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TAA/TAB Series

High-Precision TMR Angle Sensors with Amplified Analog Output

Based on the Tunnel Magneto-Resistive (TMR) effect, the TAA/TAB series comprises highly sensitive analog sensors. They are able to measure angles up to 360° with high accuracy and stability in a wide range of temperature and magnetic-field variations.

TAB4140 and TAA6140 are pure TMR bridge angle sensors providing redundant SIN/COS outputs. They also include an output amplification, well suited for remote applications.

In combination with a microcontroller and a small piece of software, these sensors offer outstanding angular measurement performance in industrial and safety-critical automotive applications.

TMR Basic Principles

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Tunnel Magneto-Resistance (TMR) sensors exploit a special form of the Magneto-Resistive (MR) effect based on quantum-mechanical processes. The MR effect appears when the change of a magnetic field applied to a conductive material leads to a change in its electrical resistance, thus transducing a magnetic stimulation into an electrical response.

In a TMR element, a stack of magnetic material is separated by an electrical insulator – the so-called tunnel barrier – into two overlapping layers (see Fig. 1–1). One of these magnetic layers (the "pinned" layer) is processed to show a well aligned in-plane magnetization that is invariant when exposed to external magnetic fields. In contrast, the magnetization of the other magnetic layer (the "free" layer) is flexible and can be modified by applying external magnetic fields. Applying a voltage between the two magnetic layers causes a current flowing (tunneling) through the barrier layer, whereas the resistance depends on the degree of magnetization of the free layer and its orientation with respect to the pinned layer: When both free and pinned layer magnetization orientations point in the same direction, the resistance is minimal, while opposite magnetization directions evoke maximum resistance. A TMR sensor is composed of a number of individual TMR elements forming the four branches of a Wheatstone bridge, where the fixed layers of the elements within each branch are identically aligned.

Applying a rotating magnetic field in the plane of the Wheatstone bridge allows to tap periodic voltage signals from the two bridges that are phase-shifted by 90° (see Fig. 1–2). These four signals finally allow to unambiguously extract the orientation of the stimulating field, i.e., the angular position of the rotating permanent magnet.

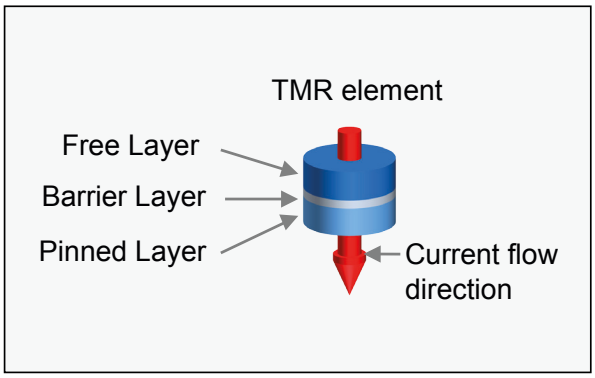

Fig. 1–1: TMR element

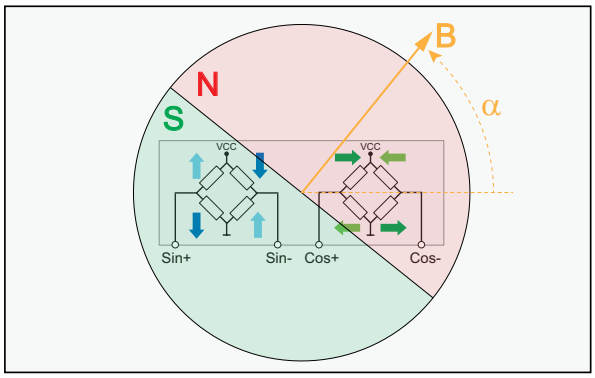

Fig. 1–2: Wheatstone bridge structure of TAS214x

General TMR Features

- High output at 1.5 V_{PP} / 3.0 V_{PP} @ 5 V (Analog output sensor TAS2141 / TAS2143)
- Good angular accuracy of ±0.6 deg. (1.5 V_{PP} differential output @ 5 V), ±0.8 deg. (3.0 V_{PP} differential output @ 5 V) (Analog output sensor TAS2141 / TAS2143)
- Low temperature drifts
- Low power consumption
- Detections can be made from 0 to 360°

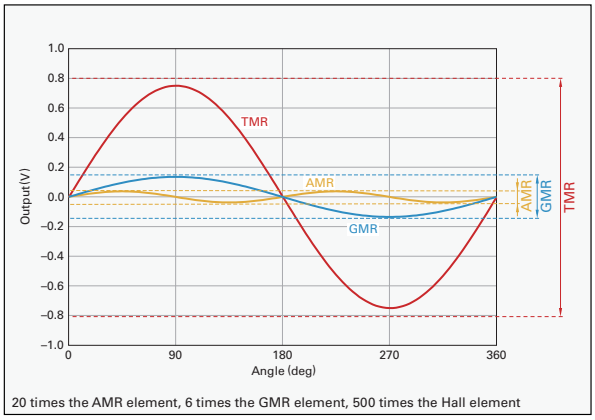

Fig. 2–1: Output wave pattern comparison TAS2141-AAAB (1.5 V_{PP} differential output)

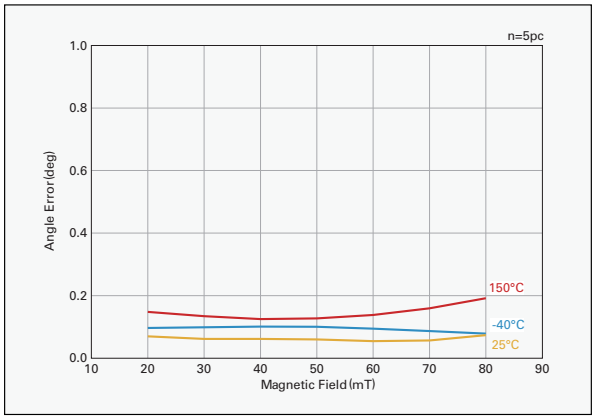

Fig. 2–2: Angle error graph TAS2141-AAAB (1.5 V_{PP} differential output)

TAB4140-BAAB

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Fourfold Full-Bridge TMR Angle Sensors with Single-Ended Amplifier/Differential Output

Application Examples

TAB4140-BAAB is the optimal system solution for applications, such as:

- EPS motor-shaft angle sensor
- Steering Wheel Angle Sensor
- Pedal Position Sensor
- Throttle Position Sensor

Features

- Redundant TMR-Sensors with integrated amplifiers for safety critical applications
- Single-ended Amplifier/Differential output (Sin+/Sin-/Cos+/Cos-)
- High reliability and low FIT rates allow operation in safety-critical applications
- In combination with simple algorithms running in micro-controllers, the remaining very low angular errors can be compensated and allows to be operated in the entire magnetic-field range without any changes in angular precision.

Physical Characteristics

- Supply voltage range: 3 V to 5.5 V
- Current consumption: 9.0 mA at 5 V (typical value)
- Wide temperature range: –40 °C to +150 °C
- Wide magnetic field range:
  - 20 mT to 80 mT (standard range)
  - 80 mT to 120 mT (extended range)
- Angle accuracy: ±0.6 deg. at standard range
- TSSOP16 package
- AEC-Q100 qualified

Benefits

- Sensor operation with harness can be supported
- Fast response, high angular accuracy suitable for fast and accurate motor control applications
- Very stable position measurement (over temperature and lifetime) – no need for re-calibration
- Integrated amplifier reduces BOM and application cost
- Completely independent between sensor1 and sensor2

TAA6140-BAAA

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Sixfold Full-Bridge Angle Sensor
with Differential Amplifier/Single-ended Output

Application Examples

TAA6140 is the optimal system solution for safety-critical applications, such as:

- Absolute Rotary Angle Sensor
- EPS Motor-shaft Angle Sensor
- Steering Wheel Angle Sensor
- Pedal Position Sensor
- Throttle Position Sensor

Features

- Three independent TMR sensors with integrated amplifiers provide high redundancy
- Differential Amplifier/Single-ended output (Sin/Cos)
- High reliability and low FIT rates allow operation in safety-critical applications
- In combination with simple algorithms running in microcontrollers, the remaining very low angular drift over temperature can be compensated and allows to be operated in the entire magnetic-field range without any changes in angular precision.

Physical Characteristics

- Recommended supply voltage range: 4.5 V to 5.5 V
- Current consumption: 17.3 mA at 5 V (maximum value)
- Wide temperature range: –40 °C to +150 °C
- Wide magnetic-field range:
  - 20 mT to 80 mT (standard range)
  - 80 mT to 120 mT (extended range)
  - higher magnetic fields with restrictions
- Angle accuracy: ±0.8 deg. at standard range
- TSSOP16 package
- AEC-Q100 qualified

Benefits

- Sensor signals prepared for simple read-out by ADC
- Fast response, high angular accuracy suitable for fast and accurate motor control applications
- Very stable position measurement (over temperature and lifetime) – no need for re-calibration
- Integrated amplifier reduces BOM and application cost
- Sensor is optimized for safety-critical applications

Internal Circuitry

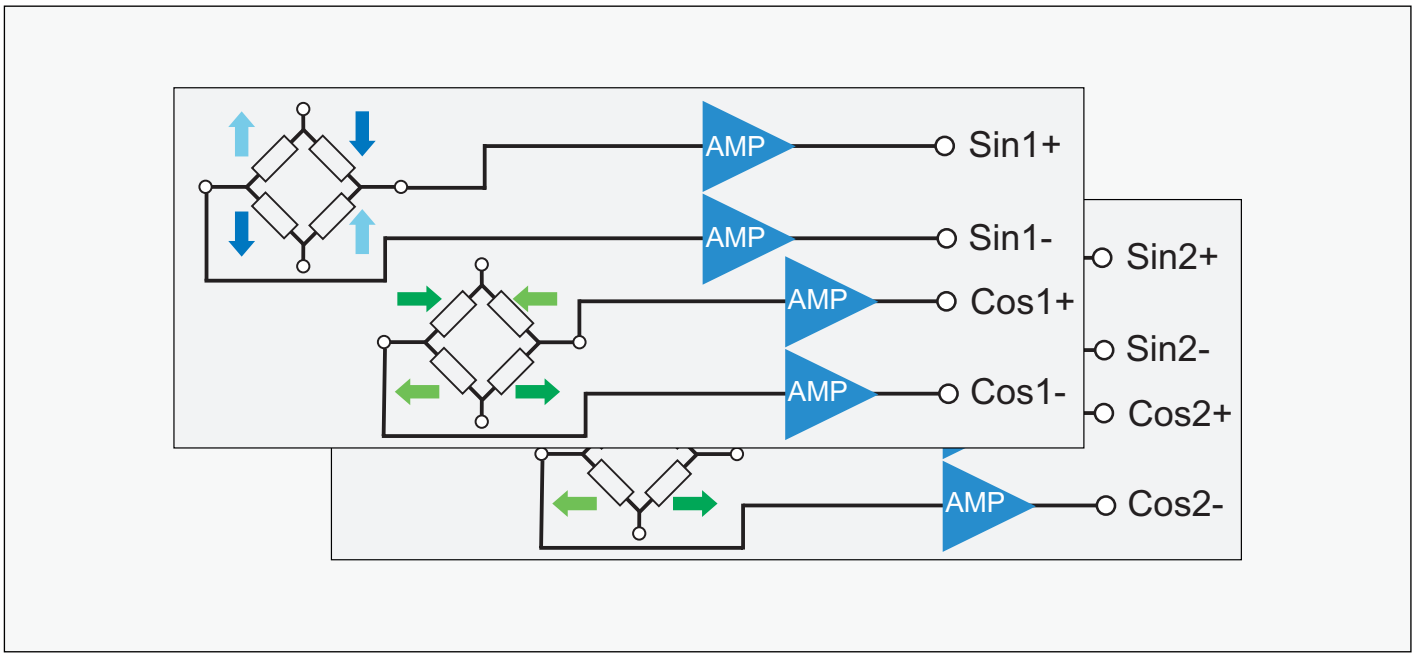

Fig. 3: Internal circuitry of TAB4140 (two dies)

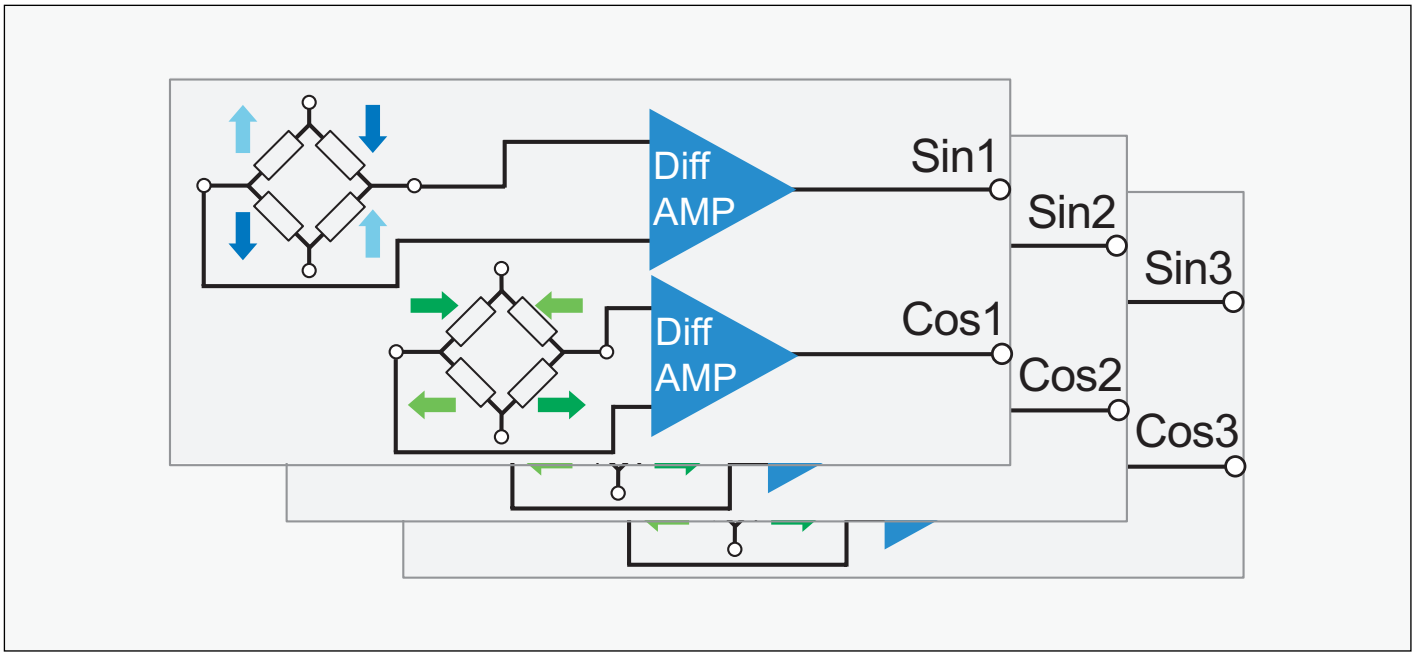

Fig. 4: Internal circuitry of TAA6140 (three dies)

Direction of pinned layer magnetization

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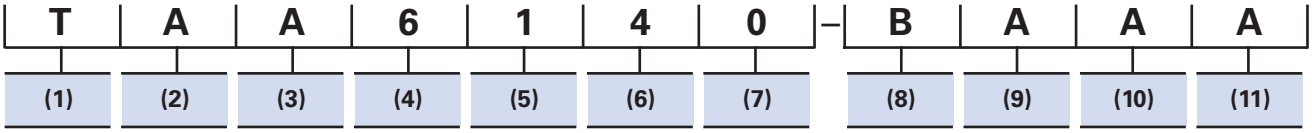
Part Number Construction



(1) Sensor technology

T	TMR

(2) Typical application

A	Angle

(3) Sensor type

A/B	AMP Differential

(4) Bridge/System

2	2
4	4
6	6

(5) Bridge type

1	Full bridge

(6) Sensing axis

4	XY

(7) Internal code

0	0
1	1
2	2
3	3

(8) Sensor package

B	TSSOP16

(9) Grade

A	Automotive

(10) Specials

A	None

(11) Product internal code

A	1
B	2

Product Lineup

Product Name	Output @5 V	Sensor technology	Typical application	Sensor type	Bridge/ System	Bridge type	Sensor axes	Internal code	Sensor package	Grade	Specials	Product Internal code
TAB4140-BAAB	3.0 V_{PP} (Support redundant system)	TMR	Angle	Ampli-fied	4	Full bridge	XY	0	TSSOP16	Automotive	none	1 for TAA6140 2 for TAB4140
TAA6140-BAAA	3.0 V_{PP} (Support redundant system)				6			0	TSSOP16			

Dimension, Packaging Information

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TSSOP16

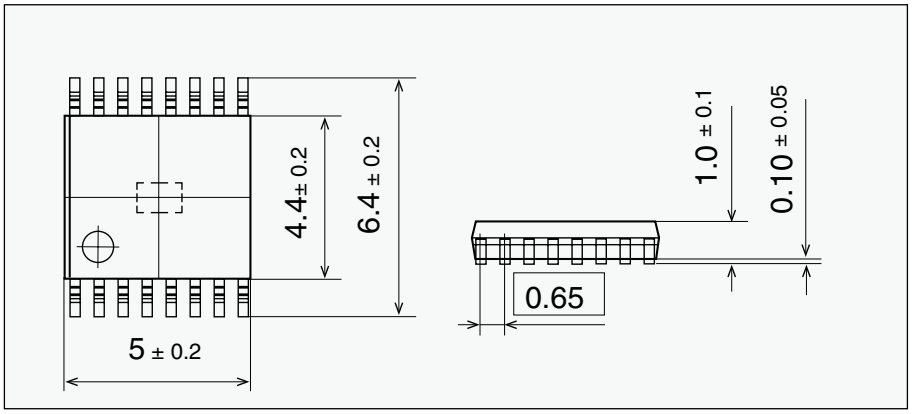

Fig. 6: TSSOP16 package

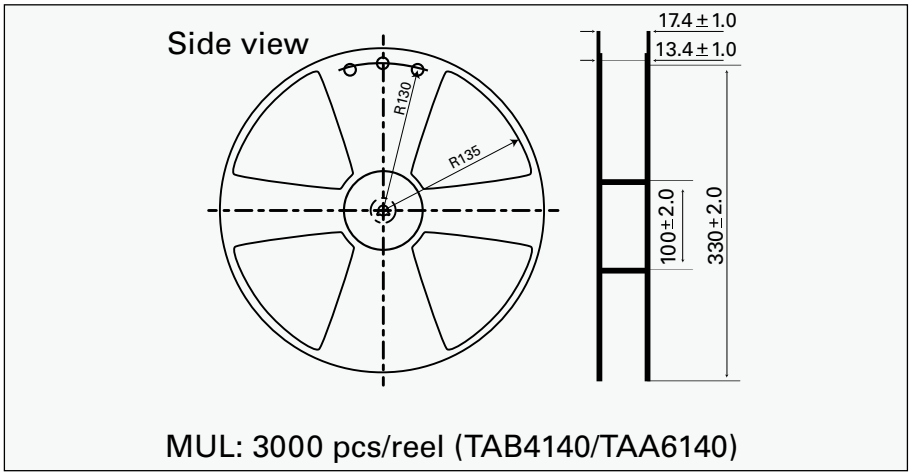

Fig. 7: Reel specifications (TSSOP16 package)

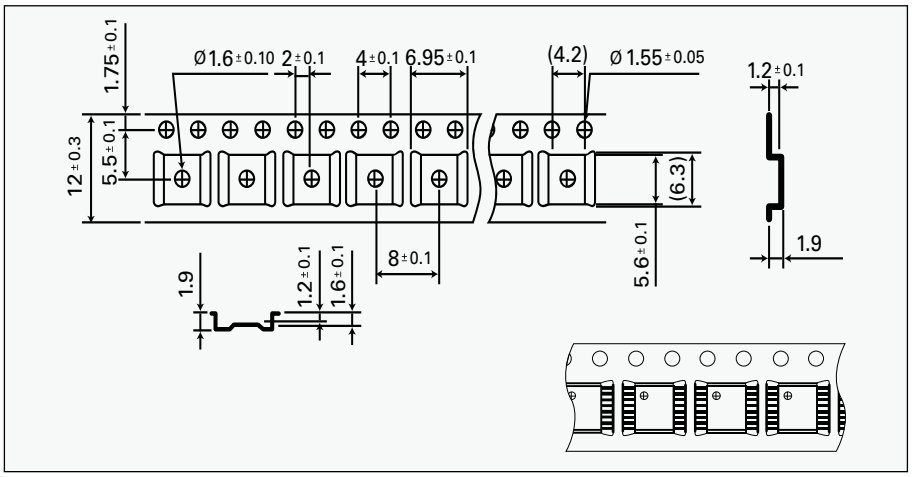

Fig. 8: Carrier tape specifications (TSSOP16 package)