TMR3022

High Performance Automotive TMR Angle Sensor

Description

The TMR3022 angle sensor is designed with two sets of redundant Wheatstone bridge structures, each consisting of four high-sensitivity tunneling magnetoresistance (TMR) sensor elements, forming two sets of half-bridge structures that separately output SIN single-ended voltage and COS single-ended voltage. The Wheatstone bridge structure of the TMR effectively compensates for the sensor's temperature drift.

A magnet is placed above the TMR3022 to provide a working magnetic field parallel to the surface of the chip. When the magnet rotates, the chip outputs a voltage signal that is a sine and cosine related to the angle of the magnetic field.

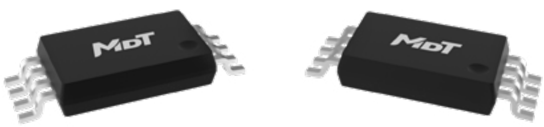
The redundant design of the TMR3022 improves the robustness of the application system. The TMR3022 achieves very low angle error when the magnetic field is maintained within the range of within 200 Gs to 800 Gs. The sensor is available in the TSSOP8 package.

Features and Benefits

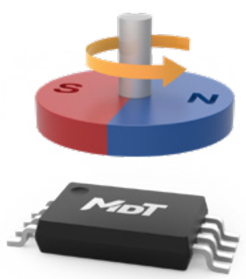
- Tunneling magnetoresistance (TMR) technology
- Two sets of redundant SIN/COS single-ended voltage outputs
- Wide range supply voltage
- Excellent temperature stability
- Excellent resistance to external magnetic field interference
- Single-chip redundancy with 4 half-bridges
- Compliant with the AEC-Q100 standard for automotive
- RoHS and REACH compliant

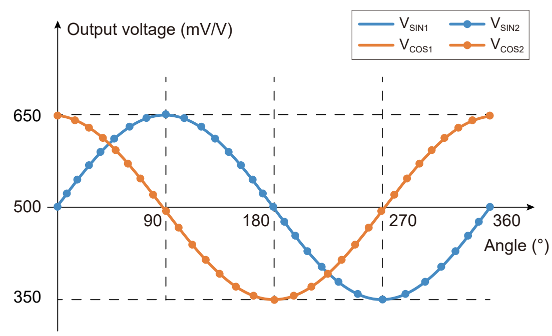
Applications

- Absolute angle sensor
- Electric power steering motor shaft angle sensor
- Steering wheel angle sensor
- Pedal position sensor
- Throttle position sensor



TSSOP8





Selection Guide

Part Number	Output	Supply Voltage	Peak Voltage Output	Package	Packing Form
TMR3022TP	Dual analog single ended	1.0 V to 5.5 V	300 mV/V	TSSOP8	Tape & Reel

Catalogue

1. Functional Block Diagram

The TMR3022 series consist of TMR (tunneling magnetoresistance) Wheatstone bridge structures, which enhance the sensor's output signal amplitude, improve the temperature characteristics of the sensor, and enhance the sensors' anti-interference performance. The redundant design enhances the robustness of the application. The functional block diagram of the TMR3022 is shown in Figure 1.

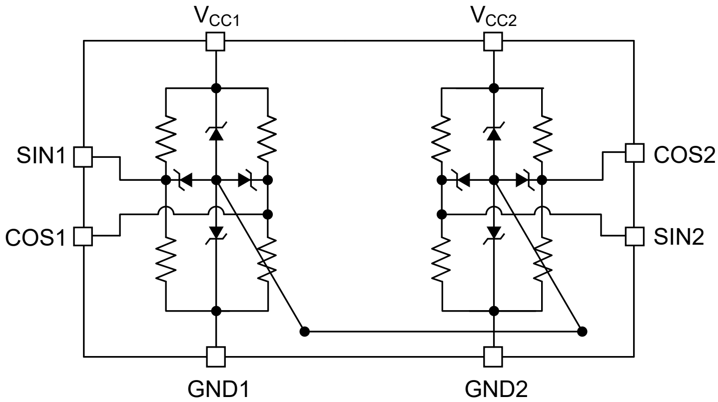


Figure 1. TMR3022 functional block diagram

2. Pin Configuration

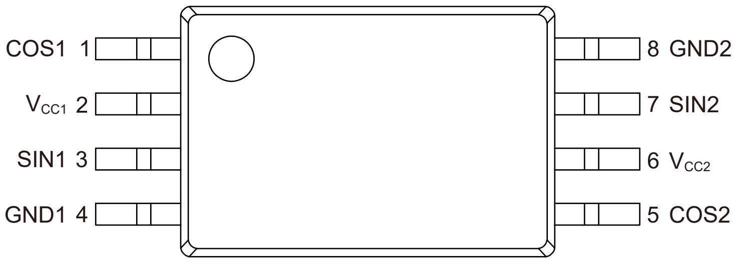


Figure 2. Pin configuration (TSSOP8)

Number	Name	Function
1	COS1	Channel 1 COS signal output
2	V_{CC1}	Chanel 1 bridge supply voltage
3	SIN1	Channel 1 SIN signal output
4	GND1	Channel 1 bridge ground
5	COS2	Channel 2 COS signal output
6	V_{CC2}	Chanel 2 bridge supply voltage
7	SIN2	Channel 2 SIN signal output
8	GND2	Channel 2 bridge ground

3. Operating Principle

The sensing direction is parallel to the chip surface as shown in Figure 3.

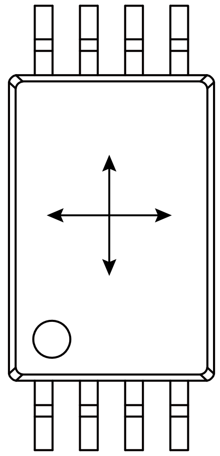


Figure 3. Sensing direction (TSSOP8)

By rotating a small magnet placed on top of TMR3022, a rotating magnetic field parallel to the surface of the magnetic is generated and is at the same angle as the magnet. Figure 4 shows the typical output signals of the TMR3022 in response to a rotating field.

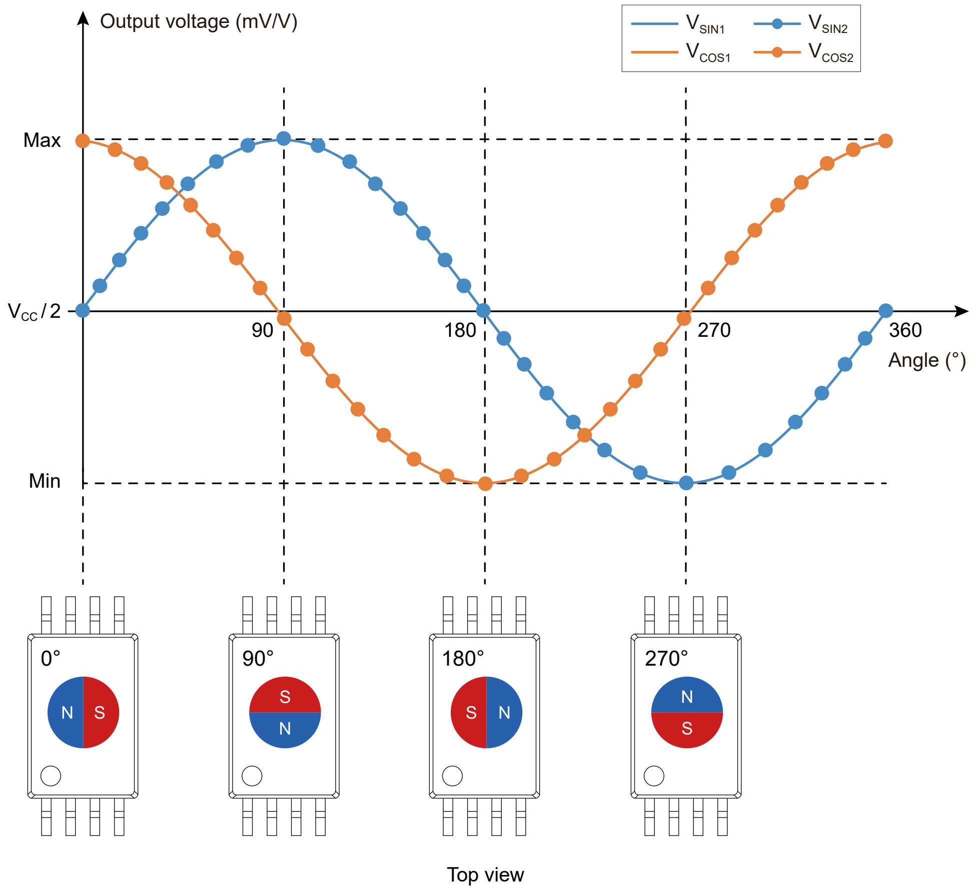


Figure 4. Typical TMR3022 output curve in response to magnet

4. Absolute Maximum Ratings

Parameters	Symbol	Min.	Max.	Unit
Supply voltage	V_{CC}	-	6.5	V
Magnetic flux density	B	-	4000	Gs
ESD performance (HBM)	$V_{ESD(HBM)}$	-	4000	V
ESD performance (CDM)	$V_{ESD(CDM)}$	-	750	V
Operating ambient temperature	T_A	-40	150	°C
Storage ambient temperature	T_{STG}	-55	150	°C
Reflow temperature	T_{reflow}	-	260	°C

Note: The absolute maximum rating only lists the conditions under which the sensors are not permanently damaged. For normal operations please refer to Specifications.

5. Electrical Specifications

V_{CC} = 5 V, T_A = 25 °C, a 0.1 μF capacitor is connected between V_{CC} and GND unless specified otherwise

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Supply voltage	V_{CC}	operating	1.0	5.0	5.5	V
Bridge resistance	R_B	T_A = 25 °C, B = 200 Gs	3	5	7	kΩ
Peak voltage	V_{PEAK}	T_A = 25 °C, B = 200 Gs	0.135	0.15	0.1675	V/V
Peak to peak voltage	V_{PP}	T_A = 25 °C, B = 200 Gs	0.27	0.3	0.335	V/V
Bias voltage	Vbias	See Section 6.3	-	$V_{CC}/2$	-	mV/V
Offset voltage	V_{OFFSET}	T_A = 25 °C, B = 200 Gs	-5	-	5	mV/V
Angle error 1)	Δθ	T_A = -40 °C to 150 °C, B = 200 Gs to 300 Gs	-	-	1.2	deg
		T_A = -40 °C to 150 °C, B = 300 Gs to 800 Gs	-	-	1	deg
		T_A = -40 °C to 150 °C, B = 800 Gs to 1200 Gs	-	-	1.2	deg
Phase error	-	T_A = 25 °C, B = 200 Gs	87	90	93	deg
Hysteresis	Hyst	T_A = 25 °C, B > 200 Gs	-	0	-	Gs
Peak synchronization coefficient	k	T_A = 25 °C, B = 200 Gs	95	100	105	%
Temperature coefficient of peak voltage	TCV_{PEAK}	T_A = -40 °C to 150 °C, B = 200 Gs to 800 Gs	-0.2	-0.15	-0.075	%/°C
Temperature coefficient of bridge resistance	TCR_B	T_A = -40 °C to 150 °C, B = 200 Gs to 800 Gs	-0.07	-0.05	-0.03	%/°C
Temperature coefficient of peak synchronization coefficient	TCk	T_A = -40 °C to 150 °C, B = 200 Gs to 800 Gs	-0.02	-	0.02	%/°C
Temperature coefficient of offset voltage	TV_{OFFSET}	T_A = -40 °C to 150 °C, B = 200 Gs to 800 Gs	-1.5	-	1.5	mV/V

Note: 1) The angle error is defined as the angle error from zero point to peak value.

6. Specification Definitions

6.1 Bridge resistance R_B

The resistance between pins V_{CC1} and GND1 or the resistance between pins V_{CC2} and GND2

6.2 Peak peak voltage V_{PP}, Peak voltage V_{PEAK}

$$V_{PP} = V_{Max} - V_{Min} \qquad V_{PEAK} = \frac{V_{Max} - V_{Min}}{2}$$

6.3 Bias voltage Vbias

$$Vbias = \frac{V_{Max} + V_{Min}}{2}$$

6.4 Offset voltage V_{OFFSET}

$$V_{OFFSET} = \frac{V_{Max} + V_{Min}}{2} - \frac{V_{CC}}{2}$$

6.5 Peak synchronization coefficient k

$$k = \frac{V_{COS\ (PEAK)}}{V_{Sin\ (PEAK)}}$$

6.6 Temperature coefficient of peak voltage TCV_{PEAK}

$$TCV_{PEAK} = \frac{V_{PEAK}(T2) - V_{PEAK}(T1)}{V_{PEAK}(25°C) \times (T2-T1)} \times 100\%$$

$T1 = T_A(Min) = -40°C$, $T2 = T_A(Max) = 150°C$

6.7 Temperature coefficient of bridge resistance TCR_B

$$TCR_B = \frac{R_B(T2) - R_B(T1)}{R_B(25°C) \times (T2-T1)} \times 100\%$$

$T1 = T_A(Min) = -40°C$, $T2 = T_A(Max) = 150°C$

6.8 Temperature coefficient of peak synchronization coefficient TCk

$$TCk = \frac{k(T2) - k(T1)}{(T2-T1)} \times 100\%$$

$T1 = T_A(Min) = -40°C$, $T2 = T_A(Max) = 150°C$

6.9 Temperature coefficient of offset voltage TV_{OFFSET}

$$TV_{OFFSET} = V_{OFFSET}(T2) - V_{OFFSET}(T1)$$

$T1 = T_A(Min) = -40°C$, $T2 = T_A(Max) = 150°C$

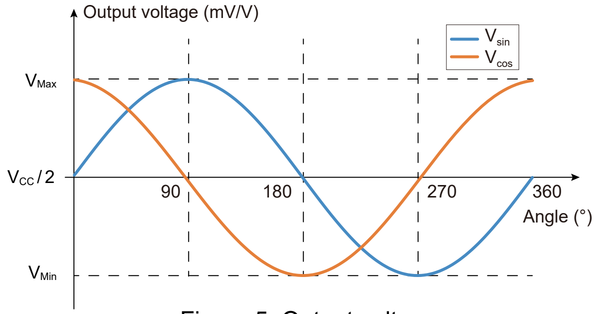


Figure 5. Output voltage

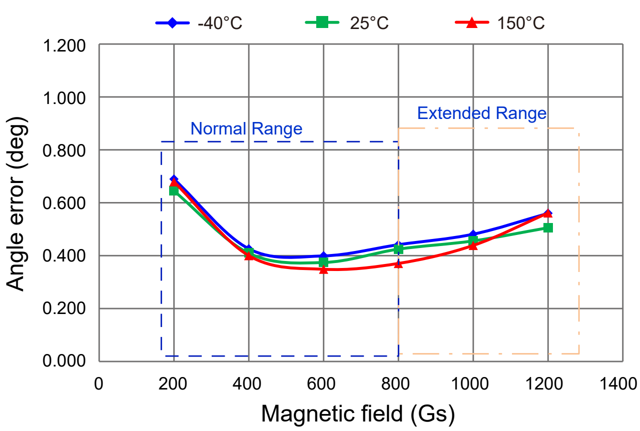


Figure 6. Magnetic field diagram

7. Dimensions

TSSOP8 Package

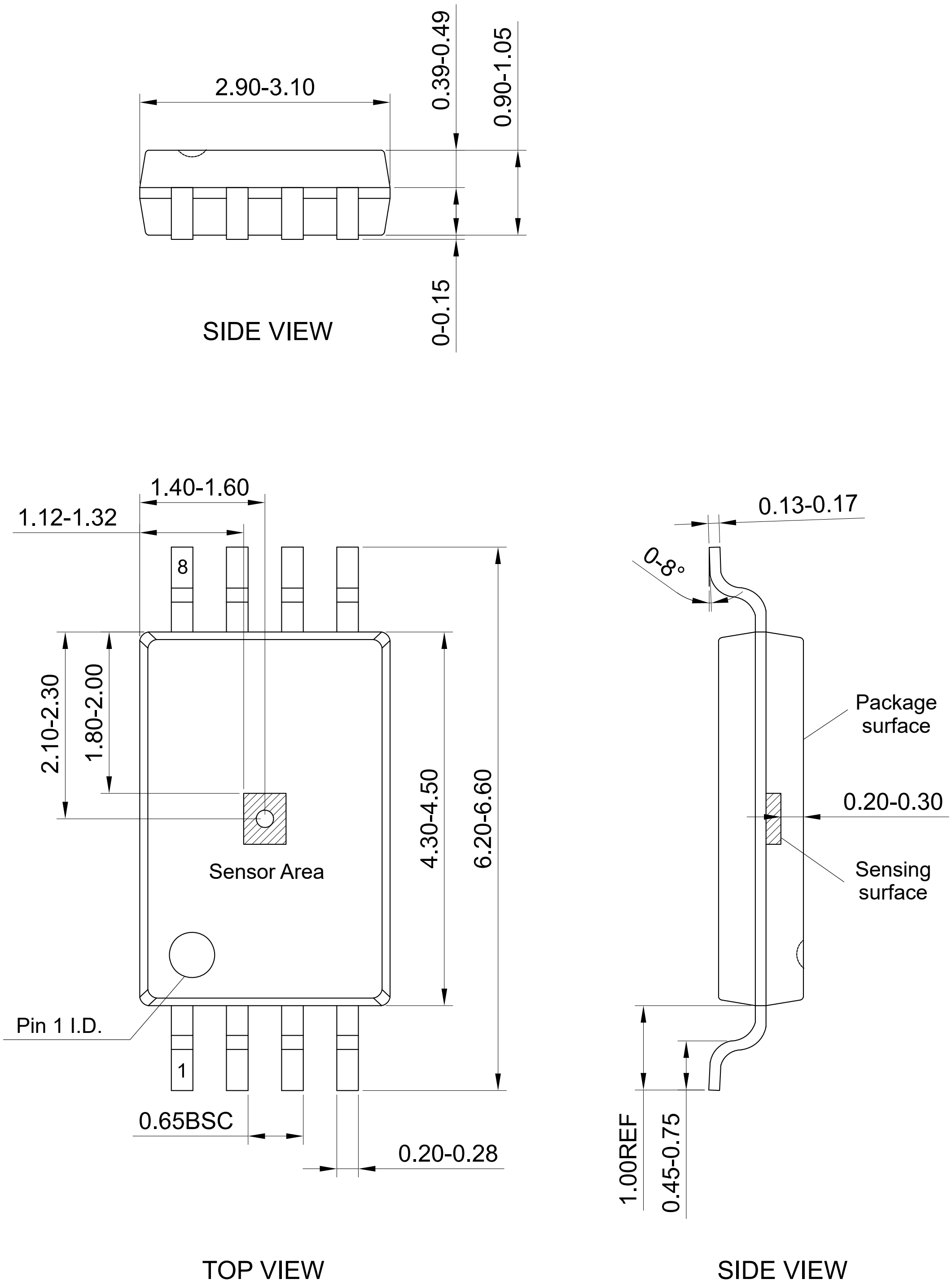


Figure 7. Package outline of TSSOP8 (unit: mm)

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