## 1. Introduction

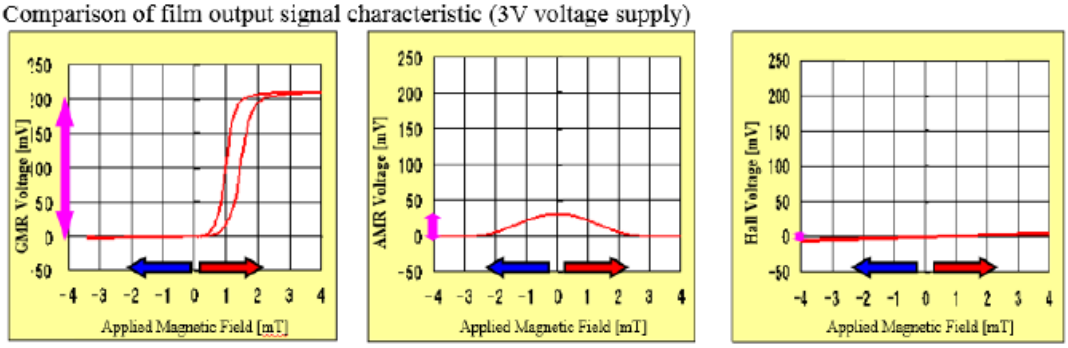
AlpsAlpine Magnetic Sensors are designed to detect horizontal magnetic field with the technology experience of HDD MR magnetic heads. These sensors are applicable for “non-contact” switch, linear position/angle, and rotation speed/direction detection.

**Comparison with other sensors magnetic**

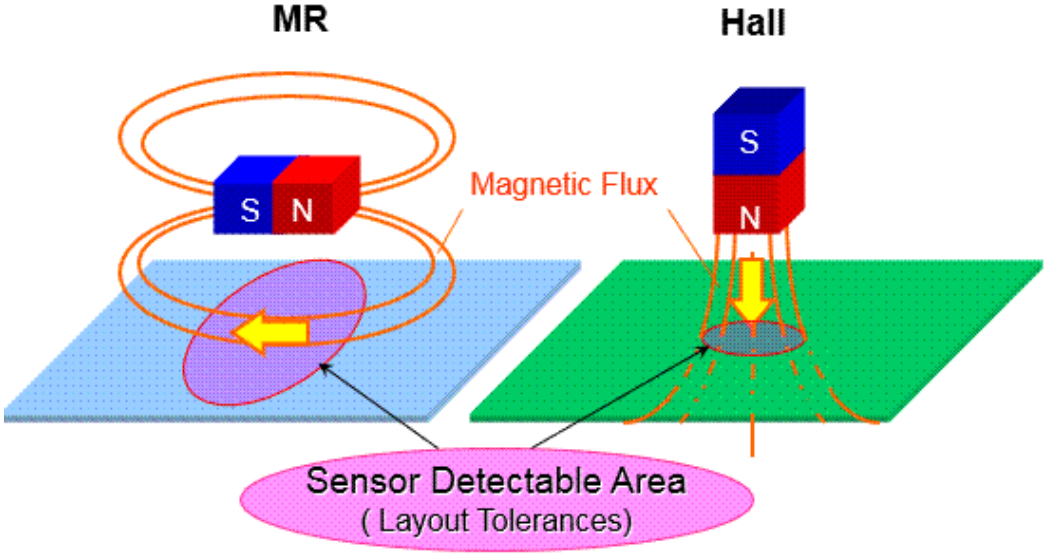
Our magnetic sensor can detect weaker magnetic field with higher accuracy.

Our magnetic sensor element’s higher output can achieve simple ASIC circuit, small power consumption, small factored PKG size, and also robustness against external noise. Sensor element itself has very sharp and accurate characteristics, so operating point is very stable even though with ASIC threshold variation or temperature variation. Other sensor suffer big disturbance from such variation.

Comparison of film output signal characteristic (3V voltage supply)




MR sensor detects horizontal magnetic field against magnet location. Hall sensor detects vertical magnetic field. In general, horizontal magnetic field has wider distribution than vertical one. So MR sensor has wider detection area than Hall sensor with same magnet size. This means MR sensor allows bigger gap between sensor vs. magnet position.



## Operating principle

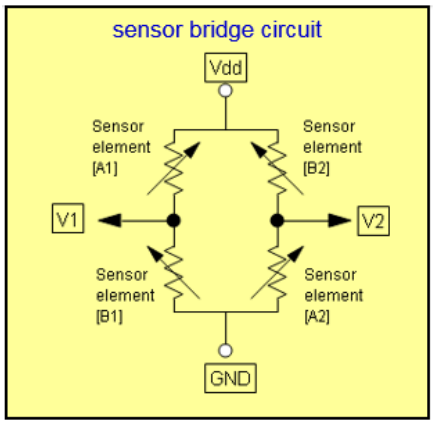
MR sensor bridge circuit has 4 elements (A1,B1,A2,B2)

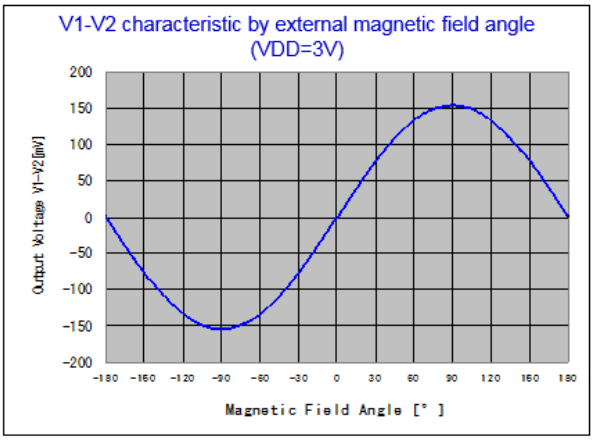
V1, V2 is sensor bridge output voltage.V1=B1/(A1+B1), V2=A2/(B2+A2)

A1,A2 and B1,B2 element's resistance changes against applied magnetic field direction.

V=V1-V2: Output voltage changes as Sin (or Cos) curve.

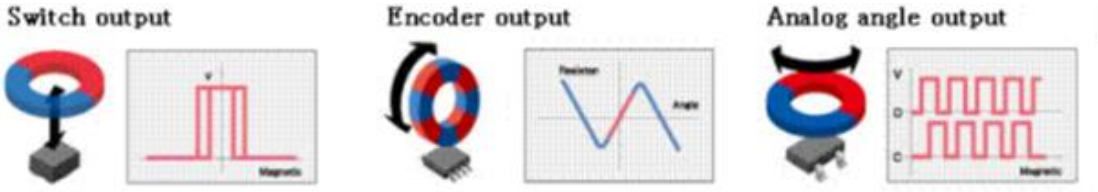
System can use this sin wave for switch, encoder, and linear position/angle detection.



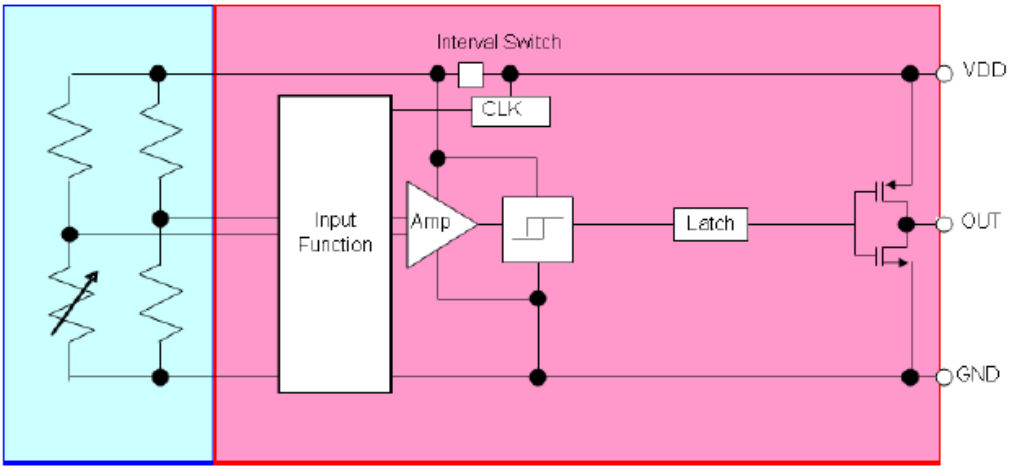

## Products variety

- Switching digital output
- Encoder digital output
- Analog angle linear output
- Analog field linear output (3-axis geomagnetic sensor)



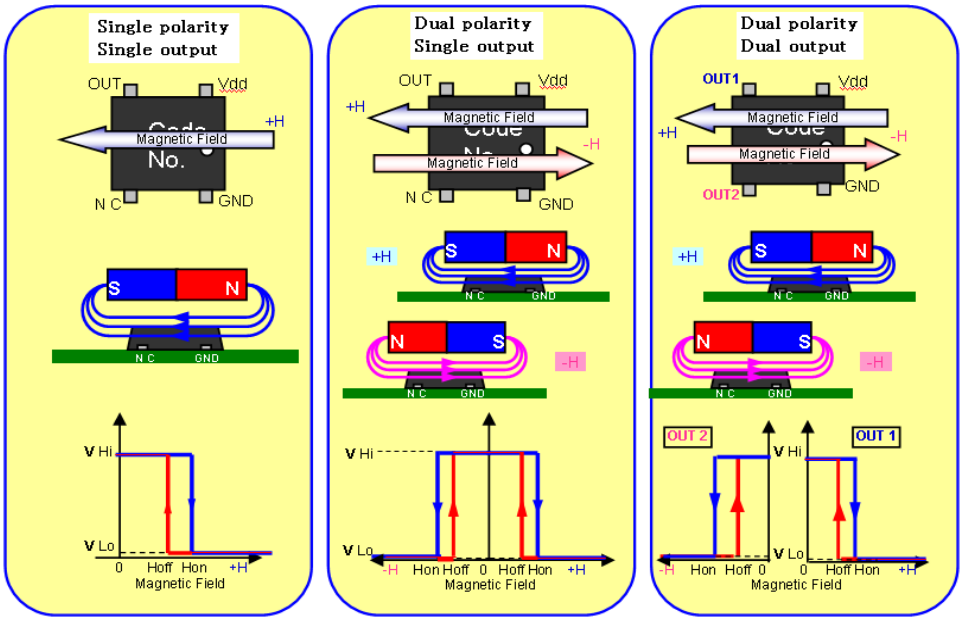
## 2.Switching digital output（HGDE, HGDG, HGDF, HGDV）

Switching type products have magneto-resistive bridge and processing ASIC circuit.
Resistance bridge output changes depending on magnetic field direction,
ASIC circuit has threshold, hysteresis, latch, and clock control for ON/OFF state.
HGDE, HGDG type use pulse drive ASIC. HGDF, HGDV type uses continuous drive ASIC.




Switching HGD types can detect horizontal magnetic field, and have 3 types of function mode.

Single polarity / Single output: detect only one side direction
Dual polarity / Single output: detect both sides direction on 1 output.
Dual polarity / Dual output: detect both sides direction separately on 2 outputs.



**System design example for switching**

This is an example for sensor/magnet switching system design.

Below graph shows the magnetic field strength vs. distance of sensor-magnet. (vertical distance or slide offset distance).

If magnet moves close to sensor, magnetic field increase and sensor moves to “ON” state.

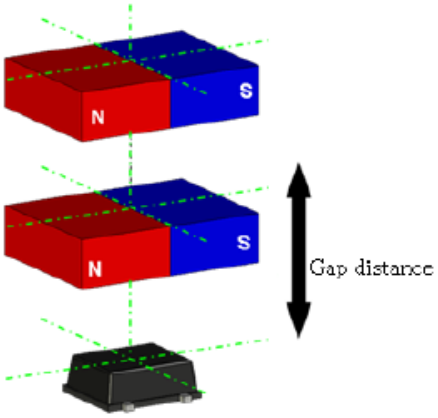
If magnet moves far from sensor, magnetic field decrease and sensor moves to “OFF” state.

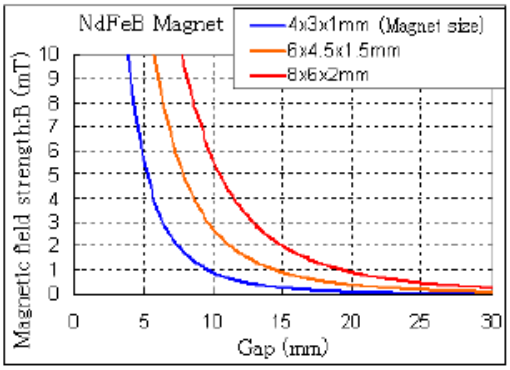
There are some product varieties of sensor sensitivity.

Hon (H operate point OFF->ON)

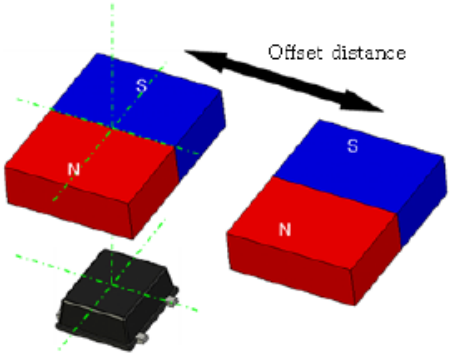
Hoff (H release point ON->OFF)

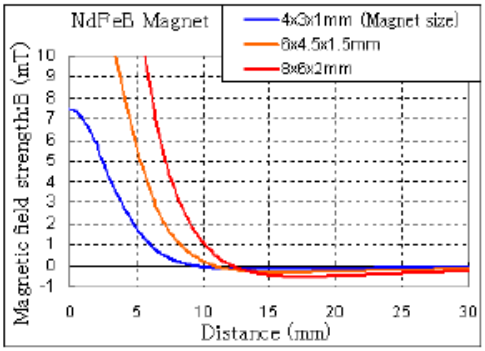
Field strength vs. Magnet position




Field strength vs. Magnet position



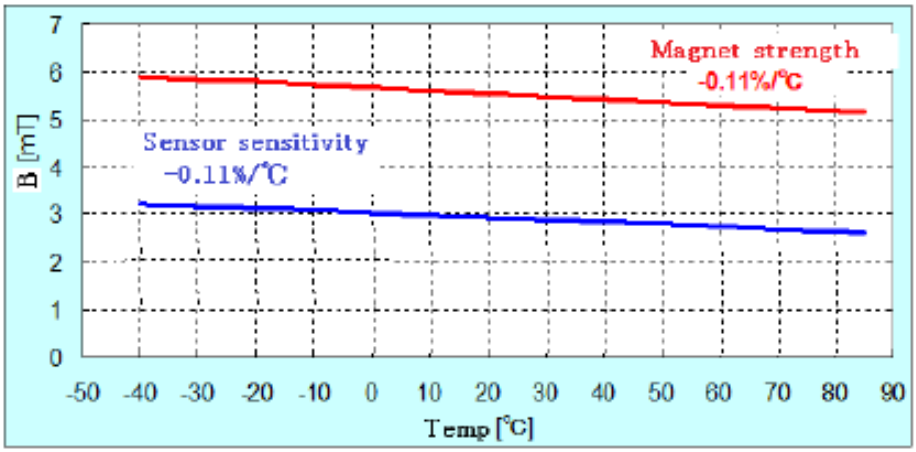
## Temperature effect

Usually, magnet power decreases at higher temperature.

ALPS magnetic sensor is designed to increase its sensitivity at high temperature.

And this can compensate magnet power decrease.

This means operate/release working distance is kept same at lower or higher temperature with ALPS sensor.




## Magnet / Sensor variation

Both magnet and sensor have product variation.

System need to be designed to work even at worst condition.

(for example, magnet weak / sensor low sensitivity / distance big combination.)

ALPS sensor has very small variation, and this will help your system design.

## Magnet / Sensor alignment offset

Alignment offset also effect to working distance.

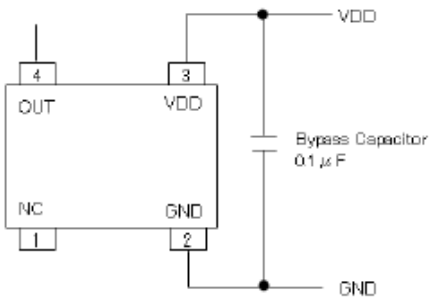
System need to be designed to work at maximum miss-alignment.

ALPS sensor has wide detecting area due to horizontal field distribution,

So it has more room for miss-alignment.

## Circuit recommendation

Bypass capacitance between VDD and GND is strongly recommended.

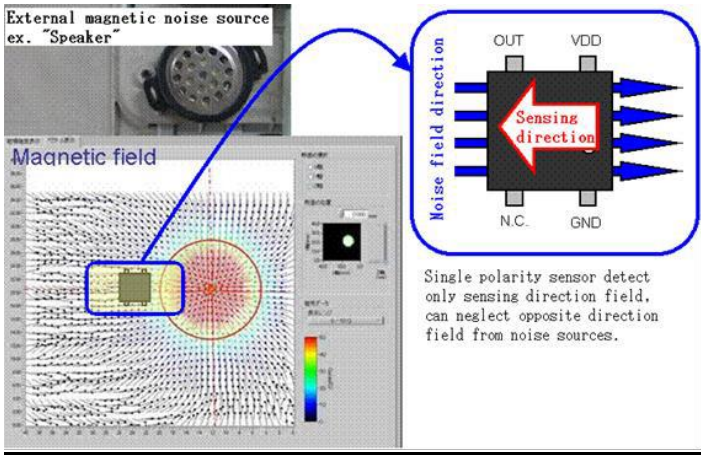


## Application example for switching function

MR magnetic sensor HGD series can detect horizontal field direction.
Below is example for Single polarity and Dual polarity type.

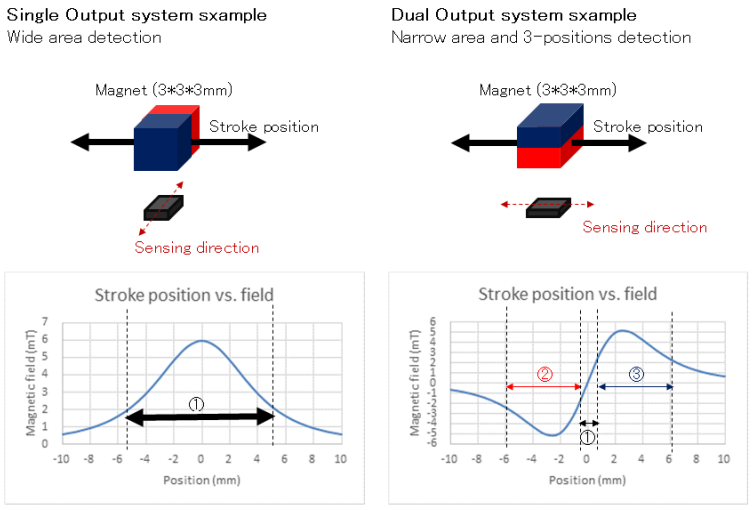
## Single polarity（HGDES, HGDGS, HGDFS, HGDVS）system design example

When magnetic sensor is located near by noise magnet like inductor or speaker, sensor may suffer disturbance and cause miss operation.
Our single polarity sensor detect only one side magnetic field.
If you can know the noise field direction, you can locate the sensor to neglect the noise field.




## Dual polarity（HGDEP,HGDGP,HGDFP,HGDED,HGDGD, HGDFD）system design example

This type sensor can detect both right and left field.
Single Output: One output can detect both direction,
You do not need to care magnet direction and make wide area detection.
Dual Output: Two outputs can detect right and left direction separately,
You can make narrow area detection and 3 positions detection



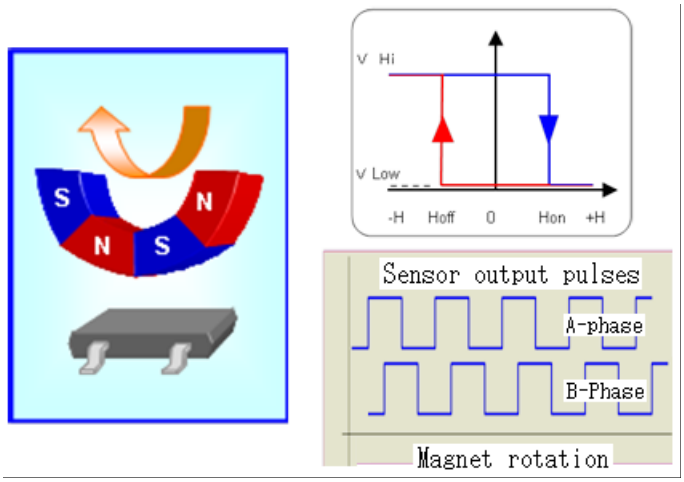
# 3.Encoder digital output（HGP）rotational detection

This type sensor can detect magnet rotation.

Sensor detects the field polarity change: S->N and N->S. (this type is called as latch detection.)

Rotation direction can be detected by using 2 sensor's signal phase.

ALPS is preparing 1in1 type (1 sensor in 1 PKG) and 2 in1 type (2 sensors in 1 PKG).




**Encoder system design example**

HGP type sensor can be used for dial rotation detection or motor rotation control.

Usually ring shape magnet is used for such purpose.

Conventional Hall sensor case: 2 sensors need to be located under the magnet.

Our 2in1 sensor case: Only 1 sensor can detect rotation speed and direction.

Also, this sensor can be located both under and besidethe magnet.

And magnetic sensitivity is high, so you can locate small magnet far from sensor.

There are conventional 2in1 type and Pitch Free 2in1 type.

Our Pitch Free 2in1 typesensor can output always 90degphase difference signal with any pole pitch magnet

This "Pitch Free" concept is the biggest advantage.

<Conventional Hall sensor>
2-sensors are required
Sensor must be located under magnet.

<ALPS HGP sensor>
1 sensor can output 2-phases
Sensor can be located both under and beside magnet

Big advantage is "Pitch Free"
Sensor always output 90degree phase difference signal with any pole pitch magnet.

**2in1type sensor Conventional design**

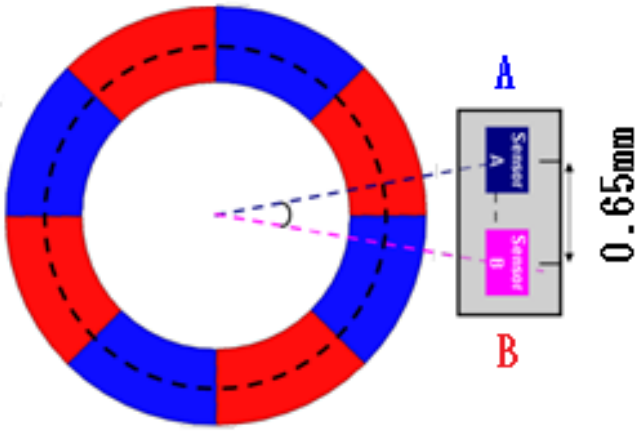
2in1PKG includes 2 sensors is 1 PKG (Phase A and Phase B)

Typical A-B mechanical distance is 0.65mm.

With this 1 PKG, you can detect both rotation speed and direction.

We recommend magnet pole pitch as 1.3mm (N or S pole each, NS pair 2.6mm),

to get A-B 90degree phase difference.



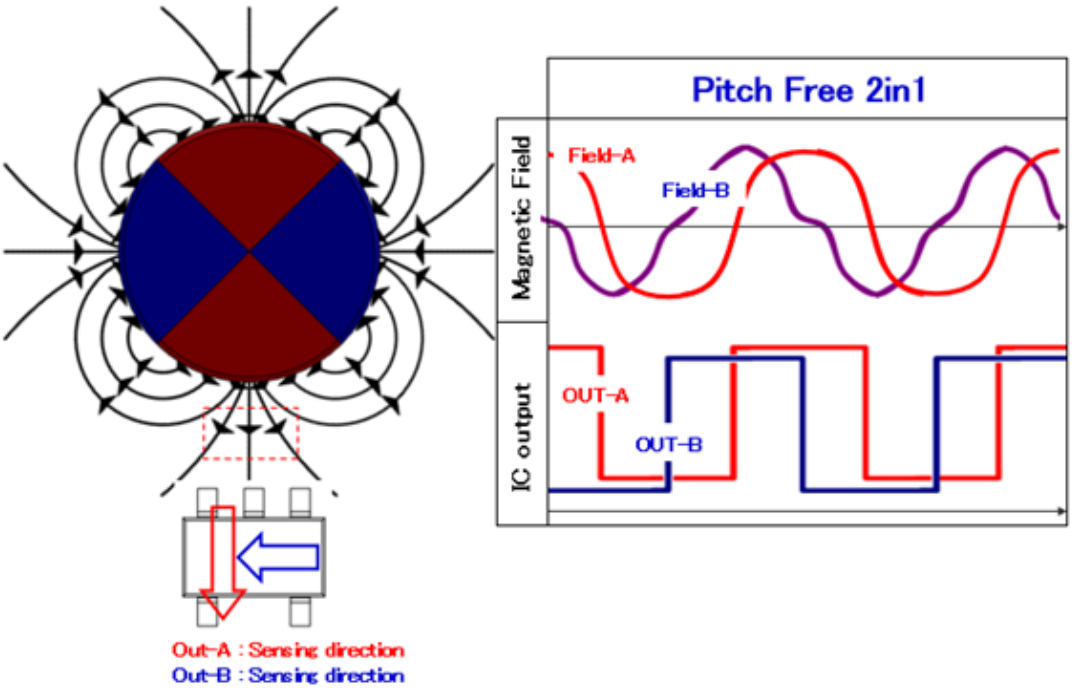

**2in1type sensor Pitch Freedesign**

2in1PKG includes 2 sensors in1 PKG. (Phase A and Phase B)

Phase A and B sensor bridge sensing direction is set as 0deg and 90deg by MR technology.

Phase A and B sensitivity center is designed in same position within 1 chip.

So you can get always 2-phase 90deg difference output with any magnet.



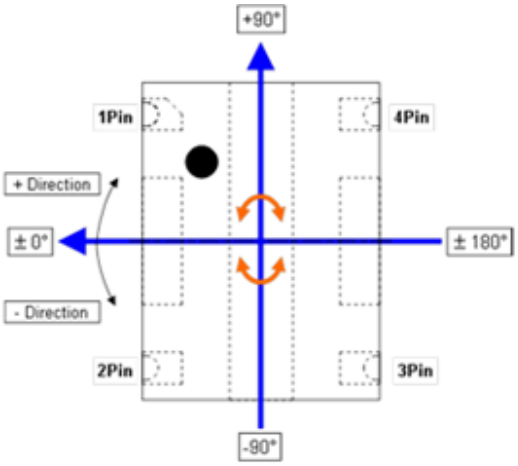
# 4.Analog angle linear output（HGARseries）

HGARseries isanalog angle sensor.ASIC is not attached.

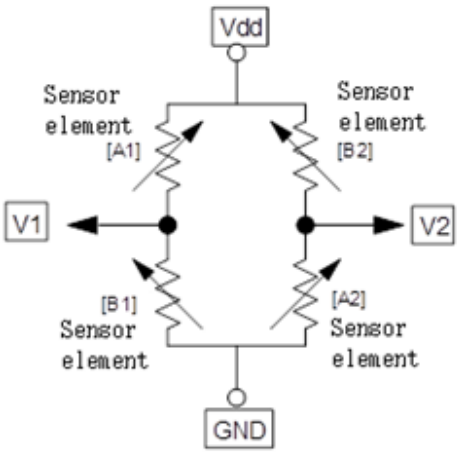
There are 1-phase output type, and 2-phase output type.

## 1-phaseoutput（HGARAMseries）

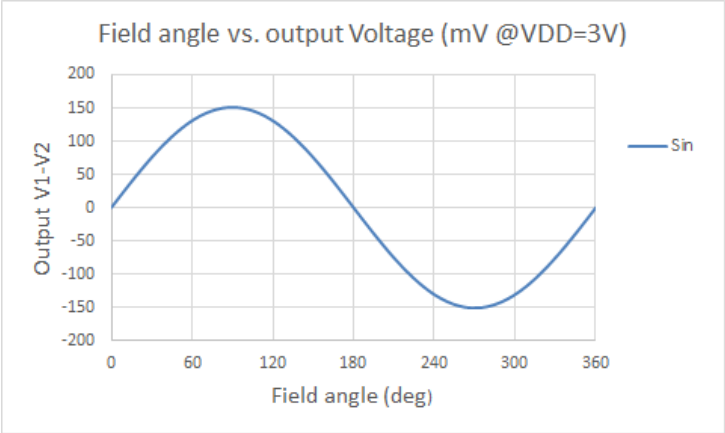
There is 1 bridge system inside.




Sensor PKG and sensing direction




Sensor bridge




HGAR can detect 360deg magnetic field angle.

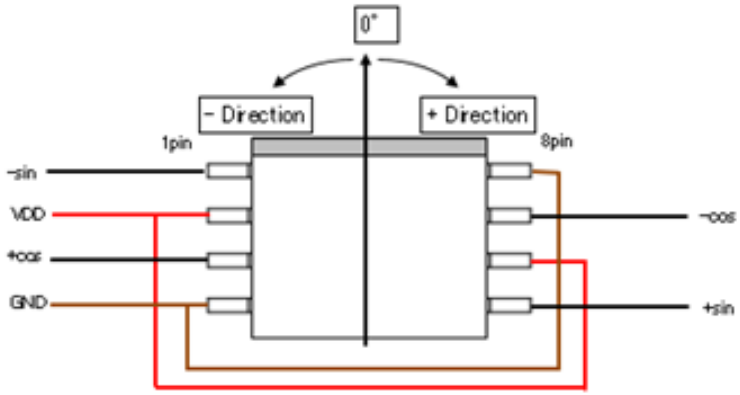
Output signal is Sin (or Cos) curve against magnetic field angle.

If the field strength is higher than saturation point (>20mT), output signal is defined only by field angle. (No effect from field strength.)

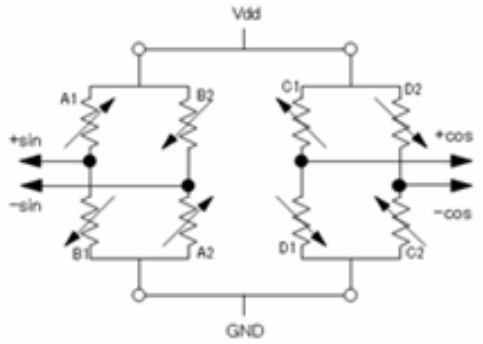
By using around±30deg area signal, raw signal is almost linear, so you can get the quasi linear angle information without any complex processing.

**2-phaseoutput（HGARAPseries）**

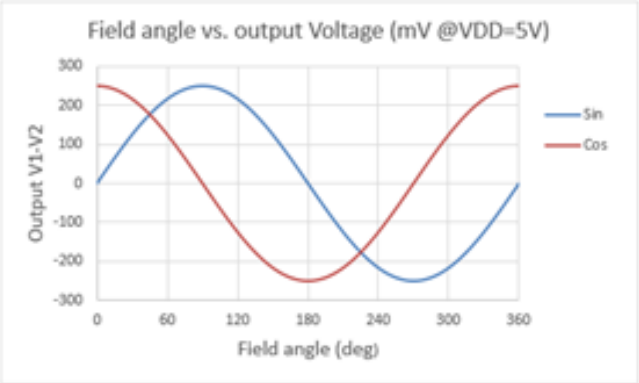
There are 2 MR bridge systems inside.

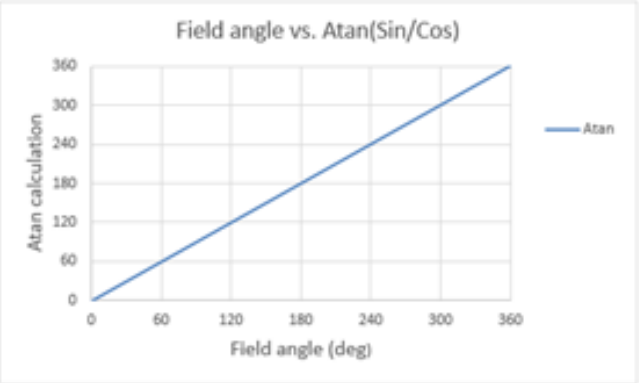



Sensor PKG and sensing direction




Sensor bridges




2-phase sensor output Sin and Cos signal against magnetic field angle.

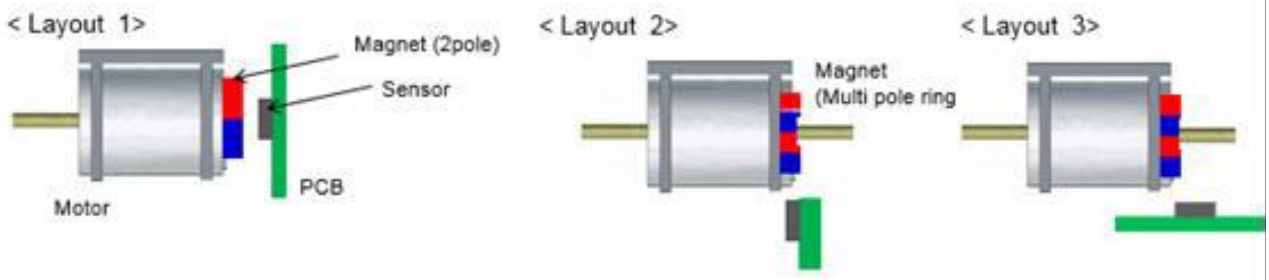
You can get absolute 360deg linear angle information after Atan(Sin/Cos) calculation.

**Application example for HGAR**

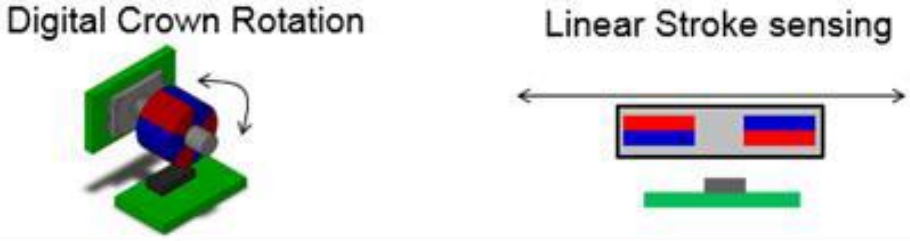
HGAR sensor can be used for various angle detection system.

Below are some examples.

<System example :Motor control>

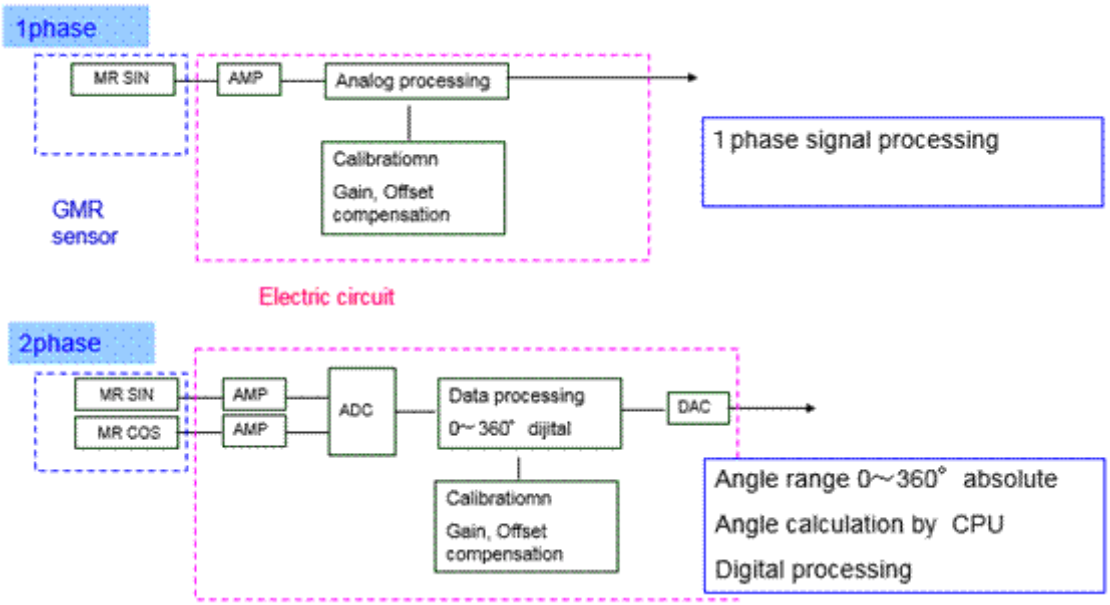



<System example :Input device>




**HGARsignal processing**

You can make signal processing circuit with HGAR MR sensor ,AMP and CPU board.



**HGAR output signal variation**

There are some variation factors.

・Amplitude(Gain)variation:
MR sensor has very small amplitude variation,
but you need to calibrate at initial assembly process.
・Offset variation:
MR sensor has very small offset variation,
but you need to calibrate at initial assembly process.
・Amplitude(Gain)change against temperature :
MR sensor has amplitude change temperature coefficient as about -3000ppm/℃.
System need to compensate this factor at low or high temperature at 1 phase system.
At 2 phase system, Sin and Cos coefficient is quietly matched,
So this factor is canceled during Atan(Sin/Cos) calculation.
・Offset drift against temperature :
MR sensor has very small offset drift.
So usually you do not care for this factor.

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