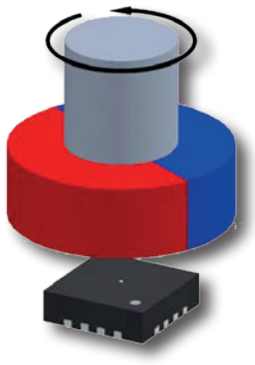
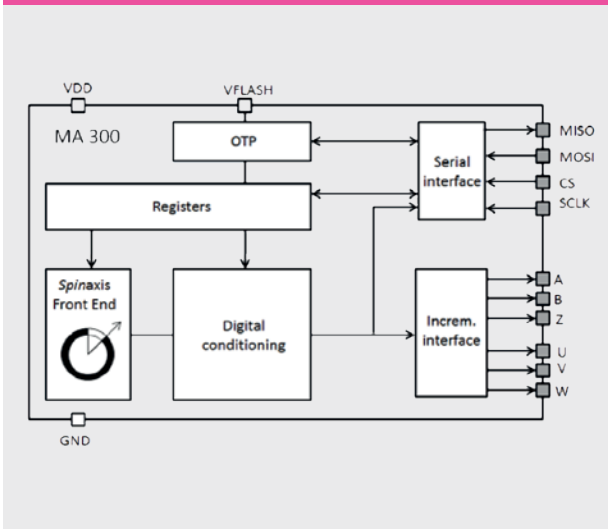
ANGULAR SENSOR FOR 3-PHASE BRUSHLESS MOTOR – MagAlpha MA300



QFN16 3x3mm package

The **MagAlpha MA300** is a magnetic sensor designed to replace the 3 Hall switch solutions for 3 phases block commutation in brushless dc motors. The IC detects the absolute angular position of a permanent magnet, typically a diametrically magnetized cylinder attached to the rotor. The MagAlpha is an extremely fast acquisition and processing sensor, allowing accurate angle measurement at speeds from 0 to 120'000 RPM. Since the measurement is spatially confined, the user has flexibility in terms of magnet shapes and configurations. This can help relaxing mechanical tolerances and, in case the end of shaft position is not available, the MagAlpha MA300 can also operate away from the axis of rotation ("side-shaft" mounting).

FUNCTIONAL BLOCK DIAGRAM – MagAlpha MA300



KEY FEATURES

- U V W signals for block commutation
- 11 bit resolution absolute angle encoder
- 500 kHz refresh rate
- Ultra low latency: 3 µs
- Serial interface for data readout and settings
- 10 bit incremental output (A, B, Z)
- Built-in linearization for side-shaft mounting
- 7.5 mA supply current

OPERATING CONDITIONS

PARAMETER	RATING		
	min.	typ.	max.
Supply voltage V_{DD} [V]	3.0	3.3	3.6
Supply current I_{sup} [mA]	5.7	6.6	8.0
Operating temperature T_{op} [°C]	-40		+125
Applied magnetic field B [mT]	30	75	150

SENSOR OUTPUT SPECIFICATIONS

PARAMETER	RATING		
	min.	typ.	max.
ABSOLUTE OUTPUT - SERIAL			
Data output length [bit]	16		16
Refresh rate [kHz]	500	520	550
Latency [µs]	2	3	4
Resolution (3σ noise level) [bit]	10.5	11.0	11.5
INCREMENTAL OUTPUT			
Resolution [edge/revol.]	1024		1024
Jitter [% of a period]		10	
Hysteresis [deg]			0.35

new

Contact for information: Dr. Wolf · Tel. +49(0)7452-6007-23 · e-mail: t.wolf@endrich.com

ANGULAR SENSOR FOR 3-PHASE BRUSHLESS MOTOR – MagAlpha MA300

PIN CONFIGURATION

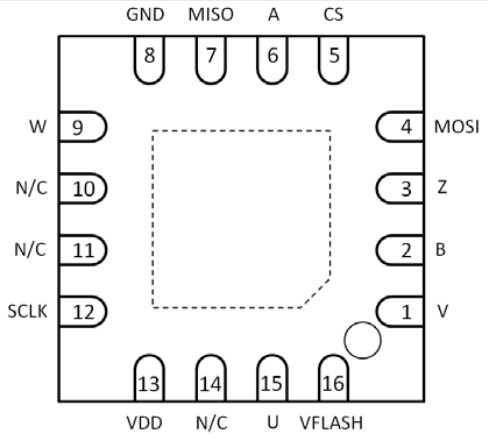


FIGURE 2 QFN16 Top view

TABLE 8 PIN FUNCTIONS

No	Name	Function
1	V	V (incremental output)
2	B	B (incremental output)
3	Z	Z (incremental output)
4	MOSI	Data in (serial)
5	CS	Chip Select (Serial)
6	A	A (incremental output)
7	MISO	Data out (serial)
8	GND	Ground
9	W	W (incremental output)
10	N/C	-
11	N/C	-
12	SCLK	Clock (serial)
13	VDD	3.3 V supply
14	N/C	-
15	U	U (incremental output)
16	VFLASH	3.6 V supply for OTP flashing

SENSOR – MAGNET MOUNTING

The sensitive volume of the MA300 is confined in a region less than 100 µm wide and consists of multiple integrated Hall devices. This volume is located, with a precision of 50 µm in the center of the QFN package, both horizontally and vertically. The sensor detects the angle of the magnetic field projected in a plane parallel to the package upper surface. It means that the only magnetic field that matters is the in-plane component (X and Y components) in the package middle point.

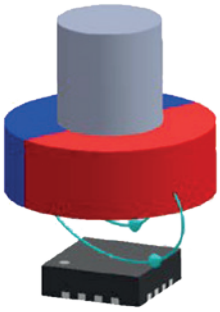


FIGURE 1 End-of-shaft mounting

This detection mode gives flexibility for the design of an angular encoder: all the sensor needs is that the magnetic vector lies essentially within the sensor plane and that its amplitude is comprised between 30 and 150 mT. Note that the MA300 does work with smaller than 30 mT fields, but the linearity and resolution performance may deviate from the specifications (table 2). The straightforward solution is to place the MA300 sensor on the rotation axis of a permanent magnet for instance a cylinder diametrically magnetized (fig. 1).

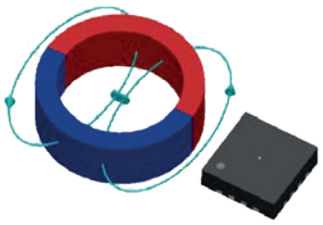


FIGURE 2 Side-shaft mounting

When the end-of-shaft position is not available the sensor can be positioned away from the rotation axis of a cylinder or ring magnet (fig. 2). In this case the magnetic field angle is not directly proportional to the mechanical angle anymore. The MA300 can be adjusted to compensate this effect and recover the linear relation between the mechanical angle and the sensor output. With multiple pole pairs, the MA300 will indicate multiple rotations for each mechanical turn.

ANGULAR SENSOR FOR 3-PHASE BRUSHLESS MOTOR – MagAlpha MA300

SENSOR FRONT-END

The magnetic field is detected with integrated Hall devices located in the package center. The particularity of this sensor is that the angle is measured using the spinaxis method which directly digitizes the direction of the field without any ATAN computation or any feedback loop based circuit (interpolators, etc.).

The spinaxis method is based on phase detection. It requires a sensitive circuitry generating a sinusoidal signal whose phase represents the angle of the magnetic field. The angle is then retrieved by a time-to-digital converter, which counts the time between the zero crossing of the sinusoidal signal and the edge of a constant waveform (Fig. 3). The digitized time is the front-end output.

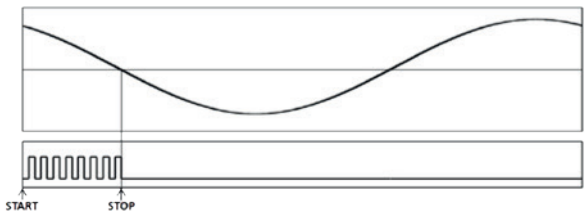


FIGURE 3 Phase detection method. Top: sine waveform. Bottom: clock of time-to-digital

Looking further down the treatment chain, it is crucial that the signal treatment does not add unwanted phase shifts. For this purpose the MagAlpha incorporates an architecture where these shifts are automatically compensated, resulting in the stability displayed in table 2. In short, the front-end delivers in a straightforward and open loop manner a digital number proportional to the angle of the magnetic field at the rate of 500 kHz.

INCREMENTAL – ABZ

With the ABZ output the MA300 emulates a 10-bit incremental encoder, such as an optical encoder, providing logic pulses in quadrature (fig. 4). Compared to A, the signal B is shifted by a quarter of pulse period. Over one revolution the A signal pulses 256 times. It makes 1024 edges per revolution. The signal Z ("Zero" or "Index") raises only once per turn, at the zero angle position.

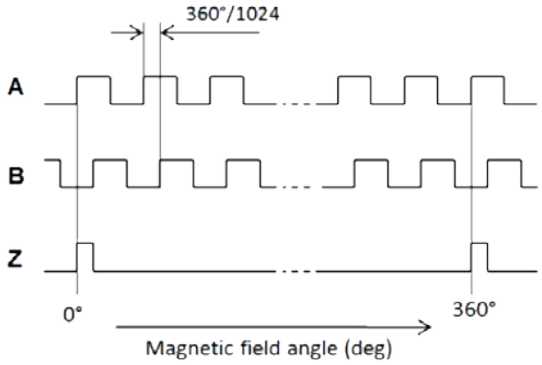


FIGURE 4 ABZ output during rotation

BLOCK COMMUTATION – UVW

The UVW output emulates the three Hall switches usually used for the block commutation of 3-phases electric motor. The three logic signals have a duty cycle of ½ and are shifted by 60 deg relative to each other (see fig. 5).

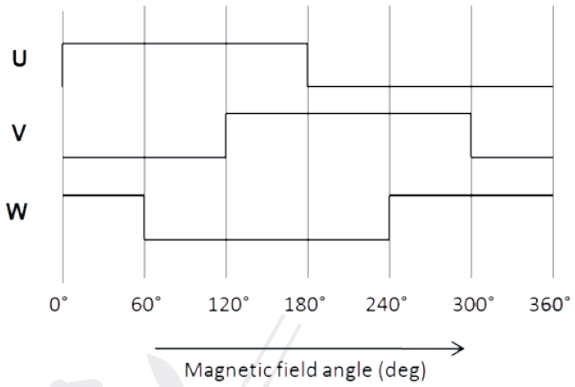


FIGURE 5 UVW output during rotation

Contact for information: Dr. Wolf · Tel. +49(0)7452-6007-23 · e-mail: t.wolf@endrich.com