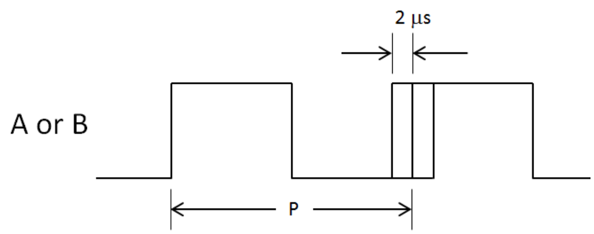


Figure 13: ABZ Jitter

Above 15,000, the ABZ signal is still usable. Note that when the jitter is larger than 25% (i.e.: when the speed exceeds 30,000 RPM), the A and B signal edge may coincide.

One-Time Programmable (OTP) Programming

The one-time programmable (OTP) memory can permanently store the content of the programmable registers. The OTP memory is made of poly-silicon fuses. By activating the flash command, the content of an entire register can be stored in the OTP memory. The flash command consists of setting some bits (F*n*, where *n* is the register number) in register 9. For flashing the register, when the bit F*n* is set, the register *n* is stored permanently. It is important to note that only one register can be flashed at a time. It is possible to operate the MagAlpha without flashing the registers (see Figure 14).

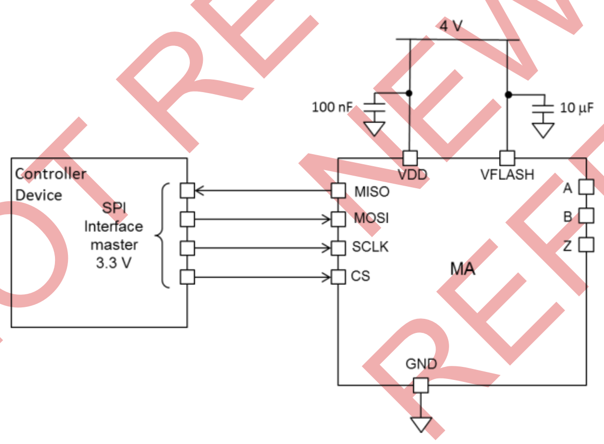


Figure 14: Circuit for Flashing

Burning the fuses during the flash process is irreversible. Once a register is flashed, the default values at power-up are always the same. After flashing, the content of the registers can no longer be modified.

Flashing Procedure

Prior to flashing, it is recommended to test the MagAlpha with the new settings and verify the performance of the sensor. Then, proceed with the flashing using the below steps:

1. Send the parameter to the register.
2. Read back for verification.
3. Connect VFLASH to VDD.
4. Raise VDD to 4V.
5. Set the bit corresponding to the register to be flashed in register 9.
6. Untie VFLASH.
7. Return VDD to 3.3V.
8. Switch the MagAlpha off and on.
9. Check by reading back the register content.

Permanently Storing the Zero Position

The following example shows how to set and flash the zero position at 50 degrees. Note that permanently storing the zero position requires burning the registers 4 and 5.

1. Convert into binary within a resolution of 12 bits. 50 deg in binary is 001000111000 (≈49.92 deg).
2. Store the 8 MSB (00100011) of the zero position in register 4:

command				reg. address				value (MSB)							(LSB)
0	0	1	0	0	1	0	0	0	0	1	0	0	0	1	1

3. Read back register 4:

command				reg. address				value (MSB)							(LSB)
0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0

If the programming was correct, the MagAlpha replies with the register 4 content:

Angle out		value (MSB)							(LSB)
A(15:12)	A(11:8)	0	0	1	0	0	0	1	1

4. Store the 4 LSB (1000) of the zero position into the 4 LSB of register 5:

command				reg. address				value (MSB)							(LSB)
0	0	1	0	0	1	0	1	0	0	0	0	1	0	0	0

5. Read back register 5:

command				reg. address				value (MSB)							(LSB)
0	0	0	1	0	1	0	1	0	0	0	0	0	0	0	0

The MagAlpha returns:

Angle out		value (MSB)							(LSB)
A(15:12)	A(11:8)	0	0	0	0	1	0	0	0

Completing Flashing

1. Connect VFLASH to VDD (4V).
2. Flash register 4:

command				reg. address				value (MSB)							(LSB)
0	0	1	0	1	0	0	1	0	0	0	1	0	0	0	0

3. Flash register 5:

command				reg. address				value (MSB)							(LSB)
0	0	1	0	1	0	0	1	0	0	1	0	0	0	0	0

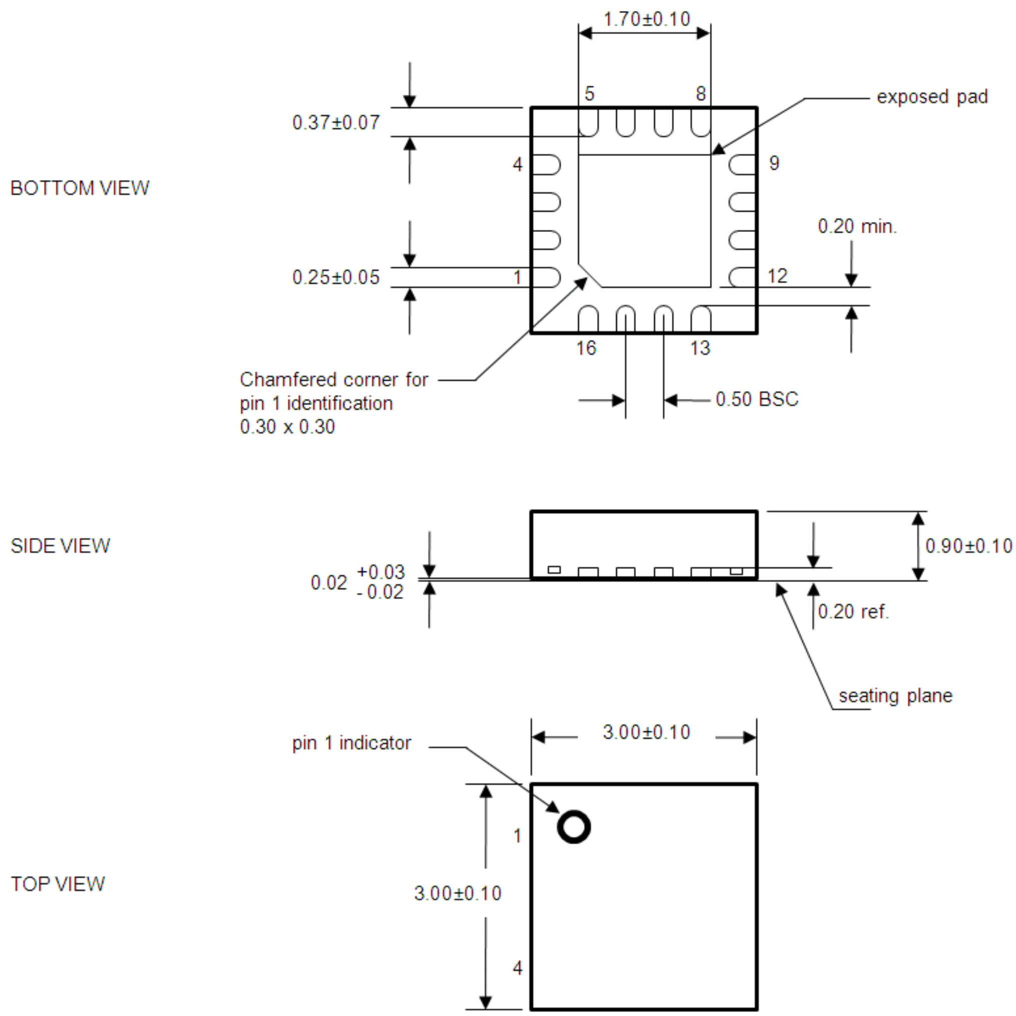
4. Disconnect VFLASH from VDD.
5. Turn the MagAlpha off and on (with VDD back to the normal 3.3V value).
6. Read back registers 4 and 5 to verify that the flashing was successfully accomplished.

For flashing multiple registers, send the flash command one by one. The flashing rate is specified in Sensor Output Specifications in the EC table.

Note that flashing of the OTP registers requires raising both 3.3V VDD and VFlash to 4V. Isolate other devices sharing the 3.3V VDD rail if they are not tolerant to 4V.

PACKAGE INFORMATION

QFN-16 (3mmx3mm)



NOTES:

1. All dimensions are in mm.
2. Package dimensions do not include mold flash, protrusions, burrs, or metal smearing.
3. Coplanarity shall be 0.08.
4. Compliant with JEDEC MO-220.

APPENDIX A: DEFINITIONS

Resolution (3σ noise level) The smallest angle increment distinguishable from the noise. Here, the resolution is defined as 3 times σ (the standard deviation in degrees) taken over 1,000 data points at a constant position. The resolution in bits is obtained with $\log_2(360/6\sigma)$.

Refresh Rate Rate at which new data points are stored in the output buffer.

Latency The time between the data-ready at the output and the instant at which the shaft passes that position. The lag in degrees is $lag = latency \cdot v$, where v is the angular velocity in deg/s.

Power-Up Time Time until the sensor delivers valid data starting at power-up.

Integral Non-Linearity (INL) Maximum deviation between the noiseless sensor output and the shaft angle if the shaft zero angle coincides with the sensor zero angle.

Drift Angle variation rate when one parameter is changed (e.g.: temperature, VDD) and all the others, including the shaft angle, are maintained constant.

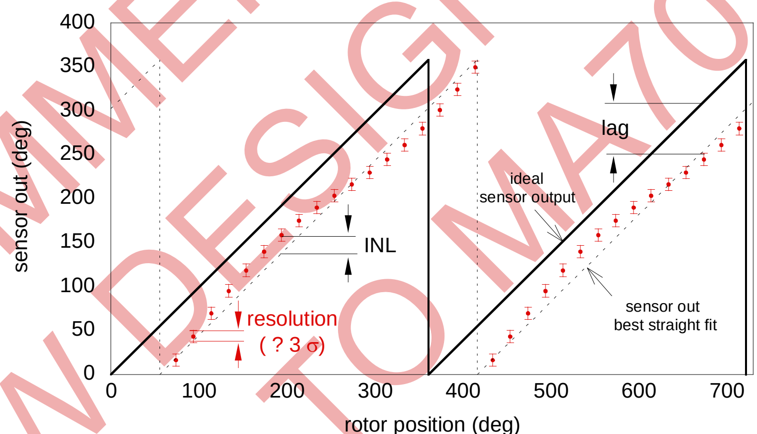


Figure A1: Absolute Angle Errors

Jitter For the incremental output, da is the maximum deviation of the angular position of an edge with respect to the ideal value. This means that each edge occurs at the ideal angle + or - the angle da.

Since the period of the A or B channel is $P = 4 \cdot 360/N$, where N is the number of edges per revolution (EPR) , the jitter is $J = da/P$.

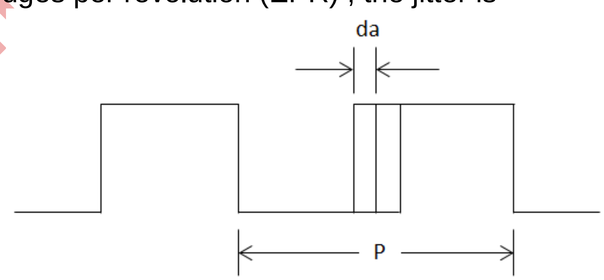


Figure A2: Jitter of Incremental Outputs

Overall Reproducibility Maximum variation between two readings, successive or not, of the same shaft position at a fixed magnetic field over the complete temperature range.

APPENDIX B: ERRATA

Drift of the ABZ Output

Symptom: when changing the rotation direction, the ABZ output may exhibits one extra edge, thus creating an angle offset of 1 LSB (360/2^10).

Detailed Description

In case of rotation direction change, the AB output behaves as shown in Figure B1. Note that to simplify this errata, we neglect the hysteresis, which does not have any effect on this issue.

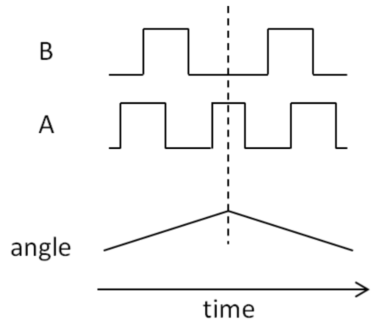


Figure B1: Mechanical Angle Changing from CW to CCW Direction at Dotted Line

Instead, when the direction change occurs when one channel is high and the other is low, one channel exhibits an extra transition, as if the rotation continues in the first direction by an angle 360°/1024=0.35°. Figure B2 shows a change from CW to CCW. In the figure, the ABZ output delivered an extra transition, creating an offset of 1 LSB in the CW direction.

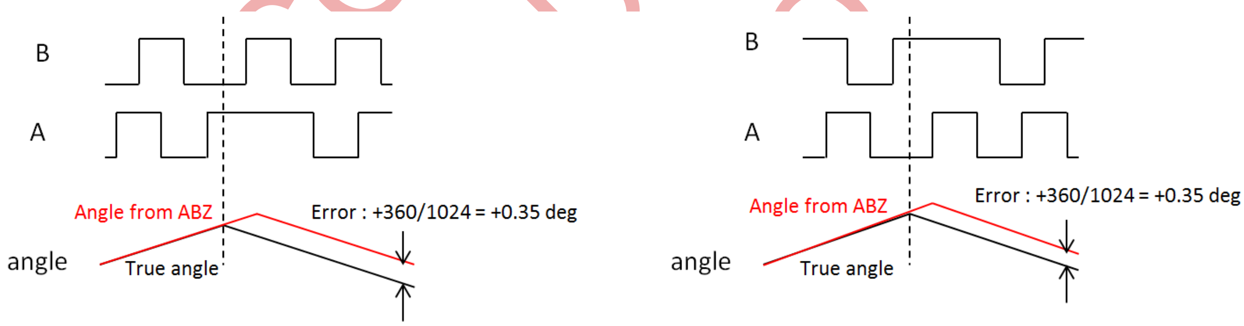


Figure B2: Direction Change from CW to CCW

In case of change from CCW to CW the same issue occurs, an extra transition induces an angle offset of 0.35°, but this time in the CCW direction.

When both A and B channels are in the same state, there is no extra transition (see Figure B3).

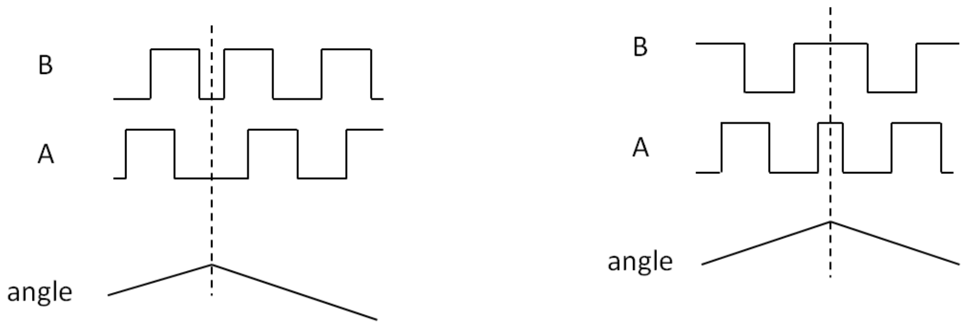


Figure B3: Direction Change from CW to CCW when Both Channels are in the Same Logical State (No Issue)

Consequence

In applications where the direction of rotation changes, the ABZ output generates additional edge transitions 50% of the time on average with equal probability in either CW or CCW directions. The angular position given by the ABZ output after N direction change behaves as a random walk. The indicated angle drifts by the quantity shown in Equation (A1):

$$drift(in\,\deg) = \sqrt{\frac{2N\,0.35°}{\pi}} \qquad \text{(A1)}$$

Recommended Actions

No fix is planned for this on the MA300 and MA700 devices. For applications using ABZ with direction change, MPS recommends using the MA302 and MA702 devices.