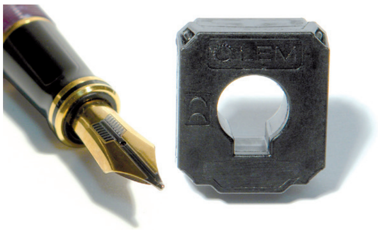
AUTOMOTIVE CURRENT TRANSDUCER OPEN LOOP TECHNOLOGY
HC5F600-S



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 ± 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 ±600 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

- 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.

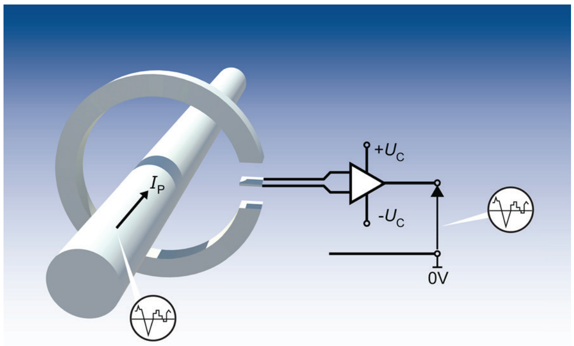
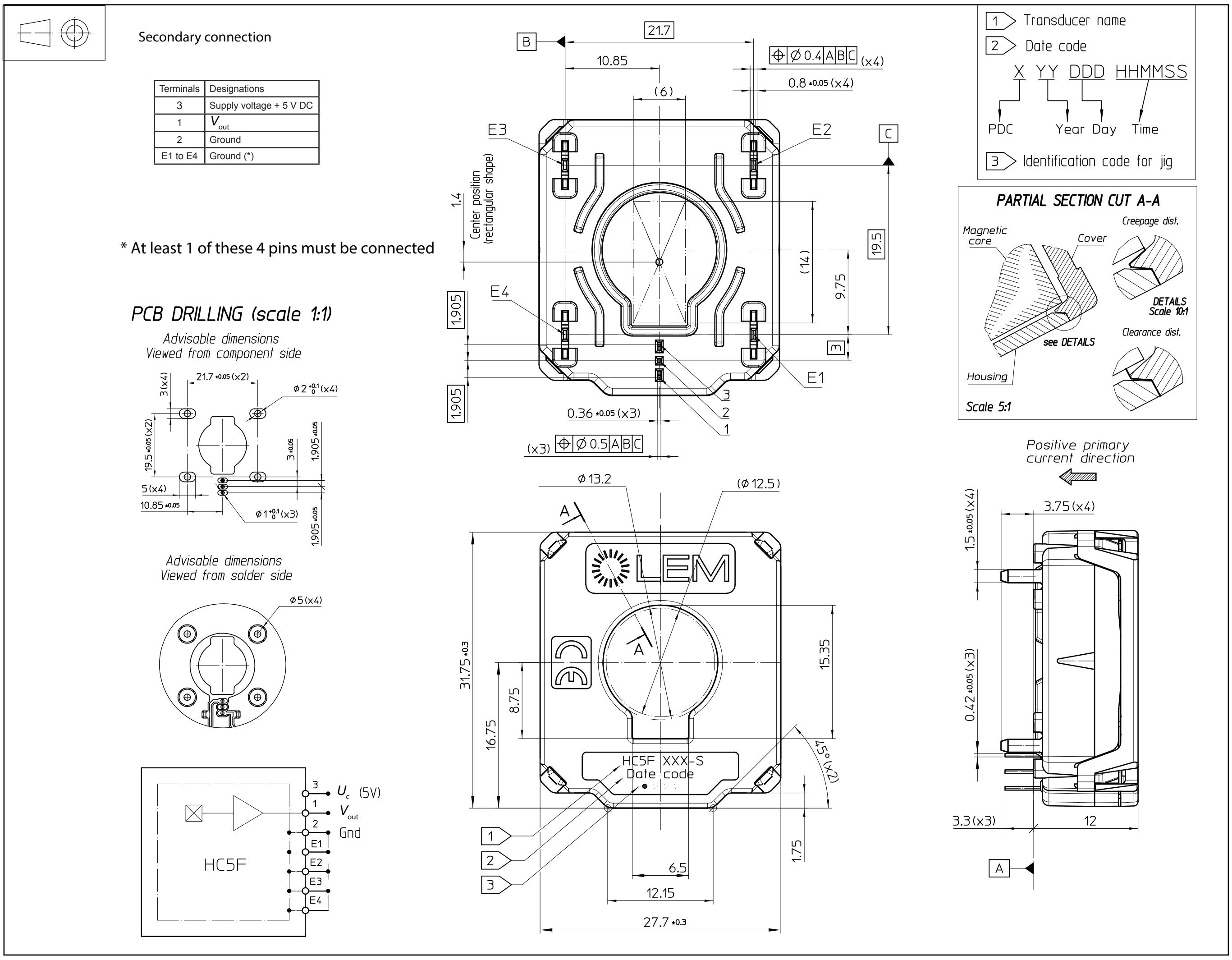


Fig. 1: Principle of the open loop transducer

HC5F600-S

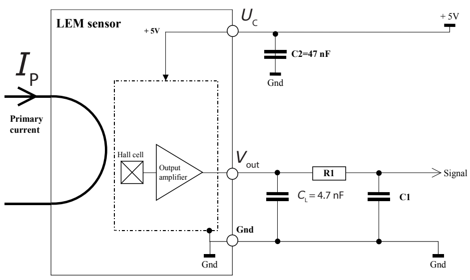
Dimensions (in mm)



Mechanical characteristics

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

Electronic schematic



Remarks

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

- $V_{out} > V_o$ when I_P flows in the positive direction (see arrow on drawing).

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)
$R1C1$ low pass filter EMC protection (optional)

HC5F600-S

Absolute ratings (not operating)

Parameter	Symbol	Unit	Specification Min	Typical	Max	Conditions
Supply over voltage	U_C	V			7	No operating, 1 min @ 25°C
Reverse voltage	U_C	V	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)	γ	m·s^{-2}			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 Min	Typical	Max	Conditions
Electrical Data						
Primary current, measuring range	I_{PM}	A	- 600		600	
Supply voltage [1]	U_C	V	4.75	5.00	5.25	
Ambient operating temperature	T_A	°C	- 40		125	
Output voltage (Analog)	V_{out}	V	$V_{out} = (U_C/5) \cdot (V_o + G \cdot I_P)$			
Sensitivity	G	mV/A		3.33		@ 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	
Performance Data [1]						
Sensitivity error	ε_G	%	- 2		2	@ T_A = 25 °C, @ U_C = 5 V
Electrical offset	I_{OE}	A	- 2.7	± 1.2	2.7	@ T_A = 25 °C
Magnetic offset	I_{OM}	A	- 1.8	± 1.0	1	@ After excursion to ± I_{PM} @ T_A = 25 °C
Offset current	I_O	A	- 3.6		3.6	T_A = 25 °C
Average temperature coefficient of I_{OE}	TCI_{OEAV}	mA/°C	- 24	± 6	24	@ -40 °C < T° < 125 °C, U_C
Average temperature coefficient of G	TCG_{AV}	%/°C	- 0.050	± 0.050	0.050	@ -40 °C < T° < 125 °C, U_C
Linearity error	ε_L	% I_P	- 1		1	Of full range
Step response time to 90 % I_{PN}	t_r	µs		5	10	
Frequency bandwidth [2]	BW	kHz	30			@ - 3 dB
Output voltage low	$V_{out\,L}$	V	0.1			@ U_C = 5 V
Output voltage high	$V_{out\,H}$	V			4.9	@ U_C = 5 V
Output voltage noise peak-peak	$V_{no\,p\text{-}p}$	mV			22	DC to 1 MHz
Output rms voltage noise rms	$V_{no\,rms}$	mV			3.3	DC to 1 MHz

Notes: [1] 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:

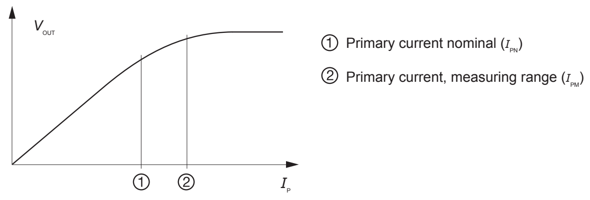
$$I_P = \left(\frac{5}{U_C} \cdot V_{out} - V_O\right) \cdot \frac{1}{G} \quad \text{with } G \text{ in (V/A)}$$

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

LEM reserves the right to carry out modifications on its transducers, in order to improve them, without prior notice

PERFORMANCES PARAMETERS DEFINITIONS

Primary current definition:



Definition of typical, minimum and maximum values:

Minimum and maximum values for specified limiting and safety conditions have to be understood as such as values shown in "typical" graphs. On the other hand, measured values are part of a statistical distribution that can be specified by an interval with upper and lower limits and a probability for measured values to lie within this interval. Unless otherwise stated (e.g. "100 % tested"), the LEM definition for such intervals designated with "min" and "max" is that the probability for values of samples to lie in this interval is 99.73 %. For a normal (Gaussian) distribution, this corresponds to an interval between -3 sigma and +3 sigma. If "typical" values are not obviously mean or average values, those values are defined to delimit intervals with a probability of 68.27 %, corresponding to an interval between -sigma and +sigma for a normal distribution. Typical, maximal and minimal values are determined during the initial characterization of a product.

Output noise voltage:

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

Magnetic offset:

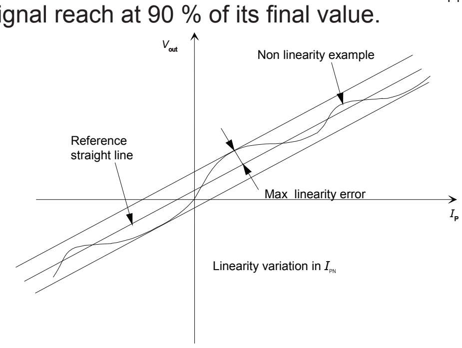
The magnetic offset is the consequence of an over-current on the primary side. It's defined after an excursion of I_{PN}.

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.

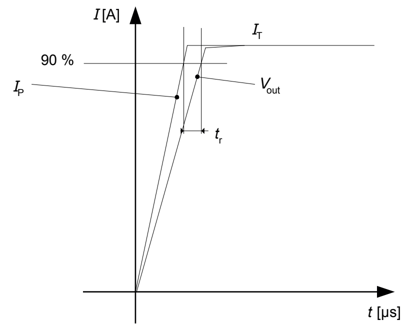


Sensitivity:

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:

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

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 detailed 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 zero. 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:

Refer to LEM GROUP test plan laboratory CO.11.11.515.0 with "Tracking_Test Plan_Auto" sheet.

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