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# TM 314 – TM 317

## In-Line Torque Transducers

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### FEATURES

- Integrated Torque and Speed Conditioning
- Torque Rating: 1000 to 10,000 N·m (737 to 7375 lb-ft)
- Accuracy: < 0.1% (depending on model)
- Overload Capacity: 200%
- Overload Limit: 500% (TM 317 up to 350%)
- High Speed Applications: up to 16,000 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 two torque transducer models: 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, allows fixed mounting of the transducer.

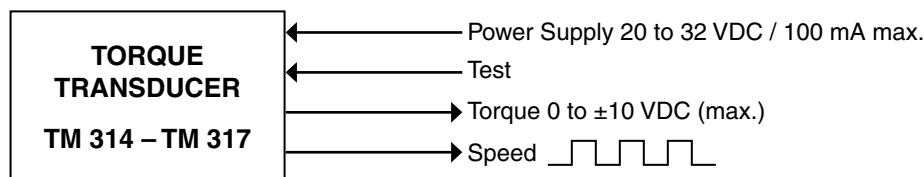
### APPLICATIONS

TM 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 both Torque Transducer series (TM and TMHS).

| Model | Nominal Rated Torque |       | Torsional Stiffness    |                        | Shaft Ends | 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   |
| 314   | 1,000                | 737   | 3.28 × 10 <sup>5</sup> | 2.41 × 10 <sup>5</sup> | keyway     | 3.00 × 10 <sup>-3</sup> | 2.24 × 10 <sup>-3</sup> | 9.9    | 21.8 |
|       |                      |       |                        |                        | splined    | 2.76 × 10 <sup>-3</sup> | 2.04 × 10 <sup>-3</sup> | 9.2    | 20.3 |
| 315   | 2,000                | 1,475 | 6.56 × 10 <sup>5</sup> | 4.83 × 10 <sup>5</sup> | keyway     | 3.29 × 10 <sup>-3</sup> | 2.43 × 10 <sup>-3</sup> | 10.8   | 23.8 |
|       |                      |       |                        |                        | splined    | 3.01 × 10 <sup>-3</sup> | 2.22 × 10 <sup>-3</sup> | 10.1   | 22.3 |
| 316   | 5,000                | 3,687 | 1.94 × 10 <sup>6</sup> | 1.43 × 10 <sup>6</sup> | splined    | 9.93 × 10 <sup>-3</sup> | 7.32 × 10 <sup>-3</sup> | 20.0   | 44.1 |
| 317   | 10,000               | 7,375 | 2.95 × 10 <sup>6</sup> | 2.17 × 10 <sup>6</sup> | splined    | 1.17 × 10 <sup>-2</sup> | 8.62 × 10 <sup>-3</sup> | 22.3   | 49.2 |

## SERIES RATINGS

The ratings in the following table apply to all standard Torque Transducer models 314–317.

| Standard Version   | Model   | TM Series  | TMHS Series     |
|--|---------|--|-----------------|
| <b>TORQUE MEASUREMENT</b>  |         |  |                 |
| Rated Torque (RT)  | 314–317 | 0 to ±100% of RT   |                 |
| Maximum Dynamic Torque Peak Value (Overload Capacity)  | 314–317 | 0 to ±200% of RT   |                 |
| Maximum Dynamic Torque Without Damage (Overload Limit)   | 314–316 | 0 to ±500% of RT   |                 |
|  | 317     | 0 to ±350% of RT   |                 |
| Combined Error of Linearity and Hysteresis to 100% of RT   | 314–316 | < ±0.1% of RT  |                 |
|  | 317     | < ±0.15% of RT   |                 |
| Combined Error of Linearity and Hysteresis from 100 to 200% of RT  | 314–316 | < ±0.1% of measured value  |                 |
|  | 317     | < ±0.15% of measured value   |                 |
| Temperature Influence on the Zero/Sensitivity:<br>• In the Compensated Range +10 °C to +60 °C<br>• In the Compensated Range -25 °C to +80 °C | 314–317 | < ±0.1% of RT/10K<br>< ±0.2% of RT/10K   |                 |
| Influence of Speed on the Zero Torque Signal   | 314–317 | < ±0.01% of RT/1000 rpm  |                 |
| Long-term Stability of Sensitivity   | 314–317 | < ±0.05% of RT/year  |                 |
| <b>SPEED MEASUREMENT</b>   |         |  |                 |
| Rated Range of Use   | 314–315 | 1 to 7,000 rpm   | 1 to 16,000 rpm |
|  | 316–317 | 1 to 5,000 rpm   | 1 to 12,000 rpm |
| Number of Teeth  | 314–317 | 60 Z   |                 |
| Minimum Speed Detection  | 314–317 | 1 rpm  |                 |
| <b>ENVIRONMENT</b>   |         |  |                 |
| Storage Temperature Range  | 314–317 | -40 °C to +100 °C  |                 |
| Operating Temperature Range  | 314–317 | -40 °C to +85 °C   |                 |
| Mechanical Shock   | 314–317 | according to IEC 68.2.27 / Class D3  |                 |
| Vibration  | 314–317 | according to IEC 68.2.6 / Class D3   |                 |
| Protection Class   | 314–317 | IP 44  |                 |
| <b>MECHANICAL CHARACTERISTICS</b>  |         |  |                 |
| Shaft Ends   | 314–315 | splined or keyway  |                 |
|  | 316–317 | splined  |                 |
| Balancing Quality  | 314–317 | G1 according to ISO 1940   |                 |
| Foot Support (Base Mount)  | 314–317 | included   |                 |
| <b>INPUT AND OUTPUT SIGNALS</b>  |         |  |                 |
| Power Supply (max. voltage / current)  | 314–317 | 20 to 32 VDC / 100 mA  |                 |
| Torque Output (rated / max.)   | 314–317 | ±5 / ±10 VDC   |                 |
| Filter Cutoff (frequency)  | 314–317 | 5000, 2500, 1000, 500, 200, 100, 40, 20, 10, 5, 2, 1 Hz                        |                 |
| Speed Output (frequency)   | 314–317 | open collector (15 Ω in series), max. 30 VDC, protected against short-circuits |                 |
| <b>CONNECTORS</b>  |         |  |                 |
| Counter Connector (female)   | 314–317 | optional (P/N 957.11.08.0081)  |                 |

**OPERATING PRINCIPLES**

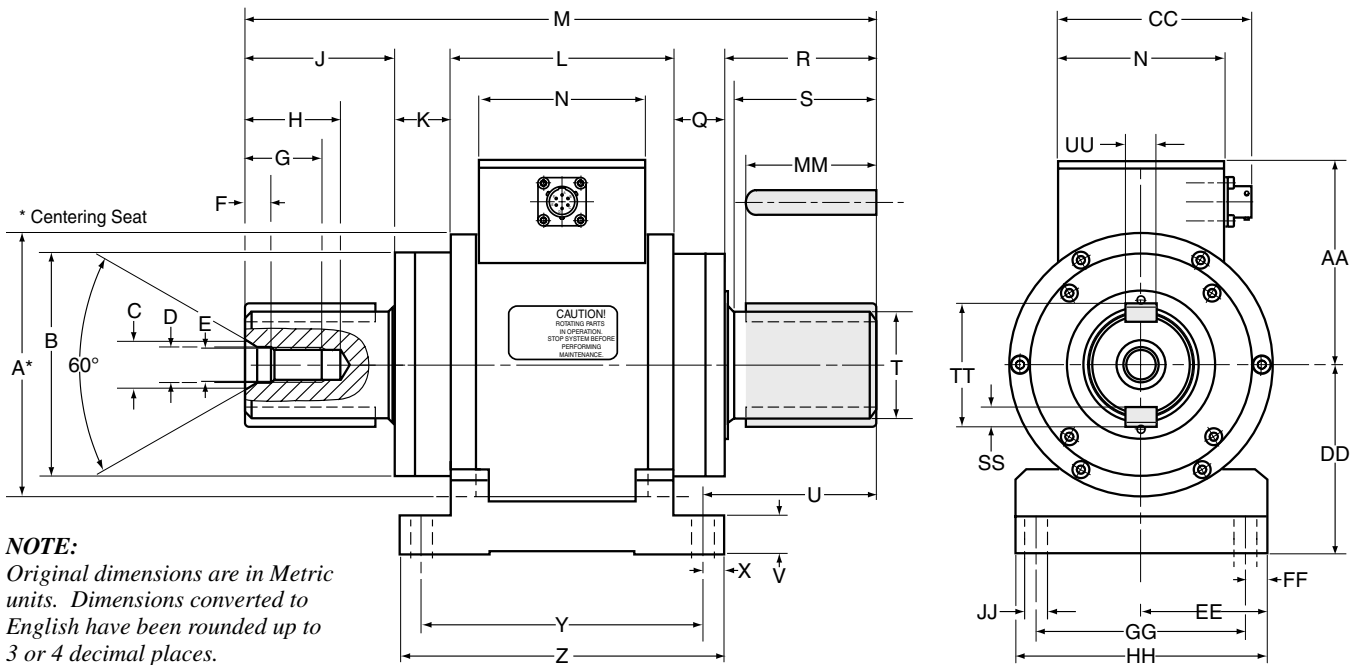
The measuring system, based on the principle of a variable, torque-proportional transformer coupling, consists of two concentric cylinders shrunk on the shaft on each side of the shaft's deformation zone, and two concentric coils attached to the housing.

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 ±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.

**TM and TMHS Transducers with Keyway Shaft**



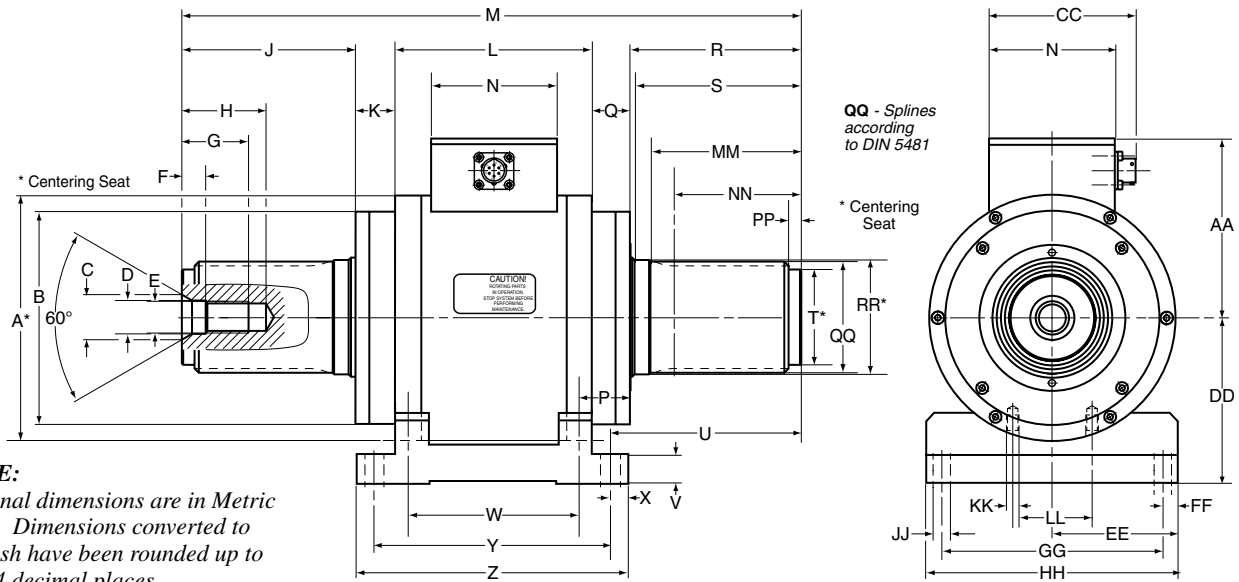
**NOTE:**  
Original dimensions are in Metric units. Dimensions converted to English have been rounded up to 3 or 4 decimal places.

| Model*  | units | Ø A              | Ø B   | Ø C   | Ø D   | E   | F     | G     | H     | J     | K     | L     | M      | N     | Q     | R     | S     | Ø T              | U     |
|---------|-------|------------------|-------|-------|-------|-----|-------|-------|-------|-------|-------|-------|--------|-------|-------|-------|-------|------------------|-------|
| 314/X31 | mm    | 125g6            | 106   | 23    | 17    | M16 | 12    | 36    | 45    | 67.7  | 26.8  | 106   | 294    | 80    | 25    | 68.5  | 65    | 50h6             | 79.5  |
|         | in    | 4.9207<br>4.9197 | 4.173 | 0.906 | 0.669 | M16 | 0.472 | 1.417 | 1.772 | 2.665 | 1.055 | 4.173 | 11.575 | 3.150 | 0.984 | 2.697 | 2.559 | 1.9685<br>1.9679 | 3.130 |
| 315/X31 | mm    | 125g6            | 106   | 23    | 17    | M16 | 12    | 36    | 45    | 87.7  | 26.8  | 106   | 334    | 80    | 25    | 88.5  | 85    | 50h6             | 99.5  |
|         | in    | 4.9207<br>4.9197 | 4.173 | 0.906 | 0.669 | M16 | 0.472 | 1.417 | 1.772 | 3.453 | 1.055 | 4.173 | 13.150 | 3.150 | 0.984 | 3.484 | 3.346 | 1.9685<br>1.9679 | 3.917 |

| Model*  | units | V     | X     | Y     | Z     | AA    | CC    | DD               | EE               | FF    | GG    | HH               | Ø JJ  | MM    | SS               | TT    | UU               |
|---------|-------|-------|-------|-------|-------|-------|-------|------------------|------------------|-------|-------|------------------|-------|-------|------------------|-------|------------------|
| 314/X31 | mm    | 18    | 10    | 134   | 154   | 98    | 93    | 90±0.025         | 60±0.025         | 10    | 100   | 120±0.05         | 11    | 60.0  | 9h11             | 57    | 14h9             |
|         | in    | 0.709 | 0.394 | 5.276 | 6.063 | 3.858 | 3.661 | 3.5443<br>3.5423 | 2.3632<br>2.3612 | 0.394 | 3.937 | 4.7264<br>4.7224 | 0.433 | 2.362 | 0.3543<br>0.3508 | 2.244 | 0.5512<br>0.5495 |
| 315/X31 | mm    | 18    | 10    | 134   | 154   | 98    | 93    | 90±0.025         | 60±0.025         | 10    | 100   | 120±0.05         | 11    | 59.7  | 9h11             | 57    | 14h9             |
|         | in    | 0.709 | 0.394 | 5.276 | 6.063 | 3.858 | 3.661 | 3.5443<br>3.5423 | 2.3632<br>2.3612 | 0.394 | 3.937 | 4.7264<br>4.7224 | 0.433 | 2.350 | 0.3543<br>0.3508 | 2.244 | 0.5512<br>0.5495 |

\* A TM Series Torque Transducer with keyway shaft is indicated by the suffix /031.  
A TMHS Series Torque Transducer with keyway shaft is indicated by the suffix /131.

**TM and TMHS 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     | P     | Q     | R     | S     | Ø T              | U     | V     |
|---------|-------|------------------|-------|-------|-------|-----|-------|-------|-------|-------|-------|-------|--------|-------|-------|-------|-------|-------|------------------|-------|-------|
| 314/X21 | mm    | 125g6            | 106   | 23    | 17    | M16 | 12    | 36    | 45    | 50.7  | 26.8  | 106   | 260    | 80    | 32    | 25    | 51.5  | 48    | 44h6             | 62.5  | 18    |
|         | in    | 4.9207<br>4.9197 | 4.173 | 0.906 | 0.669 | M16 | 0.472 | 1.417 | 1.772 | 1.996 | 1.055 | 4.173 | 10.236 | 3.150 | 1.260 | 0.984 | 2.028 | 1.890 | 1.7323<br>1.7317 | 2.461 | 0.709 |
| 315/X21 | mm    | 125g6            | 106   | 23    | 17    | M16 | 12    | 36    | 45    | 70.7  | 26.8  | 106   | 300    | 80    | 32    | 25    | 71.5  | 68    | 44h6             | 82.5  | 18    |
|         | in    | 4.9207<br>4.9197 | 4.173 | 0.906 | 0.669 | M16 | 0.472 | 1.417 | 1.772 | 2.784 | 1.055 | 4.173 | 11.811 | 3.150 | 1.260 | 0.984 | 2.815 | 2.677 | 1.7323<br>1.7317 | 3.248 | 0.709 |
| 316/X21 | mm    | 155g6            | 135   | 28.4  | 21    | M20 | 15    | 42    | 53    | 82.7  | 25.8  | 124   | 340    | 80    | 33    | 24    | 83.5  | 80    | 55h6             | 94.5  | 18    |
|         | in    | 6.1018<br>6.1008 | 5.315 | 1.118 | 0.827 | M20 | 0.591 | 1.654 | 2.087 | 3.256 | 1.016 | 4.882 | 13.386 | 3.150 | 1.299 | 0.945 | 3.287 | 3.150 | 2.1654<br>2.1646 | 3.721 | 0.709 |
| 317/X21 | mm    | 155g6            | 135   | 28.4  | 21    | M20 | 15    | 42    | 53    | 107.7 | 25.8  | 124   | 390    | 80    | 33    | 24    | 108.5 | 105   | 60h6             | 119.5 | 18    |
|         | in    | 6.1018<br>6.1008 | 5.315 | 1.118 | 0.827 | M20 | 0.591 | 1.654 | 2.087 | 4.240 | 1.016 | 4.882 | 15.354 | 3.150 | 1.299 | 0.945 | 4.272 | 4.134 | 2.3622<br>2.3615 | 4.705 | 0.709 |

| Model*  | units | W     | X     | Y     | Z     | AA    | CC    | DD               | EE               | FF    | GG    | HH               | Ø JJ  | KK           | LL    | MM    | NN    | PP    | QQ    | Ø RR             |
|---------|-------|-------|-------|-------|-------|-------|-------|------------------|------------------|-------|-------|------------------|-------|--------------|-------|-------|-------|-------|-------|------------------|
| 314/X21 | mm    | 92    | 10    | 134   | 154   | 98    | 93    | 90±0.025         | 60±0.025         | 10    | 100   | 120±0.05         | 11    | M8×10        | 36    | 42    | 28    | 8     | 45×50 | 52h6             |
|         | in    | 3.622 | 0.394 | 5.276 | 6.063 | 3.858 | 3.661 | 3.5443<br>3.5423 | 2.3632<br>2.3612 | 0.394 | 3.937 | 4.7264<br>4.7224 | 0.433 | M8×<br>0.394 | 1.417 | 1.654 | 1.102 | 0.315 | 45×50 | 2.0472<br>2.0465 |
| 315/X21 | mm    | 92    | 10    | 134   | 154   | 98    | 93    | 90±0.025         | 60±0.025         | 10    | 100   | 120±0.05         | 11    | M8×10        | 36    | 62    | 48    | 8     | 45×50 | 52h6             |
|         | in    | 3.622 | 0.394 | 5.276 | 6.063 | 3.858 | 3.661 | 3.5443<br>3.5423 | 2.3632<br>2.3612 | 0.394 | 3.937 | 4.7264<br>4.7224 | 0.433 | M8×<br>0.394 | 1.417 | 2.441 | 1.890 | 0.315 | 45×50 | 2.0472<br>2.0465 |
| 316/X21 | mm    | 106   | 10    | 150   | 170   | 113.5 | 93    | 105±0.025        | 80±0.025         | 10    | 140   | 160±0.05         | 11    | M8×10        | 50    | 70    | 50    | 8     | 60×65 | 70h6             |
|         | in    | 4.173 | 0.394 | 5.905 | 6.693 | 4.468 | 3.661 | 4.1348<br>4.1329 | 3.1506<br>3.1486 | 0.394 | 5.512 | 6.3012<br>6.2972 | 0.433 | M8×<br>0.394 | 1.968 | 2.756 | 1.968 | 0.315 | 60×65 | 2.7559<br>2.7552 |
| 317/X21 | mm    | 106   | 10    | 150   | 170   | 113.5 | 93    | 105±0.025        | 80±0.025         | 10    | 140   | 160±0.05         | 11    | M8×10        | 50    | 95    | 80    | 8     | 65×70 | 72h6             |
|         | in    | 4.173 | 0.394 | 5.905 | 6.693 | 4.468 | 3.661 | 4.1348<br>4.1329 | 3.1506<br>3.1486 | 0.394 | 5.512 | 6.3012<br>6.2972 | 0.433 | M8×<br>0.394 | 1.968 | 3.740 | 3.150 | 0.315 | 65×70 | 2.8346<br>2.8339 |

\* A TM Series Torque Transducer with splined shaft is indicated by the suffix /021.  
A TMHS Series Torque Transducer with splined shaft is indicated by the suffix /121.

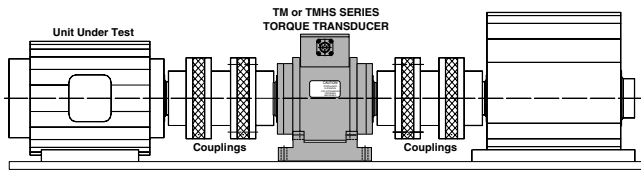
**OPTIONS**

**Flanges**

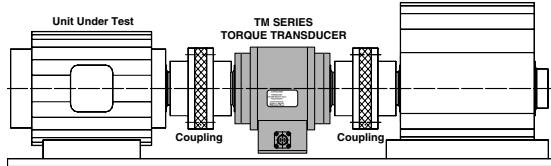
Flanges are optional for torque transducers with splined shaft ends. Flange drawing is available on request.

| Description              | Model   | P/N             |
|--------------------------|---------|-----------------|
| Flange for Model 314/X21 | FTM 214 | 415-214-960-011 |
| Flange for Model 315/X21 | FTM 215 | 415-215-960-011 |
| Flange for Model 316/X21 | FTM 216 | 415-216-960-011 |
| Flange for Model 317/X21 | FTM 217 | 415-217-960-011 |

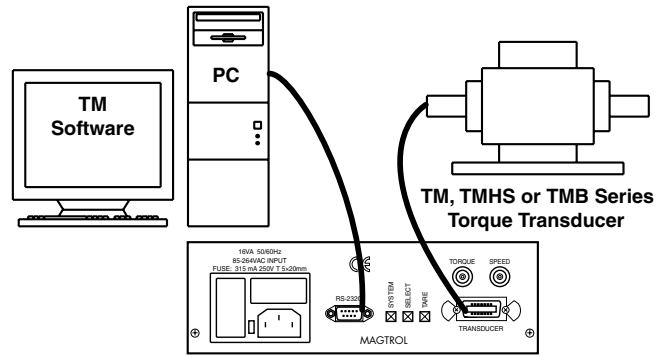
## SYSTEM OPTIONS AND ACCESSORIES



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



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



**Model 3410 Torque Display**

**PC-Based System Configuration**  
Torque Transducer with Model 3410 Display and Torque 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.

## ORDERING INFORMATION

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

| TORQUE TRANSDUCERS      |              |   |
|-------------------------|--------------|---|
| • Model TM 314-317      | TM 3□□/0□1   | 1 |
| Splined Shaft (314-317) |              | 2 |
| Keyway Shaft (314-315)  |              | 3 |
| • Model TMHS 314-317    | TMHS 3□□/1□1 | 1 |
| Splined Shaft (314-317) |              | 2 |
| Keyway Shaft (314-315)  |              | 3 |

### Torque Transducer Displays

Magtrol offers two different Torque Displays (Models 3410 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 TM 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

### TM Software

Magtrol's TM 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 Magtrol's TM Software 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  |

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



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