# AUTOMOTIVE CURRENT TRANSDUCER
# HAB 120-V/SP5

## Introduction

The HABxxx−V Family is for the electronic measurement of DC, AC or pulsed currents in high power automotive applications with galvanic isolation between the primary circuit (high power) and the secondary circuit (electronic circuit).

The HABxxx−V family gives you the choice of having different current measuring ranges in the same housing (from ± 20 A up to ±120 A).

## Features

- Open Loop transducer using the Hall effect
- Unipolar +5 V DC power supply
- Primary current measuring range up to ±120 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.

## Special features

- HAB 120-V/SP5 replace the HAB 120-V (obsolete) and improve performance with LEM8 ASIC

## Advantages

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

## Automotive applications

- Battery monitoring
- Starter Generators
- Inverters
- HEV application
- EV applications.

## Principle of HABxxx−V 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:

$$B\,(I_P) = a \times I_P$$

The Hall voltage is thus expressed by:

$$V_H = (c_H / d) \times I_H \times a \times I_P$$

Except for $I_P$, all terms of this equation are constant.
Therefore:

$$V_H = b \times I_P$$

| | |
|---|---|
| $a$ | constant |
| $b$ | constant |
| $c_H$ | Hall coefficient |
| $d$ | thickness of the Hall plate |
| $I_H$ | current across the Hall plates |

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

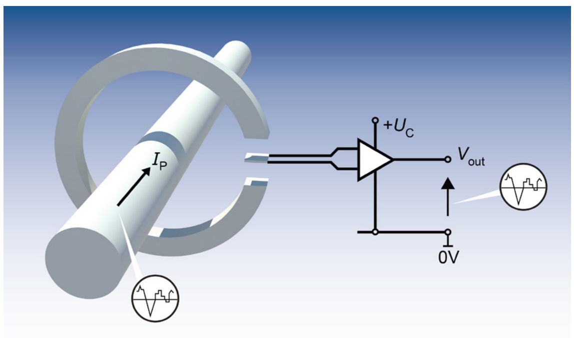
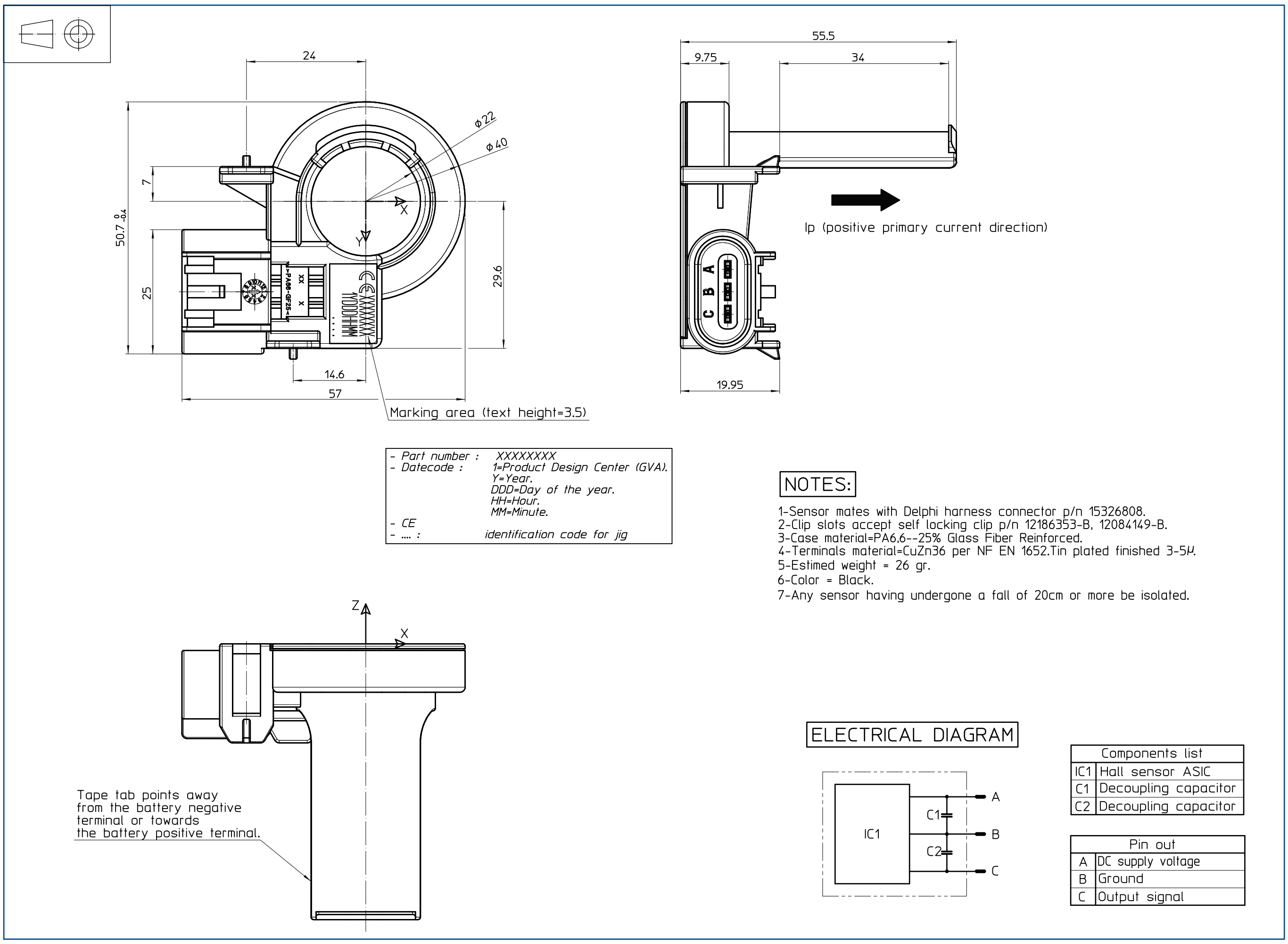
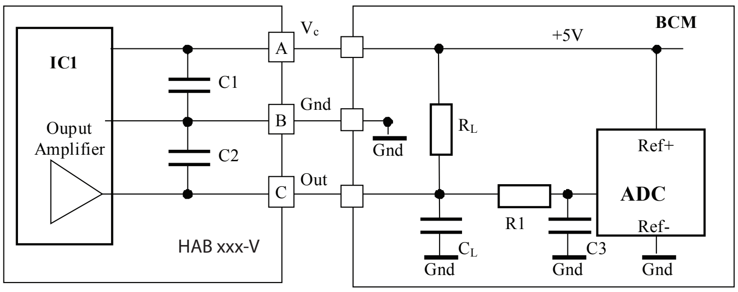



Fig. 1: Principle of the open loop transducer.

## Dimensions HABxxx−V family (in mm.)




### System artitecture




| HAB120-V/SP5 components | |
|---|---|
| IC1 | Hall sensor ASIC |
| C1 | Capacitor |
| C2 | Capacitor |

| BCM components | |
|---|---|
| $R_L$ | Load Resistor |
| $C_L$ | Load Capacitor |
| R1 | Optional High impedance protection |
| C3 | Optional Filtering Capacitor |

## Absolute maximum ratings (not operating)

| Parameter | Symbol | Unit | Specification Min | Specification Typical | Specification Max | Conditions |
|---|---|---|---|---|---|---|
| **Electrical Data** | | | | | | |
| Supply continuous over voltage | $U_C$ | V | | | 8.5 | |
| Supply over voltage | $U_C$ | V | | | 14 | 1 min |
| Reverse voltage | $U_C$ | V | −14 | | | 1 min @ $T_A$ = 25°C |
| Output over voltage (continuous) | $V_{out}$ | V | | | 8.5 | |
| Output over voltage | $V_{out}$ | V | | | 14 | 1 min @ $T_A$ = 25°C |
| Output current (continuous) | $I_{out}$ | mA | −10 | | 10 | |
| Output short−circuit duration | $T_c$ | min | | | 2 | |
| Rms voltage isolation test | $V_d$ | kV | | | 2 | IEC 60664−1 |
| Electrostatic discharge voltage | $V_{ESD}$ | kV | | | 2 | IEC 61000−4−2 |
| Ambiant storage temperature | $T_S$ | °C | − 40 | | 125 | |

## Operating characteristic

| Parameter | Symbol | Unit | Specification Min | Specification Typical | Specification Max | Conditions |
|---|---|---|---|---|---|---|
| **Electrical Data** | | | | | | |
| Primary current | $I_P$ | A | −120 | | 120 | |
| Calibration current | $I_{CAL}$ | | −60 | | 60 | @ $T_A$ = 25 °C |
| Supply voltage | $U_C$ | V | 4.5 | 5.00 | 5.5 | |
| Output voltage [1] | $V_{out}$ | V | $V_{OUT} = U_C/5$ X (2.5 +0.017 X $I_P$ ) | | | @ $U_C$ |
| Sensitivity [1] | $G$ | mV/A | | 17.00 | | @ $U_C$ = 5 V |
| Current consumption | $I_C$ | mA | | 7 | 10 | @ $U_C$ = 5 V, − 40 °C < $T_A$ < 125 °C |
| Power up inrush current [2] | $I_C$ | mA | | | 15 | @ $U_C$ < 3.5 V |
| Load resistance | $R_L$ | kΩ | 10 | | | |
| Ouput internal resistance | $R_{OUT}$ | Ω | | | 10 | |
| Capacitive loading | $C_L$ | nF | 1 | | 100 | |
| Ambiant operating temperature | $T_A$ | °C | − 40 | | 125 | |
| Output drift versus power supply | | % | | 0.5 | | |
| Frequency bandwidth [2] | $BW$ | Hz | | 80 | | @ −3 dB |
| Output clamping voltage min | $V_{SZ}$ | V | 0.2 | 0.25 | 0.3 | @ $U_C$ = 5 V |
| Output clamping voltage max | $V_{SZ}$ | V | 4.7 | 4.75 | 4.8 | @ $U_C$ = 5 V |
| Peak-to-peak noise voltage | $V_{no\ pp}$ | mV | | | 10 | |
| Resolution | | mV | | 2.5 | | @ $U_C$ = 5 V |
| Start-up time | $t_s$ | ms | | 25 | 110 | |
| Setting time after over load | | ms | | | 25 | |

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; [2] During the power up phase.

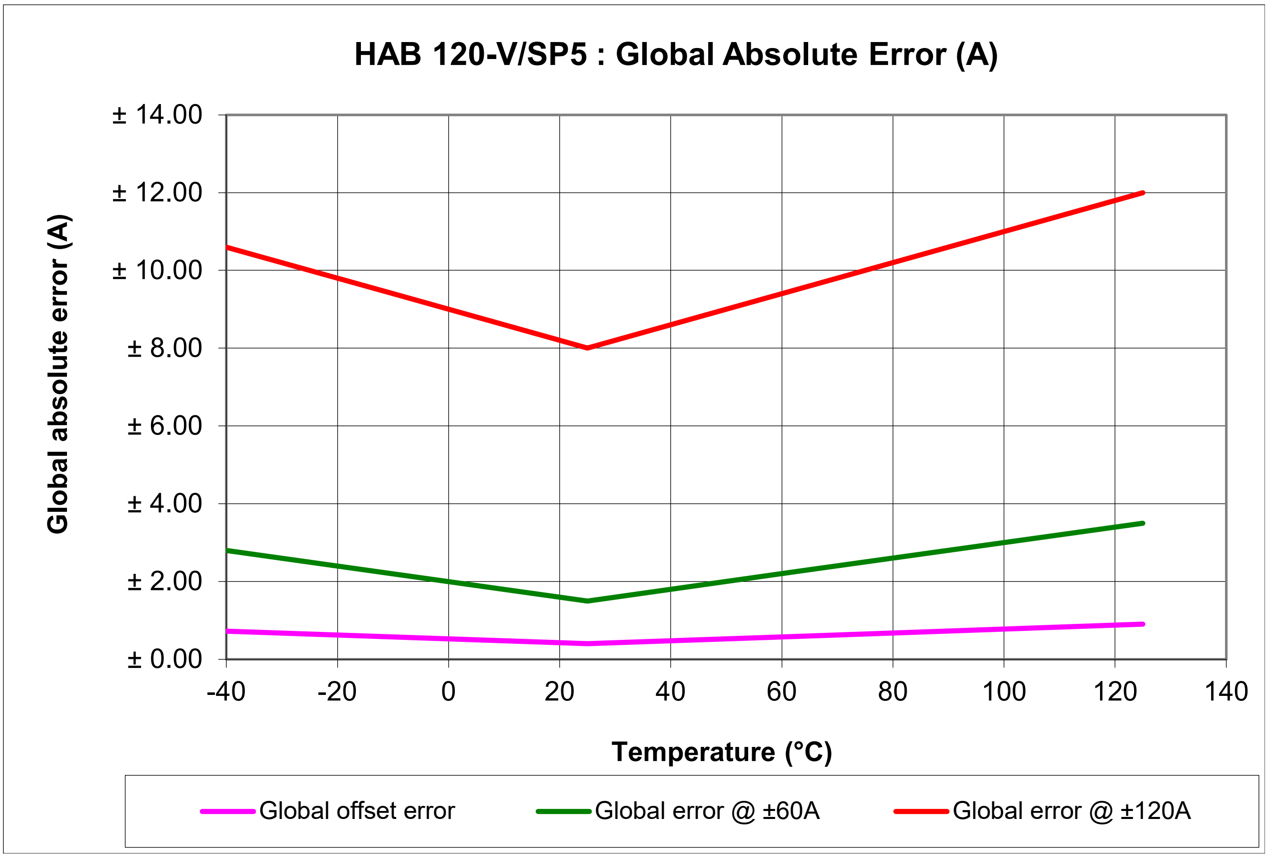
$$I_P = \left(\frac{5}{U_C} \times V_{out} - V_O\right) \times \frac{1}{G} \text{ with } G \text{ in (V/A)}$$

## Accuracy

| Parameter | Symbol | Unit | Specification | | | Conditions |
|---|---|---|---|---|---|---|
| | | | Min | Typ | Max | |
| Electrical Data | | | | | | |
| Electrical offset current | $I_{OE}$ | A | | ±0.20 | | @ $T_A$ = 25 °C, @ $V_C$ = 5 V |
| Magnetic offset current | $I_{OM}$ | A | | ±0.05 | | @ $T_A$ = 25 °C, @ $V_C$ = 5 V, after ± $I_P$ |
| Global offset current | $I_O$ | A | −0.4 | | 0.4 | @ $T_A$ = 25 °C, @ $V_C$ = 5 V |
| | | | −0.6 | | 0.6 | @ $U_C$ = 5 V, −10 °C < $T_A$ < 65 °C |
| | | | −0.9 | | 0.9 | @ $U_C$ = 5 V, −40 °C < $T_A$ < 125 °C |
| Sensitivity error | $\varepsilon_G$ | % | | ±0.3 | | @ $T_A$ = 25 °C , $I_P$ = ±60 A |
| | | | | ±1.0 | | @ −10°C < $T$ < 65 °C, $I_P$ = ±60 A |
| | | | | ±2.0 | | @ −40°C < $T$ < 125 °C, $I_P$ = ±60 A |
| Linearity error up to 60A | $\varepsilon_L$ | % | | ±0.2 | | of full range |
| Linearity error up to 80A | | | | ±1.0 | | |
| Linearity error up to 120A | | | | ±2.5 | | |

## Global Absolute Error (A)

| | Global Absolute Error (A) | | | | |
|---|---|---|---|---|---|
| Temperature | −40 °C | −10 °C | 25 °C | 65 °C | 125 °C |
| Global Offset Error | ±0.73 | ±0.58 | ±0.40 | ±0.60 | ±0.90 |
| Global Error @ ±60A | ±2.80 | ±2.20 | ±1.50 | ±2.30 | ±3.50 |
| Global Error @ ±120A | ±10.60 | ±9.40 | ±8.00 | ±9.60 | ±12.00 |

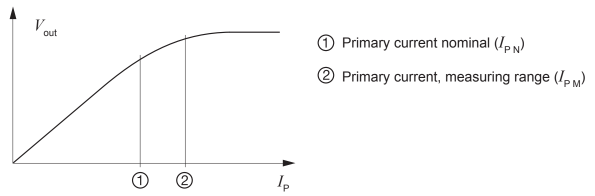




# PERFORMANCES PARAMETERS DEFINITIONS

## 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, minimum and maximum values are determined during the initial characterization of a product.

## Output noise voltage:

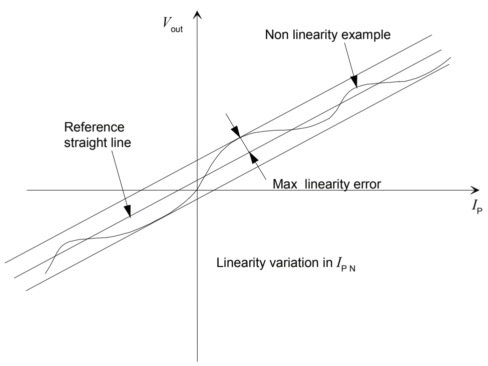
The output voltage noise is the result of the noise floor of the Hall elements and the linear amplifier.

## Magnetic offset:

The magnetic offset is the consequence of an any current on the primary side. It's defined after a stated excursion of primary current.

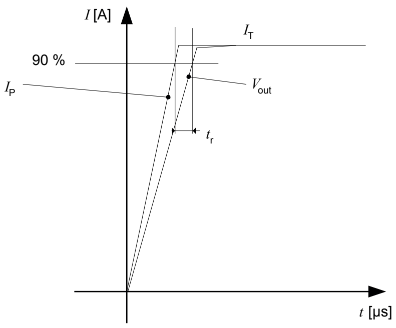
## Linearity:

The maximum positive or negative discrepancy with a reference straight line $V_{out} = f(I_P)$.
Unit: linearity (%) expressed with full scale of $I_{P N}$.




## Response time (delay time) $t_r$:

The time between the primary current signal ($I_{P N}$) 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:

$$V_{out}(I_P) = U_C/5\ (G \times I_P + V_O)$$

## 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 $I_{O\,T}$ is a maximum variation the offset in the temperature range:

$$I_{O\,T} = I_{O\,E}\ \text{max} - I_{O\,E}\ \text{min}$$

The offset drift $TCI_{O\,E\,AV}$ is the $I_{O\,T}$ 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 $U_C/2$. 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.