David Heindryckx, Field application engineer

Sense & Drive

Triaxis Gen III introduction

2019-June 8th

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Content

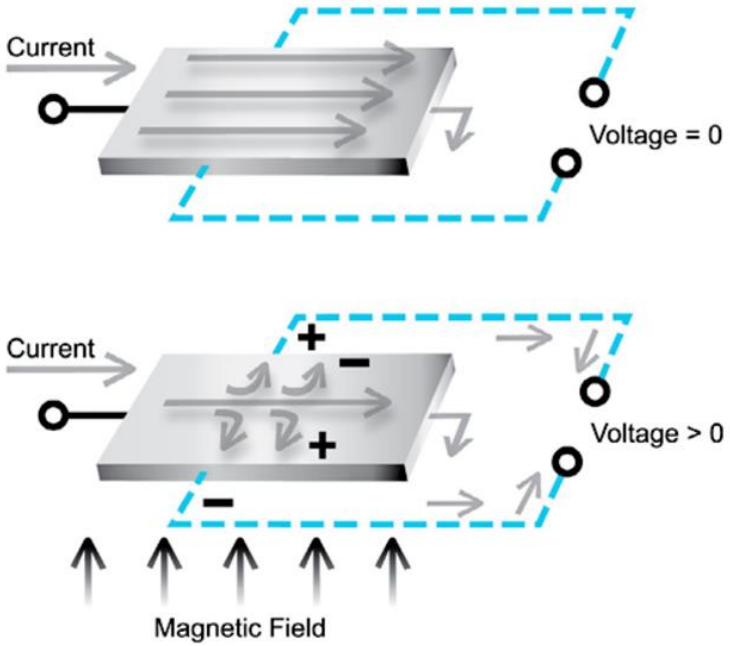
- Triaxis position sensors
  - Triaxis explained
  - Introducing Melexis Triaxis Gen III
  - Features and benefits
- Magnetometers
- Current Sensors

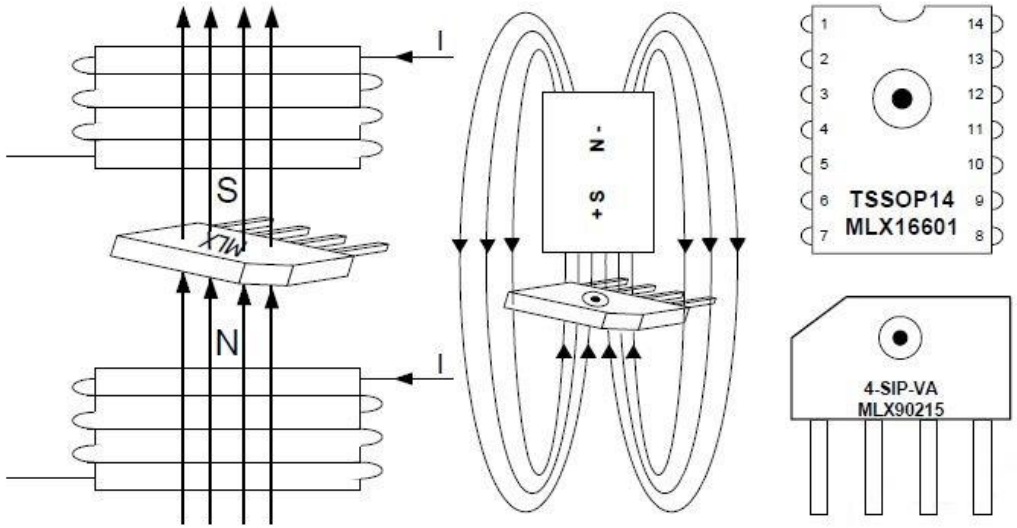
Triaxis explained

Hall effect basic

Melexis magnetic sensors utilize the Hall effect

- Discovered in 1879 by Edwin Herbert Hall (1855 - 1938)
- Effect results in a measured voltage proportional to the applied magnetic field
- Magnetic field (flux density) measured in Tesla or Gauss





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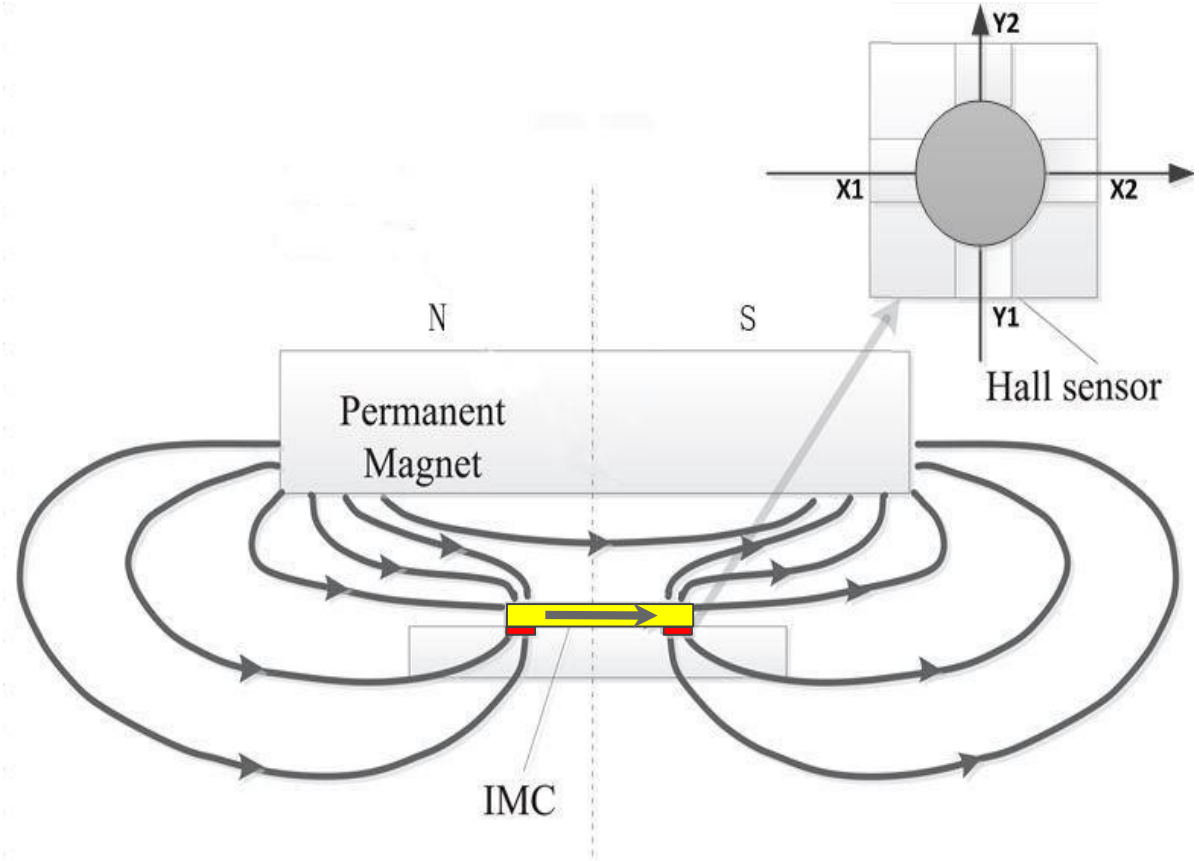
What is Triaxis

IMC(Integrated Magneto Concentrator)



- Thanks to the IMC, the flux density parallel(horizontal) to the IC surface is converted into orthogonal(vertical) components suitable for the planar Hall plate

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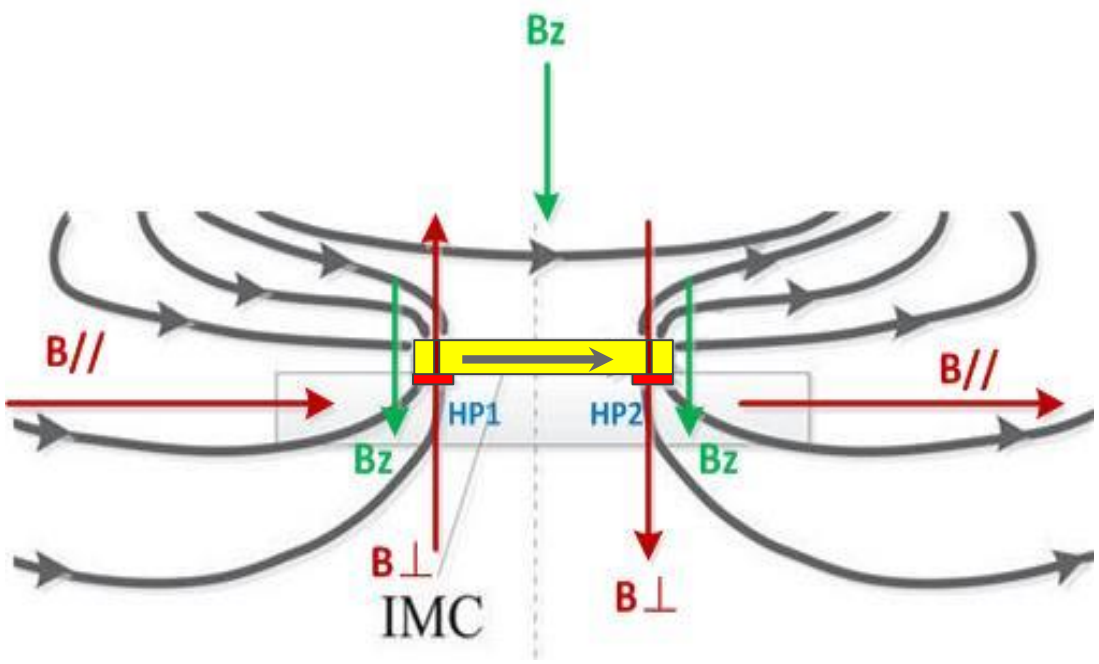
Triaxis working principle



HP1 => B1 = B⊥ - Bz

HP2 => B2 = -B⊥ - Bz

Differential "-" => B1 - B2

B1 - B2 = B⊥ - Bz - (-B⊥- Bz) = 2B⊥

Direct "+" => B1 + B2

B1 + B2 = B⊥ - Bz + (-B⊥- Bz) = -2Bz

What is Triaxis

Triaxis benefits

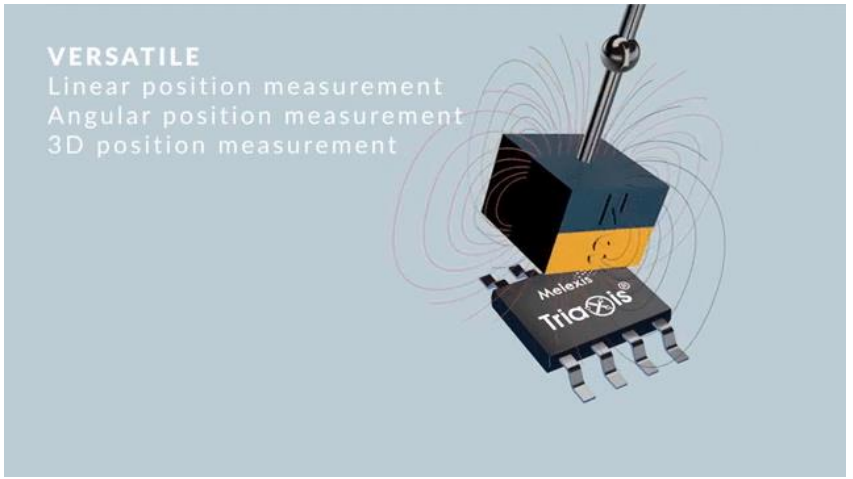
- High accuracy
  - Division of flux strength components
    - α = ATAN(B1/B2)
    - Less sensitivity to the flux density strength variations:
      - Temperature
      - Lifetime
      - Air gap

Introducing Melexis Triaxis Gen III

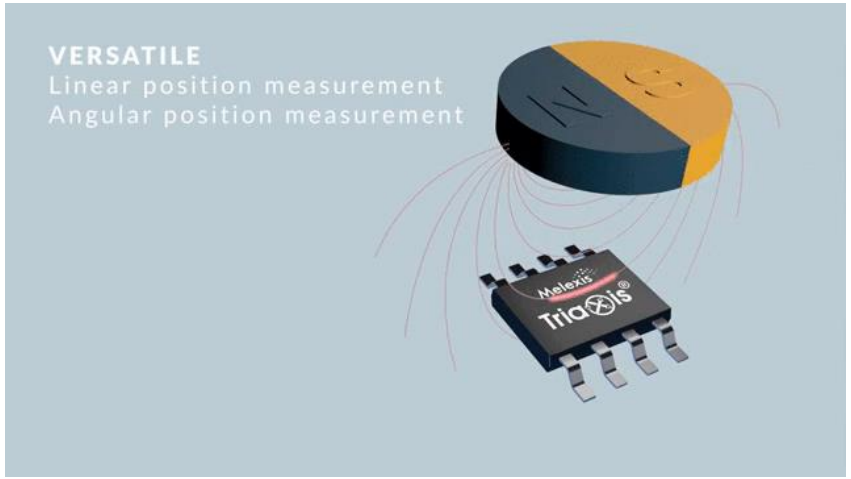
Triaxis position sensor

Sensing modes

Linear position



3D joystick position



Angular position

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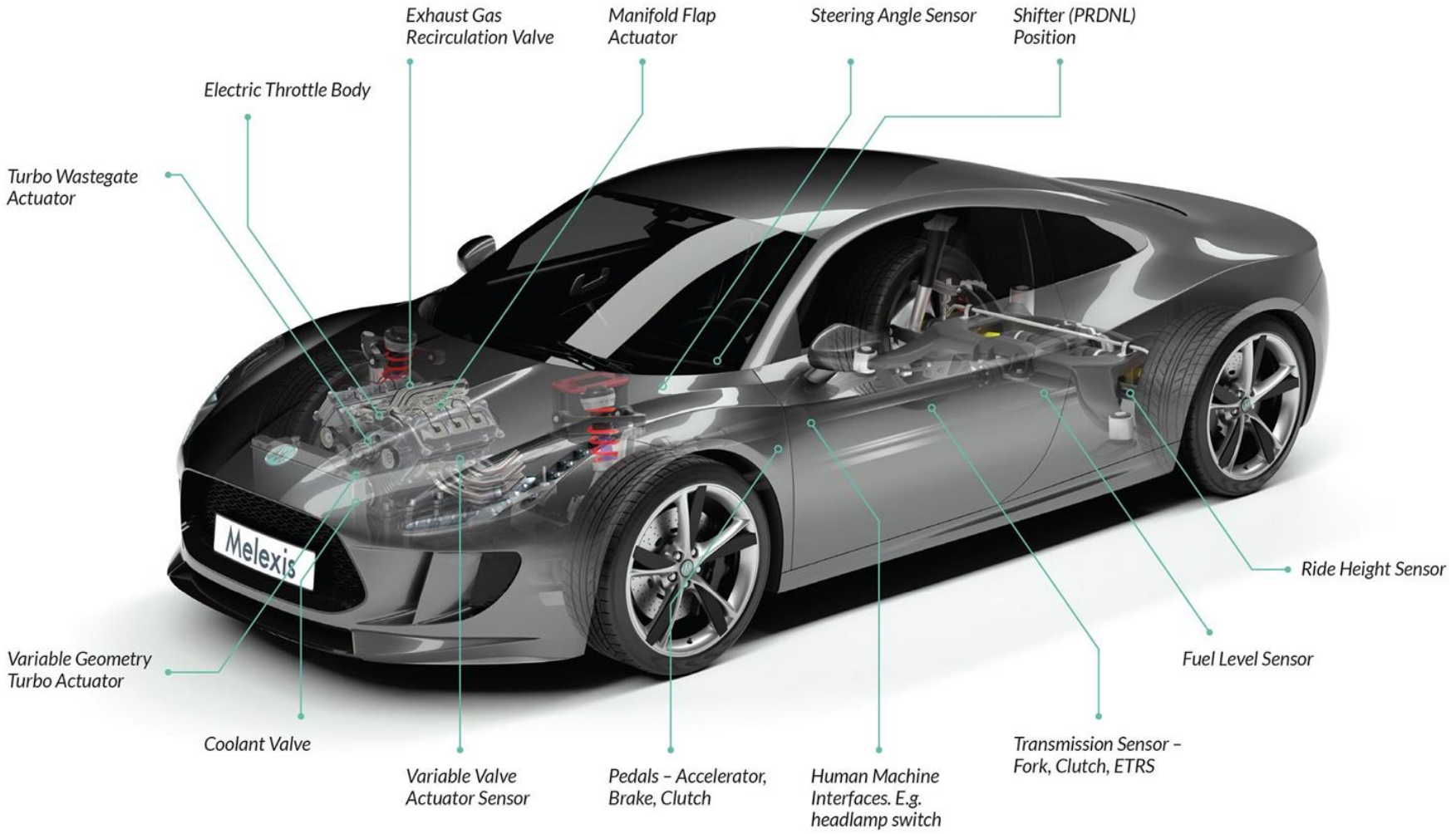
Automotive Magnetic Sensors

Applications Landscape



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Non-automotive Magnetic sensors

Applications

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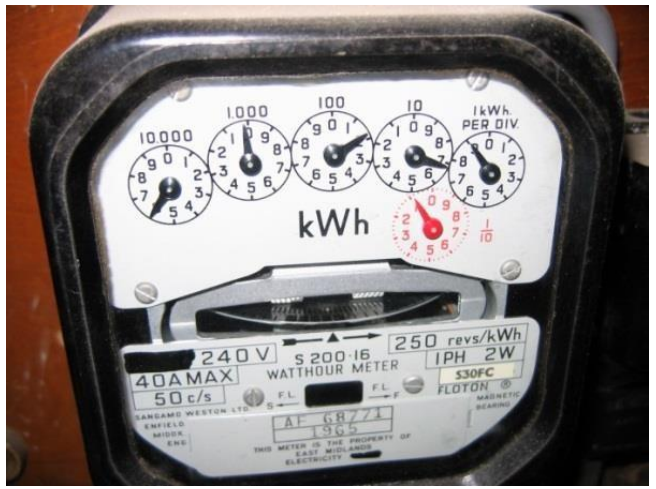
Non-automotive Magnetic sensors

Smart appliances



Energy

Consumer

Industry

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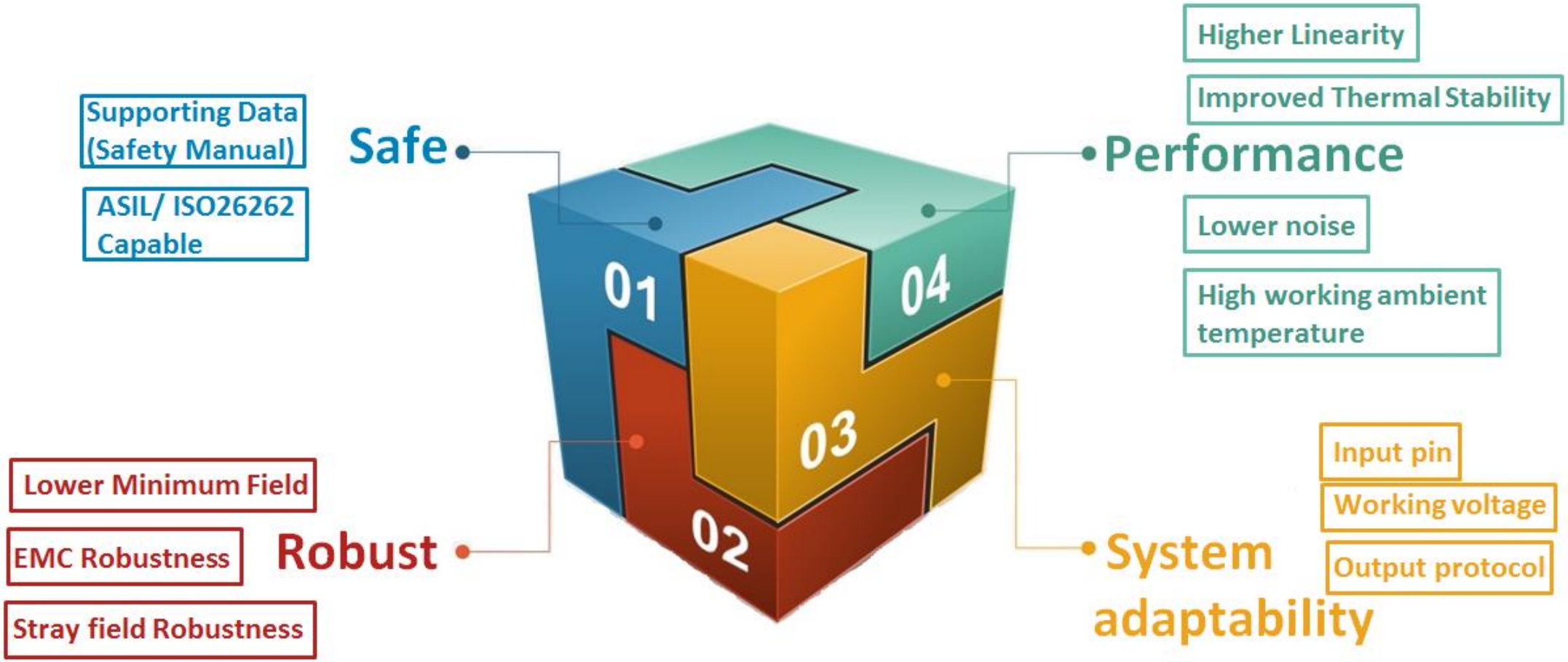
Introduction of Gen 3

New requirements drive new developments Gen 3



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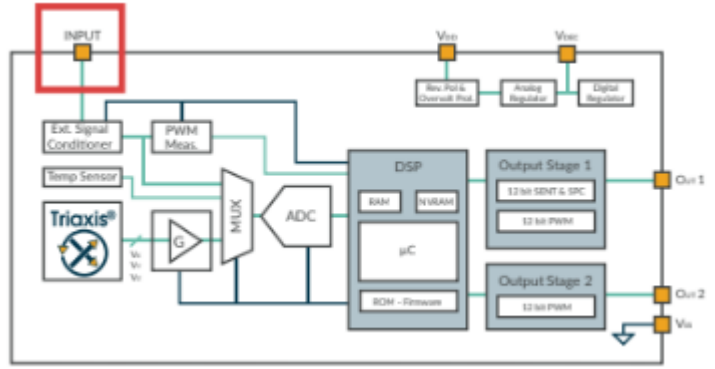
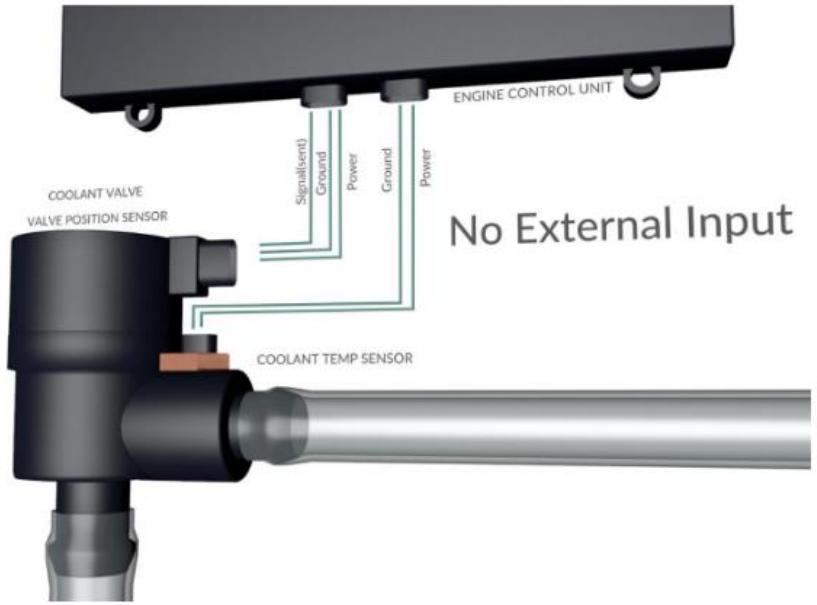
Features and Benefits

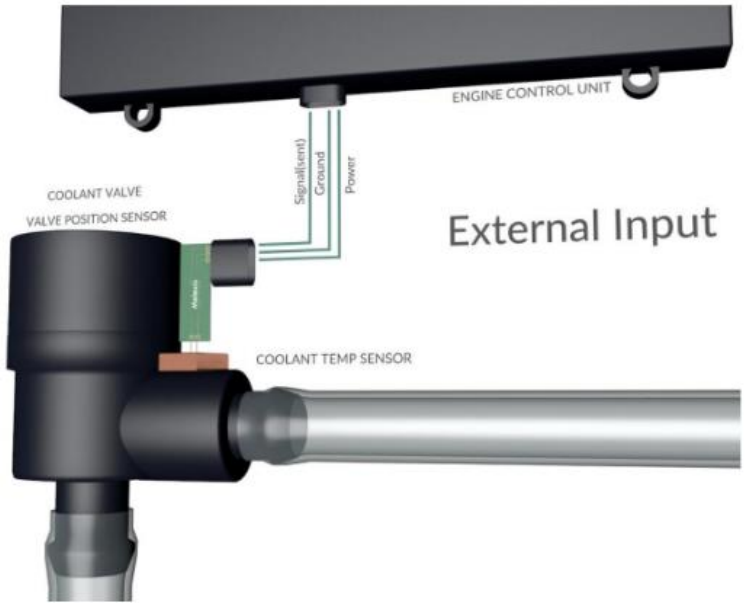
Features and benefits



MLX90374: Input Pin for Expansion Capabilities

- Input pin allows for reduction in wire count and harness complexity -> further integration & weight savings



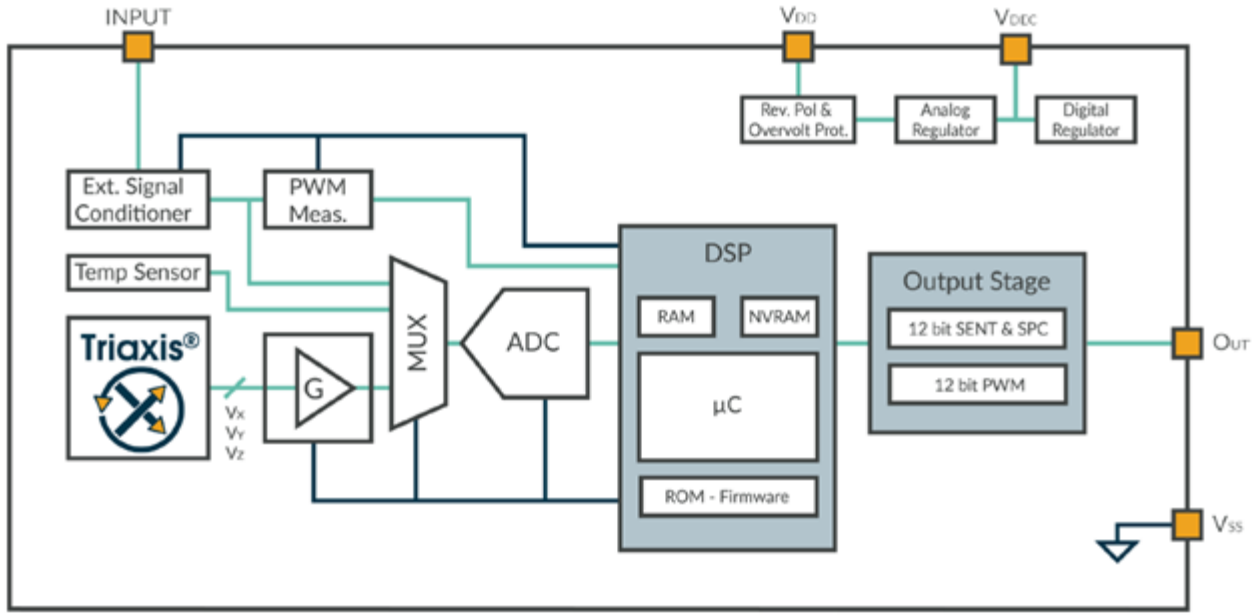


- Analog In
- PWM In

Features and benefits

Input supply voltage & output mode

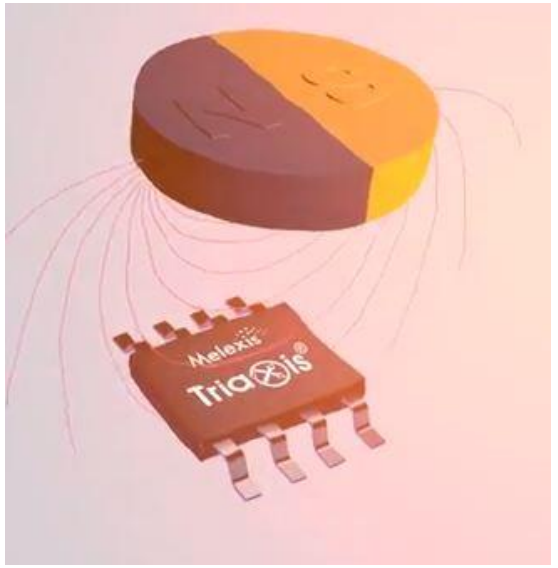
- Input voltage:
  - For voltage regulated mode
    - 4.5V --- 5.5V
  - For battery usage
    - 6V --- 18V
- Output mode:
  - MLX90371: Analog
  - MLX90372/4: PWM & SENT



High working temperature

Higher ambient temperature

-40degC



160degC

- 160°C ambient with low degradation of performance to allow customers to target high temp applications (e.g. engine compartment)

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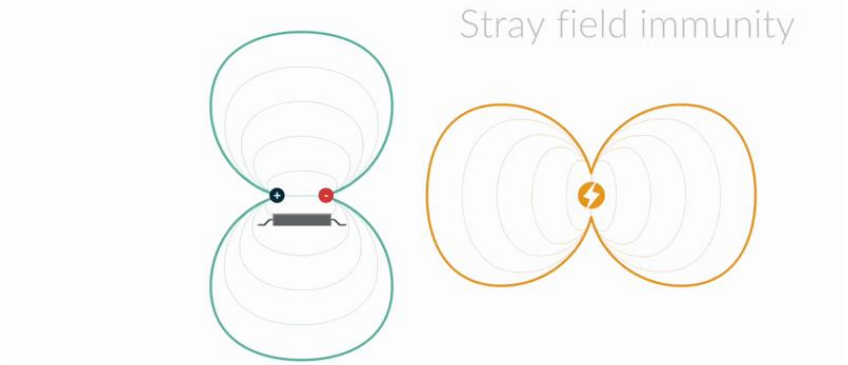
Stray field immunity

Immunity to external field (stray field robustness)

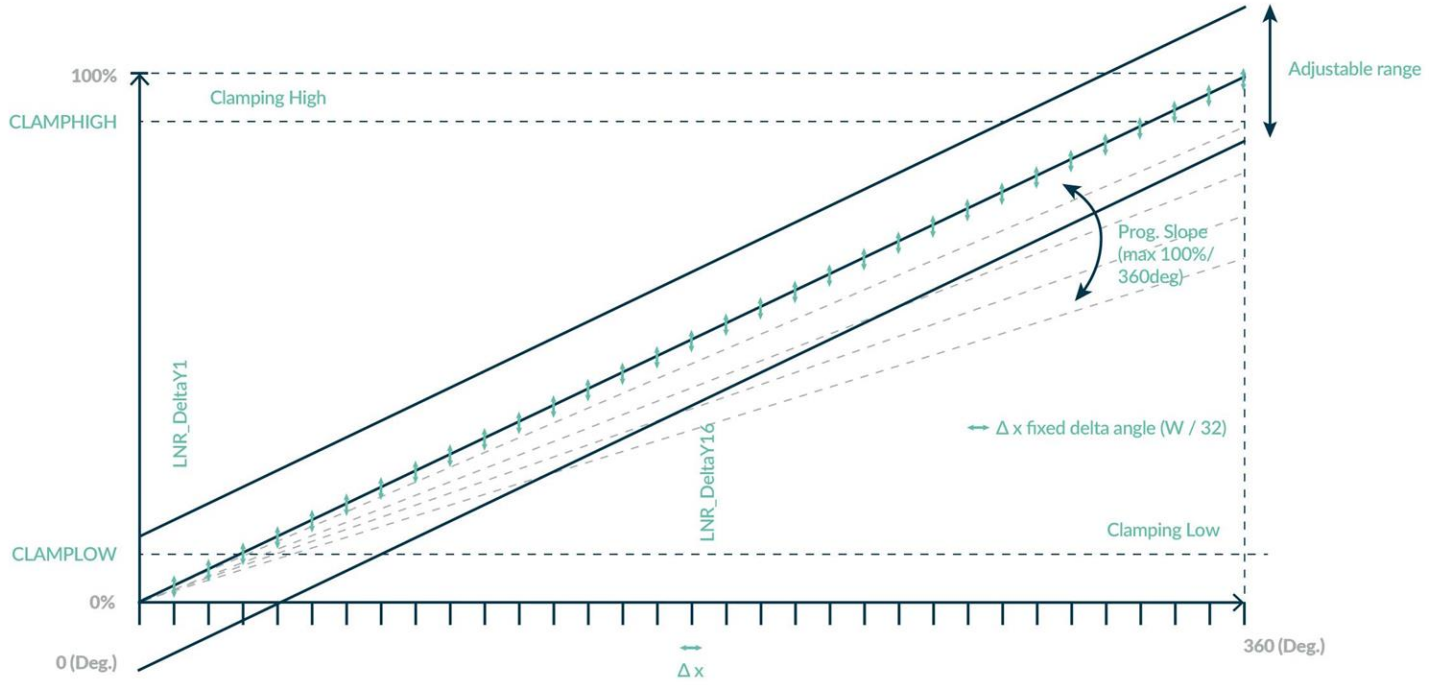


- less constraint on the sensor location vs. disturbing sources
  - ISO11452-8:2007-7: External magnetic field immunity
  - ISO will become the standard for the German OEMS/VDA
  - Based on ISO(4000A/m = 5mT) and current carrying conductor tests (400A@25mm = 3.2mT) to meet next-gen OEM requirements

Accuracy

Legacy mode

- X/Y intrinsic linearity error +-1 deg
- Max X/Y thermal drift is 0.45 deg (relative to 35 degC)
- IC Noise max 0.1deg w/o filter under 40mT
- 32points calibration

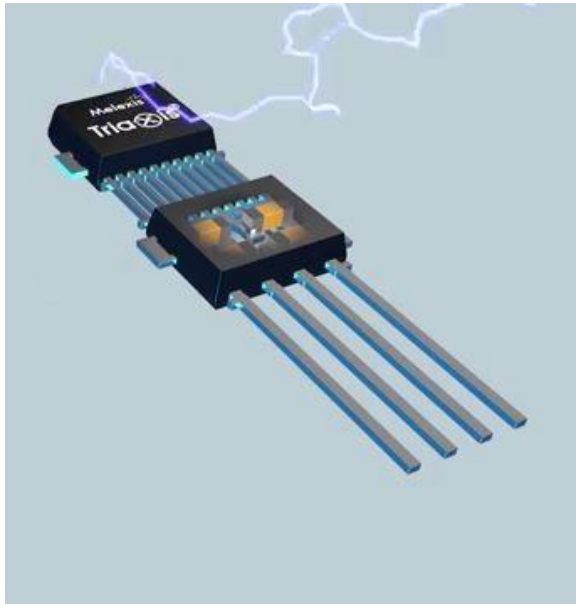


EMC/ESD

Design focus

- Gen III: EMC GM 85V DCC requirement pass @150degC with limited external components

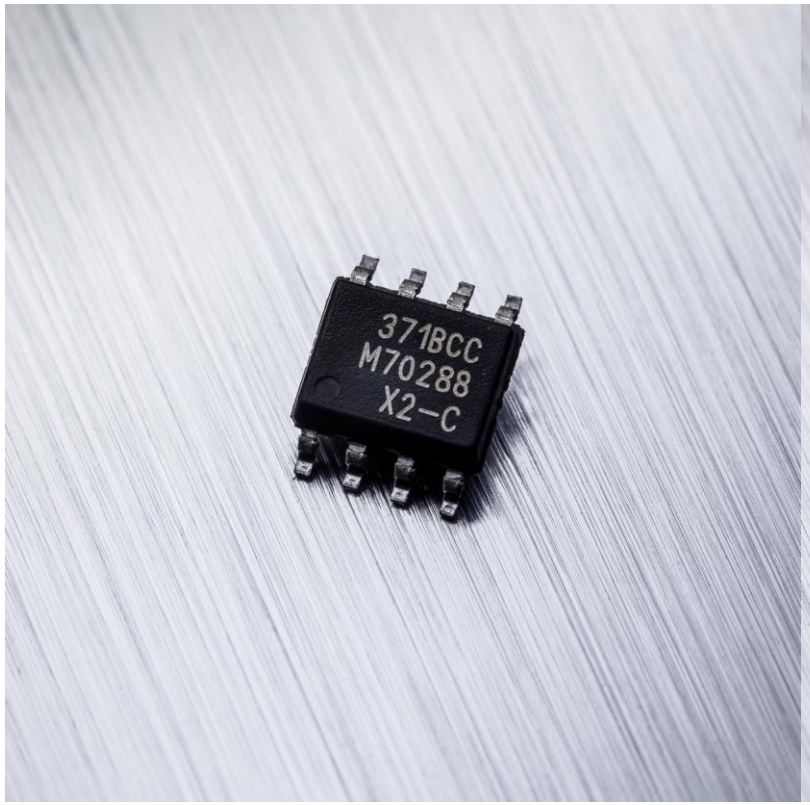
- ESD: 6KV



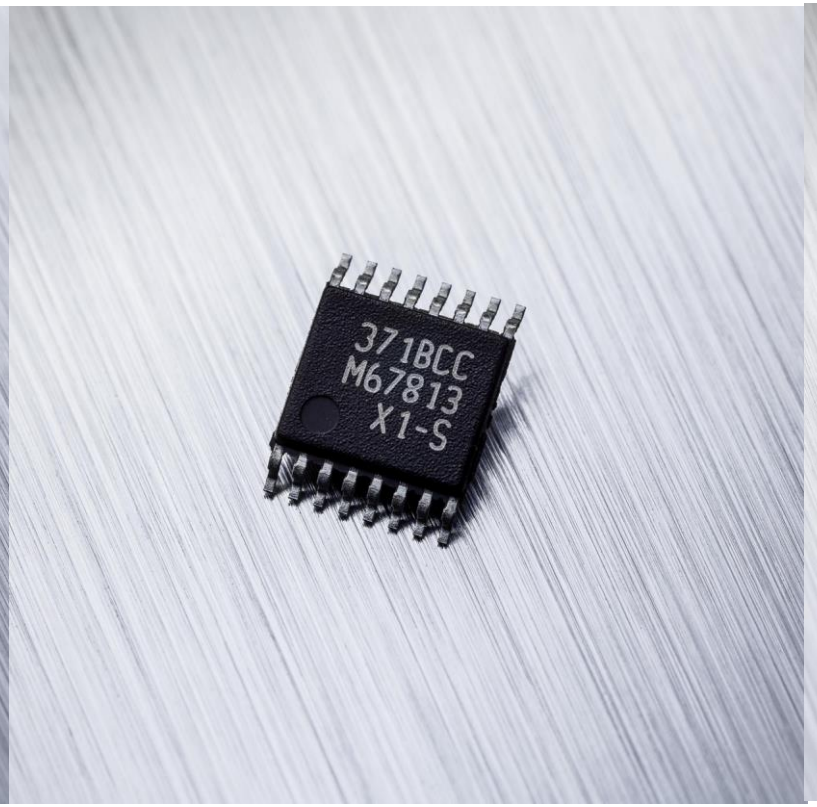
Package lists overview

Package in Gen3

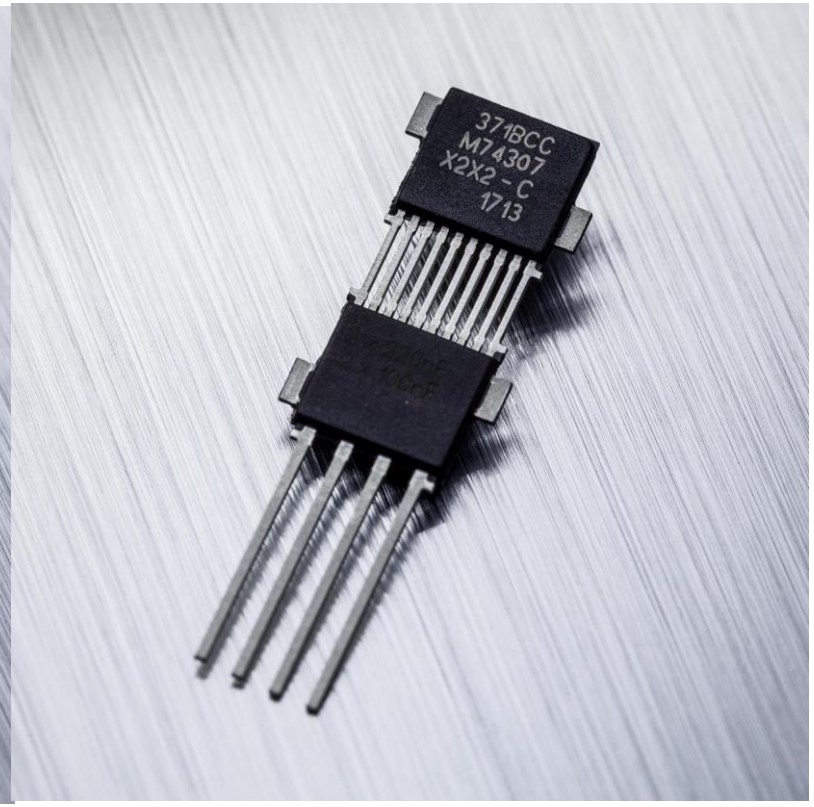
SOIC8



TSSOP16



DMP



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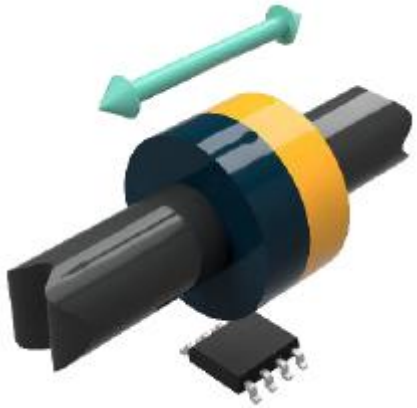
Magnetic working principle

Motion mode --- 2 pole



- End of shaft

  α = ATAN(By/Bx)

- Through shaft

  α = ATAN(K*By/Bx)

  α = ATAN(K*Bz/Bx)

- Linear

  α = ATAN(K*Bz/Bx)

  β = ATAN(K*Bz/By)

- Joystick

$$\alpha = \mathrm{ATAN}\left(\frac{\sqrt{(k_Z V_Z)^2 + (k_t(V_Y - ORTH_{zy} * V_Z))^2}}{V_x - ORTH_{zx} * V_Z}\right)$$

$$\beta = \mathrm{ATAN}\left(\frac{\sqrt{(k_Z V_Z)^2 + (k_t(V_X - ORTH_{zx} * V_Z))^2}}{V_y - ORTH_{zy} * V_Z}\right)$$

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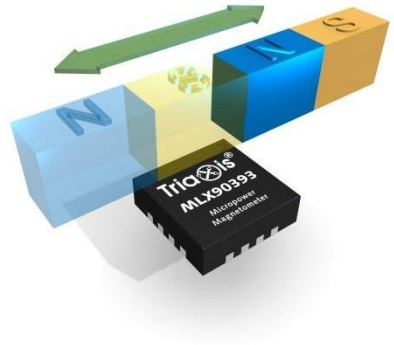
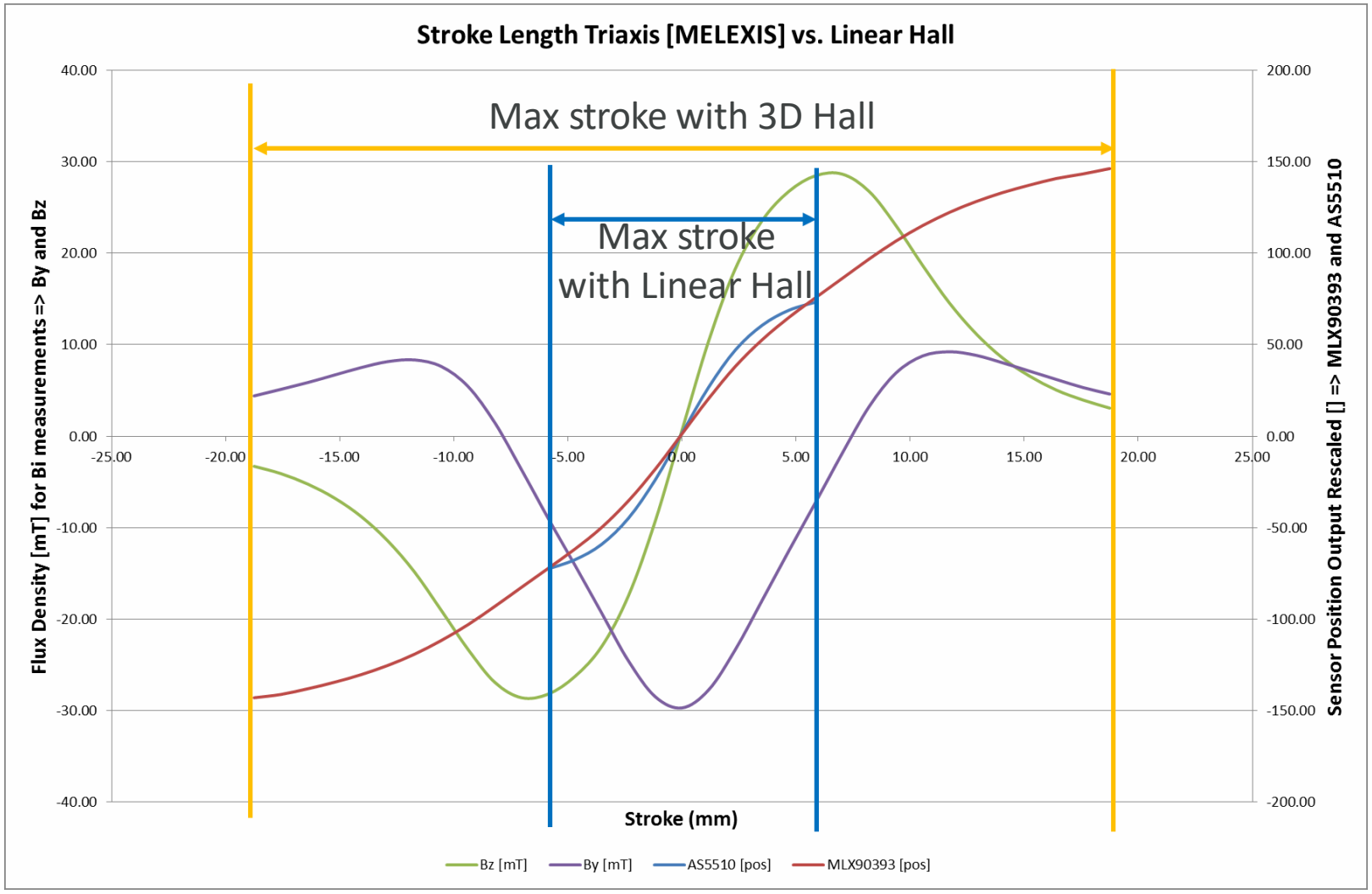
Bonus: The Triaxis Advantage

Longer stroke length (x3)





MLX90393 Magnotometer
MLX90395 Magnetometer

MLX90395 Triaxis® Magnetic Node

What Is It?

- The MLX90395 is the automotive qualified version of the MLX90393 released for consumer markets
- For all sensing motion: rotary, linear, joystick/3D
- The MLX90395 is a sensor designed to be embedded in a customers application
  - Low voltage supply only: typically 3.3V
  - I2C or SPI bus (selectable) is not for transmission over a long harness

MLX90395 Triaxis® Magnetic Node

Delta vs MLX90393

	MLX90393	MLX90395
Market	Consumer/Industrial	**Automotive** Consumer/Industrial
Example Applications	HMI, White goods, multimarket	Joystick, Stalk, Shifter, HMI
Package	QFN-16 WLCSP	QFN-16 SOIC-8
Dual die	N/A	TSSOP-16
Supply	2.2 – 3.6V	2.2 – 3.6V
Speed (XYZ)	~1kHz	**2kHz**
Measures	XYZ & T	XYZ & T & **V**
On-chip trimming	Offset SensDrift	Offset & Offdrift Sens & Sensdrift
ASIL	N/A	N/A (Safety Integration Manual available)
Temperature	-40-85°C	**-40-125°C**

MLX90395 Triaxis® Magnetic Node

MLX90395: I2C or SPI Enables Embedded Operation

- The SPI or I2C output allows for using just about any microcontroller to interface to the sensor
  - Primary application is varied: shifters, turn signal stalks, steering angle,

Shifters	Turn Signal Stalks
	

Current sensors

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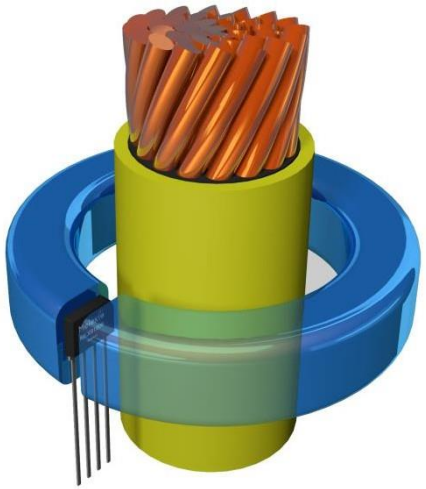
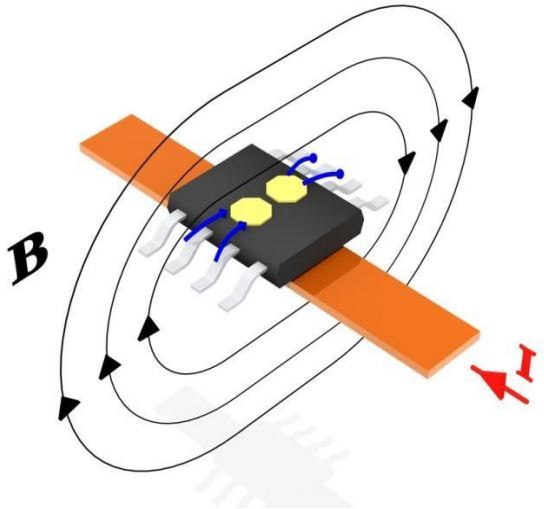
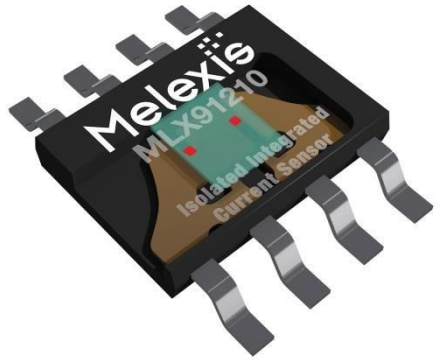
Product Families

3 Families



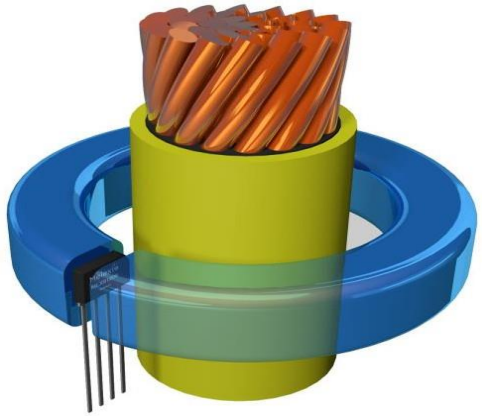




- Conventional Hall
- IMC-Hall
- Plug & Power

Non Intrusive current sensing

Conventional Hall



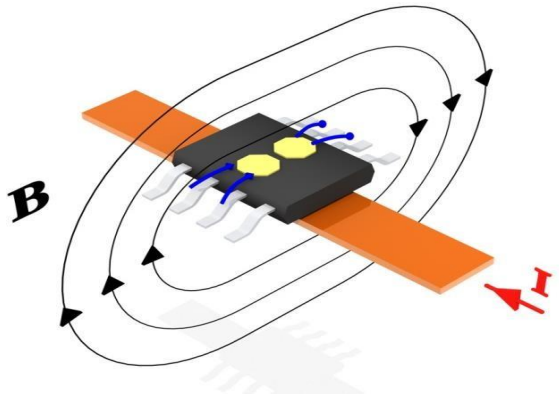
Pros

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

Cons

- Performance limited by the core
- Bigger footprint (size, weight) than Triaxis solutions

Planar Hall (Triaxis)



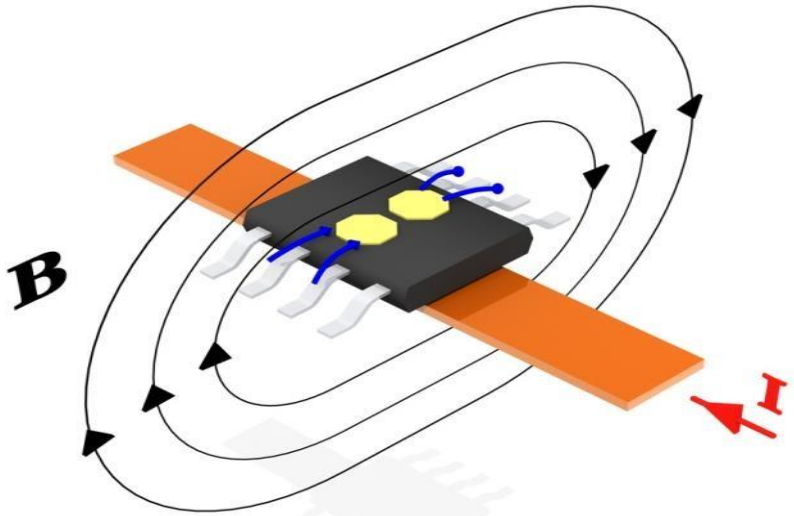
Pros

- Simple assembly and low footprint
- IMC features very high permeability and low hysteresis

Cons

- Requires magnetic shield or specific design to avoid cross-talk and/or impact from external fields

Triaxis Advantage

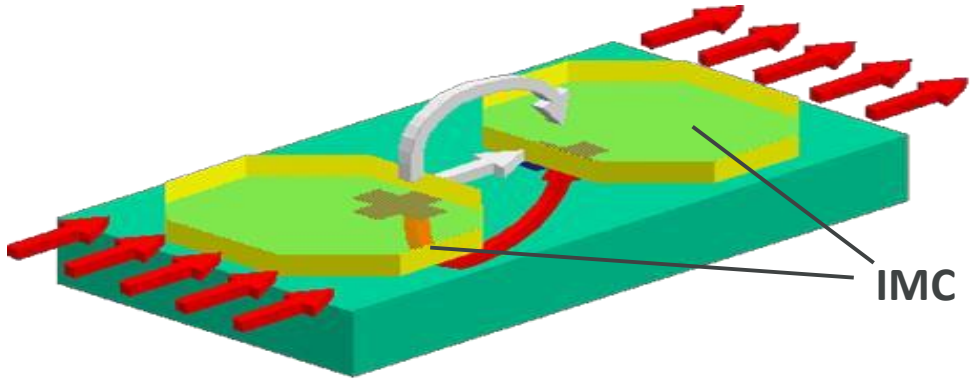


IMC makes a parallel magnetic field locally perpendicular to the chip surface

Key benefits

- Sensitive to magnetic fields **parallel** to the chip surface
- Locally **increased flux density (magnetic gain)**
  - Higher sensitivity
  - Higher signal-to-noise ratio
- Mechanical alignments and distances are crucial – Melexis will simulate and suggest shielding and physical layouts

B field



IMC = Integrated Magnetic Concentrator

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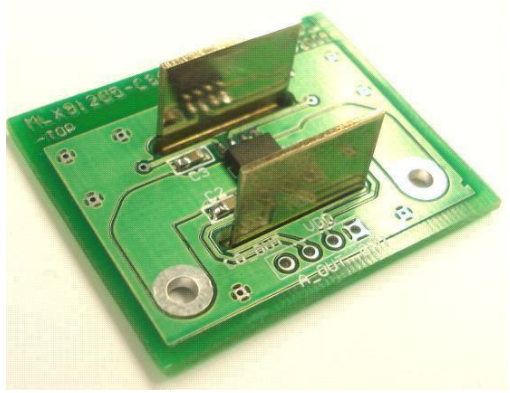
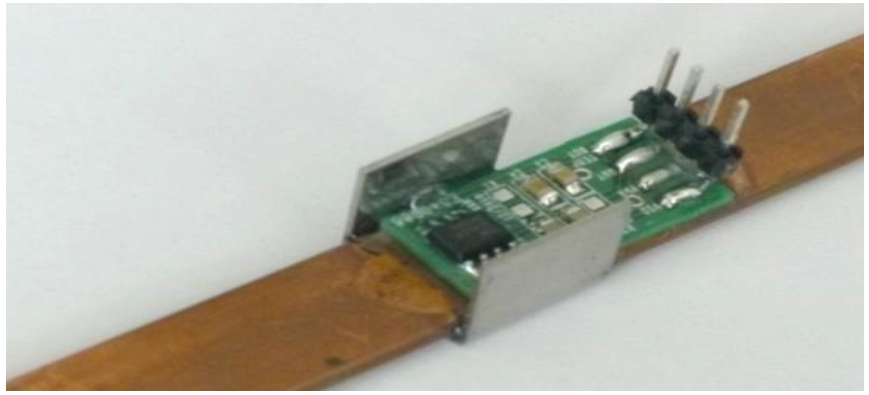
Typical Implementation

On PCB trace



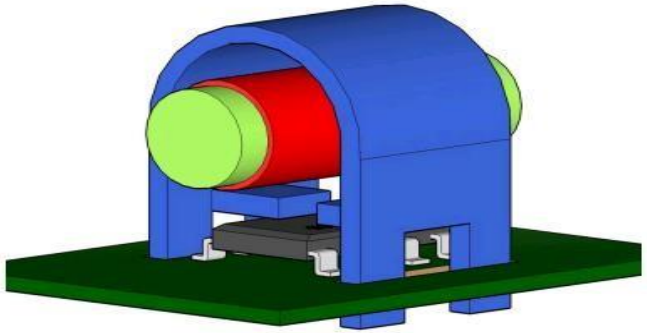
Typical range: 5-50A

On bus bar



Typical range: 50-1000A

On cable



Typical range
10-100A

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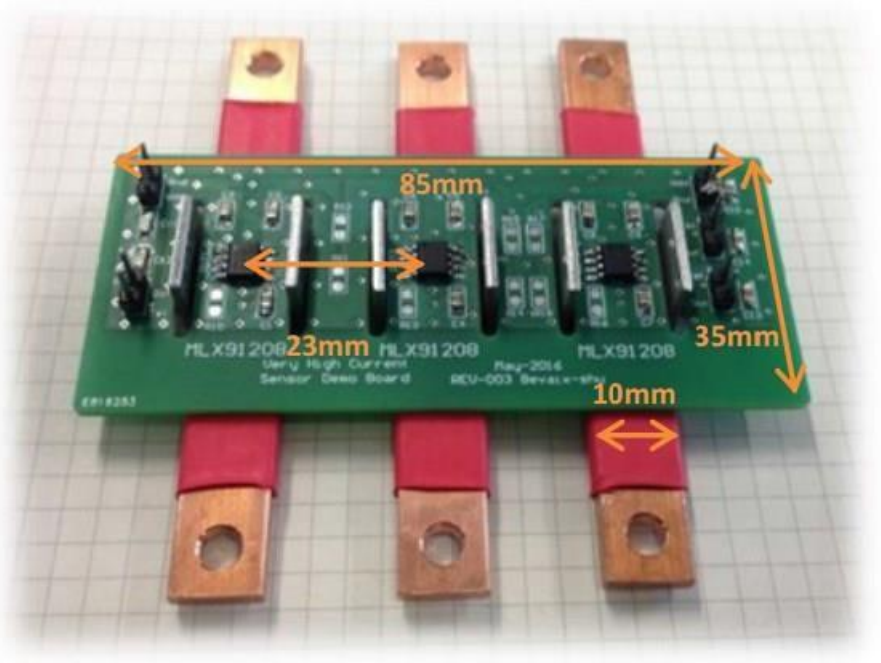
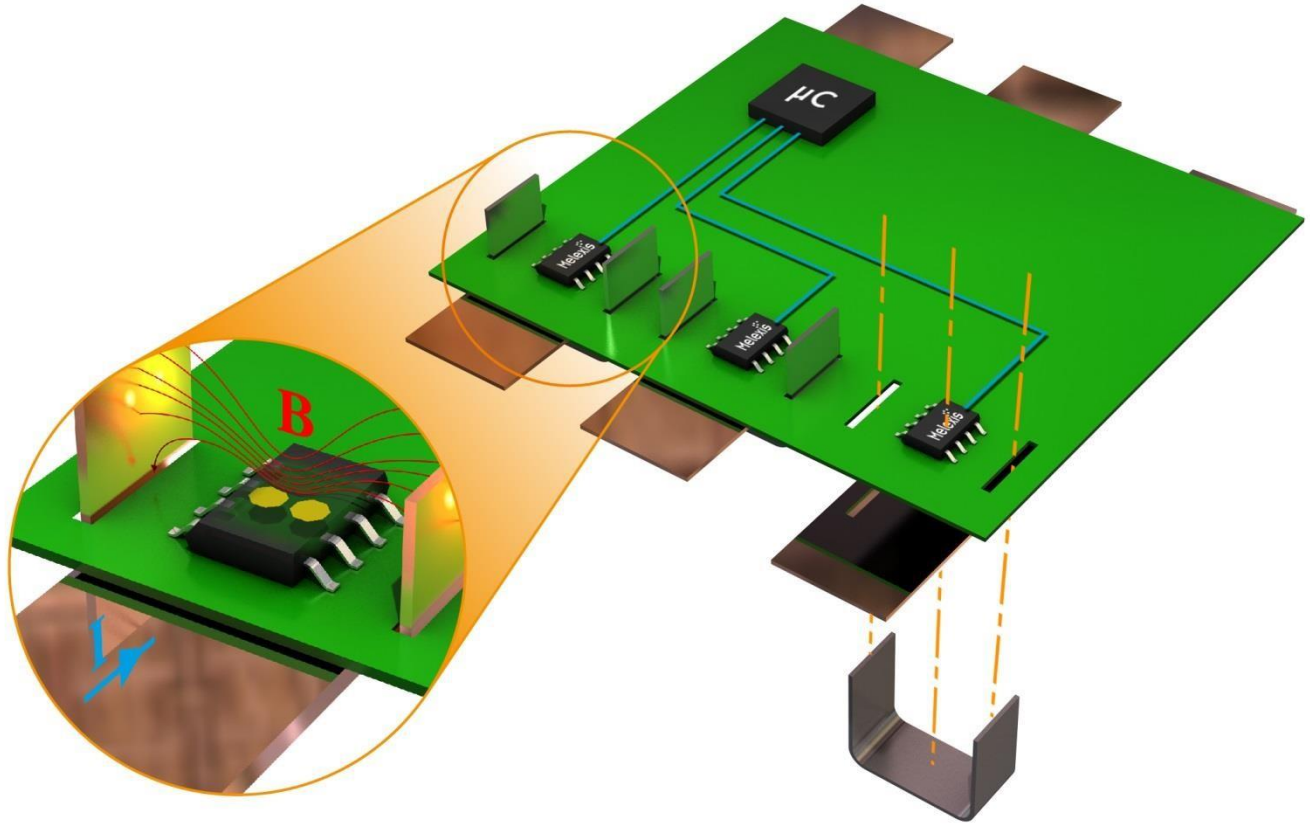
Application – Multiple Phase

- Vertical Stacking – Sensor directly on control PCB
  - Simple mechanical construction

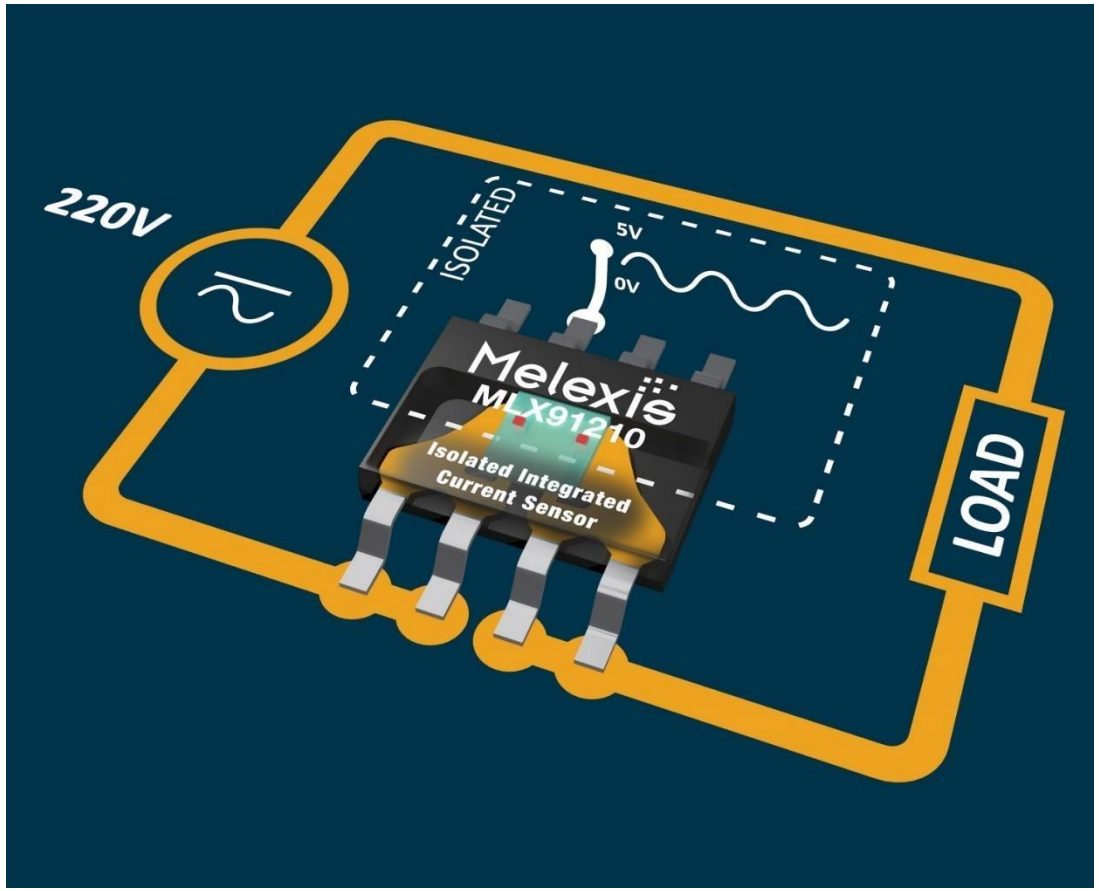




Intrusive Current Sense - Plug and Power

MLX91210 – Industrial or Consumer

- No shields – Differential measure
- Factory calibrated integrated current sensor
- Low resistance conductive path (0.7-0.8mΩ)
- Robust to external magnetic fields via differential measurement
- Industry standard SOIC footprint
- DC-100kHz bandwidth
- 2.1kV$_{RMS}$ (SOIC8) and 2.5kV$_{RMS}$ (SOIC16) isolation



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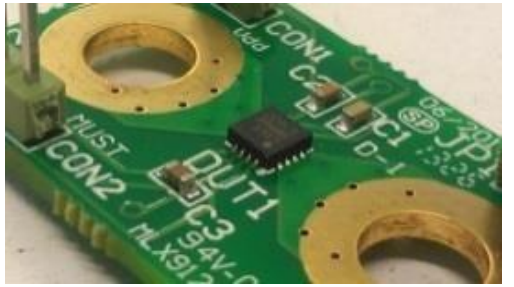
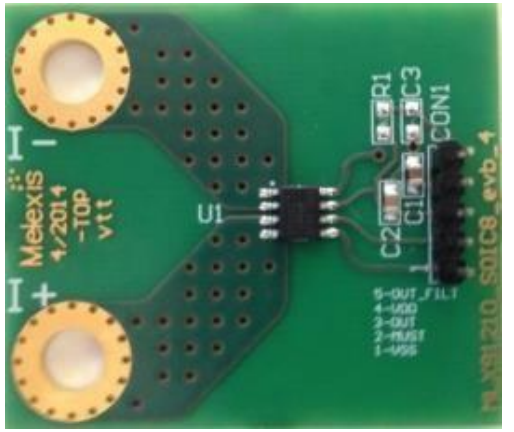
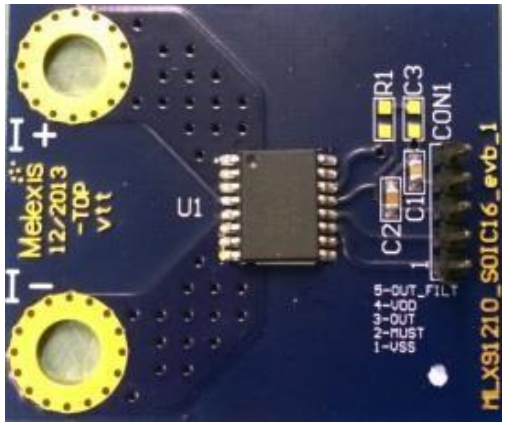
Focus product

“Plug & Power” Isolated current measurement

MLX91210	QFN	SO-8	SOIC-16
Nominal current range [A]	±40	±20	±20
Overcurrent @25°C [A]	±50	±35	±45
Sensitivity (max) [mV/A]	50	80	80
Resolution @1kHz [A]	0.04	0.02	0.02
Voltage isolation [kV]	1	2.1	2.5
Creepage distance [mm]	0.3	4	7
Response time [µs]	5	5	5
Resistance [mΩ]	0.2	0.8	0.7
Temperature range [°C]	-40 to 125°C	-40 to 125°C	-40 to 125°C







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Applications

Smart appliances

Power Extractor, Battery Charger and Converters

Energy

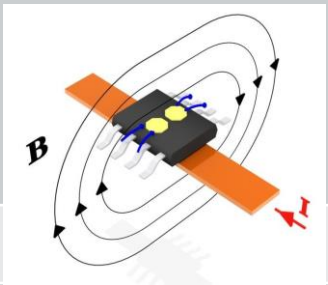
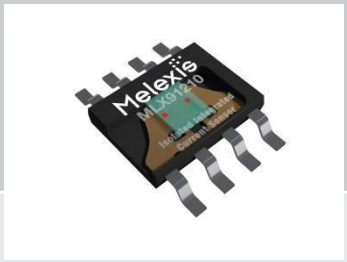
E-bikes, E-vehicles, …

Transport

PDU, Servers

Industrial

Quick Summary

	Conventional Hall	IMC-Hall	Integrated Primary
Sensing Concept			
Sensing Technology			
Mounting	Through-Hole Non-intrusive	Surface-Mount Non-intrusive	Surface-Mount Intrusive
Ferromagnetic Concentrator	Core-type External	Integrated Magnetic Concentrator (IMC)	N/A
Factory Calibration	mV/mT	mV/mT	**mV/A**
EOL Reprogramming	Correction field factor “mT/A” variation: On-Chip/Micro or Degraded Accuracy (no correction)		N/A
Current Sensing Range	10-5000A	30-1000A	10-50A
Cross-talk Immunity	Core	Shield	Differential

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Thank you
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