AUTOMOTIVE CURRENT TRANSDUCER
HAH1DR 500-S/SP1

Introduction

The HAH1DR family is for the electronic measurement of DC, AC or pulsed currents in high power automotive applications with galvanic isolation between the primary circuit (high power) and the secondary circuit (electronic circuit).

The HAH1DR family gives you the choice of having different current measuring ranges in the same housing (from ± 200 A up to ± 900 A).

Features

- Open Loop transducer using the Hall effect
- Unipolar + 5 V DC power supply
- Primary current measuring range up to ± 500 A
- Maximum rms primary current limited by the busbar, the magnetic core or the ASIC temperature T° < + 150°C
- Operating temperature range: - 40°C < T° < + 125°C
- Output voltage: full ratiometric (in sensitivity and offset)
- Compact design.

Advantages

- Excellent accuracy
- Very good linearity
- Very low thermal offset drift
- Very low thermal sensitivity drift
- Wide frequency bandwidth
- No insertion losses.

Automotive applications

- Battery monitoring
- Starter Generators
- Inverters
- HEV application
- EV application.

Principle of HAH1DR 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.

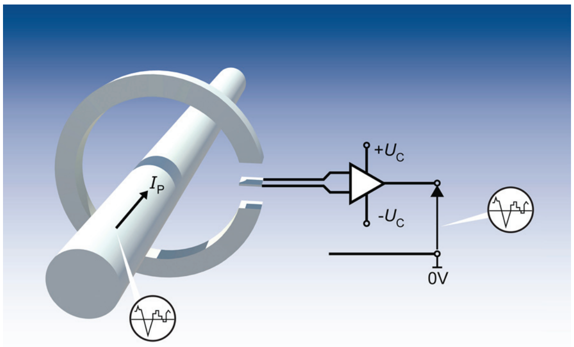
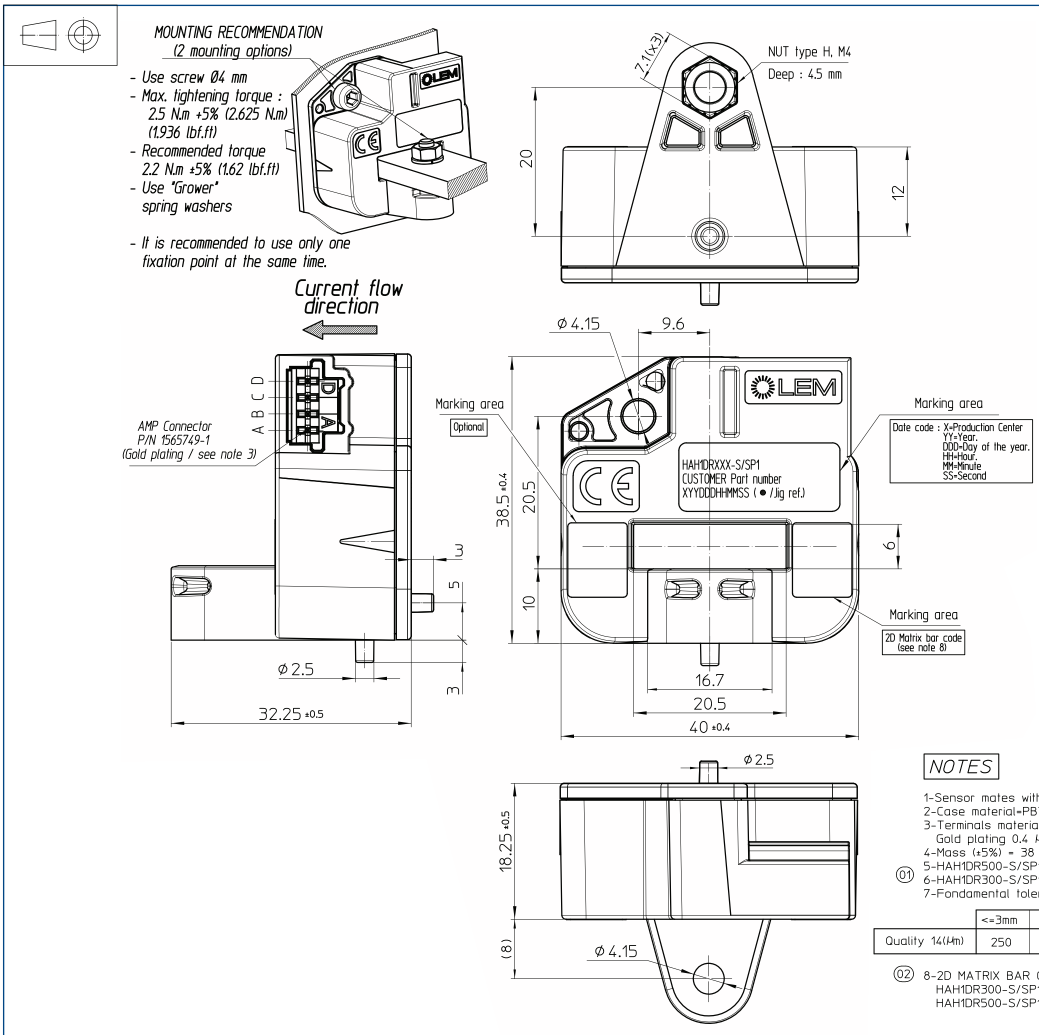


Fig. 1: Principle of the open loop transducer

HAH1DR 500-S/SP1

Dimensions HAH1DR family (in mm.)



NOTES

1-Sensor mates with AMP Connector P/N 1473672-1
2-Case material=PBT-30% glass reinforced (UL94 V0).
3-Terminals material=CuZn36 per NF EN 1652.
Gold plating 0.4 µm mini. finished.
4-Mass (±5%) = 38 gr.
(01) 5-HAH1DR500-S/SP1 Color = Black
6-HAH1DR300-S/SP1 Color = Black and white (cover).
7-Fondamental tolerances in accordance with ISO system:

	<=3mm	3to6	6to10	10to18	18to30	30to50	50to80
Quality 14(µm)	250	300	360	430	520	620	740

(02) 8-2D MATRIX BAR CODE Definition :
HAH1DR300-S/SP1 "HPCU:YF01 36652-3D000-DATE CODE"
HAH1DR500-S/SP1 "HPCU:YF01 36651-3D000-DATE CODE"

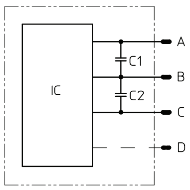
Bill of materials

• Plastic case	PBT GF 30
• Magnetic core	Iron silicon alloy
• Pins	Brass gold plated
Mass	38 g

Remarks

- $V_{OUT} > \frac{U_C}{2}$ when I_P flows in the direction of the arrow.

System architecture



Components list	
IC	Hall sensor ASIC
C1	Decoupling capacitor
C2	Decoupling capacitor

Pin out	
A	Vout
B	Ground
C	U_C (5V)
D	Not connected

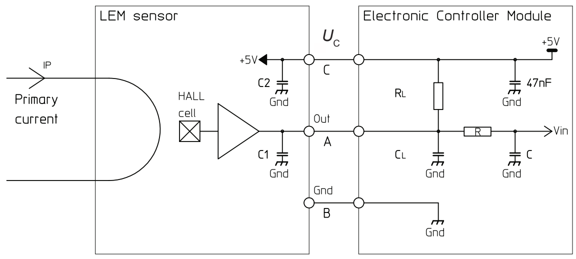
System architecture (example)

R_L >10 kΩ optional resistor for signal line diagnostic

V_{OUT}	Diagnosis
Open circuit	$V_{IN} = U_C$
Short GND	V_{IN} = OV

C_L < 100 nF EMC protection

RC Low pass filter EMC protection (optional)



HAH1DR 500-S/SP1

Absolute maximum ratings

Parameter	Symbol	Unit	Specification			Conditions
			Min	Typ	Max	
Electrical Data						
Max primary current peak	$I_{P\,max}$	A			1)	
Supply continuous over voltage	U_C	V			7	Not operating
Reverse voltage [2]	U_C	V	-0.5			1 min @ T_A = 25°C
Output over voltage (continuous)	V_{OUT}	V	-0.5		U_C + 0.5	
Continuous output current	I_{OUT}	mA	-10		10	
Output short-circuit duration	T_c	min			2	
Rms voltage for AC isolation test	U_d	kV			2	50 Hz, 1 min
Isolation resistance	R_{IS}	MΩ	500			500 V - ISO 16750-2
Electrostatic discharge voltage	U_{ESD}	kV			2	JESD22-A114-B
Ambient storage temperature	T_S	°C	-55		125	tested @ 25°C after 64h @ -55° not connected

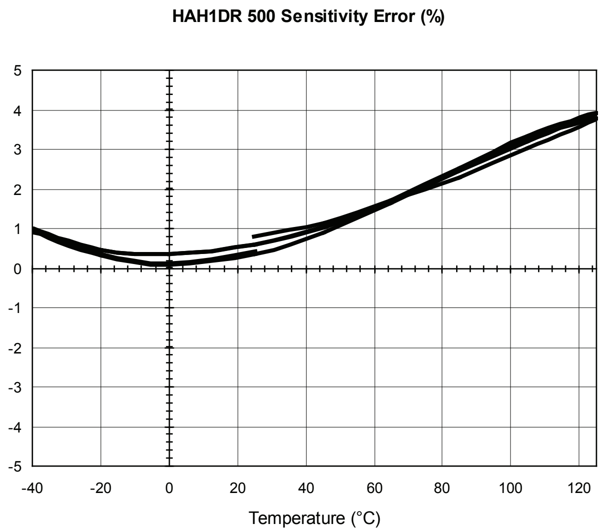
Operating characteristics

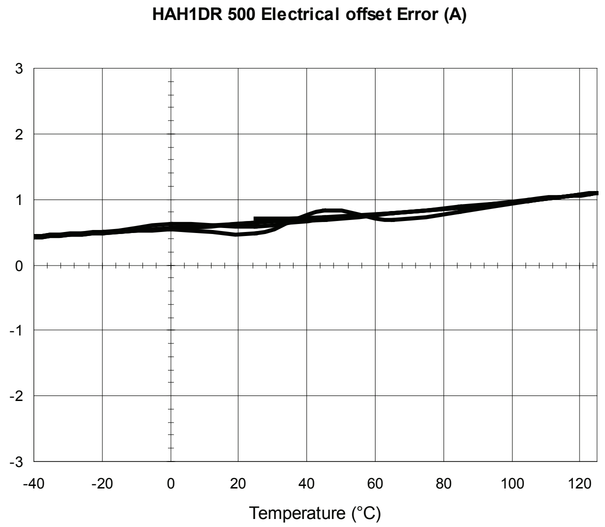
Parameter	Symbol	Unit	Specification			Conditions
			Min	Typ	Max	
Electrical Data						
Primary current	I_P	A	-500		500	
Calibration current	I_{CAL}	A	-500		500	@ T_A = 25°C
Supply voltage	U_C	V	4.75	5.00	5.25	
Output voltage (Analog) [3]	V_{OUT}	V	$V_{OUT} = (U_C/5) \times (2.5 + G \times I_P)$			@ U_C
Sensitivity [3]	G	mV/A		4		@ U_C = 5 V
Offset voltage	V_O	V		2.5		
Current consumption	I_C	mA		15	20	@ U_C = 5 V, @ - 40°C < T_A < 125°C
Load resistance	R_L	KΩ	10			
Output internal resistance	R_{OUT}	Ω			10	DC to 1 kHz
Capacitive loading	C_L	nF	1		100	
Ambient operating temperature	T_A	°C	-40		125	Connector limited 105°C
Output drift versus power supply	$V_{OUT\,PS}$	%		0.5		
Performance Data						
Sensitivity error	ε_G	%	-1.0	± 0.5	1.0	@ T_A = 25°C @ $I = I_{CAL}$
Electrical offset current	I_{OE}	A		± 1.5		@ T_A = 25°C
Magnetic offset current	I_{OM}	A		± 1.0		@ T_A = 25°C, after ± I_P
Global offset current	I_O	A	-3.3		3.3	@ T_A = 25°C
Linearity error	ε_L	%	-1		1	@ U_C = 5 V @, T_A = 25°C, @ $I = I_P$
Response time to 90 % of I_{PN} step	t_r	µs		6	10	@ d*i*/d*t* = 100 A/µs
Frequency bandwidth [4]	BW	kHz		30		@ -3 dB
Output clamping voltage min	V_{sz}	V			0.1	@ U_C = 5 V, T_A = 25°C
Output clamping voltage max	V_{sz}	V	4.9			@ U_C = 5 V, T_A = 25°C
Output voltage noise peak-peak	$V_{no\,pp}$	mV			14	DC to 1MHz

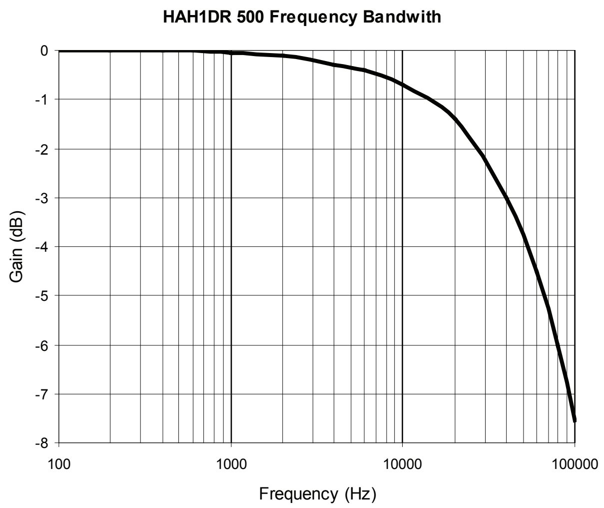
Notes:
1) Busbar temperature must be below 150°C
2) Transducer not protected against reverse polarity.
3) The output voltage V_{OUT} is fully ratiometric. The offset and sensitivity are dependent on the supply voltage U_C relative to the following formula:

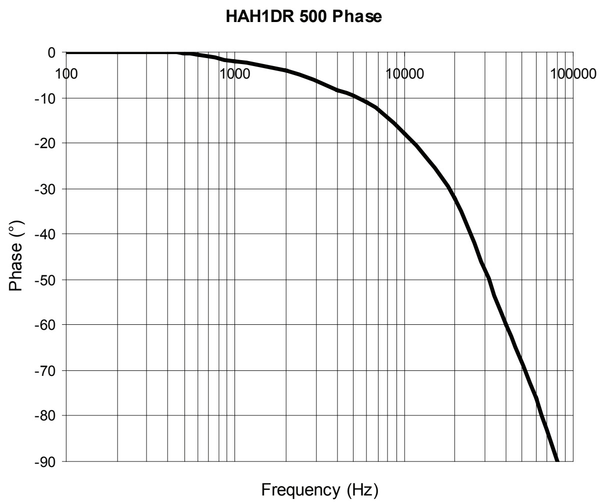
$$I_P = \left(V_{OUT} - V_O\right) \times \frac{1}{G} \times \frac{5}{U_C} \quad \text{with } G \text{ in (V/A)}$$

4) Tested only with small signal only to avoid excessive heating of the magnetic core.

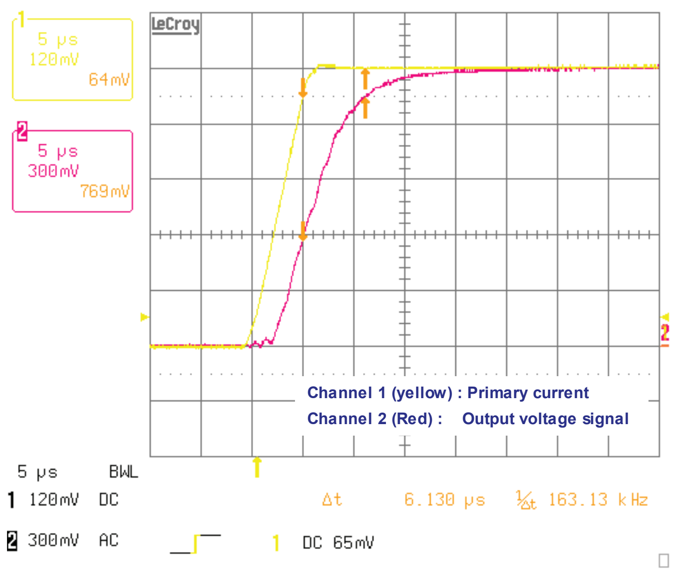






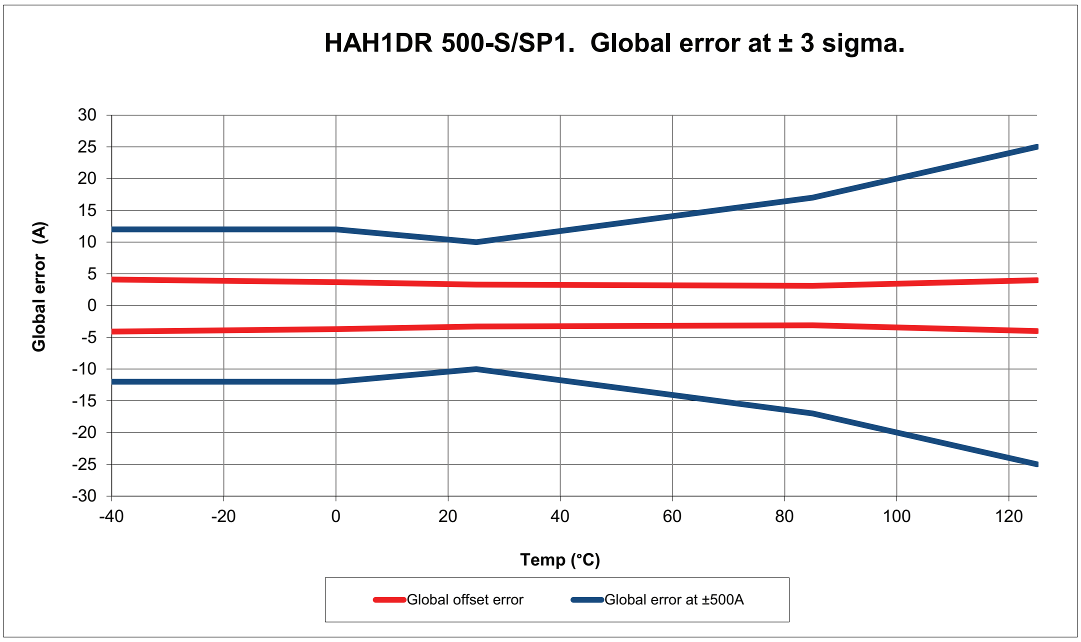


Typical response time at 100 A/µs



Global absolute error (A)

	Global error ± 3 sigma (A).				
Temperatures (°C)	-40	0	25	85	125
Global offset error (A)	± 4.1	± 3.7	± 3.3	± 3.1	± 4
Global error at ± 500A (A)	± 12	± 12	± 10	± 17	± 25

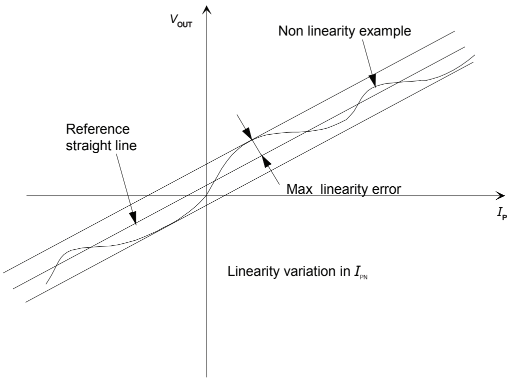


PERFORMANCES PARAMETERS DEFINITIONS

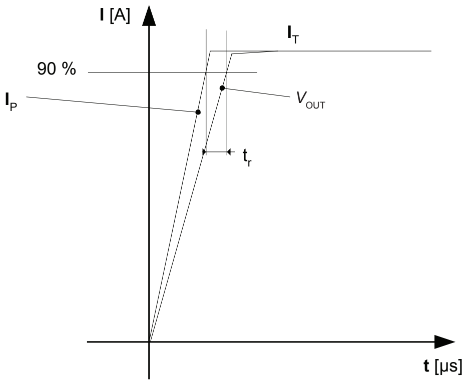
Output noise voltage:
The output voltage noise is the result of the noise floor of the Hall elements and the linear amplifier gain.

Magnetic offset:
The magnetic offset is the consequence of an over-current on the primary side. It's defined after an excursion of $I_{P\ max}$.

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 and the output signal reach at 90 % of its final value



Typical:
Theorical value or usual accuracy recorded during the production.

Laser Marking:
Readability with advocated LASER reader Brand SYMBOL Model DPM DS 3408 or 3407.

Sensitivity:
The Transducer's sensitivity G is the slope of the straight line $V_{out} = f(I_P)$, it must establish the relation:
$V_{out}(I_P) = U_C/5\ (G \times I_P + 2.5)$ (*)
(*) For all transducers with ± same I_{PN} (e.g. ± 400 A).

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 detailled 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).

Environmental test specifications

Name	Standard	Conditions
Damp heat, steady state	JESD22-A101	85°C - 85°C / 1000h
Isolation resistance	ISO 16750-2 § 4.10	500 V/1min
Temperature humidity cycle test	ISO 16750-4	-10 + 85°C 10 days
Isolation test	IEC 60664-1	2 kV/50 Hz/1min
Mechanical tests		
Vibration test (random)	IEC 60068-2-64 ISO 16750-3 & 4.1.2.5 (2007)	20 … 2000 Hz Random rms (11g rms) 8h/axis
Terminal strength test	According to LEM	
Thermal shocks	IEC 60068-214 Na	-40 + 125°C 300 cycles
Free fall	ISO 16750-3 § 4.3	1m concrete ground
EMC Test		
Radiated electromagnetic immunity	Directive 2004/104/CE ISO 11452-2	30 V/m 20-2000 MHz
Bulk current injection immunity	Directive 2004/104/CE ISO 11452-4	1-400 MHz - 60 mA
Radiated radio frequency electromagnetic field immunity	IEC 61000-4-3	80 MHz to 1,000 MHz-10V/m
Electrostatic discharge immunity test	IEC 61000-4-2	Air discharge=2 kV