

# TAD Series



## High-Precision TMR Angle Sensors with Digital Output

Based on the Tunnel Magneto-Resistive (TMR) effect, TAD Series angle sensors allow an absolute angle measurement of up to 360°, offering high sensitivity and best angle accuracy needed for demanding automotive and industrial applications.

The internal digital signal processing allows outstanding angular measurement performance, stability in a wide temperature range and increased functionality.

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.

In 360° multi-turn operation, TAD series sensors achieve excellent angle accuracy by using the “Dynamic compensation” mechanism, which eliminates magnetic, temperature, and life-time effects. They support various output Interfaces such as UVW (Hall Switch Emulation Mode), PWM, ENC (Encoder Mode or ABZ), SPI, and SENT.

To reduce system costs and provide automotive system level EMC/ESD protection, one variant also integrates six capacitors and one resistor.

# TAD2141, TAD4140

June/2020

## High-Precision TMR Angle Sensors with Digital Output



### Application Examples

TAD2141 (1 system), TAD4140 (2 systems) are the optimal system solution for applications such as:

- ◆ BLDC motor commutation e.g. for EPS
- ◆ Absolute angle sensor
- ◆ Resolver replacement

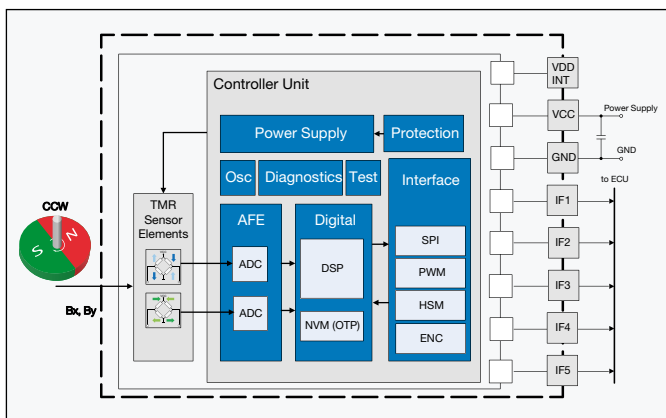


Fig. 1: Block diagram of TAD2141

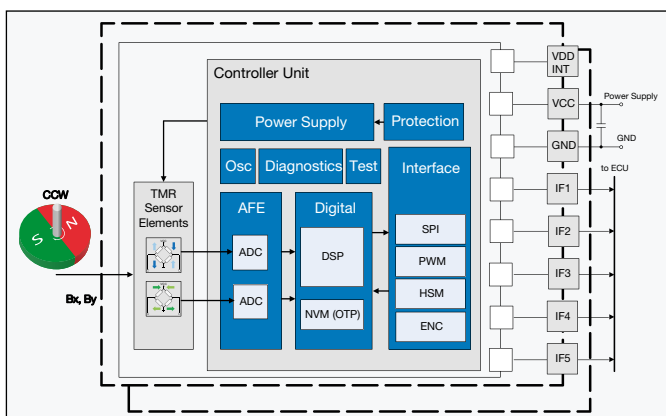


Fig. 2: Block diagram of TAD4140

### Features

- ◆ TAD2141: TMR Sensor with integrated signal processor unit
- ◆ TAD 4140: Dual, independent TMR Sensors with integrated signal processor units
- ◆ Angle error compensation: static compensation and dynamic compensation
- ◆ Various and configurable digital outputs:
  - UVW (Hall switch emulation with extrapolator)
  - PWM
  - ENC (encoder mode, ABZ)
  - SPI
- ◆ Internal diagnostic capability for high diagnostic coverage
- ◆ Continuous in operation self-tests:
  - Magnet loss detection
  - Maximum rotation speed detection
  - Over/undervoltage detection
  - Internal sensor fails
  - Signal processing supervision
  - Register CRC
- ◆ Self-Teach-in Feature for angle errors
- ◆ Compliant to ISO 26262: TAD2141 rated ASIL B and TAD4140 rated ASIL D

### Physical Characteristics

- ◆ Wide operating temperature range:
  - $T_A = -40$  to  $+150$  °C (Automotive Grade)
  - $T_J = -40$  to  $+175$  °C (Automotive Grade)
- ◆ Wide magnetic field range:
  - 20 mT to 80 mT (standard range)
  - 80 mT to 120 mT with lower accuracy
- ◆ Angle error supports  $\pm 0.3^\circ$  (Full rotation at standard range)
- ◆ Angle error supports  $\pm 0.7^\circ$  (Non Full rotation at standard range)
- ◆ TSSOP16 package for TAD2141 and TAD4140
- ◆ AEC-Q100 qualified (Grade 0)

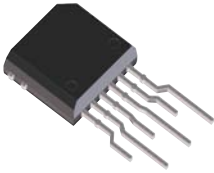
### Benefits

- ◆ Fast response, high angular accuracy, and advanced compensation algorithms suitable for fast and accurate motor control applications
- ◆ TAD4140 provides redundant position sensing and contributes to continuous function
- ◆ Self-Teach-in Feature allows compensation of system level errors
- ◆ Very stable position measurement (over temperature and lifetime) – no need for re-calibration
- ◆ UVW mode with extrapolator allows use of same setup (sensor and magnet) for different motor topologies (pole pair numbers)

# TAD2140

June/2020

## High-Precision TMR Angle Sensors with Digital Output



### Application Examples

TAD 2140 is the optimal system solution for PCB-less applications such as:

- ◆ General angular sensing
- ◆ Electrical commutated motors (e.g. actuators for Electric Power Steering or E-clutch)
- ◆ Steering angle measurements (e.g. used in EPS)
- ◆ Rotary switches

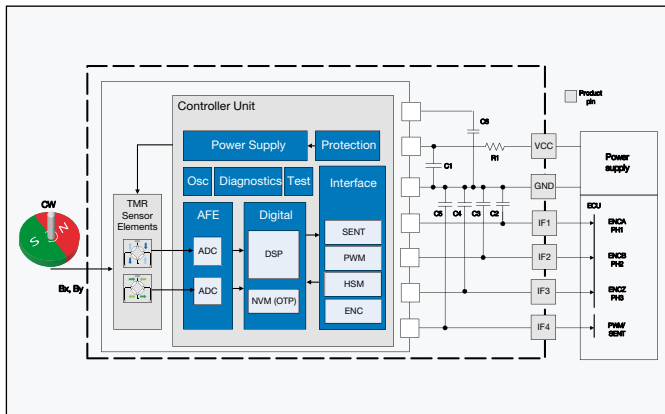


Fig. 3: Block diagram of TAD2140

### Features

- ◆ TMR Sensor with integrated signal processing, resistor and capacitors in one System-in-Package (SIP)
- ◆ Various and configurable digital outputs:
  - UVW (Hall switch emulation with extrapolator)
  - PWM
  - ENC (encoder mode, ABZ)
  - SENT SAE J2716 revision 3

- ◆ High EMC/ESD performance for automotive system level EMC
- ◆ ASIL-B ready device with several diagnostic functions and status reporting
- ◆ Angle error compensation: static compensation and dynamic compensation
- ◆ Internal diagnostic capability for high diagnostic coverage
  - Continuous self-tests in operation:
  - Magnet loss detection
  - Maximum rotation speed detection
  - Over-/undervoltage detection
  - Internal sensor failure
  - Signal processing supervision
- ◆ Compliant to ISO 26262: ASIL B

### Physical Characteristics

- ◆ Wide operating temperature range:
  - $T_A = -40\text{ °C}$  to  $157\text{ °C}$
  - $T_J = -40\text{ °C}$  to  $175\text{ °C}$
- ◆ Wide magnetic field range:
  - 20 mT to 80 mT (standard range)
  - 80 mT to 120 mT with lower accuracy
- ◆ Angle error:
  - $\pm 0.3^\circ$  (Full rotation at standard range, over lifetime)
  - $\pm 0.7^\circ$  (Non Full rotation at standard range, over lifetime)
- ◆ TO6 6-pin package (SIP)
- ◆ AEC-Q100 qualified (Grade 0)

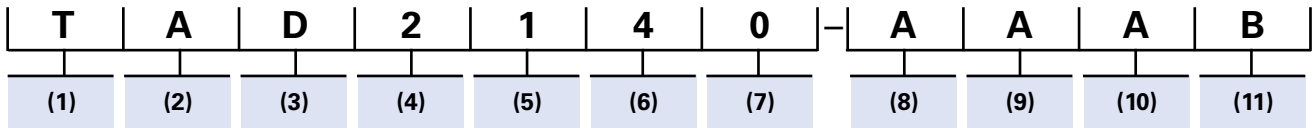
### Benefits

- ◆ Fast response, high angular accuracy, and advanced compensation algorithms suitable for fast and accurate motor control applications
- ◆ Optimized for leadframe assembly (PCB less) to reduce BOM cost
- ◆ Integrated components allow system level EMC capabilities without need for external components
- ◆ Self-Teach-in Feature allows compensation of system level errors
- ◆ Very stable position measurement (over temperature and lifetime) – no need for re-calibration
- ◆ UVW mode with extrapolator allows use of same setup (sensor and magnet) for different motor topologies (pole pair numbers)
- ◆ Dual interface use for redundant communication channels (e.g. ENC and SENT at same time)

# TAD4140, TAD2140

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## High-Precision TMR Angle Sensors with Digital Output



(1) Sensor technology  
 T TMR

(2) Sensor technology  
 A Angle

(3) Sensor technology  
 D Digital

(4) Bridge/System  
 2 2  
 4 4

(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  
 A TSSOP8  
 B TSSOP16  
 N TO6

(9) Grade  
 A Automotive  
 I Industrial

(10) Specials  
 A None

(11) Product internal code  
 A 1  
 B 2

Fig. 4: Part number construction

# TAD2140, TAD2141, TAD4140

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High-Precision TMR Angle Sensors with Digital Output

## Selection Guide

Product Name	Number of TMR Bridges	Angle Error	Output	Number of Outputs	Temperature Range	Magnetic Field Range	Detection Range	Redundancy	Self-Diagnosis	Integrated DSP (FSM)	Integrated Capacitors	Packages		Samples
												TSSOP16	TO6	
TAD 2140	2	±0.3° or less	Digital (SENT, PWM, ENC, UVW)	4	T <sub>A</sub> = -40 ~ +157 °C	20~80 mT (Can extend up to 120 mT with lower accuracy)	0~360°	-	YES	YES	YES	-	YES	Available
TAD 2141	2	±0.3° or less	Digital (SPI, PWM, ENC, UVW)	4	T <sub>A</sub> = -40 ~ +150 °C			-	YES	YES	-	YES	-	
TAD 4140	4	±0.35° or less	Digital (SPI, PWM, ENC, UVW)	8	-40 ~ +150 °C			YES	YES	YES	-	YES	-	

## Product Ordering Information

### TAD2141 – xxxx

	Output	Product Name	
Automotive use T <sub>A</sub> = -40 ~ +157 °C	PWM / ENC / UVW / SENT	TAD2140-NAAB	
Automotive use T <sub>A</sub> = -40 ~ +150 °C	SPI / PWM	TAD2141-BAAA*	
	UVW / PWM	TAD2141-BAFA*	
	ENC / PWM	ENC resolution 6 bit	TAD2141-BANA*
		ENC resolution 8 bit	TAD2141-BAMA*
		ENC resolution 10 bit	TAD2141-BADA*
ENC resolution 12 bit		TAD2141-BAKA*	
Industrial use T <sub>A</sub> = -20 ~ +125 °C	SPI / PWM	TAD2141-BIAA	
	UVW / PWM	TAD2141-BIFA	
	ENC / PWM	ENC resolution 6 bit	TAD2141-BINA
		ENC resolution 8 bit	TAD2141-BIMA
		ENC resolution 10 bit	TAD2141-BIDA
ENC resolution 12 bit		TAD2141-BIKA	

\*Under qualification

### TAD4140 – xxxx

	Output				Product Name
	Chip 1		Chip 2		
Automotive/Industrial use T <sub>A</sub> = -40 ~ +150 °C	SPI / PWM		SPI / PWM		TAD4140-BAAA
	UVW / PWM		UVW / PWM		TAD4140-BAFA
	ENC / PWM	ENC resolution 10 bit	ENC / PWM	ENC resolution 10 bit	TAD4140-BADA
		ENC resolution 12 bit		ENC resolution 12 bit	TAD4140-BAKA
Industrial use T <sub>A</sub> = -20 ~ +125 °C	ENC / PWM	ENC resolution 12 bit	UVW / PWM		TAD4140-BIHA

# TAD2140, TAD2141, TAD4140

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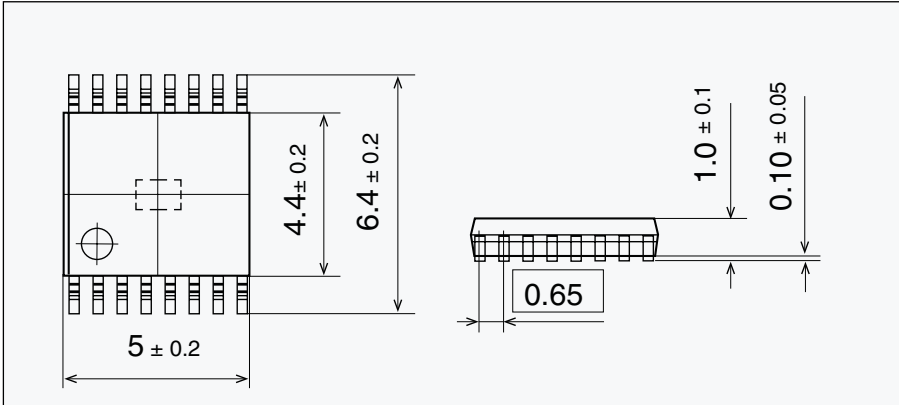


Fig. 5: TSSOP16 package

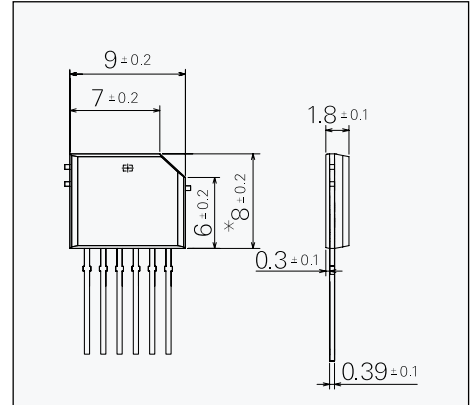


Fig. 6: TO6 package

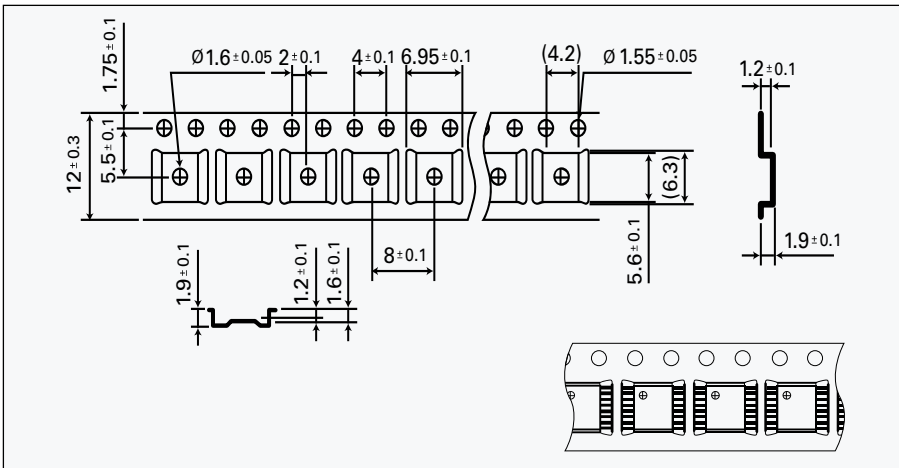
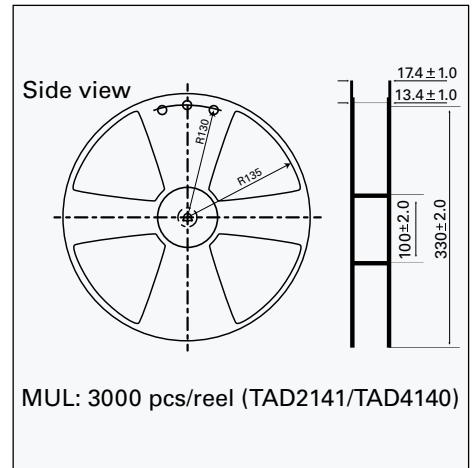


Fig. 7: Carrier tape specifications (TSSOP16 package)



MUL: 3000 pcs/reel (TAD2141/TAD4140)

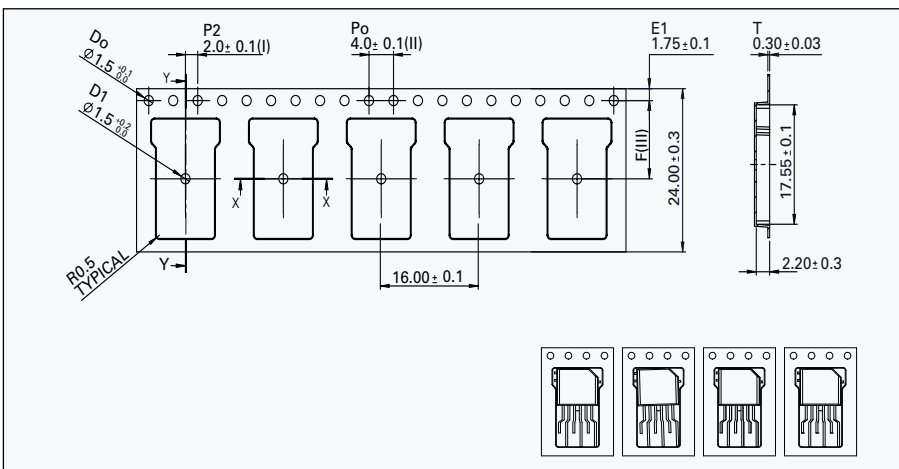
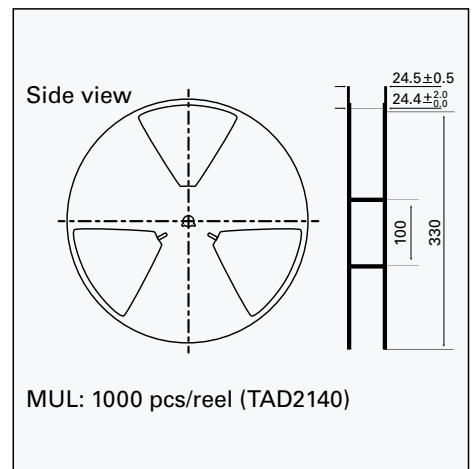


Fig. 9: Carrier tape specifications (TO6 package)



MUL: 1000 pcs/reel (TAD2140)

Please be sure to request delivery specifications that provide further details on the features and specifications of the products for proper and safe use. Please note that the contents may change without any prior notice due to reasons such as upgrading.