MLX90395 Product Launch Webinar

22-June-2020

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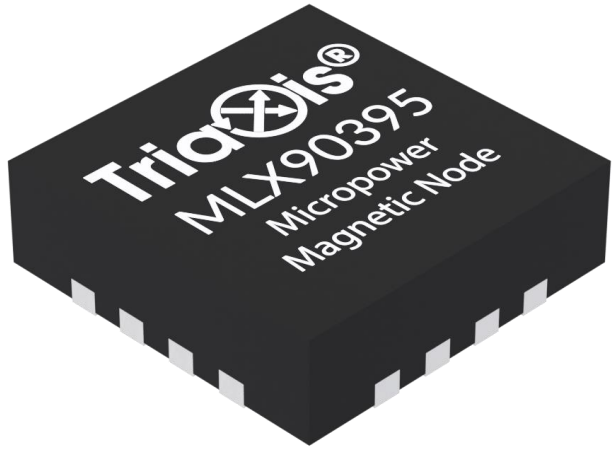
Agenda

- What is the MLX90395?
- What are differences to the MLX90393?
  - Speed, temperature, field range, packaging
- What are the similarities to the MLX90393?
  - Size, power, programming options, magnetic setup
- Magnetic setups for various motions
  - Rotary, Linear, Joystick
- Example applications

What is the MLX90395?

- The MLX90395 is a 3D magnetic field sensor designed to sense X, Y, and Z magnetic fields
- Unlike other Triaxis devices in the Melexis portfolio, the MLX90395, like the MLX90393, is designed to be a companion chip to a host microcontroller.



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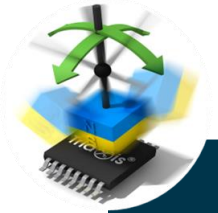
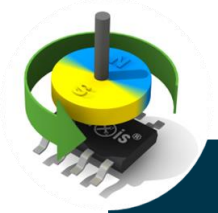
Evolution of Full 3D portfolio

Past to Present



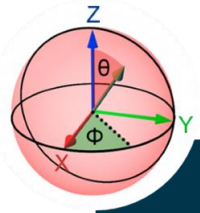
MLX90333

- Analog + SPI
- α and β angle
- Micro inside
- mA power
- 5V supply
- Single Die
  - SOIC8
- Dual Die
  - TSSOP16



MLX90363

- SPI 1MHz
- α and β, Raw XYZ
- Micro inside
- mA power
- 3.3V or 5V supply
- Single Die
  - SOIC8
- Dual Die
  - TSSOP16



MLX90395

- SPI 10MHz, I2C 400kHz
- Raw XYZ and Temp
- FSM inside
- µA power
- 2.2-3.6V supply
- Single Die
  - 3x3mm QFN16
  - SOIC8
- Dual Die
  - TSSOP16

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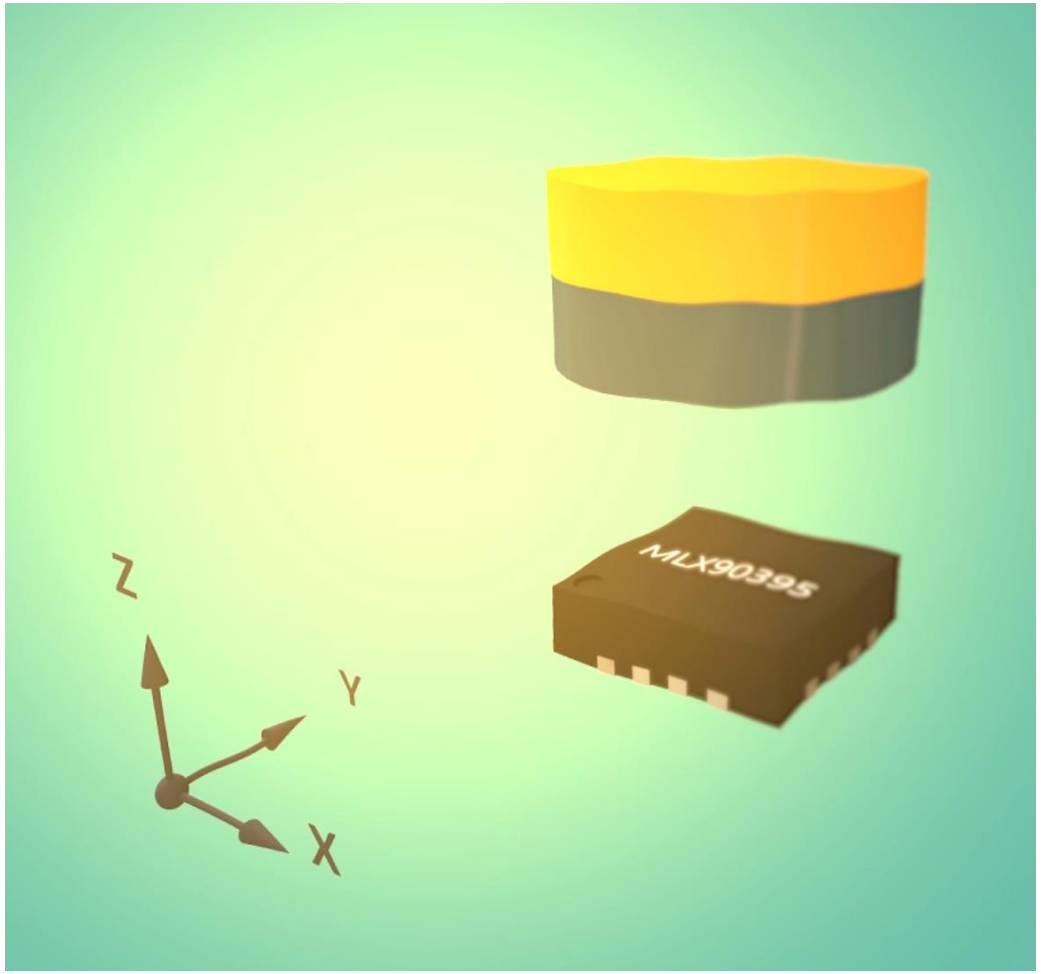
MLX90395 vs MLX90393 Key Differences

Qualification and Temperature



- The MLX90395 is automotive qualified to the AEC Q100 standard
- It also offers a wider temperature range of -40 degC to 125 degC ambient
- Suitable for on-chassis, in-cabin, or light powertrain applications as well as industrial purposes

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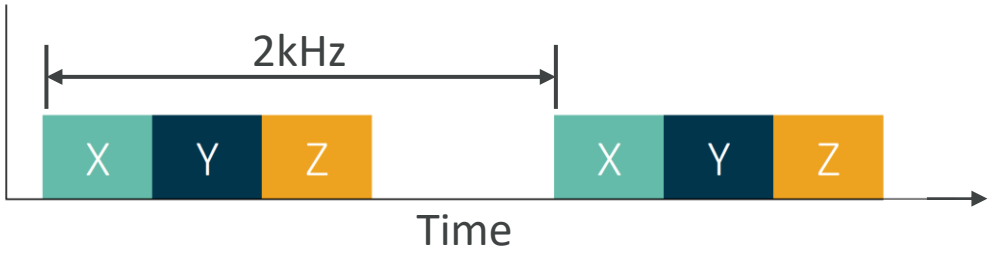
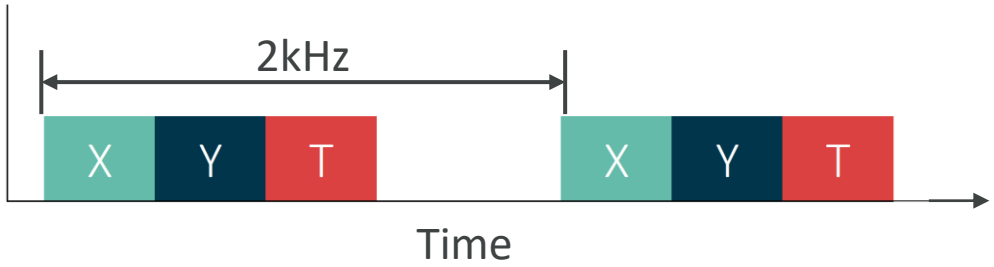
Speed

- The MLX90395 increases the speed of the signal acquisition by nearly 2x.
  - For three axis measurement: 2kHz



  - For two axis measurement + temperature : 2kHz



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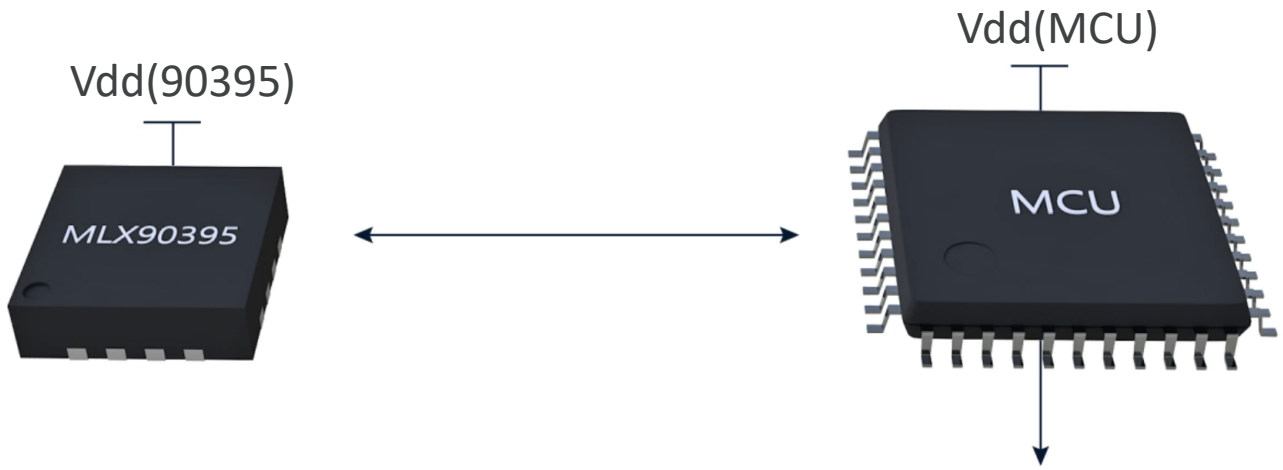
Supply Voltage Measurement

- The MLX90395 offers the ability to measure its supply voltage
  - This enables a diagnostic check of the signal chain together with the host microcontroller
  - In the event the values do not match, a diagnostic can be set, and a safe state entered



Vdd(90395)	Vdd(MCU)	Diag?
3.3V	3.3V	PASS
1.5V	3.3V	FAIL
3.3V	3.0V	FAIL

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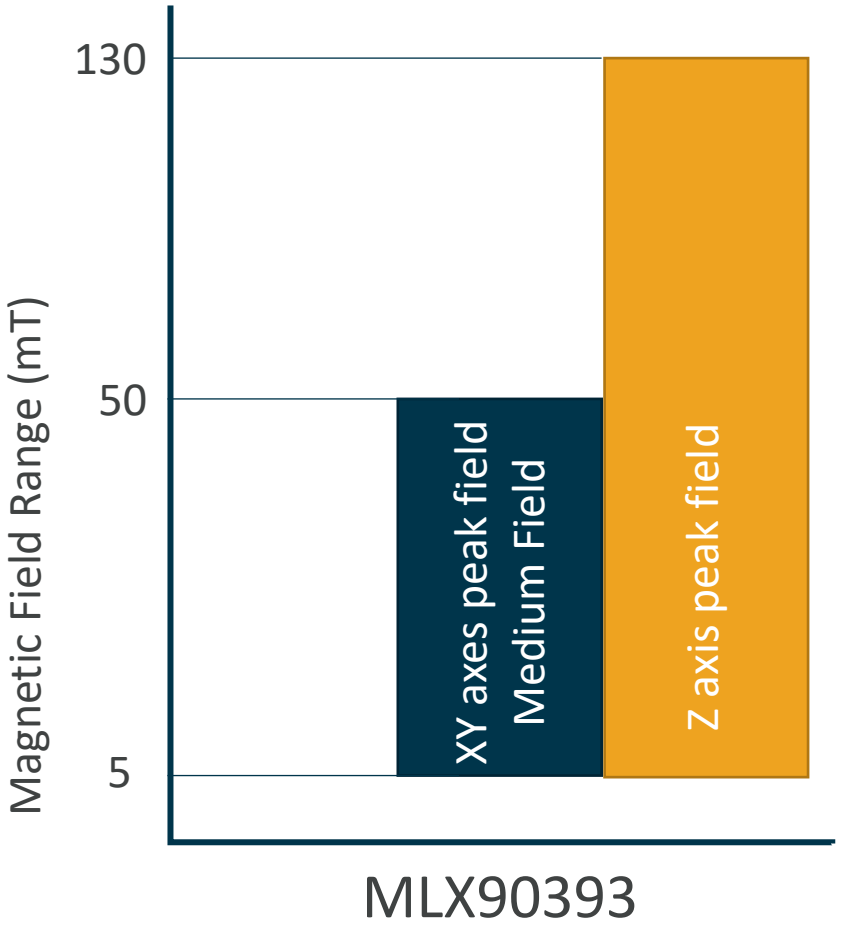
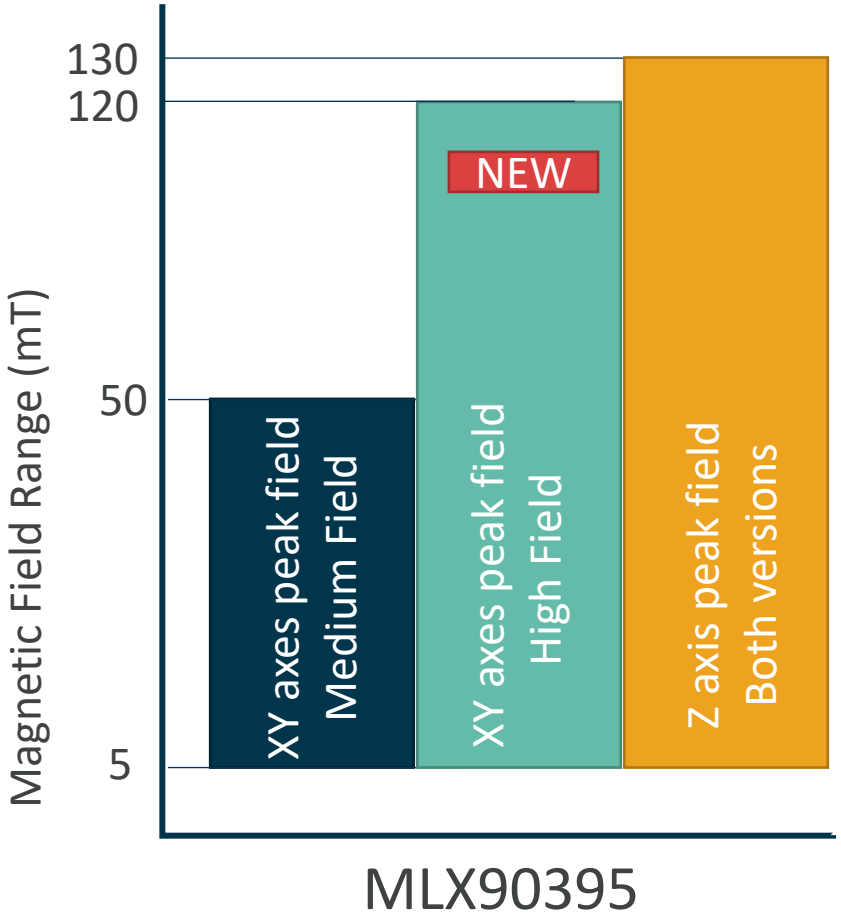
Magnetic Field Range

Medium and High Field Variants





Higher field range reduces impact of stray magnetic fields

Higher field range also allows for closer air gaps

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Protocol Enhancement (CRC)

- The MLX90395 also includes a CRC covering the measured data to ensure data integrity during transmission.
- The order of the data is similar to the MLX90393 and depends on particular register configurations and commands sent

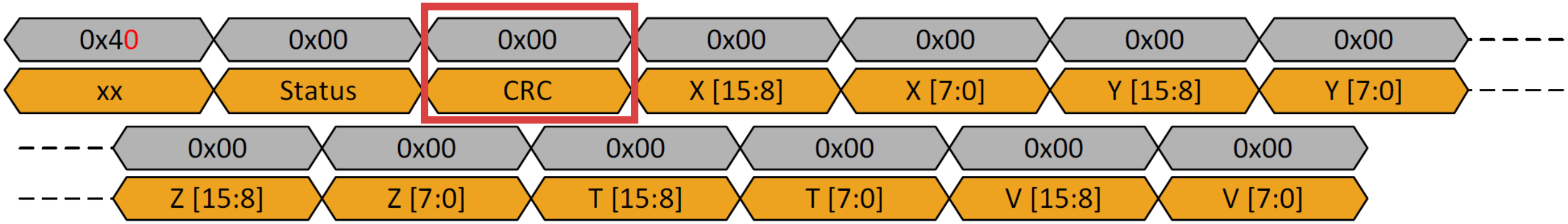
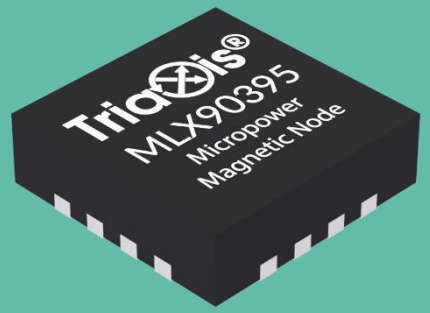


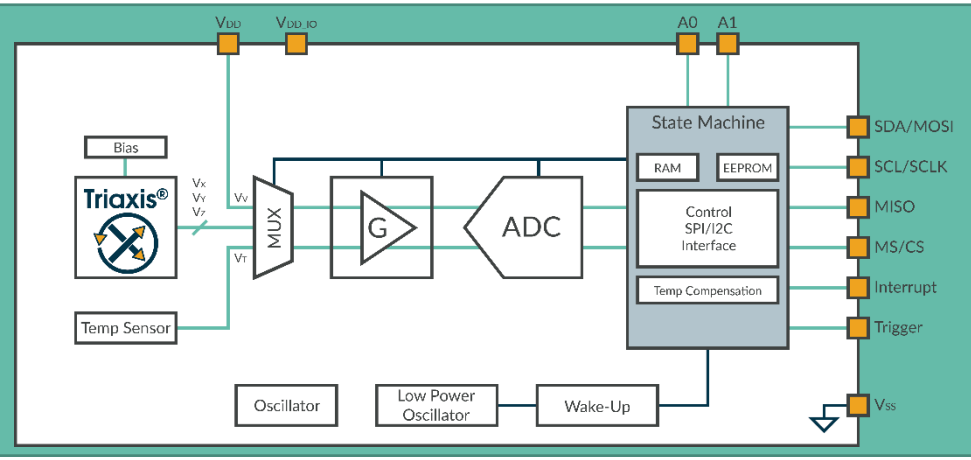
Figure 8: RM command, XYZTV

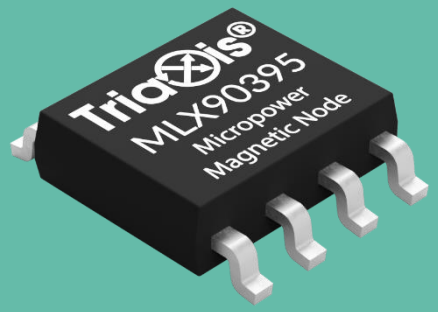
Packages

Single and Dual Die Packages

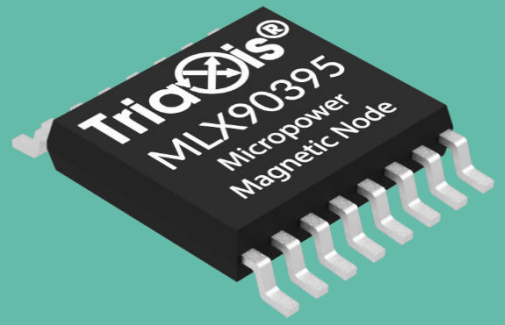


3x3mm QFN-16

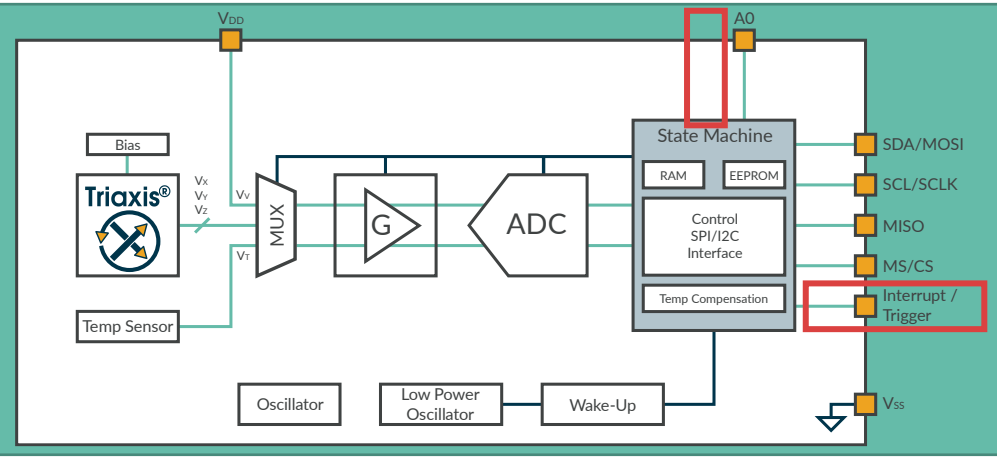




SOIC-8



TSSOP-16



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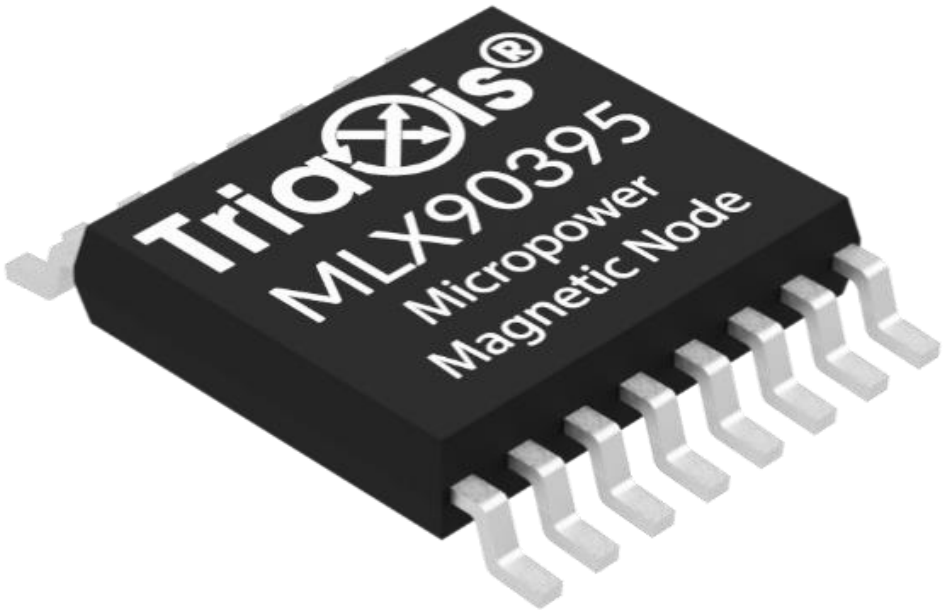
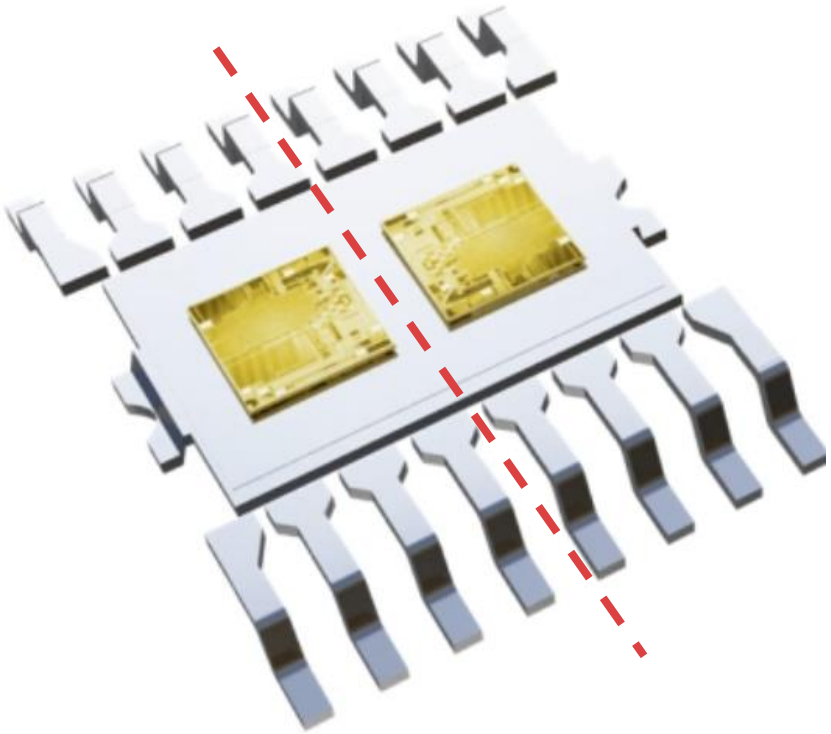
Packages

Redundant Solution

- The TSSOP-16 package contains two, fully redundant dies with independent power, ground, and IO pins





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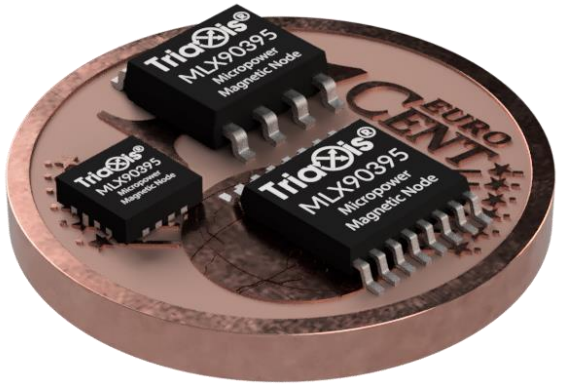
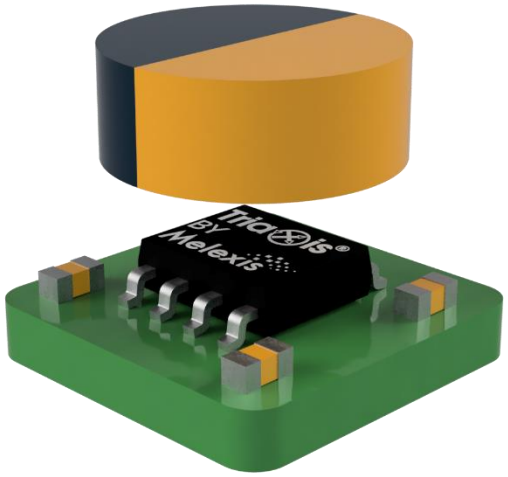
MLX90395 vs MLX90393
Key Similarities

Small Size Solution

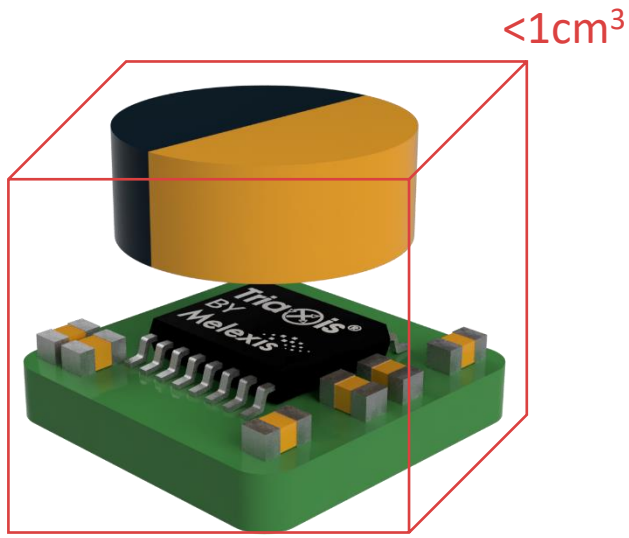
Small Size Solution

- The MLX90395 is available in industry-standard PCB surface mount packages
  - Single Die: 3x3mm QFN-16, SOIC-8
  - Dual Die: TSSOP-16





SOIC-8 Package



TSSOP-16 Package

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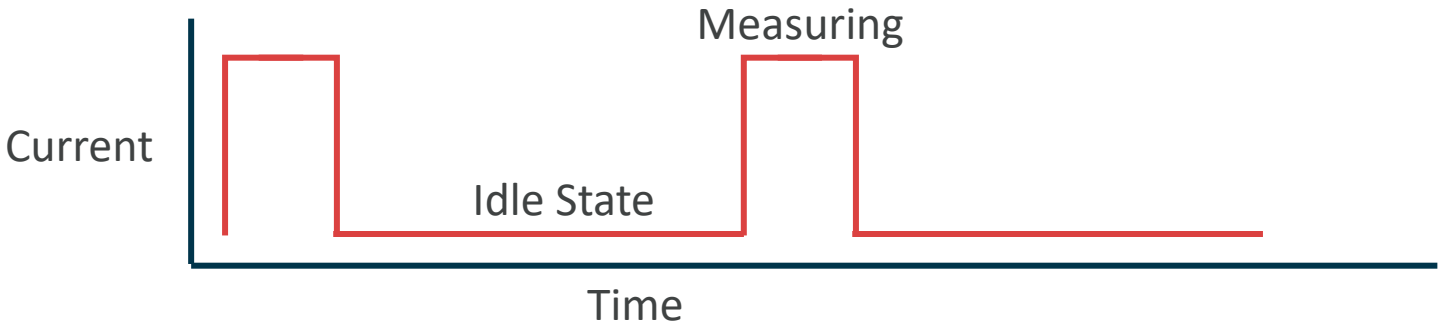
Small Power Solution

Low Supply and Low Current

- The MLX90395, like the MLX90393, operates off of a 3.3V supply.
- The current peaks at 4mA when doing a magnetic conversion and is otherwise a maximum of 20uA over all conditions.
- Total current, and therefore power draw, depends on the amount of time spent in the acquisition state vs idle or standby state.



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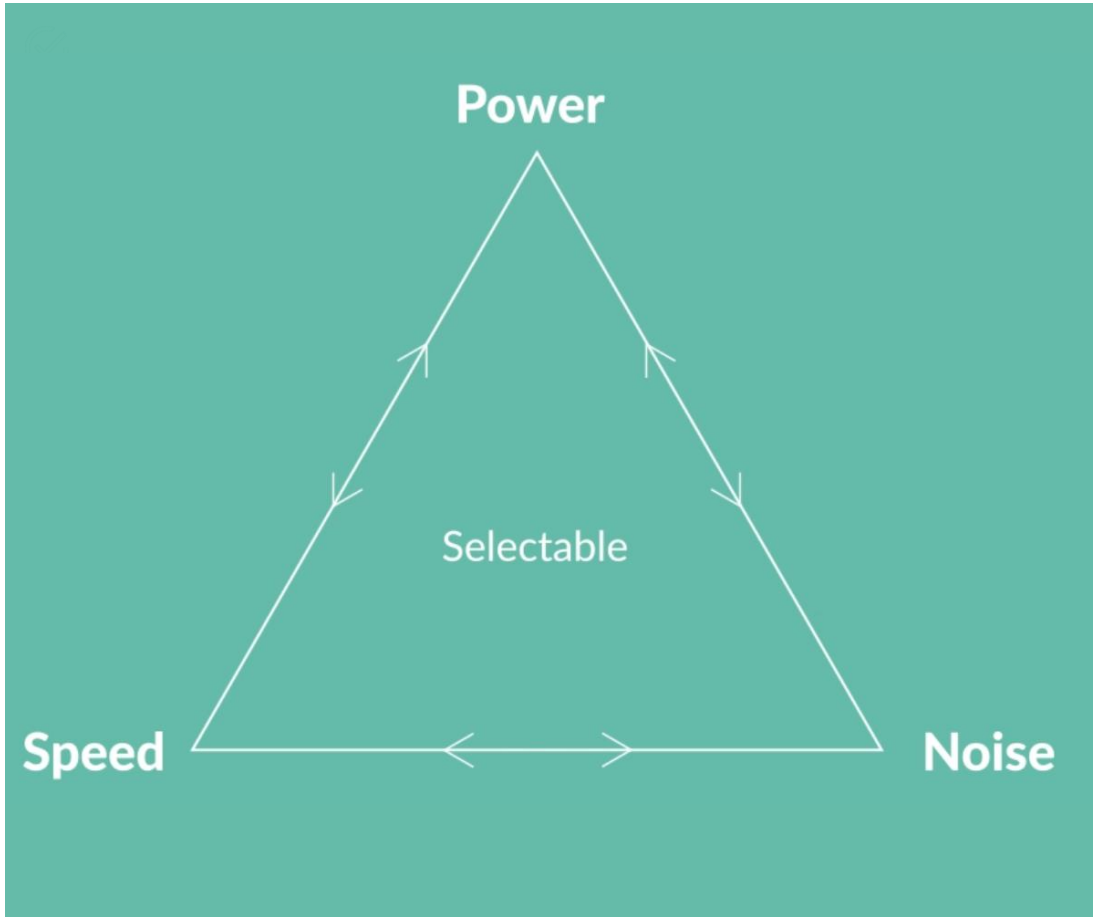
Flexible Configuration

On-the-fly Programming



- The MLX90395 offers many programmable parameters to tune the power, noise, and power draw to the application.
- For example: selecting more filtering will reduce noise, but increase power consumed.

Configurable Options

- Many parameters are programamble
  - Gain
  - Fine sensitivity and resolution
  - Measurement (axes) selection
  - Over sampling and filtering rate
  - Conversion rate (duty cycle)
  - Temperature parameters
  - Free space
    - E.g. traceability

Register	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0x00	GainSel[3:0]				HallConf[3:0]			
	Lock_HS	Lock_WR	Reserved[19]	TrimDelSDAOut[1:0]		TrimDelSDAIn[1:0]		ZSeries
0x01	BurstSel[1:0]		BurstDataRate[5:0]					
	TrigIntSel	CommMode[1:0]		WOCDiff	ExtTrig	TCmpEn	BurstSel[3:2]	
0x02	ResY[0]	ResX[1:0]		DigFilt[2:0]			OSR[1:0]	
	OSR3	0x0	VMeasEn	OSR2[1:0]		ResZ[1:0]		ResY[1]
0x03	TRef[7:0]							
	-	-	-	-	-[19]	WOCStart	TRef[9:8]	
0x04	SensTCH[7:0]							
	-	-	-	-	-	-	-	SensTCH[8]
0x05	SensTCL[7:0]							
	-	-	-	-	-	-	-	SensTCL[8]
0x06	OffsetX[7:0]							
	OffsetX[15:8]							
0x07	OffsetY[7:0]							
	OffsetY[15:8]							
0x08	OffsetZ[7:0]							
	OffsetZ[15:8]							
0x09	OffsetDriftXL[7:0]							
	OffsetDriftXH[7:0]							
0x0A	OffsetDriftYL[7:0]							
	OffsetDriftYH[7:0]							
0x0B	OffsetDriftZL[7:0]							
	OffsetDriftZH[7:0]							
0x0C	SensXY[7:0]							
	-	-	-	-	-	-	SensXY[9:8]	
0x0D	SensZ[7:0]							
	-	-	-	-	-	-	SensZ[9:8]	
0x0E	WocXYThreshold[7:0]							
	WocXYThreshold[15:8]							

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Protocol

SPI and I2C

1. SPI

Up to 10MHz Clock Frequency

Data and commands are the same across both protocols

2. I2C

Standard Mode
Up to 100kHz
Fast Mode
Up to 1MHz

Address has 1 or 2 HW selection bits

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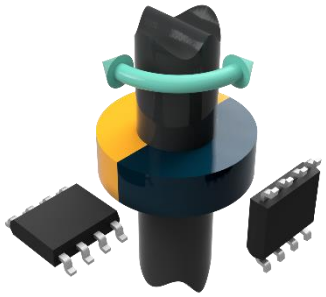
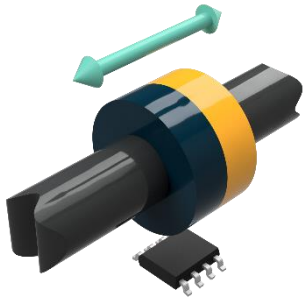
Motion Types

Rotary On-Axis



Rotary Off-Axis



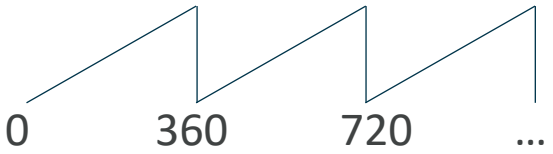
Linear

Joystick

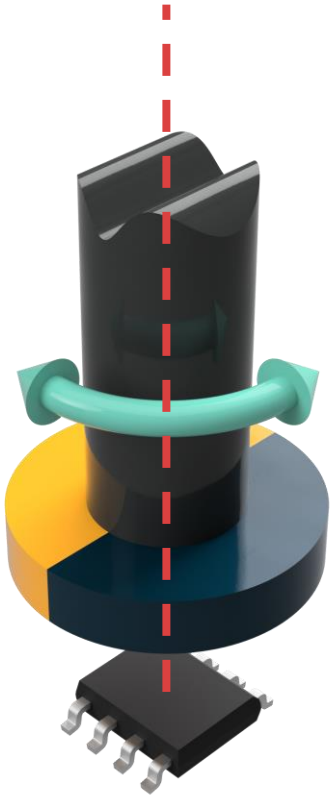
Magnet Configurations

Rotary On-Axis Motion

- On-axis motion is most common
  - Shaft, Magnet, and Sensor lie on common axis
- 360 degrees rotation



- Absolute position
- Non-contacting
  - Immune to dirt, dust, or liquids
- Also capable of detecting push and pull
- Only X and Y axes need to be measured
- Insensitive to airgap or thermal variation



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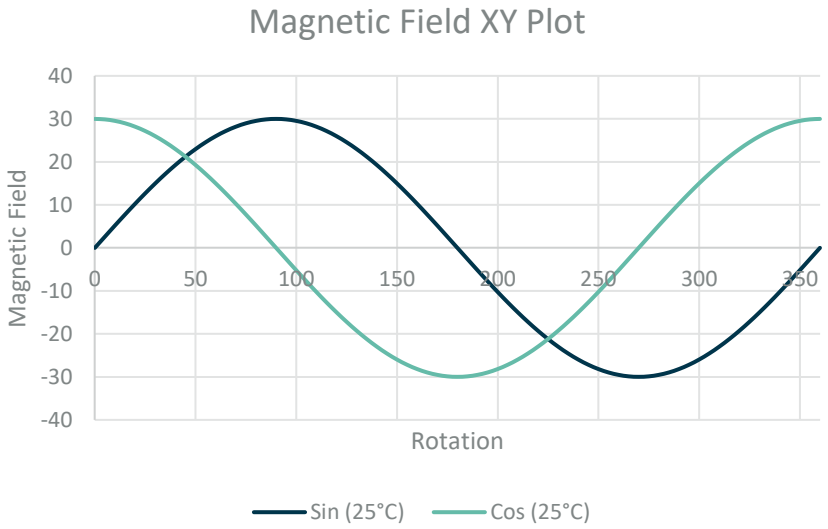
Angle Determination

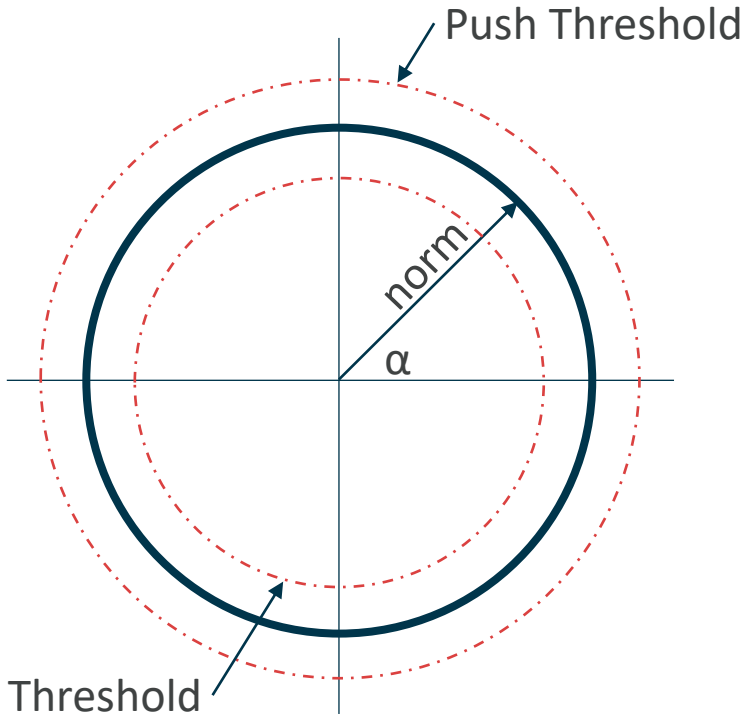
Performed in Host Microcontroller

- The angle is computed from the X and Y magnetic fields that behave as sine and cosine signals over 360 degrees rotation



$$\alpha = ATAN\left(\frac{Bx}{By}\right)$$

$$norm = \sqrt{Bx^2 + By^2}$$



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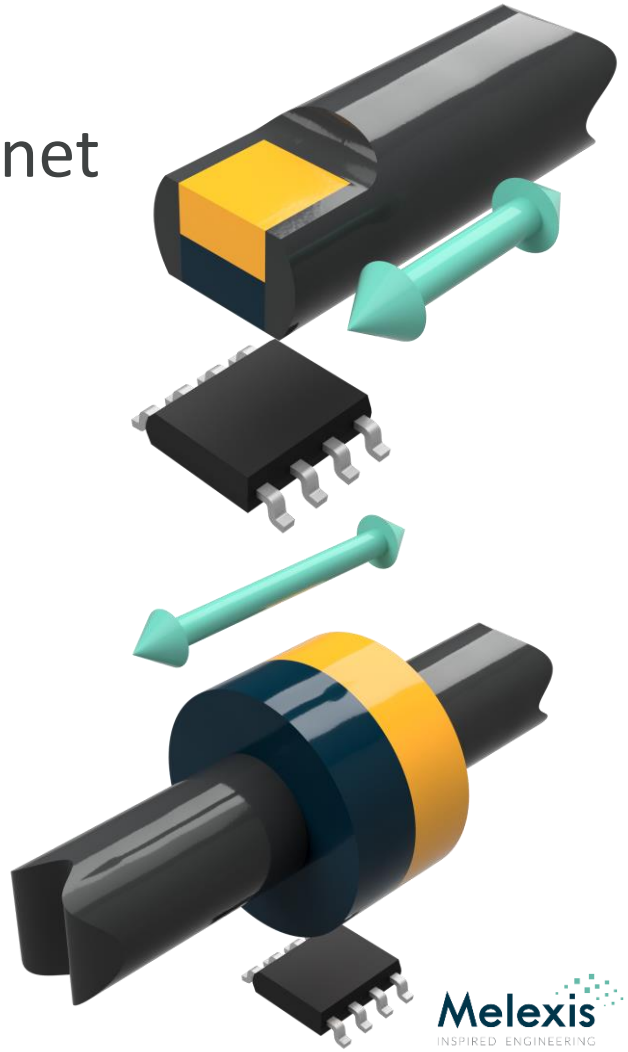
Linear or Slide Motion

- Linear motion is second most common
  - Sensor lies above or to the side of the moving magnet
- Still computes an angle
  - Mapping to mm is done via a calibration or learning step
- Absolute position
- Non-contacting
  - Immune to dirt, dust, or liquids
- Only X & Z or Y & Z axes need to be measured
- Insensitive to thermal variation



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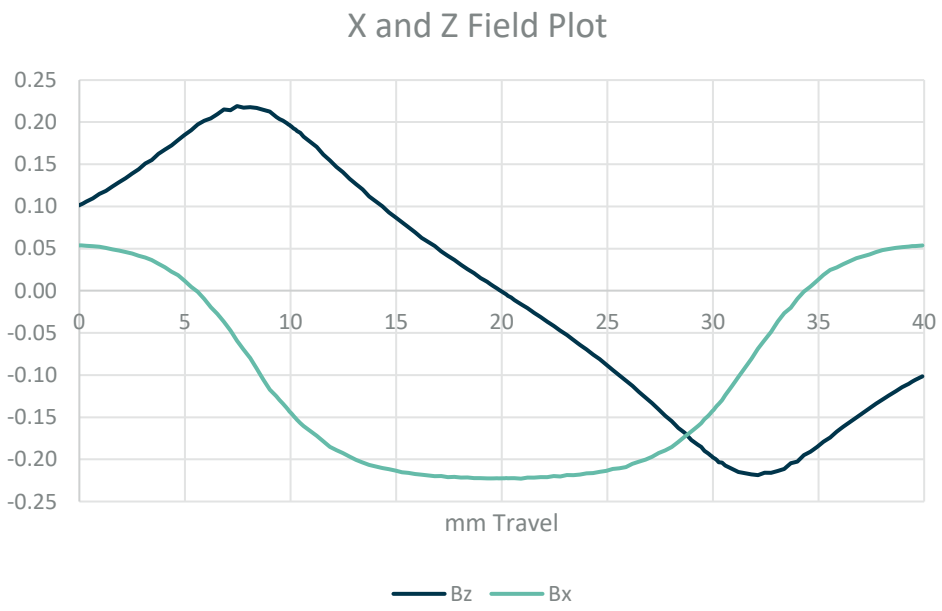
Angle Determination

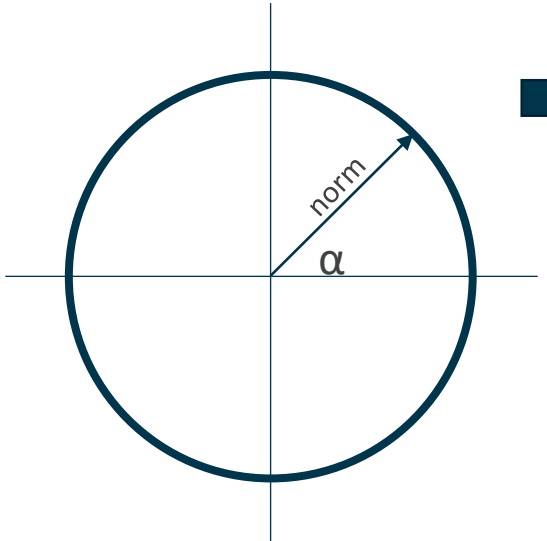
Performed in Host Microcontroller

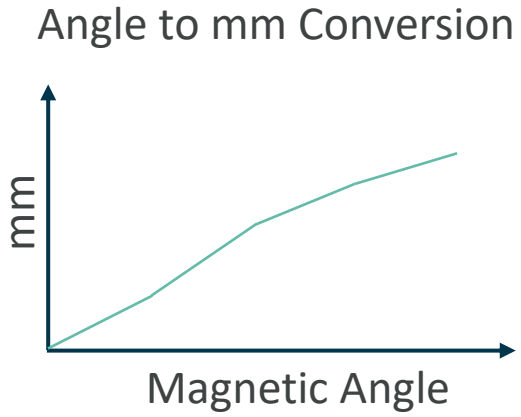
- The angle is computed from the X(Y) and Z magnetic fields that behave (somewhat) as sine and cosine signals the travel



$$\alpha = ATAN\left(\frac{Bx}{Bz}\right)$$

$$norm = \sqrt{Bx^2 + Bz^2}$$





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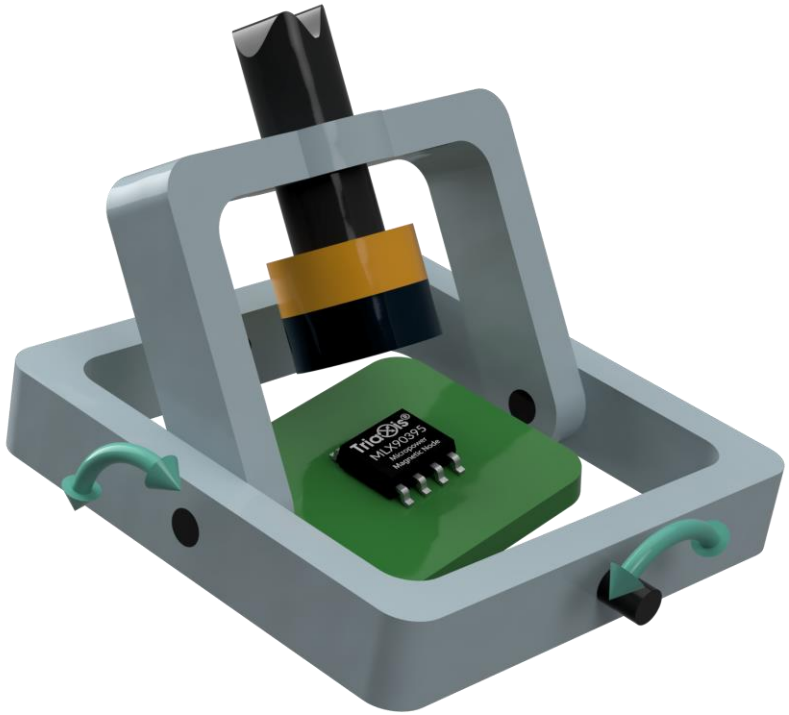
3D or Joystick Motion

- Magnet typically placed above sensor
- Up to 180 degrees (or more) depending on mechanical setup
- Absolute position
- Non-contacting
  - Immune to dirt, dust, or liquids
- Also capable of detecting push and pull
- All three axes need to be measured
- Insensitive to thermal variation

3D or Joystick Motion

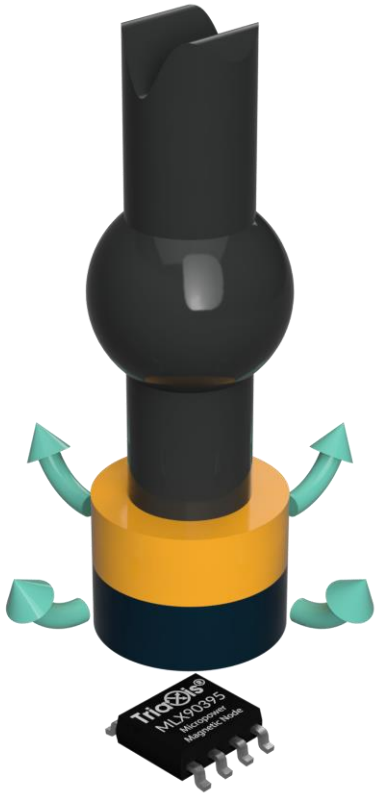
Two Different Types



Gimbal

- Pivot points in line with sensor
- Constant air gap
- Generally larger package
- One-to-one correlation
- Better nonlinearity

- Pivot point is above sensor
- Variable air gap
- Generally smaller package
- Variable correlation
- Worse nonlinearity



Ball and Socket

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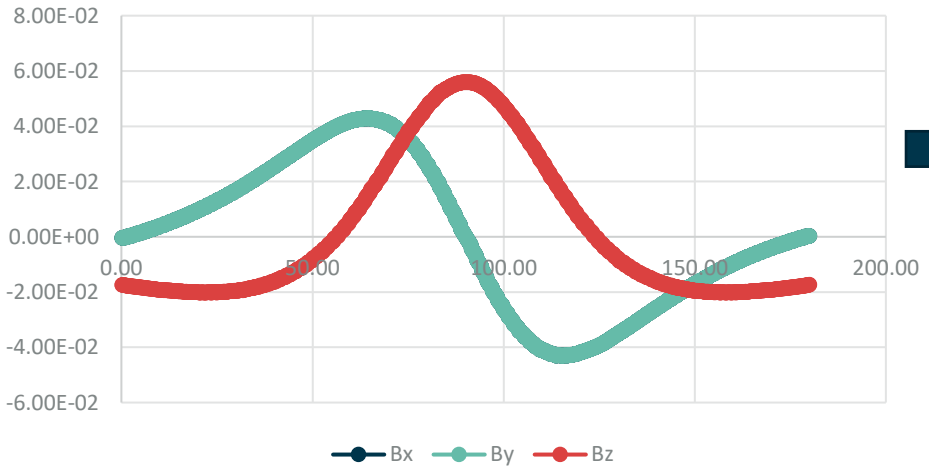
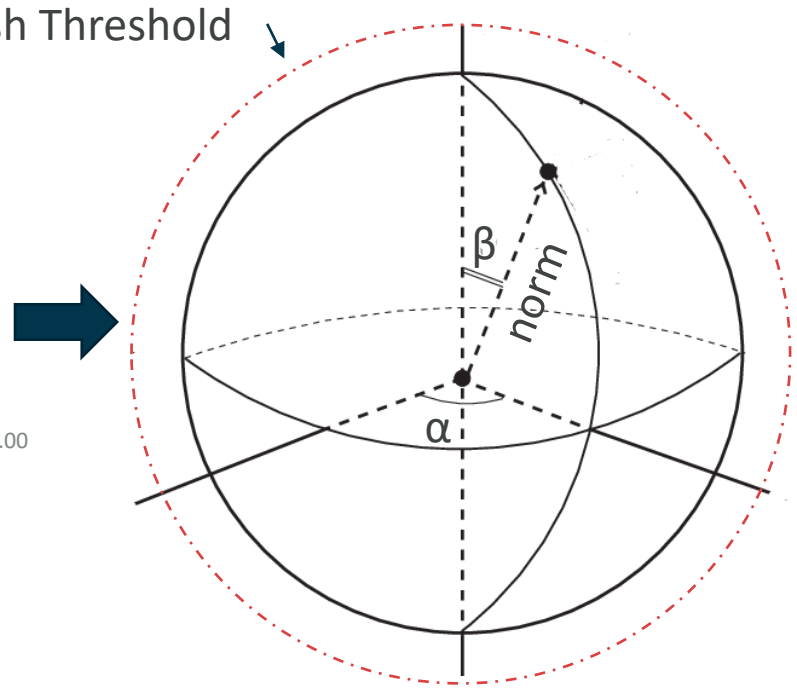
3D or Joystick Motion

- The angle is computed from the X, Y, and Z magnetic fields with the suggested formula depending on configuration





Gimbal Suggested Formulas

$$\alpha = ATAN\left(\frac{Bx}{Bz}\right)$$

$$\beta = ATAN\left(\frac{By}{Bz}\right)$$

$$norm = \sqrt{Bx^2 + By^2 + Bz^2}$$

Ball and Socket Suggested Formulas

$$\alpha = \mathrm{ATAN}\left(\frac{\sqrt{(k_z V_z)^2 + \left(k_t V_y\right)^2}}{V_x}\right)$$

$$\beta = \mathrm{ATAN}\left(\frac{\sqrt{(k_z V_z)^2 + (k_t V_x)^2}}{V_y}\right)$$

$$norm = \sqrt{Bx^2 + By^2 + Bz^2}$$

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Application Examples

MLX90395

Selection / Headlamp Switch

- Headlamp or parking lamp selection is determined via the rotary motion of the knob.
- Push and pull detection is used to enable, or disable, the front and rear fog lamps respectively
- The MLX90395 enables a non-contacting solution and reduction in part count and simplified design via removal of components like tactile switches

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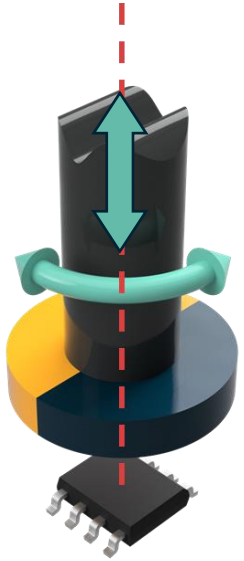
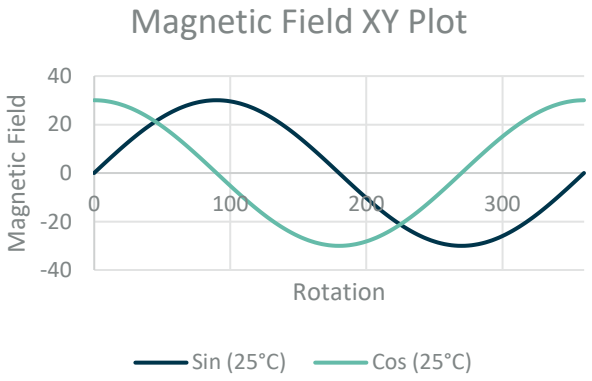
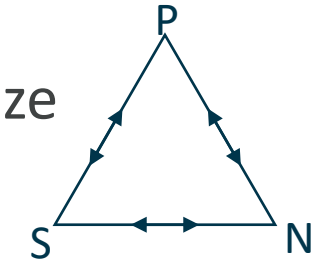
MLX90395

Selection / Headlamp Switch





- Items to Set/Configure
  - Gain – Based on applied magnetic field, target ~90% of ADC span
  - Fine Gain – Via e.g. ResX or SensXY parameters
  - Set DigFilt and OSR to optimize power, speed, noise
- Start Measurements
  - X and Y axes mandatory, others optional
  - Single, Burst, or WOC
- Process in Microcontroller
  - Update on the fly if needed



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MLX90395

Selection / Headlamp Switch

- Melexis also offers a suite of LIN switch IO devices that can read in the MLX90395, calculate the position, and return the value over the LIN bus.
  - 2-chip solution with small PCB area for small size and cost reduction
  - Integrated IO, voltage regulator, LIN transceiver
  - LED lighting capability
  - 3-wire solution

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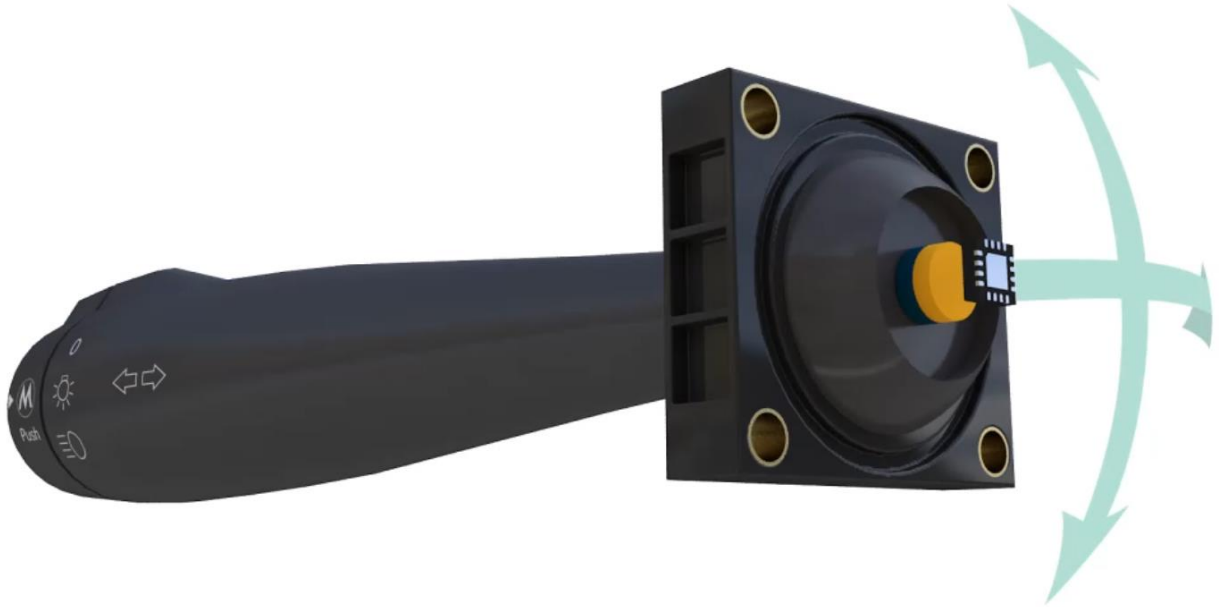
MLX90395

Turn Signal Stalk / Multifunction Switch



- Multifunction Switch used to turn on/off signals, headlamps, or windshield wipers
  - MLX90395 enables non-contacting sensing
  - Joystick motion capable for up/down and in/out detection
  - Highly reliable with diagnostics possible
  - 120mT suitable for close air gap
  - Dig protocol enables easy integration to standard microcontrollers
  - 3x3x1mm QFN16 package for small space

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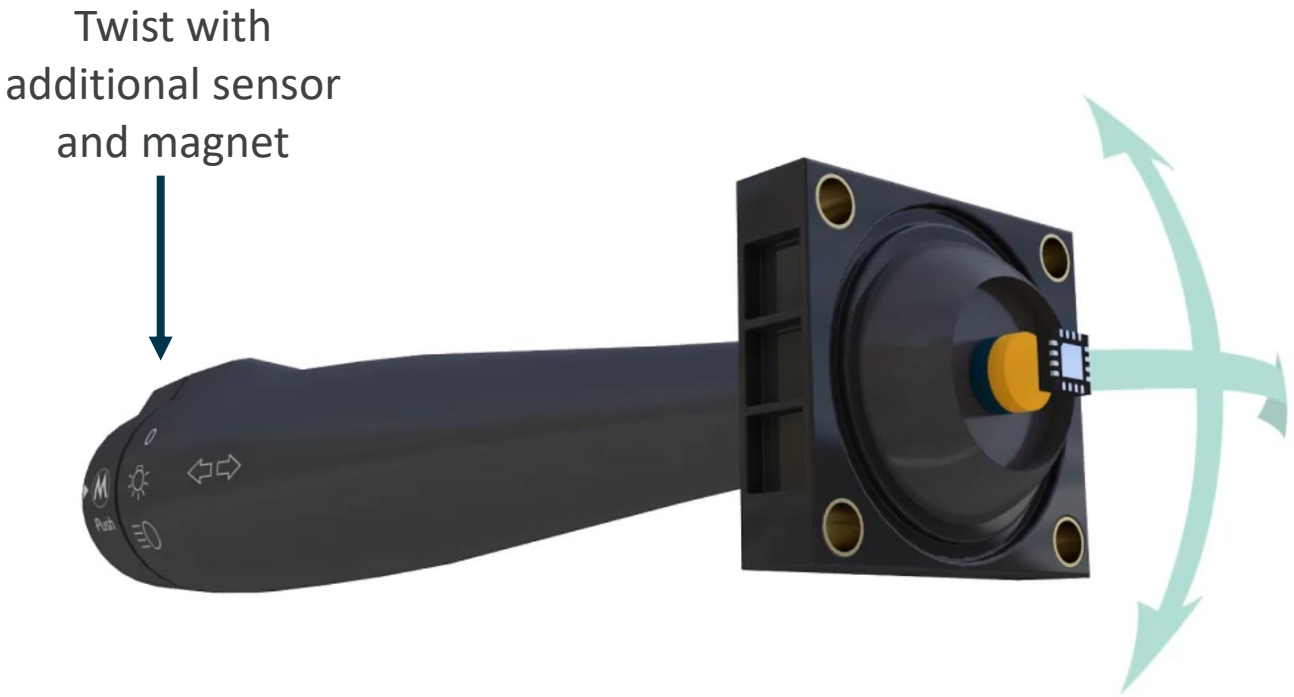
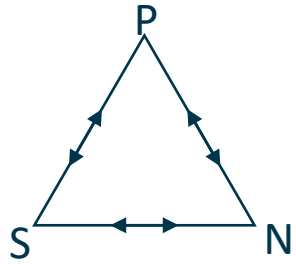
MLX90395

Turn Signal Stalk / Multifunction Switch



- Items to Set/Configure
  - Gain – Based on applied magnetic field, target ~90% of ADC span
  - Fine Gain – Via e.g. ResX or SensXY parameters
  - Set DigFilt and OSR to optimize power, speed, noise



- Start Measurements
  - X, Y, and Z axes mandatory, others optional
  - Single, Burst, or WOC
- Process in Microcontroller
  - Update on the fly if needed

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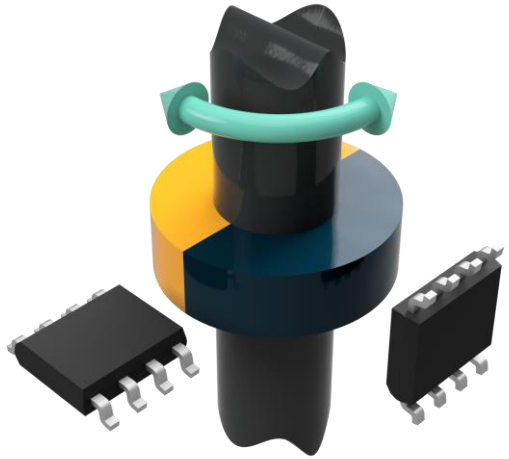
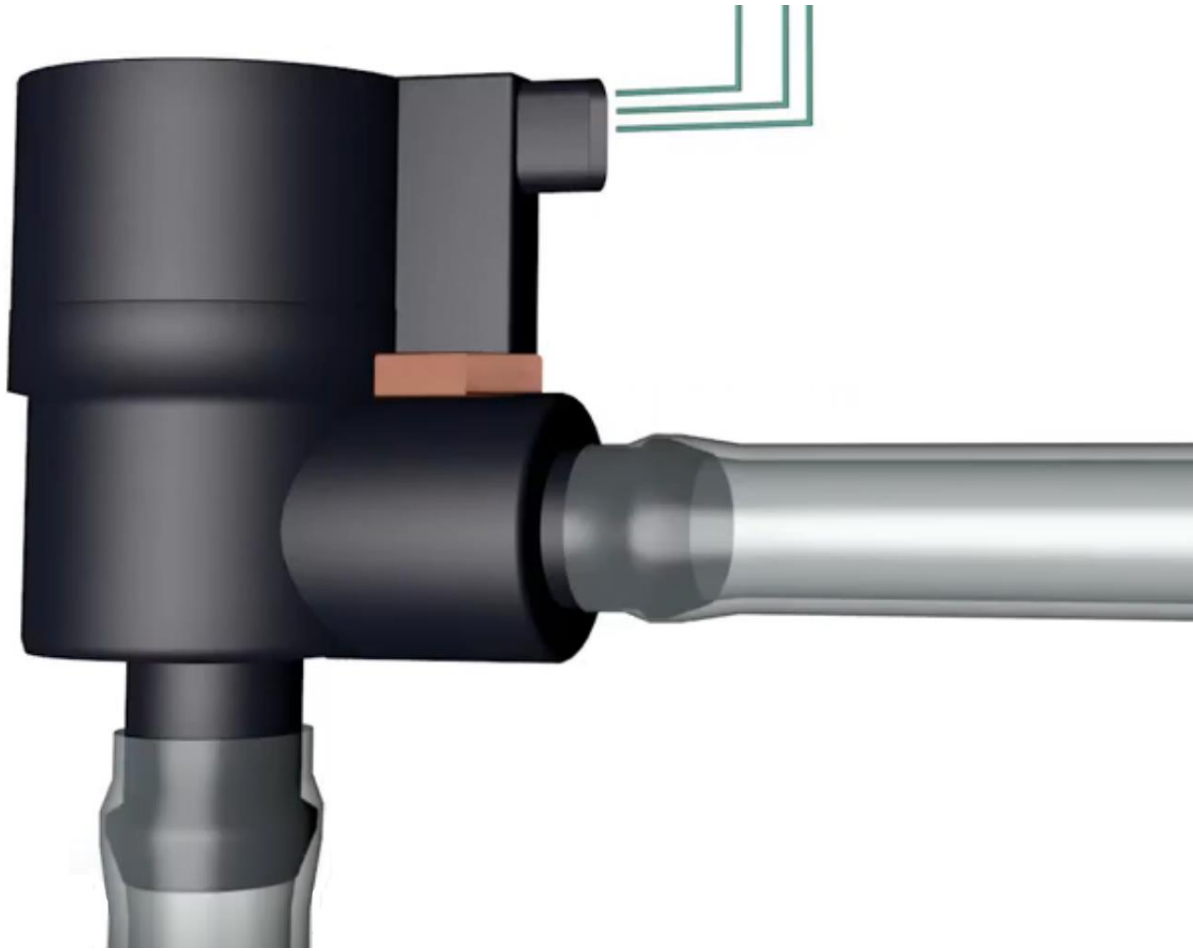
MLX90395

Valve Position Detection

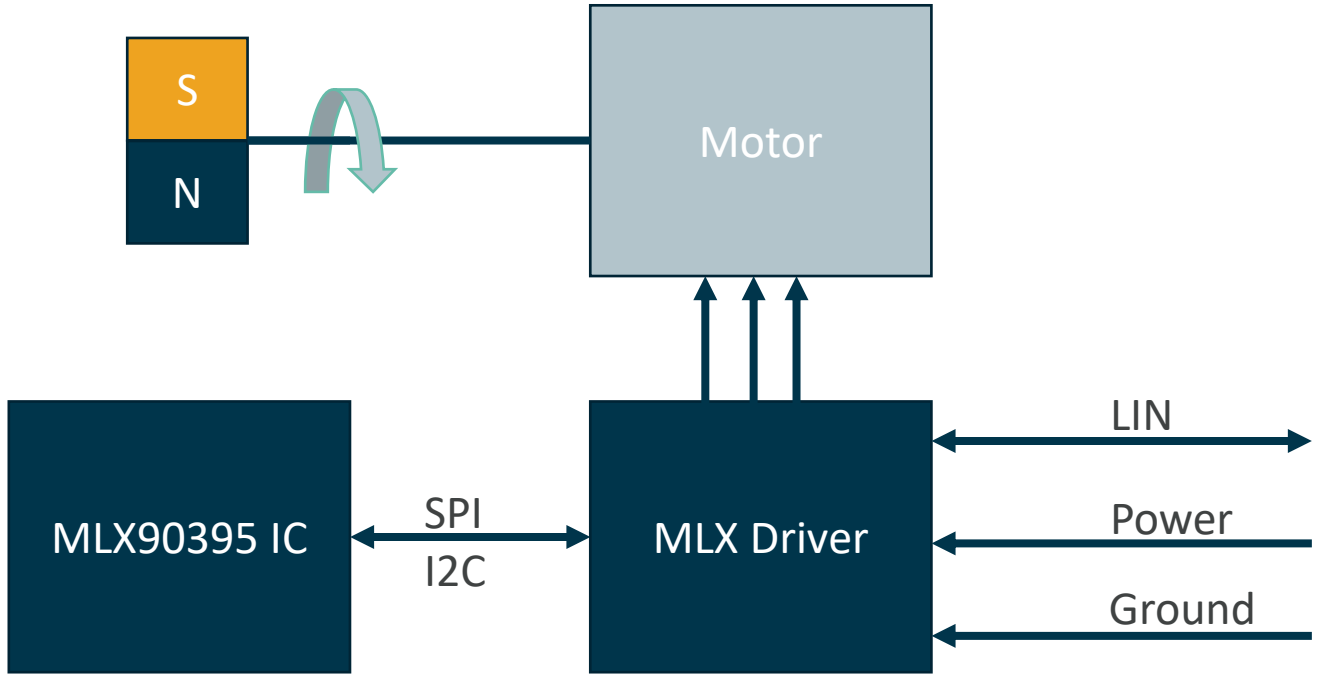
- Valve position benefits from the small packaging and flexible nature of the MLX90395
- Off-axis motion is supported for valves where an on-axis magnet is not available.

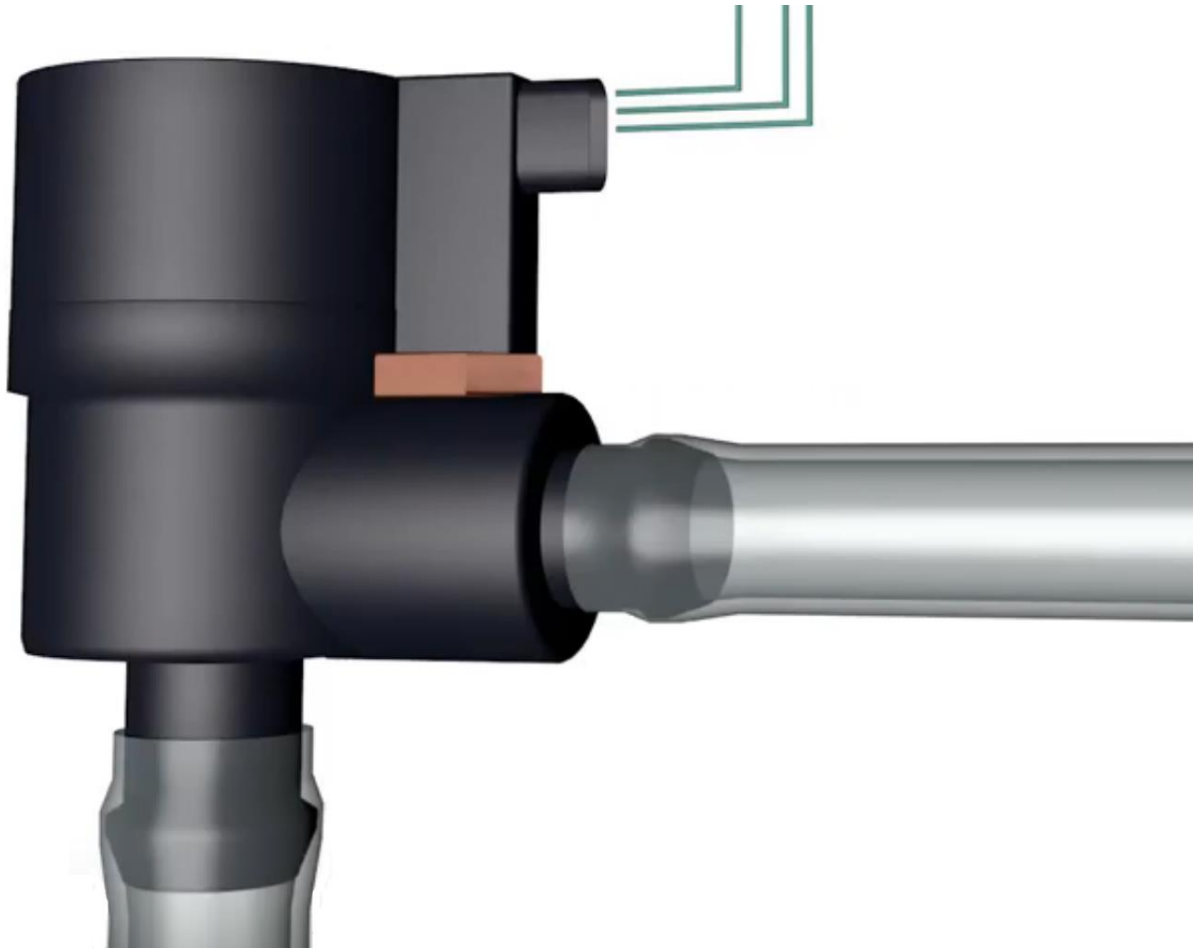




MLX90395

Valve Position Detection

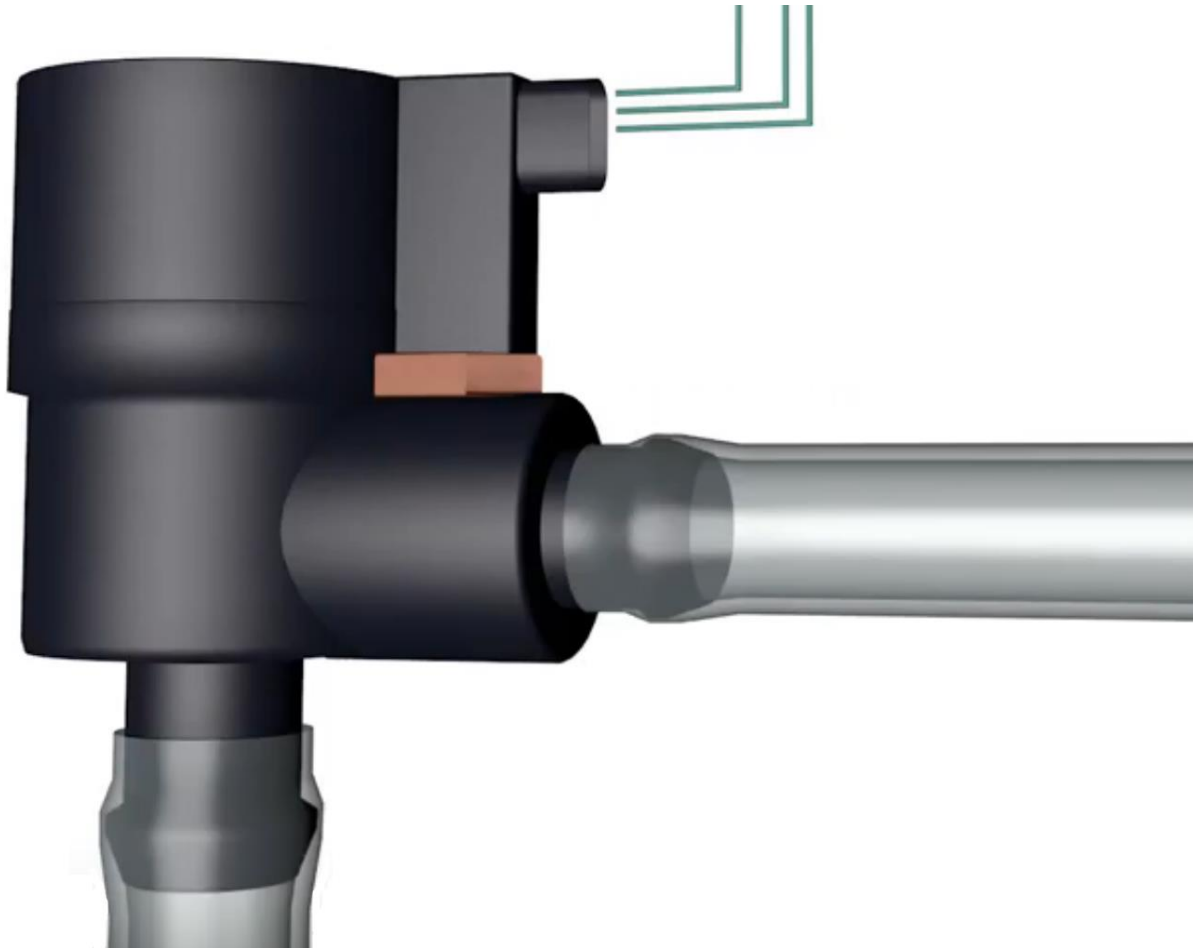




MLX90395

Valve Position Detection

- Items to Set/Configure
- Same basic configuration as the switch
  - Gain
  - Fine Gain
  - Set DigFilt and OSR
- Start Measurements
  - Axes depend on magnetic setup, usually XZ, YZ, or XY
  - Single, Burst, or WOC
- Process in Microcontroller
  - Update on the fly if needed



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Every Application is Different

Supporting Material

- Getting Started Guide

- Evaluation Board and Demos

Coming Soon!

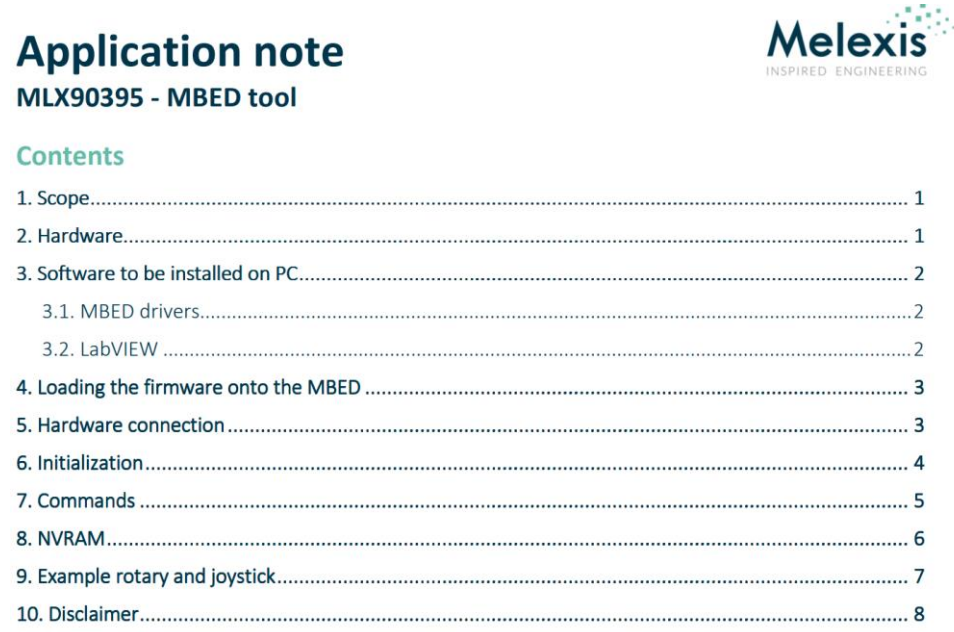
Not For Sale

Video Demo At: https://www.melexis.com/en/product/MLX90393/Triaxis-Micropower-Magnetometer

- Code Samples

```
//Initial SM-RM
cmd1[0] = 0x39;
i2c.write(addr, cmd1, 1);
i2c.read(addr, cmd1, 1);
cmd1[0] = 0x49;
```

- Contact Us at: https://www.melexis.com/en/contact/sales-contact



Application note

MLX90395 - MBED tool

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Contents

1. Scope

This document is intended for customer who wants to get started with th ry and LabVIEW UI have been created to work together with the MBED LPC1768 micr is for **demo** purposes only, to 'play around' in the lab, and only shows how the sens braries **are not written according ASIL or other ISO standards, and thus should** actual **application.**

2. Hardware

The hardware needed is an MBED (LPC1768).

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Any Questions?
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