Application Note

AS5x70

Magnetic extended range

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Revision History

Revision	Date	Owner	Description
1.0	16.10.2017	mzie	Initial version

1 General Description

In many applications where magnetic position sensors are used today the mechanical and magnetic design is very challenging for system designers. Especially the magnetic field strength and the airgap characteristics, which play a major role in the design considerations for achieving a good system accuracy comparable to other sensor technologies already used in the market (e.g. potentiometers or optical encoders). Due to mechanical production tolerances in the system or thermal drift and aging of magnets, the magnetic field strength can sometimes drop out of the recommended range for the magnetic sensor, e.g. 30 to 70mT. Therefore magnetic position sensors from AMS like the AS5x70 family have what's called a "Magnetic Extended Mode" which increases this range from 30 to 70mT to 10 to 90mT. The following sections in this application note explain the differences between the "extended mode" versus the "normal mode", and what accuracies and noise performances can be expected can be expected from each.

2 Functionality of the Extended Mode

In the frontend of each AMS magnetic position sensor is an AGC (automatic gain control) circuit. The AGC is used to regulate the bias current through the sensor's hall elements and therefore keeps the Magnitude to a constant target value of 72LSB (±2LSB). If the AGC hits the maximum (255LSB) or minimum value (0LSB) the regulation loop cannot change the current anymore and the Magnitude value will decrease or increase, respectively.

The fault condition for a “Magnetic field out of range” error (SM4) is generally linked to the value of the Magnitude.

In “normal mode” the thresholds are defined as:

If Magnitude is >80LSB (~70mT[1]) or <63LSB (~30mT[1]), then the sensor activates the safety mechanism (SM4).

If the “extended mode” is activated the thresholds are expanded to increase the possible magnetic input range:

If Magnitude is >127LSB (~90mT[1]) or <18LSB (~10mT[1]), then the sensor will activate the safety mechanism (SM4).

Figure 1 below shows the typical relationship between AGC, Magnitude and the magnetic field strength (Bz).

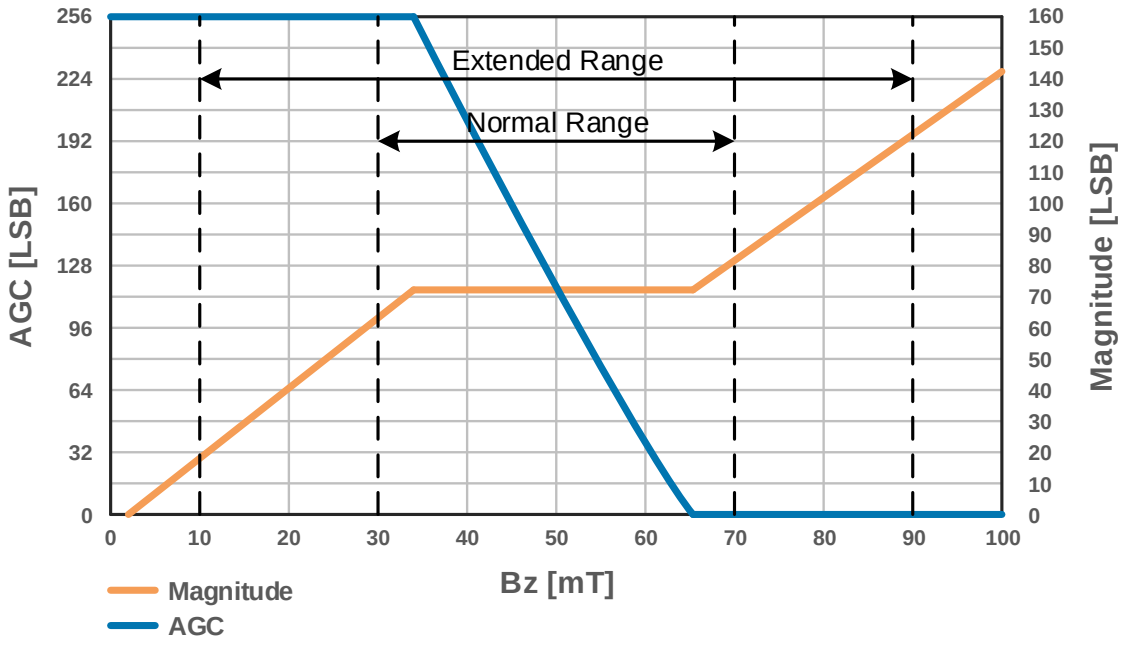

Figure 1: Typical relationship between AGC, Magnitude and magnetic field strength

Note:

1. Typical value, may vary slightly over temperature and part to part variance

3 Noise performance in extended mode

The following chapter gives some information about the drawback of using the “extended mode”, particularly as it relates to sensor noise performance.

When looking at the signal path of the AMS magnetic position sensors in Figure 2 the AGC regulates the current in the hall elements to reach a steady SNR (Signal-to-Noise Ratio) at the differential amplifiers. Due to mechanical airgap tolerances and temperature effects the magnetic field strength will increase or decrease and at a certain point the AGC (I_{HALL}) reaches its upper or lower limit. At this point the SNR at the differential amplifiers will get worse and lead to degraded overall noise performance in the sensor.

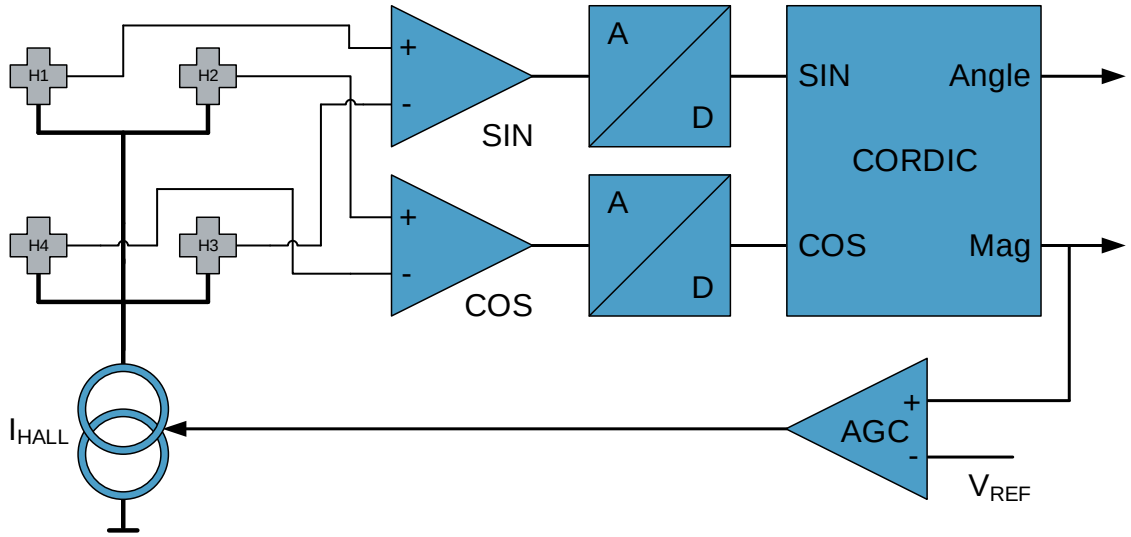

Figure 2: Signal path block diagram of AMS magnetic position sensors

The following Figure 3 shows the results of a magnetic simulation done with an 8x2.5mm NdFeB magnet (Sintered 35H, Br = 1.2 T, HcB = -919120 A/m). (Simulation done at 25°C)

As one can see the lower limit of 30mT is reached at about 2.6mm airgap. At this point it would be necessary to activate the “extended mode”.

For system designers it is always important to consider all possible influences on the magnetic field strength. For example, high temperatures will cause the magnetic field strength to drop. Similarly, mechanical tolerances and aging could increase the airgap and cause the magnetic field strength to drop. After all these issues have been considered the designer has to decide if the “Magnetic Extended Range” should be activated or not.

In general there is no drawback by just activating the extended range. Only if the “normal operating” limits of the magnetic input field are exceeded will there be influence on the noise performance of the sensor.

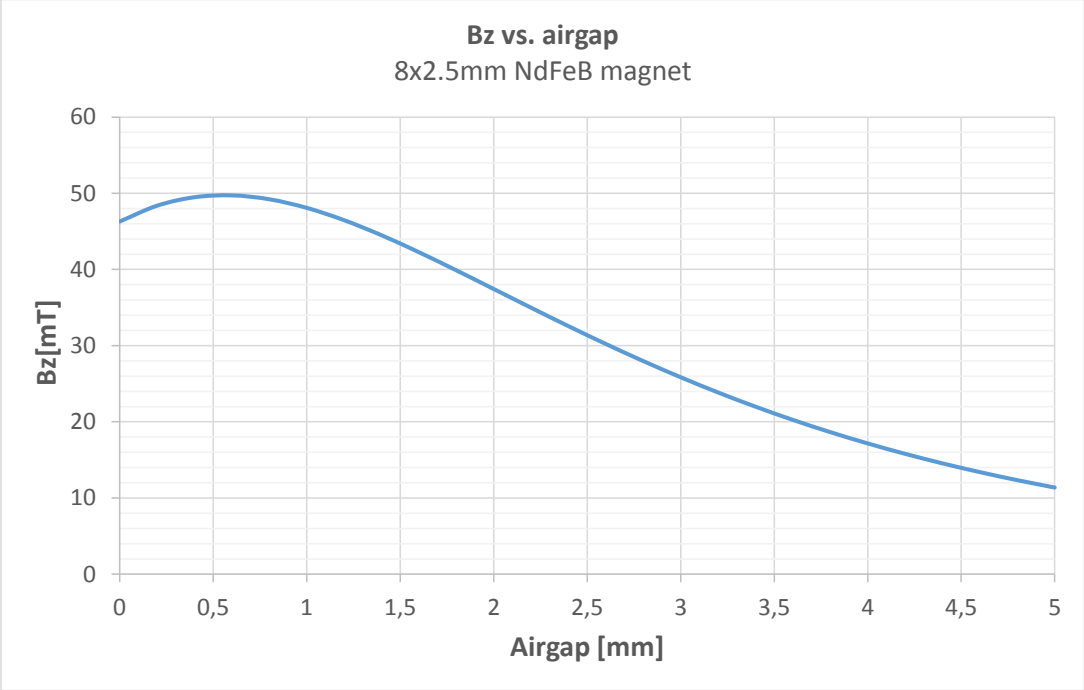

Figure 3: Magnetic simulation of magnetic field Bz versus the mechanical airgap

The following measurement has been performed to show a typical noise performance of the AS5x70 sensor in relationship with a decreasing magnetic field Bz.

The sensor was configured in a 0 – 360°, 1 quadrant configuration and the SENT output was acquired. At each z-distance (which equals a Bz value according the simulation above) 10.000 readings were recorded and the peak to peak noise in LSB and degree was calculated.

As one can see in Figure 4 below the noise is constant as long as the AGC can regulate, this is the case from 30 – 50mT. Then the noise starts increasing to a maximum value of 8LSB or 0.8 degree peak to peak, respectively, at around 10mT.

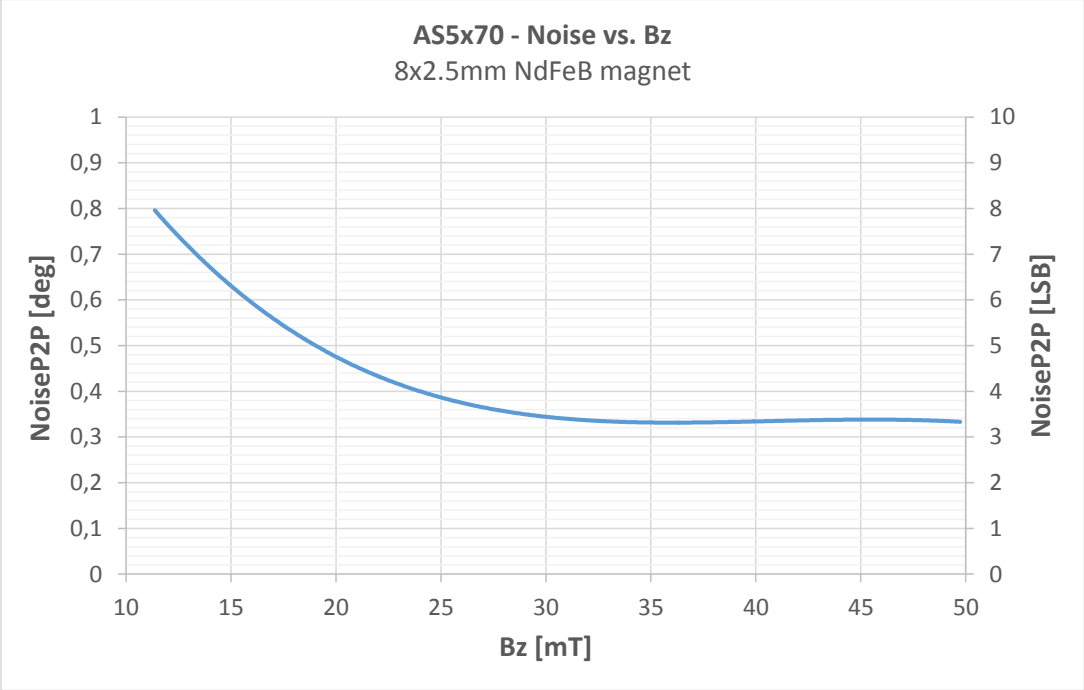

Figure 4: Noise performance versus magnetic field Bz

4 Summary

The “Magnetic Extended Range” feature available in the AS5x70 is a great benefit for system designers which have to overcome a low magnetic input field caused by a challenging mechanical or magnetic system design.

In systems were noise is an important requirement it is not recommended to go below magnetic input field levels of 20mT since the noise will increase rapidly.

For further information or help regarding the “Magnetic Extended Range” please contact the technical application team from AMS.

5 Contact Information

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