Torquetronic™ ET
Torquemeters Limited specialise in providing innovative products and custom engineered solutions for high performance rotating machinery applications with a reputation for excellent quality and service.

Torquemetric™ ET torquemeters use the phase shift principal with no shaft borne electronics, which gives almost unlimited speed capability, very high accuracy and credibility and a service life of over 30 years:

**Transmission Applications**

**Aerospace:**
- Working with leading Aerospace manufacturers and systems integrators Torquemeters designs and manufactures high performance power transmission solutions for:
  - Compressors & Turbines turbo shaft testing
  - Helicopter transmissions testing
  - Aero engine ancillaries: Alternators, Starters, Fuel pumps, Gears, Seals, bearings

**Automotive:**
- Turbocharger mapping
- Engine friction testing, Single Cylinder
- High performance engine recovery systems
- F1 KERS, MGU-H, MGU-K
- Driveline transmission component test

**Industrial:**
- Electric motor development
- Compressor & Turbine development
- Seal testing
- Power transmission component test
- Accuracy: 0.1% of Full Scale
- Speed rating to 150,000 rev/min
- Torque rating from 0.1 Nm to 77,000 Nm
- No rotating electronics
- Proven reliability & stability in demanding applications
- Interchangeable torsion shafts
- Custom designs available
- Integrated system solutions: Torquemeter and Couplings
- Intrinsically Safe also available

*More than a product... a complete driveline solution.*
The testing of modern helicopter turbo shaft engines occurs across a wide spectrum, from initial and on-going engine development, to production pass off by the OEM through Maintenance, Repair and Overhaul (MRO) by both military and civil operators.

Torquemeters Ltd has become established as the preferred supplier for the world’s most popular turbo shaft engines:

- GE’s – T700/701K, T55,56, T64, GE38
- P&W – PT6, PW210 families
- Turbomeca’s – Arriel, Makila and RTM322 engines.

1. Flange mount torquemeters, designed to directly mount from gearbox.
2. Custom design torque measurement solution for US Navy and Army for turbo shaft engine testing on the Varvo™ air dyno.
3. Typical test bed installation for turbo shaft engine: Pedestal ET3075 torquemeter and coupling; 750HP, 24,000 rpm.
4. Example of Turbo shaft engine test coupling.
5. Typical arrangement Torquetronic™ ET2145, Torbit couplings to a bookend mount for the test article; 1,400Nm, 32,000 rev/min.
6. Pedestal Torquemeter – can also act as a bearing pedestal between driving and driven machine.
Transmission Drivelines

Though the ET torquemeter is designed to be insensitive to external shaft loading the transmission driveline is critical to a successful installation and operation.

We have extensive experience in transmission engineering available to assess and recommend coupling selection:
- Disc pack
- Tordisc™ Diaphragm
- Quill

A range of factors must be considered for the transmission driveline, especially for high performance applications:
- The Speed, Torque envelope, Axial Deflection and Angular Deflection while respecting the acceptable overhung mass limitations of the various components in the transmission driveline.

Torquemeters Ltd can provide full design support which includes FEA analysis.

For applications over 80,000 rpm we recommend a Quill or Gear coupling, it provides torsional flexibility.

Example of Quill design.

### Nominal

<table>
<thead>
<tr>
<th>TORDISC™ Model</th>
<th>Cross reference to ET Model</th>
<th>SHAFT Ø (mm)</th>
<th>SPEED (rpm)</th>
<th>TORQUE (Nm)</th>
<th>SPACER LENGTH (mm)</th>
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<tr>
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</table>

Standard Tordisc coupling range. For other ratings contact Torquemeters Ltd.

### Centrifugal growth
- Coupling hub fits
- Bearing fits (non-catalogue)
- Bearing internal clearance

### Rotodynamics
- Shaft rock and bounce modes (bearing dynamic radial stiffness)
- Shaft bending critical modes
- Shaft running envelopes (sub or super critical)

### Tordisc™
- Light weight diaphragm coupling
- Reduced overhung mass and inertia
- Shear Neck can be included in the spacer shaft, acting as a mechanical fuse to limit damage in case of test article failure / over-torque event

130,000 rpm ± 20Nm Driveline solution

Because of Mass Overhang constraints affecting critical speed, spindles were introduced in the transmission driveline.
A technical specification is available for each of our standard ET torquemeters. This provides installation and driveline details that must be considered for successful operation.

Model Rating

Defines maximum rating for the specific model. You can select any Full Scale rating of your torsion shaft down to 10% of model rating. This ensures optimum accuracy of measurement.

For example the ET145 has a model rating 1,400 Nm 32,000 rpm.

If your application has maximum Full Scale of 525Nm. The Torsion shaft should be specified at 525Nm, therefore measurement accuracy of 0.1% will be of 525Nm rather than 1,400Nm.

Interchangeable Torsion shafts

Torsion shafts of different ratings can be used in the same ET model, this is a unique feature that means a single model can be used for testing a wide range of application torques at optimum Full Scale accuracy.

Permissible Speed vs Coupling C of G overhang

The acceptable half mass of couplings related to the C of G from the coupling location face (see outline drawing of model) are shown graphically for each model. These parameters should be observed to prevent issues of critical speed and reduced bearing life.

Inertia and Torsional stiffness vs Shaft Rating

Details are provided for rotor dynamic analysis.

TORQUE = SHAFT STIFFNESS x (PD-ZERO TORQUE DATUM)

All ET Torquemetrics® torquemeters are calibrated at our factory both statically and dynamically and supplied with full calibration certificates.

Static Calibration:

Shaft Stiffness is determined from the torque required to twist the torsion shaft through one signal tooth pitch i.e. 100% PD. The value of stiffness is found by performing a static calibration on the transducer using lever arms and weights. The calibration is stable as Young’s Modulus and is strictly linear.

Dynamic Calibration:

Zero Torque Datum (ZTD) is the Phase Displacement produced when the torquemeter is rotating through its entire speed range, but not transmitting torque. Torquemeters are dynamically calibrated in the factory to establish the as built ZTD. However to maximise accuracy it is generally recommended to carry out another dynamic calibration on installation to establish the in situ ZTD to compensate for any additional losses. For example: a bearing pedestal between the torquemeter and the test article.

- Resolution
- Linearity + Hysteresis
- Zero repeatability
- Temperature Compensation
- Static Calibration
- Speed

Overall accuracy 95% confidence level

Absolute: ± 0.12% FS

Repeatability: ± 0.1% FS
1. Torsion shaft
ET Torquemeters will operate in 4 quadrant modes measuring speed (Direction of Rotation) and torque (Helix) in both directions. However, for optimum accuracy a Uni Directional shaft can be selected. Shaft ends as standard have DIN 5480 splines, please refer to data sheet for specific detail.

2. Cartridge Style
As part of the “Interchangeable Torsion Shaft” system, the cartridge assembly includes the torsion shaft, the bearing sleeve and bearings. A non-cartridge style torquemeter will require the bearing housings and possible other components to be dismantled in order for the torsion shaft to be changed.

3. Bearings
ET torquemeter models have either 2 bearings or 4 bearings. High Speed ET’s have angular contact type bearings that are oil jet lubricated. Oil leakage from the bearing housings is prevented by using air-blown seals. Medium Speed ET’s have angular contact type bearings that are grease lubricated. Low Speed ET’s have deep groove type bearings that are grease lubricated.

4. Rotastat
‘Torquetronic™’ pedestal models feature a built in Rotastat system in which the pickup teeth can be rotated to generate signals with the shaft stationary. This feature is essential for the static calibration, but it also allows torque to be measured at very low speed or stationary. The rotastat motors are supplied as 12VDC or 24VDC as standard.

5. Bearing Temperature Monitoring
PT100 RTD monitor the temperature of each bearing independently.

6. Vibration Monitoring
There are accelerometer mounting features located at 90º from each other at both ends of the torquemeter for vibration monitoring. Note: Due to the size of the torquemeter some models have one mounting feature at each end of the torquemeter, refer to product data sheets.

7. Fluid Fittings – High speed models only
7 Fittings for the bearing lubrication supply (a), seal air (b) and oil/air drain (c). Please refer to data sheet for specific utility supply requirements – Air, Oil flow and pressure requirements.
Measuring steady state torque and Torsional Vibration in a single product.

The high measurement resolution of the Torquetronic™ system means it automatically captures torsional vibration present in the driveline.

TorqTo™ process the data, sampled at up to 10KHz, and provides detailed analysis.

TorqTo™ performs a Fast Fourier Transform (FFT), and displays torsional frequencies against amplitude. Analysis can be displayed in a Campbell Diagram / Colour map of torsional frequencies or Modal Plot orders against machine speed.

NEW GENERATION DELIVERING INCREASED PERFORMANCE.
THE 800 FAMILY OF PRODUCTS OFFERS A FLEXIBLE DISPLAY AND DATA ACQUISITION PLATFORM FOR ALL TORQUETRONIC™ TORQUE MEASUREMENT SYSTEMS.