AUTOMOTIVE CURRENT TRANSDUCER OPEN LOOP TECHNOLOGY
HAH1DRW 1000-S

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Introduction

The HAH1DRW family is for the electronic measurement of DC, AC or pulsed currents in high power and low voltage automotive applications with galvanic separation between the primary circuit (high power) and the secondary circuit (electronic circuit).

The HAH1DRW family gives you the choice of having different current measuring ranges in the same housing.

Features

- Ratiometric transducer
- Open Loop transducer using the Hall effect
- Low voltage application
- Unipolar + 5 V DC power supply
- Primary current measuring range ± 1000 A
- Maximum RMS primary admissible current: defined by busbar to have T° < +150 °C
- Operating temperature range: - 40 °C < T° < 125 °C
- Output voltage: full ratio-metric (in sensitivity and offset)..

Advantages

- Excellent accuracy
- Very good linearity
- Very low thermal offset drift
- Very low thermal sensitivity drift
- Galvanic separation
- High frequency bandwith
- Non intrusive solution.

Automotive applications

- Electrical Power Steering
- Starter Generators
- Converters
- Battery Management
- Motor drive application.

Principle of HAH1DRW 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.

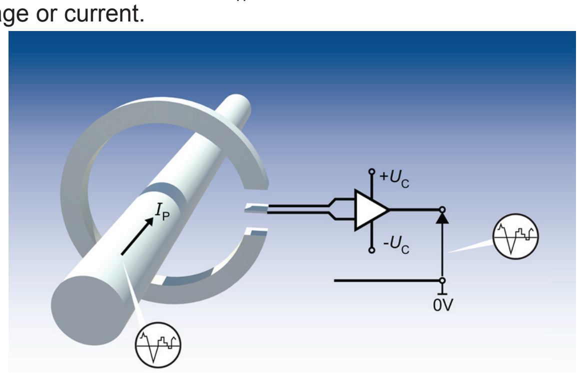
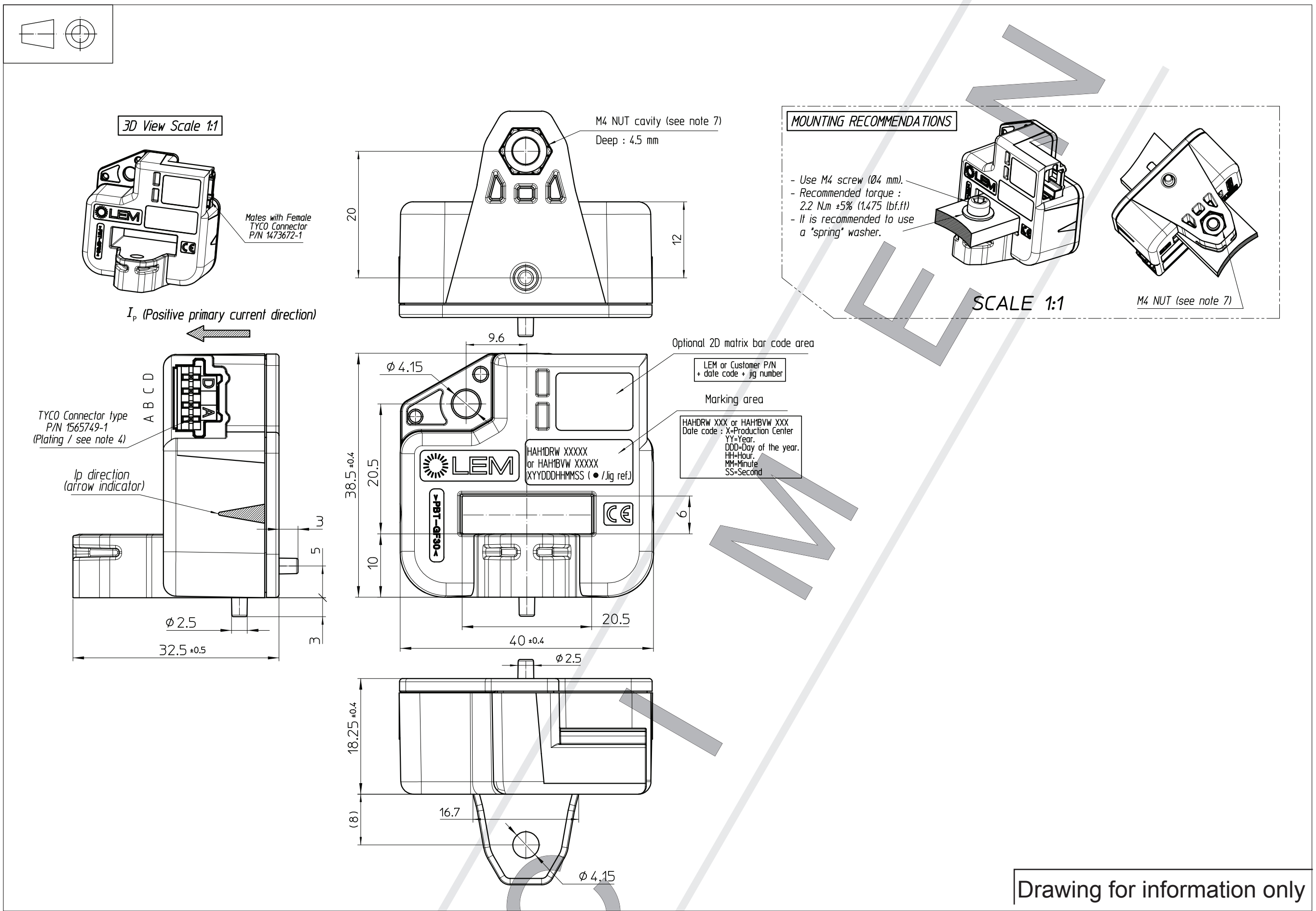


Fig. 1: Principle of the open loop transducer

N° 97.G8.60.000.P

G121106CFTSA/version 0 LEM reserves the right to carry out modifications on its transducers, in order to improve them, without prior notice www.lem.com

Dimensions HAH1DRW 1000-S (in mm)



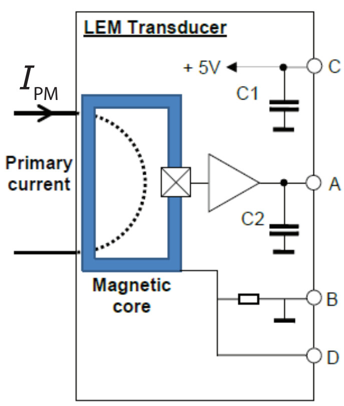
Mechanical characteristics

- Plastic case PBT GF30
- Magnetic core FeSi wound core
- Pins Brass tin plated
- Mass 57 g ± 5 %

Mounting recommendation

- Mating connector type TYCO connector P/N 1473672-1
- Assembly torque 2.2 Nm ± 5 %
- Soldering type N/A

Electronic schematic



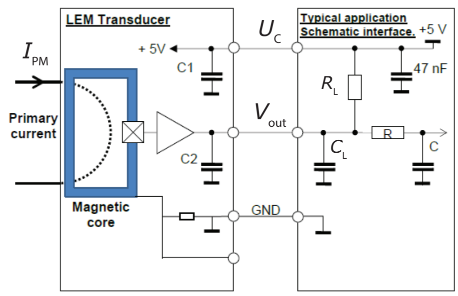
Components list		
IC	Hall sensor ASIC	
C1	Decoupling capacitor	47 nF
C2	EMC protection capacitor	4.7 nF

Pin out	
A	V_{out}
B	GND
C	U_C (5 V)
D	GND

Remarks

- $I_P = \left(\frac{5}{U_C} \cdot V_{out} - V_O\right) \cdot \frac{1}{G}$ with G in (V/A)
- $V_{out} > V_o$ when I_P flows in the positive direction (see arrow on drawing).

System architecture (example)



C_L < 2.2 nF EMC protection (optional)
RC Low pass filter (optional)

On board diagnostic

R_L > 10 kΩ. Resistor for signal line diagnostic (optional)

V_{out}	Diagnostic
Open circuit	$V_{IN} = U_C$
Short GND	$V_{IN} = 0$ V

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HAH1DRW 1000-S

Absolute ratings (not operating)

Parameter	Symbol	Unit	Specification			Conditions
			Min	Typical	Max	
Maximum supply voltage	U_C	V	- 0.5		8	[1]
Ambient storage temperature	T_S	°C	- 40		125	
Electrostatic discharge voltage (HBM)	U_{ESD}	kV			2	JESD22-A114-B
Maximum admissible vibration (random r.m.s)	γ	$m \cdot s^{-2}$			96.6	10 to 2000 Hz, - 40 °C to 125 °C
RMS voltage for AC insulation test	U_d	kV			2.5	50 Hz, 1 min
Creepage distance	d_{Cp}	mm	5.2			
Clearance	d_{Cl}	mm	4.9			
Comparative traking index	CTI	V	PLC3 (175 V - 250 V)			
Maximum output Current	I_{out}	mA	- 10		10	
Maximum output Voltage	V_{out}	V	- 0.5		U_C + 0.5	
Maximum reverse current	I_R	mA			80	

Operating characteristics in nominal range (I_{PN})

Parameter	Symbol	Unit	Specification			Conditions
			Min	Typical	Max	
Electrical Data						
Primary current, measuring range	I_{PM}	A	- 1000		1000	
Primary nominal DC or RMS current	I_{PN}	A	- 1000		1000	
Supply voltage	U_C	V	4.75	5	5.25	
Ambient operating temperature	T_A	°C	- 40		125	
Output voltage (Analog)	V_{out}	V	$V_{out} = (U_C/5) \cdot (V_o + G \cdot I_P)$			
Sensitivity	G	mV/A		2		@ T_A = 25 °C
Offset voltage	V_O	V		2.5		
Current consumption	I_C	mA		20	25	- 40 °C < T_A < 125 °C
Load resistance	R_L	KΩ	10			
Output internal resistance	R_{out}	Ω		1	10	
Performance Data						
Ratiometricity error	ε_r	%		± 0.5		
Sensitivity error	ε_G	%		± 0.6		@ T_A = 25 °C
Electrical offset current	I_{OE}	mV		± 3		@ T_A = 25 °C,@ U_C = 5 V
Magnetic offset voltage	V_{OM}	mV		± 2		@ U_C = 5 V, @ T_A = 25 °C
Linearity error	ε_L	%	- 1		1	% of full scale
Average temperature coefficient of V_{OE}	TCV_{OEAV}	mV/°C		± 0.04		
Average temperature coefficient of G	TCG_{AV}	%/°C		± 0.02		
Step response time @ 70 %	t_r	µs		2	6	di/dt = 100 A / µs
Frequency bandwidth	BW	kHz	40			@ - 3 dB
Output voltage noise peak-peak	$V_{no\ p\text{-}p}$	mV			14	DC to 1 MHz
Output RMS voltage noise	V_{no}	mV			2.2	
Phase shift	$\Delta\varphi$	°	- 4			DC to 1 KHz

Notes: [1] Exceeding 6.5 V may temporarily reconfigure the device until next power on.

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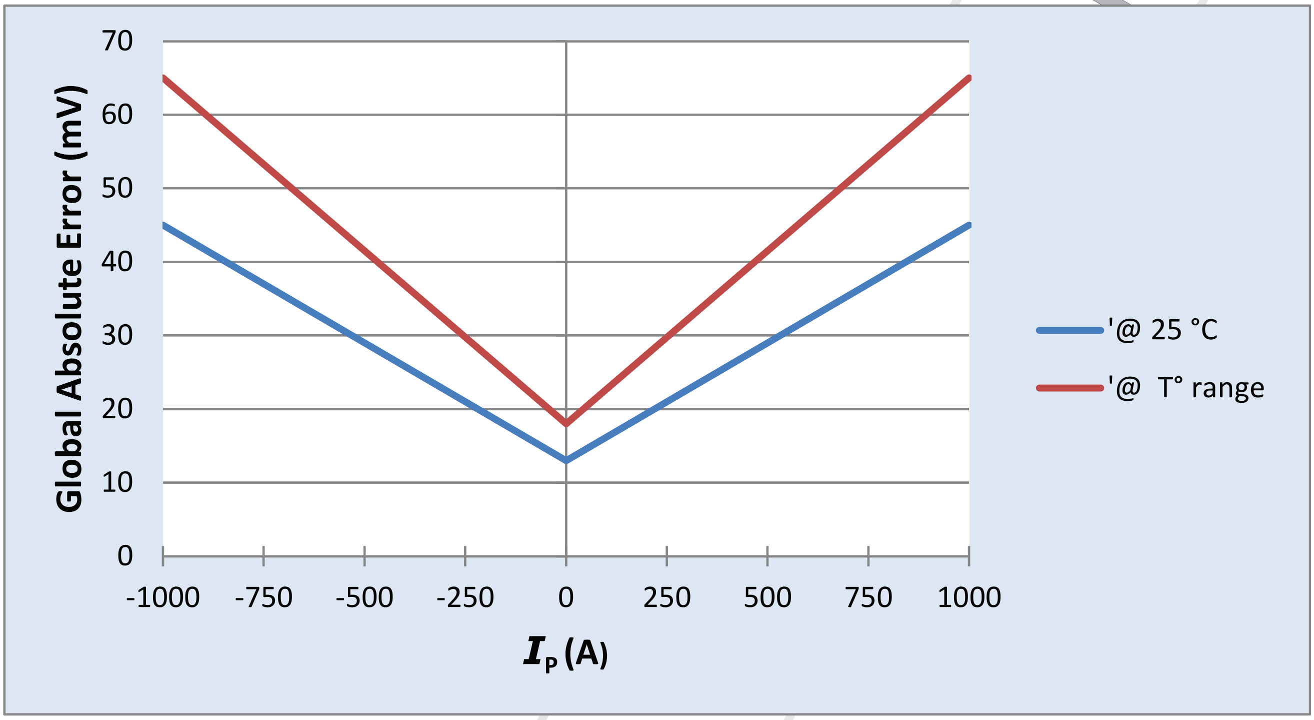
Global Absolute Error (mV) @ U_C = 5 V



I_P (A)	Accuracy @ 25 °C (mV)	Accuracy @ T ° range (mV)
- $I_{P\ max}$	45	65
0	13	18
I_{Pmax}	45	65

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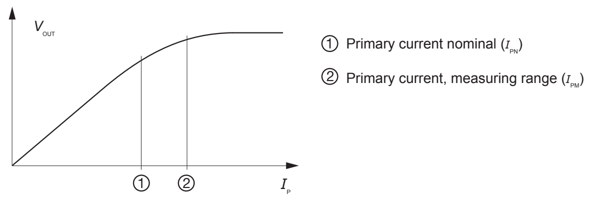
PERFORMANCES PARAMETERS DEFINITIONS

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 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 a product.

Output noise voltage:

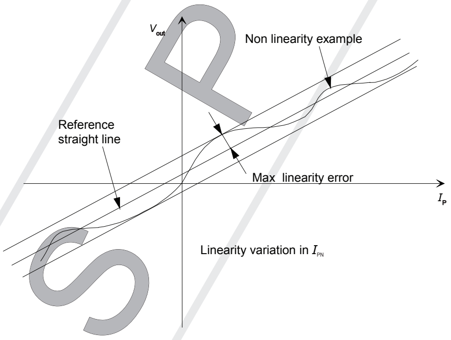
The output voltage noise is the result of the noise floor of the Hall elements and the linear amplifier.

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}.

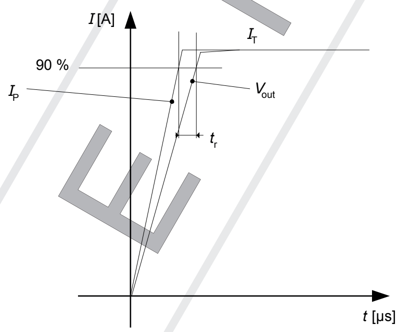
Linearity:

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:
$I_{OT} = I_{OE}$ max - I_{OE} 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 null. 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).

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Environmental test specifications:

Refer to LEM GROUP test plan laboratory CO.11.11.515.0 with “Tracking_Test Plan_Auto” sheet.

Name	Standard
CHARACTERIZATION @ 25 °C	
Sensitivity / Accuracy / Overall accuracy	LEM 98.20.00.574.0
Offset / Electrical Offset / Magnetic Offset	LEM 98.20.00.573.0
Linearity error	LEM 98.20.00.370.0
Current Consumption	LEM 98.20.00.579.0
CHARACTERIZATION WITH T °C (initial)	
Sensitivity / Accuracy / Overall accuracy	LEM 98.20.00.574.0
T °C variation of ... / Temperature Coefficient of *G*	LEM 98.20.00.574.0
Offset / Electrical Offset / Magnetic Offset	LEM 98.20.00.573.0
T °C variation of ... /Temperature Coefficient of Offset	LEM 98.20.00.573.0
Linearity error	LEM 98.20.00.370.0
Current Consumption	LEM 98.20.00.579.0
ELECTRICAL TESTS @ 25 °C	
Phase delay check	100Hz to 10kHz, at 20 A peak
Noise measurement	Sweep from DC to 1 MHz
Response time di/dt	100 A/µs, I pulse = 700 A
dv/dt	2000 V/µs, V = 2000 V
Dielectric Withstand Voltage test	2500 VAC / 1 min / 50 Hz
Isolation Resistance test	500 V DC, time = 60 s R isolation >= 500 MΩ Minimum
ENVIRONMENTAL TESTS (CLIMATIC)	
Thermal shock	IEC 60068-2-14 Na (01/2009)
Steady state T°C Humidity bias life test	JESD 22-A101 (03/2009)
MECHANICAL TESTS	
Vibration Random in T°C	IEC 60068-2-64 (02/2008)
Shocks	IEC 60068-2-27 (02/2008)
Free Fall (Device not packaged)	IEC 60068-2-31 §5.2: method 1 (05/2008)
EMC	
Immunity to ElectroStatic Discharges (Handling of devices)	ISO 10605 (07/2008)
Immunity to Conducted disturbances (BCI)	ISO 11452-4 (12/2011)
Emission Radiated (ALSE)	CISPR 25 (03/2008)

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