Magnetic Sensor
Switching output type
HGDVST022A
Design Guide

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Switching Output Type Magnetic Sensor for Vehicles HGDVST022A

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 magnetic sensor in your design.

1. Overview

Magnetic sensor for switch application (herein after magnetic switch) detects changes in magnetic field strength (flux density) and output ON/OFF signals accordingly. Table 1 shows the magnetic flux density (MFD) when the magnetic switch is operated. The magnetic switch is an open-collector output as shown in Fig. 1, which detects the magnetic flux in the direction of the length of the device package (pin3 to pin1); ON (output Low) at 2 mT (typ.) and OFF (output High) at 1.4 mT (typ.). Compared with magnetic switches for consumer product, it features a wider power supply voltage range (3 to 30V). For detail, please refer to "HGDVST022A Datasheet".

Table1 MFD for magnetic switch operation

Parameter	Symbol	Values			Unit	Note
		Min.	Typ.	Max.		
Operating Magnetic Field	Hon	-	2.0	(2.7)	mT	25deg.C
	Hoff	(0.7)	1.4	-	mT	
	Hhys	-	(0.6)	-	mT	

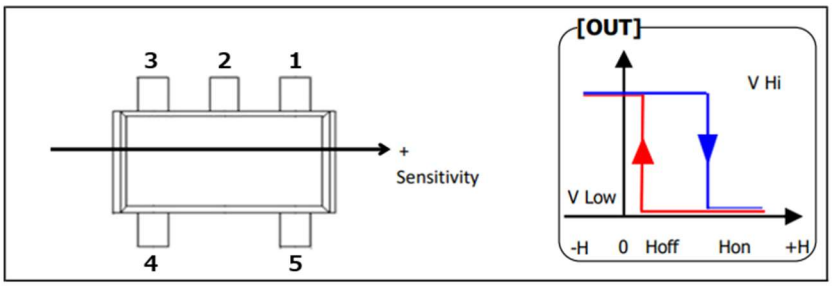

Fig.1 Sensing direction for magnetic switch

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.

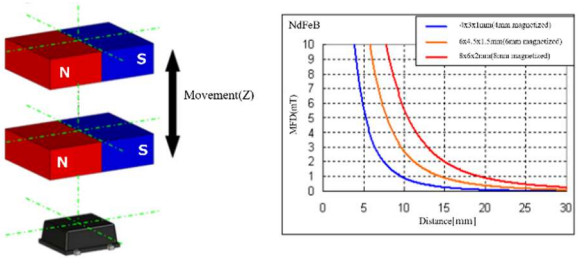

Fig.2 MFD vs vertical magnet movement

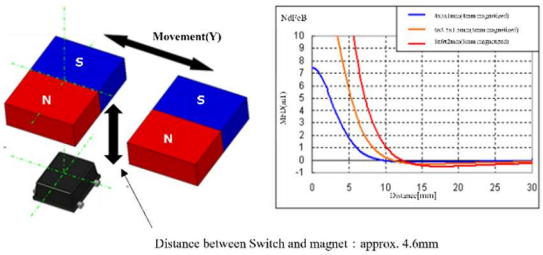

Fig.3 MFD vs horizontal magnet movement

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 magnet sensor.

Conditions

Magnet:NdFeB

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

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

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: 3.3mT or more … reserve 20% margin to maximum ON MFD (2.7mT).
- MFD at OFF: 0.56mT or less … reserve 20% margin to minimum OFF MFD (0.7mT).

Magnet position

ON: Within 6mm from the magnetic sensor.

OFF: 12mm or more from the magnetic sensor.

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

Magnet direction

If the magnetic field direction is opposite to the detection direction, the sensor will not detect.

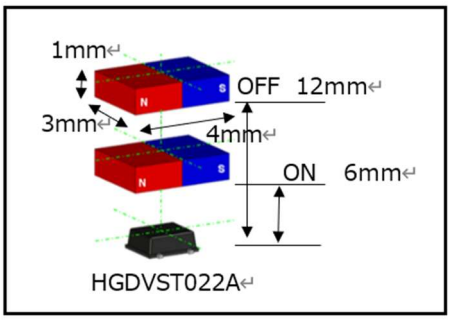

Fig.4 Magnet position

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

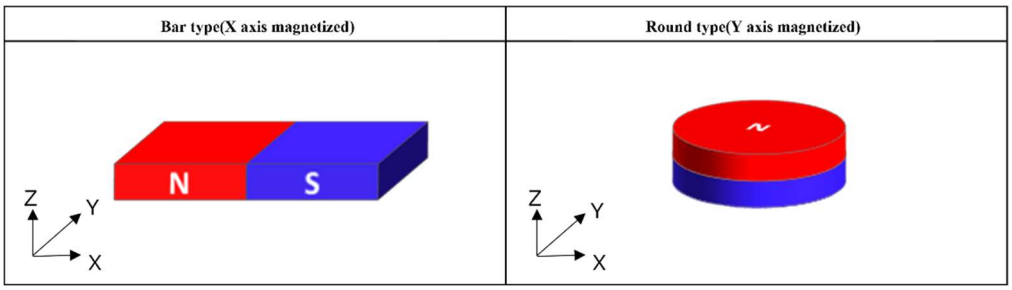

Fig.5 Examples of magnet

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

4. Circuit design

Fig.6 shows reference circuit for magnetic switch.

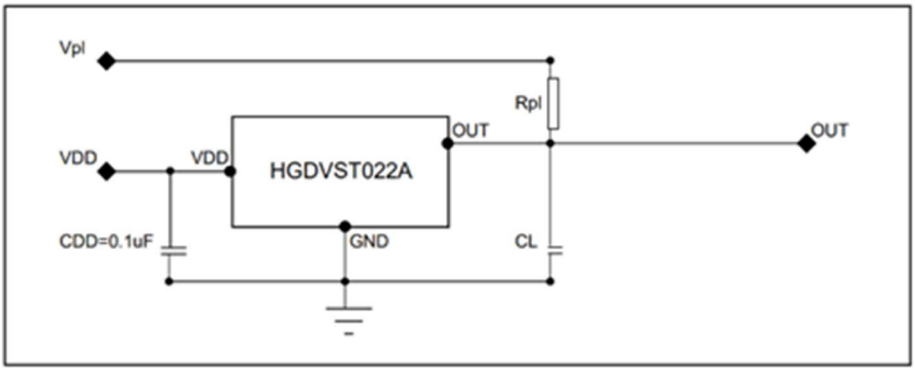

Fig.6 Reference circuit for magnetic switch

Parameters:

Supply voltage	VDD=12V
Pull-up voltage	Vpl=5V
Pull-up resistor	Rpl=3.3kΩ
Input current (OUT)	Isink=Vpl/Rpl < 10mA
Bypass Capacitor (VDD)	CDD=0.1uF
Load capacitor (OUT)	CL=30pF

HGDVST series accept high voltage. The supply voltage (VDD) and pull-up voltage (Vpl) of the magnetic switches can be up to 30 V. However, the pull-up voltage (Vpl) should be compliant with the maximum input voltage of the MCU. The pull-up resistor (Rpl) should be defined to control the maximum current of Isink up

to 10mA. The capacitor CL should be selected to ensure the overall capacity of the circuit (1000pF or less). For detail, refer to the “HGDVST022A Datasheet”.

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
Feb. 14 2024	1.0	Initial release (English version)