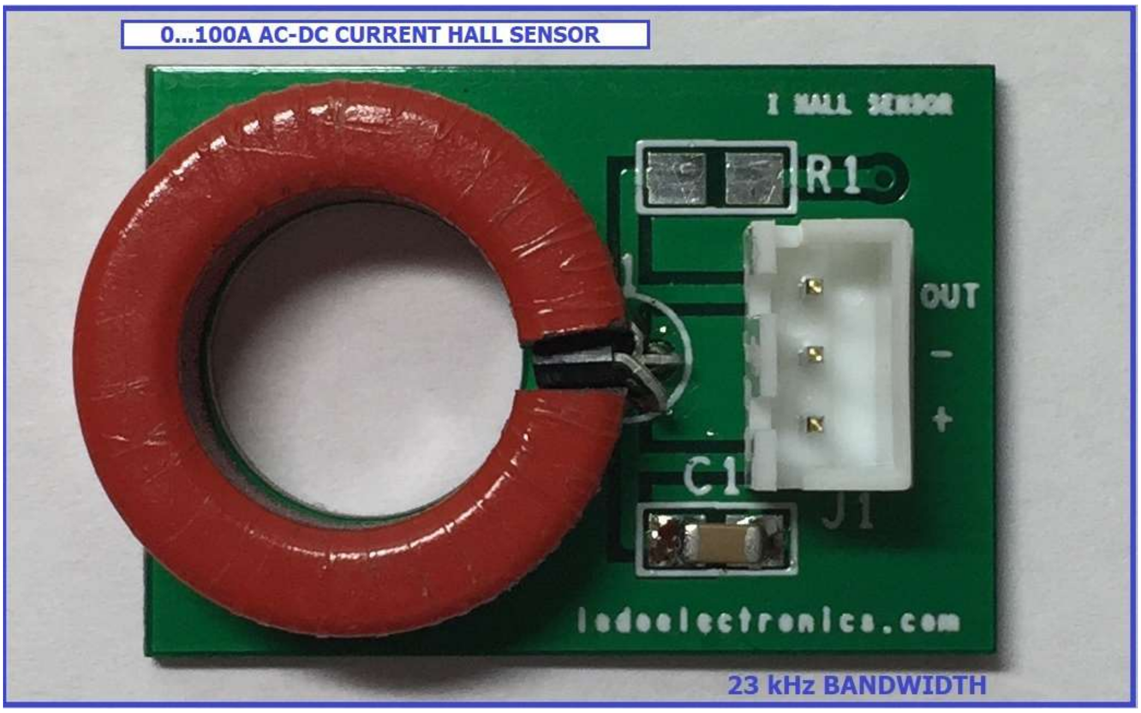
Le-H100B CURRENT HALL DETECTOR



- **4.5V to 6.0V Operation**
- **AC / DC. 0 to 23 kHz Flat Response**
- **Linear Voltage Output**

Hall current sensor, based on standard Hall effect IC with linear or discrete output such as UGN3503, SS49E, SS494 etc. they are very cheap and easy to buy.

The magnetic field of a conductor with current, according to Ampere's law, is perpendicular to the direction of current, and its density can be calculated by the formula:

$B = (\mu_0 . I) / 2\pi R;$ (1)

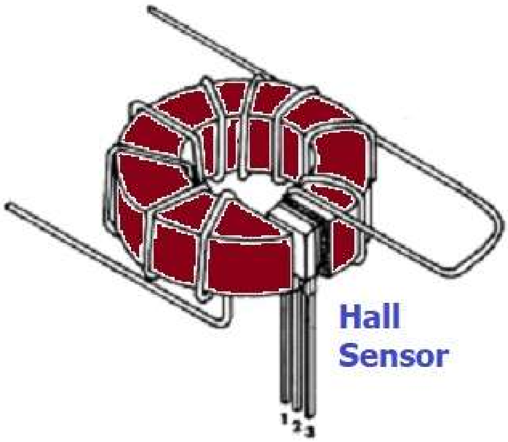
Where B is the modulus of the magnetic induction vector in Tesla,

$\mu_0 = 4\pi . 10^{-7}$ is the magnetic constant of the vacuum, I is the current in Ampers, R the radius in meters. The distance between the measurement point and the center of the live conductor.

For a current of 50A, we will have a density of 10 gauss at a distance of 10 mm. The Hall detector chips that we can buy in the market require 400… 1000 gauss to operate at maximum resolution.

These chips could be used to measure currents greater than 500A, placing them as close as possible to the live conductor or bus, with the proper orientation taking into account that the field vector is perpendicular to the direction of the current.

If we want to measure small currents, we have to amplify the magnetic field by using air-gaped core.



Sensitivity now depends on several factors, and we can adapt to any current value, acting on the number of turns, the length of the air gap, or the dimensions and material of the core according to the following formula:

$$B = \frac{I.N}{\left(\frac{Lm}{\mu_r.\mu_0} + \frac{Lg}{\mu_0}\right)}; \qquad (2)$$

Where

B is the module of the magnetic induction vector in Tesla,

$\mu_0 = 4\pi.10^{-7}$ is the magnetic constant of the vacuum,

I is the current in Amps,

$N-$ is the number of turns,

μ_{r-} Relative permeability of core material,

L_m – Magnetic lines length, M,

L_g – Airgap length, M

Example:

Let's calculate the system with the following data:

Toroide 22x14x8

μ_{r-} 125

N = 1;

I = 300A

L_g – 4 *mm* ($4.10^{-3}M$)

We calculate the length of the magnetic lines for the selected toroid:

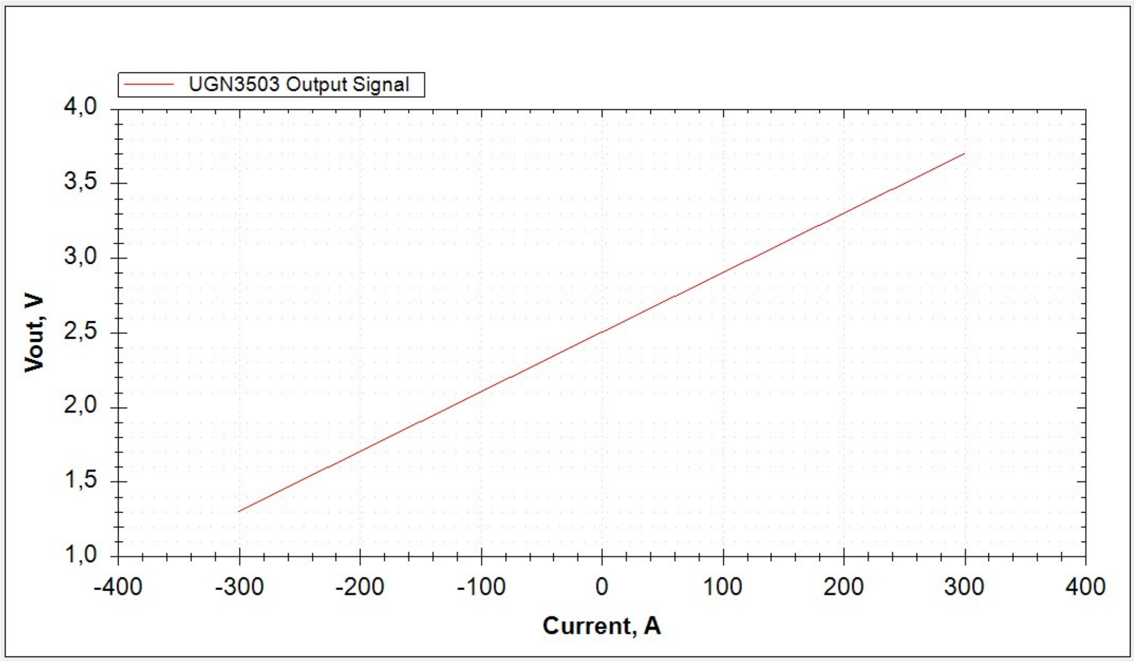
$$L_m = \frac{\pi.(D+d)}{2} = \frac{\pi.(22+1\ \ ).10^{-3}}{2} = 56.52.10^{-3}\ M;$$

Substituting all data in (2) we obtain:

$$B = 0.0847\ T = 847\ gauss\ ;$$

With the above data, and using a UGN3503 chip, we can implement a 300A current sensor, capable of measuring both direct current and alternating current, up to a frequency of 23 kHz.

If we use a 5V voltage to power the UGN3503, the output signal will be 2.5V in the absence of current. It will vary linearly depending on the value of the cable current passing through the toroid, increasing if the current is positive and decreasing if it is negative, as shown in the graph below.



The sensitivity of the current detector, designed using this methodology, can be easily modified, acting on any of the values that intervene in formula (2), the length of the air gap and the number of turns being the most influential. Hall detector IC with higher sensitivity can also be selected.

This method is also valid for the design of current relays, which can be used as protection elements. In this case, it is only necessary to replace the IC with one with a discrete output.

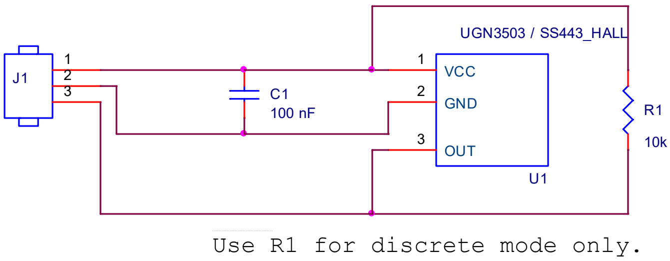


Fig.6. Current Hall Sensor Schematics.

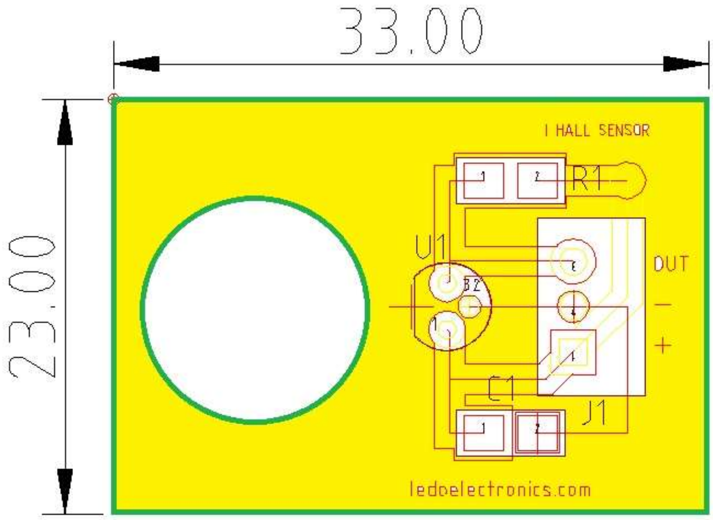


Fig.8. Current Sensor PCB Layout.

Conclusions:

The use of three-pin Hall detector ICs to measure current is a very comfortable and attractive option to be implemented in power converters and other circuits, either as a linear measurement element or as a discrete protection element. Its cost is slightly higher than that of a current transformer, but it has the following advantages:

1. It can measure alternating and direct current.

2. The presence of the air gap prevents saturation of the core.

3. Its output can be linear or discrete.

4. No danger of over voltage.

5. The insulation is as good or better than that of a transformer.

6. Lower volume and weight for low frequencies.

Bibliografía.

1. *ACS723 Allegro Microsystems Datasheet.*
2. *ACS770 Alegro Microsystems Datasheets.*
3. *Rozemblat M.A. "Магнитные элементы автоматики и методики расчета".*