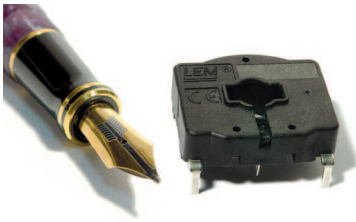# AUTOMOTIVE CURRENT TRANSDUCER
HC6F300-S

Introduction

The HC6F 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 HC6F family gives you the choice of having different current measuring ranges 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 from 200 A up to 800 A
- Maximum rms primary current limited by the busbar, 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)
- Compact design for PCB mounting.

Advantages

- Excellent accuracy
- Very good linearity
- Very low thermal offset drift
- Very low thermal gain drift
- Wide frequency bandwidth
- No insertion losses
- Very good ratio size/current range.

Automotive applications

- Starter Generators
- Converters
- Inverters
- Drives.

Principle of HC6F 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 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:

$$B \; (I_P) = \text{constant (a)} \times I_P$$

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:

$$V_H = \text{constant (b)} \times I_P$$

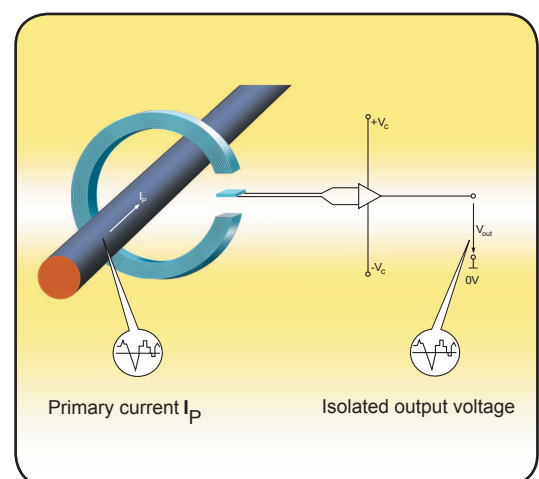The measurement signal V_H amplified to supply the user output voltage or current.

Fig. 1: Principle of the open loop transducer

HC6F300-S

Dimensions HC6F xxx-S family (in mm. 1mm = 0.0394 inch)

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

① Transducer name:
HC6Fxxx-S
(xxx= Current Range)

② Date code

1 Y DDD HHMM

Production center → Year → Day → Time
1= Geneva

Molding
Date stamp
Cavity number
Plastic material
Modification index
A (See version table)

E1   E2
E4   E3

SPS GF 30

25.4
12.7
1.5 ±0.05 (x4)
0.36 ±0.05 (x3)

Connection

+5V

3
1 — OUT
2 Gnd
E1
E2
E3
E4

HC6F-S

Current flow direction

01A

10 ±0.2
3.8 (x4)
0.8 ±0.05 (x4)
0.42 ±0.05 (x3)
1.905
25.4
12.7
5
1.905
3.3 (x3)

10.5 +0.3/0
4.2 +0.3/0
25.75
∅ 7.5 +0.3/0
14.75
29.5
12.5

① ②

Injection point
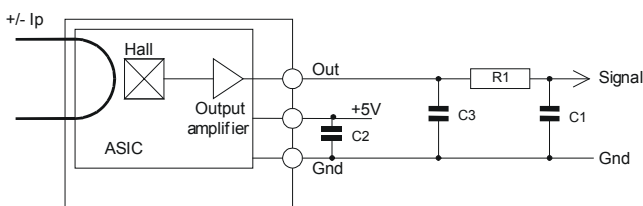
Bill of materials

- Plastic case   SPS GF 30
- Magnetic core   FeSi alloy
- Pins   Copper alloy tin platted (lead free)
- Mass   23 g

Remarks

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

Electronic schematic

+/- Ip

Hall

Output amplifier

ASIC

Out
+5V
C2
Gnd
C3
R1
C1
Signal
Gnd

Power supply decoupling capacitor: C2 = 47 nF
EMC protection capacitor   C3 = 4.7 nF

Optional:

High frequency signal noise filter:

R1 > 100 Ω

C1 = defined according to the system frequency bandwidth

HC6F300-S

Absolute maximum ratings (not operating)

Parameter	Symbol	Unit	Specification	Conditions
Maximun peak primary current (not operating)	$I_{P\,max}$	A	Defined by busbar to have T° ≤ 150°C	
Primary nominal DC or current rms	I_{PN}	A	Defined by busbar to have T° ≤ 150°C	
Maximun supply voltage (not operating)	$V_{C\,max}$	V	7	
Secondary maximum admissible power	$P_{S\,max}$	mW	150	
Ambient operating temperature	T_A	°C	- 40 < T_A < 125°C	
Ambient storage temperature	T_S	°C	- 55 < T_S < 125°C	see page 5/5
Electrostatic discharge voltage	V_{ESD}	V	2000	see page 5/5
Maximum admissible vibration	γ	m.s^{-2}	100	see page 5/5
Rms voltage for AC isolation test 50 Hz, 1 min	V_d	V	2000	

Operating characteristics

	Symbol	Unit	Specification			Conditions
			Min	Typical	Max	
Electrical Data						
Primary current, measuring range	I_{PM}	A	-300	-	300	@ - 40°C < T° < 125°C
Supply voltage [2]	V_C	V	4.75	5	5.25	@ - 40°C < T° < 125°C
Output voltage (Analog)	V_{OUT}	V	$V_{OUT} = V_C/5 \times (2.5 + 0.0067 \times I_P)$			@ - 40°C < T° < 125°C
Sensitivity	G	V/A	0.0066	0.0067	0.0068	@ T_A = 25°C
Offset voltage	V_O	V	2.471	2.5	2.529	@ V_C = 5 V; T_A = 25°C; I_P = 0 A
Current consumption	I_C	mA	-	15	20	@ - 40°C < T° < 125°C; 4.75 V < V_C < 5.25 V
Load resistance	R_L	KΩ	2	-	-	
Output internal resistance	R_{OUT}	Ω	-	-	10	
Performance Data [1]						
Sensitivity error	ε_G	%	-2.0	±0.7	2.0	@ T_A = 25°C, V_C = 5 V; Gth = 0.0067
Electrical offset	I_{OE}	A	-1.9	±0.7	1.9	@ V_C = 5 V; T_A = 25°C
	V_{OE}	mV	-12.7	±4.7	12.7	
Magnetic offset	I_{OM}	A	-2.4	±1.5	2.4	@ After excursion to ± I_P; T_A = 25°C
	V_{OM}	mV	-16	±10	16	
Temperature coefficient of	TCI_{OE}	mA/°C	-21	12	+21	@ - 40°C < T° < 125°C; V_C = 5 V
	TCV_{OE}	mV/°C	-0.14	±0.08	0.14	
Temperature coefficient of **G**	TCG	%/°C	-0.04	±0.02	0.04	@ - 40°C < T° < 125°C; V_C = 5 V
Linearity error	ε_L	% I_P	-1.0	±0.5	1.0	@ I_P; V_C = 5 V, T_A = 25°C
Response time	t_r	µs	-	8	15	@ di/dt = 50 A/µs; I_T = 200 A
Frequency bandwidth [3]	**BW**	kHz	20	-	-	@ -3 dB; I_T = 40 A rms
Output voltage noise peak-peak	$V_{no\,p-p}$	mV	-	20	25	@ T_A = 25°C; 0 Hz < f < 1 MHz
Output voltage noise rms	$V_{no\,rms}$	mV	-	3	4	@ T_A = 25°C; 0 Hz < f < 1 MHz

Note: [1] Minimum and maximum values are specified after one operating T° cycle.

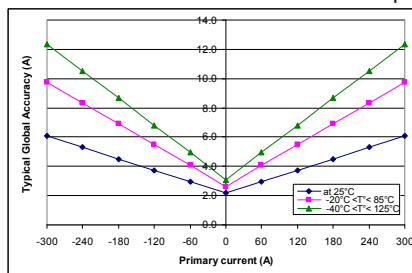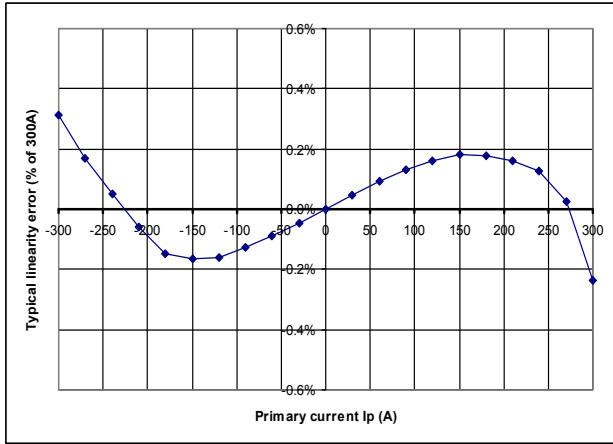*Fig. 2: Typical accuracy versus primary current across temperature*

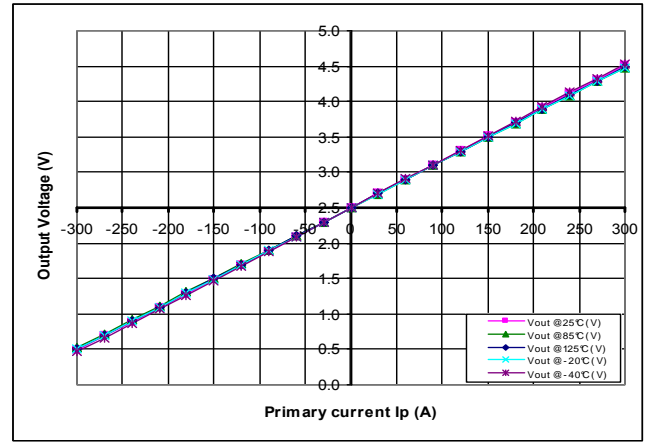*Fig.3: Typical linearity versus primary current at T° = 25°C*

Fig. 2: Typical output voltage versus primary current across temperature
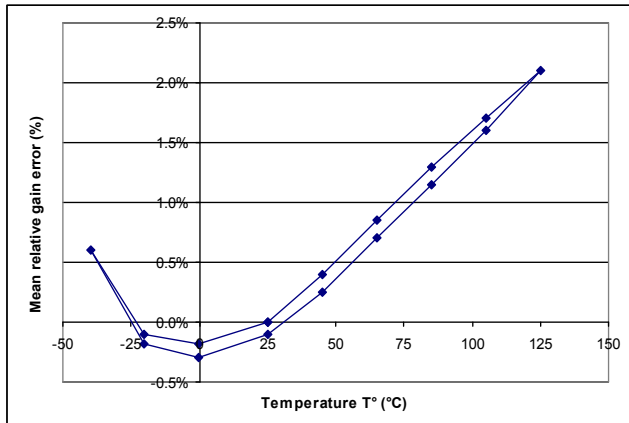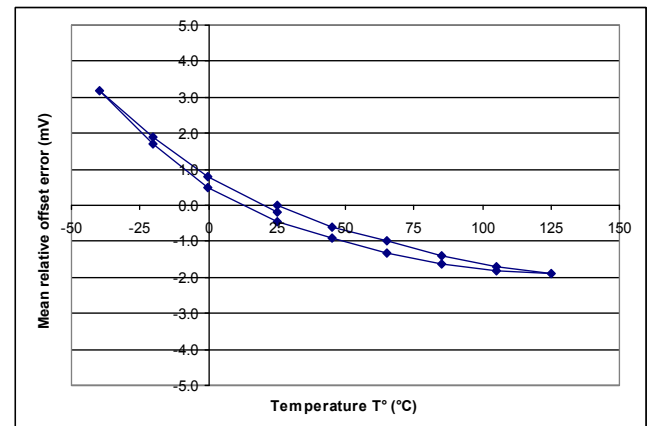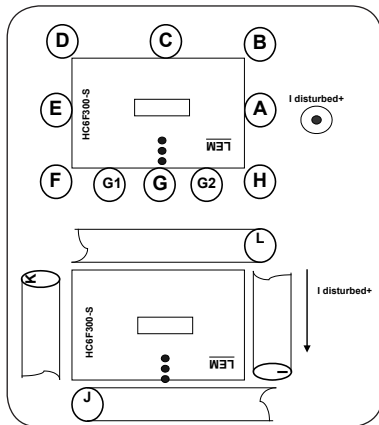

Fig 5: Typical gain error versus temperature

Fig. 6: Typical offset error versus temperature
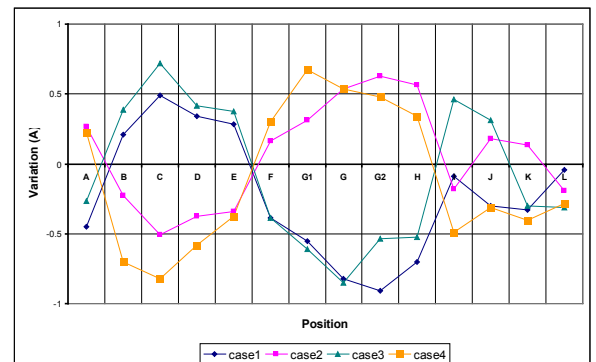
Influence of the external magnetic field

Test conditions:

- tranducers sample: HC6F300-S
- diameter of the disturbing conductor: 6 mm
- dimension of the primary busbar: 6 x 2 x 200 mm
- tested at ambient temperature

Currents levels

	CASE 1	CASE 2	CASE 3	CASE 4
I disturbant	+ 200 A	-200 A	+ 200 A	-200 A
I primary	0 A	0 A	+ 200 A	+ 200 A

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HC6F300-S
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 $I_{P\ max}$.
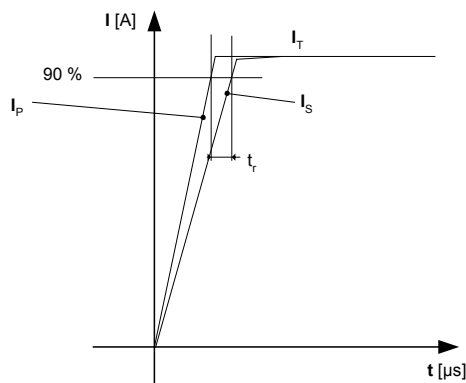
Linearity:

The maximum positive or negative discrepancy with a reference straight line $V_{OUT} = f(I_P)$.
Unit: linearity (%) expressed with full scale of $I_{P\ max}$.
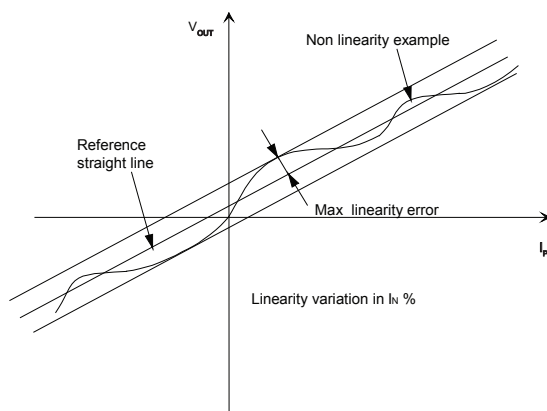
Response time (delay time) t_r:

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

(*) 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:
$I_{OT} = I_{OE}\ max - I_{OE}\ min$
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 at 25°C.
The sensitivity drift TCG_{AV} is the 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 V_O is $V_C/2$ at $V_C = 5$ V. So, the difference of $V_O - V_C/2$ 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
Low T° storage		T° - 55°C / 64 H not connected
Thermal shocks	IEC 60068 Part 2-14	T° - 30°C to 110°C /1000 cycles not connected
Low T°operation at min supply voltage	IEC 60068 Part 2-1	T° - 40°C / 1000 H supply voltage = 4.75 V
High T° operation at max supply voltage	IEC 60068 Part 2-2	T° 125°C / 1000 H supply voltage = 5.25 V
Temperature humidity bias	IEC 60068 Part 2-3	T° 90°C / 95 % RH/ 1000 H supply voltage = 5.25 V
Mechanical Tests		
Vibration	IEC 60068 Part 2-64	Room T°, acceleration 100 m/s2, frequency 20 to 500 Hz/96 H each axis
Drop test	IEC 60068 Part 2-29	Height 750 mm concrete floor each directions
EMC Test		
Electrostatic discharge	JESD22-A114-B	Applied voltage = ± 2 kV pin to pin number of discharge = 1

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