

Technologies & Products Press Conference 2014

Superior TMR angle sensing for automotive systems

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November 12, 2014

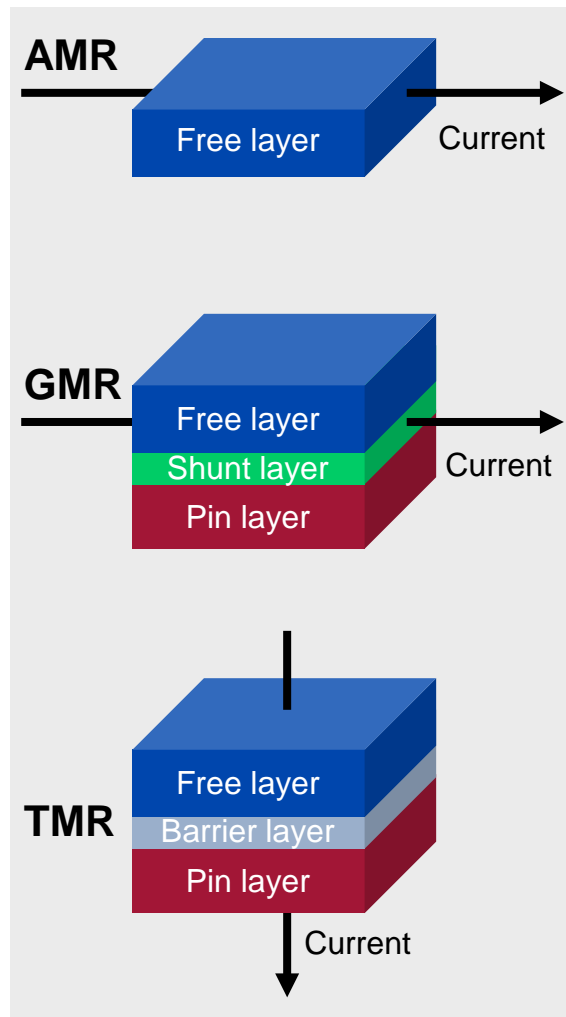
Rising requirements for automotive angle measurement



| Applications | Accuracy of conventional products | Future requirements |
|-------------------------|-----------------------------------|---|
| Throttle valve | $\pm 2^\circ$ to $\pm 3^\circ$ | $\pm 1^\circ$ |
| Wipers | $\pm 1.2^\circ$ (20 to 130 mT) | $\pm 0.6^\circ$ (20 to 130 mT) |
| Steering (EPS motor) | $\pm 0.6^\circ$ (20 to 80 mT) | $\pm 0.3^\circ$ (20 to 80 mT) Redundancy ISO 26262 |

Needed: The accuracy of angle measurements in automotive applications must be doubled!

Evolution of magneto resistive sensor technologies

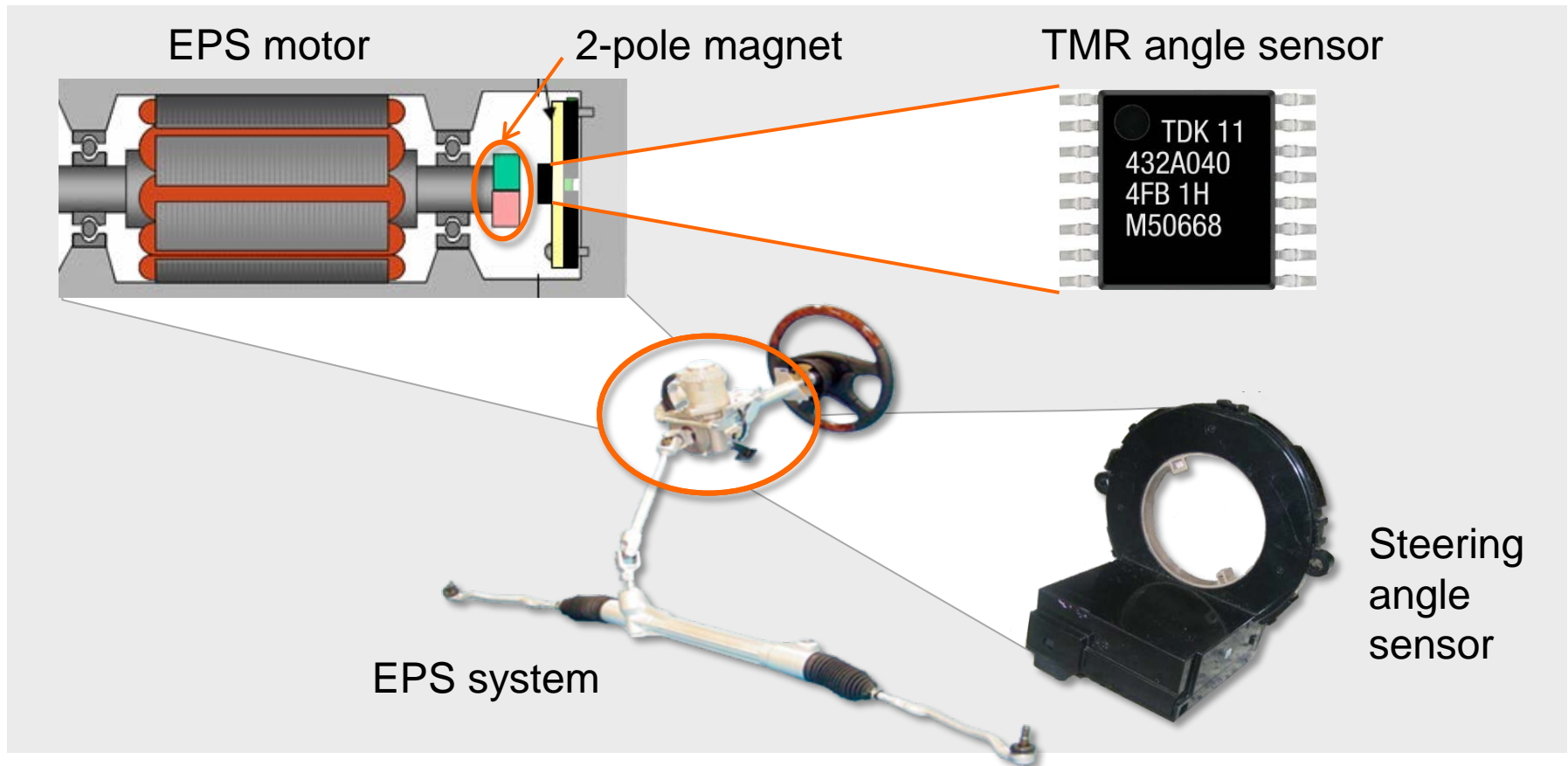


| | MR ratio [%] | Output [mV] | SNR @ 10 kHz [dB] | Output shift from 25 °C to 125 °C [%] |
|-----|--------------|-------------|-------------------|---------------------------------------|
| AMR | 3 | 90 | 72 | -29 |
| GMR | 12 | 360 | 77 | -23 |
| TMR | 100 | 3000 | 96 | -13 |

TMR output

- more than 30 times higher than AMR
- 8 times higher than GMR
- smaller thermal coefficient factor for a broad temperature range

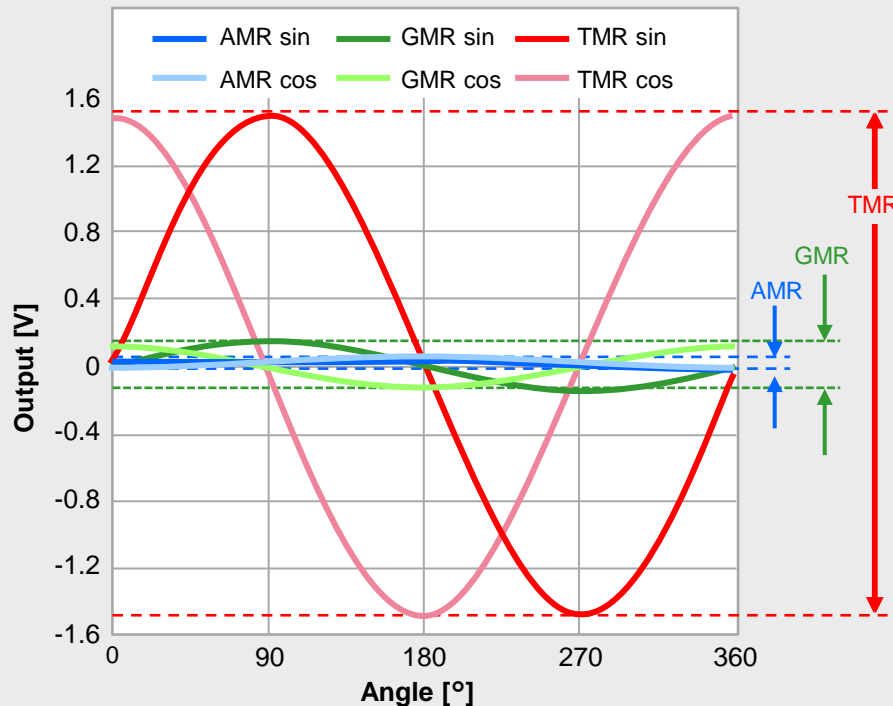
Steering – the most demanding angle sensor application



TMR sensor is positioned on the opposite side of a 2-pole magnet.

Superior performance of TDK TMR angle sensors

Output waveform



- **Higher output**
3.0 V_{pp} @ 5 V (30x AMR, 8x GMR)
- **Greater angle accuracy**
Angle accuracy of less than $\pm 0.6^\circ$ over a wide range of magnetic field strengths and temperatures (20 mT to 80 mT, -40 °C to 150 °C)
- **Lower power consumption**
5 mW under recommended operating conditions

TMR angle sensors for automotive applications

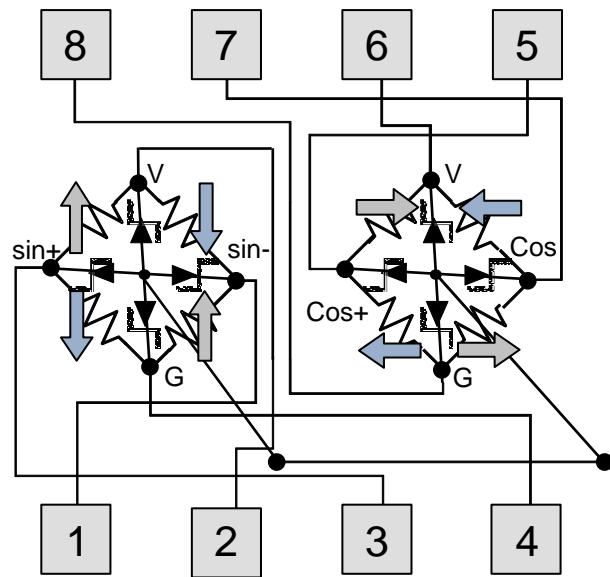


| | TAS2004 | TAS4501 | ATAS2001 |
|--------------------------|--|--|---|
| | <ul style="list-style-type: none"> • 2 directions • 2 full bridges | <ul style="list-style-type: none"> • 2 x 2 directions • 4 full bridges • Redundancy (ISO 26262) | <ul style="list-style-type: none"> • 2 directions • 2 full bridges • plus ASIC • Redundancy (ISO 26262) |
| Output | Analog | Analog | Digital |
| Package | TSSOP8 | VSOP16 | SSOP16 |
| Pin configuration | | | |
| Dimensions | 3.0 x 4.4 x 1.1 mm | 5.1 x 4.4 x 1.15 mm | 6.4 x 5.0 x 1.15 mm |

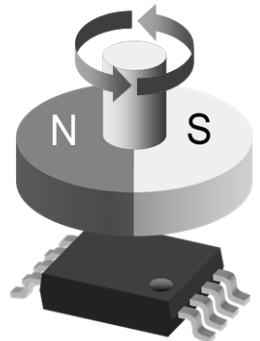
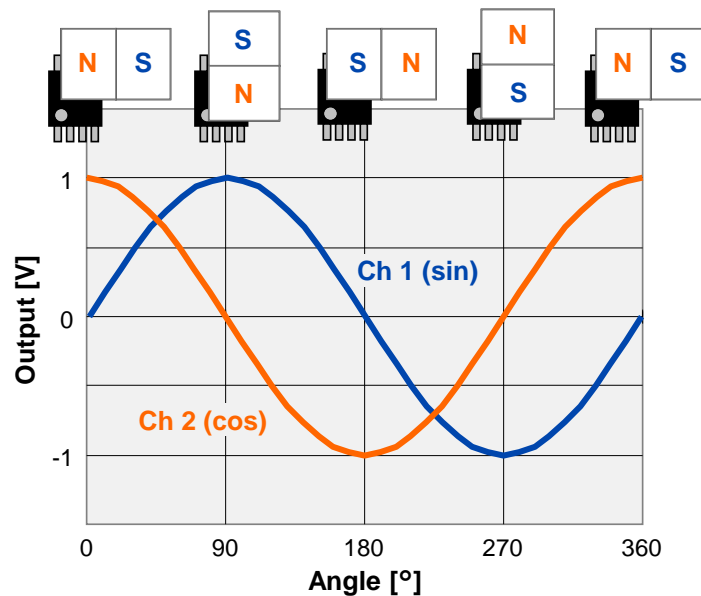
TAS2004: 2 directions, 2 full bridges, analog

- Four output waveforms (sin+, sin-, cos+, cos-) are created when the 2-pole magnet rotates
- Angle accuracy of less than $\pm 0.6^\circ$ @ 20 mT to 80 mT and -40°C to 150°C
- TSSOP8 package (3.0 mm x 4.4 mm x 1.1 mm)

Circuit



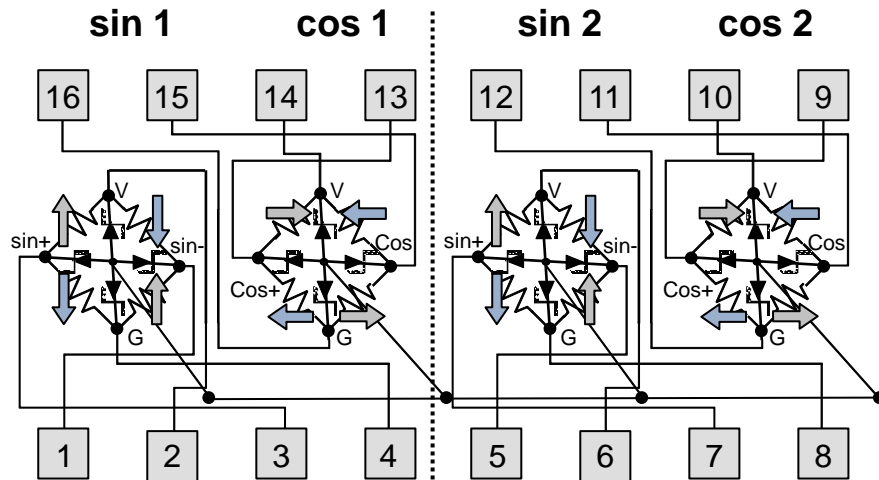
Output waveform



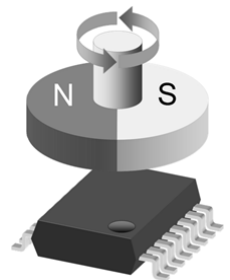
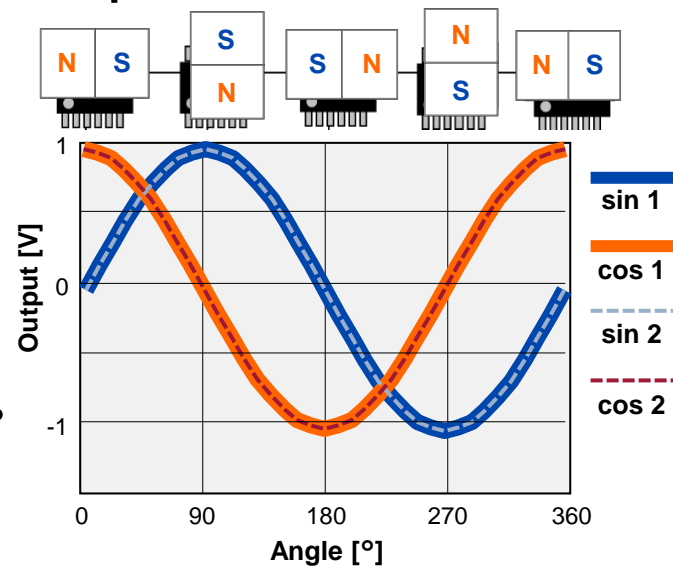
TAS4501: 2x 2 directions, 4 full bridges, analog

- 8 output waveforms (2x sin+, sin-, cos+, cos-) are created when the 2-pole magnet rotates
- Angle accuracy of less than $\pm 0.6^\circ$ @ 20 mT to 80 mT and -40°C to 150°C
- VSOP16 package (5.1 mm x 4.4 mm x 1.15 mm)

Circuit



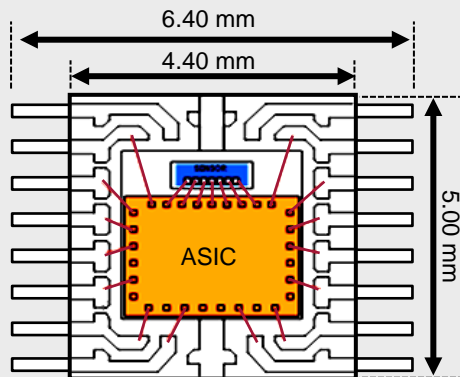
Output waveform



TAS4501 angle sensor offers redundancy in a single component.

ATAS2001 includes ASIC for digital output

High-precision digital angle sensor with signal conditioning and redundancy in a single component and support for ISO 26262



Features

- High output based on TMR technology
- Angle accuracy of $\leq \pm 0.2^\circ$ in auto-calibration mode
- High SNR
- Minimal drift over wide temperature range of -40°C to $+150^\circ\text{C}$
- Magnetic field range of 20 mT to 80 mT
- Error compensation mode
- Digital output for all standard protocols
- 14-bit A/D converter
- SSOP16 package (6.4 mm x 5.0 mm x 1.15 mm)

Error compensation significantly improves angle measurement accuracy.

Customer benefits of TDK's TMR angle sensors



- Highest measurement accuracy
- Sensor output many times higher than conventional products
- Very small temperature drift over a broad range of magnetic field strengths
- Low power consumption
- Redundancy available in a single component
- TDK supports ISO 26262 requirements

Superior performance



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