

# AMR4020V

## High Accuracy Analog Magnetic Scale Sensor

### Description

The AMR4020V fixed pitch magnetic scale sensor contains two push-pull Wheatstone bridges, each composed of four high-sensitivity anisotropic magnetoresistance (AMR) sensing elements. When the sensor moves along the length of the magnetic scale, the magnetic field changes caused by displacement, due to the alignment of the AMR elements with the magnetic pole width, result in the two Wheatstone bridges outputting two orthogonal sine wave signals. The period of the signal corresponds to the displacement of one magnetic pole width. Decoding these two sine wave signals allows for precise measurement of the relative displacement between the chip and the magnetic scale.

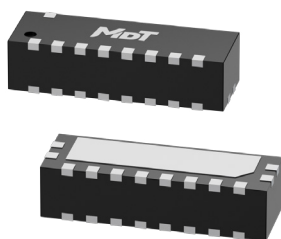
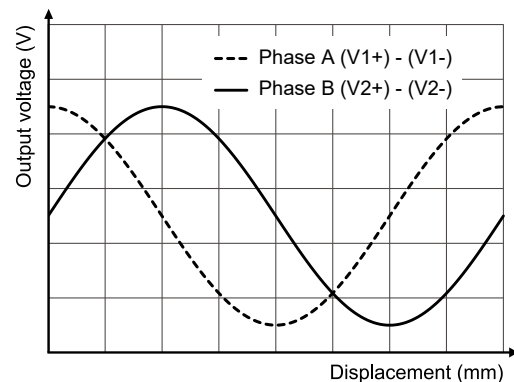
The internal structure of the sensor effectively compensates for the temperature drift, improving measurement accuracy in various application environments. The AMR4020V is housed in a small DFN21L (6 mm × 2 mm × 1.5 mm) package, with the magnetic sensing elements inside the sensor biased to one side of the package. This arrangement reduces the restrictions on the sensor's installation distance, making the structural design of the application system more flexible and facilitating assembly in confined spaces.

### Features and Benefits

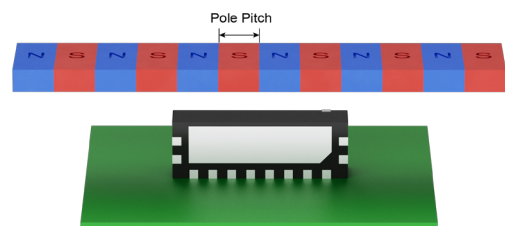
- Anisotropic magnetoresistance (AMR) technology
- Wide range supply voltages
- Large airgap tolerance
- Low saturation field
- Phase A and phase B analog output
- Excellent temperature stability
- High tolerance to external magnetic field interference
- RoHS & REACH compliant

### Applications

- Incremental or absolute encoder
- Linear or angular displacement encoder
- Magnetic scale and magnetic encoder



DFN21L



## Selection Guide

Part Number	Magnetic Pole Pitch	Output Channel	Operating Ambient Temperature	Package	Packing Form
AMR4020VD	2 mm	2	-40 °C to 125 °C	DFN21L	Tape & Reel

## Catalogue

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## 1. Functional Block Diagram

The sensor consists of a Wheatstone bridge structure made of anisotropic magnetoresistance (AMR), which enhances the output signal amplitude of the sensor and improves its temperature characteristics. The internal electrical connections of the sensor are shown in Figure 1.

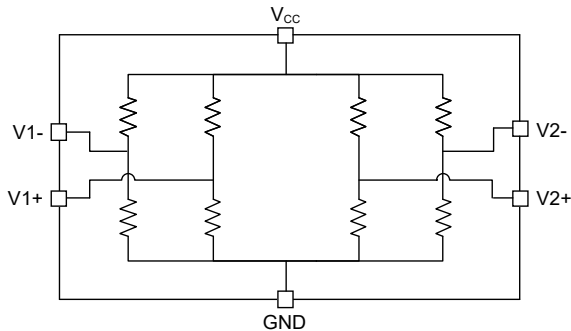


Figure 1. Block diagram

## 2. Application Schematics

The sensitive direction of the sensor is parallel to the X-Y plane of the package's silk-screened surface, as shown in Figure 2.



Figure 2. Sensing direction

When the sensor is placed in a suitable target magnetic field, the resistance of the internal AMR units changes due to different magnetic field directions, causing each of the two bridges to output a sine wave signal with a phase difference of 90 degrees (1/4 cycle). By processing these two sine wave signals, the displacement and direction of movement can be accurately detected.

Each output signal (V1 or V2) is a differential analog voltage signal, with each signal being output through two pins as indicated in the pin definition table.

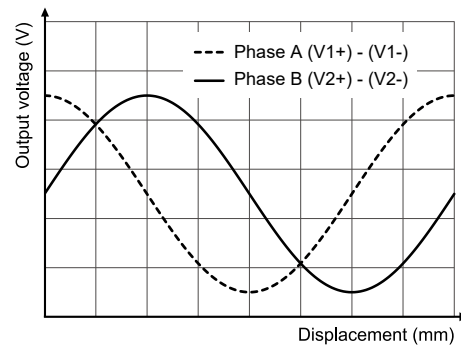


Figure 3. One Magnetic Pole Width Displacement Produces One Cycle Signal Output

## 3. Pin Configuration

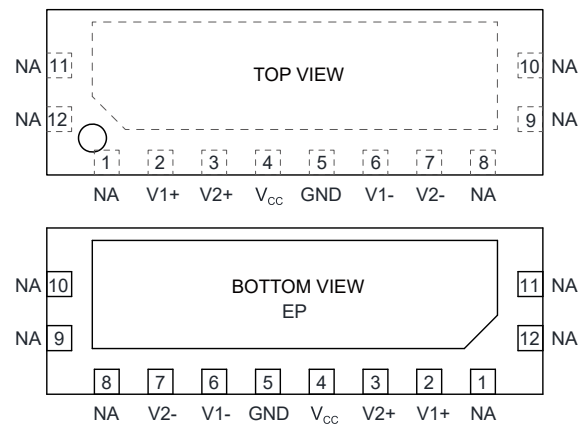


Figure 4. Pin configuration of AMR4020

Number	Symbol	Function
1	NA	-
2	V1+	Phase A signal positive output
3	V2+	Phase B signal positive output
4	V <sub>CC</sub>	Power supply
5	GND	Ground
6	V1-	Phase A signal negative output
7	V2-	Phase B signal negative output
8	NA	-
9	NA	[1]
10	NA	-
11	NA	-
12	NA	[1]
-	EP	Heat dissipation

Note: Pin 9, pin 12 and EP are connected inside the sensor.

## 4. Absolute Maximum Ratings

Parameters	Symbol	Min.	Max.	Unit
Supply voltage	$V_{CC}$	-9	9	V
Magnetic flux density	$B$	-	1500	Gs <sup>1)</sup>
Operating ambient temperature	$T_A$	-40	125	°C
Storage ambient temperature	$T_{STG}$	-40	150	°C

## 5. Electrical Specifications

$V_{CC} = 5\text{ V}$ ,  $T_A = 25\text{ °C}$ , a 0.1  $\mu\text{F}$  capacitor is connected between  $V_{CC}$  and GND

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Supply voltage	$V_{CC}$	Operating	-	5	9	V
Bridge resistance <sup>2)</sup>	$R_B$	$B = 0\text{ Gs}$ , $T_A = 25\text{ °C}$	-	1.8	-	$k\Omega$
Temperature coefficient of bridge resistance <sup>3)</sup>	$TCR_B$	$T_1 = -40\text{ °C}$ , $T_2 = +125\text{ °C}$	-	0.23	-	$\%/^{\circ}\text{C}$
Output amplitude <sup>4)</sup>	$V_{PEAK}$	$V_{CC} = 5\text{ V}$ , $T_A = 25\text{ °C}$	9	11	13	mV/V
Temperature coefficient of output amplitude <sup>5)</sup>	$TCV_{PEAK}$	$T_1 = -40\text{ °C}$ , $T_2 = +125\text{ °C}$	-	-0.4	-	$\%/^{\circ}\text{C}$
Offset <sup>6)</sup>	$V_{OFFSET}$	$V_{CC} = 5\text{ V}$ , $T_A = 25\text{ °C}$	-1	0	+1	mV/V
Temperature coefficient of offset <sup>7)</sup>	$TCO$	$T_1 = -40\text{ °C}$ , $T_2 = +125\text{ °C}$	-5	0	+5	$\mu\text{V}/\text{V}/^{\circ}\text{C}$

Note:

- 1 Gauss in air = 0.1 millitesla = 79.8 A/m
- 2) Resistance between V1+ and V1-. Resistance between V2+ and V2-. Resistances can be customized upon request.

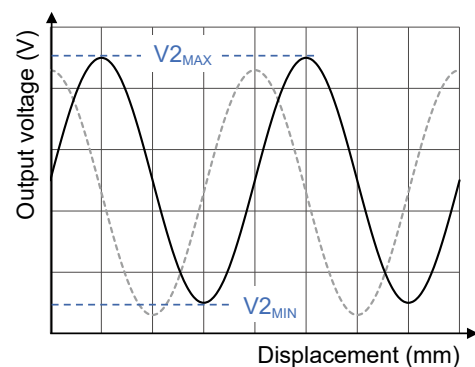
$$3) \quad TCR_B = \frac{R_B(T_2) - R_B(T_1)}{R_B(T_1) \times (T_2 - T_1)} \times 100\%$$

$$4) \quad V_{PEAK} = \frac{V_{MAX} - V_{MIN}}{2}$$

$$5) \quad TCV_{PEAK} = \frac{V_{PEAK}(T_2) - V_{PEAK}(T_1)}{V_{PEAK}(T_1) \times (T_2 - T_1)} \times 100\%$$

$$6) \quad V_{OFFSET} = \frac{V_{MAX} + V_{MIN}}{2}$$

$$7) \quad TCO = \frac{V_{OFF}(T_2) - V_{OFF}(T_1)}{T_2 - T_1}$$



## 6. Application Information

### 6.1 Application and Output Voltage Amplitude

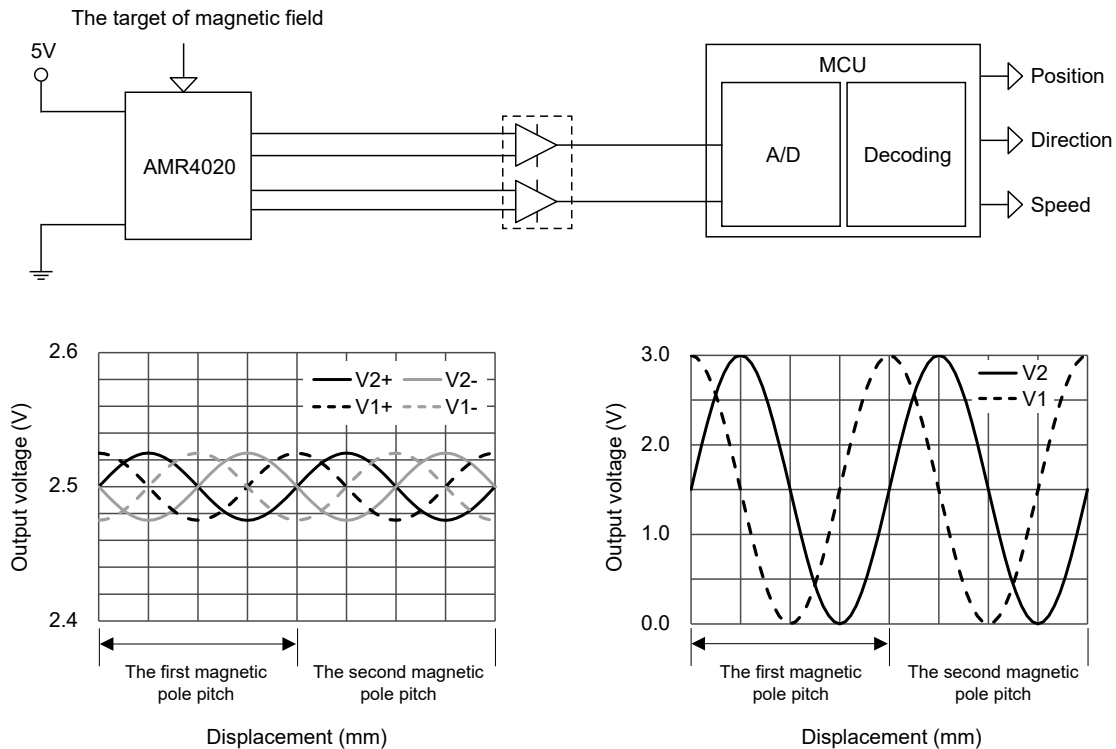


Figure 5. Operational amplifier that converts signal from single channel differential output signal to differential and adjust amplitude to input to A/D

### 6.2 Installation Requirements and Measurement Accuracy

To ensure signal quality, the sensor usually needs to be installed within an acceptable airgap (airgap < 50 % of magnetic pole pitch) such that the internal AMR sensor elements operate in a saturated field (magnetic field at sensor surface  $\geq 200$  Gs).

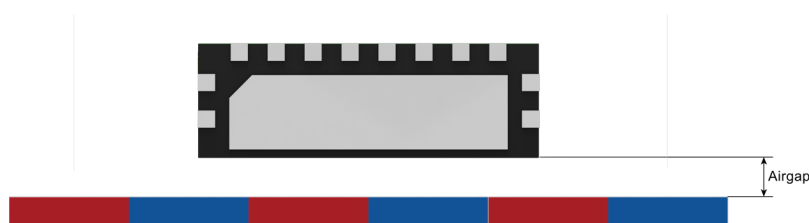


Figure 6. Relative position of the AMR4020 and magnetic scale

When properly installed, changes to airgap during operation will not affect the quality of the output signal. The measurement accuracy of the solution closely depends on factors including accuracy of the magnetic scale, magnetic pole pitch, installation and operating conditions, and analog signal processing. Usually, absolute accuracy of  $10 \mu\text{m}$  to  $50 \mu\text{m}$  is a realistic goal for system design.

## 7. Dimensions

### DFN21L Package

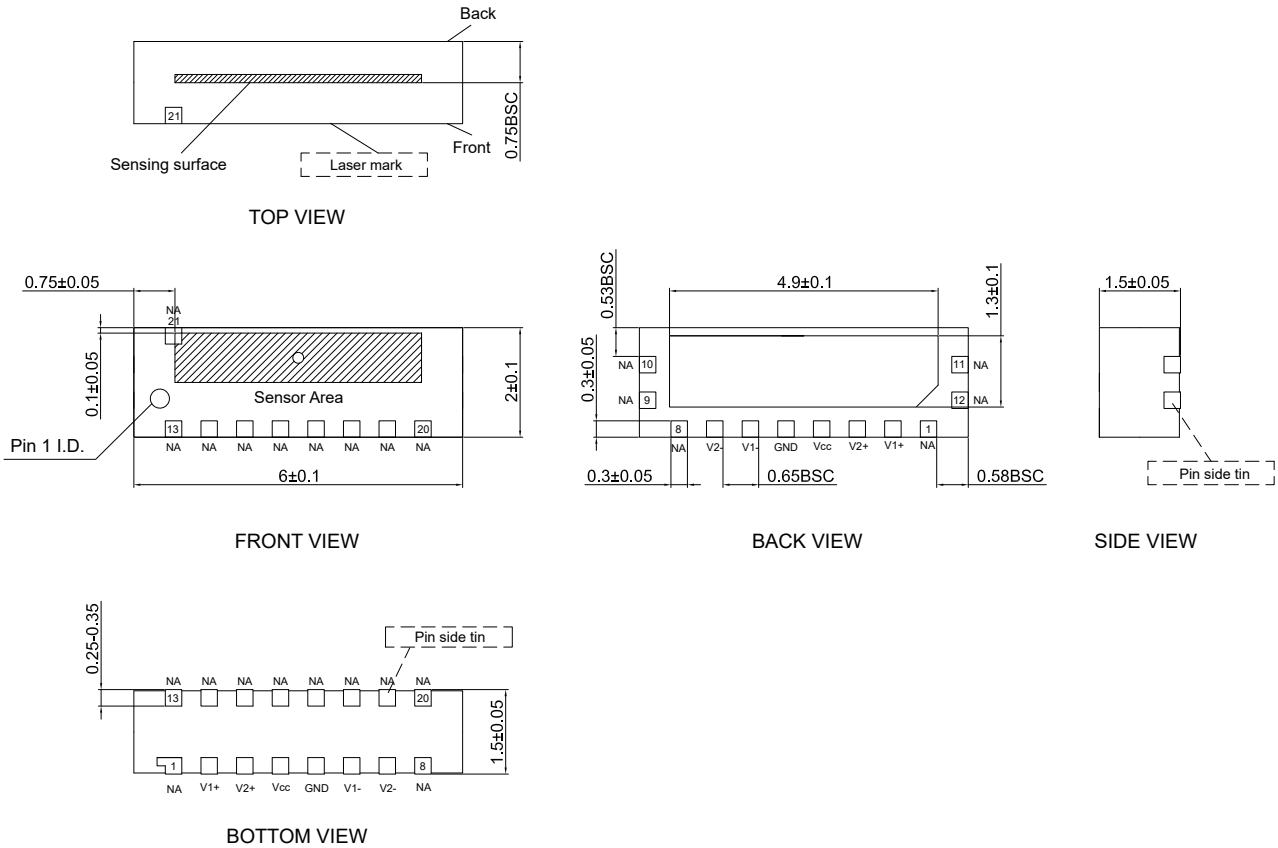


Figure 7. DFN21L package outline of AMR4020 (unit: mm)

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