Magnetic Sensor
Switching Output Type
HGDE/HGDF Series
(Dual polarity / Single output)
Design Guide

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Switching Output Type HGDE/HGDF Series (Dual polarity / Single output)

HGDEPM013A, HGDEPT021B, HGDFPT021B

Alps Alpine high-precision magnetic sensors use Giant Magneto Resistive effect (GMR) for horizontal magnetic fields detection. Utilizing the GMR element for its high output and exceptional resistance to high temperatures and magnetic fields, our sensors achieve high output level and sensitivity compared to other xMR sensors; approximately 100 times higher than Hall element and 10 times higher than AMR element based on our research. We offer various magnetic sensors for dedicated usage such as non-contact switch applications, linear position detection and angle detection as well as rotational speed and direction sensing in response to external magnetic fields.

This document provides essential information for understanding and implementing switching output type magnetic sensor Dual polarity / Single output (herein after magnetic switch) in your design.

1. Overview

Magnetic switch detects changes in magnetic field strength (flux density) and output ON/OFF signals accordingly. Magnetic switch (Dual polarity / Single output) detects any direction of horizontal magnetic field in wide area. Fig.1 shows horizontal direction of magnetic field density (MFD) in operating mode. As the example HGDEPM013A is on (output LOW) at 1.3mT(typ.) and off (output HIGH) at 0.8mT(typ.). Table 1 shows the specification of magnetic flux density (MFD) when the magnetic switch is operated.

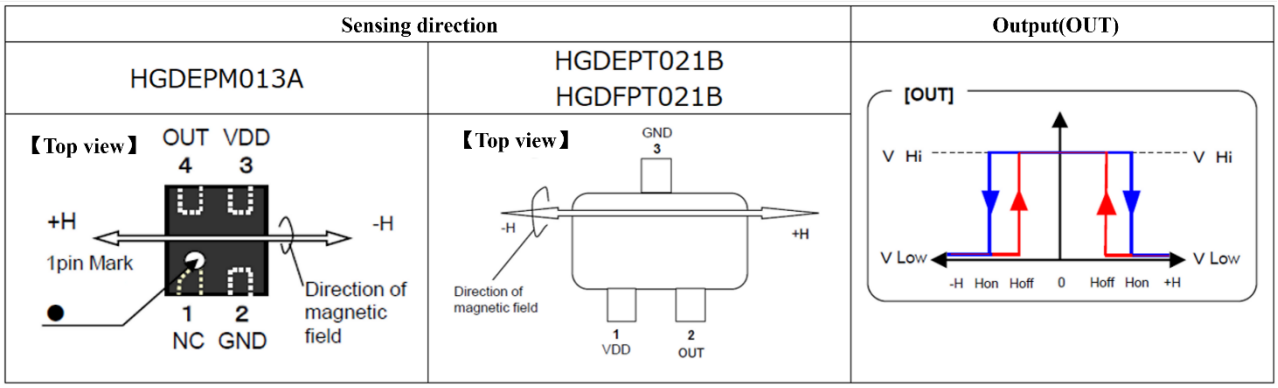

Fig.1 Sensing direction for magnetic switch

Table.1 MFD for magnetic switch operation

Product No.	Symbol	Specification			Unit.	Condition
		Min.	Typ.	Max.		
HGDEPM013A	Hon(+/-)	0.6	1.3	2.0	mT	Ta=25℃ VDD: 1.8V/3.0V
	Hoff(+/-)	0.3	0.8	1.5		
HGDEPT021B	Hon(+/-)	1.3	2.0	2.7		
	Hoff(+/-)	0.5	1.2	1.9		
HGDFPT021B	Hon(+/-)	1.3	2.0	2.7		Ta=25℃ VDD: 5V
	Hoff(+/-)	0.5	1.2	1.9		

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Fig.2 and Fig.3 show an example of MFD when the magnet is brought close to the magnetic sensor. Fig.2 shows the variation of the MFD with respect to the movement of the magnet in the vertical direction of the magnetic sensor. Fig.3 shows the variation of the MFD with respect to the movement of the magnet in the horizontal direction of the magnetic sensor.

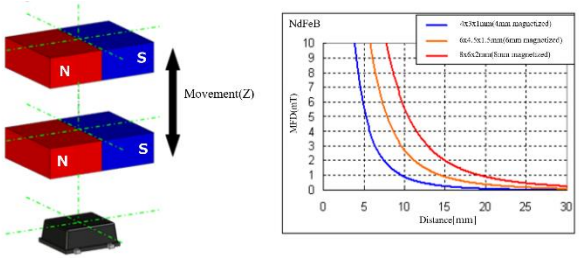

Fig.2 MFD vs vertical magnet movement

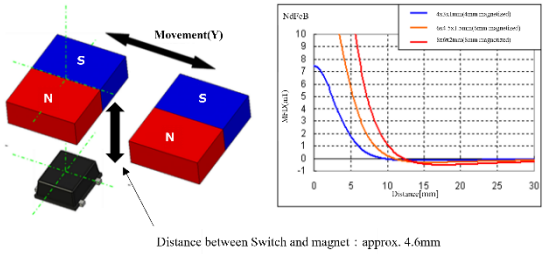

Fig.3 MFD vs horizontal magnet movement

2. Sensor layout

This section gives an example of magnetic switch design when a specified type of magnet moves in the vertical direction with respect to the magnetic switch (HGDEP013A). For designing with other products such as HGDEPT021B and HGDFPT021B, please refer to Table 2.

Conditions

Magnet: NdFeB

Magnet size: 4×3×1mm 4mm (long direction) magnetized.

Movement: Up and down of the magnet relative to the magnetic sensor.

Target value of magnetic flux density (MFD) when magnetic switch is ON or OFF

Consideration of the hysteresis is required for stable operation.

- MFD at ON: 2.4mT or more … reserve 20% margin to maximum ON MFD (2.0mT).
- MFD at OFF: 0.24mT or less … reserve 20% margin to minimum OFF MFD (0.3mT).

Magnet position

ON: Within 7mm from the magnetic sensor.

OFF: 16mm or more from the magnetic sensor.

The position of each related part is shown in Fig. 4.

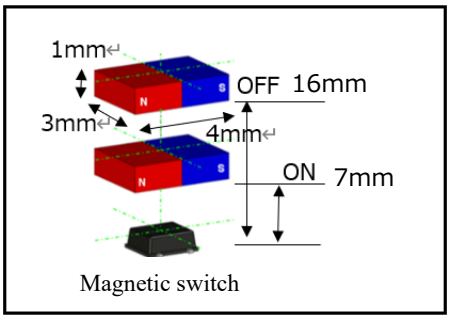

Fig.4 Magnet position

Table.2 Target value of MFD to distance

Product No.	Symbol	Specification (mT)	Target value 20% margin(mT)	Distance (mm)
HGDEPM013A	Hon(Max)	2.0	2.40	7
	Hoff(Min)	0.3	0.24	16
HGDEPT021B	Hon(Max)	2.7	3.24	6
	Hoff(Min)	0.5	0.40	13
HGDFPT021B	Hon(Max)	2.7	3.24	6
	Hoff(Min)	0.5	0.40	13

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The range in which the magnet can move is generally limited by the actual structural design, and it is necessary to select a magnet that ensures stable ON/OFF operation of the magnetic switch within this limited range. So, it is also possible to reverse the design accordingly. For instance, set the target for magnetic flux density and then discuss the selection of an appropriate magnet with the magnet manufacturer.

3. Selection of magnets

Various shapes of magnets are available in the market. Fig.5 shows examples of the magnet which can be used for magnetic switch.

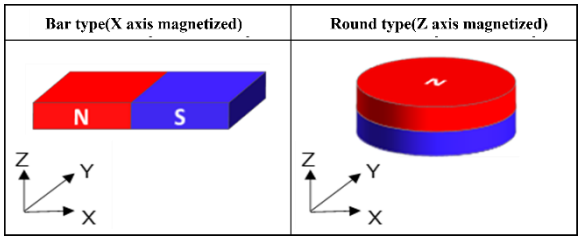

Fig.5 Examples of magnet

4. Circuit design

Fig.6 shows reference circuit for magnetic switch. Fig.6 shows reference circuit for magnetic switch. Please add current limiting resistor at OUT terminal depend on necessity.

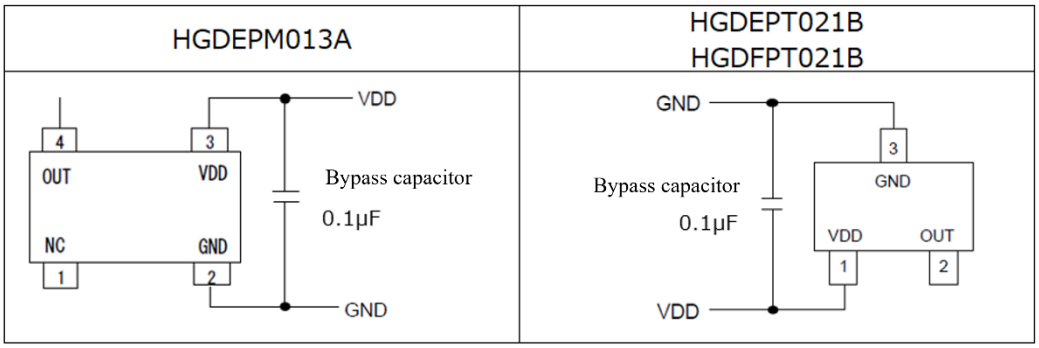

Fig.6 Reference circuit for magnetic switch

Table.3 Example of parameters

Product No.	HGDEPM013A	HGDEPT021B	HGDFPT021B
Supply voltage	1.8V(Typ.)		5V(Typ.)
Bypass capacitor	0.1uF		

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5. General precautions

The following are general precautions for using magnetic sensors and magnets.

Selecting the appropriate magnet

Select the type and strength of the magnet in accordance with the specification of the magnetic sensor and the requirements of the application scenario. Excessive strength of the magnet may cause the sensor to malfunction.

Thermal environment

Magnets are sensitive to temperature and the strength of the magnetic field varies with temperature. When the magnetic sensor and magnet are heated, the stability of the magnetic field may be affected. Therefore, it is necessary to investigate appropriate thermal countermeasures.

Influence of Magnet Configuration and Surrounding Magnetic Materials

Magnetic sensors are affected by surrounding magnetic materials (e.g. magnets, iron). Check whether the interference of the magnetic field affects the operating performance of the magnetic sensor and take care to adjust the magnet, the surrounding magnetic material, and the sensor to the appropriate positional relationship.

Static electricity

Magnetic sensors are semiconductor devices. They can be damaged by static electricity that exceeds the capacity of the specified electrostatic protection circuit. Take adequate measures to protect against static electricity during use.

EMC

Magnetic sensors may be damaged or malfunction due to over-voltage of the power supply in an automobile environment, exposure to radio waves, and so on. Implement protection measures (Zener diodes, capacitors, resistors, inductors, etc.) as necessary.

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Revision history

Date	Version	Change
May. 24 2024	1.0	Initial release (English version)

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