AUTOMOTIVE CURRENT TRANSDUCER
HAG 240-V/SP1

Introduction

The HAG Family is best suited for DC, AC or pulsed currents measurement in high power and low voltage automotive applications. It's contains galvanic isolation between the primary circuit (high power) and the secondary circuit (electronic circuit).

The HAG family gives you a choice of having different current measuring ranges in the same housing (from ± 50 A up to ± 250 A).

Features

- Open Loop transducer using the Hall effect sensor
- Low voltage application
- Unipolar + 5 V DC power supply
- Primary current measuring range from 0 A up to 240 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 ratio-metric (in gain and offset).

Advantages

- Good accuracy for high and low current range
- Good linearity
- Low thermal offset drift
- Low thermal gain drift
- Hermetic package.

Automotive applications

- Battery Pack Monitoring
- Hybrid Vehicles
- EV and Utility Vehicles.

Principle of HAG Family

The open loop transducers use an 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 control current 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 $\mathbf{I}_P$, all terms of this equation are constant. Therefore:

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

The measurement signal $\mathbf{V}_H$ amplified to supply the user output voltage or current.

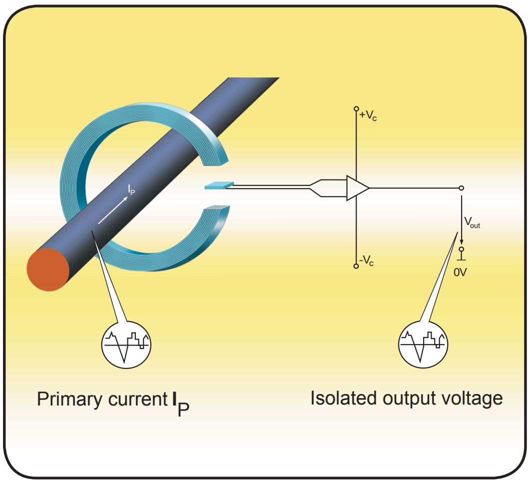
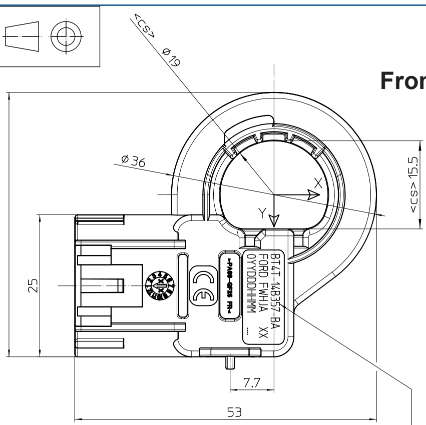


Fig. 1: Principle of the open loop transducer

HAG 240-V/SP1

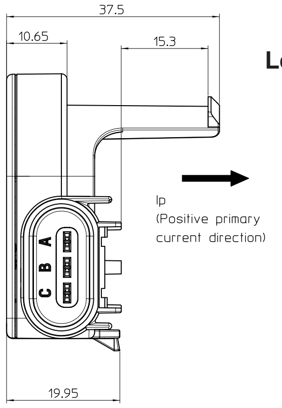
Dimensions HAG 240-V/SP1 family (in mm. 1mm = 0.0394 inch)

Front view

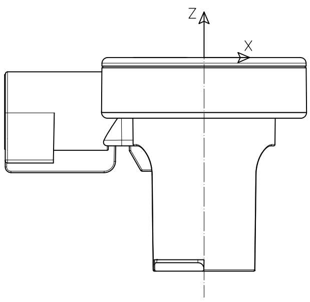


(18) -BT4T-14B357-BA: Engineering Part Number.
-FORD: Trademark "FORD"
-FWHJA: Supplier Code
-XX: Error Code
-Date code: 0=Production Center .
YY=Year
DDD=Day of the year.
HH=Hour.
MM=Minute.
- .... = Identification code for jig.

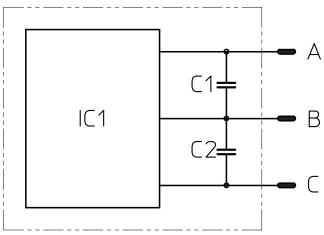
Left view



Top view



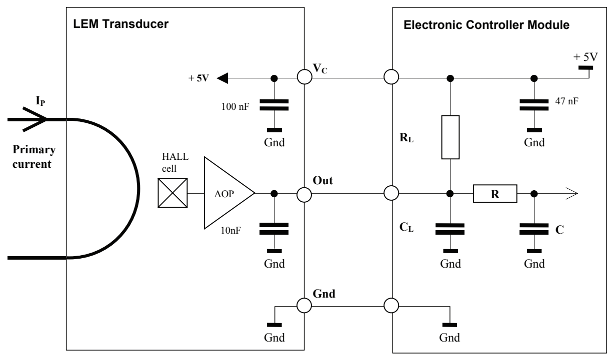
Electrical Diagram



Components list	
IC1	Hall sensor ASIC
C1	100nF±10%-X7R
C2	10nF±10%-X7R

Pin out	
A	DC supply voltage (5V)
B	Ground
C	Output signal

System Architecture



Bill of materials

- Plastic case — >PA66- GF25 FR< (UL94 V0)
- Magnetic core — FeSi alloy
- Pins — Brass tin platted
- *m* — 25 g

R_L > 10 KΩ optional resistor for signal line diagnostic

C_L > 100 nF EMC protection

RC = Low pass filter EMC protection (optinal).

HAG 240-V/SP1

Absolute maximum ratings (not operating)

Parameter	Symbol	Unit	Specification			Conditions
			Min	Typical	Max	
Electrical Data						
Max primary current peak	I_{Pmax}	A			[1]	
Supply continuous over voltage	V_C	V			8.5	
Supply over voltage	V_C	V			14	1 min @ T_A = 25°C
Reverse voltage	V_C	V	-14			1 min @ T_A = 25°C
Output over voltage (Analog)	V_{OUT}	V			8.5	
Output over voltage	V_{OUT}	V			14	1 min @ T_A = 25°C
Continuous output current	I_{OUT}	mA	-10		10	
Output short circuit duration	T_c	min			2	
Rms voltage for AC isolation test	V_d	kV			2	50Hz, 1min
Isolation resistance	R_{IS}	MΩ	500			500 V - ISO 16750-2
Electrostatic discharge voltage	V_{ESD}	kV			2	JESD22-A114-B
Ambient storage temperature	T_S	°C	-40		+125	

Operating characteristics

Parameter	Symbol	Unit	Specification			Conditions
			Min	Typical	Max	
Electrical data						
Primary current	I_P	A	0		240	
Calibration current	I_{CAL}	A	0		120	@ T_A = 25°C
Supply voltage	V_C	V	4.5	5.00	5.5	
Output voltage (Analog) [2]	V_{OUT}	V	$V_{OUT} = \frac{V_C}{5} \times (0.5 + G \times I_P)$			@ V_C
Sensitivity [2]	G	mV/A		16.67		@ V_C = 5 V
Current consumption	I_C	mA		7.5	10	@ V_C = 5 V, -40°C < T_A < 125°C
Power up inrush current	I_C	mA			20	@ V_C < 3.5 V
Load resistance	R_L	KΩ	10			
Output internal resistance	R_{OUT}	Ω			10	
Capacitive loading	C_L	nF	1		100	
Ambient operating temperature	T_A	°C	-40		125	
Output drift versus power supply	$V_{OUT\ PS}$	%		0.5		
Frequency bandwidth [3]	BW	Hz			80	@ -3 dB
Output clamping voltage min	V_{SZ}	V	0.2	0.25	0.3	@ V_C = 5 V
Output clamping voltage max	V_{SZ}	V	4.7	4.75	4.8	@ V_C = 5 V
Output voltage noise peak-peak	$V_{no\ pp}$	mV			10	
Resolution		mV		2.5		@ V_C = 5 V
Power up time		ms		25	110	
Settling time after over load		ms			25	

Notes: [1] Busbar temperature must be below 150°C
[2] 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:

$$I_P = \left(\frac{5}{V_C} \text{ x } V_{OUT} - 0.5\right) \times \frac{1}{G} \qquad \textit{with } \mathbf{G} \textit{ in (V/A)}$$

[3] Tested only with small signal only to avoid excessive heating of the magnetic core.

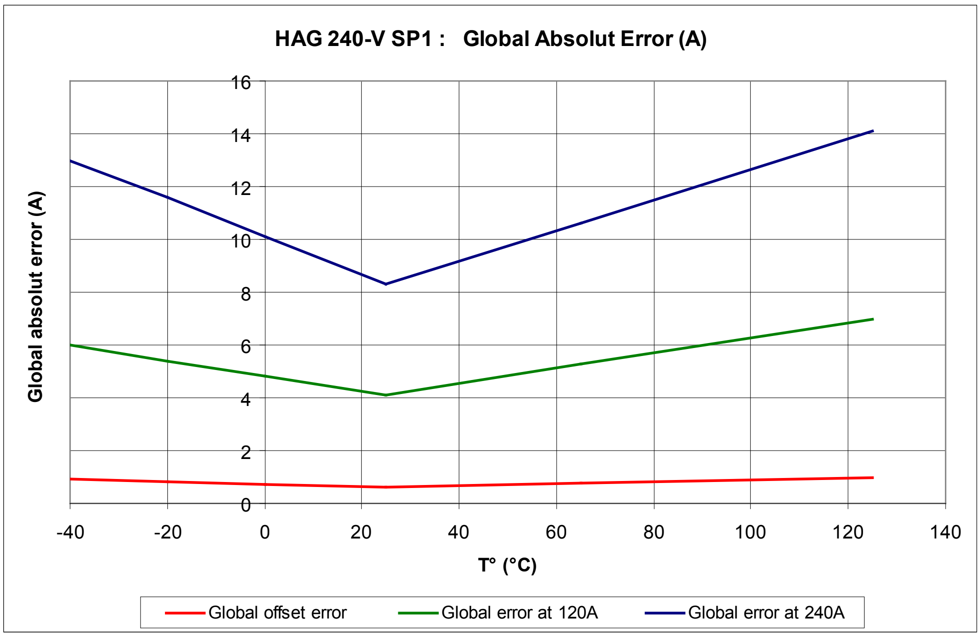
HAG 240-V/SP1

Accuracy

Parameter	Symbol	Unit	Specification			Conditions
			Min	Typ	Max	
Performance Data						
Global offset current	I_O	A		± 0.3		@ T_A = 25°C
				± 0.5		@ - 20°C < T° < 65°C
				± 0.6		@ - 40°C < T° < 125°C
Sensitivity error	ε_G	%		± 0.8		@ T_A = 25°C
				± 2		@ - 20°C < T° < 65°C
				± 4		@ - 40°C < T° < 125°C
Linearity error	ε_L	%		± 1		of full range, @ T_A = 25°C

Global error table

Parameter	Symbol	Unit	Temperature T° (°C)					
			-40°C	**-20°C**	**0°C**	**25°C**	**65°C**	**125°C**
Global offset error	X	A	± 0.90	± 0.81	± 0.72	± 0.60	± 0.76	± 1.00
Global error at 120A			± 6.00	± 5.40	± 4.80	± 4.10	± 5.30	± 7.00
Global error at 240A			± 13.00	± 11.60	± 10.10	± 8.30	± 10.60	± 14.10



HAG 240-V/SP1

PERFORMANCES PARAMETERS DEFINITIONS

Output noise voltage:

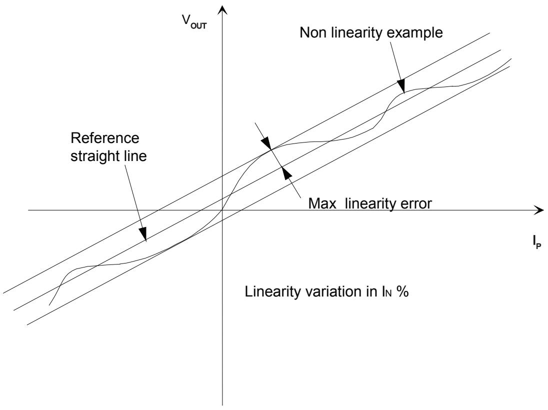
The output voltage noise is the result of the noise floor of the Hall elements and the linear I_C amplifier gain.

Magnetic offset:

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

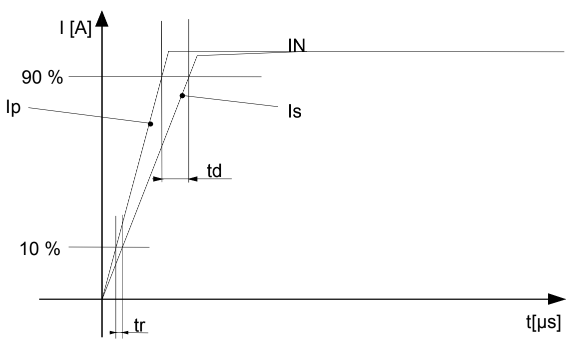
Linearity:

It's 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 $\mathbf{I}_{P\ max}$.



Response time (delay time) t_r:

The time between the primary current signal and the output signal reach at 90 % of its final values



Typical value @ T_A:

The maximum of 90% of the values found in production.

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:
$\mathbf{V}_{out} = \mathbf{V}_C/5\ (\mathbf{G} \times \mathbf{I}_P + 0.5)$

Offset with temperature:

The error of the offset in the operating temperature Eoffset is the relative variation of the offset in the temperature considered with the initial offset at 25°C.
The offset variation $\mathbf{TCV}_{OUT}$ in the operating temperature is the slope of Eoffset = f(T).

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 $\mathbf{TC}_{\varepsilon G}$ in the temperature is the slope of Eoffset = f(T).

Offset voltage @ I_P = 0 A:

Is the output voltage when the primary current is null. The ideal value of $\mathbf{V}_O$ is $\mathbf{V}_C/2$. So, the difference of $\mathbf{V}_O$ -$\mathbf{V}_C/2$ is called the total offset voltage 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.