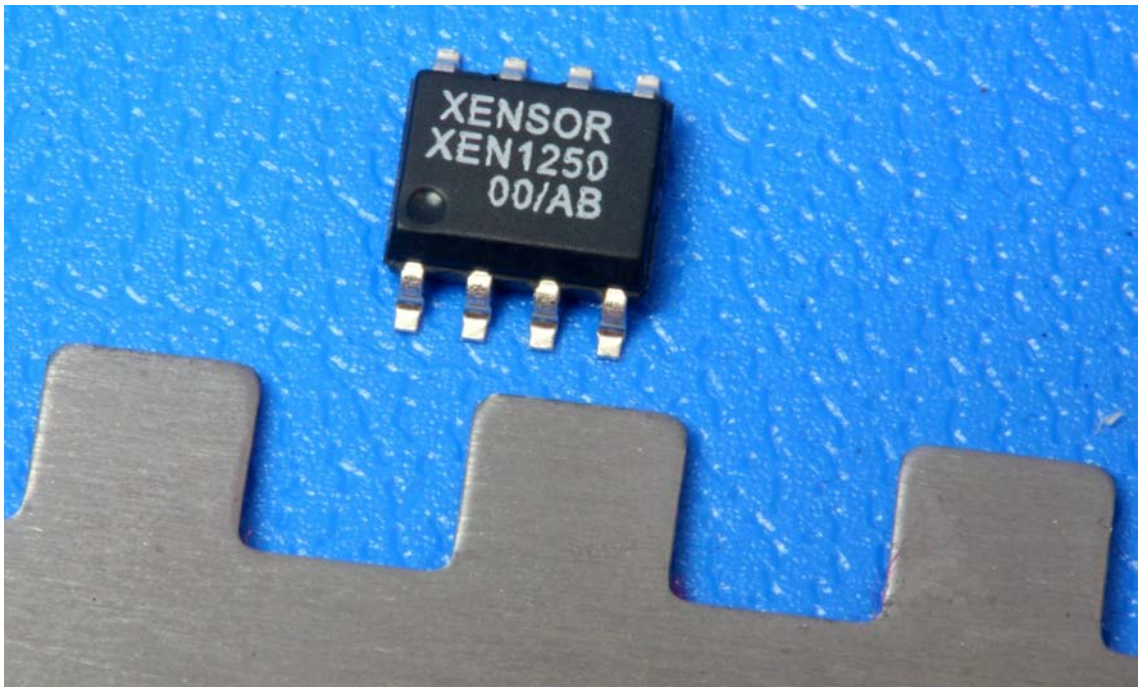

XEN-1250 digital movement sensor

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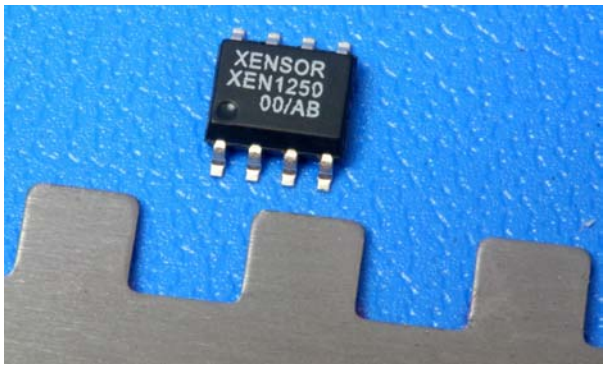
1 Introduction

1.1 Short description

Features

- Digital magnetic movement sensor.
- 3 wire operation
- Very low magnetic thresholds
- Programmable speed and threshold
- High magnetic operation range
- No permanent effects with magnetic field overloading
- North-South pole independent.
- No external components
- Small size



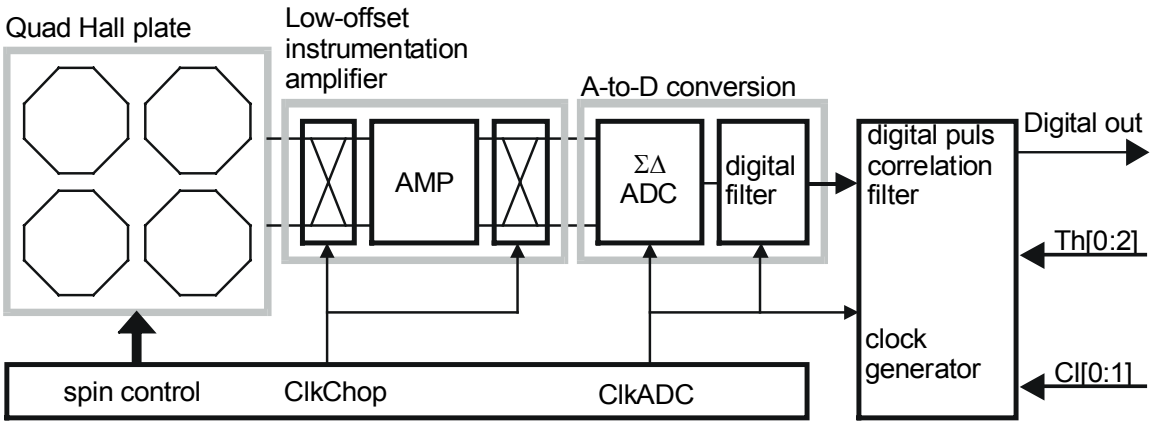
Applications

- Long distance magnetic targets
- Slow moving targets

Description

The XEN1250 is an ultra sensitive magnetic movement sensor specifically designed to determine the movement of weak magnetic targets. Typically it can be used with sensor-magnet distances up to or over 20cm. The sensor has two supply pins and a NMOS open drain output pin which pulls a few mA. The output pin is drawn to GND in case a programmed magnetic threshold is exceeded by a magnetic field pulse.
The XEN-1250 sensor is sensitive to a magnetic field applied perpendicularly to the ASIC top surface. The XEN1250 should be mounted so that a single positive or a single negative pulse is created with a passing magnet.

Figure 1.1 XEN-1250 scheme with magnetic movement correlation filter.



2 Technical data

2.1 XEN-1250 Specifications

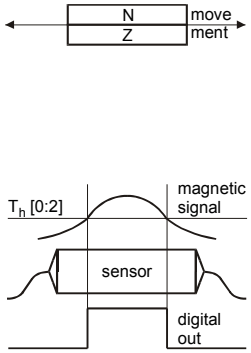
Parameters	*conditions*	*min*	*typ*	*max*	*units*
Power supply					
VDD		4.75	5	5.25	V
IDD		5.5		6.5	mA
Digital output					
Ioutput			1	4	mA
R pullup			10		kOhm
On-time output			2^{19}		Clkperiods
On-time output	@ 2.6MHz Clk		200		ms
Temperature range					
operating range		-30		+100	°C
Internal ADC					
output rate			$2^{16}/2^{17}$		Clkperiods
output rate	@ 1.3MHz Clk		20/10		Hz
output rate	@ 2.6MHz Clk		40/20		Hz
resolution (LSB)			0.33		µT
range		-10.8		10.8	mT
Internal clock generator					
Cl[1:0]					
00			1		MHz
01			1.3		MHz
10			1.7		MHz
11			2.6		MHz
Absolute accuracy			50		%
Threshold levels (Note 3)					
Th_0			16		filterbits
Th_1			32		filterbits
Th_2			64		filterbits
Pulse correlation filter					
Update rate			As ADC		
Decision delay			5		ADCsamples
Noise performance XEN-1250	@ 25°C				
magnetic noise density			0.1	0.15	$\mu T/\sqrt{Hz}$
magnetic noise density	@ 20Hz ADCsamples		8.6		filterbits

Magnetic Flux Density:	100 micro Tesla (µT) = 1 gauss (G)
Magnetic Field:	1 oersted (Oe) = 79.58 amperes/meter (A/m) 100 000 gamma = 1 Oe = 79.58 A/m in air: 1 Oe = 1 G = 100 µT
Note 1:	Dependant on clock frequency
Note 2:	Output rate of internal ADC is 2x as fast with fast conversion activated.
Note 3:	Magnetic threshold levels should be at a safe distance from the expected magnetic and sensor noise to avoid false triggering of the sensor.

2.2 Simple Design instructions

The XEN1250 is an ultra low threshold digital magnetic movement sensor. It is based on the revolutionary silicon Hall technology used in the XEN1200 compass sensor. The factory programmed XEN1250 is activated with magnetic pulses roughly above 2μT or below –2μT with pulse widths between 50ms and 1s. This is equivalent to a magnetic field created by a magnet on a distance to or over 20cm from the sensor.
The XEN1250 should be mounted so that a single positive or a single negative pulse is created with a passing magnet. In case a passing magnet causes a successive positive and negative pulse, the output will trigger twice.

Figure 2.1 Typical application XEN1250

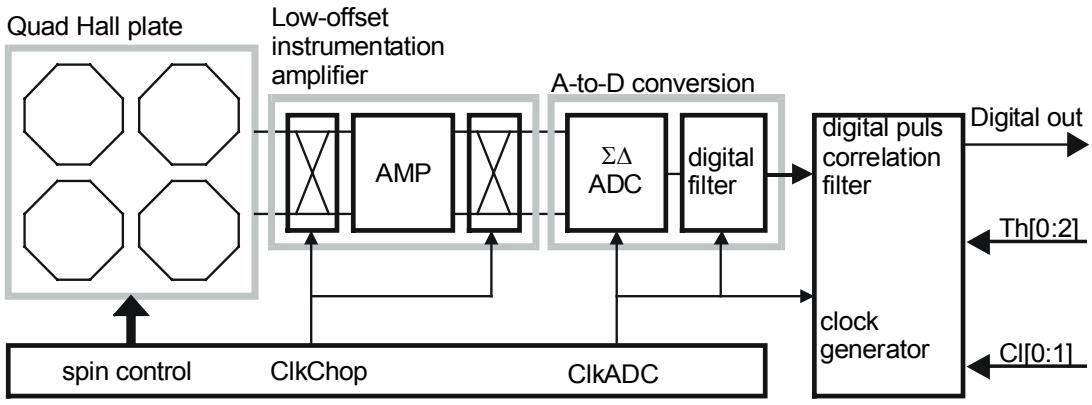


With the detection of a magnetic pulse the output pin is pulled to ground for a predetermined period of typical 300ms by an NMOS open drain transistor. The load on the output pin should not exceed 4mA. The output should be pulled up by a 10kOhm resistor to the supply voltage of the receiving unit. This voltage may not exceed the 5V supply voltage needed for the XEN1250.

The magnetic dynamic range of the XEN1250 is -10mT to 10mT. This assures correct working over the earth magnetic field orientation and disturbing magnetic sources.
The XEN1250 can not be damaged by high magnetic fields, in contrast to many magneto resistive sensors.

The XEN-1250 is a mixed-mode ASIC designed for use in combination with digital devices, such as micro-controllers, sharing the same power supply. Adequate decoupling will be beneficial for the performance of the chip. A single 100nF capacitor between VDD and ground is recommended.

Figure 2.2 Quad Hall plate scheme



2.3 Advanced design instructions

The XEN1250 magnetic thresholds and speeds can be programmed by the user by pulling one or more of the program pins on the SOIC8 package to GND. In order to make the correct decisions, it is wise to read these advanced design instructions. Under NDA Xensor offers support for specific magnetic configurations and can deliver customer specific programmed XEN1250 also. Please contact us for more details.

2.3.1 Sensor magnetic filtering

The XEN1250 is equipped with sophisticated analog and digital filtering, reducing the interference of magnetic disturbances to the lowest limits. This is done in two steps.

Analog filter
The amplified magnetic signal is continuously integrated in a Sigma-Delta ADC analog loop filter. This offers an excellent interference rejection for high-frequency (electro)magnetic noise sources which could falsely trigger a sensor.
By choosing the integration period as a multiple of the power supply frequency of 50 or 60 Hz, an excellent normal mode rejection ratio (NMRR) can be obtained as well.
The conversion speed, thus integration period of the ADC is controlled by the internal clock-generator. The output frequency of the generator can be programmed by pulling the two CI[0:1] pins to ground or leaving them floating, with resulting output frequencies as in Table 2.1.
Further control of the integration period is done with the fast conversion (FS) program pin. If it is left unconnected the integration period is 2^{16}, if it is pulled to GND 2^{17} clock periods. A good NMRR is obtained with a CLK frequency of 1311 kHz and FS on GND.

Table 2.1 Conversion

CI[0:1]	CLK frequency (kHz)	conversion time (ms)	conversion frequency (Hz)
00	1000	62.5/125	16/8
01	1311	50/100	20/10
10	1700	37/75	26/13
11	2622	25/50	40/20

Pulse correlation filter
The ADC values are further processed with a digital bandpass filter, which is particularly tuned to the detection of a passing magnet on a rotating/moving arm.
The middle frequency of this filter is 5 times tunable by choosing the operation speed of the ADC, as discussed in the former section. In this way the performance can be optimized for the expected band of rotation/movement speeds.
The filter phase shift is never more than 5 ADC samples. The filter output and also digital decision will update on the same rate as the internal ADC. The filter is fully symmetrical for North-South magnet orientation and rotation direction.

Figure 2.4 Frequency response of the magnetic pulse correlation filter for an ADC rate of 20H

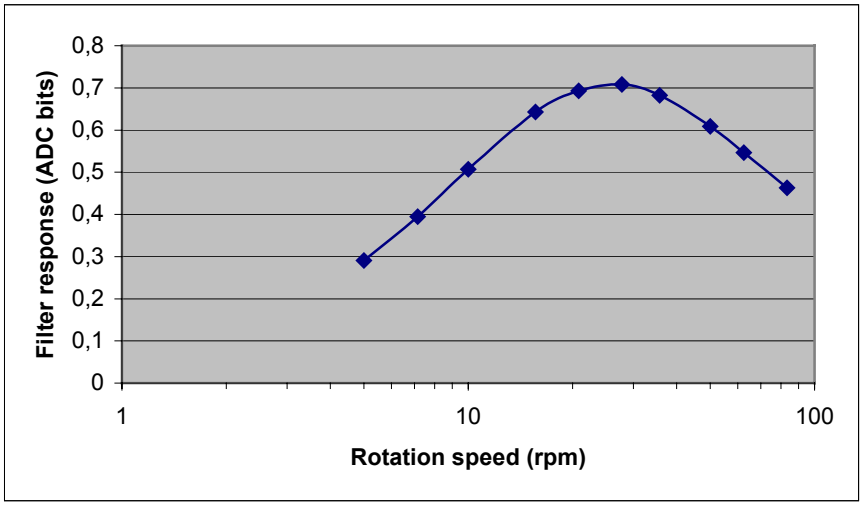
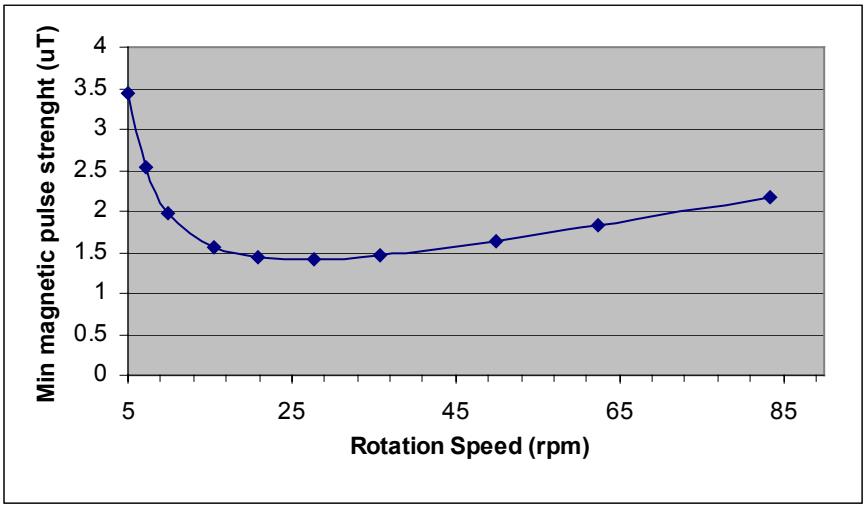


Figure 2.5 Minimum magnetic field strength of a magnetic pulse from a rotation target which is needed to trigger the XEN1250 with a sample frequency of 20Hz and a threshold level of 32.



2.3.2 Threshold choice and magnetic noise

The XEN1250 will trigger in case the filter output exceeds a programmed threshold level. The magnetic threshold of the sensor can be programmed with binary code on the T_h[0:2] pins, so values between 16 and 112 can be obtained. Since the sensor is ultra sensitive, it is important that the magnetic background fluctuations and sensor noise peaks do not exceed this level.

Magnetic noise
The sensor noise can be calculated with the sensor speed and noise figures given, and is:

$$\sigma(noise, filterbits) \approx 2\sqrt{ADCrate}$$

With an ADC sample rate of 20Hz, this would be a noise level of 9 bits filter output.

Avoid false triggering
In order to avoid false triggering, trigger levels should well exceed this noise. A recommended value would be 3 times the noise level. So the closest programmable threshold level is 32 bits, this would be T_h[0:2]=[010]. With a higher programmed ADC speed, other threshold levels can be calculated and programmed.

Ensure signal triggering
In order to ensure signal triggering the signal should exceed the threshold level with a similar margin.

Background fluctuations
In general lower magnetic thresholds than 32 bits are not wise because magnetic background fluctuations, such as modulation of the earth magnetic field by passing cars can easily be higher.

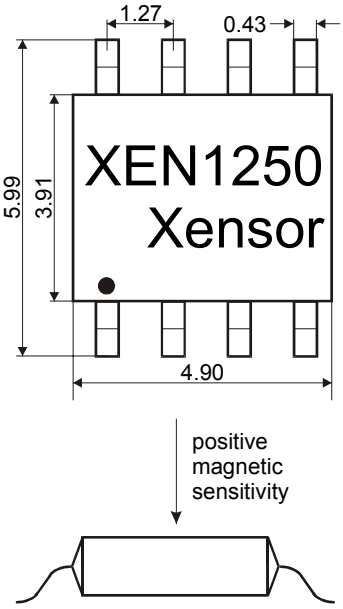
2.4 Packaging

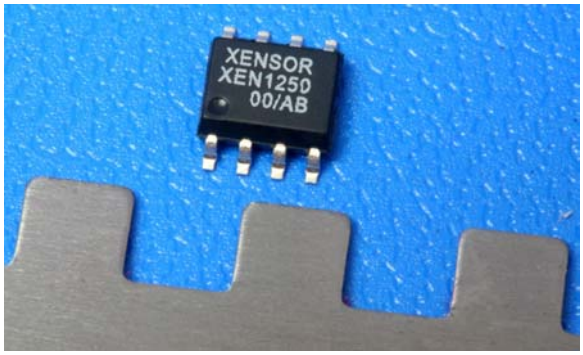
The XEN-1250 ASIC is sold in SO-8 package.

XEN-1250 Package definition: SO-8

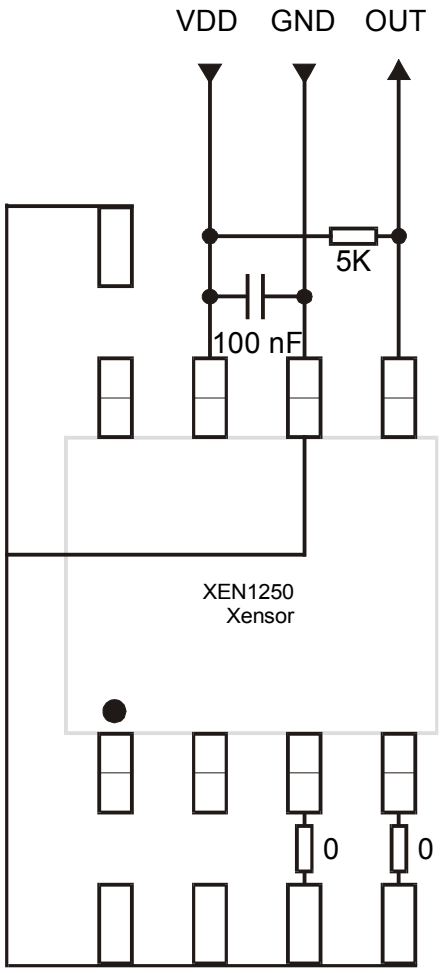
	Pin	*functionality*
1	FS	Fast conversion. If unconnected the operation of the ADC is in fast mode. By pulling this pin to GND it can be put in slow mode.
2	Th_2	MSB program pin for magnetic threshold. If unconnected it is on one. If pulled to GND on zero.
3	Th_1	ISB (Intermediate significant bit) program pin for magnetic threshold. If unconnected it is on one. If pulled to GND on zero.
4	Th_0	LSB program pin for magnetic threshold. If unconnected it is on one. If pulled to GND on zero.
5	OUT	Open drain output. Should be connected to a maximum of 5V with a pull up resistor of 10k
6	GND	Ground
7	VDD	5 V Supply power connection.
8	Cl_0	LSB Program pin for the internal clock generator. If unconnected it is on one. If pulled to GND on zero.

dimensions: mm





2.5 Typical connection scheme



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