CURRENT SENSORS

REFERENCE DESIGN GUIDE

Application Note

This document describes several reference designs for current sensing applications with either conventional or planar IMC-Hall® sensors. The design solutions cover various current ranges (from 2 to 2000A) and conductor types (bus bar, PCB, cable). Also included is a quick selection guide for Melexis Hall effect current sensors, general magnetic design guidelines and information on ferromagnetic materials.

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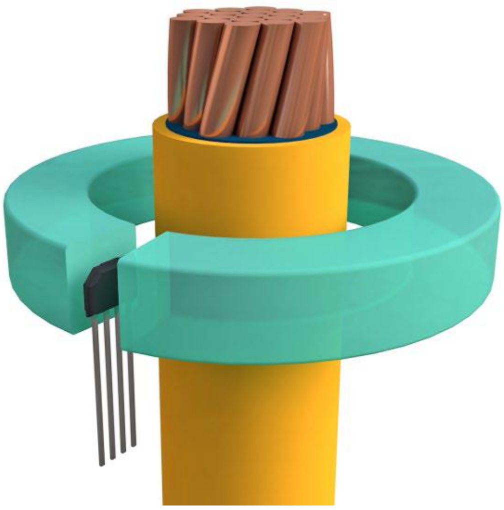
Current sensor types

Melexis provides three types of current sensors suitable for a broad range of applications.

○ Conventional Hall sensors

These current sensors are sensitive to the magnetic field **perpendicular** to the chip surface. They are meant to be used in combination with a ferromagnetic core. In a typical application, the core is wrapped around the current-carrying conductor and concentrates the magnetic flux on a small air gap (typically 2-5mm) where the sensor is inserted.



Pros

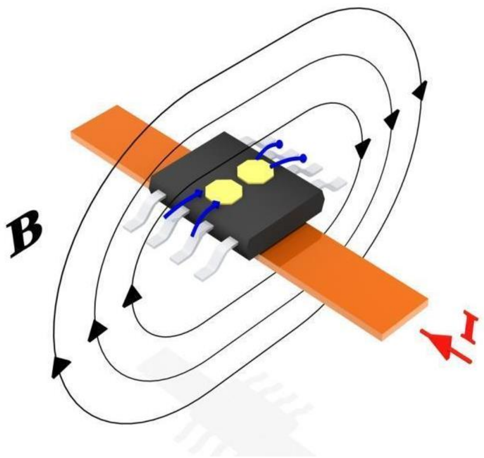
- Strong magnetic gain from the core
- Very robust against cross-talk
- Suitable for medium to very high currents

Cons

- Performance limited by the core (geometry and material): saturation, hysteresis, frequency response and thermal drift
- Bigger footprint (size, weight) than solutions based on IMC-Hall® sensors

○ Planar IMC-Hall® sensors

Thanks to the patented integrated magnetic concentrator (IMC) technology, IMC-Hall® sensors are sensitive to magnetic fields **parallel** to the chip surface. Thus, the sensors can directly measure the current flowing in a bus bar or a PCB trace below the package, without the need for a core.

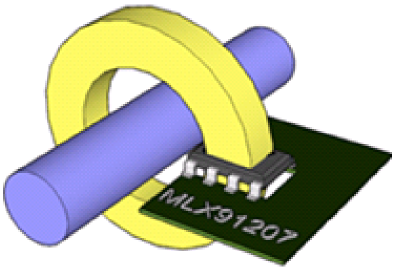


Pros

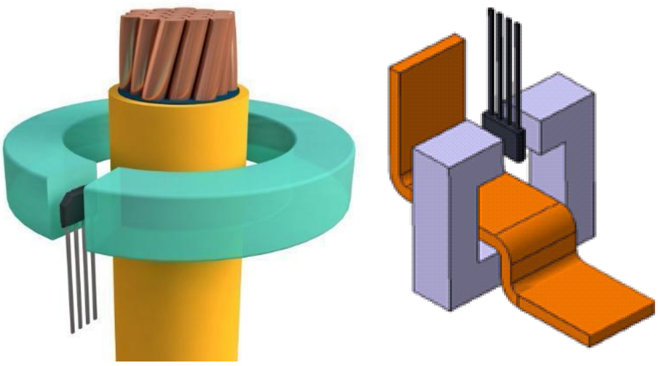
- Sensitive to magnetic field parallel to the chip surface, for easy integration and low footprint
- IMC is made of amorphous magnetic material featuring very high permeability and very low hysteresis
- Magnetic gain from IMC

Cons

- Requires magnetic shielding or specific design to avoid cross-talk and/or noise from external fields



1 Conventional Hall Sensors



1.1 Introduction

Conventional hall sensors are typically enclosed in the air gap of a ferromagnetic core (ring or square), wrapped around the current-carrying conductor.

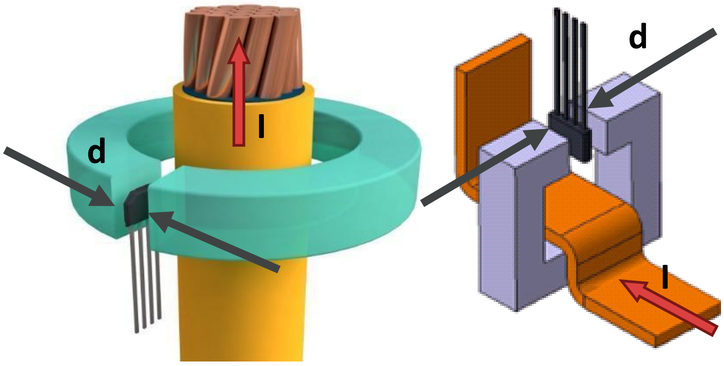


Figure 1: Example of mounting of conventional hall sensors.

The magnetic field B at the sensor position (in the center of the air gap), for a current I and a ferromagnetic core with air gap d, can be approximated as:

$$B\ [mT] = 1.25 \times \frac{I\ [A]}{d\ [mm]}$$

Equation 1: Magnetic field estimation formula for core configuration.

The naming convention for ferromagnetic cores is C followed by the air gap dimension (for instance, C5 for a 5mm air gap shield).

1.1.1 Development kit

A development kit (DVK) can be bought from distributors, including PCBs, sensors and cores with standard dimensions. Figure 2 shows the Conventional Hall Core DVK. Table 1 shows possible combinations between maximum currents, cores dimensions and sensors.

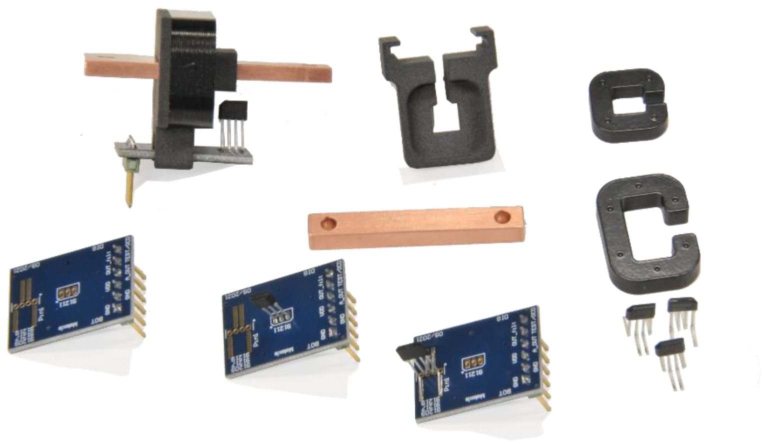


Figure 2: Development kit for conventional hall sensors

Table 1: Possible configurations with development kit.

Core dimensions	C2.5	C5	C8
Maximum Current	266 A	160 A	852 A
Magnetic field	133 mT	40 mT	133 mT
Sensor	MLX91219LVA-AAA-502	MLX91209LVA-CAA-000	MLX91219LVA-AAA-502

1.2 Quick Selection Guide

Melexis provides a list of sensors that can be selected for different applications. Each sensor can be bought with a factory trimmed sensitivity, using a specific option code. Sensitivity can be tuned according to customer needs.

1.2.1 Main features (typical)

	91209	91217	91219
Sensitivity [mV/mT] *	5-150	5-150	7-150
Thermal sensitivity drift [%S] **	±1.5	±1	±1
Thermal offset drift [mV]	±10	±5	±5
Non-linearity [%F.S.]	±0.4	±0.4	±0.3
Response time [µs]	2	2	2
Bandwidth [kHz]	250	250	400
Noise [mV_{rms}]	10	10	3
Analog output	Yes	Yes	Yes
PWM output	No	No	No
Programmable	Yes	Yes	Yes
Diagnostic functions			
▪ Over/Under-voltage detection	Yes	Yes	No
▪ Broken-track detection	No	Yes	No
▪ Clamping	No	Yes	No
▪ Over Current Detection	No	No	Yes
Possible supply voltages [V]	5	5	5, 3.3
Package	VA (SIP)	SIP4-VA	SOIC-8/SIP4-VA
Operating temperature range [°C]	-40-150	-40-150	-40-150

Table 2: Main features and specifications of conventional Hall effect current sensors, at operating temperature T = -40°C to 125°C, unless otherwise specified.

** Programmable.*

*** Thermal sensitivity drift is better for temperatures lower than 100°C.*

1.2.2 Option code and sensitivity

Sensor	Option code	Sensitivity range (typical) [mV/mT]
MLX91209	CAA-000	5-150 (50)
	CAA-001	5-150 (15)
	CAA-002	5-150 (7.3)
	CAA-003	5-150 (19)
MLX91217	ACA-000	5-150 (10)
	ACA-001	5-150 (15)
	ACA-002	5-150 (17)
	ACA-003	5-150 (9)
	ACA-005	5-150 (13)
MLX91219	AAA-500	7-105 (7)
	AAA-501	7-105 (10)

Table 3: Option code and sensitivity range of conventional Hall effect current sensors. Please contact the Melexis sales department to have customized versions. Different leads bending options are also available.

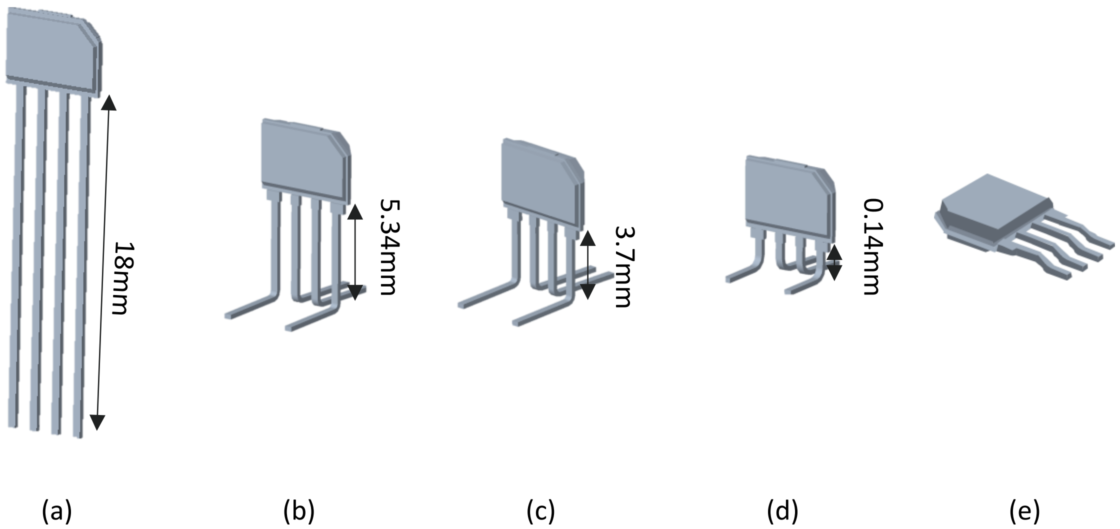
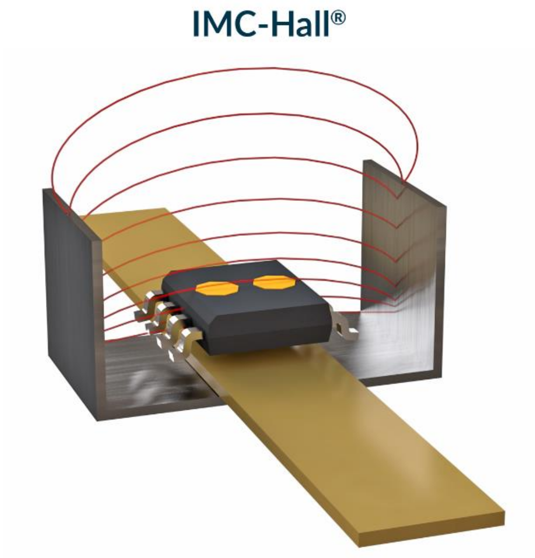
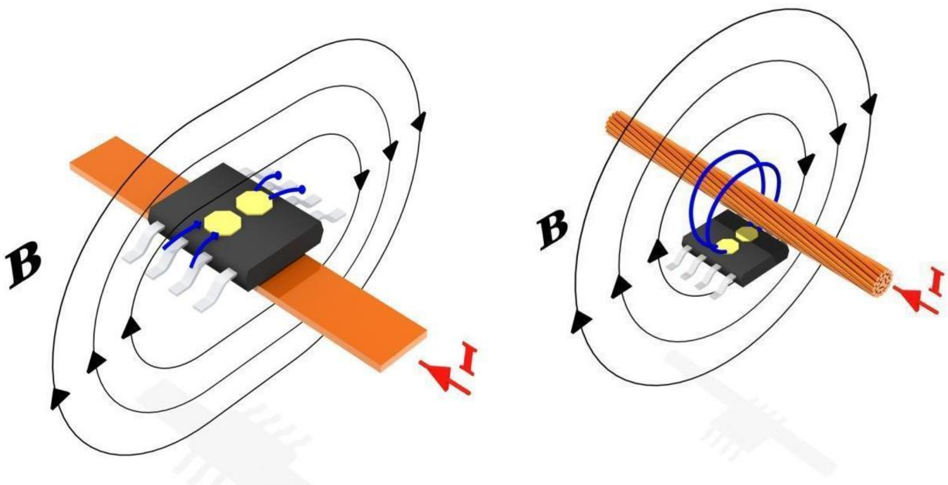


Figure 3: Different leads bending options: (a) straight leads, (b, c, d) bent leads, (e) and planar leads.



2 Planar IMC-Hall® Sensors



2.1 IMC versions

IMC-Hall® sensors are available in 4 different versions/sizes covering a broad range of sensitivities and magnetic field ranges: Low Field (LF), High Field (HF), Very High Field (VHF), Extra High Field (XHF). With its strong magnetic gain, the biggest IMC (LF) is ideally suited for applications with low currents, requiring high magnetic sensitivities (up to 700mV/mT). At the other end of the scale, the smallest IMC (XHF) can linearly sense strong magnetic fields up to ±90mT, for current sensing applications with very high-power densities.

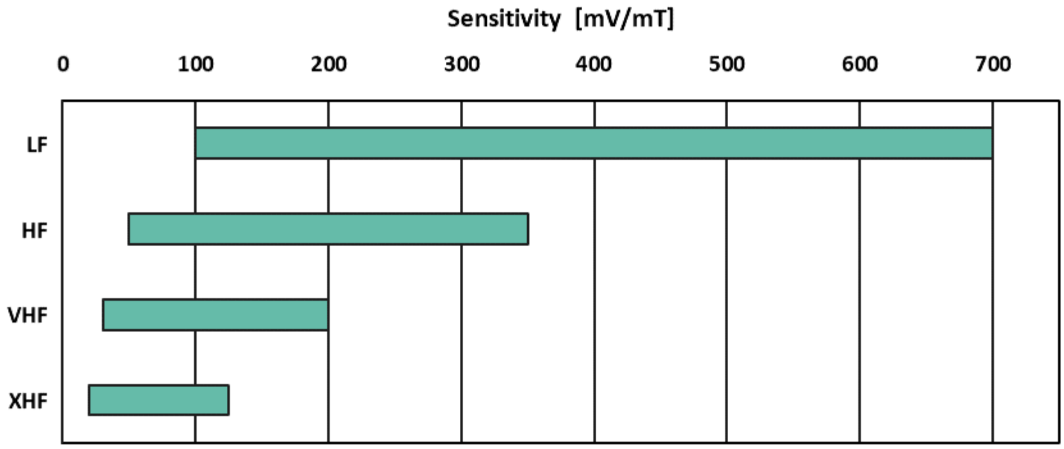


Figure 4: Sensitivity range of each IMC version.

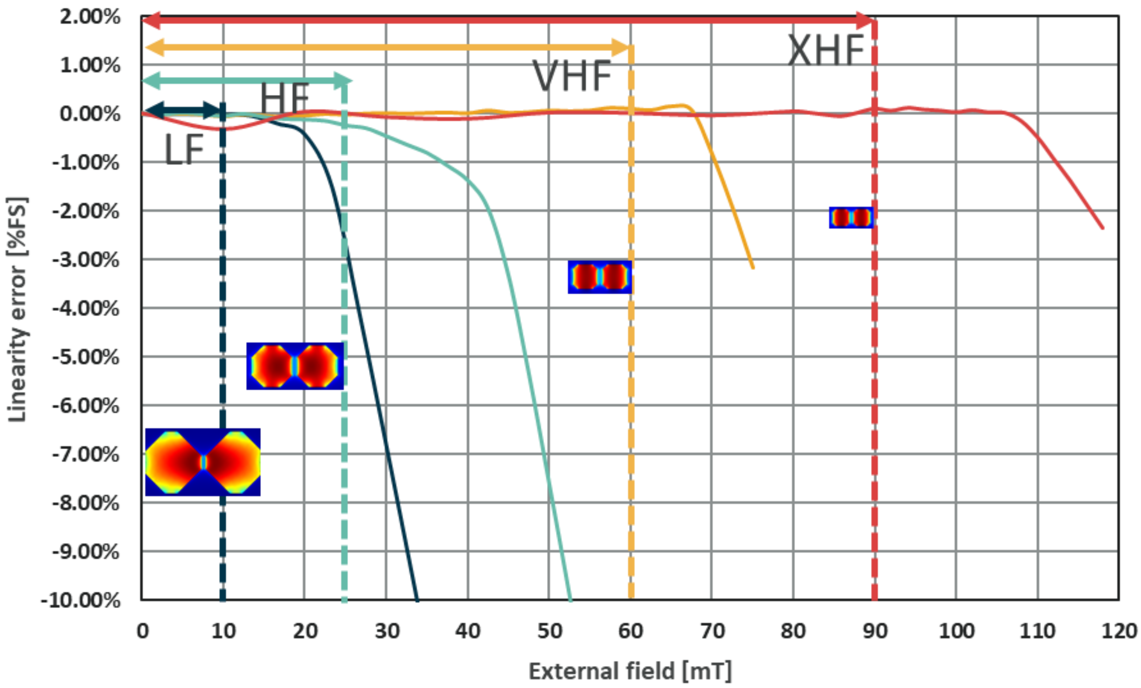


Figure 5: Linearity range for different IMC configurations.

<table>
<tr><th>Shield</th><th colspan="22">Current [A]</th></tr>
<tr><th>width [mm]</th><th>100</th><th>200</th><th>300</th><th>400</th><th>500</th><th>600</th><th>700</th><th>800</th><th>900</th><th>1000</th><th>1100</th><th>1200</th><th>1300</th><th>1400</th><th>1500</th><th>1600</th><th>1700</th><th>1800</th><th>1900</th><th>2000</th><th>3000</th><th>4000</th></tr>
<tr><td>25</td><td colspan="2">LF</td><td colspan="4">HF</td><td colspan="6">VHF</td><td>XHF</td><td colspan="6">OCR</td><td colspan="3">SAT</td></tr>
<tr><td>20</td><td>LF</td><td colspan="3">HF</td><td colspan="5">VHF</td><td colspan="3">XHF</td><td colspan="6">OCR</td><td colspan="4">SAT</td></tr>
<tr><td>15</td><td>LF</td><td colspan="2">HF</td><td colspan="4">VHF</td><td colspan="3">XHF</td><td colspan="6">OCR</td><td colspan="6">SAT</td></tr>
<tr><td>12</td><td>LF</td><td>HF</td><td colspan="3">VHF</td><td>XHF</td><td colspan="6">OCR</td><td colspan="10">SAT</td></tr>
</table>

Legend:

LF - Low field
HF - High field
VHF - Very HF
XHF - Extra HF
OCR - Over-current range
SAT - IMC® Saturation

Table 4: Optimal IMC configuration for different current ranges. Saturation of shields should also be considered. Contact our technical support team to optimize the choice of shields.

2.2 Magnetic design

2.2.1 Magnetic field estimation with shield

In a typical application, a U-shaped ferromagnetic shield is wrapped around the current conductor to protect the sensor from external fields and improve the overall robustness of the sensing solution.

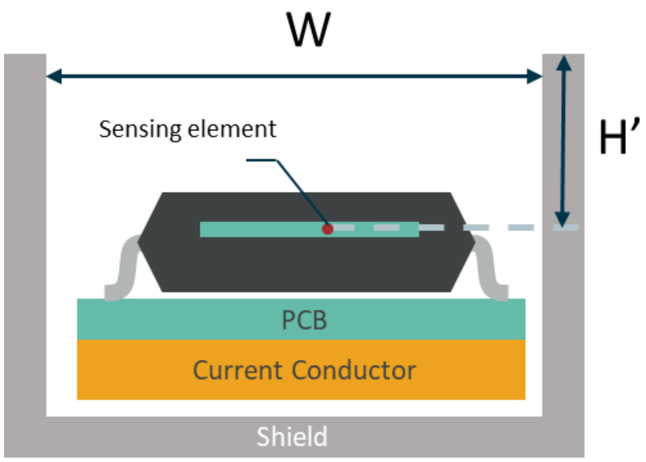


Figure 6: Shield dimensions on sensor.

The most important dimension of the shield is the inner width. In this configuration, the magnetic field B measured by the sensor for a current I and an inner width W can be estimated as:

$$B\ [mT] = 1.25 \times \frac{I\ [A]}{W\ [mm]}$$

Equation 4: Magnetic field estimation formula for shield configuration.

The current in the conductor generates a magnetic field around it. The ferromagnetic shield will guide the magnetic field lines such that a homogeneous magnetic field is generated in the U-shield between the two legs of the shield, as it is shown in Figure 7.

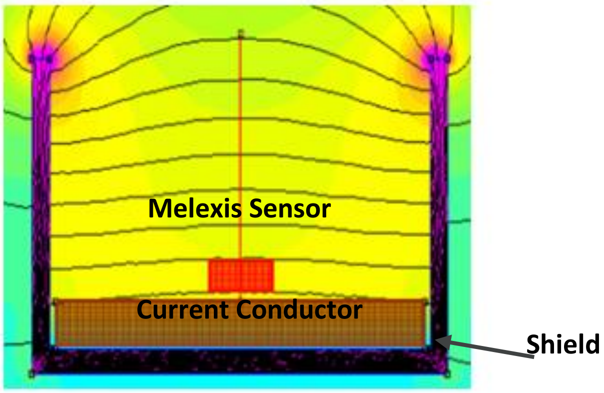


Figure 7: Magnetic field lines distribution in a typical application

Based on these considerations, the following magnetic design rules are essential in order to ensure optimal performances:

1. The current sensing module should respect the Ferromagnetic Shield, Current Conductor, and Melexis Sensor order of components.
2. In order to have an increased signal-to-noise ratio, the sensor should be mounted at a certain depth inside the opening of the shield, where the field lines are quasi-parallel to each other, and therefore homogeneous. A rule of thumb is that the distance from the sensor to the upper side of the shield (H') should be higher or equal to half the width of the shield (W).

$$H' \geq \frac{W}{2}$$

Equation 5: Optimal distance of sensor to the top of the shield.

Typically, the shield thickness ranges between 0.8 and 1.5mm (proportional to current range). The height and depth are between 12 and 15mm, in order to properly surround the sensor in each direction. The naming convention of ferromagnetic shields is U (for standard shields) or LU (for laminated shields) followed by the width number (for instance, L20). NiFe and SiFe are two available materials. Different properties are described in section 3.4.

2.2.2 Magnetic field estimation without shield

Depending on application environment and requirements, the ferromagnetic shield is not necessarily required. However, this configuration would lead to a drastic reduction of stray field immunity.

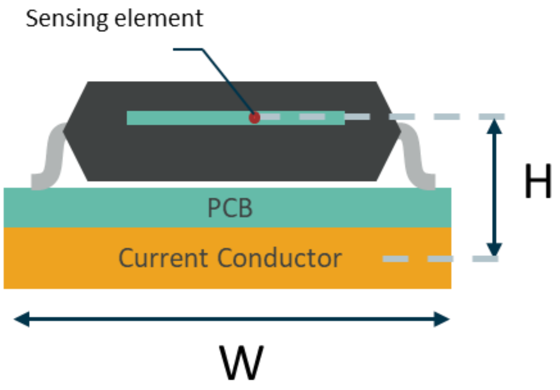


Figure 8: dimensions on sensor without shield.

Without shield, the magnetic field B measured by the sensor for a current I, a trace width W and a vertical position H can be approximated as:

$$B\ [mT] = 0.4 \times \frac{I[A]}{W[mm]} * \operatorname{atan}(\frac{W}{2H})$$

Equation 6: Magnetic field estimation formula for a configuration without shield.

2.2.3 Development kit and dimensioning examples

To have an example of the sensors performances, a development kit (DVK) can be bought from distributors, including PCBs, sensors and cores with standard dimensions. Figure 9 shows the IMC Hall Core DVK.

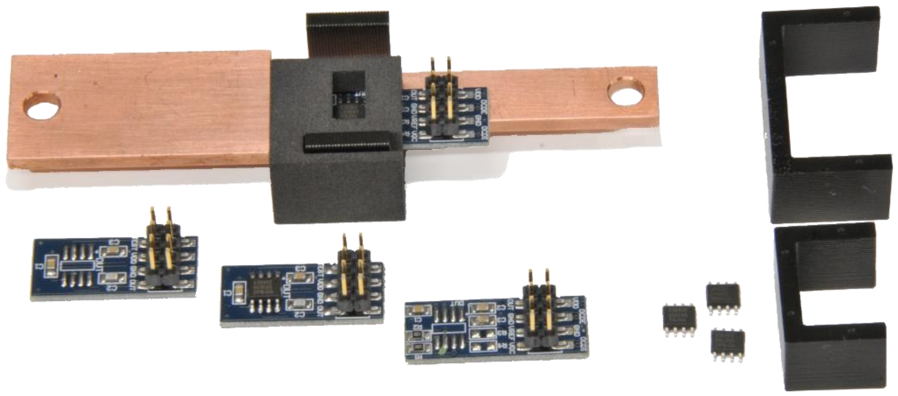


Figure 9: Development kit for IMC hall sensors.

Table 5 provides suggested system dimensions for various current ranges and for DVK combination, based on a typical design with a sensor on top of a straight bus bar surrounded by a U-shaped ferromagnetic shield. These dimensions can be easily scaled up or down for higher or lower currents according to the magnetic field estimation formula provided above, even if a solution with narrow shields is preferable.

Current [A] (peak)	Shield geometry		Magnetic Field [mT] (peak)	Sensor	
	Width [mm]	Thickness [mm]		Version	Sensitivity [mV/mT]
192	12	0.8	20	HF	100
480	12	1.5	50	VHF	40
720	15	3	60	VHF	30
1080	15	3	90	XHF	20
1200	20	3	75	XHF	25
936	15	3	78	* MLX91218LDC-ARX-300	16
528	20	3	33	* MLX91216LDC-ACV-001	60
660	25	3	33	* MLX91216LDC-ACV-001	60

Table 5: Example of configurations for different current peaks. Other combinations are possible, please contact Melexis sales department in case interested.

** Combination available in DVK.*

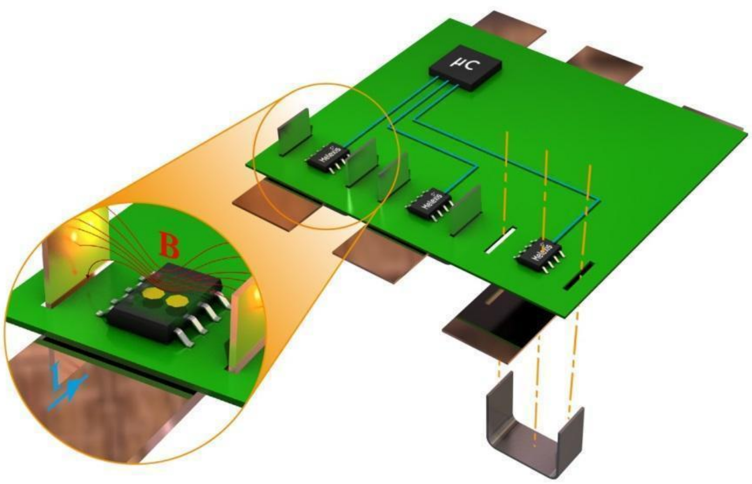


Figure 10: Example of 3-phase inverter current sensing solution with IMC-Hall® sensors.

2.2.4 Conductor with neck-down

In order to limit the cost, size and weight of the shield on systems with wide bus bars, we recommend reducing its cross-section locally, as illustrated in Figure 11. Such a neck-down has minimal impact on the electrical resistance and allows for a much more compact current sensing solution.

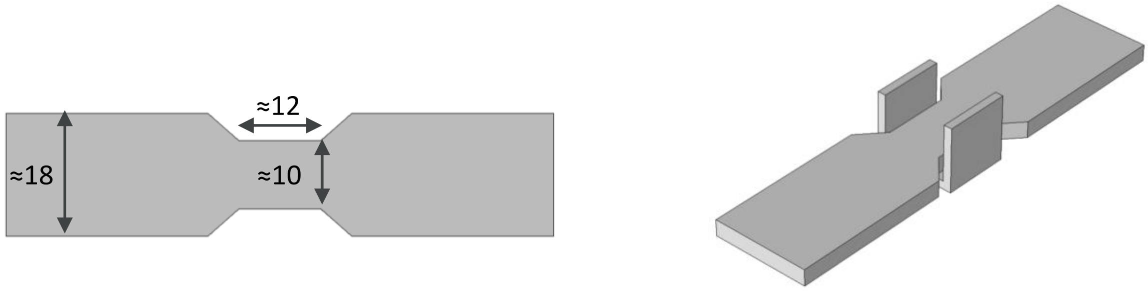


Figure 11: Necked-down bus bar example.

2.2.5 Use of laminated shields

Laminated shields are made of a stack of thin sheets separated by insulators. This allows to reduce the effect of eddy currents (that are generated in the shield by time oscillating fields, and cause gain reduction and phase shift of the sensor signal), boosting the sensing performances. Moreover, for very high currents (typically above 800A), it is often more efficient and cost-effective to use a laminated shield so that the in-plane thickness can be increased, decreasing the depth and overall footprint for the same performance.

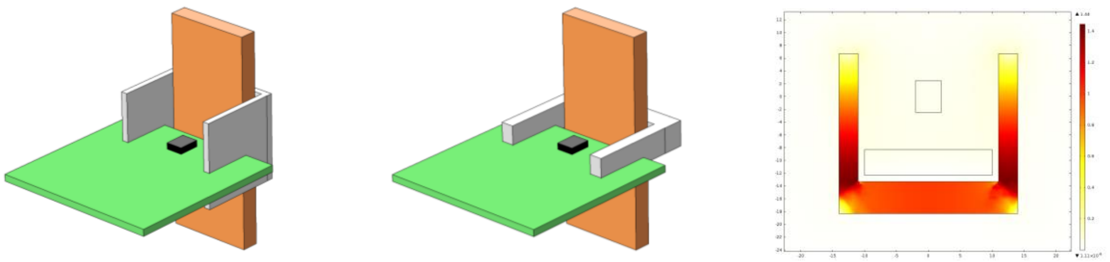


Figure 12: Shield configuration for very high currents.

2.2.6 Cancelling stray field without shield

In AC applications, external stray fields can be cancelled out by the microcontroller. Computing the difference between max and min sensor output values provides a signal independent of any parasitic DC field.

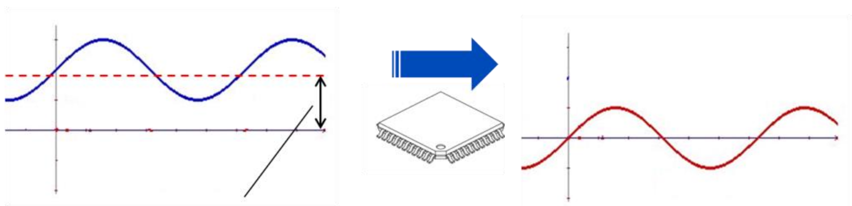


Figure 13: Stray field cancelling without shield.

2.2.7 Avoiding cross-talk without shield

Even without ferromagnetic shield, cross-talk between adjacent current tracks can be avoided by design. Figure 14 illustrates a concept of current trace layout with slots to force the current to flow perpendicular to the main track axis. The sensors are rotated by 90° with their sensitive axis (blue arrow) parallel to the current trace. With such a configuration, there is virtually no cross-talk between phases.

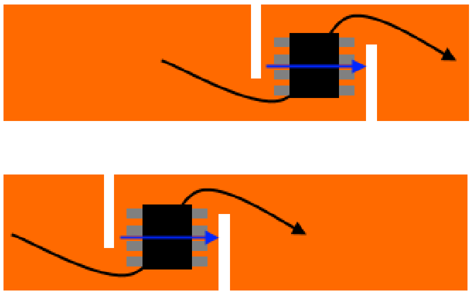


Figure 14: Current trace layout with slots and rotated sensors to avoid cross-talk between phases.

2.3 Quick Selection Guide

Melexis provides a list of sensors that can be selected for different applications. Each sensor can be bought with a factory trimmed sensitivity, using a specific option code. Sensitivity can be tuned according to customer needs.

2.3.1 Main features (typical)

	91208	91216	91218
Sensitivity [mV/mT] *			
▪ Extra High Field version (XHF)		20-125	12-115
▪ Very High Field version (VHF)	30-200	30-200	18-165
▪ High Field version (HF)	50-300	50-350	
▪ Low Field version (LF)	100-700		
Thermal sensitivity drift [%S] **	±1.5	±1	±1.5
Thermal offset drift [mV]	±10	±5	±5
Non-linearity [%F.S.]	±0.5	±0.3	±0.5
Response time [µs]	2	2	2
Bandwidth [kHz]	250	250	400
Noise	10 mVrms	6.5 mVrms	$110\ \mathrm{nT}/\sqrt{\mathrm{Hz}}$
Analog output	Yes	Yes	Yes
PWM output	No	No	No
Programmable	Yes	Yes	Yes
Diagnostic functions			
▪ Over/Under-voltage detection	Yes	Yes	No
▪ Broken-track detection	No	Yes	No
▪ Clamping	No	Yes	No
▪ Over Current Detection	No	No	Yes
Possible supply voltages [V]	5	5	5, 3.3
Package	SOIC-8	SOIC-8	SOIC-8
Temp. range [°C]	-40-150	-40-150	-40-150

Table 6: Main features and specifications of planar IMC-Hall® current sensors. Operating temperature T = -40°C to 125°C, unless otherwise specified.

** Programmable*

*** Thermal sensitivity drift is better for temperatures lower than 100°C.*

2.3.2 Option code and sensitivity range

Sensor	Option code	IMC version	Sensitivity range (typical) [mV/mT]
MLX91208	CAL-000	LF	100-700 (250)
	CAH-000	HF	50-300 (100)
	CAV-000	VHF	30-200 (40)
	CAV-001	VHF	30-200 (60)
MLX91216	ACH-000	HF	50-350 (100)
	ACV-000	VHF	30-200 (40)
	ACV-001	VHF	30-200 (60)
	ACV-002	VHF	30-200 (30)
	ACX-000	XHF	20-125 (25)
	ACX-001	XHF	20-125 (30)
	ACX-002	XHF	20-125 (20)
MLX91218	ARV-5XX	VHF	30-200
	ARV-500	VHF	30-200 (40)
	ARV-501	VHF	30-200 (60)
	ARV-502	VHF	30-200 (30)
	ARX-5XX	XHF	18-125
	ARV-303*	VHF	18-125 (30)
	ARX-300*	XHF	12-80 (14)

Table 7: Option code and sensitivity range of planar IMC-Hall® current sensors (supply voltage equal to 5V unless otherwise specified). Please contact the Melexis sales department to have customized versions.

** Supply voltage 3.3V*

2.4 PCB design: guidelines

The PCB design and layout play an important role in the final performances of the current sensing module. More specifically, two different aspects are to be considered when designing the ground layer on the PCB.
When an application implies high voltage switching (for instance in motor control applications), an expanded ground layer, as depicted in Figure 15, will help reducing the parasitic coupling capacitance generated by voltage time transients (dV/dt).

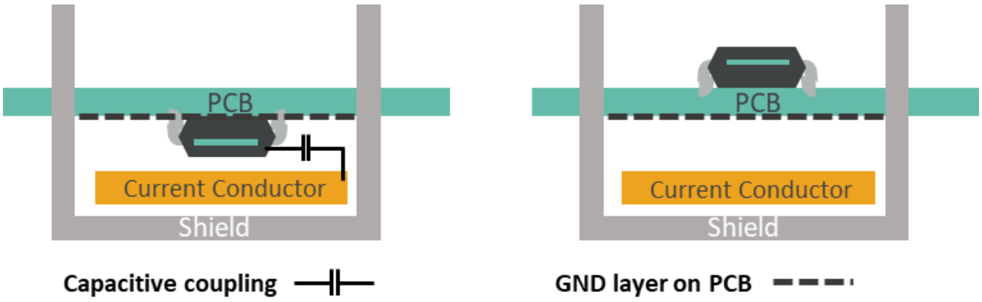


Figure 15: Current sensing structure. Expanded Ground Layer on PCB in order to reduce the parasitic coupling capacitance (coming from voltage transients).

At the same time, the ground layer can have a big impact on the response time.
If the ground layer covers all the surface of the PCB and surrounds the two legs of the shield, Eddy currents will start to flow circularly around them, generating a counter-magnetic field which slows down the response time of the sensor.
In order to avoid increased response time, the ground layer should be divided such that it interrupts the circulations of Eddy currents around the shield.

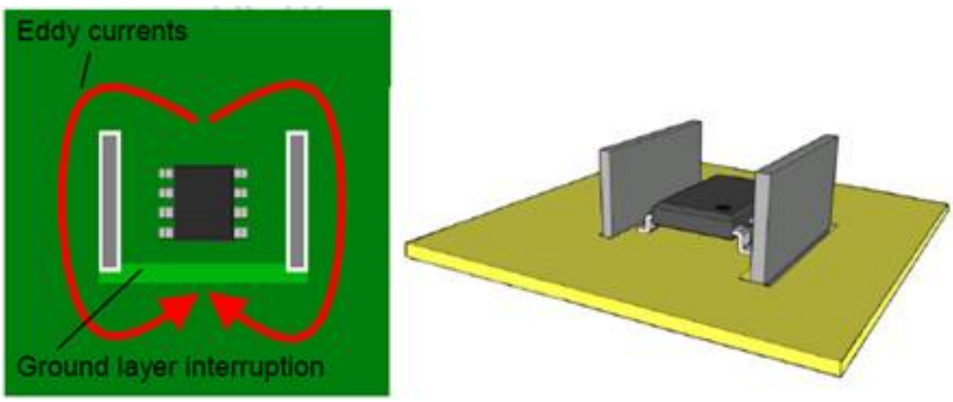


Figure 16: Current Sensing Structure – Designing the Ground Layer on the PCB such that Eddy Currents circulations is interrupted

2.5 Reference Designs

Table 8 shows an overview of reference designs based on planar IMC-Hall® current sensors.

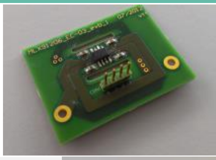
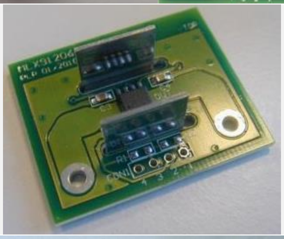
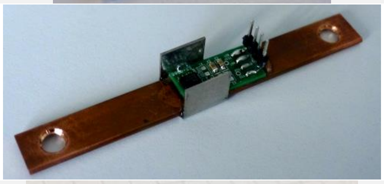
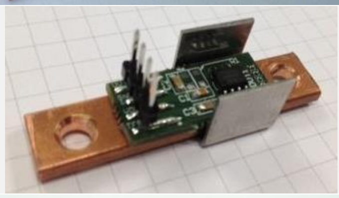
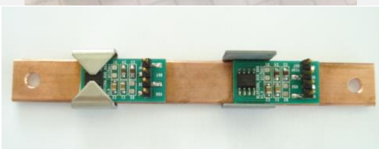
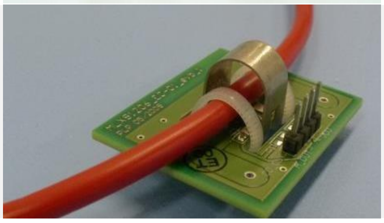
Application	Solution	Illustration
PCB trace current **2-10A**	Multi-turn and multi-layer PCB Single layer PCB with C-shaped ferromagnetic shield	 
PCB trace current **10-50A**	Single layer PCB with or without ferromagnetic shield	
Bus bar **50-250A**	High field sensor with 12mm U-shaped ferromagnetic shield	
Bus bar **300-700A**	Very high field sensor with 12mm U-shaped ferromagnetic shield	
High dynamic range **50mA to 250A**	Dual range sensor with U-shaped and C-shaped shields	
Non-intrusive current sensing from cable **10-100A**	Simple PCB with clamp-on shield wrapped around the cable	

Table 8: Overview of the reference designs based on planar IMC-Hall® current sensors.

2.5.1 PCB application, 2-10A range, multi-layer/multi-turn solution

- PCB with multiple layers and trace windings (current loops) for very high sensitivity.
- Can be used with or without ferromagnetic shield, depending on sensitivity and accuracy requirements.

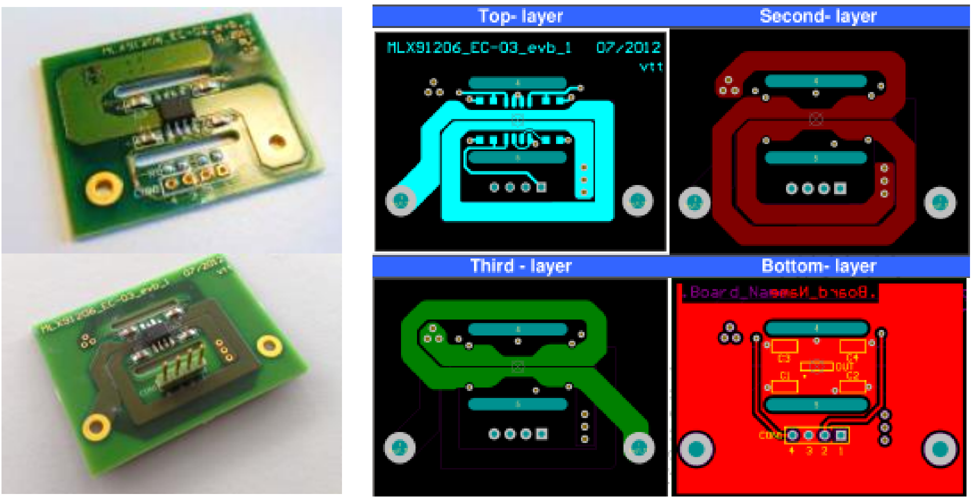


Figure 17: PCB layout example for very high sensitivity with 6 windings on 3 layers.

	3 windings w/o shield	3 windings w/ shield	6 windings w/o shield	6 windings w/ shield
Sensitivity (max) [mV/A]	210	350	420	700

Table 9: Maximum achievable sensitivities with Melexis evaluation boards.

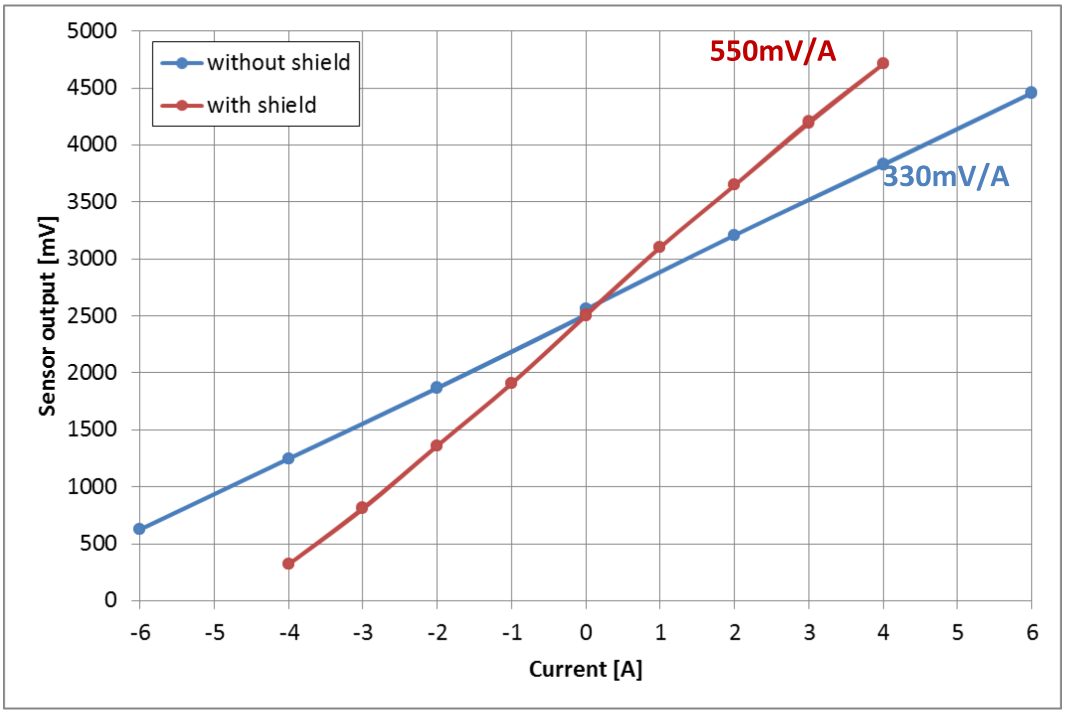
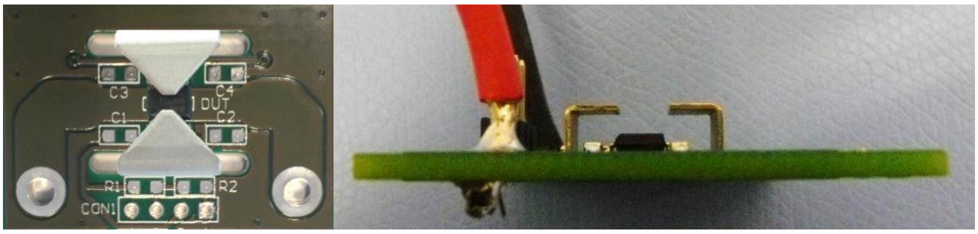


Figure 18: Example of output functions for a six-winding evaluation board, with/without shield.

2.5.2 PCB application, 2-10A range, ferromagnetic shield solution

- PCB with one layer and a single current trace (no windings).
- Closed ferromagnetic shield for high magnetic gain.



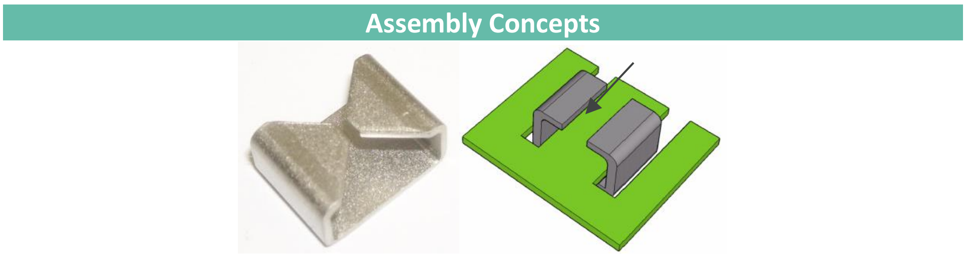


Figure 19: Shield in one piece inserted through slots on the PCB edge.

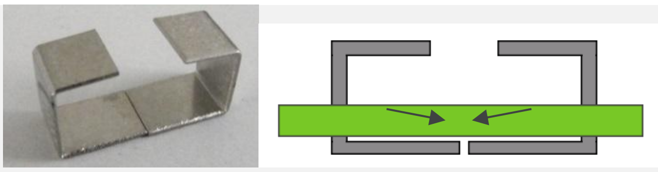


Figure 20: Shield in two parts inserted in PCB slits and assembled together.

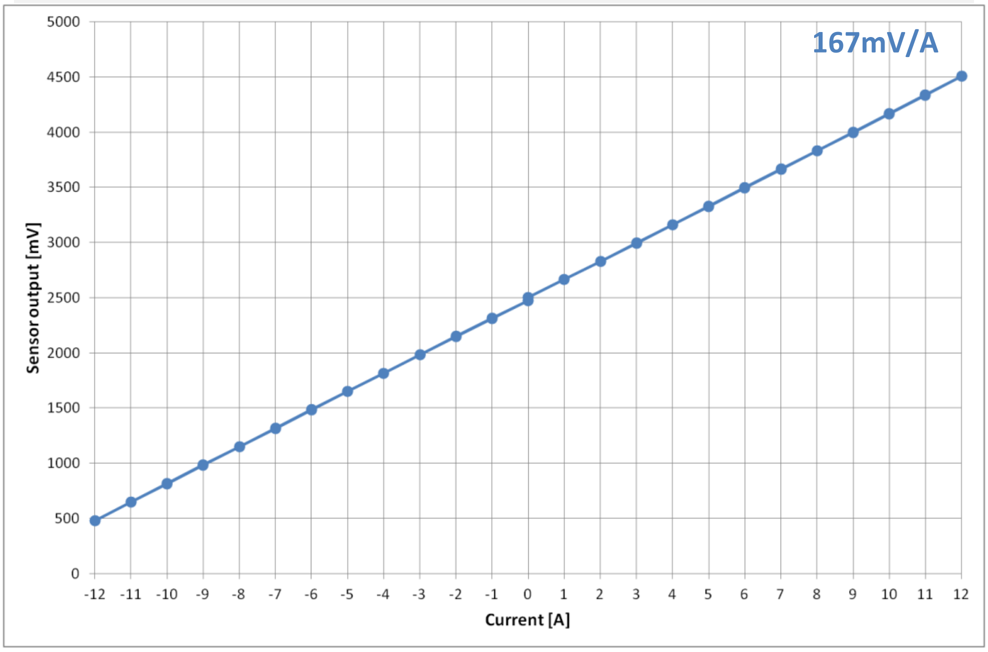


Figure 21: Example of output function for a single-layer PCB with closed shield.

2.5.3 PCB application, 10-50A range

- PCB with one layer and a single current trace.
- To be used with or without ferromagnetic shield (U-shaped).
- **Sensitivity:** up to 60mV/A (without shield) and 170mV/A (with shield).

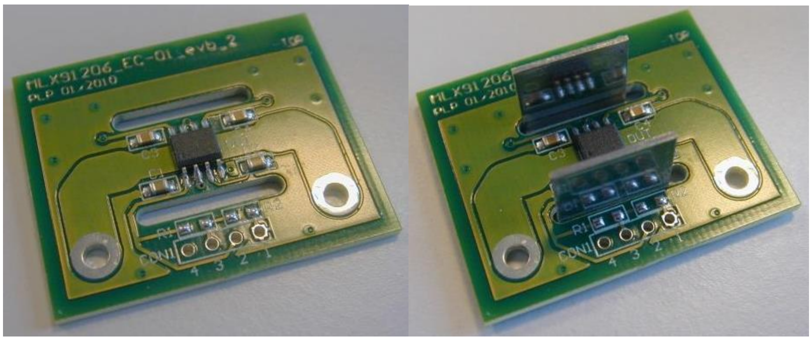


Figure 22: Single-layer evaluation board without and with shield.

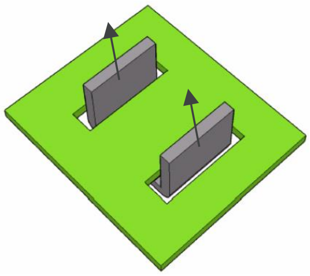


Figure 23: Shield assembly through PCB slits.

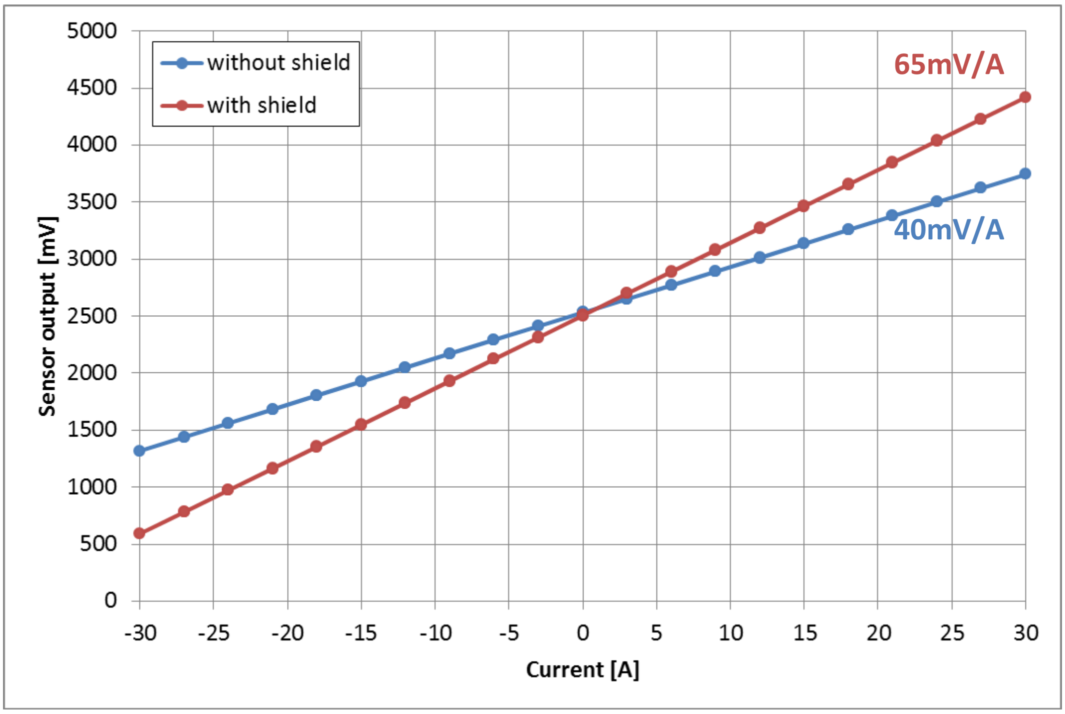


Figure 24: Example of output function for a single-layer PCB, with/without shield.

2.5.4 Bus bar application, 50-250A range

- The high field (HF) sensor on PCB is mounted directly above the conductor.
- A simple, low-cost and compact U-shaped shield is mounted around the sensor to protect it from stray fields and ensure good signal robustness against vibrations and displacements.
- With the dimensions demonstrated here, the linearity error is lower than ± 1.5A up to ±250A.

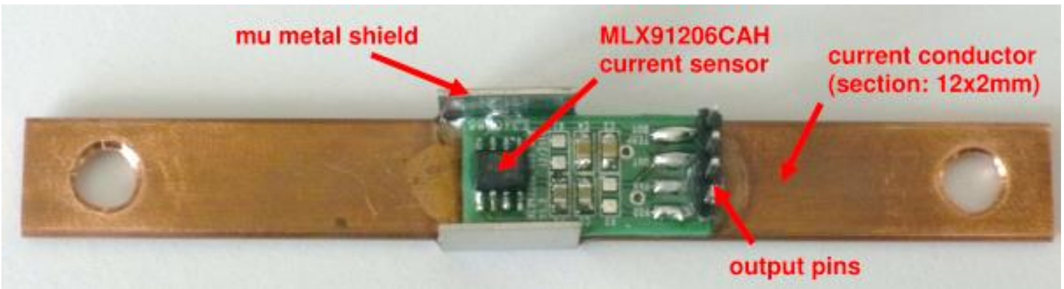


Figure 25: Demonstrator based on MLX91206 HF sensor and U12 shield with 0.8mm thickness.

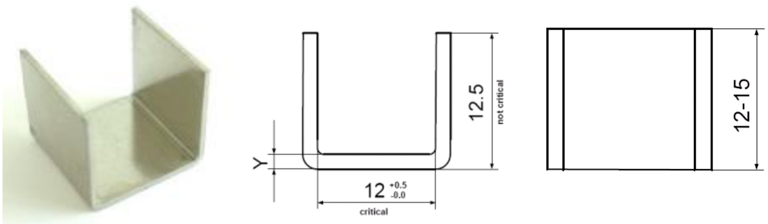


Figure 26: Shield dimensions.

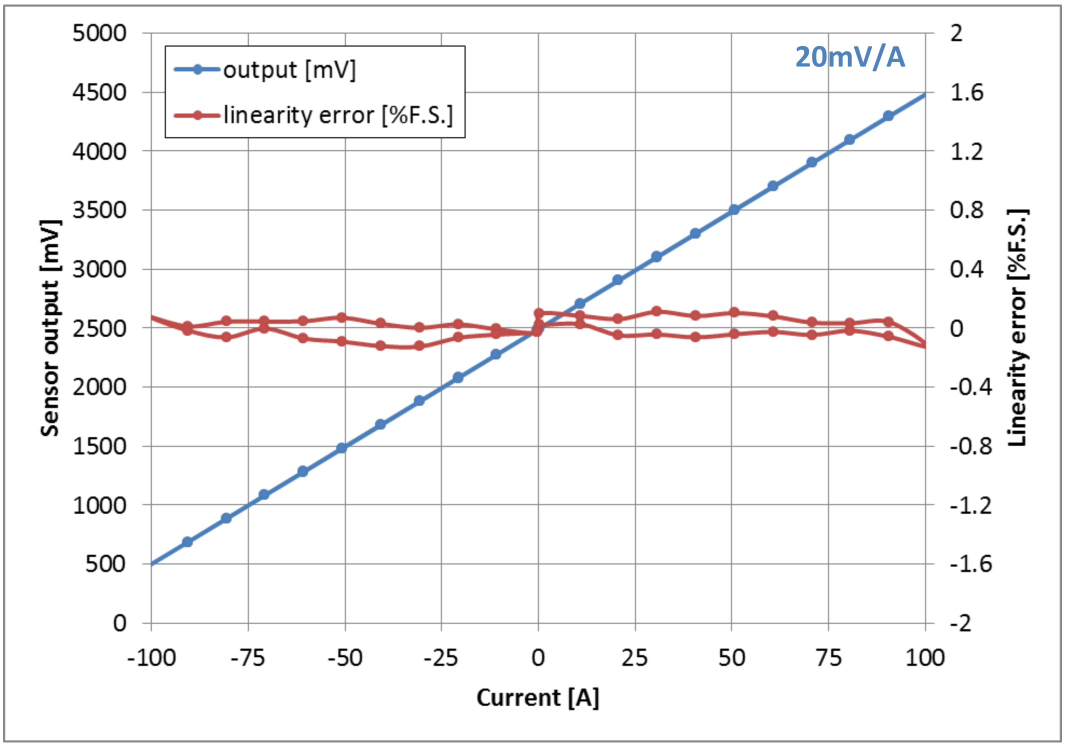


Figure 27: Typical output and non-linearity of a sensor calibrated for ±100A.

2.5.5 Bus bar application, 300-700A range

- With the very high field (VHF) sensor, the measurement range can be extended to 700A while keeping the same inner width than for the previous design (12mm). Only the shield thickness must be adapted from 0.8 to 1.5mm.
- The linearity error is lower than ±5A up to ±650A.
- Very compact solution to measure 700A with a footprint of less than 2cm².

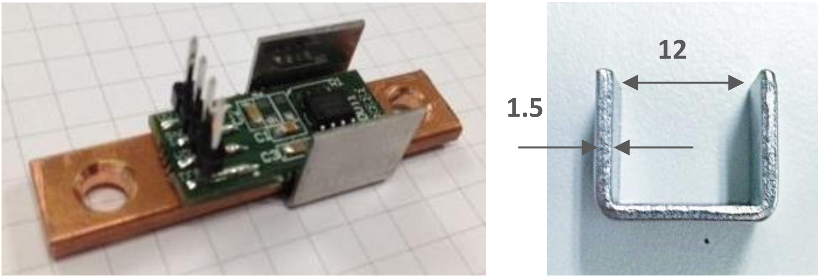


Figure 28: Demonstrator based on MLX91208 VHF sensor and U12 shield with 1.5mm thickness.

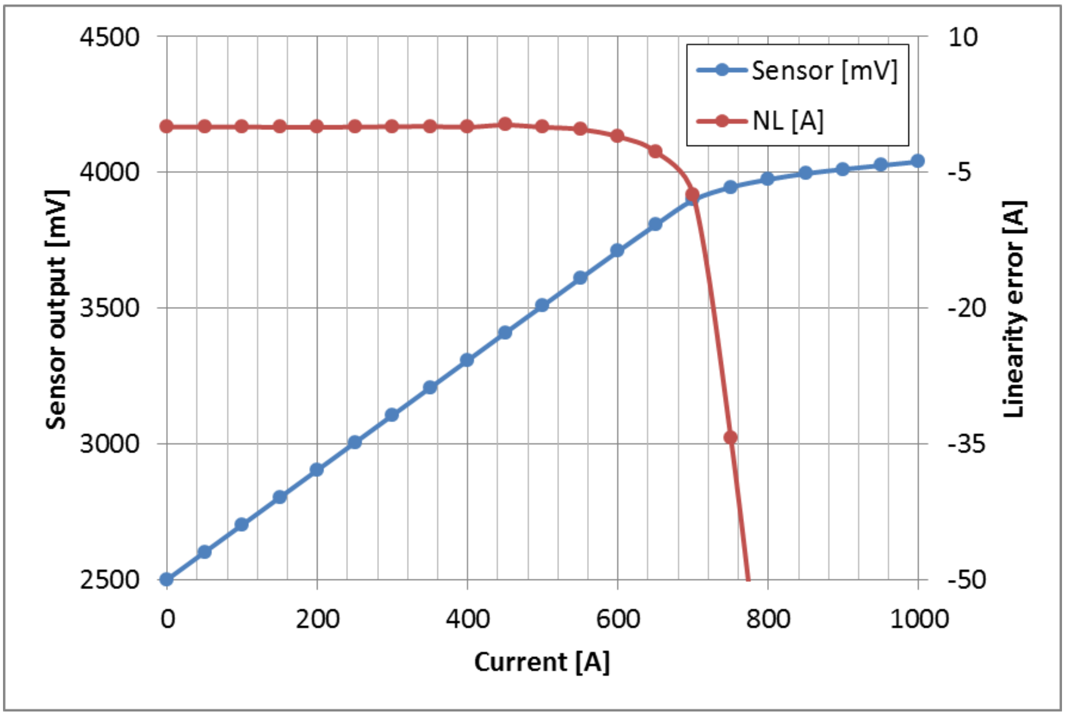
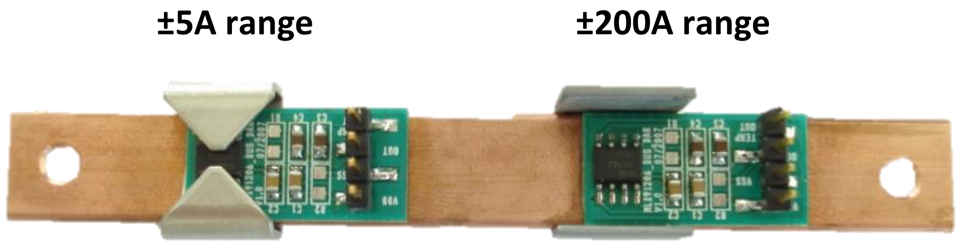
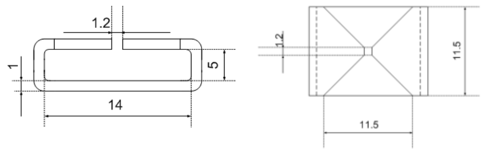
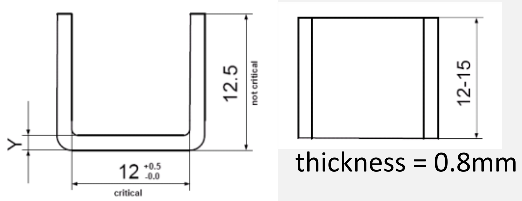


Figure 29: Sensor output and linearity error versus current.

2.5.6 Bus bar application, dual range 5A/200A

- Solution for applications with a wide dynamic range.
- One sensor with C-shaped (closed) shield for high accuracy at small currents (typ. ±5A).
- One sensor with U-shaped shield for high saturation limit (typ. ±200A).
- Other combinations of ranges are possible depending on the application requirements.



View	Dimension [mm]
	
	

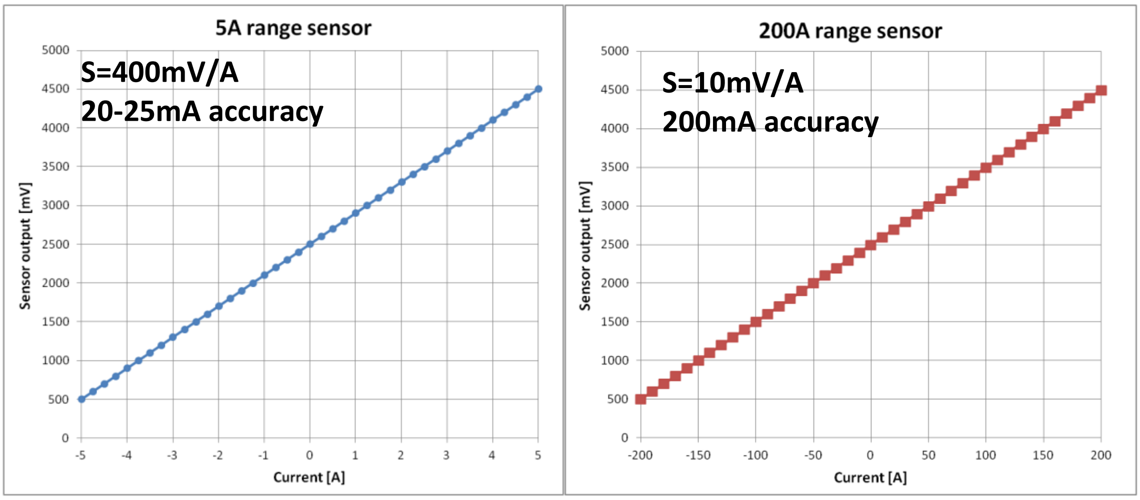


Figure 30: Typical output of the 5A and 200A range sensors.

2.5.7 Cable application, 10-100A range

- The clamp-on shield gathers the magnetic field around the cable and concentrates it above the sensor package. Small air gap ensures high magnetic gain.
- Shield geometry can be adapted to match various cable diameters and current ranges.

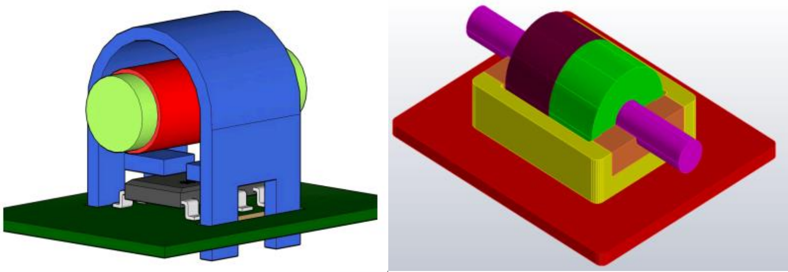


Figure 31: Cable clamp concepts (left: monolithic shield, right: two-part shield in plastic housing).

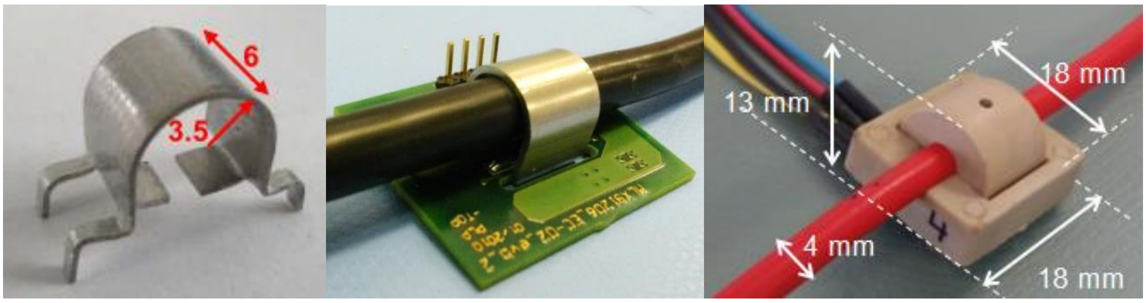


Figure 32: Implementation examples (monolithic and two-part shield in plastic housing).

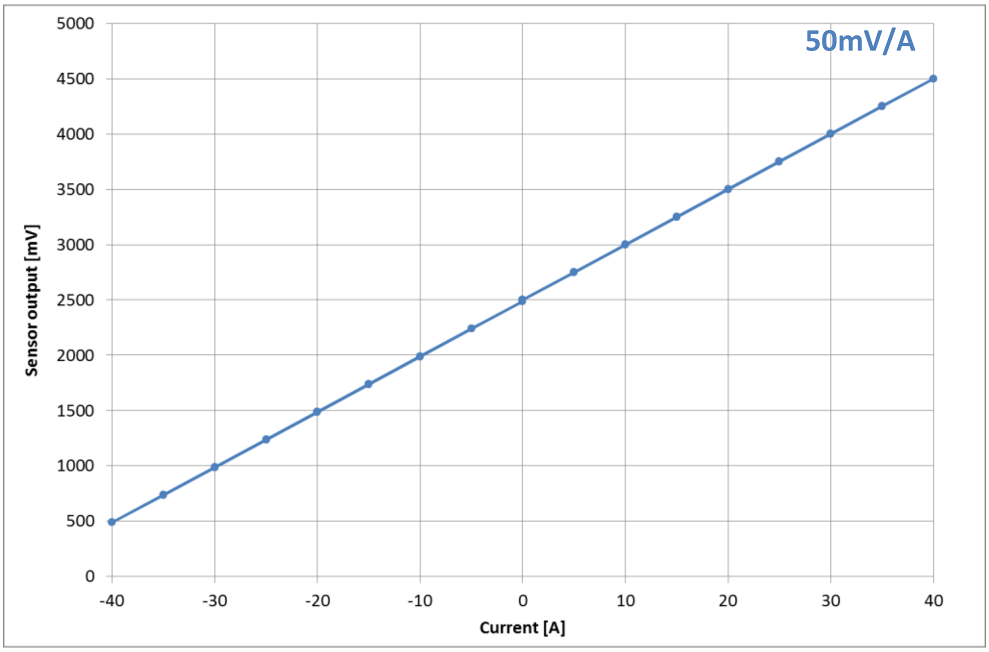


Figure 33: Example of output function with a cable-clamp demonstrator calibrated for ±40A.

3 Ferromagnetic materials

3.1 Suppliers

Melexis partnered with MagLab and PML India for ferromagnetic material supply.

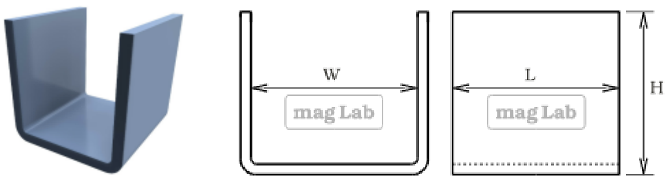
www.maglab.ch www.pmlindia.com

Recently, PML and MagLab signed an exclusive collaboration in the field of contactless current sensing. This cooperation between MagLab and PML offers an efficient and cost-effective solution for customers requiring magnetic shields. MagLab takes care of the engineering side, while PML manufactures the products to our specifications.

3.2 Ferromagnetic shields

3.2.1 U-Shield

Standard (U) and laminated (LU) shields can be ordered using the following order codes convention (valid for both types).



U-Shield – Width – Length – Height – Thickness (– Ni)

Order code example	W [mm]	L [mm]	H [mm]	T [mm]
U-Shield – 12 – 13 – 12.5 – 0.8	12	13	12.5	0.8

Material Specification	T [mm]	Ni [%]
Standard material	0.8	48
Other Thickness options	0.35 / 0.5 / 1 / 1.2	…

Figure 34: Ordering information for the standard U-shield from MagLab.

3.2.2 Mechanical assembly

Ferromagnetic shields can be assembled by crimping, screwing or bonding (glue or tape). They can also be encapsulated in a pre-molded plastic case. The optimal solution depends on the application. In any case, care should be taken to avoid mechanical stress on the part of the shield involved in the magnetic measuring circuit.

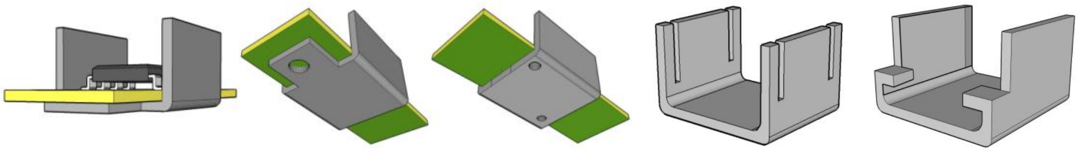


Figure 35: Several solutions for shield assembly.

One of the most common solutions is to use a pre-molded plastic case, with slots to insert the shields, as illustrated on the pictures below.

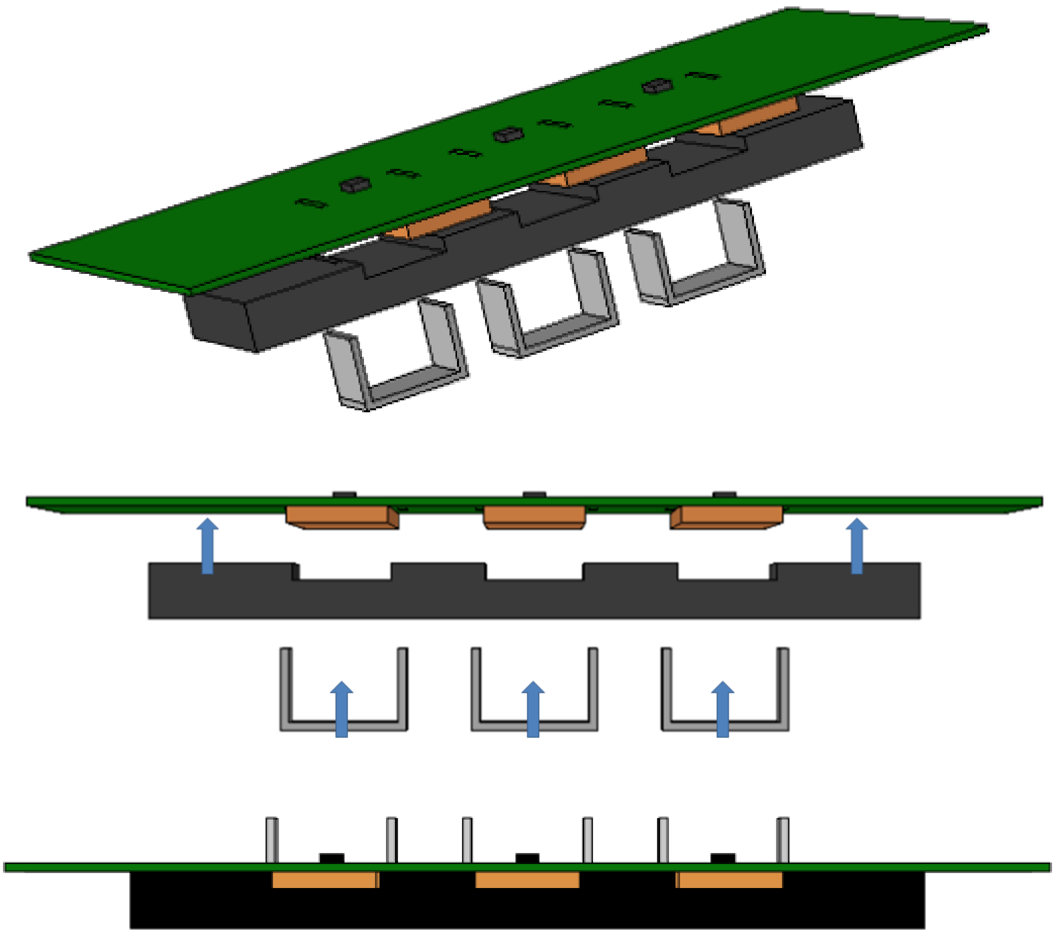
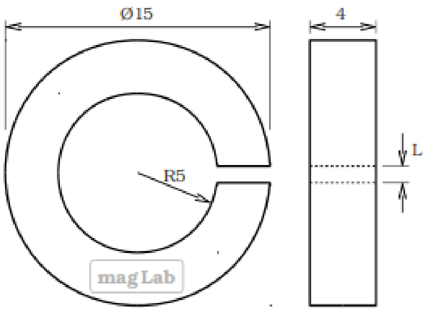


Figure 36: Assembly with pre-molded plastic case.

3.3 Ferromagnetic cores

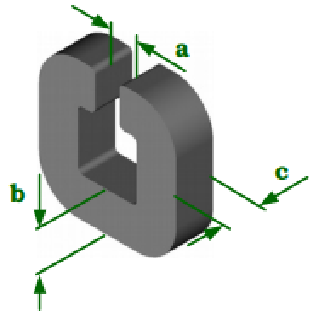
Amorphous ferromagnetic cores can be ordered with the following order codes convention.



AMC1R5 – L

Order code example	L [mm]
AMC1R5 – 5	5

Laminated cores can be ordered using the following order codes convention.



Ca – b – c

Order code example	a [mm]	b [mm]	c [mm]
C2.5 – 4 – 3.8	2.5	4	3.8

3.4 Ferromagnetic materials comparison

The performance of the current sensing solution relies on the careful selection of a proper core or shield material and manufacturing conditions (annealing, lamination, etc.).
Table 10 displays the main features of the most common material types.

Material	Price	Saturation field density B_{SAT}[T]	Hysteresis [%FS]
SiFe	$$	1.5	<0.25%
50% NiFe	$$$	1.3	<0.1%
ferrite	$	0.5	0.1%

Table 10: Features of most common ferromagnetic core materials.

4 End-of-line Calibration

4.1 Introduction

Each current sensor is individually tested and calibrated over temperature on the Melexis production line. However, in order to achieve optimal accuracy, a final calibration is required at customer-side after assembly to compensate for mechanical tolerances (sensor position deviations, shield dimensions, etc.)
This final calibration can be done in two ways: either by using the Melexis tools to directly program the sensor EEPROM, or by adjusting the gain/offset at microcontroller level.

4.2 Direct sensor calibration

All current sensor products (starting from MLX91206) can be programmed using the Melexis universal programmer (PTC-04) and related software. The PTC-04 communicates with the sensor through 3- or 4-wire connectors, and with the PC through USB or RS-232. Melexis provides a library of sensor-specific high-level functions (.dll), which can be used to develop custom software using common programming language (C/C++, Labview, etc.)
The calibration is a fast two-step process: the sensor output function (gain and offset) is adjusted automatically based on two reference measurements (i.e. zero current and nominal current).

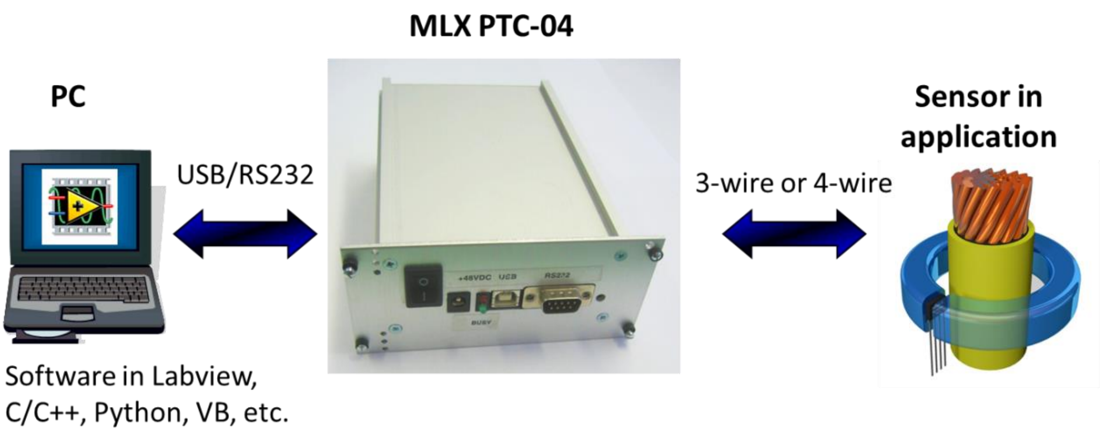


Figure 37: scheme of PTC-04 connection.

4.3 Micro-controller level calibration

A micro-controller level correction is recommended for multi-sensors applications, i.e. on power distribution units, where typically 12 to 24 sensors are on the same PCB in order to monitor the current of each channel.
All of these Melexis current sensors are factory calibrated over temperature. After assembling of the factory-calibrated sensors on each channel, a reference current is applied on each channel. The output voltage of each sensor is measured and the required corrective factor is thus calculated and stored in the microcontroller.

5 Additional information

Please refer to the following document for additional information on specific topics:

Typical cores and shield geometries
Standard designs of laminated and un-laminated U-shields and C-cores.

Current sensors programming and calibration
Different options available for customers in terms of sensor calibration.

6 Contact us

To get in contact with our current sensors application team, please fill and submit the technical inquiry form.

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