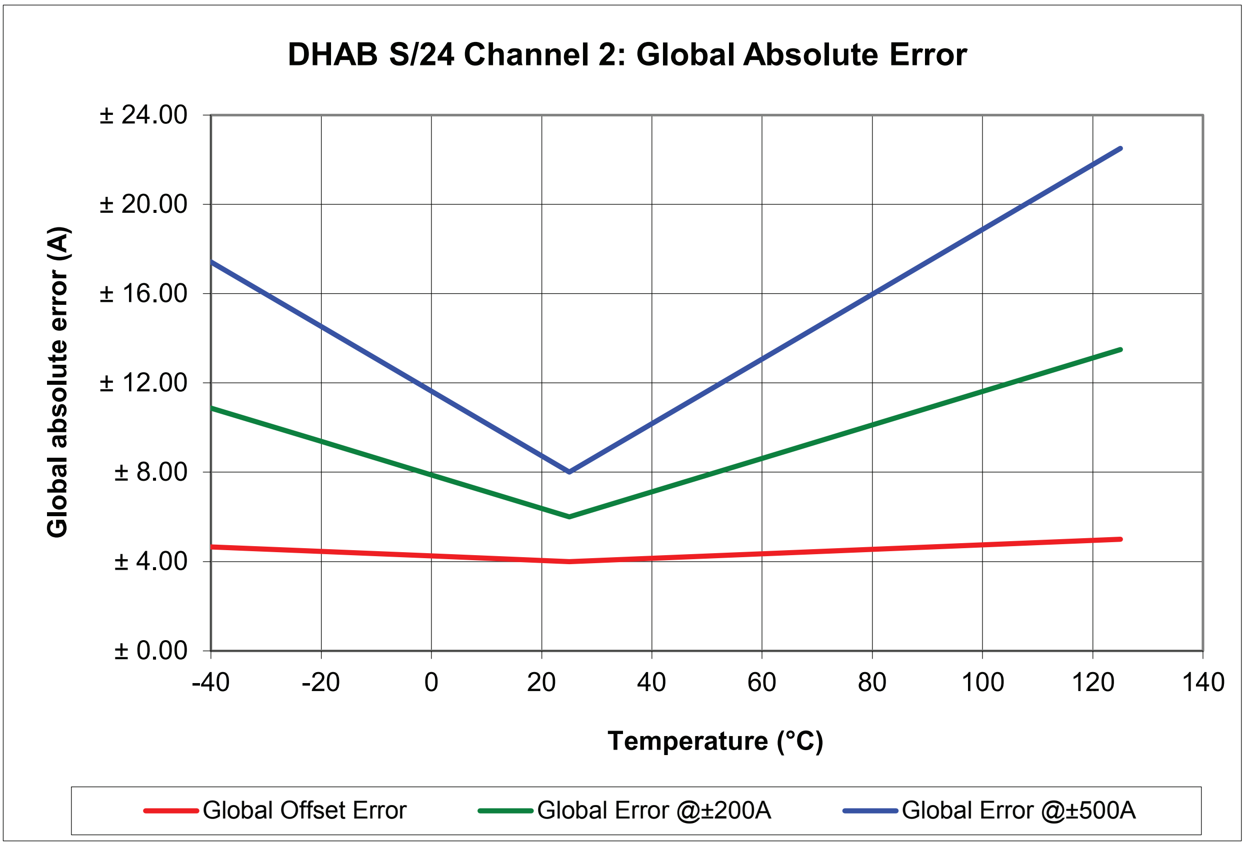


ACCURACY

Channel 2

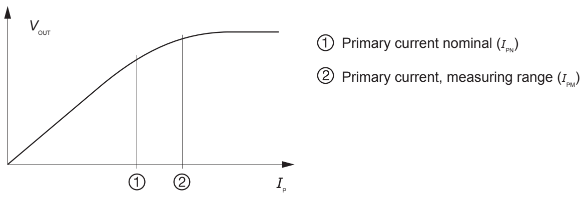
Parameter	Symbol	Unit	Specification Min	Specification Typical	Specification Max	Conditions
Electrical offset current	$I_{OE\ Channel\ 2}$	mA		± 0.8		@ T_A = 25 °C
Magnetic offset current	$I_{OM\ Channel\ 1}$	mA		± 2.8		@ T_A = 25 °C
Global offset current	$I_{O\ Channel\ 1}$	mA	- 4		4	@ T_A = 25 °C
			- 4.4		4.4	@ - 10 °C < T° < 65 °C
			- 5		5	@ - 40 °C < T° < 125 °C
Sensitivity error	ε_G	%		± 0.5		@ T_A = 25 °C
				± 2		@ - 10 °C < T° < 65 °C
				± 3.5		@ - 40 °C < T° < 125 °C
Linearity error	ε_L	%		± 0.5		off full range

Channel 2	Global Absolute Error (A)					
Temperature	- 40	- 20	0	25	65	125
Global offset error	± 4.65	± 4.45	± 4.25	± 4.00	± 4.40	± 5.00
Global offset error @ ± 10 A	± 10.88	± 9.38	± 7.88	± 6.00	± 9.00	± 13.50
Global offset error @ ± 20 A	± 17.43	± 14.53	± 11.63	± 8.00	± 13.80	± 22.50



PERFORMANCES PARAMETERS DEFINITIONS

Primary current definition:



Definition of typical, minimum and maximum values:

Minimum and maximum values for specified limiting and safety conditions have to be understood as such 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 a product.

Output noise voltage:

The output voltage noise is the result of the noise floor of the Hall elements and the linear amplifier.

Magnetic offset:

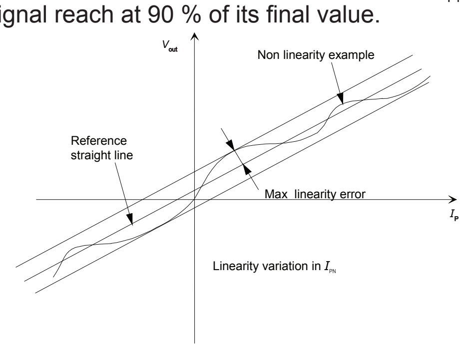
The magnetic offset is the consequence of an over-current on the primary side. It's defined after an excursion of I_{PN}.

Linearity:

The maximum positive or negative discrepancy with a reference straight line $V_{out} = f\,(I_P)$.
Unit: linearity (%) expressed with full scale of I_{PN}.

Response time (delay time) t_r:

The time between the primary current signal (I_{PN}) and the output signal reach at 90 % of its final value.

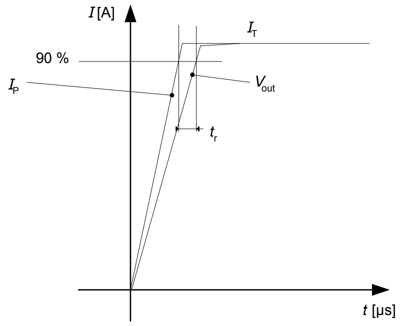


Sensitivity:

The transducer's sensitivity G is the slope of the straight line $V_{out} = f\,(I_P)$, it must establish the relation:

$$V_{out}\,(I_P) = U_C/5\,(G \cdot I_P + V_o)$$

Offset with temperature:



The error of the offset in the operating temperature is the variation of the offset in the temperature considered with the initial offset at 25 °C.
The offset variation I_{OT} is a maximum variation the offset in the temperature range:

$$I_{OT} = I_{OE}\ \mathrm{max} - I_{OE}\ \mathrm{min}$$

The offset drift TCI_{OEAV} is the I_{OT} value divided by the temperature range.

Sensitivity with temperature:

The error of the sensitivity in the operating temperature is the relative variation of sensitivity with the temperature considered with the initial offset at 25 °C.
The sensitivity variation G_T is the maximum variation (in ppm or %) of the sensitivity in the temperature range:
G_T = (Sensitivity max - Sensitivity min) / Sensitivity at 25 °C.
The sensitivity drift TCG_{AV} is the G_T value divided by the temperature range. Deeper and detailed info available is our LEM technical sales offices (www.lem.com).

Offset voltage @ I_P = 0 A:

The offset voltage is the output voltage when the primary current is zero. The ideal value of V_O is $U_C/2$ at U_C = 5 V. So, the difference of $V_O - U_C/2$ is called the total offset voltage error. This offset error can be attributed to the electrical offset (due to the resolution of the ASIC quiescent voltage trimming), the magnetic offset, the thermal drift and the thermal hysteresis. Deeper and detailed info available is our LEM technical sales offices (www.lem.com).

Environmental test specifications:

Name	Standard	Conditions
Thermal shocks	GM &5.5.5 (IEC 60068 Part 2-14)	T° - 40 °C + 125 °C / 300 cycles not connected. Criteria: ε_G < 3 % @ 25 °C
Power temperature	GM &5.5.6 (IEC 60068 Part 2-14 Nb	T° - 40 °C + 125 °C/595 cycles, supply voltage = 5 V Criteria: ε_G < 3 % @ 25 °C
Temperature humidity cycle test	GM &6.18.1 (IEC 60068 2-38)	T° -10 °C + 65 °C/10 cycles, supply voltage = 5 V Criteria: ε_G < 3 % @ 25 °C
Mechanical tests		
Vibration test	GM &6.6.2 (IEC 60068 2-64)	Acceleration 30m/s2, 25 °C, frequency 20 to 1000 Hz/8h each axis
Drop test	GM &6.10 (IEC 60068 2-32)	Drop 1m, 2 falls/part, 1 part/axis, 3 axes, criteria: relative sensitivity error 3 %
EMC Test		
RMS voltage for AC Insulation test	GM &6.4-13 (IEC 60068 2-38)	
Bulk current injection immunity	ISO 11452-4	Criteria B
Electrostatic discharge immunity test		2 KV, Criteria B

LEM reserves the right to carry out modifications on its transducers, in order to improve them, without prior notice