Selection Guide for Automotive and Industrial Applications

TMR Sensors
TAS 214x, TAS 414x
TMR-Bridge Angle Sensor for Position Sensing Applications

TAS 214x and TAS 414x are pure TMR-bridge angle sensors which allow absolute angle measurement of up to 360°. Based on the Tunnel Magneto-Resistive (TMR) effect, they offer high sensitivity and best angle accuracy needed for demanding automotive applications. Stability in a wide range of temperature, supply voltage and magnetic field variations is also achieved. In combination with a microcontroller and a small piece of software these sensors offer outstanding angular measurement performance.

**Features**
- Specialized angle sensor for use under harsh environmental conditions.
- High reliability and low FIT rates allow operation in safety-critical applications
- Simple circuitry and low number of external components allow fast and easy development.
- Diagnostic capability through direct monitoring of the sensor elements.
- 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 complete magnetic field range without any changes in angular precision.

**Physical Characteristics**
- Recommended supply voltage range: 3 V to 5.5 V
- Current consumption: 2 mA / 4 mA at 5 V
- Wide temperature range: −40 °C to +150 °C
- Wide magnetic field range:
  - 20 mT to 80 mT (standard range)
  - 20 mT to 120 mT with lower accuracy
  - higher magnetic fields with restrictions
- Angle accuracy: ±0.6 to 0.8 deg.

**Benefits**
- Very high output differential voltages (1.5 V<sub>pp</sub> or 3.0 V<sub>pp</sub>) at V<sub>SUP</sub> = 5 V, allow direct connection to ADCs and provide high signal resolution over temperature
- Simple IC-controlled read-out of analog voltages
- Compliant to ISO 26262: supports ASIL D on system level (TAS 414x).
- No external trimming components required
- Suitable for operation with wide range of supply voltages
- Small single-mold packages available:
  - TSSOP8 for TAS 214x
  - TSSOP16 and QFN16 for TAS 414x
- AEC-Q100 qualified

**Typical Applications**
- Absolute rotary angle sensor
- EPS motor-shaft angle sensor
- EPS angle sensor
- Throttle position sensor
- Resolver replacement
TAS 214x, TAS 414x

Pin connections of TAS 214x and TAS 414x

Internal circuitry of TAS 214x and TAS 414x

Packages of TAS 214x and TAS 414x
TAD 2140 and TAD 2141 are TMR angle sensors which allow absolute angle measurement of up to 360°. Based on the Tunnel Magneto-Resistive (TMR) effect, they offer high sensitivity and best angle accuracy needed for demanding automotive applications. The internal digital signal processing allows outstanding angular measurement performance. Stability in a wide range of temperature, and magnetic field variations is also achieved.

The sensors are pre-calibrated at manufacturing and additionally offer in-application calibration modes. The “Static compensation” targets the elimination of angle errors caused by mechanical misalignment between magnet and sensor. These correction parameters are programmed at EOL. In 360° multi-turn operation, TAD 2140 and TAD 2141 achieve excellent angle accuracy by using the “Dynamic compensation” mechanism, which eliminates magnetic, temperature, and life-time effects.

TAD 2140 and TAD 2141 support various output interfaces such as UVW (Hall Switch Emulation Mode), PWM, ENC (Encoder Mode), SPI or SENT. To reduce system costs, TAD 2140 integrates six capacitors and one resistor. They act as filter components and provide increased durability and automotive system level EMC/ESD protection.

**Features**
- Two TMR bridges including signal processor unit in one TO6 or TSSOP16 package
- Various and configurable digital outputs:
  - UVW (Hall Switch Emulation Mode)
  - PWM
  - ENC (Encoder Mode)
  - SENT SAE J2716 JAN2010 revision 3 (TAD 2140)
  - SPI (TAD 2141)
- High EMC/ESD performance for automotive system level EMC (TAD 2140)
- ASIL-B ready device with several diagnostic functions and status reporting (TAD 2140)
- Internal diagnostic capability including direct monitoring of the sensor elements
- Continuous in operation self-tests:
  - Magnet loss detection
  - Maximum rotation speed detection
  - Over/undervoltage detection
  - Internal sensor fails
  - Signal processing supervision
  - Register CRC

**Physical Characteristics**
- Performance-dependent current consumption down to 12.5 mA
- Wide operating temperature range: $T_J = -40 \, ^\circ C$ to 175 $^\circ C$
- Wide magnetic field range:
  - 20 mT to 80 mT (standard range)
  - 80 mT to 130 mT with lower accuracy
- Lowest deviation of angle error of just ±0.05°
- Guaranteed angle accuracy of ±0.2° (in multi-turn application)

**Typical Applications**
- BLDC motor commutation e.g. for EPS
- Absolute angle sensor
- Resolver replacement

**Benefits**
- Fast response, high angular accuracy, and advanced compensation algorithms
- Compliant to ISO 26262: supports ASIL B on system level (TAD 2140)
- No PCB required (TAD 2140)
TAD 2140, TAD 2141

Block diagram of TAD 2140

Block diagram of TAD 2141

TMR bridges of TAD 2140/2141

Packages of TAD 2140 and TAD 2141
## Selection of Sensor Type

<table>
<thead>
<tr>
<th>Product Name</th>
<th>TAS 2141</th>
<th>TAS 2143</th>
<th>TAS 4140</th>
<th>TAS 4141</th>
<th>TAS 4142</th>
<th>TAD 2140</th>
<th>TAD 2141</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of TMR Bridges</td>
<td>2</td>
<td>4</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Angular Position Detection – On-Axis</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Angle Error</td>
<td>±0.6° or less</td>
<td>±0.8° or less</td>
<td>±0.6° or less</td>
<td>±0.8° or less</td>
<td>±0.8° or less</td>
<td>±0.2° or less</td>
<td>±0.2° or less</td>
</tr>
<tr>
<td>Number of Outputs</td>
<td>4</td>
<td>4</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Temperature Range</td>
<td>TA= −40...150 °C</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Tj= −40...175 °C</td>
<td>TA= −40...150 °C</td>
</tr>
<tr>
<td>Magnetic Field Range</td>
<td>20...80 mT (typical)</td>
<td>80...130 mT (extended range)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Detection Range</td>
<td>360°</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Redundancy</td>
<td>–</td>
<td>–</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Self-Diagnosis</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Integrated DSP (FSM)</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Integrated Capacitors</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>YES</td>
<td>–</td>
</tr>
<tr>
<td>Packages</td>
<td>TSSOP8</td>
<td>YES</td>
<td>YES</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>TSSOP16</td>
<td>–</td>
<td>–</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>QFN-16</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>YES</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>TO6</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>YES</td>
</tr>
<tr>
<td>Samples</td>
<td>Available</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

**Analog Sensors**

- TAS 2141
- TAS 2143
- TAS 4140
- TAS 4141
- TAS 4142
- TAD 2140
- TAD 2141

**Digital Sensors**

- TAS 2141
- TAS 2143
- TAS 4140
- TAS 4141
- TAS 4142
- TAD 2140
- TAD 2141

---

**Summary**

- **Number of TMR Bridges:** 2, 4, 2
- **Angular Position Detection – On-Axis:** YES, YES, YES, YES, YES, YES, YES
- **Angular Position Detection – Off-Axis:** YES, YES, –, YES, –, YES, –
- **Angle Error:** ±0.6° or less, ±0.8° or less, ±0.6° or less, ±0.8° or less, ±0.8° or less, ±0.2° or less, ±0.2° or less
- **Number of Outputs:** 4, 4, 8, 8, 8, 4, 4
- **Temperature Range:** TA= −40...150 °C, Tj= −40...175 °C, TA= −40...150 °C
- **Magnetic Field Range:** 20...80 mT (typical), 80...130 mT (extended range)
- **Detection Range:** 360°
- **Redundancy:** –, –, YES, YES, YES, –, –
- **Self-Diagnosis:** –, –, –, –, –, YES, YES
- **Integrated DSP (FSM):** –, –, –, –, –, YES, YES
- **Integrated Capacitors:** –, –, –, –, –, YES, –
- **Packages:** TSSOP8, TSSOP16, QFN-16, TO6
- **Samples:** Available
About TDK Corporation

TDK Corporation is a leading electronics company based in Tokyo, Japan. It was established in 1935 to commercialize ferrite, a key material in electronic and magnetic products. TDK’s comprehensive portfolio features passive components such as ceramic, aluminum electrolytic and film capacitors, as well as magnetics, high-frequency, and piezo and protection devices. The product spectrum also includes sensors and sensor systems such as temperature and pressure, magnetic, and MEMS sensors. In addition, TDK provides power supplies and energy devices, magnetic heads and more. These products are marketed under the product brands TDK, EPCOS, InvenSense, Micronas, Tronics and TDK-Lambda. TDK’s further main product groups include magnetic application products, energy devices, and flash memory application devices. TDK focuses on demanding markets in the areas of information and communication technology and automotive, industrial and consumer electronics. The company has a network of design and manufacturing locations and sales offices in Asia, Europe, and in North and South America. In fiscal 2018, TDK posted total sales of USD 12 billion and employed about 103,000 people worldwide.

Contact

TDK Europe GmbH • D-81617 Munich (Germany)
Tel. +49 89 540 200 • E-mail: info@eu.tdk.com • www.tdk.eu