TS 100 SERIES
IN-LINE TORQUE SENSORS

FEATURES

- Integrated Torque, Speed and Angle conditioning
- Torque Range: 0.02 N·m ... 500 N·m
- Integrated Speed Encoder with Index
- Accuracy: 0.05 ... 0.075 %
- Overload Capacity: 200 %
- Overload Limit: 300 %
- Speed Range: ≤ 15 000 rpm
- Torque Output: ±5 V DC (±10 V DC)
- USB Interface & analog Connection
- LED operating status control
- Non-contact (no slip rings)
- Single DC Power Supply: 12 ... 32 V DC
- Calibration Certificate on 2nd Measurment Range available



Fig. 1: TS 110, TS 104 & TS 113 | In-Line Torque Sensor

DESCRIPTION

Magtrol's TS 100 Series In-LineTorque Sensors provide extremely accurate torque and speed measurement. Each model has an integrated conditioning electronic module providing 0 ... ±5 V DC (±10 V DC) 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 a minimum of 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 100 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 V DC (12 ... 32 V DC) 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: 0.02 ... 500 N·m.

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 (10 kHz). The analog signal provides a 0 ... ±5 V DC output corresponding to the sensor nominal range up to 200 % of measuring range (0 ... ±10 V DC). The USB interface can easily be connected and used with the LabVIEW™ dedicated software (TORQUE) delivered with the sensor.

APPLICATIONS

TS 100 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

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INTEGRATED ENCODER

TS 100 Series Torque Sensors integrate a high-end encoder with a minimum of 360 PPR (Pulses Per Revolution) on 2 distinct signals (Tach A, Tach B), 90° out of phase providing an angular measurement resolution ≤ 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. Depending on sensor model, the number of pulses can be 360, 400 or 720 PPR (refer to specification table) and higher rate up to 5 000 PPR are available in option.

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 V DC (12 ... 32 V DC) from the analog connector. The signal cutoff frequency can be digitally selected and configured in a range 2 Hz ... 1000 Hz.

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.

ELECTRICAL CONFIGURATION

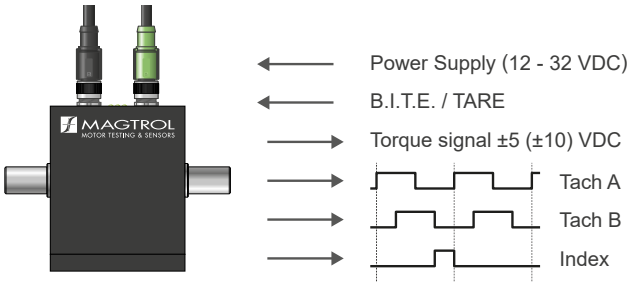

Fig. 2: TS 100 Series Torque Sensor electrical input and output

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 100 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 199 ... TS 103 cannot be used in suspended installation as the weight of the sensor will degrade the accuracy of the measurement due to radial forces.

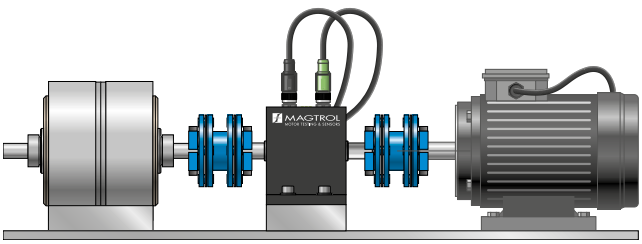

Fig. 3: Supported installation
Mandatory for standard and high speed applications.

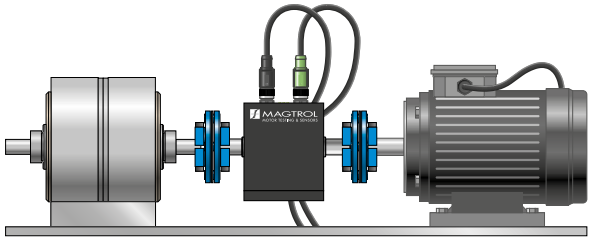

Fig. 4: Suspended installation for low speed applications only.
A single element coupling can be used to create a shorter drive train (configuration for TS 199 ... TS 103 not permitted).

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SYSTEM CONFIGURATIONS

The TS 100 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 70XX - Dynamometer Controller, MODEL 3411 - Torque Display, etc.).

The sensors can be used with Magtrol software, such as TORQUE (included) or M-TEST, to aquiere and display the data. Both software run in the LabVIEW™ environment.

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 100 Series Torque Sensor is used solely with a USB connection, it must be supplied (12 ... 32 V DC) through its analog connection.

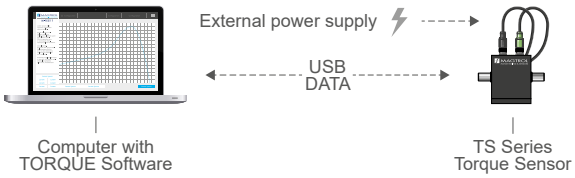

Fig. 5: TS Torque Sensor USB only configuration

ANALOG WITH DYNAMOMETER CONTROLLER

In this configuration the power supply to the sensor is provided by the dynamometer controller. The DSP 70XX 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.

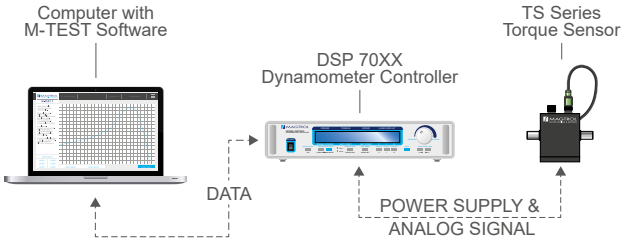

Fig. 6: TS 100 Series Torque Sensor analog configuration connected to and power supplied by the DSP 7000.

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 100 Torque Sensor's USB connection to the computer supplies data acquisition using TORQUE Software.

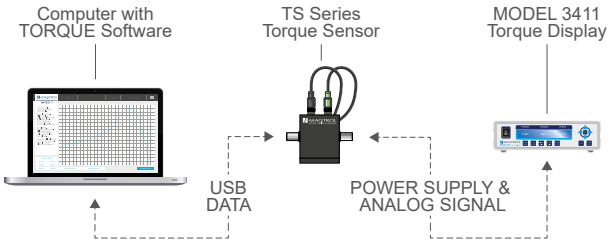

Fig. 7: TS 100 Series Sensor configuration with MODEL 3411 Torque Display

CALIBRATION CERTIFICATE ON 2nd MEASUREMENT RANGE

The TS 100 Torque Sensors are not available in dual measurement range. However, Magtrol offers the possibility of issuing an additional calibration certificate for a 2nd measurement range. For example, on 1/5 of the nominal value, with measurements performed on 5 points. This option is only available if reference weights are available.

Calibrations are carried out in our ISO / IEC 17025:2017 accredited torque measurement laboratory (SCS 0139). Our Swiss laboratory benefits from international recognition by ilac-MRA which guarantees equivalence with organizations accredited by COFRAC, DAkkS, UKAS, A2LA, ANAB, NVLAP, etc.



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SPECIFICATIONS

MECHANICAL CHARACTERISTICS

MODEL	NOMINAL RATED TORQUE (RT)	SHAFT DIAMETER	ACCURACY CLASS	MAX. SPEED	ENCODER RESOLUTION	TORSIONAL STIFFNESS [h]	MOMENT OF INERTIA	ANGULAR DEFORMATION [i]
	N·m	mm	%	rpm	PPR [g]	N·m / rad	kg·m²	Degree
TS 199	0.02	3	0.1	150	5000	3.5	1.79×10^{-6}	0.32
TS 100	0.05	6	0.05	15000	360 [a]	24.0	1.96×10^{-6}	0.12
TS 101	0.1					24.0		0.24
TS 102	0.2					58.0	1.97×10^{-6}	0.20
TS 103	0.5					160.0		0.18
TS 104	1.0	8				330.0	2.19×10^{-6}	0.17
TS 105	2.0					330.0		0.34
TS 106	5.0					665.0	2.23×10^{-6}	0.42
TS 107 [i]	10.0	9				1020.0	2.34×10^{-6}	0.56
TS 108 [i]	10.0	18	0.075	8000	400 [a]	1800.0	3.14×10^{-5}	0.32
TS 109	20.0					3600.0		0.32
TS 110	50.0					7400.0	3.38×10^{-5}	0.39
TS 111	100.0	19				9600.0	3.54×10^{-5}	0.60
TS 112	200.0	30		6000	720	38700.0	4.67×10^{-4}	0.30
TS 113	500.0					62800.0	4.81×10^{-4}	0.46

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 10000 sample per second
Combined Error of Linearity & Hysteresis	0.05 ... 0.1 % of RT [c]
Noise Spectral Density	2 ppm of RT / √ Hz typical [b,c]
Speed Influence on Zero Torque	< 0.015 % / 1000 rpm [d]
Power Supply Change Sensitivity [e]	< 50 (ppm of RT / V)

USB SPEED & ANGLE MEASUREMENT

MODEL	TS 100 - TS 107	TS 108 - TS 111	TS 112 - TS 113
Speed & Angle Measurement	360 PPR [a,g]	400 PPR [a,g]	720 PPR [g]
	2 signals, 90° phase shift (quadrature X4) + Index Optical Encoder		
Computed Speed Accuracy (USB Output)	< ±0.05% [f]		
Angle Resolution (USB)	0.25°	0.225°	0.125°
Accuracy (over 360°)	±0.25°	±0.225°	±0.125°
Thermal drift	< 50 ppm over temperature range		

a) Available with 1000 PPR (speed limit 5000 rpm) or 5000 PPR (speed limit 1000 rpm).

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

c) Please refer to the "Accuracy Class" column in the table.

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° of rotation.

g) PPR means Pulse Per Revolution.

h) Calculated at the middle of shaft outputs.

i) For 10 N·m, if speed does not exceed 8000 rpm, TS 108 is recommended

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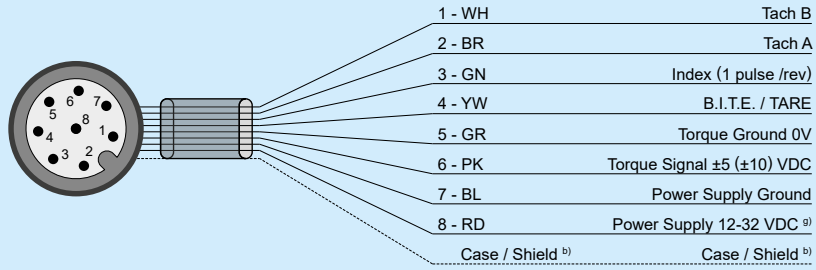
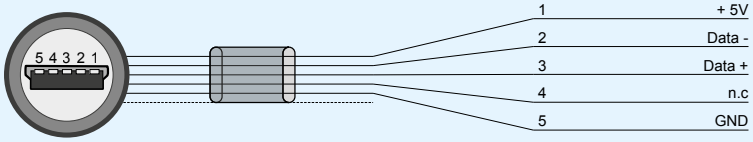
SPECIFICATIONS

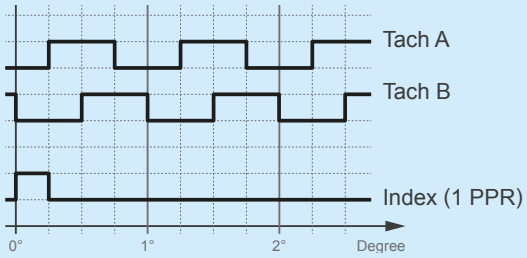
ENVIRONMENT & CERTIFICATIONS

Storage Temperature	-40 °C ... +85 °C
Operating Temperature	-25 °C ... +80 °C
Temperature Influence on Zero / Sensitivity	< ±0.1 % / 10 °C for the range -25 °C ... +80 °C [a]
Mechanical Shock	IEC 60068-2-27 : 2008 / Class C3
Vibration Sinusoidal	IEC 60068-2-6 : 2007 / Class C3
Protection Class	IP 44 (DIN EN 60529)
EMC / EMI Compatibility	IEC 61326-1 / IEC 61321-2-3
Balancing Quality	G 2.5 according to ISO 1940
Safety Standard	ISO 13849 / EN 62061
Low voltage	IEC 61010-1

ELECTRICAL CHARACTERISTICS & CONNECTIONS

Power Supply (voltage range / max. power)	12 ... 32 V DC / < 2.2 W (24 V DC recommended)
Analog Torque Output (rated / max.)	±5 V / ±10 V (max. output current 2 mA)
Torque Signal Bandwidth (-3 dB) controlled by USB command.	2 Hz / 5 Hz / 10 Hz / 20 Hz / 50 Hz / 100 Hz / 1 000 Hz (50 Hz is factory default)
Wiring diagram (Analog)	
Wiring diagram (USB)	 USB - Mini B

ANALOG INPUT AND OUTPUT SIGNALS

Tach Outputs & Index	Tach A + B, number of PPR, 100 kHz max. frequency, Index 1 PPR [c,d,e,f]  TTL, max. output current 5 mA
B.I.T.E. (Built-In Test Equipment)	B.I.T.E. Input pin grounded for more than 1 s allows +60 % FSD shift at the O/P for 5 s (refer to manual for more information)
TARE	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.

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) Number of PPR according to model number. Please see «Encoder Resolution» in specification table (page 4)

e) Available in option with 1 000 PPR (speed limit 5 000 rpm) or 5 000 PPR (speed limit 1 000 rpm)

f) The diagram represents the behavior for a 360 PPR encoder

g) The TS 100 Series Sensors are protected against reverse polarity.

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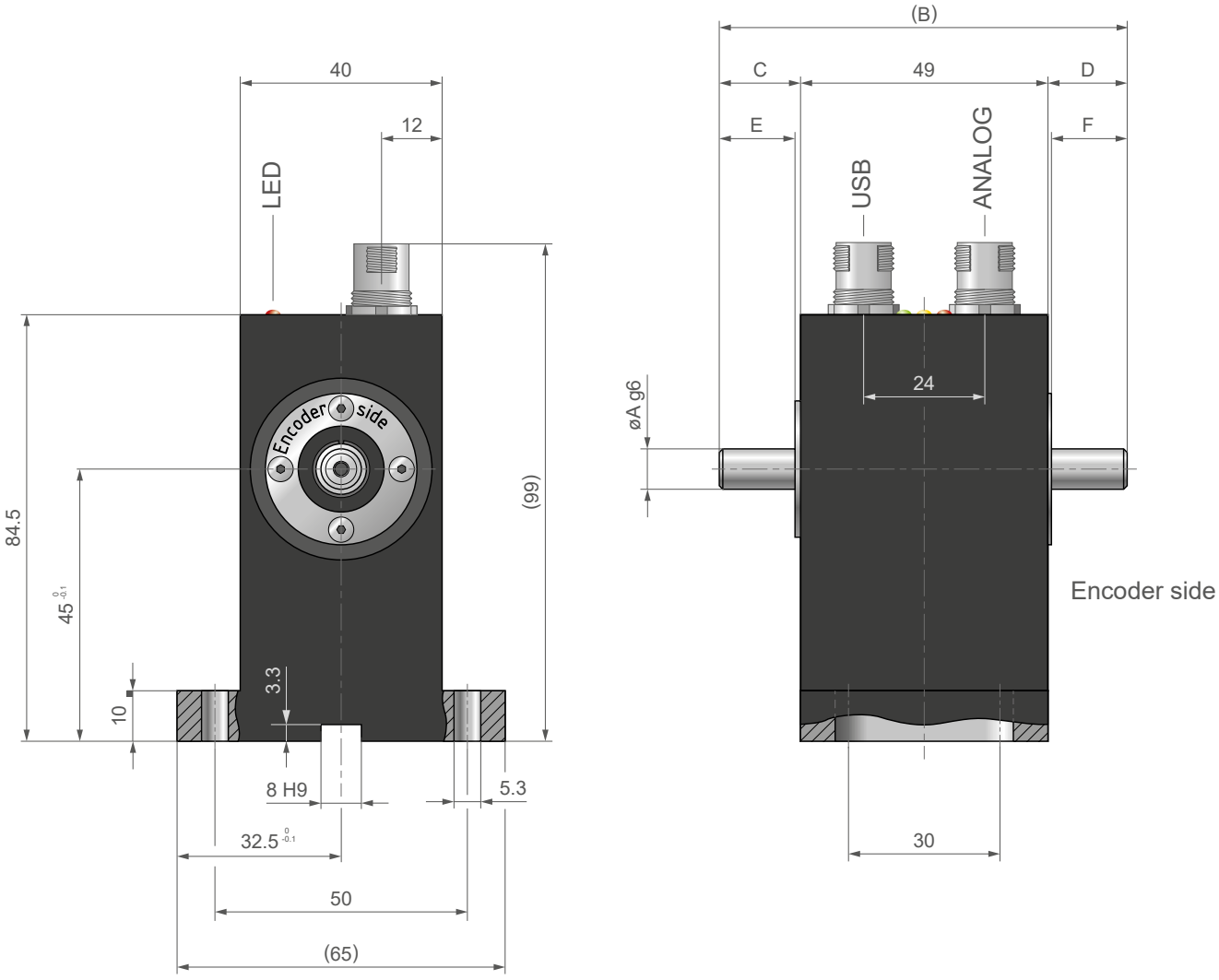
TS 100-107 DIMENSIONS



NOTE: All values are in SI units. Dimensions are in millimeters.

MODEL	TORQUE [N·m]	øA g6	B	C	D	E	F	WEIGHT
TS 199	0.02	3	74.8	12.9	12.9	10.9	12.0	0.50 kg
TS 100	0.05	6	80.8	16.1	15.7	15.0	15.0	
TS 101	0.1							
TS 102	0.2							
TS 103	0.5							
TS 104	1.0	8	85.0	18.2	17.8	17.1	17.1	0.65 kg
TS 105	2.0							
TS 106	5.0		90.8	21.1	20.7	20.0	20.0	0.70 kg
TS 107	10.0	9						

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

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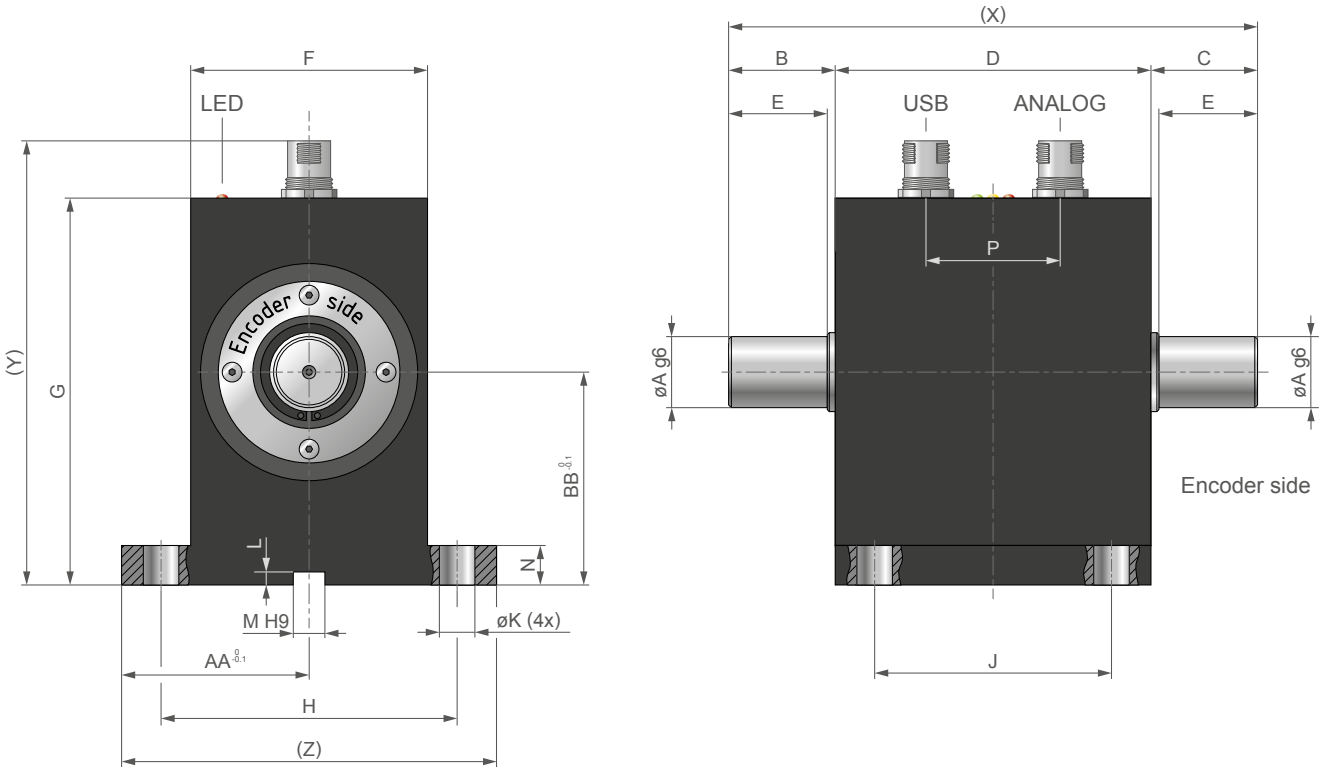
TS 108-113 DIMENSIONS



NOTE: All values are in SI units. Dimensions are in millimeters.

MODEL	TORQUE	øA	B	C	D	E	F	G	H	J	øK
TS 108	10 N·m	18 g6	27.0	27.0	80	25	60	96.3	75	60	9
TS 109	20 N·m										
TS 110	50 N·m		37.0	37.0		35					
TS 111	100 N·m	19 g6	42.0	42.0		40					
TS 112	200 N·m	30 g6	46.7	47.3	110	45	95	144.0	125	80	11
TS 113	500 N·m										

MODEL	L	M	N	P	AA	BB	X	Y	Z	WEIGHT
TS 108	3.3	8 H9	10	34	47.5 (0 -0.1)	45 (0 -0.1)	134	111	95	1.25 kg
TS 109										
TS 110							154			1.30 kg
TS 111							164			1.35 kg
TS 112	4.1	10 H9	20	34	75.0 (0 -0.1)	75 (0 -0.1)	204	159	150	5.00 kg
TS 113										

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SYSTEM OPTIONS AND ACCESSORIES

COUPLINGS

When Magtrol TS100 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.



Fig. 8: MIC Series Miniature coupling

TSB - 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.



Fig. 9: TSB | Torque Speed Box

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.

MODEL 3411 - TORQUE DISPLAY

Magtrol offers the MODEL 3411 - 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



Fig. 10: MODEL 3411 | Torque Display

DSP 701X - DYNAMOMETER CONTROLLER

Magtrol's DSP 701X 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 701X can provide complete PC control via the USB or IEEE-488 interface. With up to 500 readings per second, the DSP 701X is ideally suited for both the test lab and the production line. Standard Features:

- **DSP 7011 Single Channel**: Easy to use plug & play solution;
- **DSP 7012 Dual Channel**: Enables the support of two testing instruments with independent or tandem configurations and two fully independent control loops;
- Built-in Alarm System (power, torque, speed, etc.);
- Speed & Torque closed loop Operating Modes;
- Programmable Digital PID Values;
- Built-in Current-Regulated Supply;
- Selectable Torque Units (imperial, metric).



Fig. 11: DSP 7011 | Dynamometer Controller

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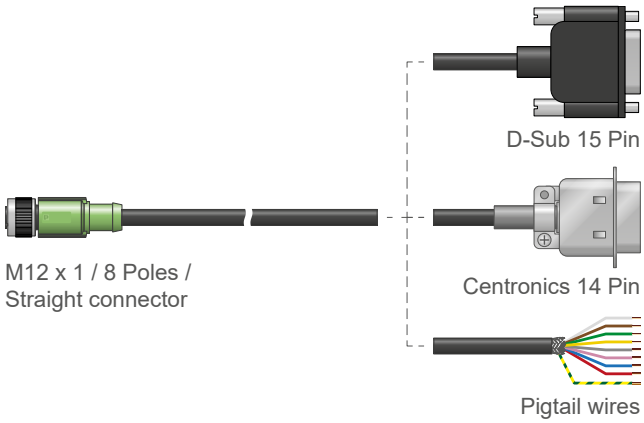
SYSTEM OPTIONS AND ACCESSORIES

CABLE ASSEMBLIES (ANALOG & POWER SUPPLY / USB)

Each TS 100 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 Centronics connector for use with MODEL 3411 Torque Display or DSP 700X Dynamometer Controller) are available on request.





M12 x 1 / mini-B /
Straight connector

2.0 USB-A

ORDERING NUMBER	ER 12	_	/ 0	_

0 : Pigtail wires
1 : 14 Pin Centronics connector [a]
2 : 15 Pin D-Sub connector [b]

1 : Cable length 5 m
2 : Cable length 10 m
3 : Cable length 20 m
4 : Cable length 3 m

ORDERING NUMBER	957-11-07-251	_

3 : Cable length 2 m
4 : Cable length 5 m

a) For use with: MODEL 3411, DSP 70**0X**, TSB 038, SBB-14.
b) For use with: DSP 70**1X**, TSB 138, SBB-15.

ORDERING INFORMATION

ORDERING NUMBER	TS	_ _ _	/ XX

199, 100, 101, ... , 113 : Model TS

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

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