Application Note: AS5048 –Stepper Motor Position Control

AS5048

14-bit Rotary Position Sensor with Digital Interface

Table of Contents

1 General Description 3
2 Hardware configuration 3
3 General considerations 4
4 End of move position monitoring 5
5 Continuouse position monitoring 5
6 Closed loop position control 6
7 Ordering Information 7
Copyright 8
Disclaimer 8

Revision History

Revision	Date	Owner	Description
1.0	18.11.2013	RPH	Initial revision

1 General Description

This application note explains how step and position monitoring of a stepper motor can be performed using the AS5048 14-bit Rotary Position Sensor.

Lots of applications require monitoring of stepper motor activity to detect step loss. Otherwise, the position of the actuator would be wrong if steps are lost.

Typically there are three main reasons to implement stepper motor position monitoring:

1) **Reduce power consumption and motor size** by monitoring the stepper motor
2) **Safety relevant applications** require permanent monitoring of the motor shaft
3) **Closed loop position control** of a stepper motor

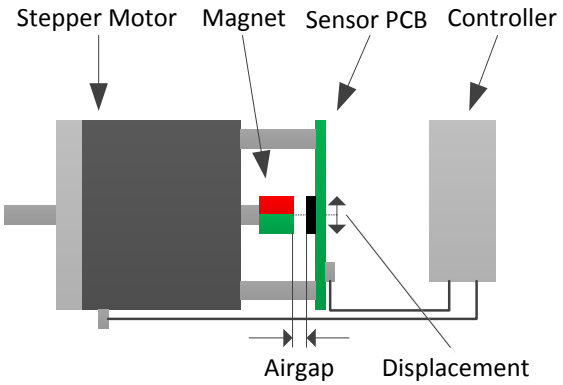
Find more information on our webpage:

http://ams.com/eng/Products/Magnetic-Position-Sensors

2 Hardware configuration

The example configuration of the stepper motor and AS5048 is shown below in Figure 1. The sensor PCB and the stepper motor is connected to the controller.

Figure 1:
Hardware Configuration



For fast sensor evaluation, an evaluation kit for stepper motors is available on our webpage.

-> AS5048A-EK-AB-STM1.0

-> AS5048B-EK-AB-STM1.0

3 General considerations

For stepper motors, the angle per full step is calculated as shown below in

Equation 1.

Equation 1:

Angle per step

$$\alpha = \frac{360°}{2 * p * m}$$

$where: m \ldots number\ of\ phases\ ;\ p \ldots number\ of\ pole\ pairs$

This gives following full step angle values for a two-phase stepper motor with typically 50 polepairs.

Table 1:
Angle per step

Polepairs	Angle/step		Wave drive	Half step	1/16 step
50	1,8°		1,80°	0,90°	0,11°

The position sensor resolution is 14 bit what gives an angular granularity of:

$$angle\ per\ count = \frac{360°}{2^{14}} = 0.022\ °/LSB$$

The output noise is $0.06\ °/\mathrm{LSB}$ rms and the non-linearity is:

Table 2:
AS5048 Non-linearity

Magnet diameter	Magnet displacement	Temperature	INL
8 mm	0 µm		±0.4°
8 mm	500 µm		±0.7°
8 mm	500 µm	-40 to 150°C	±1.2°

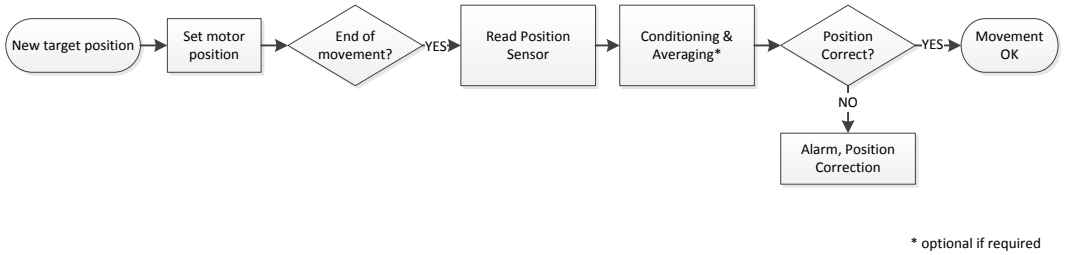
Including external averaging and linearization of the sensor output, a maximum system accuracy of 0.05° is possible.

4 End of move position monitoring

The end of move position monitoring is used to verify the motor position after movement. The stepper motor moves to the desired position. After the movement the angle position is read and analyzed. If the end position is not correct, the position is corrected or an alarm is triggered.

To improve the precision of the high resolution angle value, averaging and linearization of the position sensor output can be implemented. The position sensor is read after movement and does not influence the motor speed. The flow chart is shown in Figure 2.

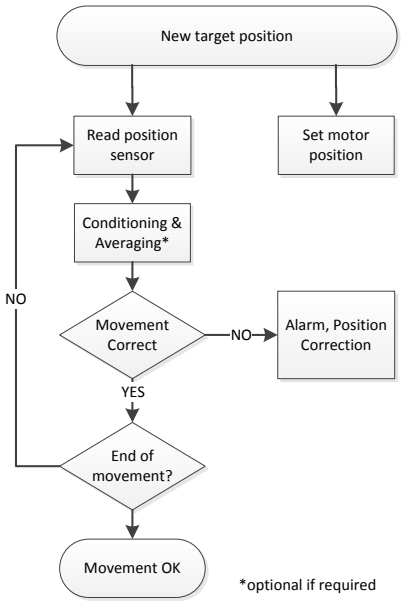
Figure 2:
End of move position monitoring



5 Continuouse position monitoring

To monitor the complete movement, the sensor output is read permanently and triggers an alarm or correction if the performed movement exceeds the target movement as shown below in Figure 3.

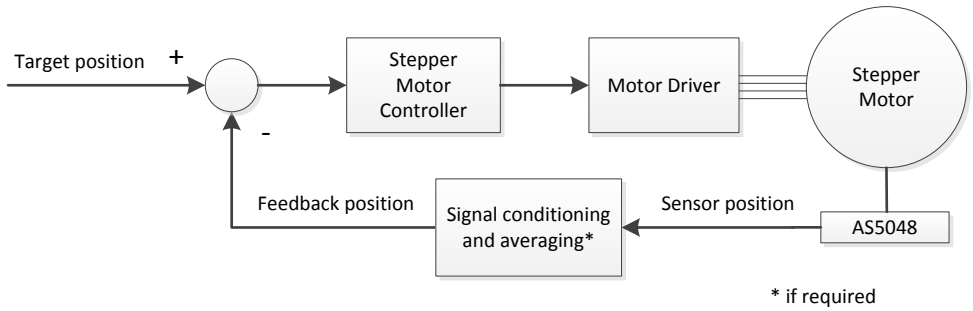
Figure 3:
Continuous position monitoring



6 Closed loop position control

Other applications require a continuously corrected actuator position. This is enabled by implementing a closed loop position control. The position sensor is continuously read to calculate the position error. Existing position error is immediately corrected.

Figure 4:
Closed loop position control



7 Reducing the power consumption

By implementing a monitoring of the stepper motor movement, the power consumption of the stepper motor can be reduced. Depending on the error angle of the stepper motor, the motor current can be controlled. This allows reducing the power consumption as well as motor size.

8 Ordering Information

Table 3:
Ordering Information

Ordering Code	Description	comments
AS5048A-EK-AB-STM1.0	AS5048A Eval-Kit for stepper motor	SPI interface
AS5048B-EK-AB-STM1.0	AS5048B Eval-Kit for stepper motor	I2C interface

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Contact Information

Headquarters

ams AG
Tobelbader Strasse 30
8141 Unterpremstaetten
Austria
T. +43 (0) 3136 500 0
For Sales Offices, Distributors and Representatives, please visit:
http://www.ams.com/contact