AUTOMOTIVE CURRENT TRANSDUCER OPEN LOOP TECHNOLOGY
HAH1BVW S/D02

Introduction

The HAH1BVW family is for the electronic measurement of DC, and low frequency current in high power and low voltage automotive applications with galvanic separation between the primary circuit (high power) and the secondary circuit (electronic circuit).

The HAH1BVW 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 ±350 A (high range) ±60 A (low range)
- 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).

Special feature

- Dual output.

Advantages

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

Automotive applications

- Battery Management.

Principle of HAH1BVW 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:

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

With d = thickness of the Hall plates

I = current across the Hall plates

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.

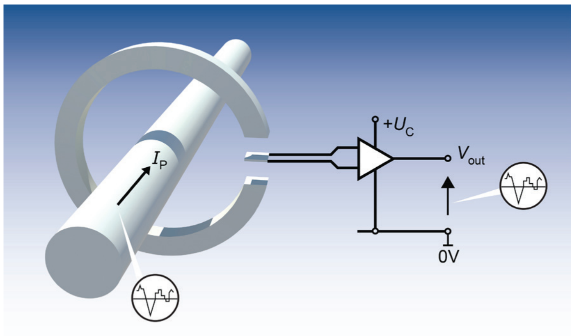
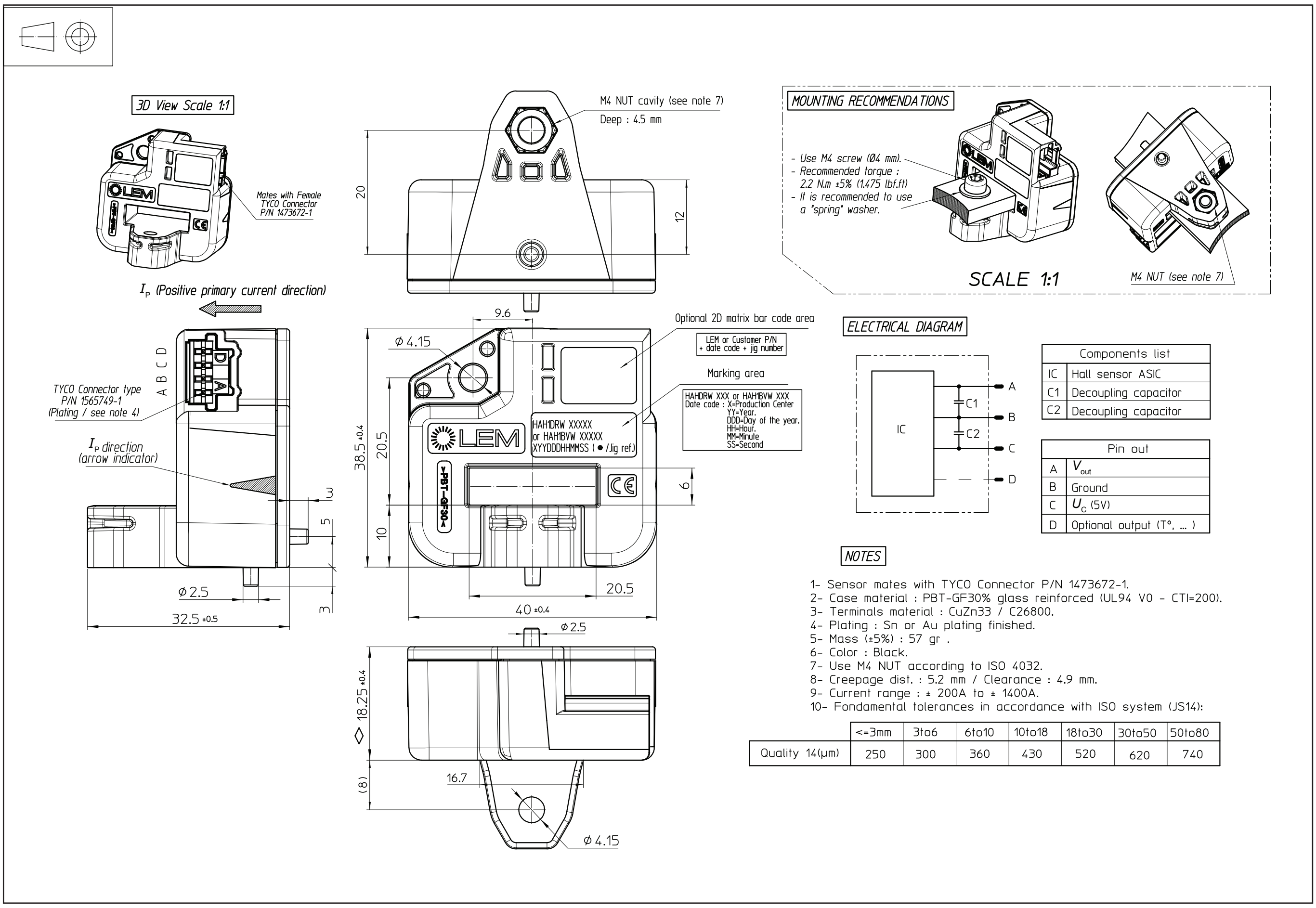


Fig. 1: Principle of the open loop transducer

Dimensions (in mm)



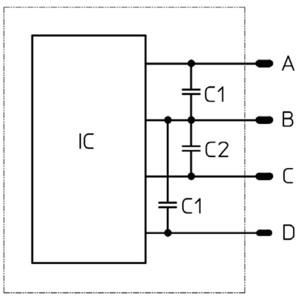
Mechanical characteristics

- Plastic case — PBT GF 30
- Magnetic core — Iron silicon alloy
- Mass — 57 g (±5 %)
- Electrical terminal coating — Brass tin plated
- IP level — IP ×2

Mounting recommendation

- Connector type — AMP 1473672-1

Electronic schematic



	Components list	BV version
IC	Hall sensor ASIC	
C1	Decoupling capacitor	68 nF
C2	Decoupling capacitor	100 nF

	Pin out
A	V_{out} Low range
B	Ground
C	U_C (5V)
D	V_{out} High range

Remark

- V_{out} > 2.5 when I_P flows in the direction of the arrow.

System architecture (example)

R_L > 10 kΩ optional resistor for signal line diagnostic

V_{out}	Diagnostic
Open circuit	V_{in} = < 0.15 V
Short GND	V_{in} = < 0.15 V

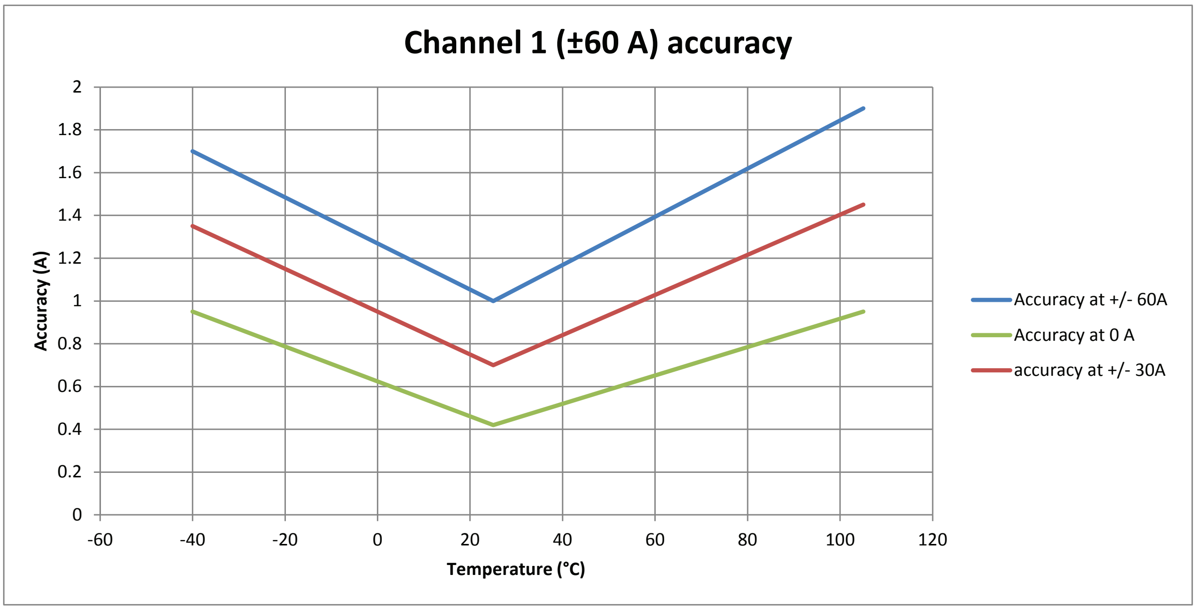
C_L ≤ 100 nF EMC protection
RC Low pass filter EMC protection (optional)

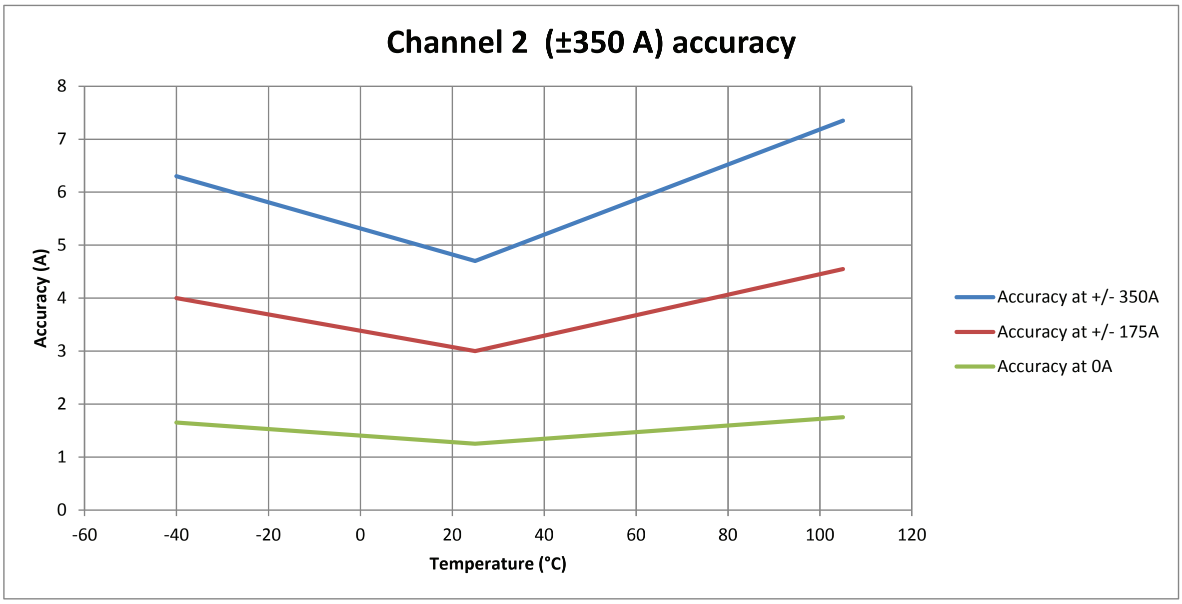
Absolute ratings (not operating)

Parameter	Symbol	Unit	Specification Min	Specification Typical	Specification Max	Conditions
Maximum supply voltage	U_C	V			14	
Maximum reverse supply voltage	U_C	V	−14			
Maximum output voltage	V_{out}	V	−14		14	V_{out} Reverse / Forward voltage
Maximum output current	I_{out}	mA	−10		10	
Ambient storage temperature	T_S	°C	−40		125	
Electrostatic discharge voltage (HBM)	U_{ESD}	kV			8	IEC 61000-4-2
Maximum admissible vibration (random rms)	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	50 Hz, 1 min
Creepage distance	d_{Cp}	mm	5.2			
Clearance	d_{Cl}	mm	4.9			
Comparative tracking index	*CTI*		PLC3 (175 V − 250 V)			

Operating characteristics in high/low range (I_{PN})

Parameter	Symbol	Unit	Specification Min	Specification Typical	Specification Max	Conditions
Electrical Data						
Primary current, measuring range, high range	I_{PM}	A	−350		350	
Primary current, measuring range, low range	I_{PN}	A	−60		60	
Supply voltage	U_C	V	4.5	5	5.5	
Ambient operating temperature	T_A	°C	−40		125	
Output voltage	V_{out}	V	$V_{out} = (U_C/5) \times (V_o + G \times I_P)$			
Sensitivity high range	G	mV/A		5.71		@ T_A = 25 °C
Sensitivity low range	G	mV/A		33.33		
Offset voltage	V_O	V		2.5		
Output resolution		mV		1.22		
Output clamping high voltage	V_{SZ}		4.74	4.75		@ U_C = 5 V
Output clamping low voltage	V_{SZ}			0.25	0.26	@ U_C = 5 V
Current consumption	I_C	mA		14		@ T_A = 25 °C, @ U_C = 5 V
					20	
Load resistance	R_L	KΩ	10			@ T_A = 25 °C
Output internal resistance	R_{out}	Ω		1		@ T_A = 25 °C
					10	
Performance Data						
Ratiometricity error	ε_r	%		±0.2		
Sensitivity error	ε_G	%		±1		@ T_A = 25 °C
Electrical offset current	I_{OE}	mV		±2.5		@ 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}	$TCV_{OE\ AV}$	mV/°C		±0.04		
Average temperature coefficient of G	TCG_{AV}	%/°C		±0.02		
Step response time @ 70 %	t_r	ms			10	
Frequency bandwidth	*BW*	Hz		70		@ −3 dB
Output voltage noise peak-peak	$V_{no\ pp}$	mV			10	DC to 1 MHz
Output rms voltage noise	V_{no}	mV			1.6	
Power up time		ms			1	
Setting time after overload	t_s	ms			10	



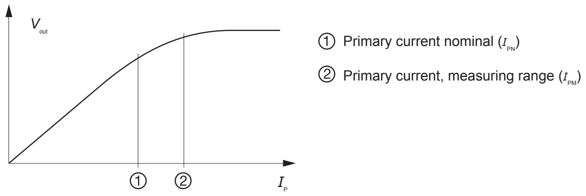


Channel 1 global error (A)			
Temperature (°C)	Accuracy at ±60 A	Accuracy at ±30 A	Accuracy at ±0 A
−40	1.7	1.35	0.95
25	1	0.7	0.42
105	1.9	1.45	0.95

Channel 2 global error (A)			
Temperature (°C)	Accuracy at ±350 A	Accuracy at ±175 A	Accuracy at ±0 A
−40	6.3	4	1.65
25	4.7	3	1.25
105	7.35	4.55	1.75

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, minimum and maximum 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:

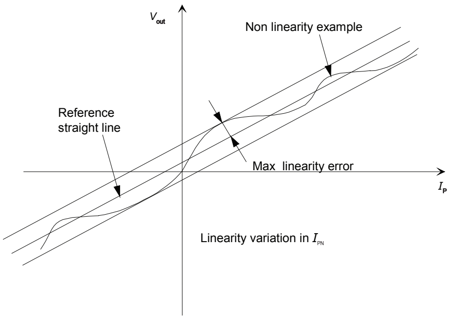
The magnetic offset is the consequence of an over-current on the primary side. It's defined after an excursion of I_{PN}.

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.

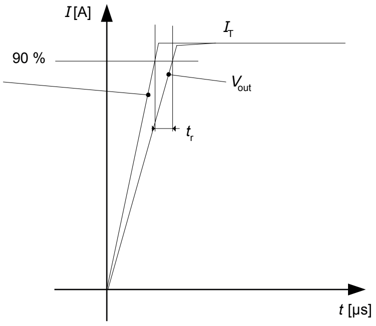


Sensitivity:

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

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

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:

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

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 $U_C/2$. 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:

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