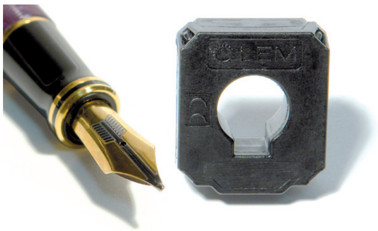
AUTOMOTIVE CURRENT TRANSDUCER
HC5F900-S



Introduction

The HC5F family is for the electronic measurement of DC, AC or pulsed currents in high power and low voltage automotive applications with galvanic isolation between the primary circuit (high power) and the secondary circuit (electronic circuit).

The HC5F family gives you the choice of having different peak currents (from ± 200 A up to ± 900 A) in the same housing.

Features

- Open Loop transducer using the Hall effect
- Low voltage application
- Unipolar + 5 V DC power supply
- Primary current measuring range up to ± 900 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 (sensitivity and offset)
- High speed transducer.

Advantages

- Good accuracy
- Good linearity
- Low thermal offset drift
- Low thermal sensitivity drift.

Automotive applications

- Electrical Power Steering
- Starter Generators
- Converters ...

Principle of HC5F 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 $\mathbf{I}_P$, 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.

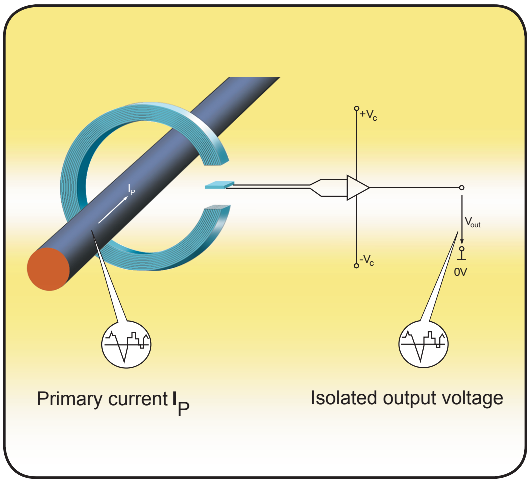


Fig. 1: Principle of the open loop transducer

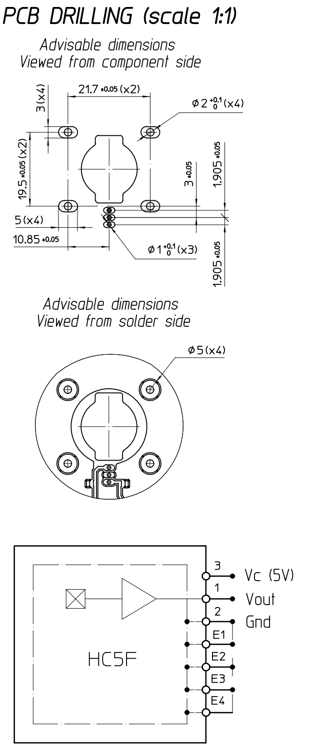
HC5F900-S

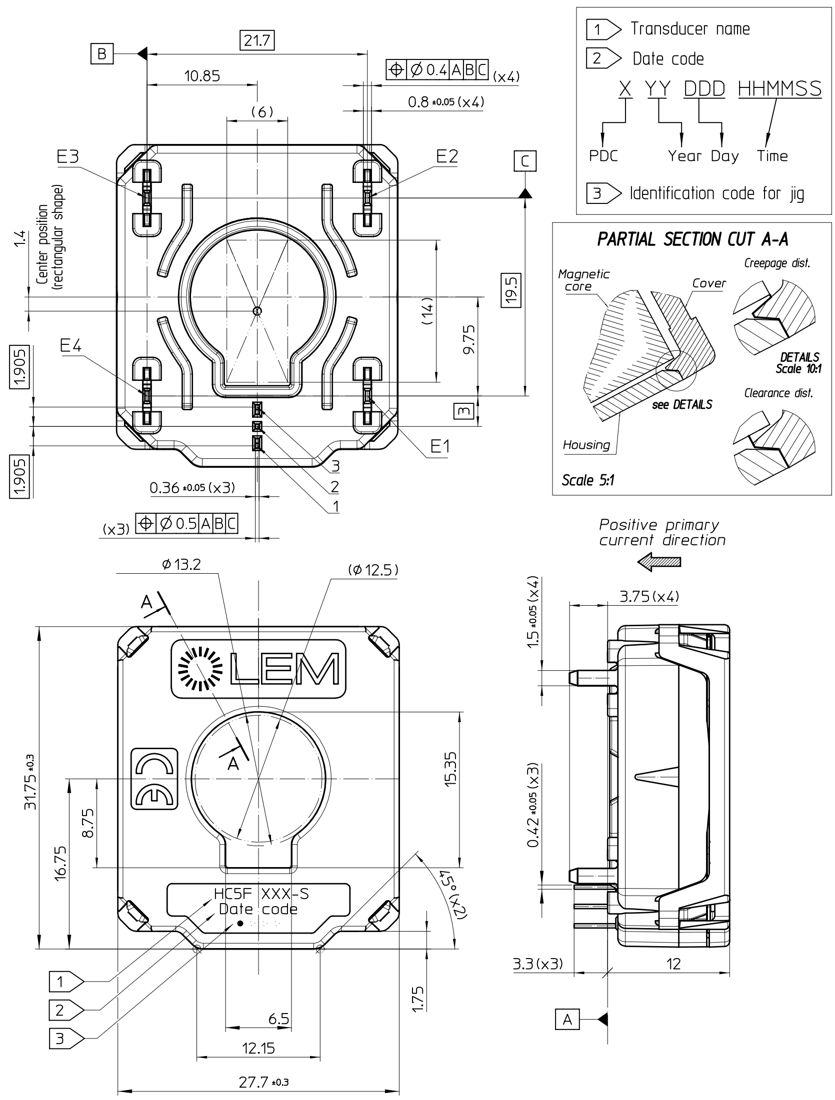
Dimensions HC5F900-S family (in mm.)

Secondary connection

Terminals	Designations
3	Supply voltage + 5 V DC
1	V_{OUT}
2	Ground
E1 to E4	Ground (*)

(*) Only 1 of these 4 pins could be connected





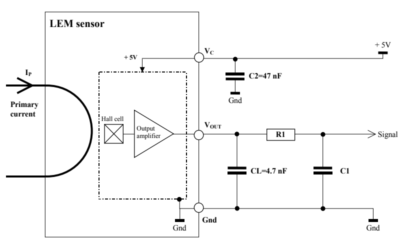
Bill of materials

- Plastic case — PA66-GF25
- Magnetic core — FeSi alloy
- Pins — Copper alloy base tin plated (lead free)
- Mass — 26 g

Remarks

- General tolerance ± 0.2 mm
- $V_{OUT} > \frac{V_C}{2}$ when I_P flows in the direction of the arrow.

Electronic schematic



R_{LOAD} > 10 KΩ
C_{LOAD} Nominal value 4.7 nF ± 10 %
(C_{LOAD} is obligation to stabilize and to avoid the ondulation of the output signal)
R_1C_1 low pass filter EMC protection (optional)

HC5F900-S

Absolute maximum ratings (not operating)

Parameter	Symbol	Unit	Specification			Conditions
			Min	Typical	Max	
Supply over voltage	V_C	V			7	No operating, 1 min@ 25°C
Reverse voltage	V_C	V	Not applicable			No operating
Output over voltage	V_{out}	V	- 0.5		V_C + 0.5	No operating
Continuous output current	I_{out}	mA	- 10		10	No operating
Output short-circuit duration	t_C	min			2	
Maximum admissible vibration	γ	$m.s^{-2}$			200	ISO 16750-3&4.1.2.1.2.1
Rms voltage for AC insulation test 50 Hz, 1 min	V_d	kV			1.2	IEC 60664 Part 1
Electrostatic discharge voltage	V_{ESD}	kV			2	JESD22-A114-B
Ambient storage temperature	T_S	°C	- 55		150	tested after 64H @-55°C connected
Clearance distance	dCl	mm	1.2			
Creepage distance	dCp	mm	1.65			

Operating characteristics

Parameter	Symbol	Unit	Specification			Conditions
			Min	Typical	Max	
Electrical Data						
Primary current, measuring range	I_P	A	- 900		900	
Calibration current	I_{CAL}	A		800		T_A = 25°C
Supply voltage [1]	V_C	V	4.75	5.00	5.25	
Output voltage (Analog)	V_{OUT}	V	$V_{OUT} = (V_C/5) \times (2.5 + 0.00222 \times I_P)$			@ V_C
Sensitivity	G	mV/A		2.22		@ V_C = 5 V
Current consumption	I_C	mA		12	20	
Load resistance	R_L	KΩ	10			
Capacitive loading	C_L			4.7		
Output internal resistance	R_{OUT}	Ω			10	
Ambient operating temperature	T_A	°C	- 40		125	
Performance Data [1]						
Sensitivity error	ε_G	%	- 2		2	@ T_A = 25°C; V_C = 5 V
Electrical offset	I_{OE}	A	- 3.8	± 2	3.8	T_A = 25°C
Magnetic offset	I_{OM}	A	- 2.4	± 1.5	2.4	@ After excursion to ± I_P; T_A = 25°C
Offset current	I_O	A	- 4.6		4.6	T_A = 25°C
Average temperature coefficient of I_{OE}	TCI_{OEAV}	mA/°C	-36	± 10	36	@ - 40°C < T° < 125°C; V_C
Average temperature coefficient of G	TCG_{AV}	%/°C	-0.050	± 0.025	0.050	@ - 40°C < T° < 125°C; V_C
Linearity error	ε_L	% IP	-2		2	Of full range; I_P > 800 A or < -800 A
Linearity error	ε_L	% IP	-1		1	Of full range; - 800 A or < I_P < + 800 A
Response time	t_r	µs		5	10	
Frequency bandwidth [2]	BW	kHz	30			@ - 3 dB
Output voltage low	V_{OUTL}	V	0.1			@ V_C = 5 V
Output voltage high	V_{OUTH}	V			4.9	@ V_C = 5 V
Output voltage noise peak-peak	$V_{no\ p\text{-}p}$	mV			15	DC to 1 MHz
Output voltage noise rms	$V_{no\ rms}$	mV			2.9	DC to 1 MHz

Notes: [1] 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:

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

[2] Small signal only to avoid excessive heating of the busbar, the magnetic core and the ASIC.

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.

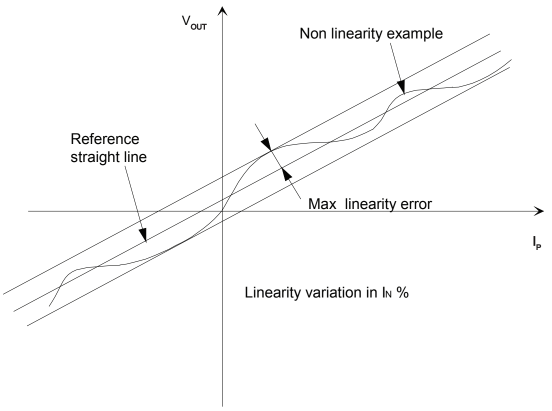
Magnetic offset:

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

Linearity:

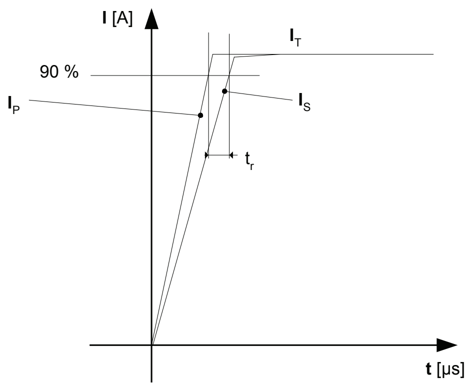
The maximum positive or negative discrepancy with a reference straight line $V_{OUT} = f(I_P)$.

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



Response time (delay time) t_r:

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



Typical:

Theorical value or usual accuracy recorded during the production.

Sensitivity:

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

$V_{out}(I_P) = \mathbf{V_C}/5\ (G \times \mathbf{I_P} + 2.5)$ (*)

(*) 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 I_{OT} is a maximum variation the offset in the temperature range:

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

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

NAME	STANDARD	CONDITIONS
ENVIRONMENTAL TESTS		
Thermal shocks	IEC 60068-2-14 test Na (01/2009)	T° - 40°C to 125°C / 30 mn each, 300 cycles not connected
T° humidity cyclic	ISO 16750-4	10 cycles of 24H, high T°, power supply on monitored
Power temp cycle	IEC 60068 Part 2-14 test Nb (01/2009)	T° - 40°C to 125°C, 15 mn/step, transition time 15 mn 600 cycles
Temperature humidity bias	JESD22-A101 (04/97)	T° 85°C / 85 % RH/ 1000 H power supply on, monitored each 6H
MECHANICAL TESTS		
Sinus vibration	ISO 16750-3 & 4.1.2.1.2.1 (08/2007)	No power supply- profile 1 f = 100 to 1000 Hz, g = 100 to 200 m/s², 22H/axis, 3 axis, T°C cycle -40°C to 125°C
Random vibration	IEC 60068-2-64 (02/2008)	No power supply g rms = 27.8 m/s², f = 10 Hz to 1 kHz, PSD = 0.14 to 20 (m/s²) ²/Hz 12H/axis X and Y, 36 H for axis Z, T°C. cycle -40°C to 125°C
Stocks	IEC 60068-2-27 (02/2008)	Half sine shocks @ 25°C, 25 g/ 15 ms, 132 shocks/direction, 6 directions, 100 g/11 ms, 3 shock/direction, 6 directions
Drop test	ISO 16750-3& 4.3 (08/2007)	Drop 1 m, 2 falls/part, 1 part/axis, 6 directions, parts without PCB
ELECTRICAL TESTS		
Rms voltage for AC isolation test	IEC 60664-1	1.2 kV/50 Hz/1 mn
Isolation resistance	ISO 16750-2& 4.10	500 V DC, 25°C, $R_{isolation}$ > 10 MOhms
EMC TESTS		
Electrostatic discharge	IEC 61000-4-2	Contact ± 2 kV , air ± 2 kV
Electrostatic discharge	JESD22-A114-B	HBM: 1.5 kOhms / 100 pF 2kV