TS SERIES
IN-LINE TORQUE SENSORS

FEATURES

- Integrated torque, speed and angle conditioning
- Torque range: from 0.05 N·m to 10 N·m
- Integrated speed encoder with index
- Accuracy: < 0.1 %
- Overload capacity: 200 %
- Overload limit: 300 %
- Speed range: up to 15 000 rpm
- Torque output: ± 5 VDC (± 10 VDC)
- USB interface & analog connection
- LED operating status control
- Non-contact (no slip rings)
- Single DC power supply: 12 - 32 VDC

DESCRIPTION

Magtrol’s TS Series In-Line Torque Sensors provide extremely accurate torque and speed measurement. Each model has an integrated conditioning electronic module providing 0 VDC to ± 5 VDC (± 10 VDC) torque output through an 8-pole connector, as well as a USB interface which can be directly connected to a computer. The sensor is delivered with software allowing easy connection and data acquisition. A speed encoder provides 360 PPR (Pulse Per Revolution) in Tach A, Tach B and Index reference Z (1 PPR). Magtrol Torque Sensors are very reliable, providing high overload protection, excellent long-term stability and high noise immunity. TS Series sensor models are strain gauge-based measuring systems with imbedded telemetry signal transmission. Three LED lights located on the sensor cover allow a visual check of the sensor status by color code (combination of the 3 LEDs). The sensor is powered by 24 VDC (12 - 32 VDC) through its 8-pole connector. TARE & B.I.T.E. (Built-In Test Equipment) can be activated by either software or input from the 8-pole connector. Available torque ranges from 0.05 N·m to 10 N·m. Higher torque ranges will be available soon.

USB & ANALOG OUTPUT

The sensor offers both an isolated USB interface and an analog output. Both signals can be utilized simultaneously. For example, control loop data can be acquired using a computer via the USB interface while fast data acquisition can be performed using the analog output. In addition torque, speed, and angle data can be acquired using the USB interface while fast control loop data can be acquired using the analog output signals.

The refresh time of the continuous analog signals is 100 μs (10kHz). The analog signal provides a 0 to ±5 VDC output corresponding to the sensor nominal range up to 200% of measuring range (0 to ±10 VDC). The USB interface can easily be connected and used with the LabVIEW™ dedicated software delivered with the sensor.

APPLICATIONS

TS Series Torque Sensors provide dynamic torque and speed measurement of:

- Windshield wipers, electric windows, starters, generators and brakes in the automotive industry
- Pumps - water and oil
- Reduction gears and gearboxes
- Clutches
- Motorized valves & actuators
- Drills, pneumatic tools and other machine tools
- Torque & friction measurement in medical devices and the watch industry
INTEGRATED ENCODER

TS Series Torque Sensors integrate a high-end encoder with 360 PPR (Pulses Per Revolution) on 2 distinct signals (Tach A, Tach B) 90° out of phase providing an angular measurement resolution of 0.25°. A third signal offers 1 PPR (Z) providing an angular reference. The sensor body is marked with «Encoder Side» to indicate the encoder location. In low speed applications, where the angular position/accuracy of the test object is important, the encoder side needs to be directly connected to the test object so that the angular measurement is not influenced by the sensor deformation zone.

SYSTEM STATUS INDICATORS

A color code is given by the activation of 3 LEDs lights (Yellow, Green, Red) located on the top cover of the sensor. This color code continuously communicates the operating status of the sensor, such as measuring status, tare functions, offset value, B.I.T.E. (Built-In Test Equipment) and overload.

OPERATING PRINCIPLES

The measuring system is based on strain gauge technology directly applied on the sensor measuring section and connected in Wheatstone full bridge circuit. The strain gauge and its associated front end amplifier are powered by a high frequency power transfer. Under the applied torque, the measuring section will elastically deform providing a strain in the measuring elements. A microprocessor conditions the signal from the amplifier and transfers the measured values to the stator via contactless telemetry data transfer. On board micro-controllers manage all the internal functions, such as power transfer, data collecting and filtering, calibration and set-up, tare and B.I.T.E. (Build-In Test Equipment) functions, as well as the LED operating status control code. The sensor is supplied by 24 VDC (12-32 VDC) from the analog connector. The signal cutoff frequency can be digitally selected and configured in a range from 2 Hz up to 1 000 Hz.

ELECTRICAL CONFIGURATION

Fig. 2: TS Series Torque Sensor electrical input and output

SUPPORTED & SUSPENDED INSTALLATIONS

The device can be used in both supported and suspended configurations. Supported configuration is recommended for the majority of applications (mandatory for high speed testing). The TS Series can be installed without the base mount in a suspended configuration. The benefit of this configuration is the use of a single element coupling creating a shorter drive train. This configuration is only applicable for low speed measurement.

CAUTION: TS 100-102 cannot be used in suspended installation as the weight of the sensor will degrade the accuracy of the measurement due to radial forces.

Fig. 3: Supported installation
Mandatory for standard and high speed applications.

Fig. 4: Suspended installation for low speed applications only.
A single element coupling can be used to create a shorter drive train. This specific configuration cannot be used for TS 100-102.
SYSTEM CONFIGURATIONS

The TS Series Torque Sensor can be connected in various configurations. It can be used independently (via an external power supply) or in combination with other Magtrol devices (e.g. DSP 7000 - High-Speed Dynamometer Controller, MODEL 3411 - Torque Display, ...). The sensors can be used with Magtrol software, such as M-TEST or TORQUE (included), to allow the data to be acquired and displayed. The double signal output, analog and USB, can be used simultaneously. For example, one channel for data acquisition and the other one for closed loop control of a drive line.

USB CONNECTION

When a TS Series Torque Sensor is used solely with a USB connection, it must be supplied (12-32 VDC) through its analog connection.

ANALOG WITH DYNAMOMETER CONTROLLER

In this configuration the power supply to the sensor is provided by the dynamometer controller. The DSP 7000 is a high speed programmable dynamometer controller. The analog only connection is used and data acquisition is supplied through a computer with M-TEST software.

ANALOG & USB WITH TORQUE DISPLAY

In this configuration the power supply to the Sensor is provided by the torque display. The MODEL 3411 is a torque/speed/power display. The TS Torque Sensor's USB connection to the computer supplies data acquisition using TORQUE Software.

Fig. 5: TS Torque Sensor USB only configuration

Fig. 6: TS Torque Sensor analog configuration connected to and power supplied by the DSP7000.

Fig. 7: TS Sensor configuration with MODEL 3411 Torque Display
### SPECIFICATIONS

#### MECHANICAL CHARACTERISTICS

<table>
<thead>
<tr>
<th>MODEL</th>
<th>NOMINAL RATED TORQUE (RT)</th>
<th>SHAFT DIAMETER</th>
<th>MAX SPEED</th>
<th>TORSIONAL STIFFNESS</th>
<th>MOMENT OF INERTIA</th>
<th>ANGULAR DEFORMATION</th>
<th>WEIGHT</th>
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<tbody>
<tr>
<td>TS 100</td>
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<td>15000</td>
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<td>1.96x10^-6</td>
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<td></td>
<td></td>
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<td></td>
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<td></td>
<td></td>
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<td></td>
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<tr>
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<td>8</td>
<td></td>
<td>330</td>
<td>2.19x10^-6</td>
<td>0.17</td>
<td>0.65</td>
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<td>8000</td>
<td>3600</td>
<td>N/D</td>
<td>0.32</td>
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<td>TS 106</td>
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<td></td>
<td>7380</td>
<td>N/D</td>
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<td>38800</td>
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<td>1.1</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TS 111 a)</td>
<td>100</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TS 112 a)</td>
<td>200</td>
<td>32</td>
<td>6000</td>
<td>62840</td>
<td>N/D</td>
<td>0.46</td>
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</table>

#### TORQUE MEASUREMENT

- **Maximum Dynamic Torque Peak Value**: 200 % of RT
- **Maximum Static Torque Without Damage**: 300 % of RT
- **Resolution at RT**: 11000 points
- **Sampling Frequency**: 16 bits at 10,000 sample/second
- **Combined Error of Linearity and Hysteresis**: < 0.1% of RT
- **Noise Spectral Density**: 2 ppm of RT / √ Hz typical
- **Speed Influence on Zero Torque**: < 0.015% / 1000 rpm
- **Power Supply Change Sensitivity**
  - < 50 (ppm of RT / V)

#### USB SPEED & ANGLE MEASUREMENT

- **Speed & Angle Measurement**: Based on 360 pulses, 2 signals, 90° phase shift (quadrature X4) + Index Optical Encoder
- **Computed Speed Accuracy (USB Output)**: < ±0.05%
- **Angle Resolution (USB)**: 0.25°
- **Accuracy**: ±0.25° over 360°
- **Thermal drift**: < 50 ppm over temperature range

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**a)** These models are currently under development

**b)** Corresponds to <0.05 % of RT, peak to peak over the entire 1 kHz bandwidth

**c)** For TS 100 (0.05 N·m) this parameter is degraded by a factor of 2. Applicable to both analog and USB output

**d)** For TS 100 (0.05 N·m) and TS 101 (0.1 N·m) this parameter is degraded by a factor of 2.

**e)** Torque output change due to power supply change

**f)** Constant speed and based on the last 360 pulses
### SPECIFICATIONS

#### ENVIRONMENT & CERTIFICATIONS

<table>
<thead>
<tr>
<th>Specification</th>
<th>Specification value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage Temperature</td>
<td>-40 °C to +85 °C</td>
</tr>
<tr>
<td>Operating Temperature</td>
<td>-25 °C to +80 °C</td>
</tr>
<tr>
<td>Temperature Influence on Zero / Sensitivity</td>
<td>&lt; ±0.1 % / 10 °C for the range -25 °C to +80 °C</td>
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<tr>
<td>Mechanical Shock</td>
<td>IEC 60068-2-27 : 2008 / Class C3</td>
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<tr>
<td>Vibration Sinusoidal</td>
<td>IEC60068-2-6 : 2007 / Class C3</td>
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<tr>
<td>Protection Class</td>
<td>IP44 (DIN EN 60529)</td>
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<tr>
<td>EMC / EMI Compatibility</td>
<td>IEC 61326-1 / IEC 61321-2-3</td>
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<tr>
<td>Balancing Quality</td>
<td>O 2.5 according to ISO 1940</td>
</tr>
<tr>
<td>Safety Standard</td>
<td>ISO 13849 / EN 62061</td>
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<tr>
<td>Low voltage</td>
<td>IEC 61010-1</td>
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#### ELECTRICAL CHARACTERISTICS & CONNECTIONS

<table>
<thead>
<tr>
<th>Specification</th>
<th>Specification value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power Supply (voltage range / max. power)</td>
<td>12 to 32 VDC / &lt; 2.2 W (24 VDC recommended)</td>
</tr>
<tr>
<td>Analog Torque Output (rated / max.)</td>
<td>± 5 V / ± 10 V (max. output current 2 mA)</td>
</tr>
<tr>
<td>Torque Signal Bandwidth (-3 dB)</td>
<td>2 Hz / 5 Hz / 10 Hz / 20 Hz / 50 Hz / 100 Hz / 1000 Hz</td>
</tr>
<tr>
<td></td>
<td>(50 Hz is factory default)</td>
</tr>
</tbody>
</table>

#### Wiring diagram (Analog)

```
1 - White
2 - Brown
3 - Green
4 - Yellow
5 - Grey
6 - Pink
7 - Blue
8 - Red
```

#### Wiring diagram (USB)

```
1 - White
2 - Tach B
3 - Tach A
4 - + 5V
5 - GND
```

#### ANALOG INPUT AND OUTPUT SIGNALS

<table>
<thead>
<tr>
<th>Specification</th>
<th>Specification value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tach Outputs &amp; Index</td>
<td>Tach A + B, 360 PPR, 100 kHz max. frequency, Index 1 PPR</td>
</tr>
<tr>
<td>B.I.T.E. (Built-In Test Equipment)</td>
<td>B.I.T.E. Input pin grounded for more than 1 s allows +60 % FSD shift at the O/P for 5s (refer to manual for more information)</td>
</tr>
<tr>
<td>TARE</td>
<td>TARE Input pin pulled up to 12 V min. / 32 V max. for more than 1 s enables a TARE function in the sensor. Depending on how long voltage is applied, the TARE is either saved or dismissed.</td>
</tr>
</tbody>
</table>

**a)** For TS 100 (0.05 N·m) this parameter is degraded by a factor of 2. Applicable to both analog and USB output

**b)** Cable shield connected to GND at user side

**c)** PPR means Pulse Per Revolution

**d)** Available with 5000 PPR (speed limit 1000 rpm)
# TS 100-107 DIMENSIONS

**NOTE:** All values are in metric units. Dimensions are in millimeters.

<table>
<thead>
<tr>
<th>MODEL</th>
<th>TORQUE [N·m]</th>
<th>øA g6</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
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<td>6</td>
<td>80.8</td>
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<td>15.7</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>TS 102</td>
<td>0.2</td>
<td></td>
<td>8</td>
<td>85</td>
<td>18.2</td>
<td>17.8</td>
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<tr>
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<td>0.5</td>
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<td></td>
<td>19</td>
<td></td>
</tr>
<tr>
<td>TS 104</td>
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<td>85</td>
<td>18.2</td>
<td>17.8</td>
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<tr>
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<td></td>
<td>8</td>
<td>90.8</td>
<td>21.1</td>
<td>20.7</td>
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<tr>
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<td>5</td>
<td></td>
<td>9</td>
<td></td>
<td></td>
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<tr>
<td>TS 107</td>
<td>10</td>
<td></td>
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**NOTE:** 3D STEP files of most of our products are available on our website: www.magtrol.com; other files are available on request.
### TS 109-113 DIMENSIONS

**NOTE:** All values are in metric units. Dimensions are in millimeters.

<table>
<thead>
<tr>
<th>MODEL</th>
<th>TORQUE [N·m]</th>
<th>øA</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
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<td>20</td>
<td>18 g6</td>
<td>27</td>
<td>80</td>
<td>25</td>
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<td>38</td>
<td>80</td>
<td>36</td>
<td>30</td>
<td>60</td>
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<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>TS 112</td>
<td>200</td>
<td>32 g6</td>
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<td>80</td>
<td>95</td>
<td>135</td>
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<table>
<thead>
<tr>
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<th>J</th>
<th>K</th>
<th>L</th>
<th>M</th>
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<th>BB</th>
<th>X</th>
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<td>9</td>
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<tr>
<td>TS 112</td>
<td>20</td>
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<td>4.1</td>
<td>10 H9</td>
<td>75 (h6)</td>
<td>65 (h6)</td>
<td>197</td>
<td>147.5</td>
<td>150</td>
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<td>TS 113</td>
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<td>4.1</td>
<td>10 H9</td>
<td>75 (h6)</td>
<td>65 (h6)</td>
<td>197</td>
<td>147.5</td>
<td>150</td>
</tr>
</tbody>
</table>

**a)** Notice: These models are currently under development (subject to change)

**NOTE:** 3D STEP files of most of our products are available on our website: www.magtrol.com; other files are available on request.
COUPLINGS

When Magtrol TS Series Torque Sensors are mounted in a drive train, double-element miniature couplings are ideal, although single-element couplings can be used for low speed applications. The criteria for selecting appropriate couplings for torque measurement is as follows:

▪ High torsional spring rate: Ensures a high torsional stiffness and angular precision
▪ Clamping quality (should be self-centering and of adequate strength)
▪ Speed range
▪ Balancing quality (according to speed range)
▪ Alignment capability

The higher the speed of the application the more care is required in selecting the coupling and assembling (alignment and balancing) the drive train configuration. Magtrol provides a wide range of couplings suitable for torque measurement applications and can assist you in choosing the right coupling for your transducer.

TORQUE SPEED BOX

Magtrol's TSB Torque Speed Box allows data acquisition from two torque transducers simultaneously and provides the torque's analog signal output and speed's TTL signal output.

TORQUE «SOFTWARE»

Magtrol's TORQUE Software is an easy-to-use LabVIEW™ executable program used to automatically collect torque, speed, mechanical power and angle data. This data can be printed, displayed graphically or quickly saved as a Microsoft® Excel spreadsheet. Standard features of TORQUE include: multi-axis graphing, measured parameter vs. time, adjustable sampling rates and multi-language display.

TORQUE DISPLAY

Magtrol offers the MODEL3411 - Torque Display which supplies power to any TS/ TM/ TMHS/ TMB Sensor/ Transducer and displays torque, speed and mechanical power. Features include:

▪ Adjustable English, Metric and SI torque units
▪ Large, easy-to-read vacuum fluorescent display
▪ Built-in self-diagnostic tests (B.I.T.E.)
▪ Overload indication
▪ Tare function
▪ USB & Ethernet interface
▪ 2 BNC back panel outputs: torque (analog raw sensor signal) & speed (TTL or analog)
▪ Closed-box calibration
▪ Includes Magtrol's TORQUE Software

HIGH-SPEED DYNAMOMETER CONTROLLER

Magtrol's DSP 7000 High-Speed Programmable Dynamometer Controller employs state-of-the-art digital signal processing technology to provide superior motor testing capabilities. Designed for use with any Magtrol Hysteresis, Eddy-Current or Powder Brake Dynamometer, Magtrol In-Line Torque Transducer/ Sensor or auxiliary instrument, the DSP 7000 can provide complete PC control via USB interface or IEEE-488 optional. Standard Features:

▪ DSP 7001 Single Channel: Easy to use plug & play solution
▪ DSP 7002 Dual Channel: Enables the support of two testing instruments with independent or tandem configurations and two fully independent control loops
▪ Built-in Alarm System
▪ Speed & Torque closed loop Operating Modes
▪ Programmable Digital PID Values
▪ Built-in Current-Regulated Supply
▪ Adjustable Torque Units.

Fig. 8: MIC Series Miniature coupling
Fig. 9: TSB | Torque Speed Box
Fig. 10: MODEL 3411 | Torque Display
Fig. 11: DSP 7000 | High-Speed Dynamometer Controller
SYSTEM OPTIONS AND ACCESSORIES

CABLE ASSEMBLIES (ANALOG & POWER SUPPLY / USB)

Each TS Series Torque Sensor is delivered with a 3 meter cable for supply and analog signals (M12 straight connector and Pigtail wires) as well as a 2 meter USB cable (M12 mini-B / 2.0 USB-A).

Other lengths and cable configurations (e.g. with a 14 Pin connector for use with Model 3411 Torque Display or DSP 7000 Dynamometer Controller) are available on request.

ORDERING INFORMATION

ORDERING NUMBER | TS 1_ _ / XX
01, 02, ..., 13 : Model TS

Example: TS 109 In-line Torque Sensor would be ordered as: TS 109/XX.