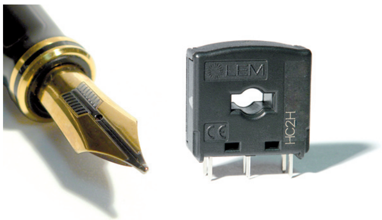
# AUTOMOTIVE CURRENT TRANSDUCER
# HC2H250-S CLIPS



## Introduction

The HC2H CLIPS 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 HC2H CLIPS 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 80 A up to 250 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 (in sensitivity and offset)
- Compact design for PCB mounting.

## Advantages

- Excellent accuracy
- Very good linearity
- Very low thermal offset drift
- Very low thermal sensitivity drift
- Wide frequency bandwidth
- No insertion losses.

## Automotive applications

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

## Principle of HC2H CLIPS 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:

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

The Hall voltage is thus expressed by:

$$\mathbf{V_H} = (\mathbf{R_H}/d) \times \mathbf{I} \times \text{constant (a)} \times \mathbf{I_P}$$

Except for $I_P$, 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.

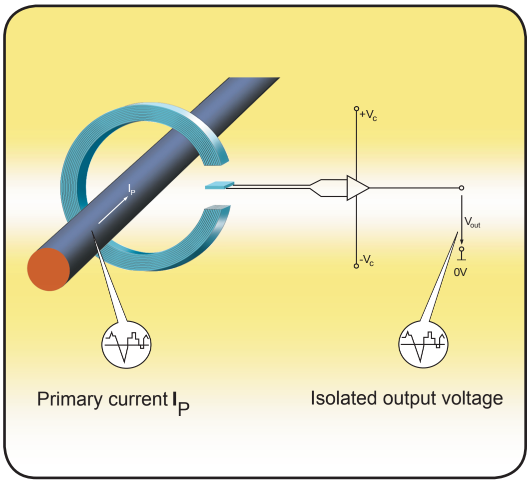



Fig. 1: Principle of the open loop transducer

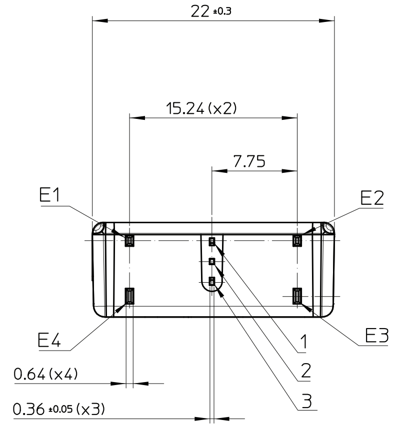
# HC2H250-S CLIPS

## Dimensions HC2H250-S CLIPS family (in mm. 1mm = 0.0394 inch)

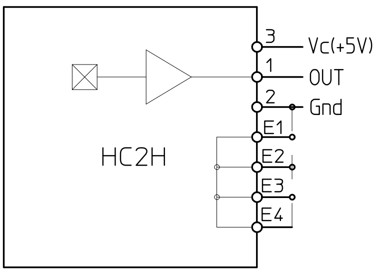
### Secondary connection

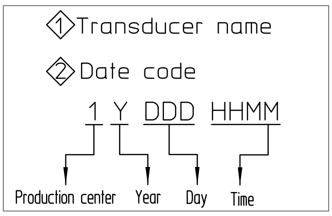
| Terminals | Designations |
|---|---|
| 3 | Supply voltage + 5 V DC |
| 1 | $V_{OUT}$ |
| 2 | Ground |
| E1 to E4 | Ground (*) |

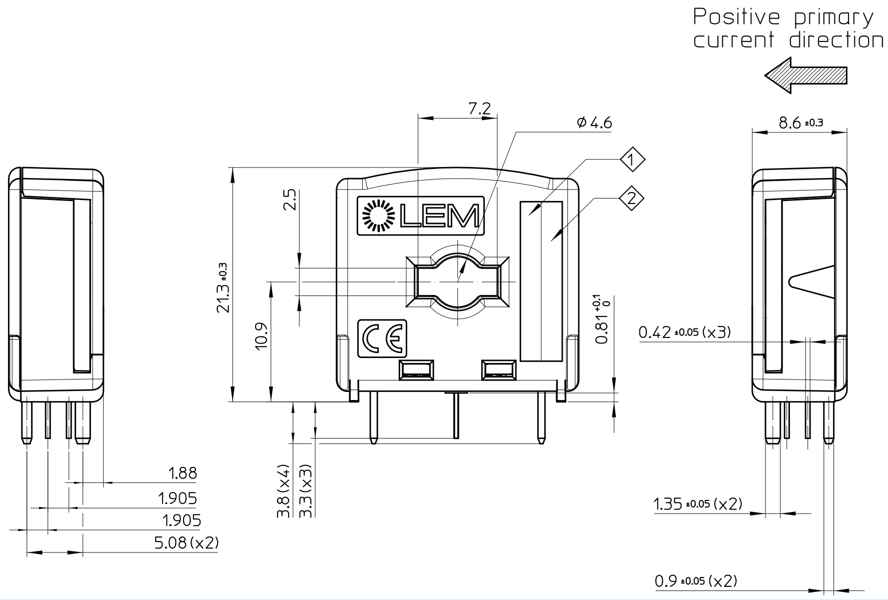
(*) Only 1 of these 4 pins could be connected




### Connection



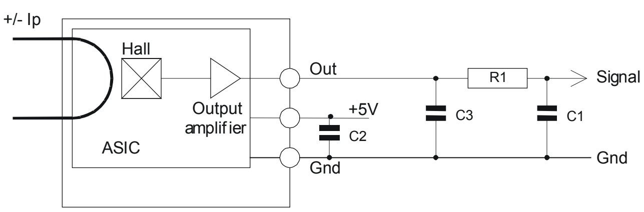

### Bill of materials

- Plastic case — PBT GF 30
- Magnetic core — FeSi alloy
- Pins — Copper alloy tin platted (lead free)
- Mass — 7.5.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




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

# HC2H250-S CLIPS

## Absolute maximum ratings (not operating)

| Parameter | Symbol | Unit | Specification | Conditions |
|---|---|---|---|---|
| Maximum 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 | |
| Maximum 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 | $-40 < T_S < 125$°C | |
| Electrostatic discharge voltage | $V_{ESD}$ | V | 2000 | see page 4/4 |
| Maximum admissible vibration | $\gamma$ | $m.s^{-2}$ | 100 | see page 4/4 |
| Rms voltage for AC isolation test | $V_d$ | V | 2000 | |

## Operating characteristics

| Parameter | Symbol | Unit | Specification | | | Conditions |
|---|---|---|---|---|---|---|
| | | | Min | Typical | Max | |
| **Electrical Data** | | | | | | |
| Primary current, measuring range | $I_{PM}$ | A | -250 | | 250 | @ - 40°C < T° < 125°C |
| Supply voltage [1] | $V_C$ | V | 4.75 | 5.00 | 5.25 | @ - 40°C < T° < 125°C |
| Output voltage (Analog) [1] | $V_{out}$ | V | $V_{OUT} = (V_C/5) \times (2.5 + 0.008 \times I_P)$ | | | @ - 40°C < T° < 125°C |
| Sensitivity [1] | G | V/A | 0.0078 | 0.008 | 0.0082 | @ $T_A$ = 25°C; $V_C$ = 5 V |
| Offset voltage [1] | $V_O$ | V | 2.477 | 2.5 | 2.523 | @ $V_C$ = 5 V; $T_A$ = 25°C; $I_P$ = 0 A |
| Current consumption | $I_C$ | mA | - | 13.5 | 17 | @ - 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 | $\varepsilon_G$ | % | -2.0 | ± 0.7 | 2.0 | @ $T_A$ = 25°C, $V_C$ = 5 V; Gth = 0.008 V/A |
| Electrical offset | $I_{OE}$ | A | -1.5 | ± 0.63 | 1.5 | @ $V_C$ = 5 V; $T_A$ = 25°C |
| | $V_{OE}$ | mV | -12 | ± 5 | 12 | |
| Magnetic offset | $I_{OM}$ | A | -1.4 | ± 0.9 | 1.4 | @ After excursion to ± $I_P$; $T_A$ = 25°C |
| | $V_{OM}$ | mV | -11.2 | ± 7.2 | 11.2 | |
| Temperature coefficient of $I_{OE}$ | $TCI_{OEAV}$ | mA/°C | -15.0 | ± 6.3 | 15.0 | @ - 40°C < T° < 125°C; $V_C$ = 5 V |
| Temperature coefficient of $V_{OE}$ | $TCV_{OEAV}$ | mV/°C | -0.12 | ± 0.05 | 0.12 | |
| Temperature coefficient of G | $TCG_{AV}$ | %/°C | -0.04 | ± 0.02 | 0.04 | @ - 40°C < T° < 125°C; $V_C$ = 5 V |
| Linearity error | $\varepsilon_L$ | % $I_P$ | -1.5 | ± 0.8 | 1.5 | @ $I_P$; $V_C$ = 5 V, $T_A$ = 25°C |
| Response time | $t_r$ | µs | - | 15 | 20 | @ di/dt = 50 A/µs; $I_T$ = 100 A |
| Frequency bandwidth [2] | BW | kHz | 20 | - | - | @ -3 dB; $I_T$ = 40 A rms |
| Phase shift | $\Delta\varphi$ | ° | - | - | TBD | |
| Output voltage noise peak-peak | $V_{no\,p\text{-}p}$ | mV | - | 13 | 18 | @ $T_A$ = 25°C; 0 Hz < f < 1 MHz |
| Output voltage noise rms | $V_{no\,rms}$ | mV | - | 1.5 | 3 | @ $T_A$ = 25°C; 0 Hz < f < 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 excessives heatings of the busbar, the magnetic core and the ASIC.

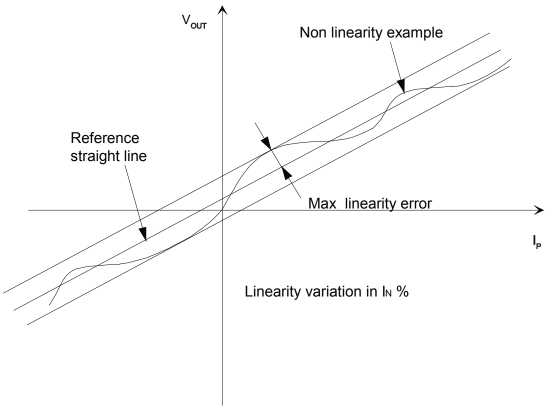
# HC2H250-S CLIPS

## PERFORMANCES PARAMETERS DEFINITIONS

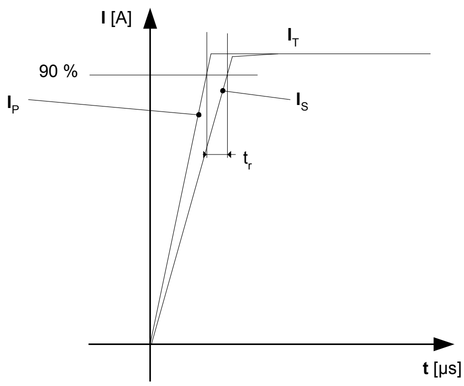
### Output noise voltage:
The output voltage noise is the result of the noise floor of the Hall elements and the linear $I_C$ amplifier gain.

### 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** x $I_P$ + 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 |
|---|---|---|
| Thermal shocks | IEC 60068 Part 2-14 | T° - 40°C to 125°C /500 cycles not connected |
| Temperature humidity bias | JESD 22-A101 | T° 85°C / 85 % RH/ 1000 H |
| **Mechanical Tests** | | |
| Vibration | IEC 60068 Part 2-64 | Room T°, Acceleration 100m/s2, frequency 20 to 500 Hz / 96 H each axis |
| Drop test | ISO 16750-3 & 4.3 | Height 1 m, 3 axis, 2 directions per axis, concrete floor |
| **EMC Test** | | |
| Electrostatic discharge | JESD22-A114-B | Applied voltage = ± 2 kV pin to pin number of discharge = 1 |
| Rms voltage for AC isolation test | ISO 16750-2 (labo) | 2 kV, 50 Hz, 1 min |
| Bulk current injected-radiated immunity | ISO 11452 Part 4 | |