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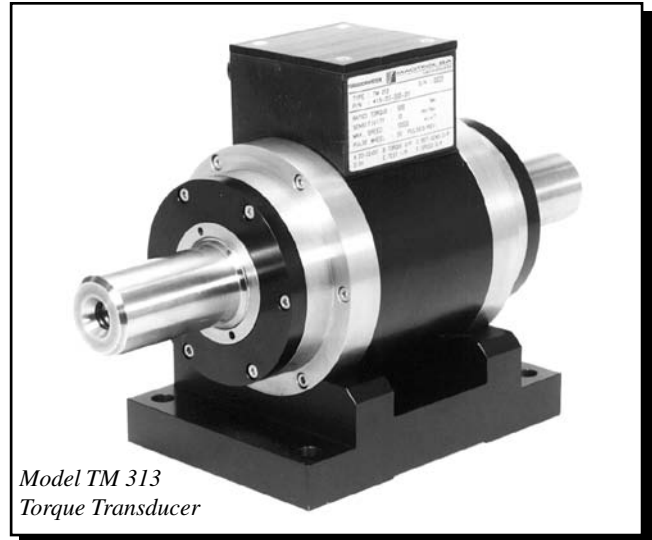
# TM 309 – TM 313

## In-Line Torque Transducers

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### FEATURES

- Integrated Torque and Speed Conditioning
- Torque Rating: 20 N·m to 500 N·m (37 lb·ft to 369 lb·ft)
- Accuracy: < 0.1%
- Overload Capacity: 200%
- Overload Limit: 400%
- High Speed Applications: up to 32,000 rpm
- Non-Contact (no slippings)
- No Electronic Components in Rotation
- High Electrical Noise Immunity
- Single DC Power Supply: 20 VDC to 32 VDC
- Immediate Speed Detection
- Adjustable Torque Signal Frequency Limitation
- Built-in Test Function
- Stainless Steel Shaft
- EMC Susceptibility Conforms to European Standards



### DESCRIPTION

Magtrol's In-Line Torque Transducers provide extremely accurate torque and speed measurement over a very broad range. Each model has an integrated conditioning electronic module providing a 0 to  $\pm 10$  VDC torque output and an open collector speed output. Magtrol Torque Transducers are very reliable, providing high overload protection, excellent long term stability and high noise immunity.

All transducer models employ our unique non-contact differential transformer torque measuring technology. This measuring technology offers many benefits, most notably that no electronic components rotate during operation.

To provide customers with several price/performance options, Magtrol offers three torque transducer models: basic accuracy (TMB series), high accuracy (TM series) and high speed with high accuracy (TMHS).

Each transducer consists of a hardened stainless steel shaft with smooth or splined shaft ends, an anodized aluminium housing containing the guide bearings and an electronic measurement conditioner. The integrated electronic circuit, supplied by single

DC voltage, provides torque and speed signals without any additional amplifier. The transducer is a stand-alone measuring chain. Connections are made by means of a 6-pole male connector mounted on the housing. A removable aluminium base—delivered as standard with TM and TMHS models, and as an option for TMB transducers—allows fixed mounting of the transducer.

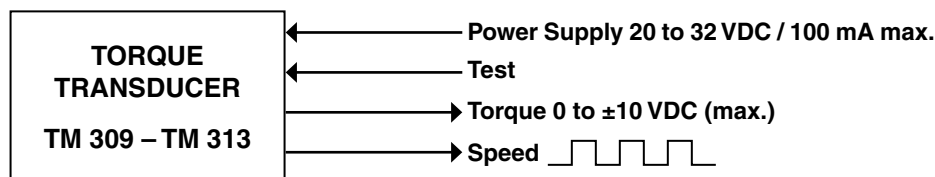
### APPLICATIONS

TM, TMB and TMHS Series Torque Transducers provide dynamic torque and speed measurement of:

- Propellers - aerospace, marine and helicopter
- Windshield wipers, electrical windows, starters, generators and brakes in automobile industry
- Pumps - water and oil
- Reduction gears and gearboxes
- Clutches
- Motorized valves
- Drills, pneumatic tools and other machine tools

### BASIC SYSTEM CONFIGURATION

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## MODEL RATINGS

The ratings in the following table apply to all Torque Transducer series (TM, TMHS and TMB).

Model	Nominal Rated Torque		Torsional Stiffness		Moment of Inertia		Weight *	
	N-m	lb-ft	N-m/rad	lb-ft/rad	kg-m <sup>2</sup>	lb-ft-s <sup>2</sup>	kg	lb
309	20	15	2.4 × 10 <sup>3</sup>	1.770 × 10 <sup>3</sup>	1.49 × 10 <sup>-4</sup>	1.03 × 10 <sup>-4</sup>	2.5	5.51
310	50	37	5.7 × 10 <sup>3</sup>	4.204 × 10 <sup>3</sup>	1.52 × 10 <sup>-4</sup>	1.12 × 10 <sup>-4</sup>	2.5	5.51
311	100	74	1.14 × 10 <sup>4</sup>	8.408 × 10 <sup>3</sup>	1.55 × 10 <sup>-4</sup>	1.14 × 10 <sup>-4</sup>	2.5	5.51
312	200	148	3.82 × 10 <sup>4</sup>	2.82 × 10 <sup>4</sup>	4.85 × 10 <sup>-4</sup>	3.57 × 10 <sup>-4</sup>	4.1	9.04
313	500	369	9.58 × 10 <sup>4</sup>	7.07 × 10 <sup>4</sup>	5.16 × 10 <sup>-4</sup>	3.80 × 10 <sup>-4</sup>	4.4	9.70

\* The weight for TMB series transducers ordered without an optional foot mount is slightly lower.

## SERIES RATINGS

The ratings in the following table apply to all standard Torque Transducer models 309–313, except where specifically noted.

Standard Version	TM Series	TMHS Series	TMB Series
<b>TORQUE MEASUREMENT</b>			
Rated Torque (RT)	0 to ±100% of RT		
Maximum Dynamic Torque Peak Value (Overload Capacity)	0 to ±200% of RT		
Maximum Dynamic Torque Without Damage (Overload Limit)	0 to ±400% of RT		
Combined Error of Linearity and Hysteresis to 100% of RT	< ±0.1% of RT	< ±0.1% of RT	< ±0.1% of RT
Combined Error of Linearity and Hysteresis from 100 to 200% of RT	< ±0.15% of RT	< ±0.15% of RT	< ±0.15% of measured value
Temperature Influence on the Zero/Sensitivity:			
• In the Compensated Range +10 °C to +60 °C	< ±0.1% of RT/10K		< ±0.2% of RT/10K
• In the Compensated Range -25 °C to +80 °C	< ±0.2% of RT/10K		< ±0.4% of RT/10K
Influence of Speed on the Zero Torque Signal	< ±0.01% of RT/1000 rpm		< ±0.02% of RT/1000 rpm
Long-term Stability of Sensitivity	< ±0.05% of RT/year		< ±0.1% of RT/year
<b>SPEED MEASUREMENT</b>			
Rated Range of Use	models 309–311 1 to 10,000 rpm	1 to 32,000 rpm	1 to 4,000 rpm
	models 312–313 1 to 10,000 rpm	1 to 24,000 rpm	1 to 4,000 rpm
Number of Teeth	60 Z		
Minimum Speed Detection	1 rpm		
<b>ENVIRONMENT</b>			
Storage Temperature Range	-40 °C to +100 °C		
Operating Temperature Range	-40 °C to +85 °C		
Mechanical Shock	according to IEC 68.2.27 / Class D3		
Vibration	according to IEC 68.2.6 / Class D3		
Protection Class	IP 44		
<b>MECHANICAL CHARACTERISTICS</b>			
Shaft Ends	model 309 smooth	smooth	keyway
	models 310–311 smooth	smooth	keyway
	models 312–313 smooth or splined	smooth or splined	keyway
Balancing Quality	G1 according to ISO 1940		G2.5 according to ISO 1940
Foot Support (Base Mount)	included	included	optional
<b>INPUT AND OUTPUT SIGNALS</b>			
Power Supply (max. voltage / current)	20 to 32 VDC / 100 mA		
Torque Output (rated / max.)	±5 / ±10 VDC		
Filter Cutoff (frequency)	5000, 2500, 1000, 500, 200, 100, 40, 20, 10, 5, 2, 1 Hz		
Speed Output (frequency)	open collector (15 Ω in series), max. 30 VDC, protected against short-circuits		
<b>CONNECTORS</b>			
Counter Connector (female)	optional (P/N 957.11.08.0081)		

## OPERATING PRINCIPLES

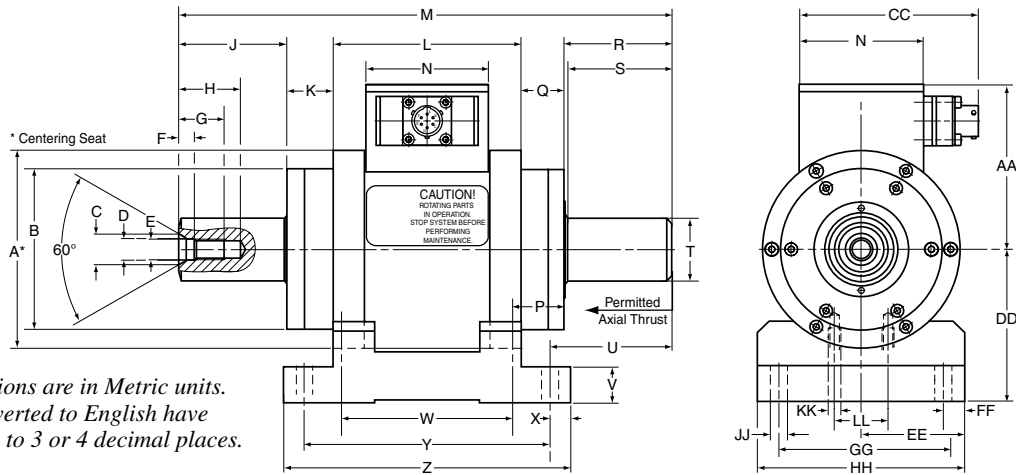
The measuring system, based on the principle of a variable, torque-proportional transformer coupling, consists of two concentric cylinders shrunk on the shaft on each side of the shaft's deformation zone, and two concentric coils attached to the housing.

Both cylinders have a circularly disposed coinciding row of slots and rotate with the shaft inside the coils. An alternating current with the frequency of 20 kHz flows through the primary coil. When no torque is applied, the slots on the two cylinders fail to overlap. When torque is applied, the deformation zone undergoes an angular deformation and the slots begin to overlap.

Thus a torque-proportional voltage is on the secondary coil. The conditioning electronic circuit incorporated in the transducer converts the voltage to a nominal torque signal of 0 to  $\pm 5$  VDC. A low-pass filter (Butterworth/2nd order), adjustable from 5 kHz to 1 Hz, allows tuning of the torque signal frequency limitation.

An optical sensor reads the speed on a toothed path machined directly on the measuring system. The electronic conditioner outputs a frequency signal proportional to the shaft rotational speed. An active circuit compensates the zero and sensitivity temperature drifts within a tolerance of 0.1% / 10 K.

## TRANSDUCERS WITH SMOOTH SHAFT



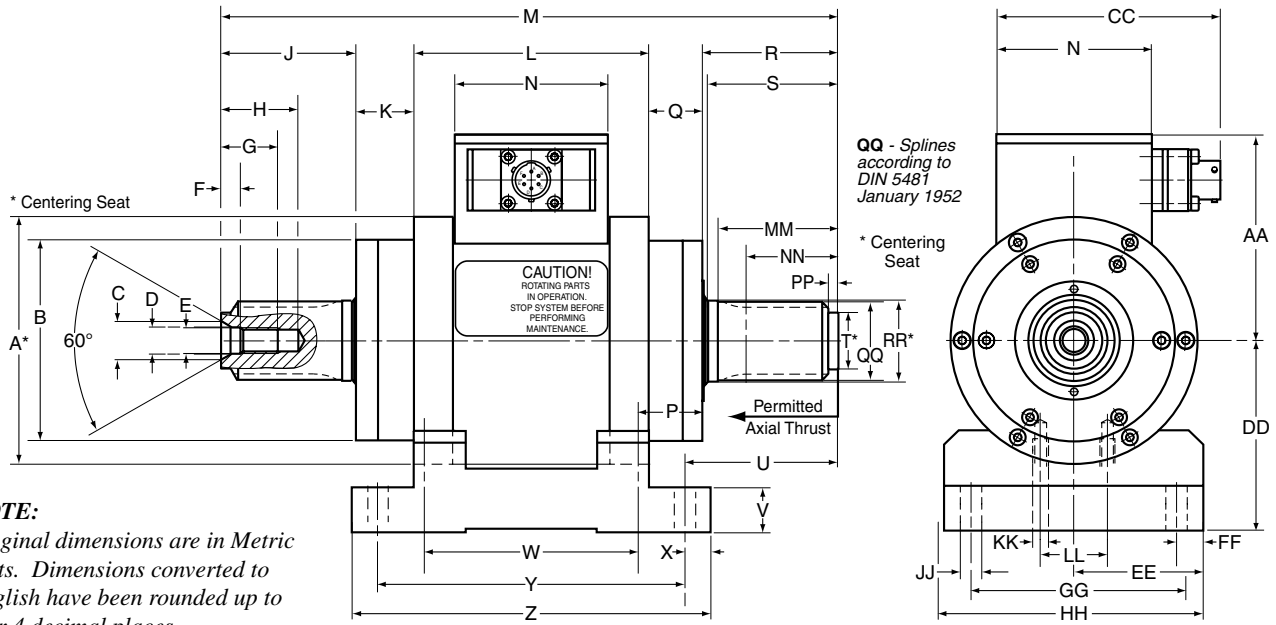
### NOTE:

Original dimensions are in Metric units.  
Dimensions converted to English have been rounded up to 3 or 4 decimal places.

Model	units	Ø A	Ø B	Ø C	Ø D	E	F	G	H	J	K	L	M	N	P	Q	R	S	Ø T
309/X11	mm	82g6	64	9.6	6.4	M6	5.0	16	21	26.2	16.8	86	170.4	60	20	15	26.4	25	20h6
	in	3.2283 3.2270	2.52	0.378	0.252	M6	0.197	0.63	0.827	1.031	0.661	3.386	6.709	2.362	0.787	0.591	1.039	0.984	0.7874 0.7869
310/X11	mm	82g6	64	9.6	6.4	M6	5.0	16	21	36.2	16.8	86	190.4	60	20	15	36.4	35	20h6
	in	3.2283 3.2270	2.52	0.378	0.252	M6	0.197	0.63	0.827	1.425	0.661	3.386	7.496	2.362	0.787	0.591	1.433	1.378	0.7874 0.7869
311/X11	mm	82g6	64	9.6	6.4	M6	5.0	16	21	41.2	16.8	86	200.4	60	20	15	41.4	40	20h6
	in	3.2283 3.2270	2.52	0.378	0.252	M6	0.197	0.63	0.827	1.622	0.661	3.386	7.89	2.362	0.787	0.591	1.63	1.575	0.7874 0.7869
312/X11	mm	96g6	78	14.9	10.5	M10	7.5	22	30	46.4	22.8	91	228.0	60	25	21	46.8	45	30h6
	in	3.7791 3.7782	3.071	0.587	0.413	M10	0.295	0.866	1.181	1.827	0.898	3.583	8.976	2.362	0.984	0.827	1.842	1.772	1.1811 1.1806
313/X11	mm	96g6	78	14.9	10.5	M10	7.5	22	30	56.4	22.8	91	248.0	60	25	21	56.8	55	30h6
	in	3.7791 3.7782	3.071	0.587	0.413	M10	0.295	0.866	1.181	2.22	0.898	3.583	9.764	2.362	0.984	0.827	2.236	2.165	1.1811 1.1806

Model	units	U	V	W	X	Y	Z	AA	CC	DD	EE	FF	GG	HH	Ø JJ	KK	LL
309/X11	mm	29.4	12	76	10	110	130	74	87	60 <sup>(0/-0.05)</sup>	45±0.025	8	74	90±0.05	6.6	M5×10	20
	in	1.157	0.472	2.992	0.394	4.331	5.118	2.913	3.425	2.3622 2.3603	1.7726 1.7707	0.315	2.913	3.5453 3.5413	0.260	M5×0.394	0.787
310/X11	mm	39.4	12	76	10	110	130	74	87	60 <sup>(0/-0.05)</sup>	45±0.025	8	74	90±0.05	7	M5×10	20
	in	1.551	0.472	2.992	0.394	4.331	5.118	2.913	3.425	2.3622 2.3603	1.7726 1.7707	0.315	2.913	3.5453 3.5413	0.276	M5×0.394	0.787
311/X11	mm	44.4	12	76	10	110	130	74	87	60 <sup>(0/-0.05)</sup>	45±0.025	8	74	90±0.05	7	M5×10	20
	in	1.748	0.472	2.992	0.394	4.331	5.118	2.913	3.425	2.3622 2.3603	1.7726 1.7707	0.315	2.913	3.5453 3.5413	0.276	M5×0.394	0.787
312/X11	mm	53.8	18	83	10	119	139	80	87	75 <sup>(0/-0.05)</sup>	50±0.025	10	80	100±0.05	9	M6×8	26
	in	2.118	0.709	3.268	0.394	4.685	5.472	3.15	3.425	2.9527 2.9508	1.9695 1.9675	0.394	3.15	3.9390 3.9350	0.354	M6×0.315	1.024
313/X11	mm	63.8	18	83	10	119	139	80	87	75 <sup>(0/-0.05)</sup>	50±0.025	10	80	100±0.05	9	M6×8	26
	in	2.512	0.709	3.268	0.394	4.685	5.472	3.15	3.425	2.9527 2.9508	1.9695 1.9675	0.394	3.15	3.9390 3.9350	0.354	M6×0.315	1.024

**TRANSDUCERS WITH SPLINED SHAFT**



**NOTE:**  
Original dimensions are in Metric units. Dimensions converted to English have been rounded up to 3 or 4 decimal places.

Model	units	Ø A	Ø B	Ø C	Ø D	E	F	G	H	J	K	L	M	N
312/X21	mm	96g6	78	14.9	10.5	M10	7.5	22	30	40.4	22.8	91	216	60
	in	3.7791 3.7782	3.071	0.587	0.413	M10	0.295	0.866	1.181	1.591	0.898	3.583	8.504	2.362
313/X21	mm	96g6	78	14.9	10.5	M10	7.5	22	30	52.4	22.8	91	240	60
	in	3.7791 3.7782	3.071	0.587	0.413	M10	0.295	0.866	1.181	2.063	0.898	3.583	9.449	2.362

Model	units	P	Q	R	S	Ø T	U	V	W	X	Y	Z	AA	CC
312/X21	mm	25	21	40.8	39	22h6	47.8	18	83	10	119	139	80	87
	in	0.984	0.827	1.606	1.535	0.8661 0.8656	1.882	0.709	3.268	0.394	4.685	5.472	3.15	3.425
313/X21	mm	25	21	52.8	51	22h6	59.8	18	83	10	119	139	80	87
	in	0.984	0.827	2.079	2.008	0.8661 0.8656	2.354	0.709	3.268	0.394	4.685	5.472	3.15	3.425

Model	units	DD	EE	FF	GG	HH	Ø JJ	KK	LL	MM	NN	PP	QQ	Ø RR
312/X21	mm	75 (0/-0.05)	50±0.025	10	80	100±0.05	9	M6×8	26	35	24	4	26×30	31h6
	in	2.9527 2.9508	1.9695 1.9675	0.394	3.15	3.9390 3.9350	0.354	M6×0.315	1.024	1.378	0.945	0.157	26×30	1.2205 1.2198
313/X21	mm	75 (0/-0.05)	50±0.025	10	80	100±0.05	9	M6×8	26	47	36	4	26×30	31h6
	in	2.9527 2.9508	1.9695 1.9675	0.394	3.15	3.9390 3.9350	0.354	M6×0.315	1.024	1.850	1.417	0.157	26×30	1.2205 1.2198

**OPTIONS**

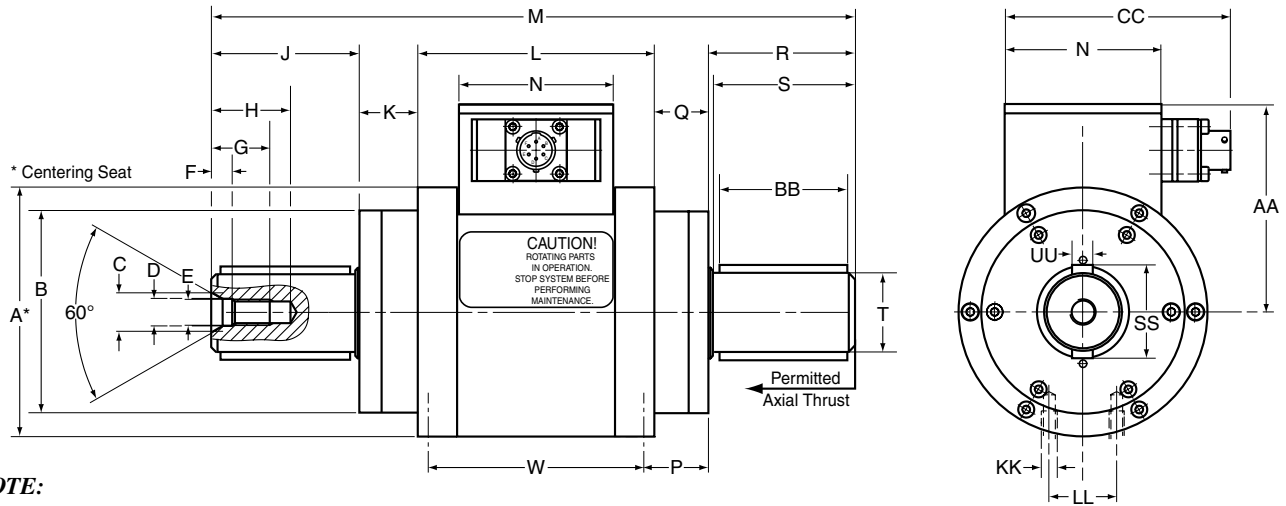
**Flanges**

Flanges are optional for torque transducers with splined shaft ends. Flange drawing is available on request.

Description	Model	P/N
Flange for Model 312/X21	FTM 212	415-212-960-011
Flange for Model 313/X21	FTM 213	415-213-960-011



## TMB TRANSDUCERS WITH KEYWAY

**NOTE:**

Original dimensions are in Metric units. Dimensions converted to English have been rounded up to 3 or 4 decimal places.

Model	units	Ø A	Ø B	Ø C	Ø D	E	F	G	H	J	K	L	M	P
310/431	mm	82g6	64	9.6	6.4	M6	5.0	16	21	36.2	16.8	86	190.4	20
	in	3.2283 3.2270	2.52	0.378	0.252	M6	0.197	0.63	0.827	1.425	0.661	3.386	7.496	0.787
311/431	mm	82g6	64	9.6	6.4	M6	5.0	16	21	41.2	16.8	86	200.4	20
	in	3.2283 3.2270	2.52	0.378	0.252	M6	0.197	0.63	0.827	1.622	0.661	3.386	7.89	0.787
312/431	mm	96g6	78	14.9	10.5	M10	7.5	22	30	46.4	22.8	91	228.0	25
	in	3.7791 3.7782	3.071	0.587	0.413	M10	0.295	0.866	1.181	1.827	0.898	3.583	8.976	0.984
313/431	mm	96g6	78	14.9	10.5	M10	7.5	22	30	56.4	22.8	91	248.0	25
	in	3.7791 3.7782	3.071	0.587	0.413	M10	0.295	0.866	1.181	2.22	0.898	3.583	9.764	0.984

Model	units	N	Q	R	S	Ø T	W	AA	BB	CC	KK	LL	SS	UU
310/431	mm	60	15	36.4	35	20h6	76	74	32	87	M5x10	20	25	6h9
	in	2.362	0.591	1.433	1.378	0.7874 0.7869	2.992	2.913	1.26	3.425	M5x0.394	0.787	0.984	0.2362 0.2350
311/431	mm	60	15	41.4	40	20h6	76	74	37	87	M5x10	20	25	6h9
	in	2.362	0.591	1.63	1.575	0.7874 0.7869	2.992	2.913	1.457	3.425	M5x0.394	0.787	0.984	0.2362 0.2350
312/431	mm	60	21	46.8	45	30h6	83	80	42	87	M6x8	26	36	8h9
	in	2.362	0.827	1.842	1.772	1.1811 1.1806	3.268	3.15	1.653	3.425	M6x0.315	1.024	1.417	0.3150 0.3135
313/431	mm	60	21	56.8	55	30h6	83	80	52	87	M6x8	26	36	8h9
	in	2.362	0.827	2.236	2.165	1.1811 1.1806	3.268	3.15	2.047	3.425	M6x0.315	1.024	1.417	0.3150 0.3135

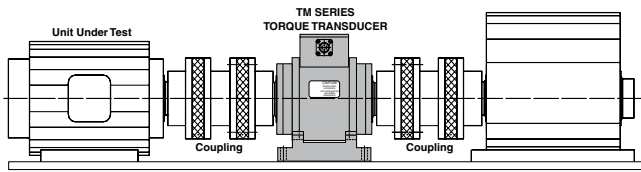
## OPTIONS

### Foot Mount

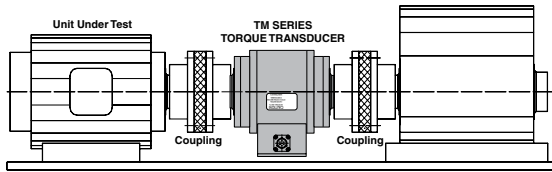
For foot mount dimensions, refer to U–Z and DD–JJ dimensions of the smooth shaft transducer.

Description	Model	P/N
Foot mount for models 310–311 PTM 310		415-309-950-011
Foot mount for models 312–313 PTM 312		415-312-950-011

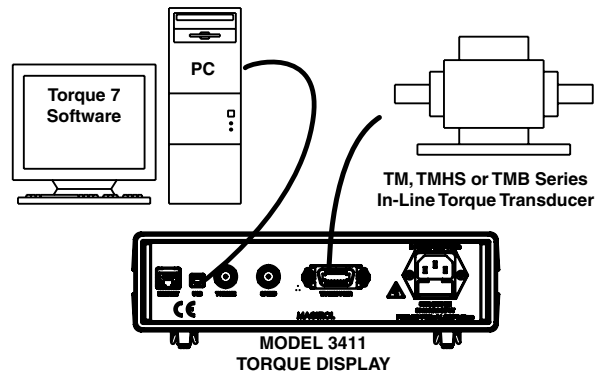
## SYSTEM OPTIONS AND ACCESSORIES



**Supported Installation**  
Mandatory for high speed applications.



**Suspended Installation**  
For low speed applications only, uses single-element couplings to create a shorter drive train.



**PC-Based System Configuration**  
Torque Transducer with Model 3411 Display and Torque 7 Software

### Couplings

When Magtrol TMB, TM and TMHS Series Torque Transducers are to be mounted in a drive train, double-element miniature couplings are the ideal complement, although single-element couplings can be used for low speed applications. Several manufacturers provide adequate couplings for both supported and suspended drive train installations. The criteria for selecting appropriate couplings for torque measurement is as follows:

- High torsional spring rate: Ensures high torsional stiffness & angular precision (should be > 3 times the torque transducer stiffness)
- Clamping quality (should be self-centering & 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. Your Magtrol sales representative 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 Transducer Displays

Magtrol offers two different Torque Displays (Models 3411 and 6400) which supply power to any TM/TMHS/TMB Transducer and display 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
- Overload indication
- Tare function
- RS-232 interface
- Torque and speed outputs
- Closed-box calibration
- Includes Magtrol Torque 7 Software

The Model 6400 Display has the following additional features:

- Pass/fail torque-speed-power testing capabilities
- RS-232 and IEEE-488 interface
- Auxiliary analog input

### Torque 7 Software

Magtrol's Torque 7 Software is an easy-to-use Windows® executable program, used to automatically collect torque, speed and mechanical power data. The data can be printed, displayed graphically or quickly saved as a Microsoft® Excel spreadsheet. Standard features of Torque 7 include: peak torque capture, multi-axes graphing, measured parameter vs. time, adjustable sampling rates and polynomial curve fitting.

Accessories	Model #
Torque Transducer Connector Cable (5/10/20 m)	ER 113

**ORDERING INFORMATION**

Magtrol Torque Transducer model numbers must be preceded by the series type and followed by the appropriate suffix.

TORQUE TRANSDUCERS	
• Model TM 309-313	TM 3□□/0□1
Smooth Shaft (309-313)	1
Splined Shaft (312-313)	2
• Model TMHS 309-313	TMHS 3□□/1□1
Smooth Shaft (309-313)	1
Splined Shaft (312-313)	2
• Model TMB 309-313	TMB 3□□/431

*Due to the continual development of our products, we reserve the right to modify specifications without forewarning.*

[www.magtrol.com](http://www.magtrol.com)

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