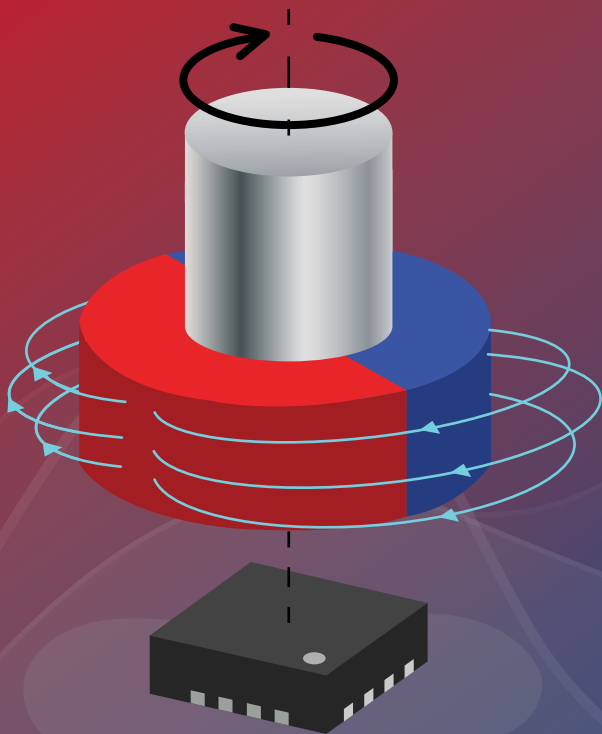# MAGNETIC ANGULAR POSITION SENSORS

Power Management Solutions

MPS

MonolithicPower.com

Quality Assurance & Reliability Commitment

The MPS Quality Assurance organization develops, coordinates, and champions strategic quality initiatives throughout MPS Inc., its foundries, and sub-contractors. Its mission is to enable MPS to design, develop, manufacture, and deliver products to our customers with world-class quality and reliability that meet and exceed our customers' expectations.

MPS and Its Supplier Quality Systems and Certificates:

- ISO9001:2008 (MPS)
- EU RoHS/HF/REACH Compliant (MPS)
- Sony Green Partner (MPS & Suppliers)
- TS16949 (Suppliers)
- ISO14001 (Suppliers)

Product Quality:

- Automotive Products Qualified per AEC-Q100 Standard
- Standard Products Qualified per JEDEC and Military Standard
- Reliability Failure Rate <10FIT
- Product Quality Level <1.0ppm

Quality Control and Monitor:

- On-Site Foundry and Assembly Teams for Real-Time Actions
- Quarterly Supplier Quality Review and Annual Supplier Audit
- Short-Term Reliability Monitor Test – Daily
- Long-Term Reliability Monitor Test – Monthly
- Real-Time Engineering Actions on Monitor Failure
- Quarterly Reliability Monitor Reports

mps

IN THIS GUIDE

MagAlpha Sensor Overview

The MPS MagAlpha family of magnetic angle position sensors offers a revolutionary way to measure angles. Leveraging more than a decade of experience, the MagAlpha range offers unique performance advantages compared to rival magnetic sensing technologies.

MagAlpha sensors use the patented SpinAxis™ Hall measurement technique that provides instantaneous angle position in a digital format. SpinAxis™ uses a phase detection approach that eliminates any need for analog-to-digital conversion or complex angle calculation used by more traditional technologies (see Figure 1).
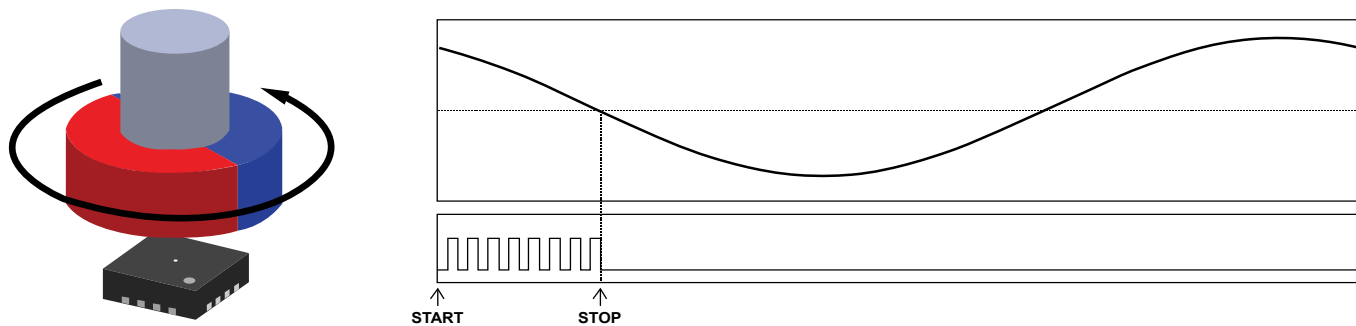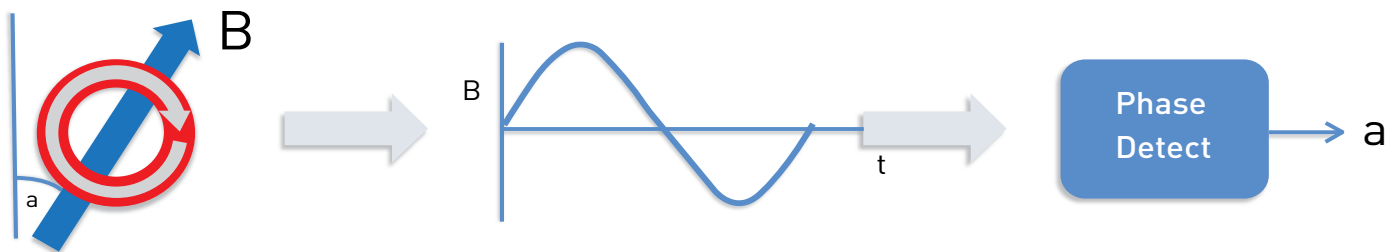

Figure 1: SpinAxis™ Technique

The benefits of the SpinAxis™ technique has allowed MPS to develop different angle sensor ranges spanning all types of end applications, from low-cost consumer rotary knobs to high-speed motor commutation and position control.

Advantages of MagAlpha Sensors

Traditional magnetic angle sensors use a set of Hall plates orientated in the x- and y-axes that convert the amplitude of the rotating magnetic field into a sine and a cosine waveform. The two waveforms are then digitized with analog-to-digital converters (A-to-D), and the angle is computed using an arc tangent calculation. This approach has some disadvantages. Firstly, the amplitude of the magnetic field being measured musy be matched to the A-to-D converter's input range for best results. This limits the minimum and maximum range of the magnetic field that can be accommodated and the magnet's distance from the sensor. The second major disadvantage is that the A-to-D conversion and arc tangent calculation take some time, which translates to angle error or position lag at the sensor output. Typical latency can be hundreds of microseconds for this older technique.

MagAlpha sensors in contrast utilize an array of Hall plates that are sampled successively at very high speeds in such a way that the signal phase represents the angle to be measured. The "phase-to-digital" SpinAxis™ technique captures the angle instantaneously every 1µs without the need for A-to-D conversion or arc tangent calculation. This means the sensor is able to work over a wider magnetic field range (typically 30-150mT), giving greater flexibility and tolerance for magnet positioning.

The fast Hall sampling and subsequent digital conditioning result in very low latency from Hall array sampling to the data availability at the sensor output. Typical latency is only 10µs at a constant rotation speed, allowing MagAlpha sensors to operate in systems with high rotation speed or that require fast position control loops. Rotation speeds from zero to more than 100kRPM are possible.

Side-Shaft Capability

MagAlpha sensors support both end-of-shaft and side-of-shaft topologies. In end-of-shaft the sensor is placed directly below the magnet connected to the rotating shaft. This topology gives the best performance but is not always mechanically convenient because the end of a rotating shaft may not be accessible. For example, in a motor, it may be hidden by the shaft bearing, or driving into a gear box.

Side-shaft topology allows the magnet to be placed to the side of a ring magnet mounted on the rotating shaft. This is advantageous for many designs as the ring can be located anywhere on the shaft, which allows the sensor to be embedded more easily within the motor or product casing. MagAlpha sensors contain dedicated bias trimming register, which allow the extra magnetic fields seen in side-shaft mode to be normalized in amplitude so that the sensor maintains a linear output response over the full angle measurement range (see Figure 6, page 11).

MagAlpha angle sensors offer the following advantages:
- Instantaneous angle sensing: up to 1µs sample rate, only 10µs latency at 100kRPM
- High resolution up to 14 bits
- Support for shaft rotation speeds from zero to over 100kRPM
- Wide magnetic field range support from 15mT to 150mT working range
- End- and side-shaft sensor topologies
- Low power consumption: 3.3V, 12mA
- Small form factor: 3x3mm QFN-16 package

Rotary Human-Machine-Interface Applications

MA8xx Family

Rotary knobs are used in a diversity of human-to-machine-interface applications, such as the program selector on a washing machine or the infotainment control in a car. These applications typically use a conventional potentiometer or mechanical rotary applications, which have limited life spans due to mechanical wear and tear or environmental degradation. The use of magnetic angle sensors to implement contactless sensing eliminates both issues to provide a long lifetime solution.

The MagAlpha MA8xx family is a new, simple-to-use, digital, magnetic sensor range designed to replace analog potentiometers or rotary switches in such applications. The sensor detects the absolute angular position of a permanent magnet attached to the rotating knob. Typically, a simple diametrically magnetized cylinder with a 3 to 8mm diameter is suitable.

Different options are available, including digital angle output via SPI/SSI bus, incremental ABZ interface, or PWM output.

Programmable threshold magnetic field strength detection is built in to enable implementation of a contactless push or pull button. Detection is performed by reading the device registers or the logic state of the two output signals. In this way, a combined rotary knob with "push or pull to select" functionality can be created.

Figure 2: Block Diagram of MA8xx Family Sensor
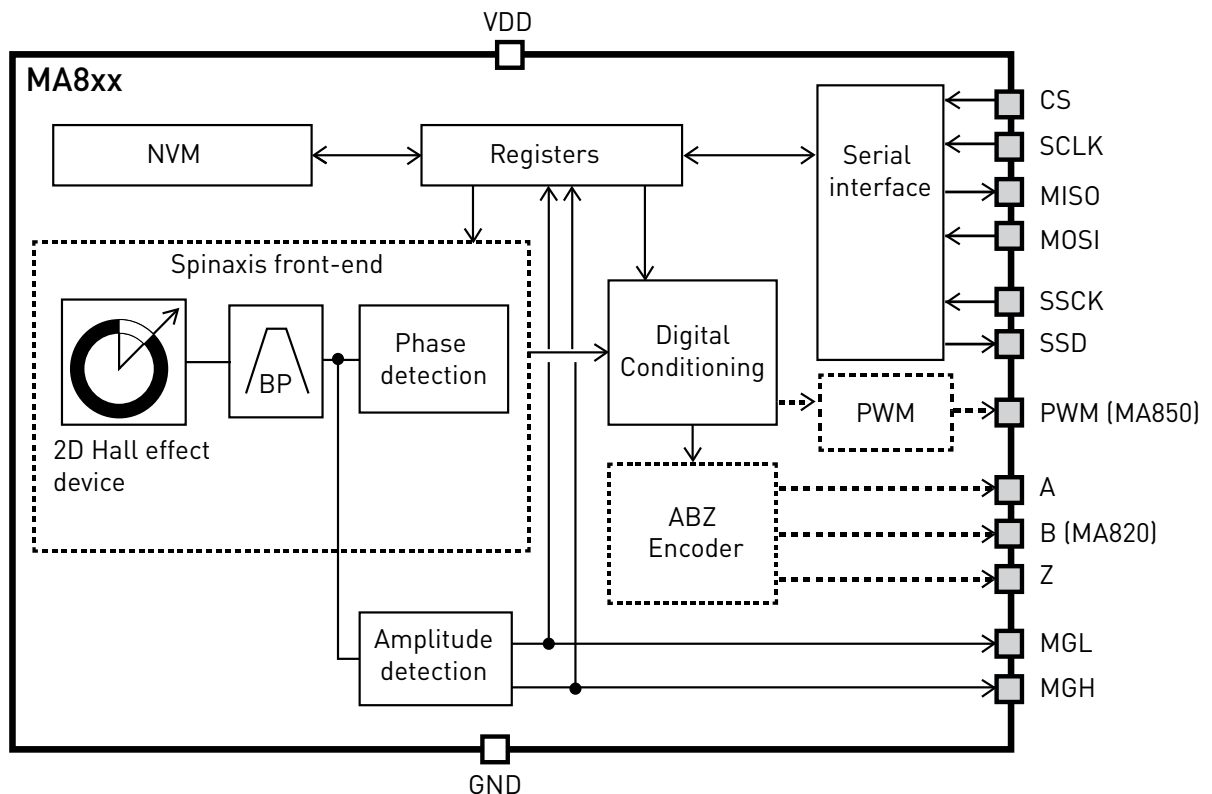
Push-Button Functionality

The MA8xx family provides contactless push- or pull-button functionality via programmable magnetic field strength thresholds, which can detect the distance of the magnet to the sensor. The graph in Figure 3 shows how this may be implemented with a change in magnet position of approximately 0.9mm crossing the programmed field threshold to cause the MGH signal to change from logic 0 to logic 1.

Figure 3: Example of Push-Button Detection B(mT) v. Air Gap
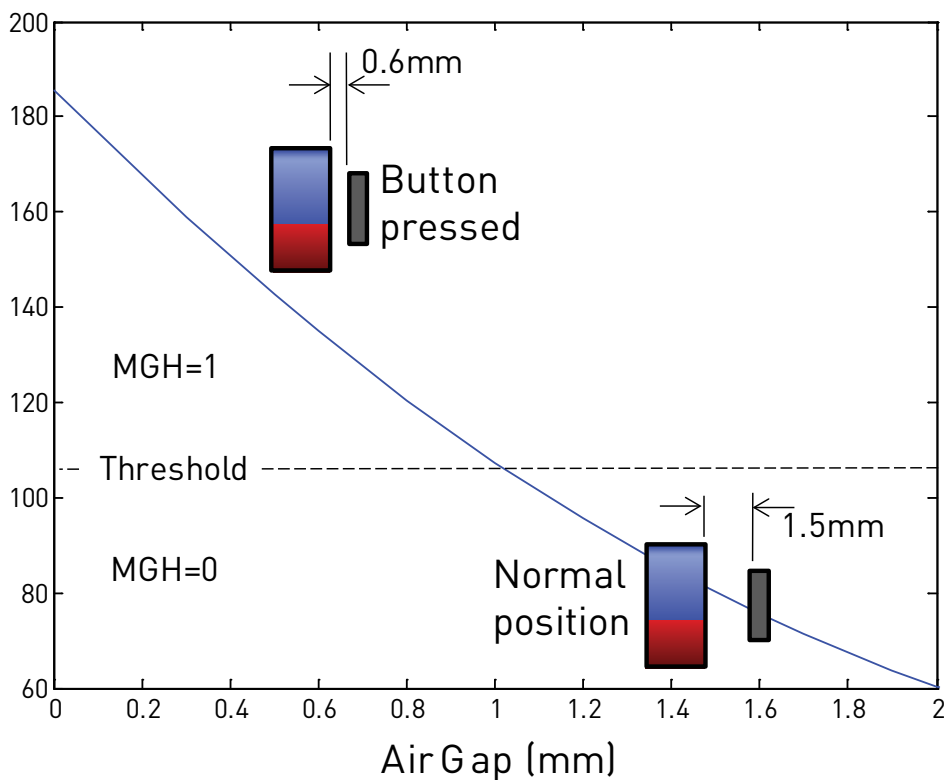
Non-Volatile Memory

Configuration parameters are stored in the MA8xx device's non-volatile memory automatically via the SPI interface. The non-volatile memory provides storage for the reference zero angle position and the magnetic field detection thresholds.

The MA8xx family operates from a 3.3V supply and is packaged in a 3x3mm QFN package. The operating temperature is -40 to +125°C.

Table 1: MA8xx Family Sensor Range

Features by Part		Turning Knob Applications		
	Unit	MA800	MA820	MA850
		Digital Out	ABZ Incremental Out	PWM Out
Effective angle resolution	bit	8	8	8
Magnetic field range	mT	30 ..150	30 ..150	30 ..150
Zero setting		✔	✔	✔
SPI register configuration		✔	✔	✔
Absolute angle on SPI	bit	8	-	-
Absolute angle on SPI	bit	8	-	-
ABZ incremental			✔	
ABZ resolution	PPR		1 .. 64	
PWM output				✔
PWM resolution	bit			8
Magnetic field detection		✔	✔	✔
Push-button functionality		✔	✔	✔

MA800: Digital SPI Output

The MA800 sensor outputs the digital angle read-ing via an SPI or SSI interface. This allows for an easy interface to all types of microcontrollers.

The digital angle is an absolute value with 8-bit resolution between 0 and 360 mechanical de-grees. Because it measures the absolute angle, the position information is always true, even after the power is cycled.
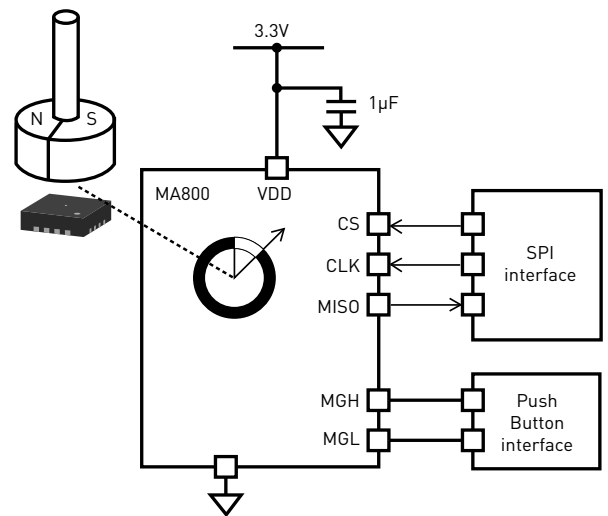
MA820: ABZ Output

The MA820 features a programmable, incremental, ABZ encoder interface. This provides two channels (A and B) of quadrature encoded signals with a programmable number of pulses per channel for each full 360° turn. The pulses per channel can be set from 1 to a maximum of 64 per revolution. The 90° quadrature spacing of the two channels also provides direction of turn information. An index pulse output (Z) is provided to reference the knob's zero position. The zero reference can be set during system production and programmed into the non-volatile memory of the device.

Figure 4: Quadrature ABZ Waveform
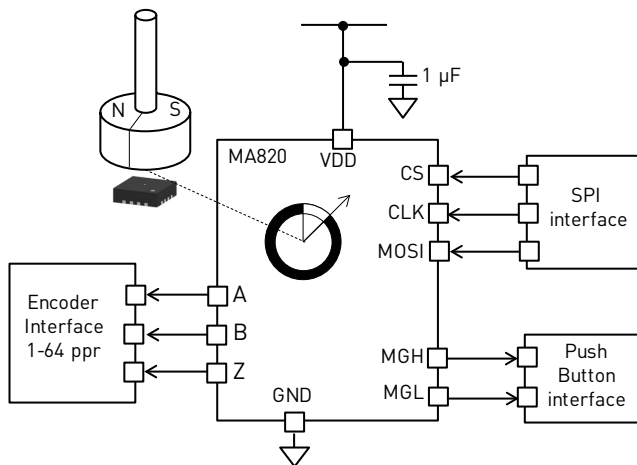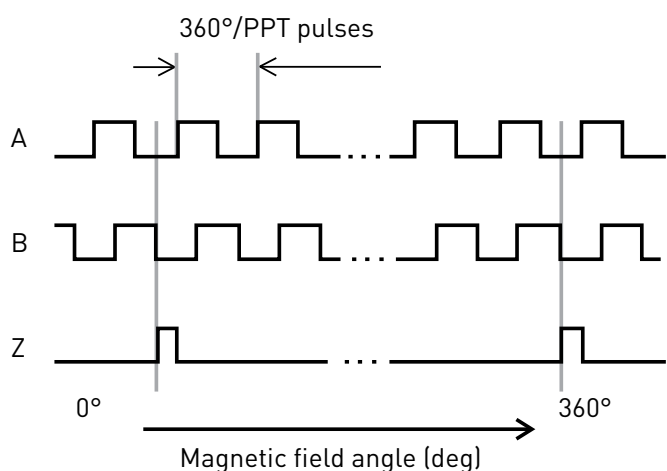
MA850: PWM Output

For applications wanting to retrofit to the analogue output of a potentiometer solution, the MA850 provides a PWM output, which can also be filtered to provide a ratiometric linear voltage that is proportional to the angle. The PWM has an 8-bit resolution and frequency of approximately 50kHz. Adding an R-C network to the output provides an output voltage over the range from 0 to the device supply voltage of 3.3V. For a 0 to 5V application, the R-C network can be buffered by a simple OP-AMP circuit to provide a wider output voltage range.

Figure 5: Example of a Potentiometer-Like Assembly Using Contactless Sensing with MA800/820/850
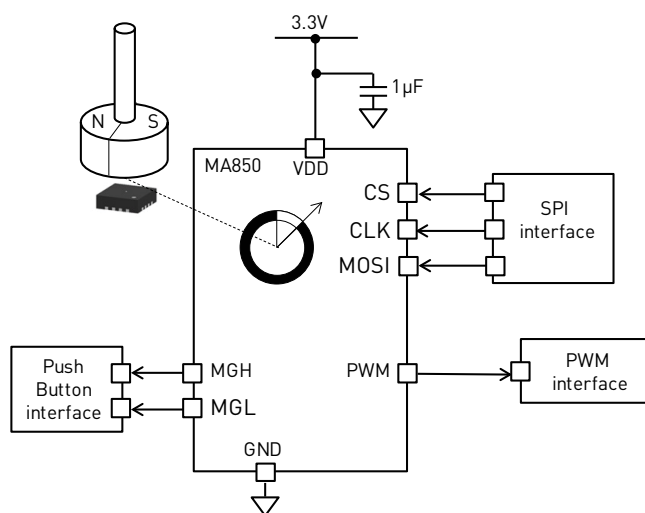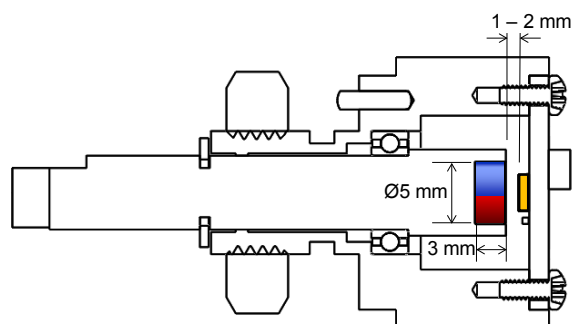
Brushless DC Motor Control Applications

MA1xx and MA3xx Families

Three-phase brushless DC (BLDC) motors are increasingly popular in many applications, offering high reliability and long operating life due to the electrical commutation scheme that replaces older carbon brushed motors.
MPS offers a range of MagAlpha angle sensors optimized for brushless motor commutation,

position, and speed control. The MagAlpha sensor is able to generate both the UVW commutation signals and the position information needed for motor control systems, either in the form of a direct digital angle read over the SPI interface or an ABZ incremental encoder quadrature output interface.

Table 2: MagAlpha Motor Application Devices

Features by Part Applications	Unit	Motor Commutation MA102 Replacing 3 Hall Switch	Motor Commutation and Position Controlled Drives MA302 BLDC Motor	MA310 Side-Shaft optimized BLDC	MA330 Programmable Filter Bandwidth
Effective angle resolution	bit	12	12	12	9 - 14
Filter bandwidth	Hz	390	390	93	23 - 6000
Magnetic field range	mT	30 .. 150	30 .. 150	15 .. 150	30 .. 150
Zero setting		✔	✔	✔	✔
Side-shaft compensation		✔	✔	✔	✔
Adjustable direction		✔	✔	✔	✔
SPI register configuration		✔	✔	✔	✔
Absolute angle on SPI	bit	8	12	12	9 - 14
ABZ incremental			✔	✔	✔
ABZ resolution	PPR		1 .. 256	1 .. 256	1 .. 1024
Adjustable Z pulse				✔	✔
UVW output		✔	✔	✔	✔
UVW pole pairs per revolution	bit	1 .. 8	1 .. 8	1 .. 8	1 .. 8
Differential UVW		✔			
Magnetic field monitoring		✔	✔	✔	✔

Motor Commutation Sensors

MA102: PWM Output

The MA102 can replace the conventional three Hall switch approach with a single sensor and disc magnet mounted at the end of the rotor shaft or to the side of a ring magnet mounted on the rotor shaft (see Figure 6). The MagAlpha MA102 generates the UVW output signals used to commutate a brushless DC motor with programmable commutation angle step spacing to support one to eight magnet pole pairs on the rotor. Complementary UVW signals are provided to support differential signalling for greater cable length in noisy environments. Reprogrammable non-volatile memory (NVM) is provided to store configuration parameters, including the zero reference angle, pole pair step angle, and side-shaft optimization (see Figure 7).
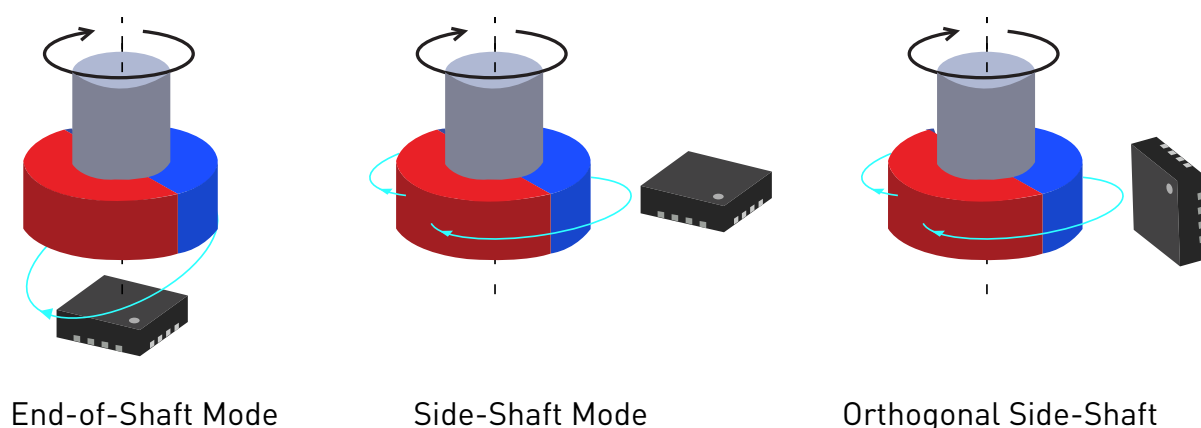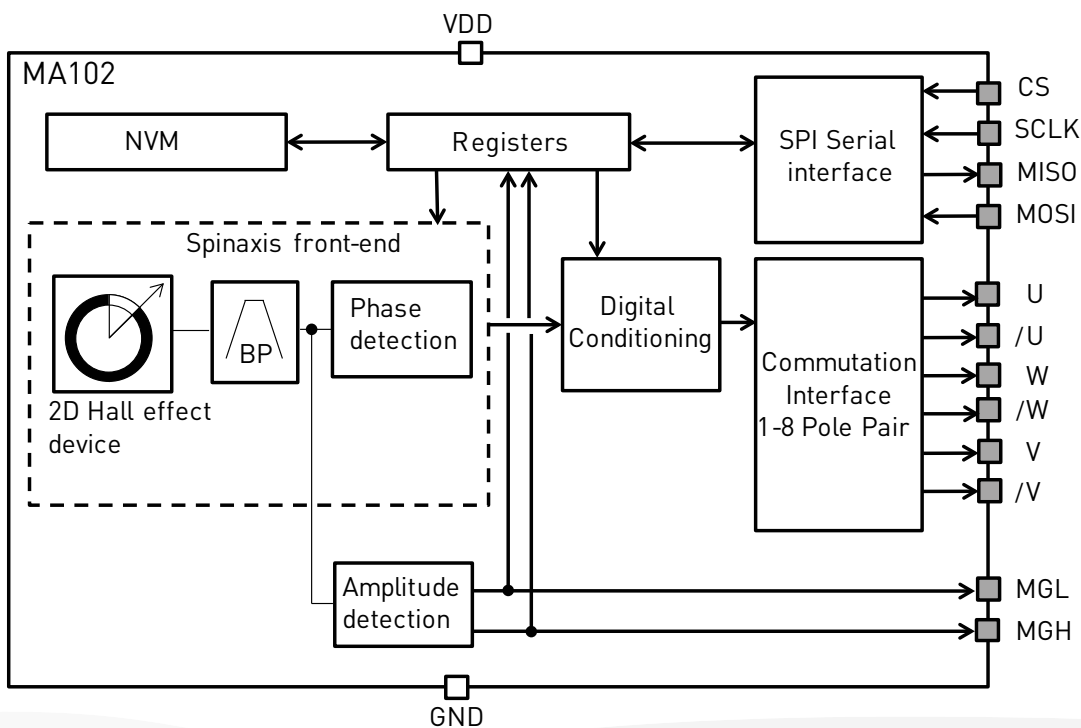
Figure 6: Magnet and Sensor Positioning

End-of-Shaft Mode   Side-Shaft Mode   Orthogonal Side-Shaft

Figure 7: MA102 Commutation Sensor

# Motor Commutation with Position Control (Servo Motor)

MA3xx Family

Brushless DC motors are used in many applications requiring position control. Examples include robotics, process automation, automotive actuators, and power tools. Such motors are usually referred to as servo motors and typically use an encoder mounted on the motor shaft to provide position, direction, or speed feedback to the control system. These external encoders increase the solution cost and size.

The MagAlpha MA3xx range provides the ability to commutate the brushless motor and provide an incremental ABZ style encoder interface in the same sensor device for speed and position control. This saves cost and allows for a very compact servo solution size (see Figure 8).

The MagAlpha MA3xx range features include:

- SPI interface for direct digital angle reading and chip configuration
- ABZ encoder interface with up to 1024 pulses per channel per turn
- UVW commutation interface with pole pair emulation from a simple two-pole magnet
- Magnetic field strength monitoring for diagnostics
- One-time programmable or reprogrammable non-volatile memory for storage of zero position and other programmable chip configuration parameters

Figure 8: MagAlpha MA3xx Block Diagram
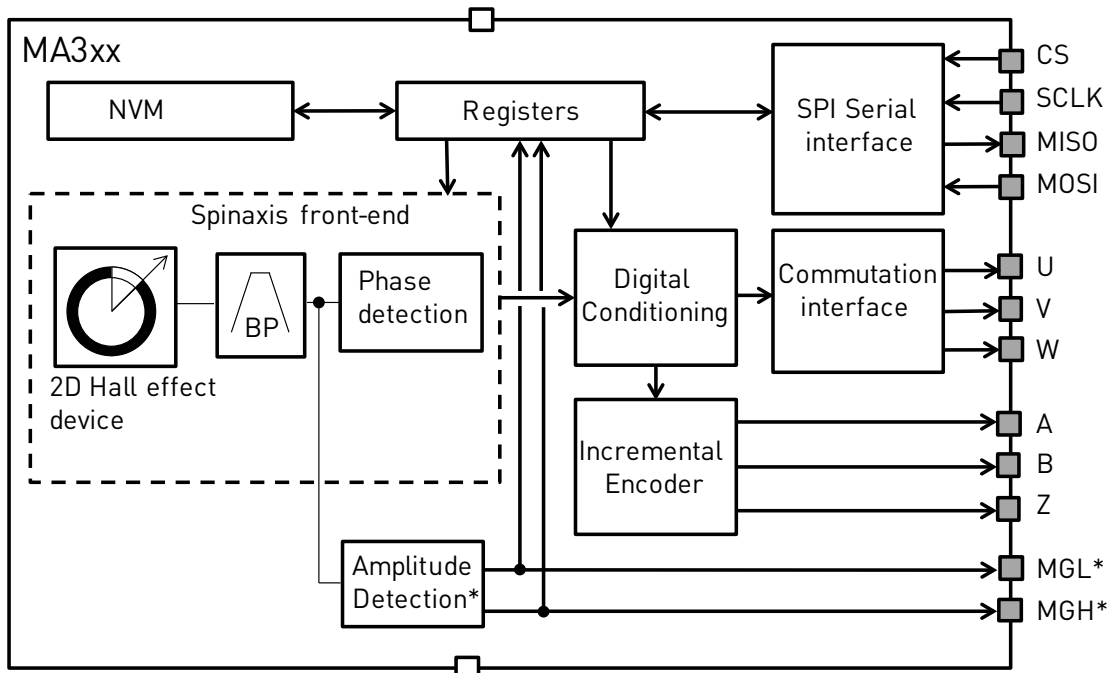
MA302: 12-Bit Fast-Response Servo Motor Sensor

The MagAlpha MA302 is optimized for high dynamic response and is suited to applications that experience rapid speed change and need to support high rotation speeds. Examples include high-speed brushless or permanent magnet motors in servo applications.

The digital conditioning block is optimized to maintain the highest resolution over different operating conditions. Speeds of up to 60kRPM are supported on the SPI, ABZ, and UVW interfaces. End- and side-shaft topologies are supported.
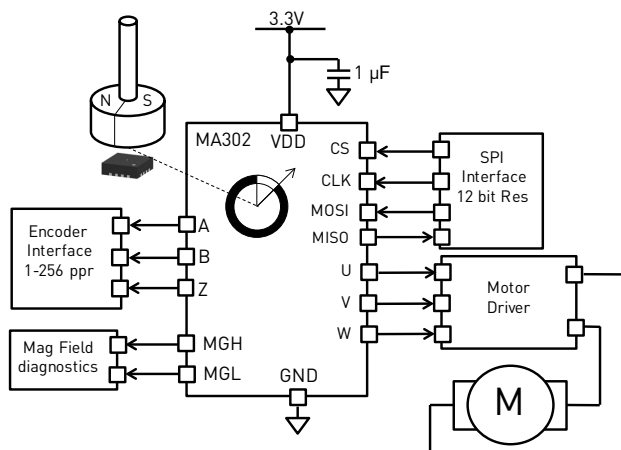
# MA310: 12-Bit Side-Shaft Optimized Servo Motor Sensor

The MA310 is optimized for side-shaft topologies where magnetic field strength is typically lower due to magnet position and the need to equalise the magnitude of the multiple magnetic fields sensed to obtain a linear output response. The MA310 is able to work with magnetic fields as low as 15mT and still achieve 12-bit digital angle resolution on its SPI interface.

MA330: 9 to14-Bit Adjustable Filter Bandwidth Angle Sensor NEW

The MagAlpha MA330 features selectable, digital filter bandwidths and ABZ interface hysteresis settings so that the users can optimize the sensor to meet the dynamic response needs of different control loop types. Loop response time can be traded against angle resolution, start-up time, ABZ pulse count, and hysteresis to match different system types.

An example application could be to support a higher ABZ pulse count of up to 1024 pulses per channel compared to the 256 found in the MA302. The MA330 is typically aimed at brushless DC servo motor applications where it can provide both commutation and encoder functionality.

Accurate angle sensing at speeds from 0 to 60kRPM is supported. Absolute digital angle via SPI plus incremental ABZ and UVW interfaces are provided. End- and side-shaft magnet topologies are supported.
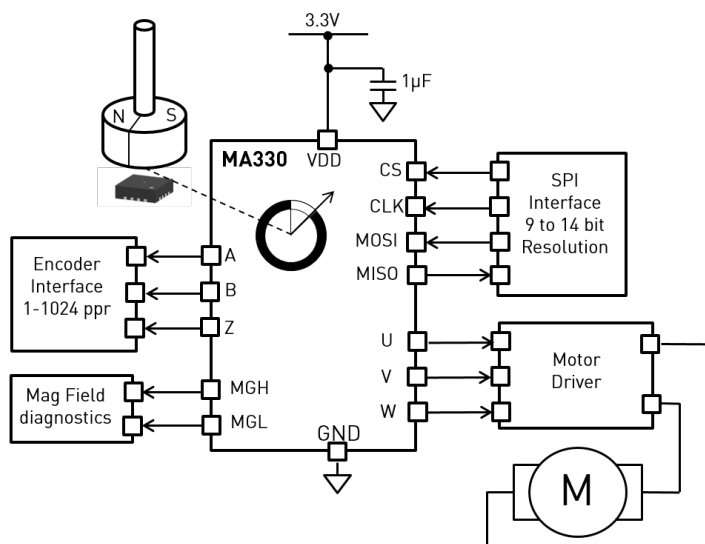
MA3xx Applications - Complete Miniature Servo Drive Motor Example

An example of a complete miniature servo drive implementation using the MA302 is shown in Figure 9.

Figure 9: Servo Motor Example using the MA3xx Sensor
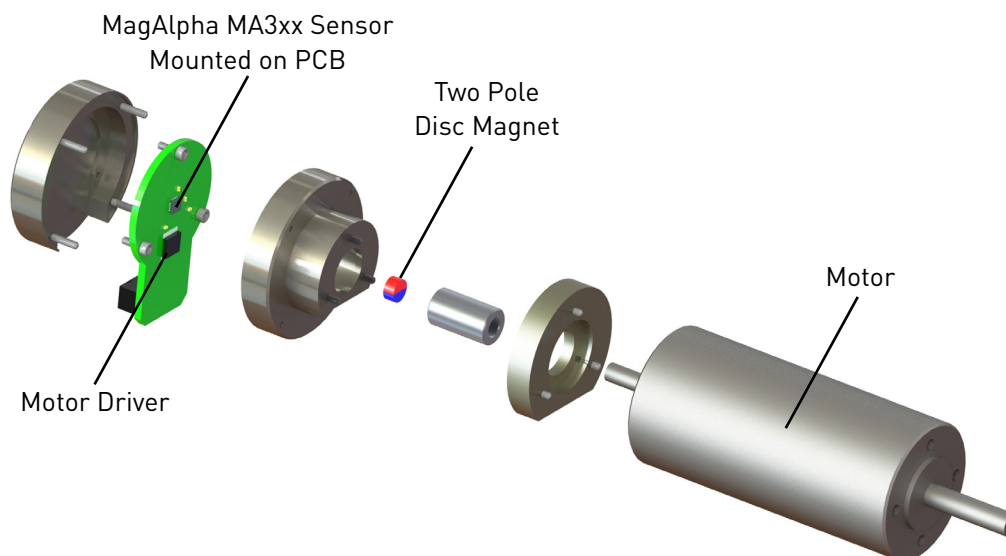
Motor Commutation Application Overview

Brushless DC (BLDC) or electronically commutated (EC) motors require feedback to the controlling electronics to indicate the position or angle of the rotor so that power can be applied to each of the stator windings at the correct time to maintain smooth rotation with low torque ripple.

Traditionally, this has been done using three Hall sensors to sense the field of the magnets mounted on the rotor. The disadvantage of this approach is that the Hall sensors need accurate mechanical alignment to the magnets mounted on the rotor so that the poles align correctly to the stator phases. This can be a complex manual procedure during motor manufacturing. For very small motor sizes, it can also be physically difficult to accommodate the three conventional Hall sensors inside the motor body.

The MagAlpha range simplifies commutation by converting the measured digital angle internally into the required UVW signals.

The MagAlpha range of sensors can be mounted either at the end of the rotor opposite a simple two-pole, diametrically polarised disc magnet or mounted to the side of a two-pole ring magnet mounted on the rotor shaft. This allows for an extremely compact mechanical arrangement. Figure 10 shows the 60° UVW commutation signals for a two-pole rotor (one pole pair) configuration.

Motor manufacturing is further simplified by the ability to perform rotor magnet to stator phase alignment by programming the zero angle offset position into reprogrammable non-volatile memory. This can be done as an automated software procedure at the end-of-line test during motor manufacturing.

Brushless DC Motor Commutation

Simple Single Pole Pair

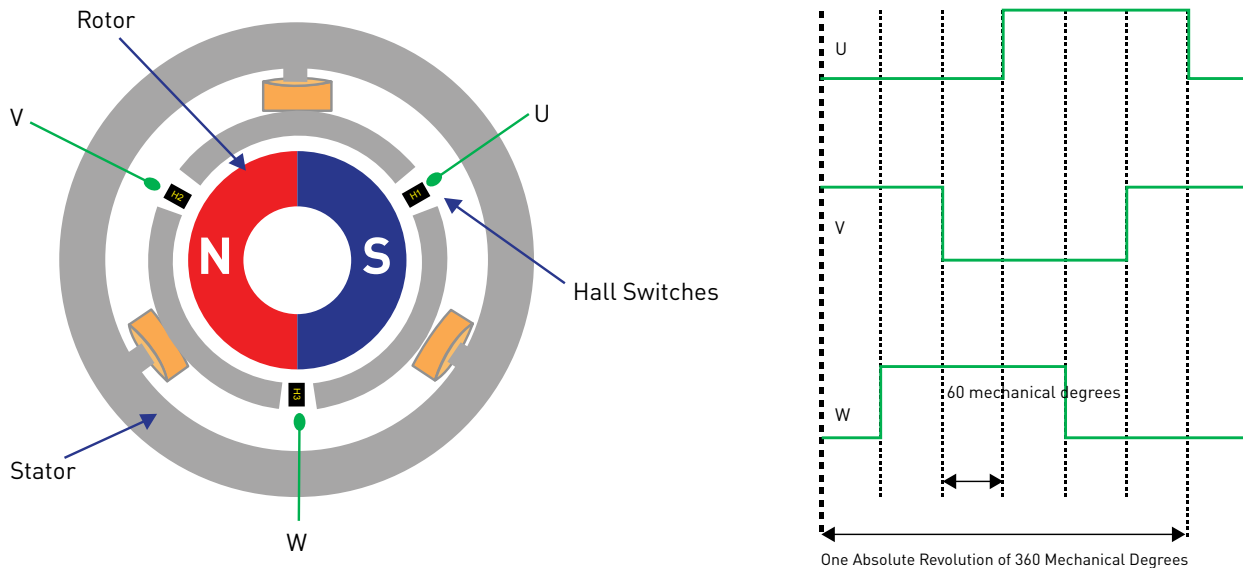**Conventional Two-Pole Rotor (One Pole Pair) BLDC Motor with Three Hall Switches**

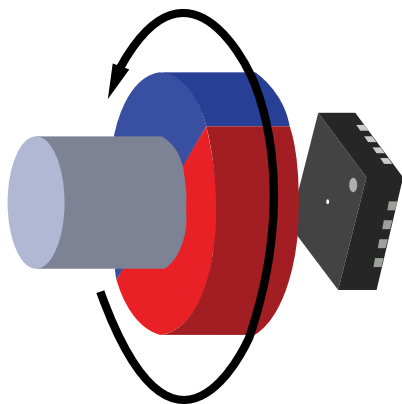One Absolute Revolution of 360 Mechanical Degrees

Figure 10: Replacing Three Hall Sensor Approach with the MagAlpha Sensor

MagAlpha Two-Pole Disc Magnet at End of Rotor
6x60° States per 360°
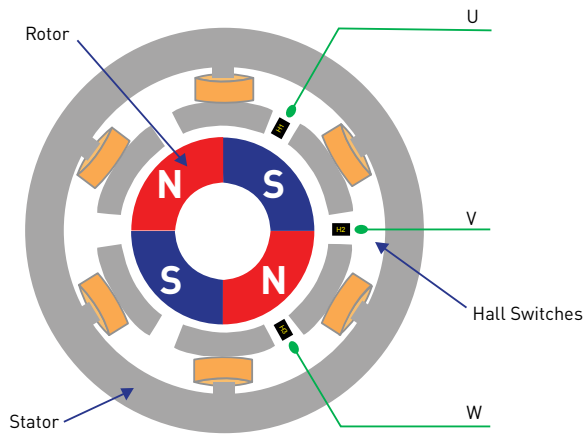Emulating Two-Pole Rotor with Three Hall Switches

Commutation of Multi-Pole Pair Brushless DC Motors

To provide smoother operation with low ripple, most three-phase brushless DC motors use more than one pole pair on the rotor. As the number of poles increases, the number of angular states for one 360° revolution increases. This can reduce torque ripple. However, this means that the control algorithm must process more UVW commutation steps for each revolution. This can limit the maximum motor speed due to system processing limits, and eventually a trade-off is reached between motor performance and cost.
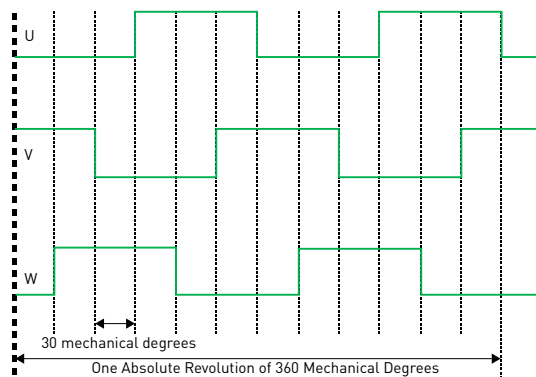
The MA102 sensor can produce UVW signalling for 1 to 8 pole pair rotors using a simple two-pole, diametrically polarized magnet at the end or side-shaft (see Figure 11).

The low latency angle acquisition of the SpinAxis™ sensing technique means that rotor speeds up to 60kRPM can be supported, even for high pole pair counts.

Figure 11: Multi-Pole Pair Emulation with the MagAlpha

Traditional Four-Pole Rotor (Two Pole Pair) BLDC Motor with Three Hall Sensors

New Four-Pole Rotor (Two Pole Pair) BLDC Motor with MagAlpha Solution

The MA102 programmed for 12 x 30° stats per 360° replaces three conventional Hall switches and uses a simple two-pole disc magnet to commutate a four-pole rotor BLDC motor

Pole Pairs	States per Revolution	State Width in Degrees
2	6	60
3	12	30
3	18	20
4	24	15
6	36	10
8	48	7.5

General Angle Sensor Applications

MA7xx Family

Many applications require position or angle feedback for system control. Examples include:

- Robot consumer appliances
- Joysticks / gaming devices
- Camera gimbal stabilization
- Industrial process automation: rotary position encoders & actuators
- Automotive systems: pumps, fans, e-turbo, headlight adjusters, windshield wipers

The MagAlpha MA7xx range provides accurate sensing of the angular position with the direct output of the digital angle value on an SPI or SSI interface, incremental encoder information on the ABZ interface, and PWM output.
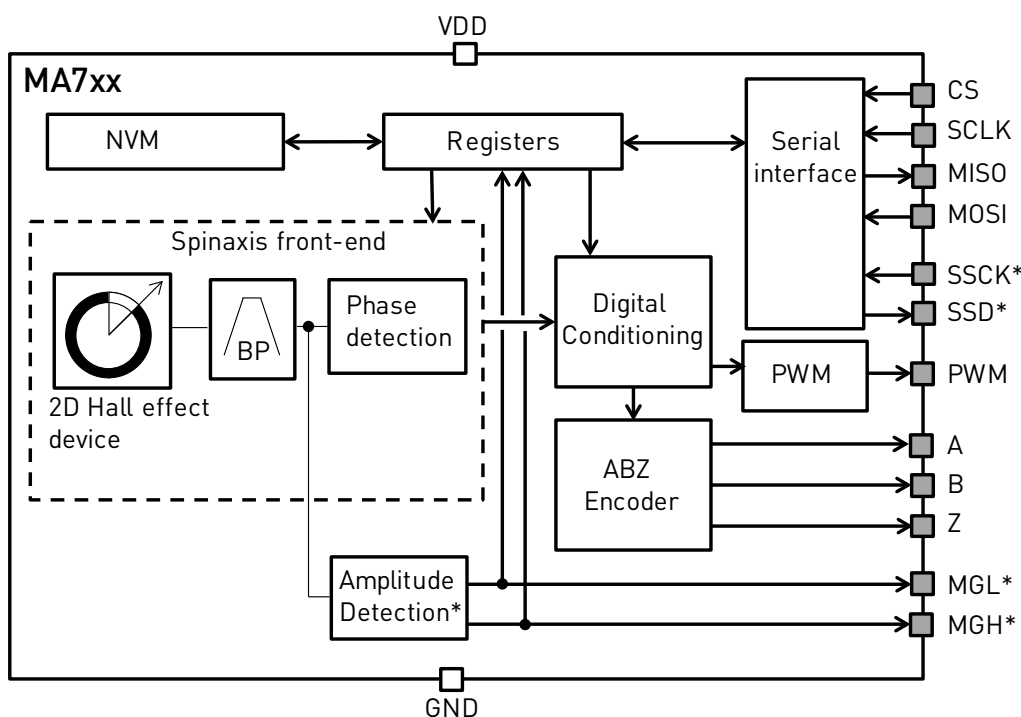
Table 3: MagAlpha Rotary Angle Sensors

Features by Part Applications	Unit	Rotary Angle Sensors					
		MA702 General Purpose	MA704 Highly Dynamic	MA710 Side-shaft Optimized	MA730 High Resolution	MA732 Programmable Filter Bandwidth Digital & ABZ	MA780 Low-Power Automatic Sampling
Effective angle resolution	bit	12	10	12	14	9 - 14	8 - 12
Filter bandwidth	Hz	390	2970	93	23	23 .. 6000	5 .. 6000
Magnetic field range	mT	30 .. 150	30 .. 150	15 .. 150	40 .. 150	40 .. 150	30 .. 150
Zero setting		✔	✔	✔	✔	✔	✔
Side-shaft compensation		✔	✔	✔	✔	✔	✔
Adjustable direction		✔	✔	✔	✔	✔	✔
SPI register configuration		✔	✔	✔	✔	✔	✔
Absolute angle on SPI	bit	12	10	12	14	9 - 14	8 - 12
Absolute angle on SSI	bit	12	10	12	14	9 - 14	
ABZ incremental		✔	✔	✔	✔	✔	
ABZ resolution	PPR	1 .. 256	1 .. 64	1 .. 256	1 .. 1024	1 .. 1024	
Adjustable Z pulse		✔	✔	✔	✔	✔	
PWM output		✔	✔	✔	✔	✔	
PWM resolution	bit	12	10	12	14	14	
Magnetic field detection		✔	✔	✔	✔	✔	✔

MA702: 12-Bit Fast-Response Angle Sensor

The MA702 is optimized for encoder applications needing high accuracy over rapidly changing rates of rotatin change.

Example applications include external position encoders on servo motor drives and industrial actuators. The internal signal conditioning is optimized to provide 12-bit position resolution while maintaining low latency under rapid speed change. Speed ranges from zero to over 60kRPM are supported.

12-bit absolute digital angle resolution is available via the SPI bus. A programmable ABZ quadrature encoder interface provides 1 to 256 pulses per 360° rotation. End- and side -shaft magnet topologies are supported.
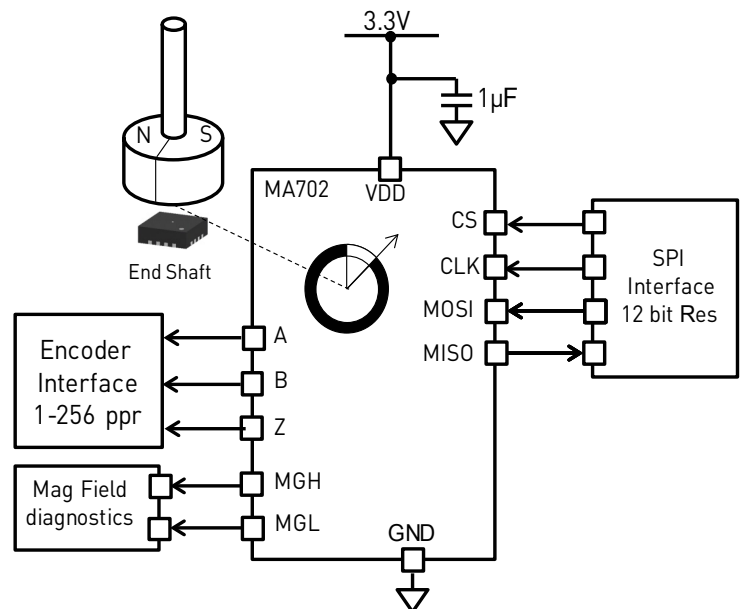
MA704: 10-Bit Ultra-Fast Response Angle Sensor

The MA704 is optimized for position control loops needing very high dynamic response times. Compared to the MA702, the MA704 resolution is restricted to 10 bits, and the internal signal conditioning is further optimized to provide the shortest response times to speed change.

Rotation speeds from zero to over 100kRPM are supported. 10-bit absolute digital angle resolution is available via the SPI bus. A programmable ABZ quadrature encoder interface provides 1 to 64 pulses per 360° rotation. End and side-shaft magnet topologies are supported.
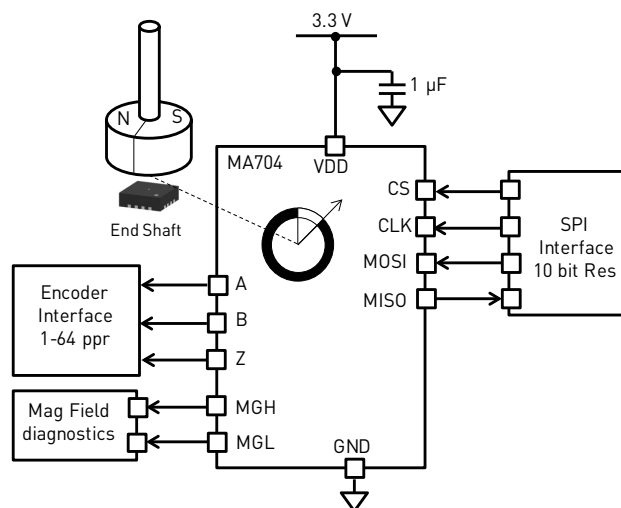
MA710: 12-Bit Side-Shaft Optimized Sensor

The MA710 is optimized for applications that work with side-shaft magnet positioning.

In side-shaft orientation, the sensor sees magnetic field strengths of different amplitudes and has to equalize these to linearize the sensor's response. MagAlpha sensors supporting side-shaft position enable this feature by use of bias current trimming (BCT) registers to normalize field strengths in the relevant axis.

Figure 12: Side-Shaft Mode
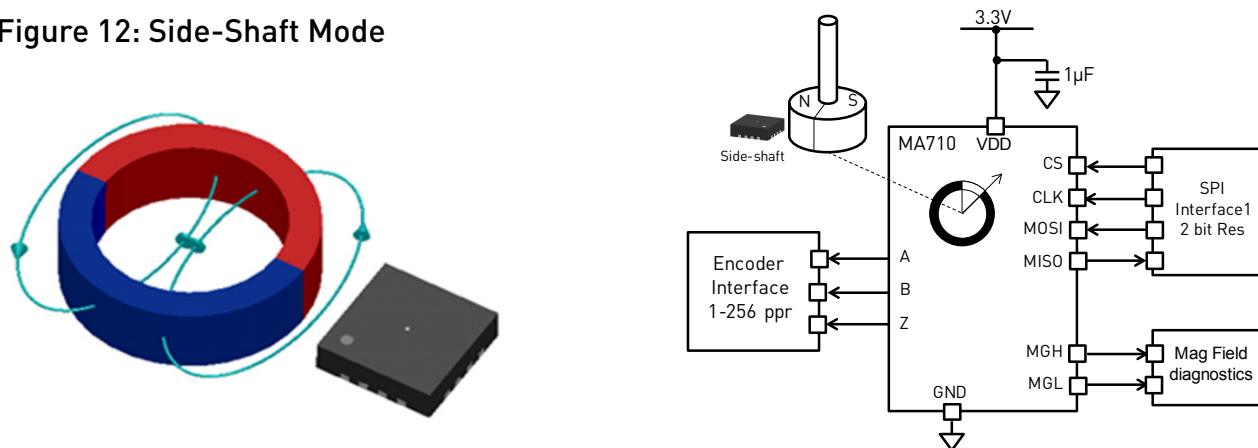
One consequence of side-shaft positioning is that the resulting field strengths are lower than in end-of-shaft magnet positioning. The MA710 is optimized to compensate for these lower field strengths while maximising angle resolution.

12-bit absolute digital angle resolution is available via the SPI bus. A programmable ABZ quadrature encoder interface provides 1 to 256 pulses per 360° rotation.

MA730: 14-Bit High Resolution Angle Sensor

Replaces Optical Encoders

The MA730 is optimized for encoder applications needing the highest resolution. The absolute digital angle is provided on the SPI interface with 14-bit resolution. A programmable 12-bit resolution ABZ incremental encoder interface is provided with up to 1024 pulses per revolution per channel, or 4096 combined edges.

Signal conditioning time is increased to maximize the output resolution. Rotation speeds of over 50k RPM are supported. Typical applications include replacement of optical encoders for higher system reliability and lower system cost.

Figure 13: A Conventional Optical Encoder
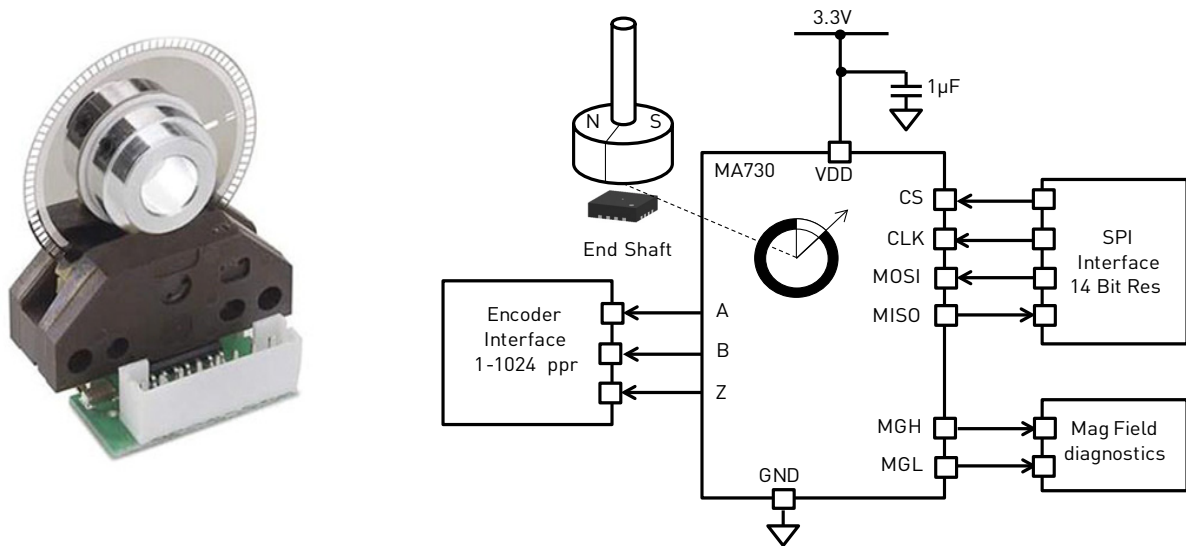
MA732: 9 to14 Bit Adjustable Filter ABZ Angle Sensor **NEW**

The MagAlpha MA732 features programmable digital filter bandwidths and ABZ interface hysteresis settings so that users can optimize the sensor to meet the dynamic response needs of different types of control loop. Loop response time can be traded against angle resolution, start-up time, and ABZ pulse count and hysteresis to match different system types. An example application could be to support a higher ABZ pulse count of up to 1024 pulses per channel compared to the 256 found in the MA702. Example MA732 applications include position or speed encoders in brushless DC servo motor or actuators.

Accurate angle sensing at speeds from 0 to 60kRPM is supported. SPI, SSI, ABZ and PWM interfaces are provided. End- and side-shaft magnet topology are supported.
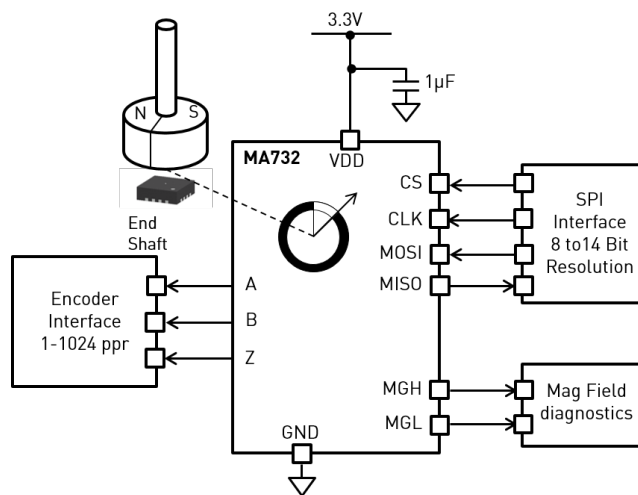
MA780: 12-Bit Low-Power Angle Sensor with Auto Sampling **NEW**

The MA780 is a rotary angle position sensor targeted at applications requiring very low average power consumption, typically battery-powered systems. It has the ability to wake for a short period to measure the angle and then return to a very low standby power. The wake and sleep cycle can either be controlled via an external microprocessor or automatically by the sensor itself.

Automatic sampling intervals can be programmed into the MA780 memory. The sensor can either interrupt the external system to alert that new angle date is available or can be programmed to only interrupt the external system if the angle has changed by a specific number of threshold degrees. In this way, it is possible to achieve average current consumption in the uA range. Angle resolution can be traded for faster start-up times to optimize power consumption. Resolutions from 8 to 12 bits are possible.

Typical applications might include battery powered wall thermostats, movement sensors, or user interfaces. The MA780 operates from 3.3V with a 1.8V I/O voltage option typically consuming 10mA during active measurement and 1µA in low power mode.
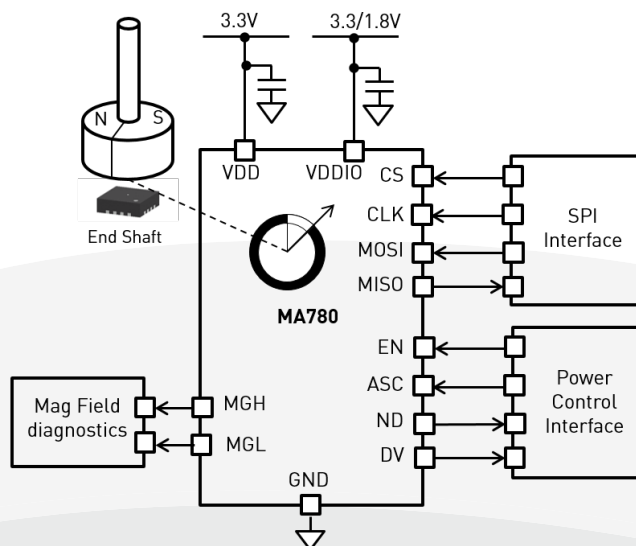
Automotive-Grade Magnetic Angle Sensors

MAQ430 & MAQ470: 12-Bit Sensors NEW

The MagAlpha MAQ470 and MAQ430 are automotive-grade versions of the MA702 and MA302 sensors. Both are qualified to AEC-Q Grade 1, covering an operating temperature range from -40 to +125°C. Operation over a wide magnetic field range of 30 to 150mT in either end-of-shaft or side-shaft topologies is possible. Typical application examples include rotary user interface controls in the cabin, or compact motorised actuators in systems such as tailgate lifts, automated door handles, and HVAC flap position adjustment.

The MAQ470 and MAQ430 both provide absolute rotary angle information via SPI (and SSI on the MAQ470) interface with 12-bit (3-sigma) accuracy. Both feature an ABZ quadrature incremental encoder interface with programmable pulse count. Additionally, the MAQ470 provides absolute angle via a PWM output, while the MAQ430 provides UVW signals for brushless motor commutation applications.

Eight programmable magnetic field thresholds allow detection of changes in the distance between the magnet and the sensor. A typical application for this is rotary user interfaces implementing a high-reliability, contactless, push button.

Typical in-cabin rotary user control

Table 3: MagAlpha Rotary Angle Sensors

Features by Part Applications	Unit	Automotive Angle Sensing MAQ470-AEC1 **NEW** Position / Speed Sensing	Automotive Motor Commutation and Position Control in Brushless Motors MAQ430-AEC1 **NEW** BLDC Motors
Effective angle resolution	bit	12	12
Filter bandwidth	Hz	390	390
Magnetic field range	mT	30 .. 150	30 .. 150
Zero setting		✔	✔
Side-shaft compensation		✔	✔
Adjustable direction		✔	✔
SPI register configuration		✔	✔
Absolute angle on SPI	bit	12	12
Absolute angle on SSI	bit	12	
ABZ incremental		✔	✔
ABZ resolution	PPR	1 .. 256	1 .. 256
Adjustable Z pulse		✔	✔
PWM output		✔	
PWM resolution	bit	12	
UVW output			✔
UVW pole pairs per revolution			1 .. 8
Magnetic field detection		✔	✔
Temperature range	bit	-40 to +125	-40 to +125

Filtering the PWM Output

For parts with a PWM output (MA702, MA704, MA710, MA730, MA750), the PWM can be filtered to provide a ratiometric linear analog voltage replicating the output of a conventional potentiometer.

For an analog output in the same range as the MagAlpha supply of 0 to 3.3V, a simple R-C can be used, or for a wider output voltage range (for example, 0.5V to 4.5V as found in many potentiometer-based systems), an OP-AMP filter can be used (see Figure 14 and Figure 15 below).

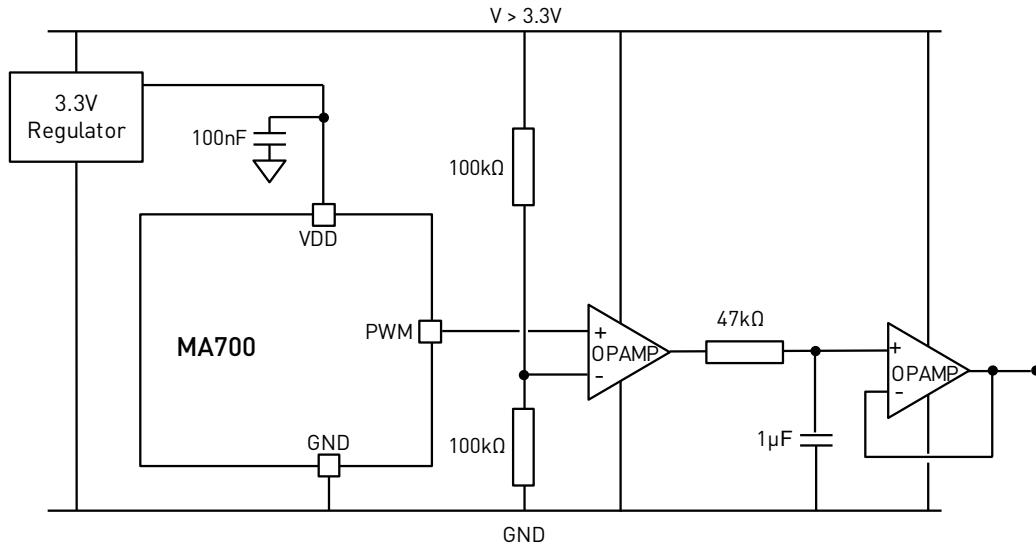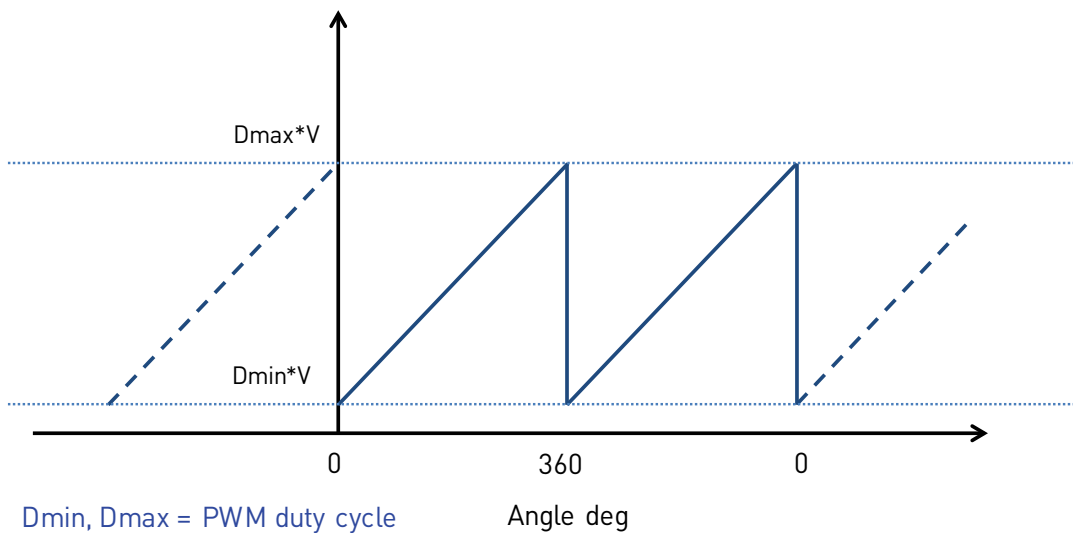**Figure 14: Example of Circuit for MA700 Filtering the PWM Output with an OP-AMP**


Figure 15: Filtered PWM Output

MagAlpha Sensor Evaluation Kits

MPS provides a variety of evaluation tools and software to aid development with the MagAlpha family of angle sensors. The MagAlpha communication kit (MACOM) interfaces via a standard PC USB port to a Windows-based software GUI that displays the sensors output angle value. It also allows configuration of various MagAlpha parameters, including zero position offset, side-shaft linearization, and magnetic field strength thresholds. Cables are included to interface either to the MagAlpha TMBA test boards or to the rotary EVMA turning knob evaluation kits. A summary of the kits is shown in the table below.

For a complete list of available kits, please visit MonolithicPower.com.

Name	Part Number	Kit Contents	Description
MagAlpha Communication Kit	EVKT-MACOM	LPC Link2 board TBMA-CONN board EVMA-CONN board 1 16-pin ribbon cable w/connectors 2 8-pin female micromatch connectors MACOM app for Windows	Universal PC USB interface kit for all MagAlpha sensor products
Test Board MA Long	TBMAxxx-LT	Long shape test board for MagAlpha xxx = specific MAxxx part	Used with MACOM interface kit or customer's own SPI interface
Test Board MA Round	TBMAxxx-RD	Round shape test board for MagAlpha xxx = specific MAxxx part	Used with MACOM interface kit or customer's own SPI interface
Rotary Knob Kit	EVKTxxx-KNOB	Sensor assembly with end-of-shaft mounted magnet and rotary knob xxx = specific MAxxx part	Used to evaluate MagAlpha in rotary interface applications

Communication Interface
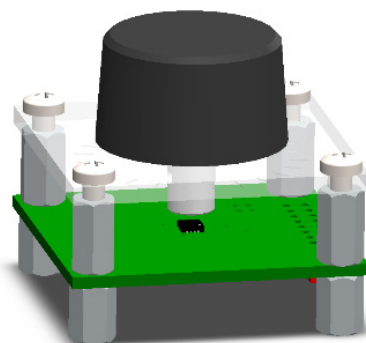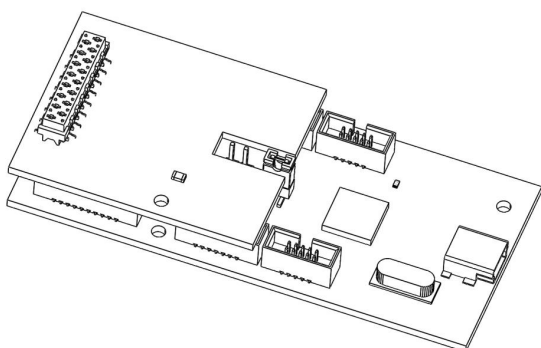
ABOUT MONOLITHIC POWER SYSTEMS

Who we are:

We are creative thinkers. We break boundaries. We take technology to new levels. As a leading international semiconductor company, Monolithic Power Systems (MPS) creates cutting-edge solutions to improve the quality of life with green, easy-to-use products.

What we do:

We make power design fun! With our innovative proprietary technology processes, we thrive on re-imagining and re-defining the possibilities of high-performance power solutions in industrial applications, telecom infrastructures, cloud computing, automotive, and consumer applications.

Where we come from:

It started with a vision. Michael Hsing, pioneering engineer and CEO, founded Monolithic Power Systems, Inc. in 1997 with the belief that an entire power system could be integrated onto a single chip. Under his leadership, MPS has succeeded not only in developing a monolithic power module that truly integrates an entire power system in a single package, but also it continues to defy industry expectations with its patented groundbreaking technologies.

Our values:

We cultivate creativity
As a company we believe in creating an environment that encourages and challenges our employees to collaborate and think outside the box to excel beyond their preconceived capabilities.

We do not accept the status quo
We do not believe in limitations. It is not about what is, but what can be. Possibilities are endless at MPS.

We are passionate about sustainability
It's about the future. From materials to finances, we are committed to conservation. We will not tolerate waste in an effort to improve and preserve the quality of life.

We are committed to providing innovative products to our customers.
Let us do the heavy lifting. We relentlessly strive to make system design versatile and effortless to meet our customers' specific needs. We'll do the work, so our customers can have the fun!

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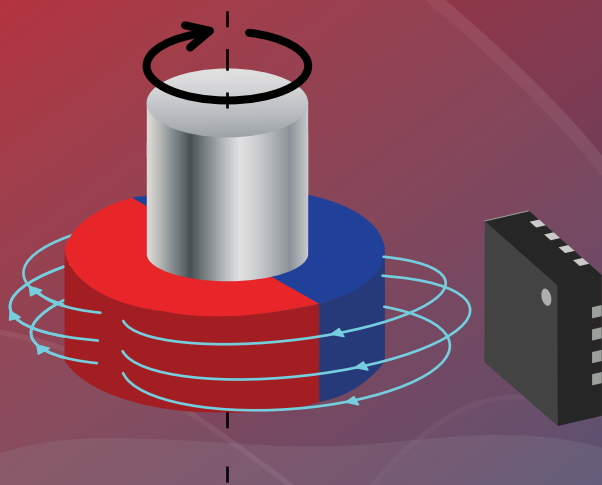Tel: +49 89 80913512-0

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