

# 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  $\pm 350$  A (high range)  $\pm 60$  A (low range)
- Maximum RMS primary admissible current: defined by busbar to have  $T^\circ < +150$  °C
- Operating temperature range:  $-40$  °C  $< T^\circ < 125$  °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

$$I = \text{current across the Hall plates}$$

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.

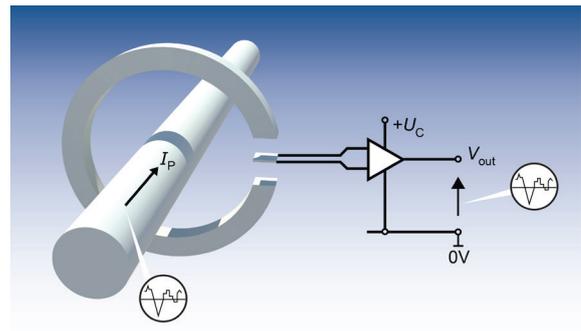
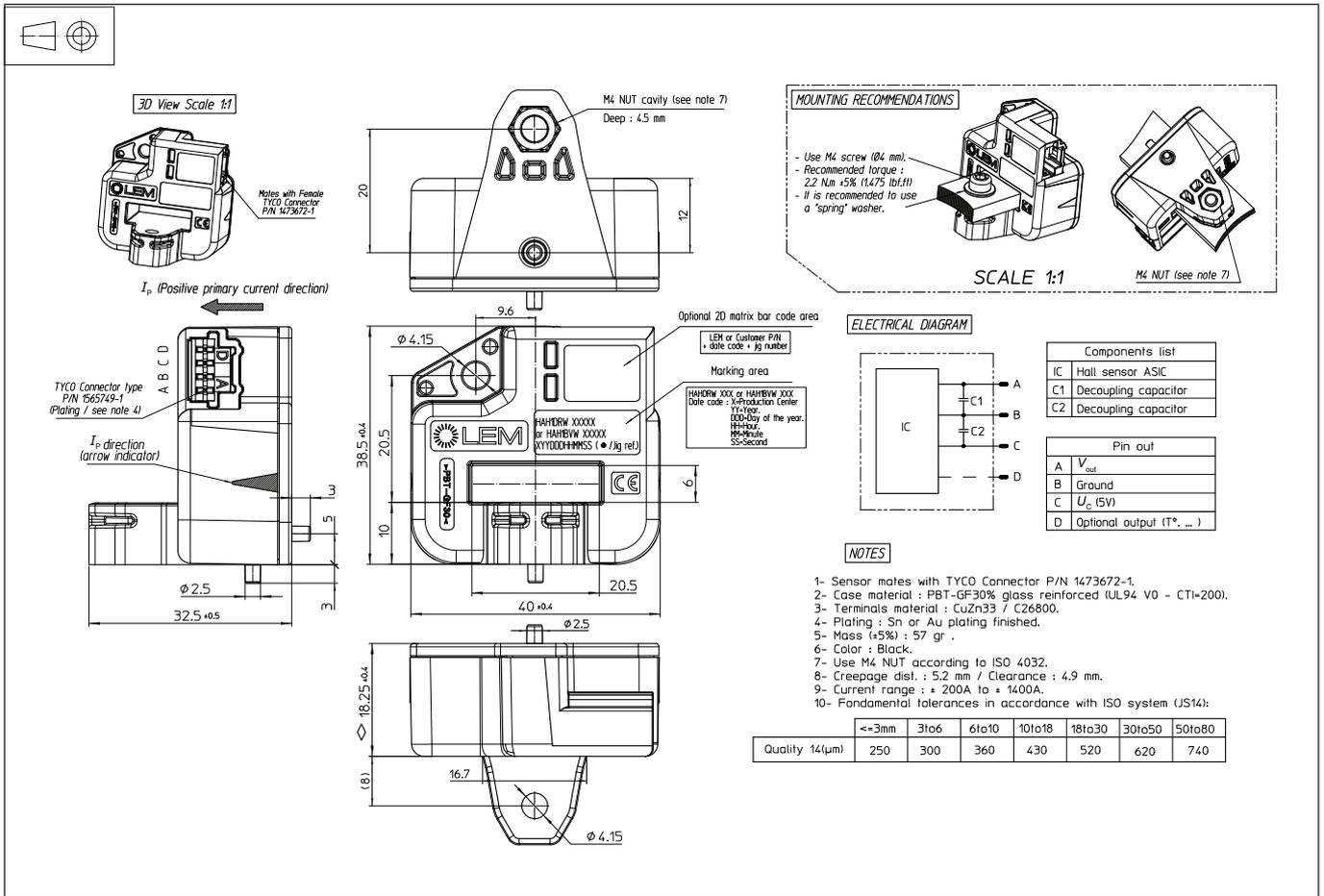


Fig. 1: Principle of the open loop transducer

## Dimensions (in mm)



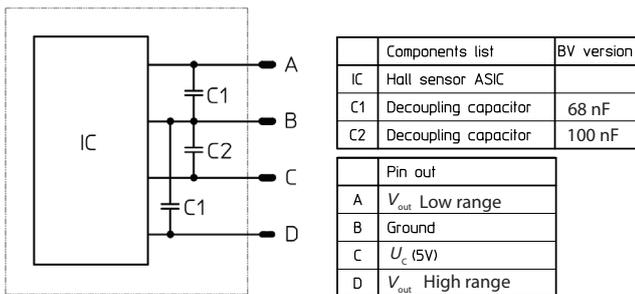
### Mechanical characteristics

- Plastic case PBT GF 30
- Magnetic core Iron silicon alloy
- Mass 57 g ( $\pm 5\%$ )
- Electrical terminal coating Brass tin plated
- IP level IP  $\times 2$

### Mounting recommendation

- Connector type AMP 1473672-1

### Electronic schematic



### Remark

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

### System architecture (example)

$R_L > 10$  k $\Omega$  optional resistor for signal line diagnostic

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

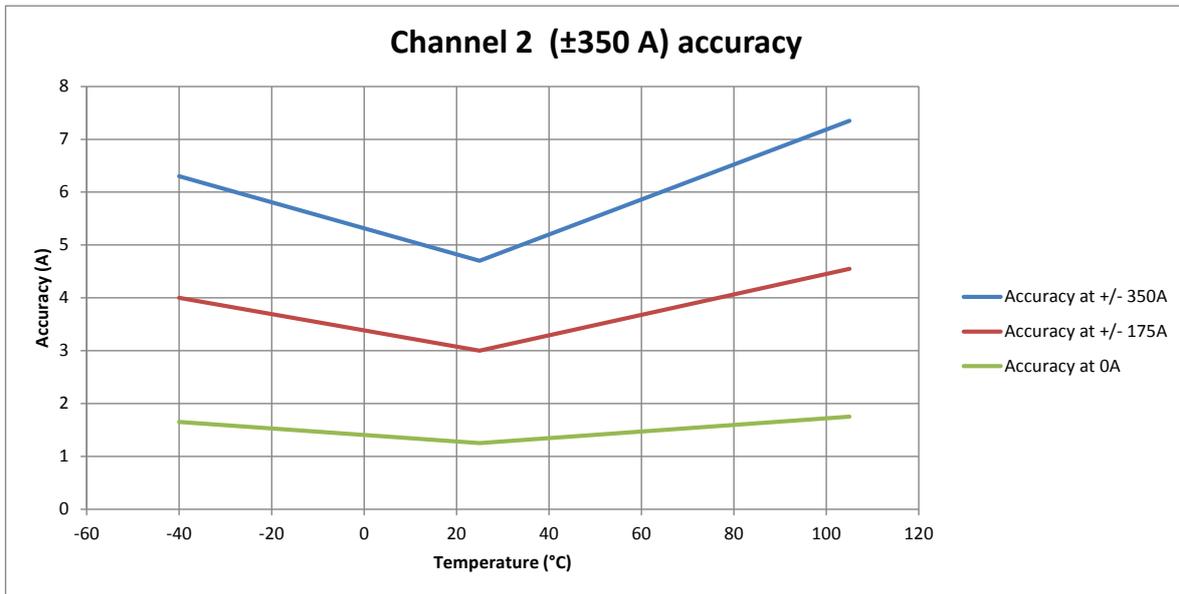
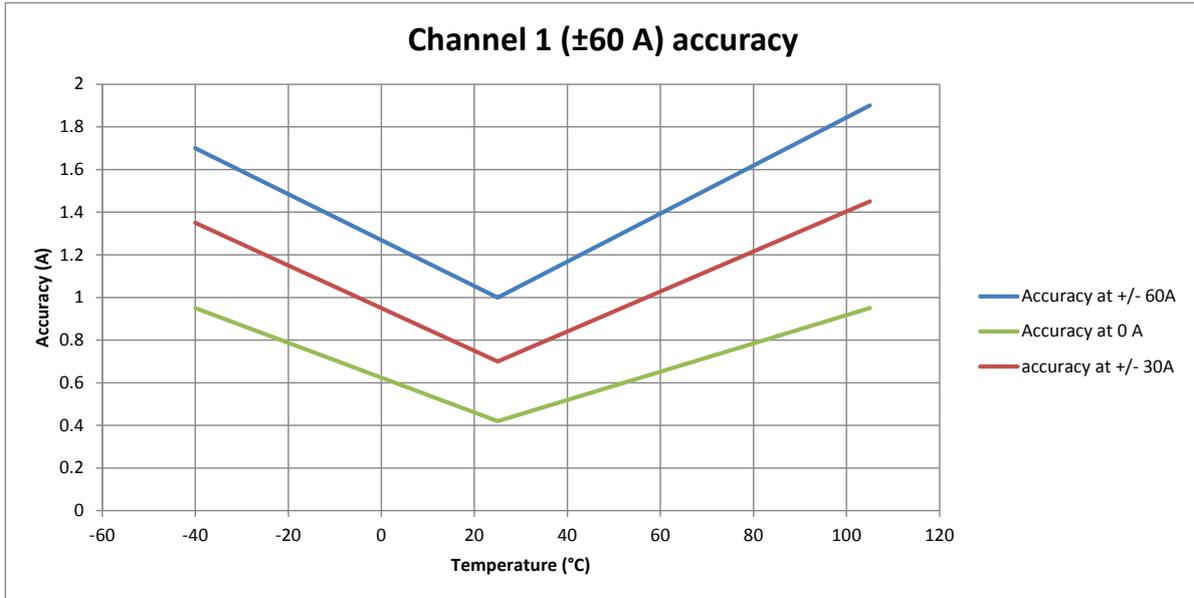
$C_L \leq 100$  nF EMC protection  
RC Low pass filter EMC protection (optional)

**Absolute ratings (not operating)**

Parameter	Symbol	Unit	Specification			Conditions
			Min	Typical	Max	
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)	$\gamma$	m·s <sup>-2</sup>			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			Conditions
			Min	Typical	Max	
<b>Electrical Data</b>						
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	20	@ $T_A = 25$ °C, @ $U_c = 5$ V
Load resistance	$R_L$	KΩ	10			@ $T_A = 25$ °C
Output internal resistance	$R_{out}$	Ω		1	10	@ $T_A = 25$ °C
<b>Performance Data</b>						
Ratiometricity error	$\epsilon_r$	%		±0.2		
Sensitivity error	$\epsilon_G$	%		±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	$\epsilon_L$	%	-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	

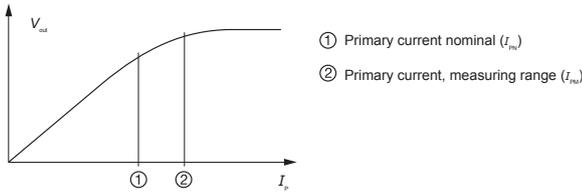


Channel 1 global error (A)			
Temperature (°C)	Accuracy at $\pm 60$ A	Accuracy at $\pm 30$ A	Accuracy at $\pm 0$ A
-40	1.7	1.35	0.95
25	1	0.7	0.42
105	1.9	1.45	0.95

Channel 2 global error (A)			
Temperature (°C)	Accuracy at $\pm 350$ A	Accuracy at $\pm 175$ A	Accuracy at $\pm 0$ 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  $I_{PN}$ .

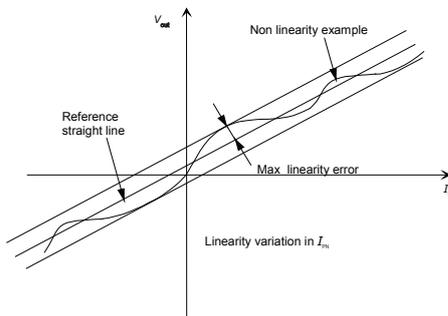
**Linearity:**

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.

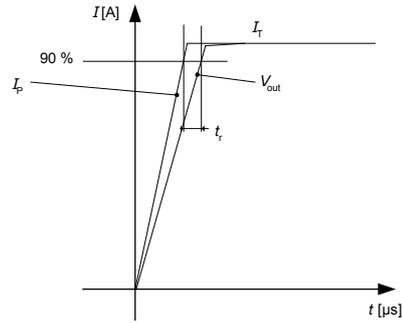


**Sensitivity:**

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:

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

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:

$$G_T = (Sensitivity \max - Sensitivity \min) / Sensitivity \text{ at } 25 \text{ }^\circ\text{C}$$

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](http://www.lem.com)).

**Offset voltage @  $I_P = 0 \text{ A}$ :**

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](http://www.lem.com)).

**Environmental test specifications:**

Refer to LEM GROUP test plan laboratory CO.11.11.515.0 with "Tracking\_Test Plan\_Auto" sheet.