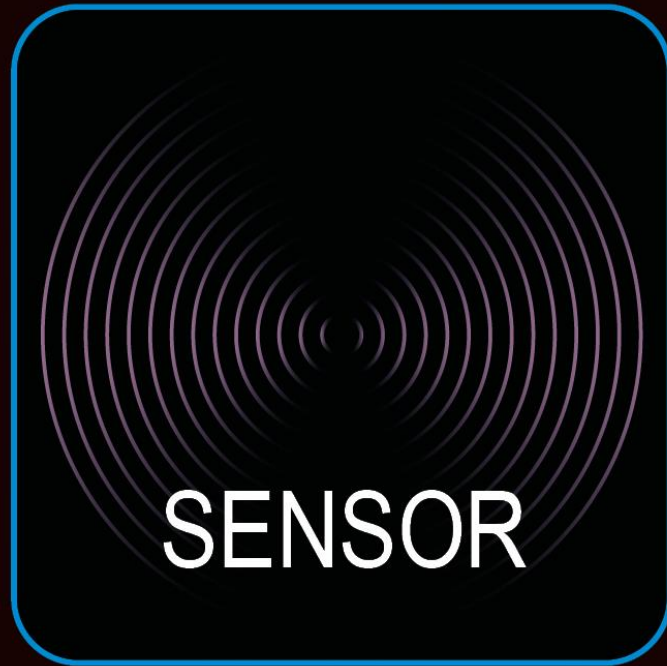


RUTRONIK TECHTALK **MEETS**



08.06. - 10.06.2021 | **ONLINE**

Overview of the Melexis Magnetic Position Sensors Portfolio

Jerome Degois
Regional Marketing Manager



Agenda

- Upcoming product launches

1. Value Optimized sensing

New 3D magnetometer MLX90392

2. Mainstream sensing

New 2D angular sensor MLX90421/22

3. Performance sensing

Rotary position sensor MLX90377 for Automotive applications

Joystick sensor MLX90378 for industrial markets

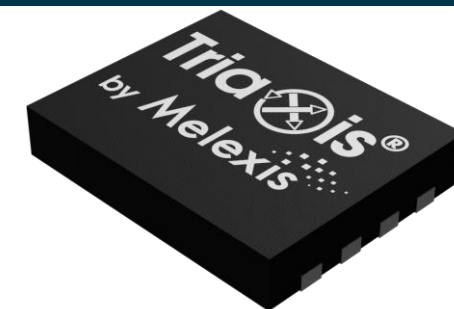
Value Optimized Sensing

Value optimized Sensing

NEW

MLX90392

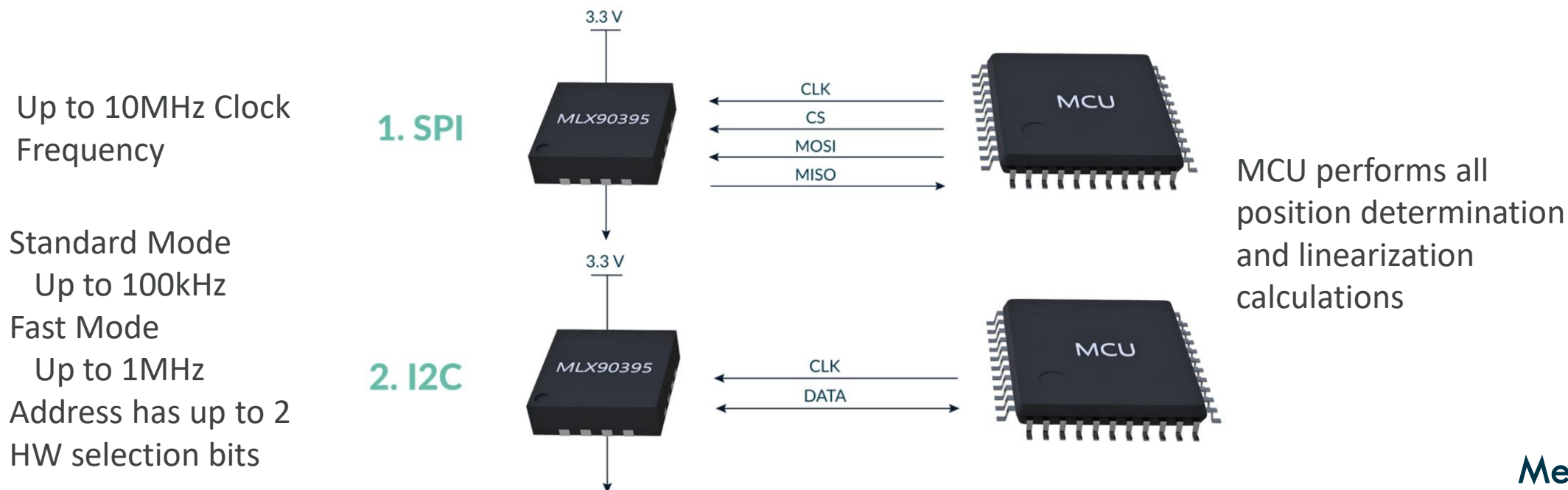
- New 3D magnetometer for Consumer Markets



- Launch date: 6th May 2021

Value Optimized Sensing

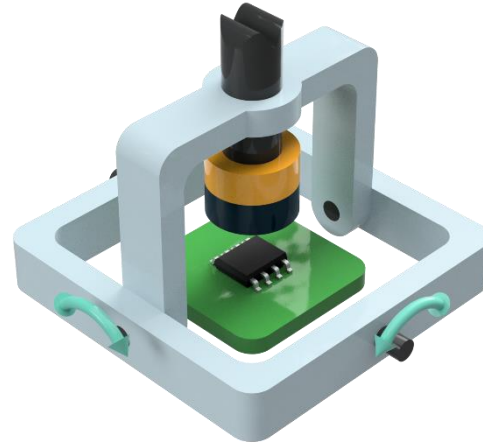
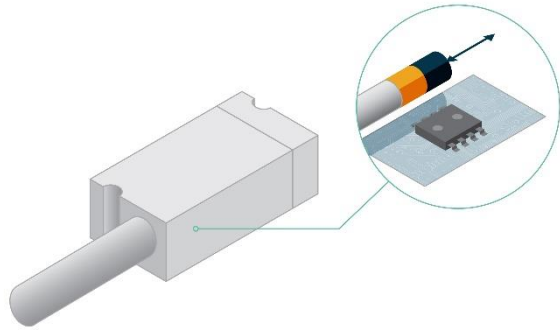
- The magnetic nodes are magnetic field sensors designed to sense X, Y, and Z magnetic fields
- Unlike other Triaxis devices in the Melexis portfolio, these devices are designed to be a companion chip to a host microcontroller with position calculation and linearization performed on the microcontroller.



Triaxis® 3D Magnetometer

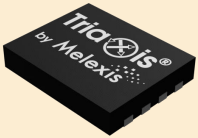
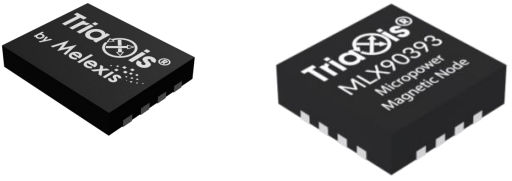

Many motions in 1 package

Linear sensor



Triaxis® 3D Magnetometer

Portfolio

Micro Power			
Part	90392 "Magnetic Node Gen II - Low supply" NEW	90393 "Magnetic Node Gen I"	90395 "Magnetic Node Gen II"
Market	Consumer	Consumer / Industrial	Industrial / Automotive
Supply	1.65V..1.95V	2.2V..3.3V	2.6V..3.3V
Packages	 UTDFN-8	 QFN-16 UTDFN-8	 QFN-16 SOIC-8 TSSOP-16
Magnetic Field range	+/-5mT & +/-50mT	+/-50mT	+/-50mT & +/-120mT
Application	Mono-sensor	Multi-sensor	Multi-sensor
Relative cost	€	€€	€€€
Status Q2/2021	Launch on 6 th May 2021	MP	MP

Value optimized Sensing

Value proposition

Triaxis® 3D Magnetometer benefits

Programmable in situ
Flexible magnet mounting
Limited PCB footprint with 2x 2.5mm package
Space constrained applications (only 0.4mm high)
Battery powered application down to 100µA @F=100Hz
Compatibility with 1.8V microcontroller supply
Easy implementation of a 2D/3D angular applications

MLX90393 [reference]

Feature+	Benefit for the customer
Low noise	Better position accuracy
Bus application	up to 16 slaves on one I ² C bus

MLX90395 [difference with the MLX90393]

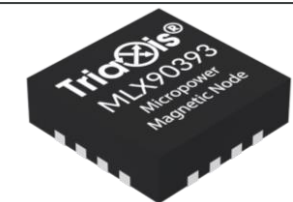
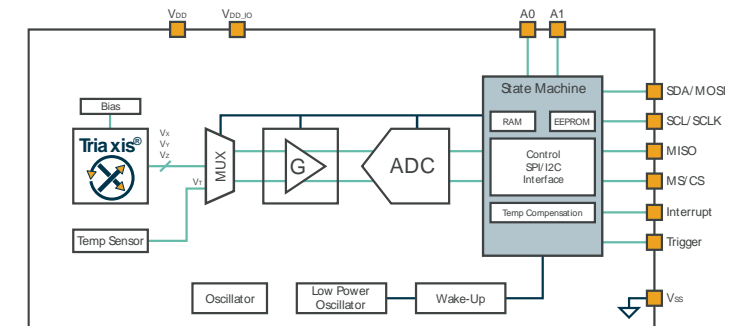
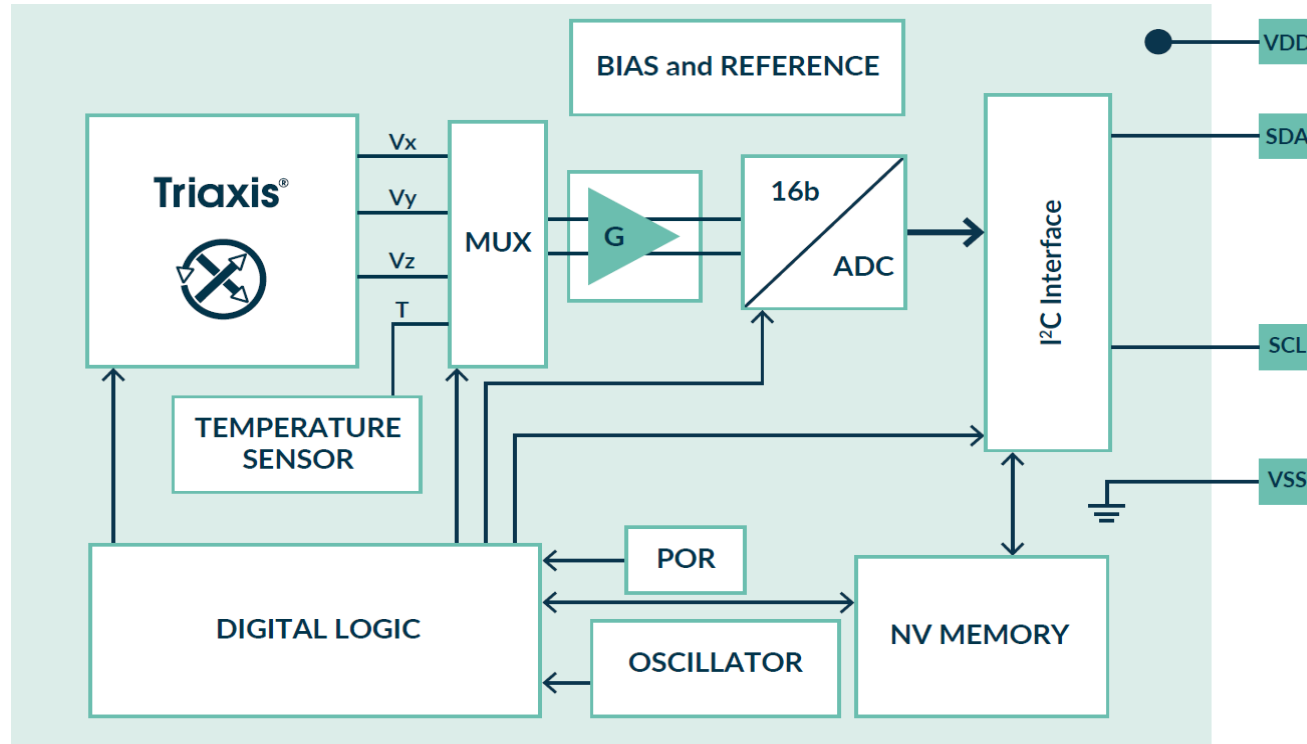
Feature+	Benefit for the customer
CRC (Cyclic Redundancy Check) on the data frame	Very high level of data integrity. The customer can address safety applications.
High temperature	Up to 125C ambient temperature
Dual die package	Full redundancy for safety critical applications
2KHz update rate	Faster applications

MLX90392 [difference with the MLX90393]

Feature+	Benefit for the customer
Supply 1.8V	The customer can supply the sensor with the same power supply as the µC. No LDO / additional regulator required.
1.4Khz update rate	Faster applications

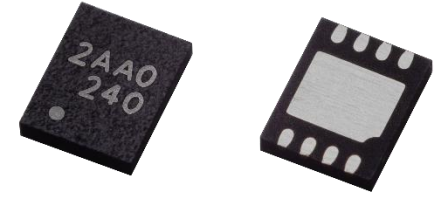
MLX90392

Block diagram



MLX90392

Key figures – *Noise & Current*



Average Current
(100Hz)

RMS Noise XY

100uA



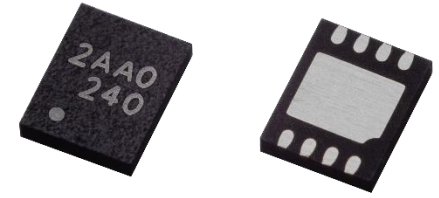
25uT

950uA



7uT

MLX90392



Key figures - *Consumer*

Output protocol

I2C

- Fast Mode (400kHz) and plus (1MHz)
- Fixed HW Address + 7bits SW

Functional modes

Idle mode

- Sleep mode

Single measurement

- Command XYZ and Temp

Continuous mode

- Continuous up to 1.4KHz data rate
- Program Interval (0.1% to 100%DC)

Memory

Type

- OTP

Electrical

Supply

- Vdd=1.8V +/-0.15V

Idd_Sleep

- 1.5uA

Idd_Meas

- XY: 2.7mA, Z: 1.8mA

Idd_avg
(@100Hz)

- 950uA with Low Noise
- 100uA with Medium Noise

Noise rms

- Low noise <7uT
- Medium Noise XY~25uT Z~35uT

Package

Type

- UTDFN-8

Temperature

Range

- -40 to 85degC

MLX90392

Main applications

PC Peripherals



Source: Logitech

Gaming / Joysticks



Source: Sony

Whitegoods HMI



Doors / windows closing detection



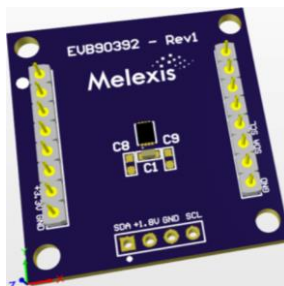
Anti-tamper for e-meters



MLX90392

Evaluation Tools

- ✓ User interface to get started fast!
- ✓ Code Samples compatible with Arduino - Mbed
- ✓ Evaluation Board and Demos



MLX90392

Documentations

✓ Get started with the EVB!

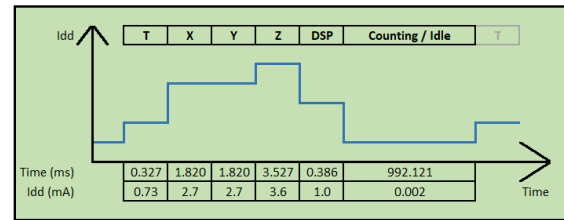
✓ Average Current consumption calculator

MLX90392 IDD Calculator Rev 001

Version	-010
T_COMP_EN	1
DIG_FILT_HALL_T	1
DIG_FILT_HALL_XY	4
DIG_FILT_HALL_Z	5
OSR_TEMP	1
OSR_HALL	1
Burst frequency (Hz)	Single
Single frequency (Hz)	1

	Number of clocks	Time (typ, ms)	Idd (typ, mA)
Temperature	784	0.327	0.73
X	4368	1.820	2.7
Y	4368	1.820	2.7
Z	8464	3.527	3.6
DSP	926	0.386	1.0
Subtotal		7.879	
Idle Counting duration		0.000	
Idle Idle time		7.879	
Period		1000.000	
Counting/Idle duration		992.121	0.0015

[No timing conflict?] OK/NOK:	OK
Average current consumption (mA):	0.025



Application note

MLX90392 EVB

1. Scope

This document shows the schematic of the EVB and how it can be used easily to get started. Note that any of the code is provided as is, and is not guaranteed to be error free. It is only to be used as a demo.

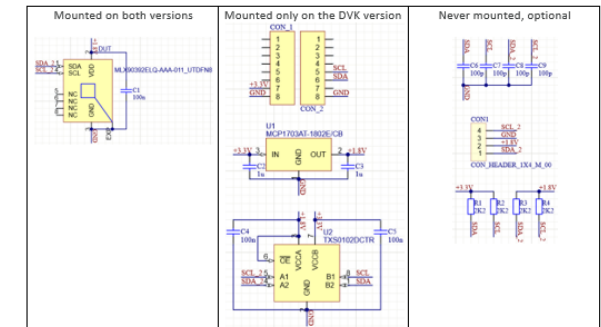
1.1. Different EVB Versions

Important: the MLX90392 operates at 1.8V, which means that when connecting it to a microcontroller one needs to either use a 1.8V microcontroller or use a level shifter in between. The EVB for both the 50mT and the 5mT version are offered in two flavors for exactly this reason. The PCB itself is the same, but some components are not mounted on the breakout version:

- **Breakout version:** The IC is mounted, together with a 100nF decoupling capacitor. The four pins of the IC are directly routed to the 4-pin header.
- **DVK Magnetic version:** The IC is mounted, together with a 100nF decoupling capacitor. Also a level shifter and 1.8V regulator is added to the PCB to translate the 3.3V supply and signal levels from the main DVK to the 1.8V levels needed by the IC. This version can be used also with other microcontrollers not operating at 1.8V, using the parallel connectors. Note that the drill holes of these are smaller than the standard headers, this due to the DVK having precision header sockets.

1.2. Schematic

The schematic is for each version (Breakout and DVK) the same, and shown below for the -011 version of the IC. Some components are never populated but can be placed by the user in case needed.



REVISION 001
[DOCSERVER NR]

Page 2 of 12

Mainstream Sensing

Magnetic Position Sensors

■ Rotary Motion

- Up to 360 degrees
- On or off axis


■ Linear/Arc Motion

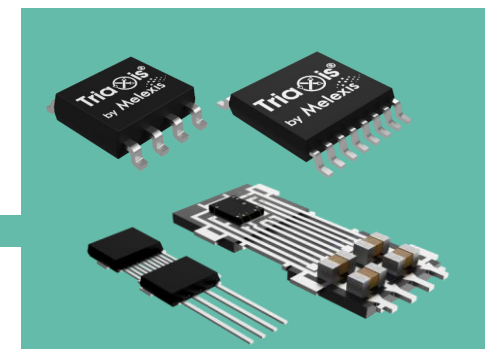
- Up to 30mm (± 15 mm) per sensor

■ Joystick/3D Motion

- Up to 180 degrees in 2 axes

■ Common Benefits

- Non contacting – no wear-out of sensing element
- Small size – PCB-mount and PCB-less packages
- Excellent accuracy and low drift
- High EMC and absolute max ratings
- Simple magnet requirements
- Long history – First 3D sensor on the market since 2004
- ISO26262 /  for safety critical applications



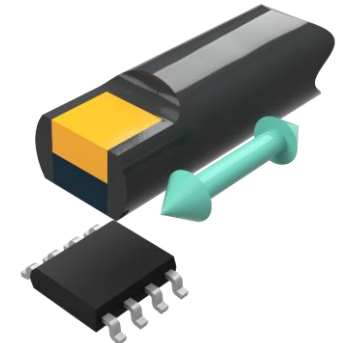
Mainstream Sensing

MLX90364 and MLX90365

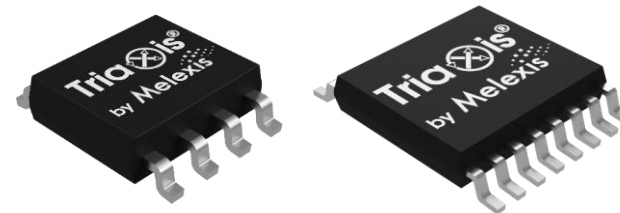
Parameter		MLX90364	MLX90365
MOTION	Rotary	▪	▪
	Linear	▪	▪
	Joystick		
STRAY FIELD IMMUNE	Rotary		
	Linear		
PACKAGE	SOIC-8		▪
	TSSOP-16		▪
	PCB-less	▪ (DMP-4)	
OUTPUT	Analog	▪	▪
	PWM	▪	▪
	SENT		
ASIL	B (SEooC)		



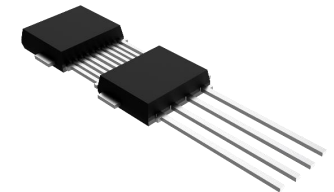
Rotary motion without stray field robustness



Linear motion without stray field robustness



Single Die SOIC-8
Dual Die (redundant) TSSOP-16



Single Die PCB-less DMP-4

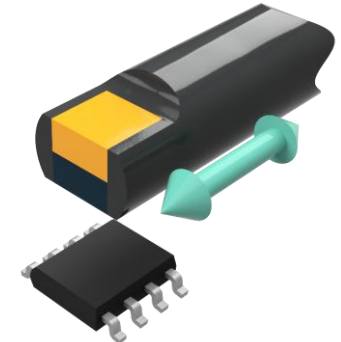
Mainstream Sensing

MLX90366 and MLX90367

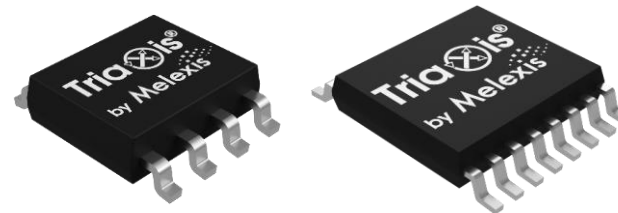
Parameter		MLX90366	MLX90367
MOTION	Rotary	▪	▪
	Linear	▪	▪
	Joystick		
STRAY FIELD IMMUNE	Rotary		
	Linear		
PACKAGE	SOIC-8		▪
	TSSOP-16		▪
	PCB-less	▪ (DMP-4)	
OUTPUT	Analog		
	PWM		
	SENT	▪	▪
ASIL	B (SEooC)		



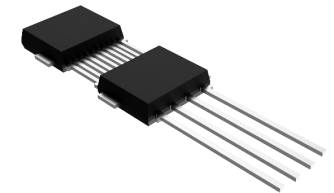
Rotary motion without stray field robustness



Linear motion without stray field robustness



Single Die SOIC-8
Dual Die (redundant) TSSOP-16



Single Die PCB-less DMP-4

Mainstream Sensing

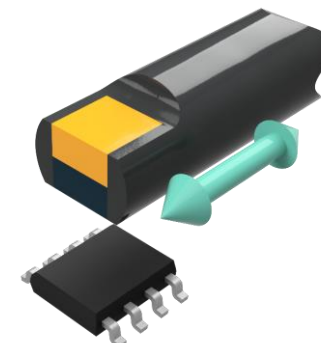
MLX90421 and MLX90422

NEW!! In June 2021

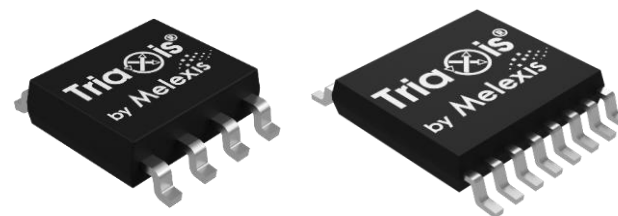
Parameter		MLX90421	MLX90422
MOTION	Rotary	▪	▪
	Linear	▪	▪
	Joystick		
STRAY FIELD IMMUNE	Rotary		
	Linear		
PACKAGE	SOIC-8	▪	▪
	TSSOP-16	▪	▪
	PCB-less	▪	▪
OUTPUT	Analog	▪	
	PWM	▪	
	SENT		▪
ASIL	B (SEooC)	▪	▪



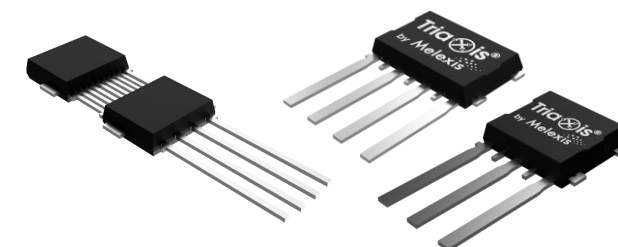
Rotary motion without stray field robustness



Linear motion without stray field robustness



Single Die SOIC-8
Dual Die (redundant) TSSOP-16



Single Die PCB-less DMP-4 and
SMP-3. Dual die SMP-4

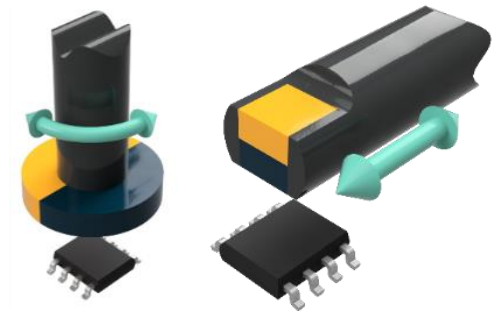
Mainstream Sensing

MLX90421 and MLX90422

Value proposition

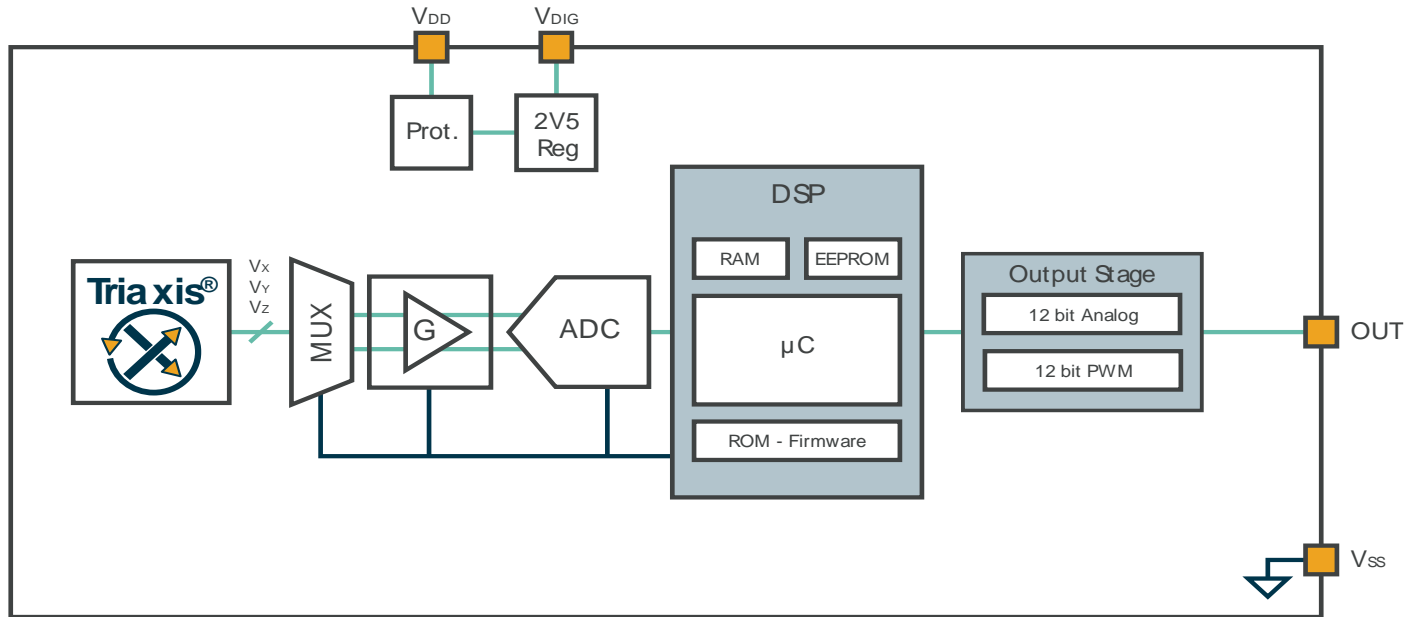
Triaxis technology unique value with:

- improved EMC capability and absolute maximum ratings up to the level of MLX9037x family
- Same feature set as MLX9036x
 - On and off-axis rotary and linear position sensing
 - 3/4/5 and 16 calibration points for high accuracy
 - Wide magnetic field range (10-70mT)
- ASIL B SeooC acc. to ISO26262 (eq. to SIL2)



MLX90421

Block diagram

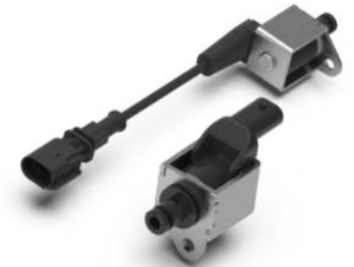


Confidential

MLX90421

Applications

- Industrial - Agriculture :
 - Joystick with angular movement (2 x sensors),
 - Generic low speed rotary encoder
 - Water valve for Mobile Hydraulics
- Motorcycles:
 - Clutch pedal sensor
 - Throttle
- Logistics – Off road vehicles
 - Height sensor
 - Pedal sensor



Confidential

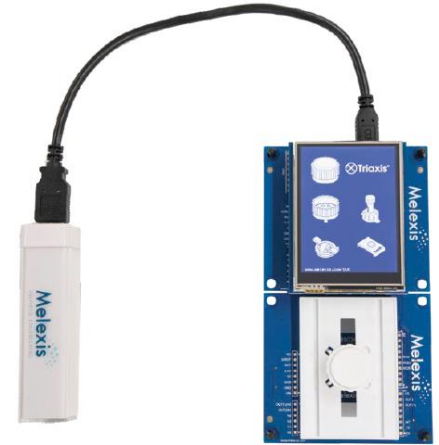
MLX9042x

Product	Launch date
MLX90421 – Legacy Analog / PWM Out	Jun. 21 (only SMD packages)
MLX90422 – Legacy SENT Out	

MLX90421

Tools & Support material

- EVB's – Compatible with Triaxis DVK
- App note – Back-end calibration methods
- Programmable through standard Melexis programmer PTC04

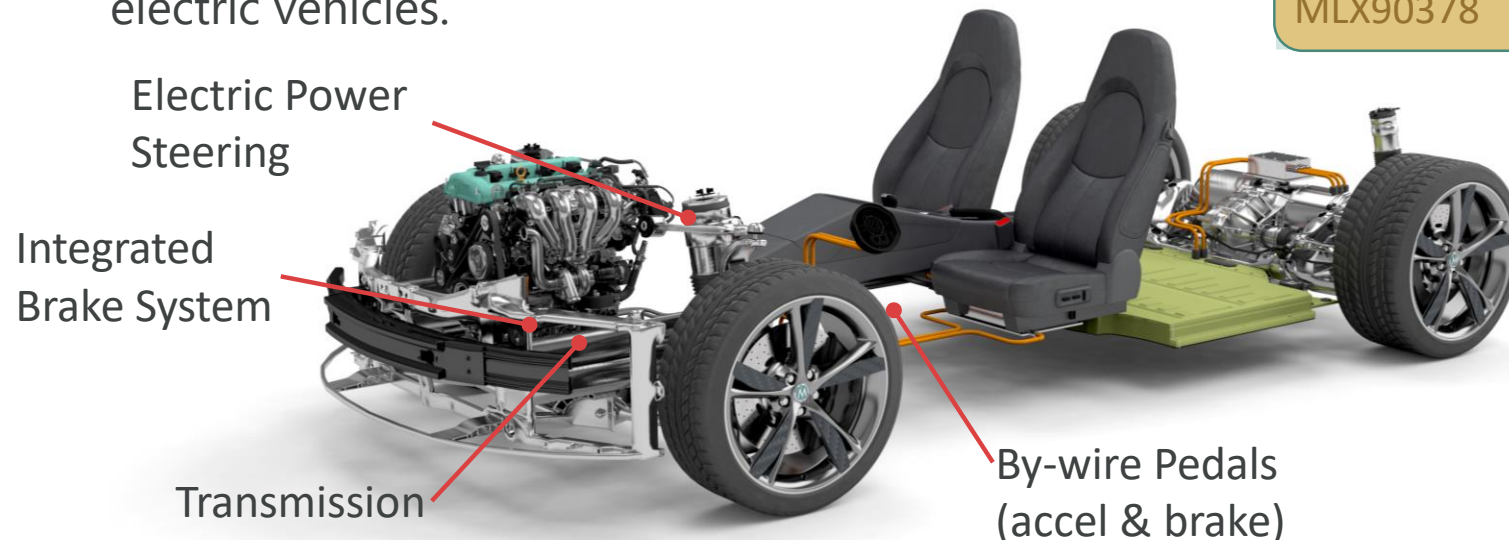


Performance Sensing

Performance Sensing

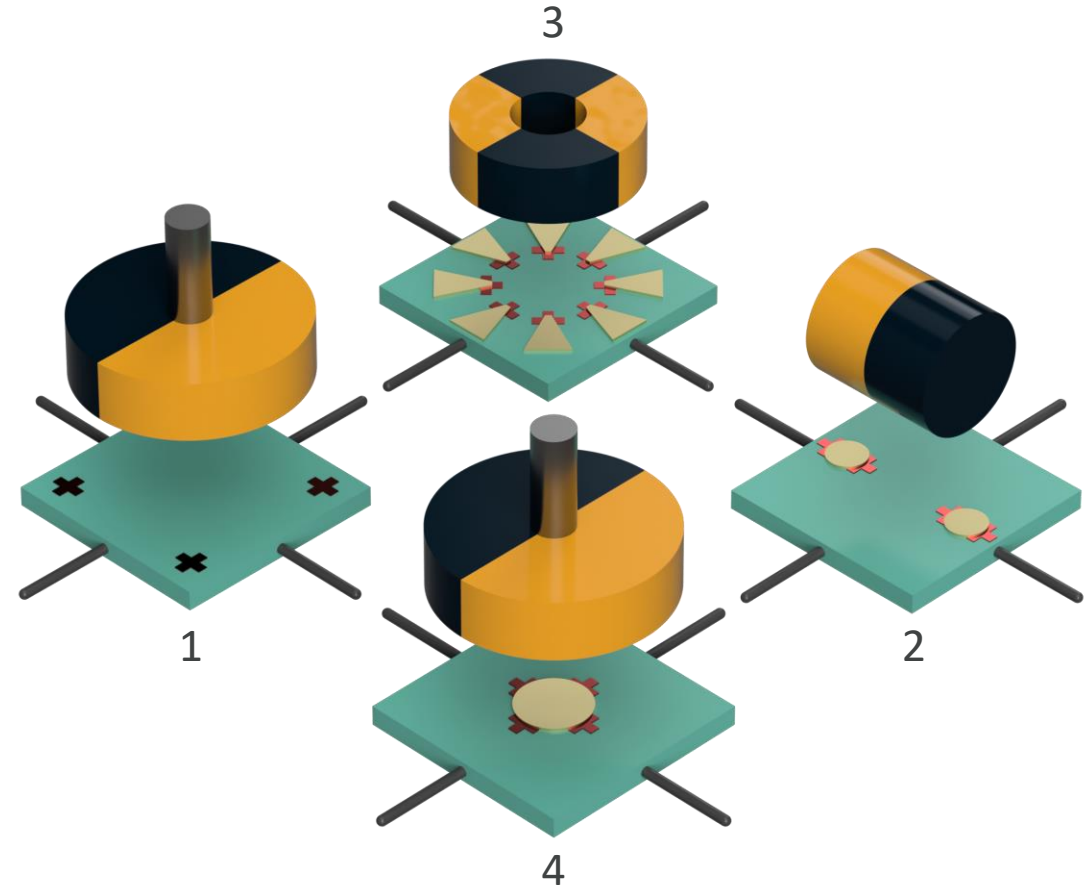
- Newer, safety critical applications like steering angle sensors, brake sensors, park lock, and by-wire pedals will find an excellent match in the performance sensing product group.
- These devices offer best-in-class thermal drift, noise, ASIL capability for rotary, linear, and joystick/3D motions. High ambient operating range and stray field robust modes ensure this group can support every type of powertrain; from internal combustion to hybrids to full battery electric vehicles.

Product	Motion	Output
MLX90371	Rotary, Linear	Analog, PWM
MLX90372	Rotary, Linear	SENT
MLX90373	Rotary, Linear	PSI5
MLX90374	Rotary, Linear	2x PWM, SENT
MLX90376	Rotary, Linear	Analog, PWM, SENT, SPC
MLX90377	Rotary, Linear	Analog, PWM, SENT, SPC
MLX90378	Joystick	2x PWM, SENT

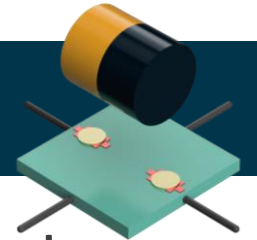


Technology

- Shapes other than a single disc support different methods of sensing
 1. No IMC for rotary 360 degree sensing with stray field immunity
 2. Dual disc for linear or arc motion with stray field immunity
 3. Sun & bubbles mode for 180 degree sensing with stray field immunity
 4. Single disc or clover for rotary and linear motion without stray field immunity



Technology

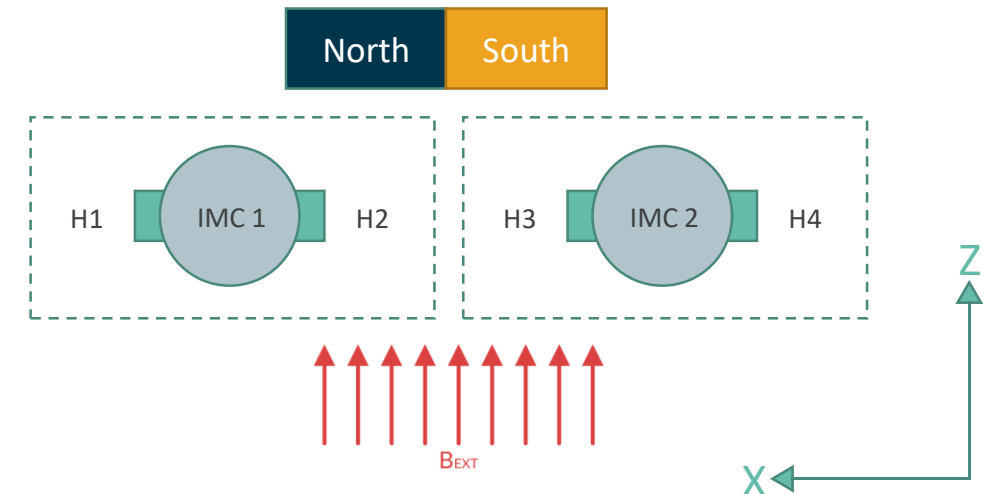


- 2. Two discs for linear or arc motion with stray field immunity

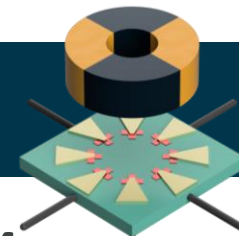
- $BX_{IMC\ 1} = H1 - H2$
- $BX_{IMC\ 2} = H3 - H4$
- $BZ_{IMC\ 1} = H1 + H2$
- $BZ_{IMC\ 2} = H3 + H4$
- $Angle = ATAN(\Delta BX / \Delta BZ)$
 - $\Delta BX = BX_{IMC\ 1} - BX_{IMC\ 2}$
 - $\Delta BZ = BZ_{IMC\ 1} - BZ_{IMC\ 2}$

- Suitable for linear or arc motion
 - ~20mm maximum linear travel or arc length
 - 2-pole magnet, typically a rod magnet

- Differential sensing between two points provides immunity to common mode magnetic fields in any orientation
 - Usable field is a *gradient* vs *homogenous* field (mT/mm vs mT)



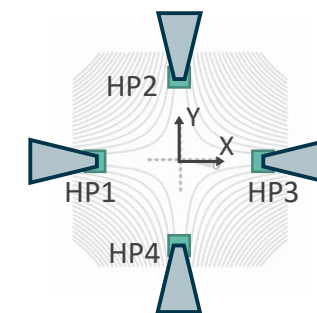
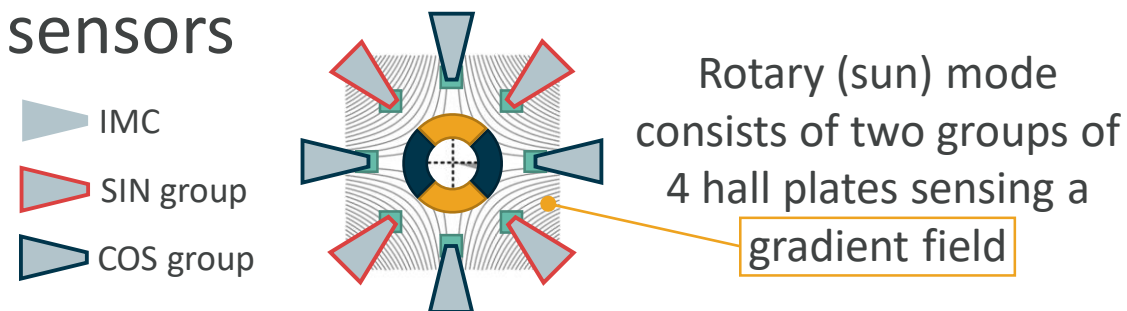
Technology



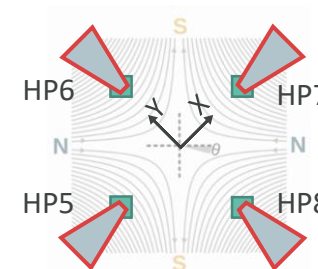
- 3. Sun shape for on-axis rotary motion with stray field immunity
 - Angle = $\text{ATAN}(\text{SIN}/\text{COS})/2$
 - Suitable for rotary on-axis motion
 - 180-degree maximum rotation capability
 - 4-pole magnet, typically a donut/ring
 - Application note is available to describe the magnet requirements. Sample magnets are also available.



- Gradient field produced by 4-pole magnet is sensed by two groups of sensors

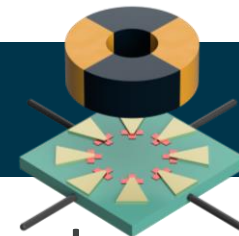


$$\cos \alpha \equiv \left[\left(\frac{dBx}{dx} \right) - \left(\frac{dBy}{dy} \right) \right]$$

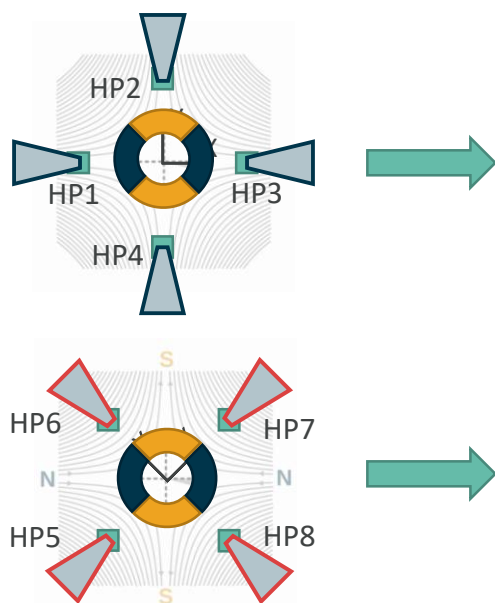


$$\sin \alpha \equiv \left[\left(\frac{dBx}{dy} \right) + \left(\frac{dBy}{dx} \right) \right]$$

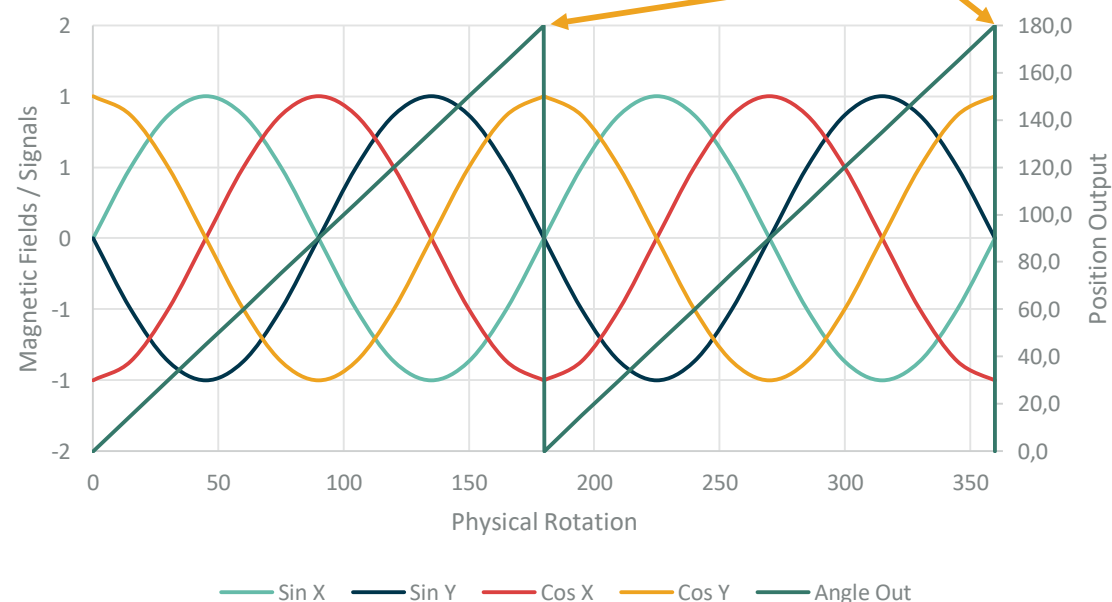
Technology



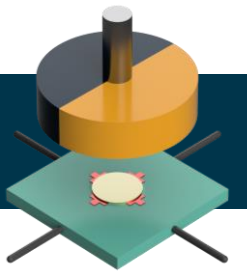
- 3. Sun shape for on-axis rotary motion with stray field immunity
 - Due to differential sensing common mode / stray fields are not sensed



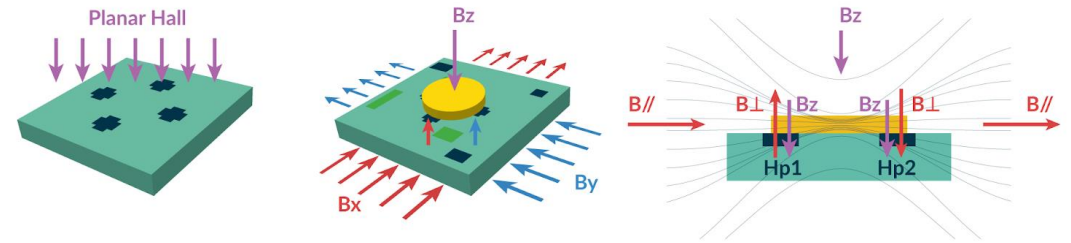
- Four signals are generated and processed to determine the magnetic angle.
 - With a 4-pole magnet the output is periodic over 180 degrees



Technology



- 4. With a single disc
 - HP1 signal = $B1 = B_{\perp} - B_z$
 - HP2 signal = $B2 = -B_{\perp} - B_z$
 - Differential Measurement: $B1 - B2$
 - $B1 - B2 = (B_{\perp} - B_z) - (-B_{\perp} - B_z) = 2B_{\perp}$
 - Direct Measurement: $B1 + B2$
 - $B1 + B2 = (B_{\perp} - B_z) + (-B_{\perp} - B_z) = -2B_z$



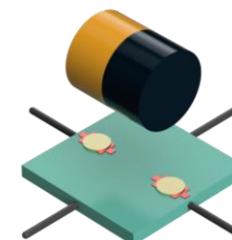
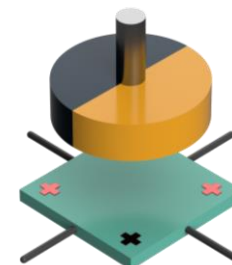
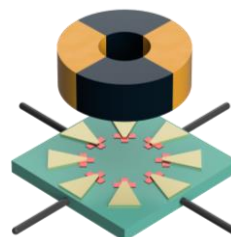
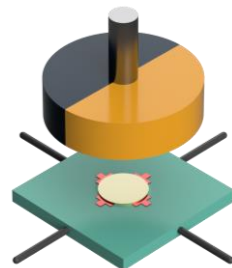
Differential Mode \Rightarrow

$B_{\perp X}$ & $B_{\perp Y}$
 B_z cancelled

Direct Mode \Rightarrow

B_z
 $B_{\perp X}$ & $B_{\perp Y}$ cancelled

Technology

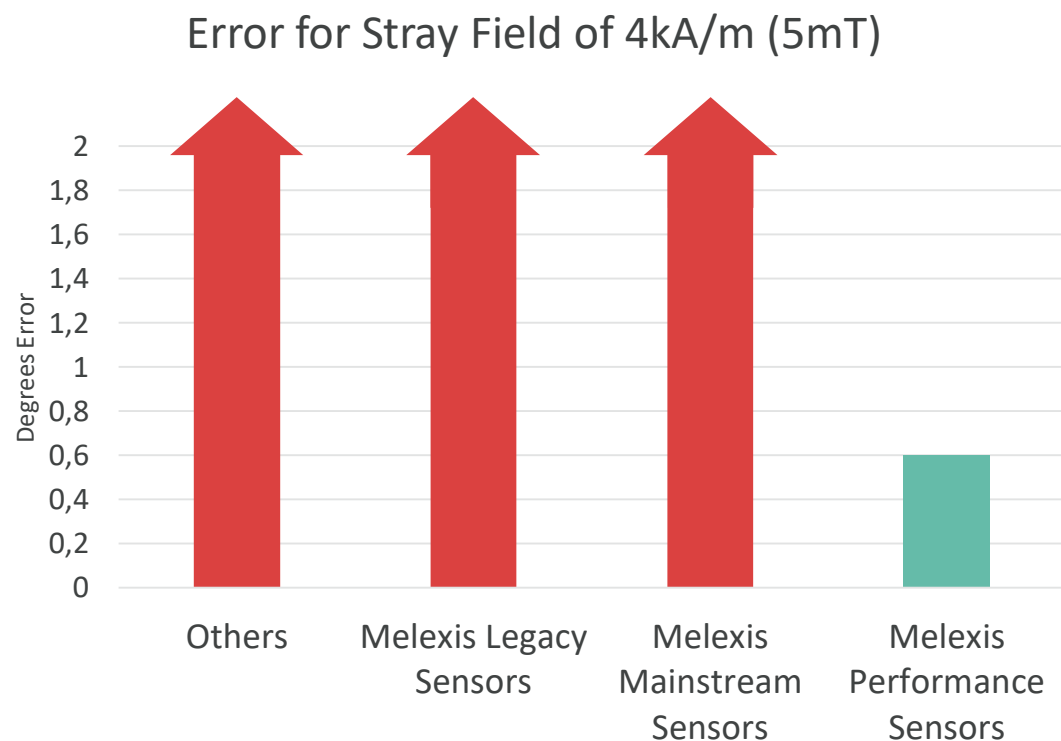


	Legacy / Clover	Sun/Bubbles	NoIMC (dBz)	Dual Disc
Suitable for:	On-axis rotary (360 deg) Off-axis rotary (360 deg) Linear Motion Joystick/3D/XYZ	On-axis rotary (180 deg)	On-axis rotary (360 deg)	Off-axis rotary Linear
Stray field immune	No	Yes (to 4kA/m = 5mT) (<0.3 deg deviation)	Yes (to 4kA/m = 5mT) (<0.6 deg deviation)	Yes (to 4kA/m = 5mT) (<0.6 deg deviation)
Thermal drift	Best overall (0.45 deg)	Best of rotary types for stray field (0.85 deg)	Moderate (0.9-1.2 deg)	Moderate (0.8 deg)
Noise	Best overall (0.2 deg)	Best of rotary types for stray field (0.4 deg)	Moderate (0.4-0.6 deg)	Moderate (0.3 deg)
Magnetic design	Simple	Complex	Simple	Moderate

Note: Worst case values for typical operating conditions. Different modes and magnetic configurations may yield different values

Technology

■ Stray Field Immunity Performance and Capability

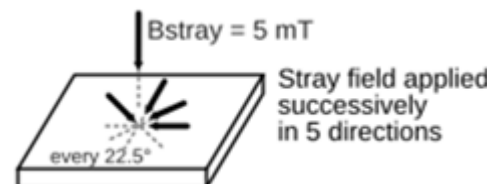


■ Stray field immunity tested acc. ISO 11452-8

- Criteria: <0.6 deg angle error when exposed to stray field

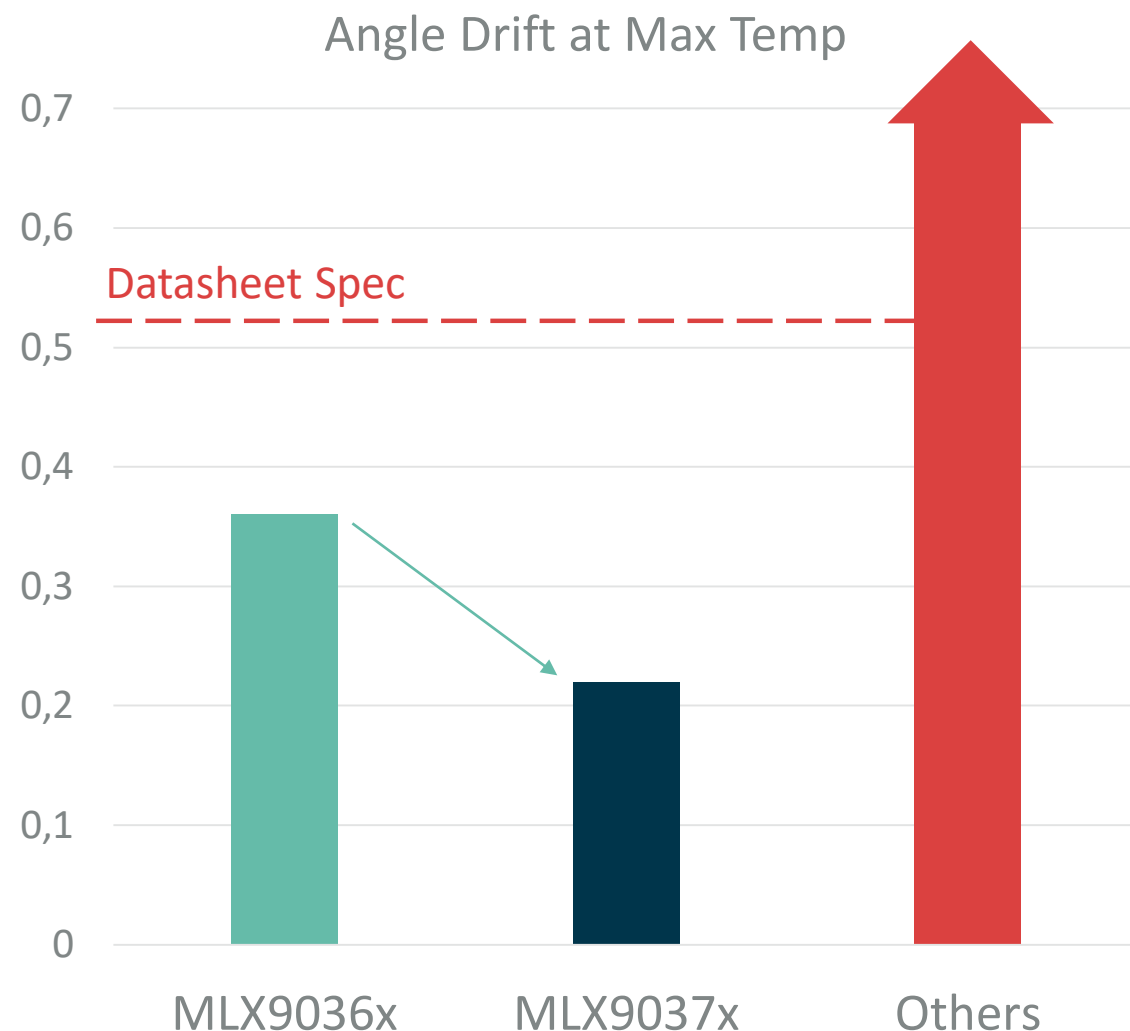
DC Magnetic Field Testing

A/m	Front	Right	Top
4000	Status 1	Status 1	Status 1
3000	Status 1	Status 1	Status 1
1000	Status 1	Status 1	Status 1
900	Status 1	Status 1	Status 1



Performance Sensing

- Best-in-class Thermal Drift and Noise
- Additionally,
 - operates at a higher ambient temperature of 160°C
 - Or at a lower minimum field (10mT)
- Lower Field -> Same performance as mainstream sensors
- Same Field -> Higher performance



Performance Sensing

- ISO26262 Readiness
 - Supported via SEooC (Safety Element out of Context) approach
 - ASIL C – MLX90377, MLX90378
- Extended On Board Diagnostics Supporting ASIL Capability
- Gateway for External Sensor (Readout / Input)
 - PWM, NTC, or a switch can be read

Performance Sensing

- Improved EMC and Absolute Max Ratings (AMR)

Maximum rating	MLX9036x	MLX90377
VDD Positive voltage	24V	37V
VDD Reverse polarity	-12V	-18V
OUT Positive voltage	18V	28
OUT Reverse polarity	-0.3V	-18V

- EMC improvements enable **first-time-right** design especially with PCB-less packages or a minimum of external components.

- MLX90377 shows outstanding reverse polarity on both the supply and output
 - Leading to reduction of electrical overstress returns for **higher quality**

EMC Test	MLX90366	MLX90377	Remark
GM DCC	Damage	±85V	
CE AN	Class 3	Class 5	RF Emissions
VW ESD 15kV	Status II	Status I	All pins A1, Housing A2
BCI Closed Loop Method	Status I	Status I	
Ford RI130	Status II	Status I	440nF on Vdd
Ford RE310	Fail	Pass	MLX90372-ADE
Ford CI280	Fail	Pass	MLX90372-ADE
Ford CI260	>29us	>80us	(Waveform C)

Performance Sensing

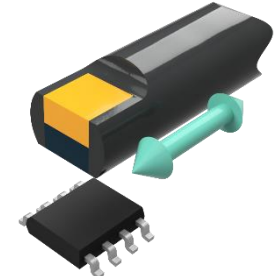
NEW: Released in June 2021!!

MLX90377

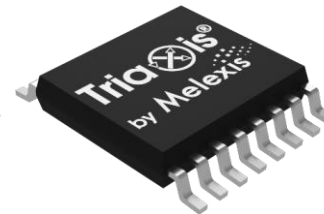
Parameter		MLX90377
MOTION	Rotary	▪
	Linear	▪
	Joystick	
PACKAGE	SOIC-8	▪
	TSSOP-16	▪
	DMP (PCB-less)	▪
OUTPUT	Analog	▪
	PWM	▪
	SENT	▪
	SPC	▪
ASIL	B (SEooC)	▪
	C (SEooC)	▪



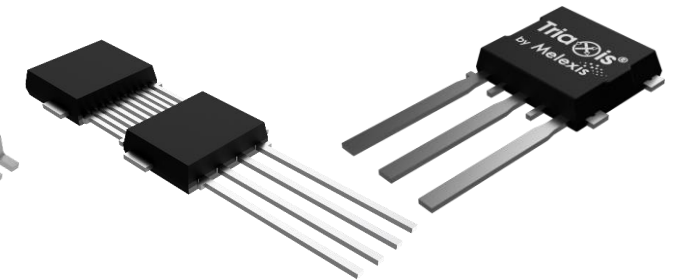
Rotary motion with and without stray field robustness



Linear motion with and without stray field robustness



Single Die SOIC-8
Dual Die (redundant) TSSOP-16



Single Die PCB-less DMP-4
Single Die PCB-less SMP-3

Performance Sensing

MLX90377

¹: Operating mode and condition dependent. At minimum required signal and highest temp noise & drift is maximized

Parameter	MLX90377
Motion Capability	Rotary, Linear
Output Data	Position as analog, PWM, or SENT, SPC data
Stray Field Immunity	Yes – Sun, Dual Disk
ASIL (ISO26262)	ASIL C
Single Die Packages	Surface mount 2 nd gen PCB-less
Dual Die Packages	Surface mount
Calibration Points	8 flexible, 32 fixed
Absolute Max Ratings	Vdd: -18V, +37V Vout: -18V, +28V
Ambient Temp Range	-40-160 degC
Thermal Drift max ¹	0.45 – 1.4 deg
Noise max ¹	0.1 – 0.9 deg
Magnetic field input ¹ (~min to typ range)	10mT - 70mT or 3 - 10mT/mm stray field mode
Relative Cost	\$-\$\$

Outstanding refresh rate in Analog: 200us typ!!

Triaxis[®] Position Sensors

■ Single Mold Package Mechanical Integration Features

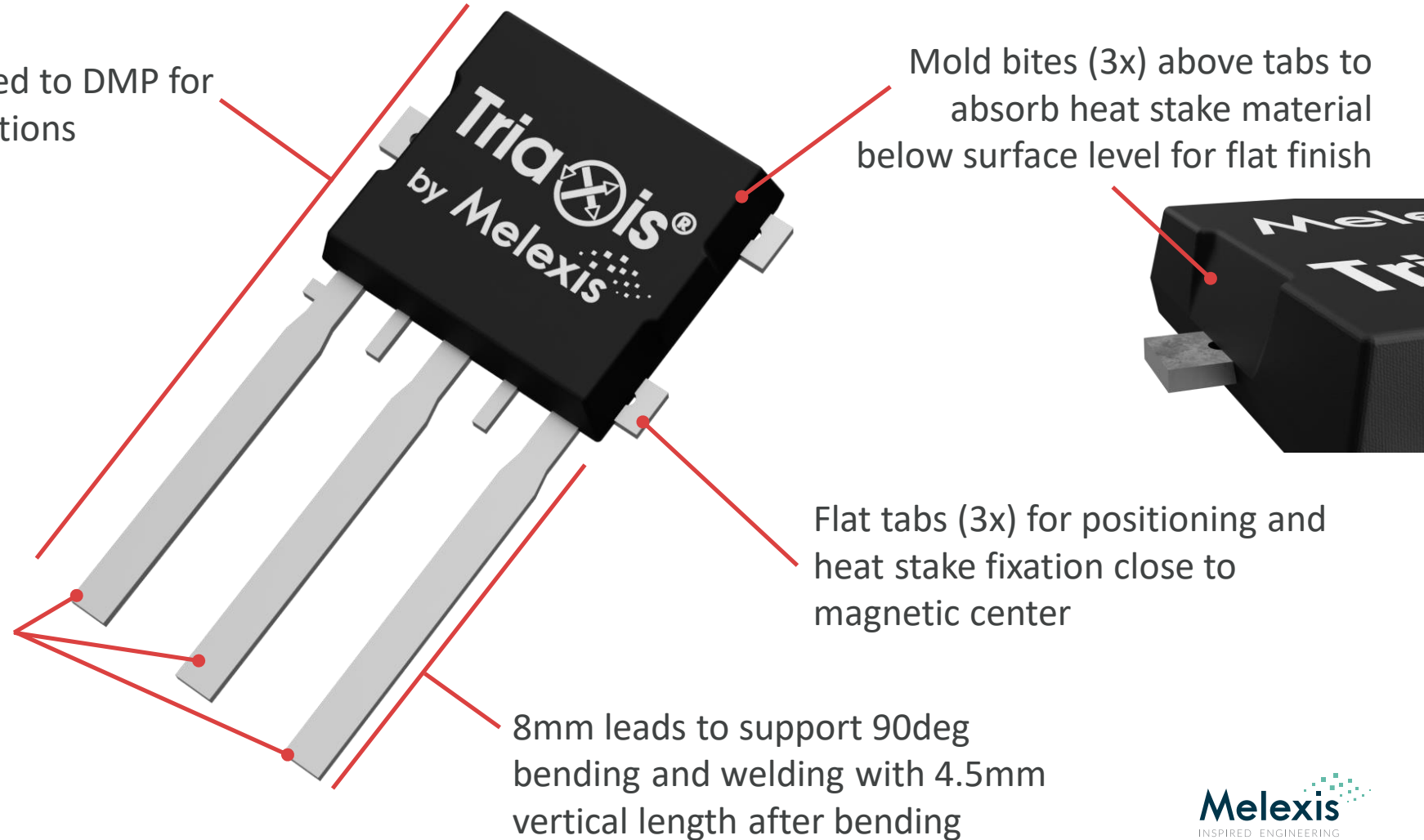
Smaller footprint compared to DMP for space constrained applications

Mold bites (3x) above tabs to absorb heat stake material below surface level for flat finish

2.5mm pitch, 0.8mm wide leads suitable for electric and laser welding
No trim & form of pins needed leading to higher quality and less manufacturing steps

Flat tabs (3x) for positioning and heat stake fixation close to magnetic center

8mm leads to support 90deg bending and welding with 4.5mm vertical length after bending

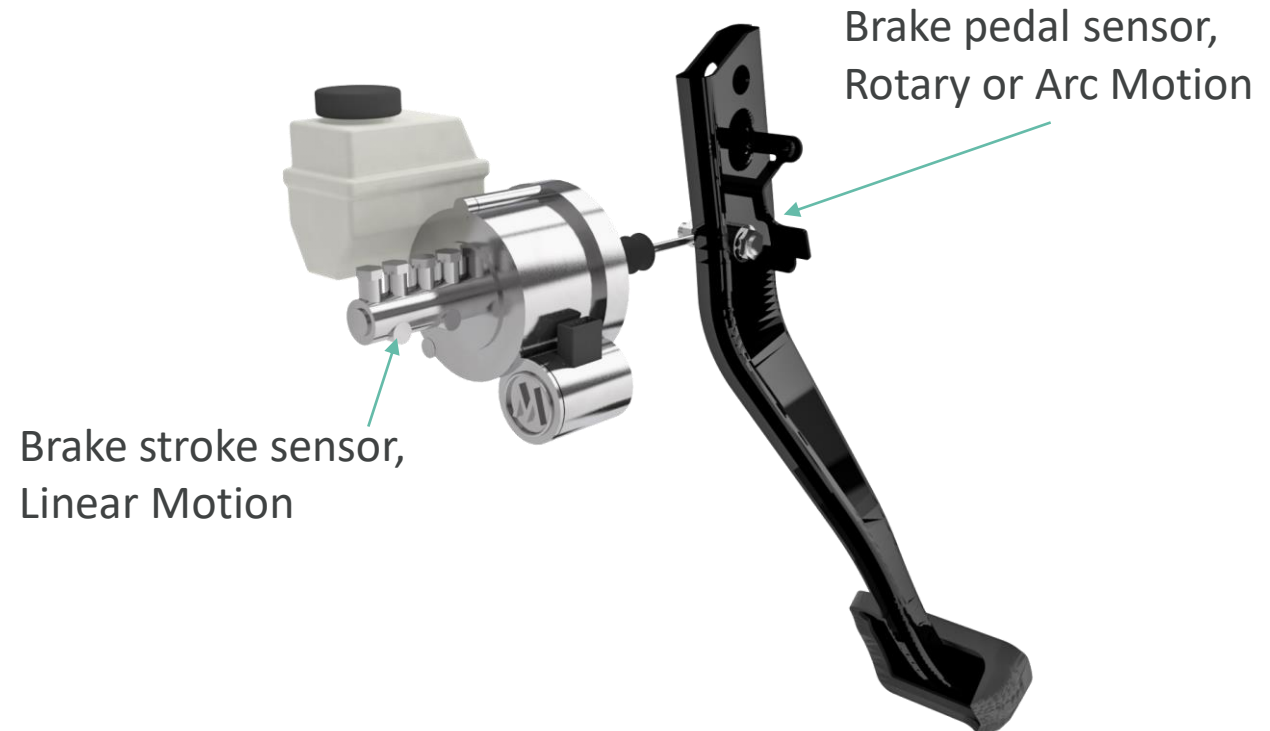


Example Applications – MLX90377

Brake Stroke Sensing

- New integrated braking systems utilize a brake travel sensor in a linear motion with high demands
 - Functional Safety and Redundancy
 - Stray field tolerance
- New systems utilized for
 - Electrification (improved regenerative braking)
 - Safety (faster actuation)
 - Comfort (custom brake control)

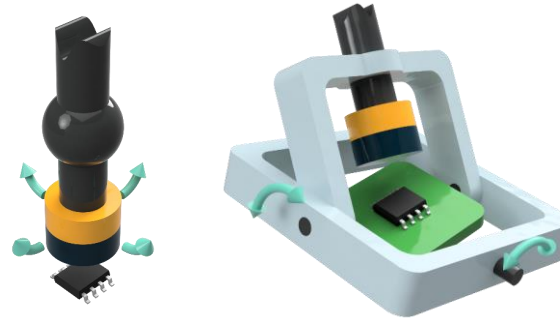
- Brake Travel Sensor (electrified braking)



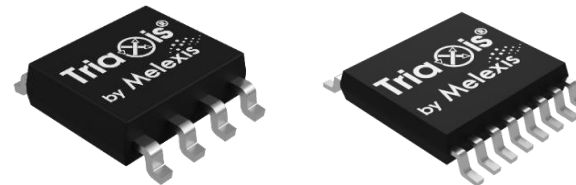
Performance Sensing

MLX90378

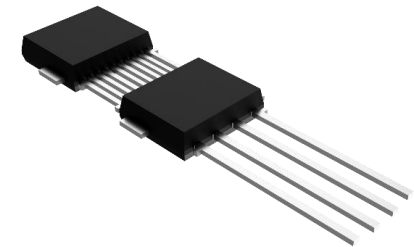
Parameter		MLX90378
MOTION	Rotary	
	Linear	
	Joystick	▪
PACKAGE	SOIC-8	▪
	TSSOP-16	▪
	DMP (PCB-less)	▪
OUTPUT	Analog	
	PWM	▪ (2x)
	SENT	▪ (1x)
	PSI5	
ASIL SIL	B (SEooC)	
	C SEooC / SIL3	▪



Joystick / 3D motion without
stray field robustness



Single Die SOIC-8
Dual Die (redundant) TSSOP-16

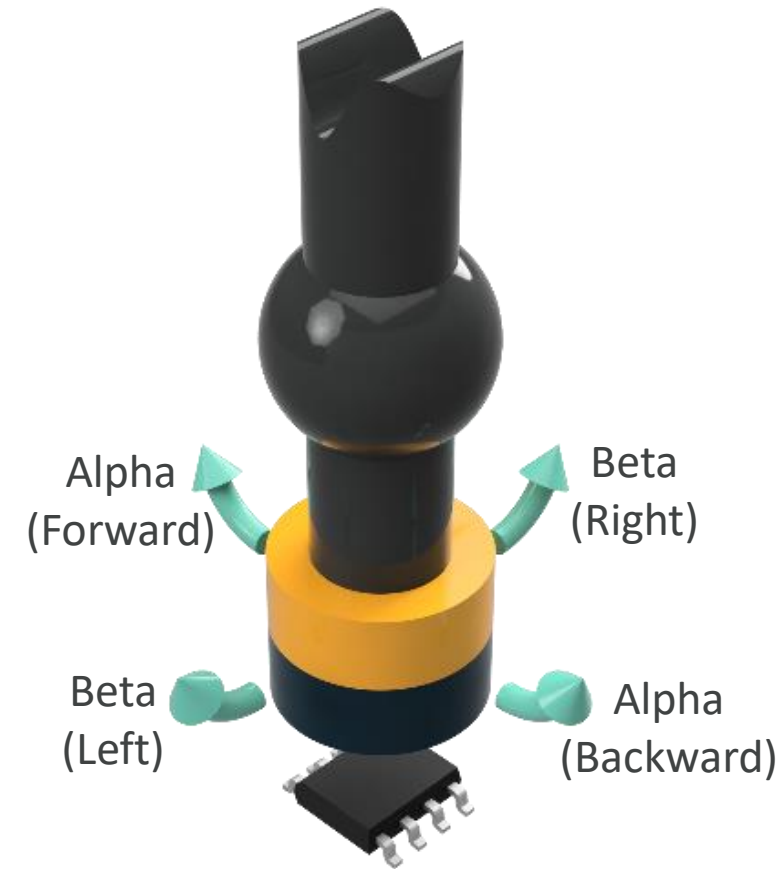


Single Die PCB-Less DMP-4

Performance Sensing

MLX90378

- Provides Three Output Types (customer selectable)
 - 2x Independent PWM channels
 - 1x SENT
 - 1x SENT + 1x Aux for push detection
- Supports Multiple Modes of Operation
 - Alpha / Beta angle output (SENT or PWM)
 - Alpha / Beta angle output with push detection (SENT)
 - XYZ field magnitude output (SENT)
 - Alpha / Beta angle with input pin measurement (SENT)



Performance Sensing

MLX90378

Parameter	MLX90378
Motion Capability	Joystick / 3D
Output Data	Position as 2x PWM, or SENT data
Stray Field Immunity	No (Legacy/Clover)
ASIL (ISO26262) SIL(IEC61508)	ASIL C SIL3
Single Die Packages	Surface mount
Dual Die Packages	Surface mount
Calibration Points	8 flexible, 32 fixed
Absolute Max Ratings	Vdd: -18V, +37V Vout: -18V, +28V
Ambient Temp Range	-40-160 degC
Thermal Drift max ¹	0.6 – 0.8 deg
Noise max ¹	0.1 – 0.4 deg
Magnetic field input ¹ (~min to typ range)	10mT - 70mT

Performance Sensing

MLX90378

- Alpha / Beta via the SENT fast channel

Format	Data Nibbles	Data 1	Data 2	Data 3	Data 4	Data 5	Data 6
Two 12-bit fast channels	6	Ch1 MSN	Ch1 MidN	Ch1 LSN	Ch2 LSN	Ch2 MidN	Ch2 MSN
Alpha Angle Channel				Beta Angle Channel			

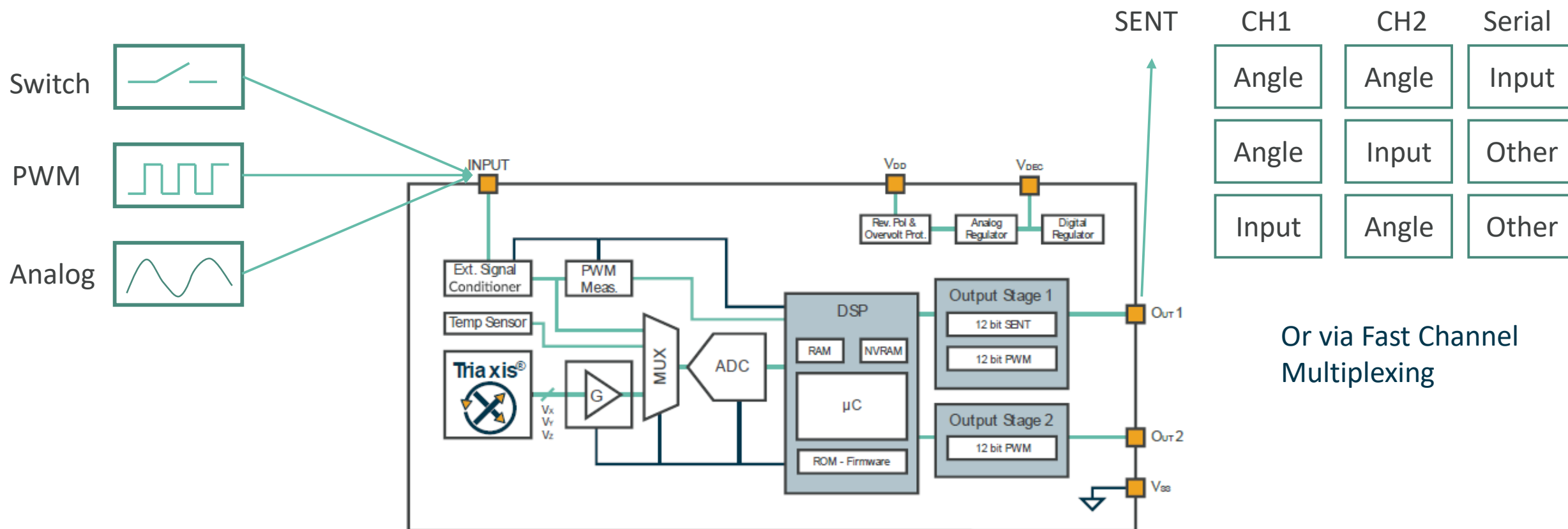
- XYZ (Magnetic Fields) via SENT fast channel multiplexing

Fast Channel Msg #	Type	Data Nibble 1	Data Nibble 2	Data Nibble 3	Data Nibble 4	Data Nibble 5	Data Nibble 6
1.1	X Value	FC = 0	DCC = 0	X MSN	X MidMSN	X MidLSN	X LSN
1.2	Y Value	FC = 1	DCC = 0	Y MSN	Y MidMSN	Y MidLSN	Y LSN
1.3	Z Value	FC = 2	DCC = 0	Z MSN	Z MidMSN	Z MidLSN	Z LSN
...	X Value	FC = 1	DCC = 1				

Performance Sensing

MLX90378

■ Input Pin for Expansion Capabilities



Magnetic position sensors

Applications with current products

Mobile vehicles – off-road

Armrest

- Tractors
- Cranes



Joysticks

- Wheelchair
- All off-road vehicles
- Aircraft



An underwater scene with a deep blue background. Several sharks are visible, including a large hammerhead shark in the upper center and another hammerhead in the lower left. Numerous smaller fish are scattered throughout the water.

Thank You