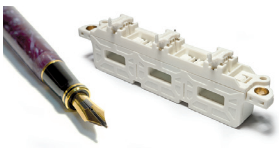
AUTOMOTIVE CURRENT TRANSDUCER
HAH3DR 700-S00



Introduction

The HAH3DR family, a tri-phase tranducer 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 HAH3DR family gives you the choice of having different current measuring ranges in the same housing (from ± 100 A up to ± 900 A).

Features

- Open Loop transducer using the Hall effect
- PCB mounting
- Low voltage application
- Unipolar + 5 V DC power supply
- Primary current measuring range up to ± 700 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).

Advantages

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

Automotive applications

- Starter Generators
- Inverters
- HEV application
- EV application
- DC / DC converter.

Principle of HAH3DR 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 (Fig. 1).
Within the linear region of the hysteresis cycle, **B** is proportional to:

$$\mathbf{B}\ (\mathbf{I}_P) = \text{constant (a)} \times \mathbf{I}_P$$

The Hall voltage is thus expressed by:

$$\mathbf{V}_H = (R_H/d) \times \mathbf{I} \times \text{constant (a)} \times \mathbf{I}_P$$

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

$$\mathbf{V}_H = \text{constant (b)} \times \mathbf{I}_P$$

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

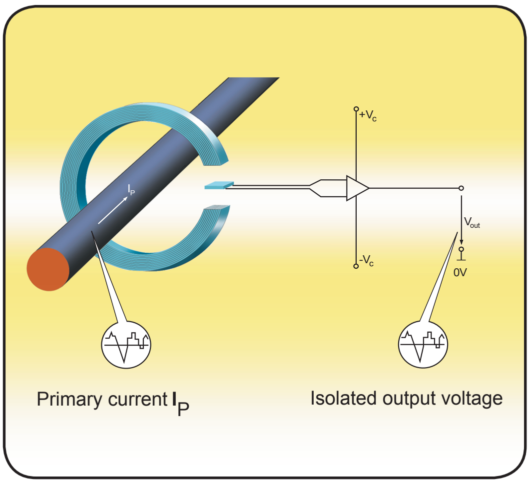


Fig. 1: Principle of the open loop transducer

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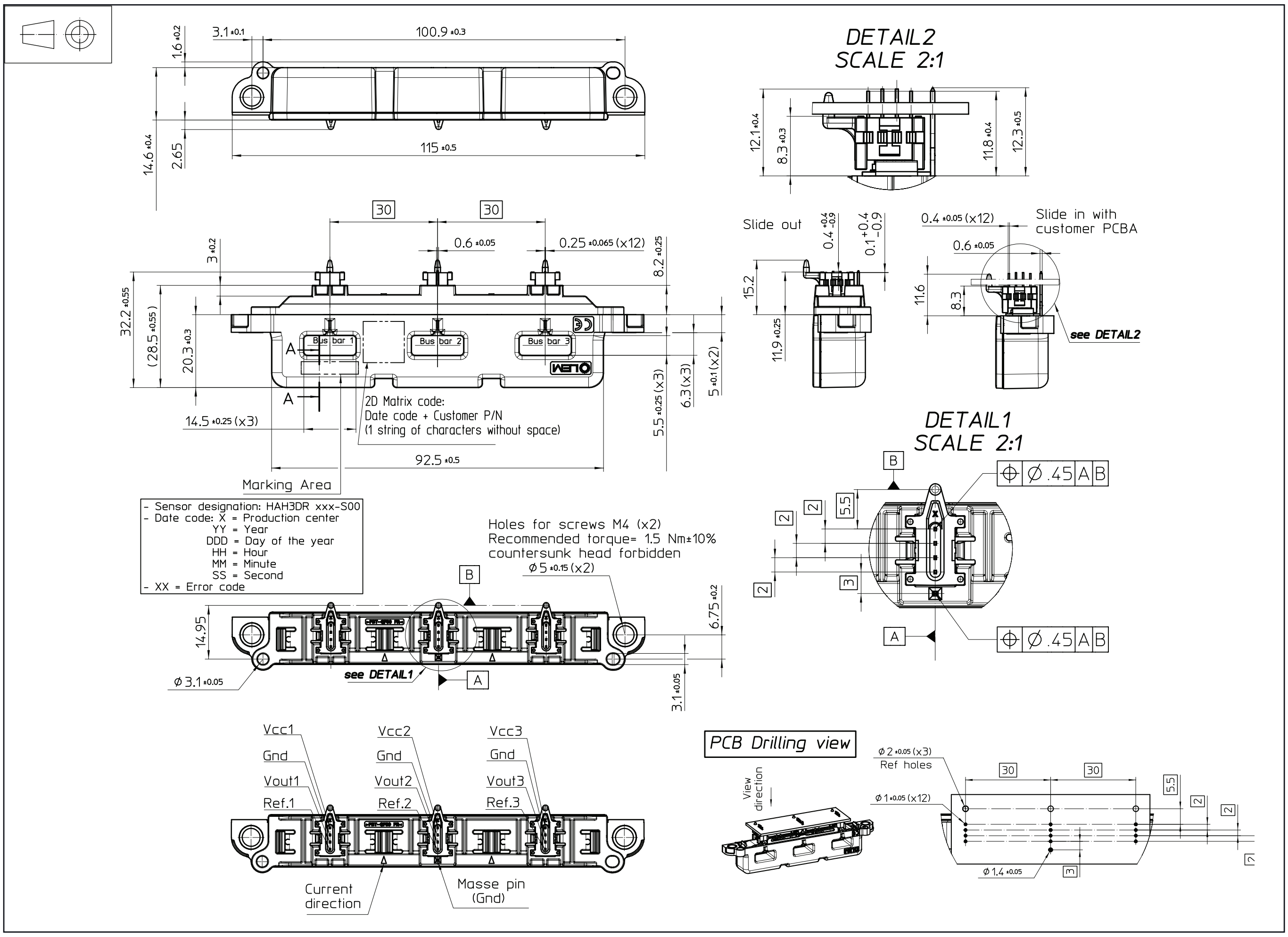
Dimensions HAH3DR family (in mm)



Bill of materials

- Plastic case PBT GF 30 % (UL 94 V0)
- Magnetic core FeSi wound core
- Pins Copper alloy tin plated (lead free)
- Mass 74 g ± 5 %

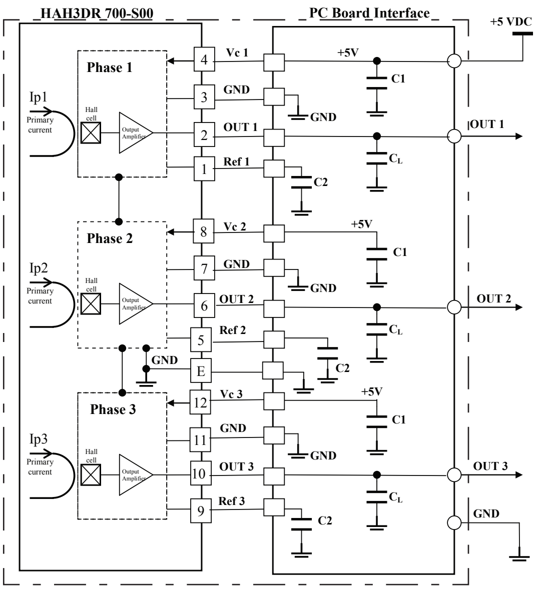
R_L >10 kΩ optional resistor for signal line diagnostic

C_L 4 nF < **C_L** < 18 nF EMC protection
Nominal value 4.7 nF
(**C_L** is an obligation to stabilize and to avoid the undulation of the output signal)

Capacitor of V_{ref}/GND 1 nF < C2 < 47 nF

Capacitor of V_c/GND 47 nF < C1 < 1 µF

Electronic schematic



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Absolute maximum ratings

Parameter	Symbol	Unit	Specification Min	Specification Typ	Specification Max	Conditions
Electrical Data						
Max primary current peak	I_{Pmax}	A			1)	
Supply continuous over voltage	V_C	V			8	Not operating
					6.5	Exceeding this voltage may temporarily reconfigure the circuit until next power-on
Output voltage min	V_{sz}	V			0.2	@ V_C = 5 V, T_A = 25°C
Output voltage max			4.8			@ V_C = 5 V, T_A = 25°C
Maximum reverse polarity current 2)		mA	-80		80	
Continuous output current	I_{OUT}	mA	-1		1	R_L = 10 kΩ
Rms voltage for AC isolation test	V_d	kV			2.5	50 Hz, 1 min, IEC 60664 part1
Isolation resistance	R_{IS}	MΩ	500			500 V DC- ISO 16750
Electrostatic discharge voltage (HBM)	V_{ESD}	kV			2	JESD22-A114-B class 2
Ambient storage temperature	T_S	°C	-50		125	
Clearance distance	dCI	mm		3.78		
Creepage distance	dCp	mm		4.78		

Operating charcteristics

Parameter	Symbol	Unit	Specification Min	Specification Typ	Specification Max	Conditions
Electrical Data						
Primary current	I_P	A	-700		700	
Supply voltage *)	V_C	V	4.75	5.00	5.25	
Output voltage (Analog) 3)	V_{OUT}	V		$V_{OUT} = (V_C/5) \times (2.5 + G \times I_P)$		@ V_C
Sensitivity 3) *)	G	mV/A		2.86		@ V_C = 5 V
Current consumption (for 3 phases) *)	I_C	mA		44	50	@ V_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	4	4.7	18	
Ambient operating temperature	T_A	°C	-40		125	
Output drift versus power supply	$V_{OUT\ PS}$	%		0.5		
Performance Data (Phases Coupling influences included) @ 4 Sigma						
Sensitivity error *)	ε_G	%		± 0.5		@ T_A = 25°C
				± 1		@ T_A = 25°C, after T° cycles
Electrical offset voltage *)	V_{OE}	mV		± 4		@ T_A = 25°C, @ V_C = 5 V
Magnetic offset current *)	V_{OM}		-7.5		7.5	@ T_A = 25°C, @ V_C = 5 V, after ± I_P
Global offset voltage *)	V_O		-20.0		20.0	@ T_A = 25°C, @ V_C = 5 V, Hysteresis included
Average temperature coefficient of V_{OE}	$TCV_{OE\ AV}$	mV/°C	-0.15		0.15	@ - 40°C < T° < 125°C
Average temperature coefficient of **G**	TCG_{AV}	%/°C	-0.040	± 0.01	0.040	@ - 40°C < T° < 125°C
Linearity error *)	ε_L	%	-1		1	@ V_C = 5 V @, T_A = 25°C, @ I = I_P
Response time to 90 % of I_{PN} step	t_r	µs		4	6	@ di/dt = 100 A/µs
Frequency bandwidth 4)	BW	kHz	40			@ -3 dB
Phase delay		°	-4		0	@ DC to 1 kHz
Output voltage noise peak-peak	$V_{no\ pp}$	mV			20	DC to 1MHz

Notes:
*) The parameter with *) will be checked 100% during the calibration phase
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 V_C relative to the following formula:

$$I_P = \left(V_{OUT} - \frac{V_C}{2}\right) \times \frac{1}{\mathbf{G}} \times \frac{5}{V_C} \quad \text{with } \mathbf{G} \text{ in (V/A)}$$

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

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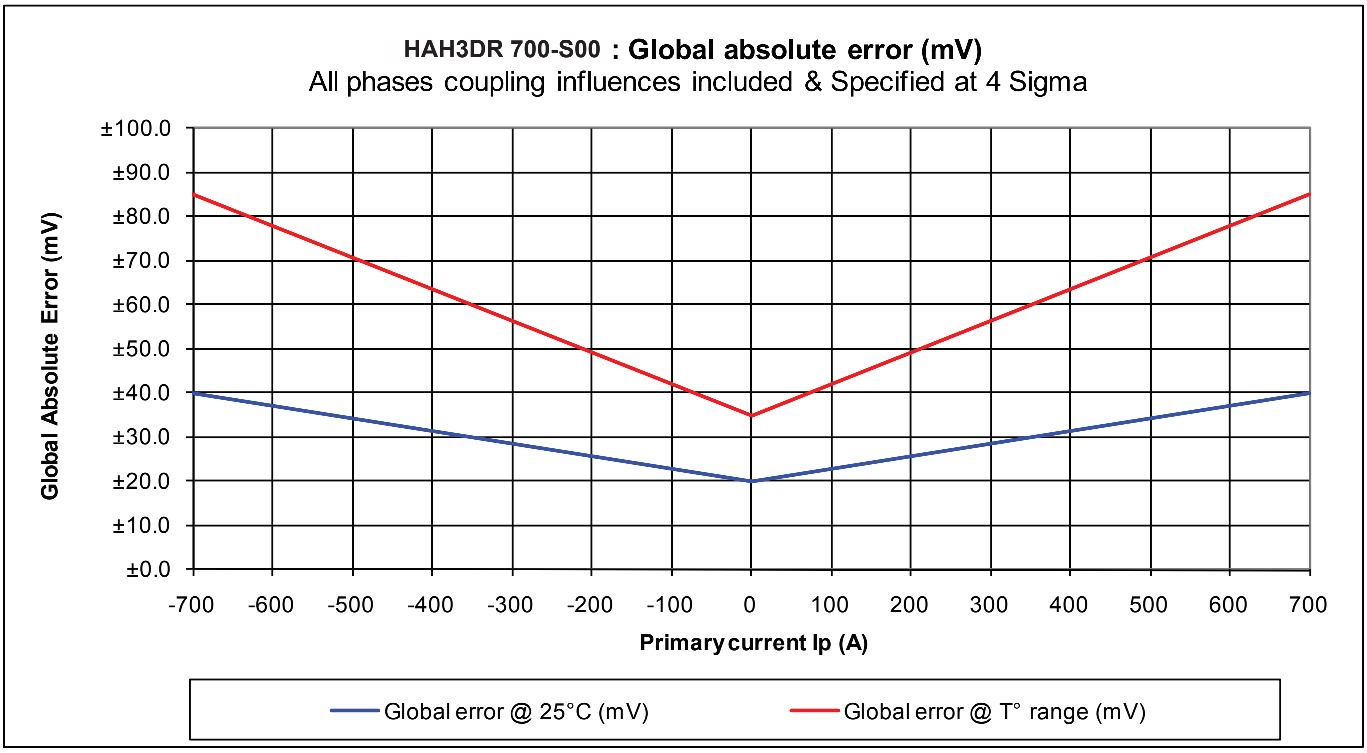

Global absolute error specified at 4 Sigma

I_P (A)	Globale error @ 25°C (mV)	Globale error @ T° range (mV)
-700	±40.0	±85.0
0	±20.0	±35.0
700	±40.0	±85.0

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PERFORMANCES PARAMETERS DEFINITIONS

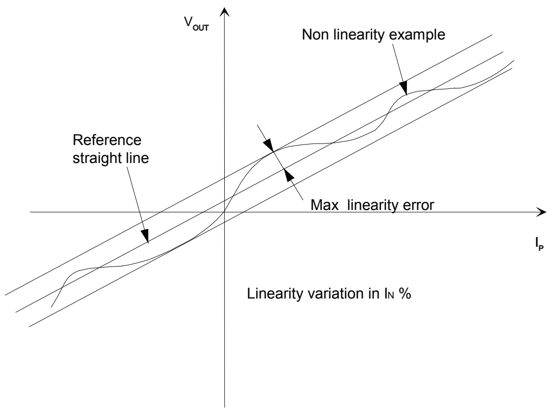
Output noise voltage:
The output voltage noise is the result of the noise floor of the Hall elements and the linear I_C amplifier gain.

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

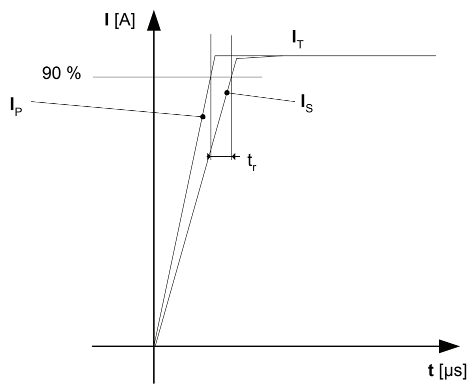
Linearity:
The maximum positive or negative discrepancy with a reference straight line $\mathbf{V}_{OUT}$ = f ($\mathbf{I}_P$).

Unit: linearity (%) expressed with full scale of $I_{P\ max}$.

Linearity is measured on cycle + $\mathbf{I}_P$, O, - $\mathbf{I}_P$, O, + $\mathbf{I}_P$ without magnetic offset (average values used).



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:
Theoretical value or usual accuracy recorded during the Design Validation tests.

Sensitivity:
The Transducer's sensitivity **G** is the slope of the straight line $\mathbf{V}_{out}$ = f ($\mathbf{I}_P$), it must establish the relation:

$\mathbf{V}_{out}$ ($\mathbf{I}_P$) = $\mathbf{V}_C$/5 (**G** x $\mathbf{I}_P$ + 2.5) (*)

(*) For all symetrics transducers.

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 $\mathbf{I}_{OT}$ is a maximum variation the offset in the temperature range:

$\mathbf{I}_{OT}$ = $\mathbf{I}_{OE}$ max - $\mathbf{I}_{OE}$ min

The Offset drift $\mathbf{TCI}_{OEAV}$ is the $\mathbf{I}_{OT}$ 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 $\mathbf{G}_T$ is the maximum variation (in ppm or %) of the sensitivity in the temperature range:

$\mathbf{G}_T$ = (Sensitivity max - Sensitivity min) / Sensitivity at 25°C.

The sensitivity drift $\mathbf{TCG}_{AV}$ is the $\mathbf{G}_T$ value divided by the temperature range.

Offset voltage @ I_P = 0 A:
Is the output voltage when the primary current is null. The ideal value of $\mathbf{V}_O$ is $\mathbf{V}_C$/2 at $\mathbf{V}_C$ = 5 V. So, the difference of $\mathbf{V}_O$ -$\mathbf{V}_C$/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.

Environmental test specifications
See PV test.

LEM

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