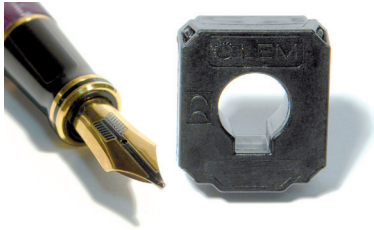


# AUTOMOTIVE CURRENT TRANSDUCER OPEN LOOP TECHNOLOGY

## HC5F700-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 separation 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  $\pm 200$  A up to  $\pm 900$  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  $\pm 700$  A
- Maximum RMS primary current limited by the busbar, the magnetic core or the ASIC temperature  $T^\circ < + 150$  °C
- Operating temperature range:  $- 40$  °C  $< T^\circ < + 125$  °C
- Output voltage: full ratiometric (sensitivity and offset)
- High speed transducer.

### Advantages

- Excellent accuracy
- Very good linearity
- Very low thermal offset drift
- Very 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 (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.

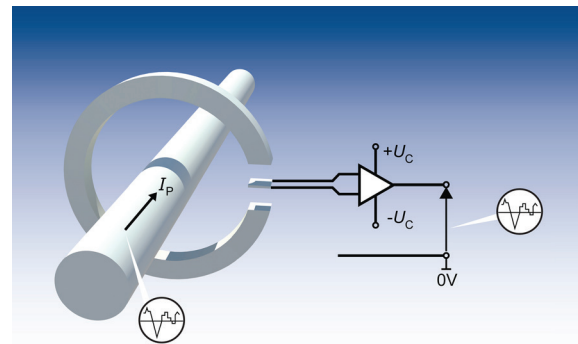
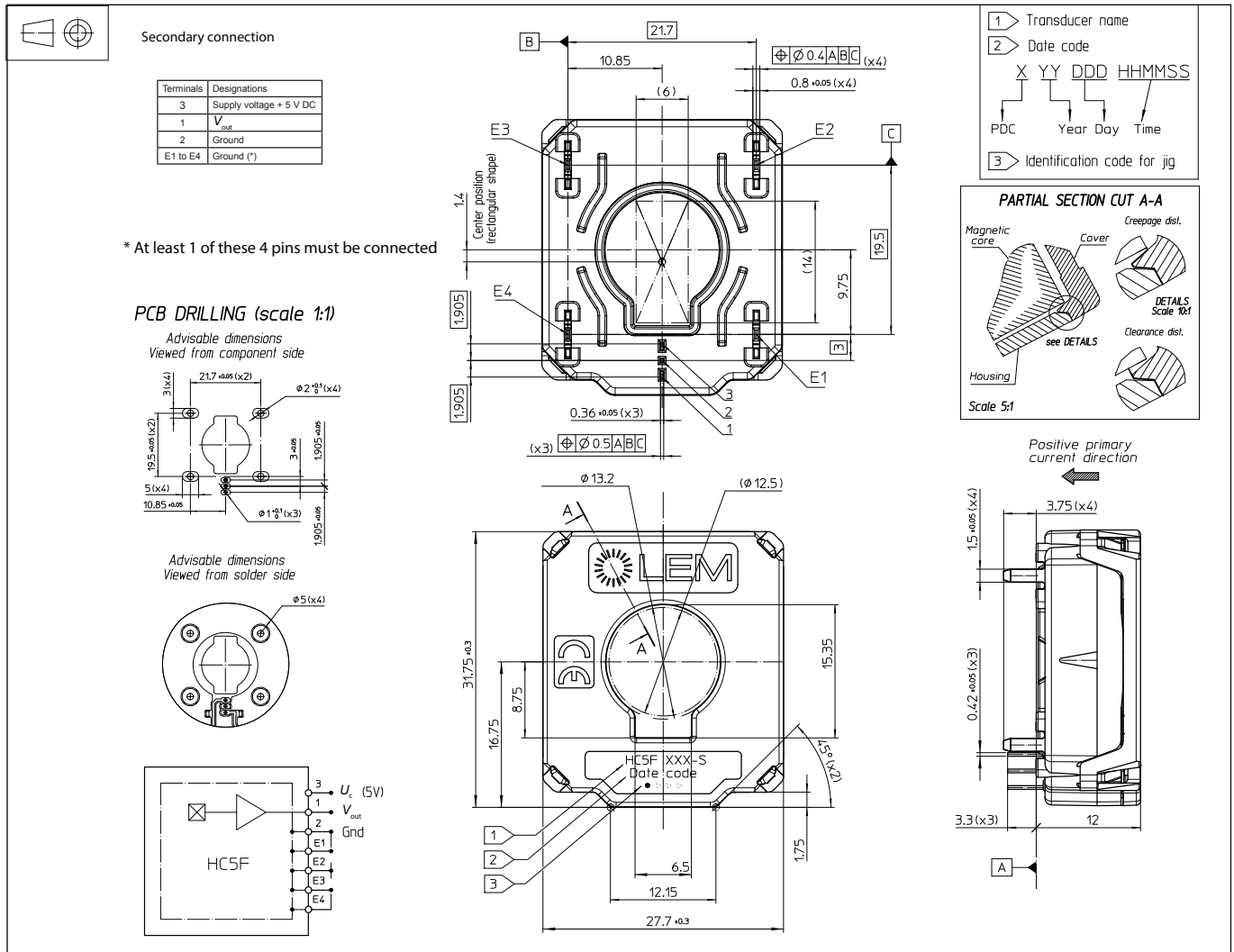


Fig. 1: Principle of the open loop transducer

# HC5F700-S

## Dimensions (in mm)



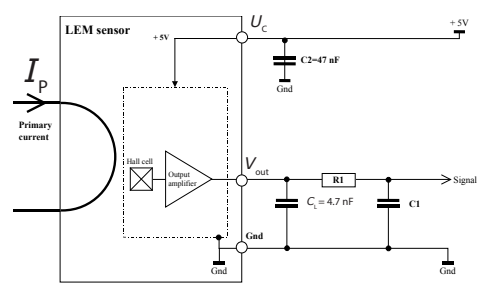
### Mechanical characteristics

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

### Remarks

- $$I_p = \left( \frac{5}{U_c} \cdot V_{out} - V_0 \right) \cdot \frac{1}{G} \text{ with } G \text{ in (V/A)}$$
- $V_{out} > V_0$  when  $I_p$  flows in the positive direction (see arrow on drawing).

### Electronic schematic



- $R_{LOAD} > 10 \text{ K}\Omega$
- $C_{LOAD}$  Nominal value  $4.7 \text{ nF} \pm 10 \%$  ( $C_{LOAD}$  is obligation to stabilize and to avoid the ondulation of the output signal)
- $R1C1$  low pass filter EMC protection (optional)

## Absolute ratings (not operating)

Parameter	Symbol	Unit	Specification			Conditions
			Min	Typical	Max	
Supply over voltage	$U_C$	V			7	No operating, 1 min @ 25°C
Reverse voltage			Not applicable			
Ambient storage temperature	$T_S$	°C	- 55		150	Tested after 64 h @ - 55 °C connected
Electrostatic discharge voltage	$U_{ESD}$	kV			2	JESD22-A 114-B
Maximum admissible vibration (random)	$\gamma$	m·s <sup>-2</sup>			200	ISO 16750-3&4.1.2.1.2.1
Rms voltage for AC insulation test, 50 Hz, 1 min	$U_d$	kV			1.2	IEC 60664 Part 1
Creepage distance	$d_{Cp}$	mm	1.2			
Clearance	$d_{Cl}$	mm	1.65			
Maximum continuous output current	$I_{out}$	mA	- 10		10	
Maximum output voltage	$V_{out}$	V	- 0.5		$U_C + 0.5$	No operating
Maximum Output short circuit duration	$t_c$	s			2	

## Operating characteristics in nominal range ( $I_{PN}$ )

Parameter	Symbol	Unit	Specification			Conditions
			Min	Typical	Max	
<b>Electrical Data</b>						
Primary current, measuring range	$I_{PM}$	A	- 700		700	
Supply voltage <sup>1)</sup>	$U_C$	V	4.75	5.00	5.25	
Ambient operating temperature	$T_A$	°C	- 40		125	
Output voltage (Analog)	$V_{out}$	V	$V_{out} = (U_C/5) \cdot (V_o + G \cdot I_p)$			@ $U_C$
Sensitivity	$G$	mV/A		2.86		@ $U_C = 5 V$
Current consumption	$I_C$	mA		12	20	
Load resistance	$R_L$	KΩ	10			
Capacitive loading	$C_L$	F		4.7		
Output internal resistance	$R_{out}$	Ω			10	
<b>Performance Data <sup>1)</sup></b>						
Sensitivity error	$\epsilon_G$	%	- 2		2	@ $T_A = 25 °C$ , @ $U_C = 5 V$
Electrical offset	$I_{OE}$	A	- 3	± 1.5	3	@ $T_A = 25 °C$
Magnetic offset	$I_{OM}$	A	- 2.2	± 1.5	2.2	@ After excursion to ± $I_p$ @ $T_A = 25 °C$
Offset current	$I_O$	A	- 4		4	$T_A = 25 °C$
Average temperature coefficient of $I_{OE}$	$TCI_{OEAV}$	mA/°C	- 30	± 7	30	@ - 40 °C < $T$ < 125 °C, $U_C$
Average temperature coefficient of $G$	$TCG_{AV}$	%/°C	- 0.050	± 0.025	0.050	@ - 40 °C < $T$ < 125 °C, $U_C$
Linearity error	$\epsilon_L$	% $I_p$	- 1		1	Of full range
Step response time to 90 % $I_{PN}$	$t_r$	µs		5	10	
Frequency bandwidth <sup>2)</sup>	$BW$	kHz	30			@ - 3 dB
Output voltage low	$V_{outL}$	V	0.1			@ $U_C = 5 V$
Output voltage high	$V_{outH}$	V			4.9	@ $U_C = 5 V$
Output voltage noise peak-peak	$V_{no p-p}$	mV			19	DC to 1 MHz
Output rms voltage noise rms	$V_{no rms}$	mV			2.9	DC to 1 MHz

Notes: <sup>1)</sup> 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:

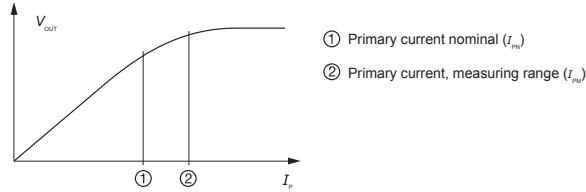
$$I_p = \left( \frac{5}{U_C} \cdot V_{out} - V_o \right) \cdot \frac{1}{G} \text{ with } G \text{ in (V/A)}$$

<sup>2)</sup> 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 amplifier.



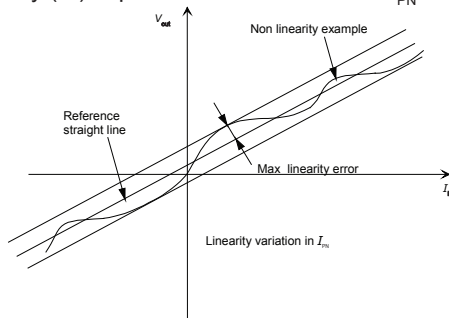
### Magnetic offset:

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

### Linearity:

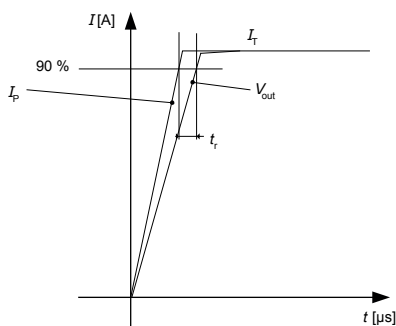
The maximum positive or negative discrepancy with a reference straight line  $V_{out} = f(I_p)$ .

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.



### Typical:

Theoretical 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:

$$V_{out}(I_p) = U_C/5 (G \cdot I_p + V_o)$$

### 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  $U_C/2$  at  $U_C = 5 \text{ V}$ . 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](http://www.lem.com)).

### 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 24 H, 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/s <sup>2</sup> , 22 H/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/s <sup>2</sup> , f = 10 Hz to 1 kHz, PSD = 0.14 to 20 (m/s <sup>2</sup> ) <sup>2</sup> /Hz 12 H/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 insulation test	IEC 60664-1	1.2 kV/50 Hz/1 mn
Insulation resistance	ISO 16750-2& 4.10	500 V DC, 25 °C, R <sub>insulation</sub> > 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