FASTENER TESTING SYSTEMS

PCB PIEZOTRONICS
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FASTENER TESTING

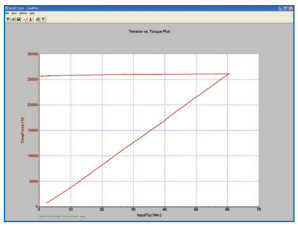
Many factors must be considered when establishing a threaded fastener bolted joint analysis program, which should include methods for modeling the joint, determining torque-tension characteristics and friction coefficients, and experimental testing of components and assemblies.

Test methods have been established and published for mechanical properties such as hardness, tensile strength, and torsional strength as well as corrosion and hydrogen embrittlement. These provide the baseline information necessary for proper interpretation of the friction coefficient, torque-tension, and angular ductility testing tests that are used to complete the evaluation of bolted joints. Once the basic material strength and friction coefficient information has been determined, an additional method, Torque-Angle Signature Analysis, can provide valuable information on joint strength and performance when applied to testing fasteners in bolted joints.The basic torque-angle signature can be used as a starting point for all analysis. For example, it can be used to illustrate the influence of underhead and thread friction on the tightening process where an increase in friction, in either the thread or underhead regions, can result in a proportional increase in the slope of the torque-angle signature. The study of the slope of the torque-angle curve when the fastener is tightened is an important component of analyzing the performance of threaded fasteners in bolted joints.

To apply torque-angle signature analysis, a torque-angle recording device is needed for measurement and curve plotting. The recorder can provide curves on-screen for analysis as well as print them out for additional study. Tightening, audit, and release angle signatures for a given bolted joint can be simultaneously displayed and printed. A careful review of the applied torque vs. angle-of-turn plot, signature analysis can be used to evaluate bolted joints for loss of preload due to settling, creep and relaxation, or vibration and dynamic loading. In addition, joint strength problems such as thread strip and embedment of bearing surfaces and material yield within the bolted joint are easily identified.

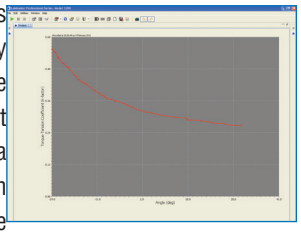
The following tests are typically conducted in the fastener testing area:

TORQUE TENSION TESTING



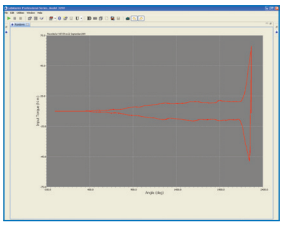
Threaded fastener testing usually begins with determining how consistently the fastener will perform when tightened into an assembly. This testing mounts the test bolt and test nut in a fastener tension load cell along with a test washer or a coupon of the actual assembly material to determine the relationship between torque, angle of rotation, and clamp load. An example is where the applied torque must fall within a defined window of acceptability when reaching a specified clamp load. A variety of graphs can be generated depending upon your data requirements, such as Torque vs. Clamp Load, Torque vs. Angle, or Torque and Clamp Load vs. Angle. Required components include data acquisition, a rotary torque angle transducer, a clamp force load cell, a DC electric drive motor and controller, and a suitable fixture assembly for mounting test system components.

FRICTION COEFFICIENT TESTING



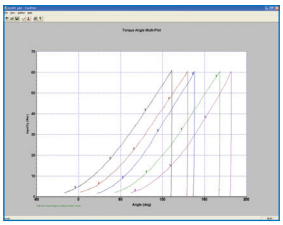
The application of plating or coatings to a threaded fastener can greatly affect the state of friction in the joint. A small change in the amount of friction in a joint can produce a great variation in clamp load when the fastener is tightened. To ensure that the state of friction is consistent, the fastener is mounted in a special clamp force load cell that measures not only clamp load but also thread torque, which is referred to as a research head. This allows the testing software to separate the thread torque from the input torque to determine the underhead friction torque and thread friction torque. These values are used along with the geometry of the fastener to calculate friction coefficients for the underhead and thread regions, as well as the so-called “nut factor”, K. Systems for testing friction coefficients include a data acquisition module, a rotary torque angle transducer, a research head load cell, a DC electric drive motor and controller, and a suitable fixture assembly for mounting test system components.

LOCKNUT TESTING



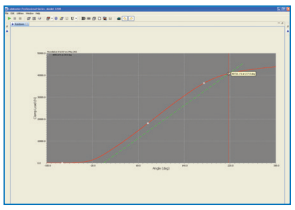
Special test routines include those required for testing prevailing torque locknuts according to widely accepted test specifications. There are several test specifications for verifying the performance characteristics of fasteners with built-in thread locking devices. These devices include nylon thread lockers, crimped or deformed nuts, thread patches, or adhesives. The nut is run down onto a test bolt and the applied torque and angle of fastener rotation is measured to determine how much energy is required to break through the locking device. The amount of torque required to remove the nut may also be measured. This testing may also require that the fastener be run down several times with the measured torque of the first rundown compared to that of a subsequent rundown, such as the fifth or tenth run. Typical system components will include data acquisition with drive motor interface, DC drive motors, rotary torque angle transducers, clamp force load cells, and fixture assemblies.

BOLTED JOINT ANALYSIS AND TROUBLESHOOTING



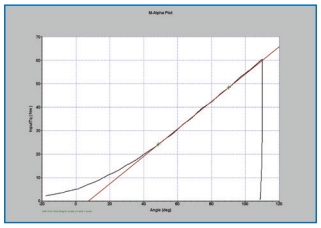
The starting point for bolted joint analysis is the torque-angle signature recorded during testing. Many things can be learned from reviewing the torque vs. angle curve including the influence of underhead and thread friction on the tightening process. The first step in signature analysis is to examine the slope of the elastic tightening zone. For example, an increase in friction, in either the thread or underhead regions, results in a proportional increase in the slope of the torque-angle signature. If fastener clamp load can be measured, the torque-angle signature can be used to determine the angle-tension coefficient which can then be used to verify clamp load in actual assemblies. A system to perform this testing will include at least data acquisition and a rotary torque-angle transducer. A transducer that can measure clamp load is a very helpful accessory.

YIELD DETERMINATION TESTING



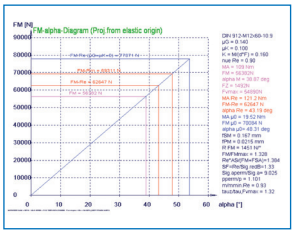
Determining the point at which the fastener begins to yield can be a critical bit of knowledge, particularly for a critical fastener application. Yield determination testing mounts the fastener in a tension load cell with test washers or coupons of actual materials. The fastener is tightened to failure and the resulting data is examined to determine the yield point of the fastener.

ASSEMBLY STRATEGY TESTING



Determining the tightening strategy for a given assembly often begins with torque-to-failure testing where the fasteners are driven to failure on actual assemblies. Torque-angle signatures can be plotted and analyzed to determine the point of yield, the point of fracture, the onset of elastic tightening, and other important aspects of the joint. Once the cause of failure is analyzed, this data can then be used to help establish or verify the assembly specifications and the type of tightening strategy that will produce reliable assemblies. Our exclusive patented M-Alpha graphing capability can also be used to estimate the relative difference in clamp loads produced with different coatings, plating, finishes, etc. Required components may include data acquisition, rotary torque angle transducer, clamp force load cell, and a drive motor similar to that used in the assembly process.

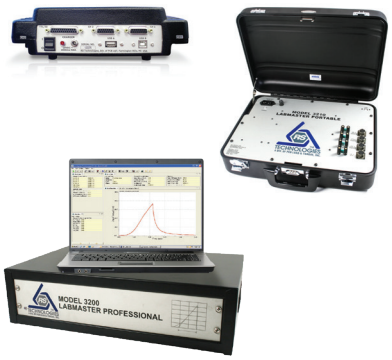
BOLTED JOINT MODELING AND ANALYSIS



Often before fastener testing is begun, it can be helpful to model the bolted joint to determine the possibility of failure in one of the components. The SR1 Bolted Joint Design and Analysis software can be used to calculate the stresses present in the joint and identify possible causes of failure. SR1 is an enhanced calculation method based on the German engineering standard, VDI-2230, that is often used to close the loop between fastener design and application. SR1 can also be used to provide correlation between the results of the experimental testing described above.

COMPONENTS OF A TORQUE- TENSION SYSTEM

Whether a portable test system or a full laboratory system, they are typically comprised of the following five components: data acquisition, rotary torque transducer, clamp force load cell, drive system, and a fixture assembly.

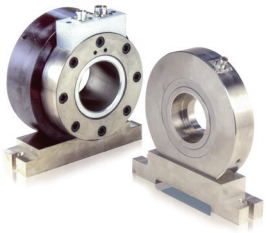


DATA ACQUISITION OPTIONS

The key component in a torque-tension test system is data acquisition. PCB offers three levels of instrumentation. The portable Model 962 is the entry-level system for collecting torque, angle, and clamp load data that can store, print, and upload graphic and numeric data to a PC. The Model 3210 LabMaster Portable features 4 channels of data input for torque & angle, clamp load, thread torque, and additional analog devices with numerous graphing and plotting capabilities, as well as the ability to calculate head & thread friction coefficients, and determine fastener yield. The Model 3200 LabMaster Professional has the same data acquisition capabilities as the Model 3210 and adds the capability of controlling the drive motor during the test to allow a higher level of testing accuracy and providing the capability of testing for prevailing torque, rotational capacity, and other advanced fastener testing requirements.

ROTARY TORQUE-ANGLE SENSORS

The second component in a test system measures the applied torque and the angle of fastener rotation. These accurate and durable sensors come in a variety of capacities, from 32 ozf-in up to 18,000 lbf-ft. They are fitted onto the “business end” of the drive tool to record the input torque and the angle of fastener rotation.

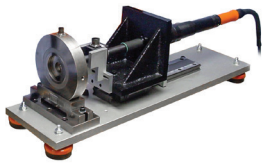


FASTENER TENSION LOAD CELL

The third major component measures the clamp load or fastener tension developed when the fastener is tightened. RS Technologies can provide the right sensor for the test at hand from simple fastener load washers that can measure clamp load on actual assemblies, to more accurate fastener clamp load cells for torque-tension testing, up to torque-tension load cells for measuring thread torque in addition to clamp load for higher level calculation of friction coefficients.

DRIVE SYSTEM

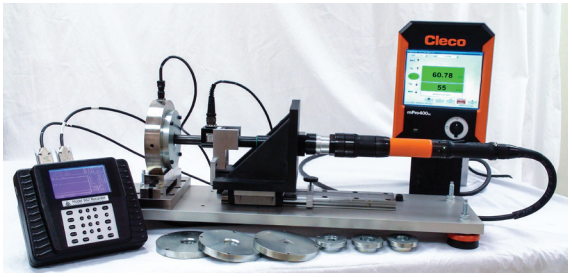
The fourth component is the drive system that supplies the applied torque to tighten the fastener. For the most basic system it might be a hand-held tool. For most standard torque-tension testing it’s a DC electric drive motor and controller that are controlled by the operator. For the more advanced systems, the motor is controlled by the LabMaster Professional. The LabMaster testing software allows the operator to specify the tool output torque and RPM, when the tool should be shut off, cycle the fastener multiple times, etc.



FIXTURE ASSEMBLY

The fifth and final component is a fixture assembly that brings all of the system together. These come in a variety of configurations, vertical, horizontal, tabletop, freestanding, or mobile cart. They provide mounting for the drive motor, torque-angle sensor, clamp force or torque-tension load cells.

EXAMPLE TEST SYSTEM CONFIGURATIONS

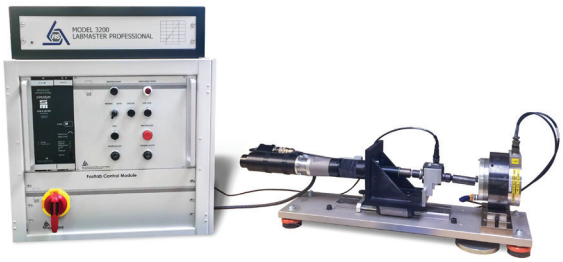


BASIC TORQUE TENSION TEST SYSTEM

This tabletop torque-tension test stand provides all you need to meet the torque-tension testing requirements of most OEM and industry standards. It features a Model 962 2-channel recorder that records and provides the test data in numeric or graphic form. It can also upload the data to a laptop or desktop computer for further analysis. The system also includes a DC electric tool and controller, a rotary torque transducer, and a clamp force transducer. The system is completed with a fixture assembly with a slide bearing mounting for the DC drive tool and mounting for the rotary torque sensor and clamp force load cell.

PART NUMBER	DESCRIPTION*
080962-01000	Model 962 2-channel Recorder
08CLEC-00MTR	DC Drive Motor, 15-150 Nm, 165 RPM max, controller and cable
039050-51201	200 Nm (148 lbf-ft) Rotary Torque Sensor
059810-01104	100 kN (22,480 lbf) Torque Tension Load Cell
109100-01440	Tabletop Fastener Test Stand
100M10-30431	M10 Test Plate Set
099404-30563	Torque Sensor Cable
099404-30610	Load Cell Cable
NA	Notebook computer (customer supplied)
109100-01440	Tabletop Fastener Test Stand

*Fastener sizes M6 to M12 (¼ in to ½ in)



COMPLETE TORQUE TENSION TEST SYSTEM

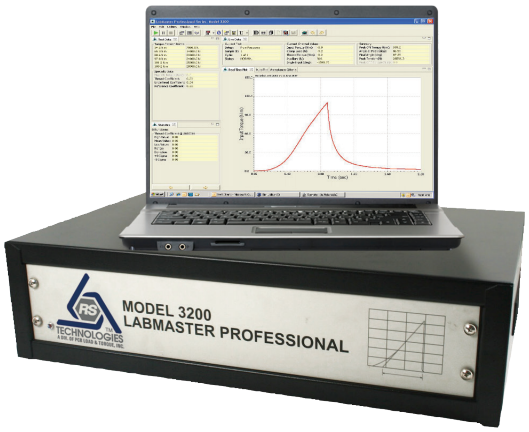
The complete fastener test system can perform a wide variety of automated and semi-automated tests on threaded fasteners. You can acquire, record, and plot basic torque, angle, and clamp load data, determine thread torque, underhead friction torque, friction coefficients, joint relaxation, joint yield, and tool performance characteristics. You can setup and test a wide variety of fastener types including prevailing torque locknuts.

The complete system starts with a LabMaster Pro module connected to a desktop or laptop computer. These let you set-up and run the test, record all of the data inputs, and provide output in the form of numeric or graphic data. The system features a DC electric drive motor and servo controller to apply the torque, a torque-angle sensor to measure the input torque and fastener rotation, a research head to measure clamp load and thread torque, and a properly sized fixture assembly for mounting all components.

PART NUMBER	DESCRIPTION*
083200-01000	Model 3200 LabMaster Professional
089200-00528	DC Drive Motor & Controller, 20-260 Nm (192 lbf-ft), 220 RPM Max.
039250-51201	200 Nm (148 lbf-ft) Rotary Torque-Angle Sensor
059600-01104	100 kN (22,480 lbf) 150 Nm (111 lbf-ft) Research Head
109100-01440	Tabletop Fastener Test Stand
100M10-30431	M10 Test Plate Set
099404-30563	Torque Sensor Cable
099404-30566	Research Head Cable
NA	Desktop/laptop computer (customer supplied)

*Fastener sizes M6 to M13 (¼ in to ½ in)

LABMASTER PROFESSIONAL



The Model 3200 LabMaster Professional is the key part of a fastener torque-tension test system. It provides complete data acquisition of applied torque, angle of fastener rotation, clamp load and thread torque. This system allows graphing of any input versus any other such as torque vs. angle, torque vs. clamp load, etc., and also provides multiple plotting capabilities so that plots of several tests can be overlaid. When thread torque is measured, the LabMaster Professional can calculate friction coefficients to help determine fastener performance. When fasteners are taken into yield, the LabMaster Professional can determine the point of yield as a function of angle and clamp load or torque.

TEST, ANALYZE, CERTIFY

The LabMaster Professional is an advanced, multi-purpose system designed to test threaded fasteners, analyze bolted joints, and certify power tools. It's comprised of two components: the LabMaster Professional module that contains data acquisition and drive motor interface capabilities,are then displayed and managed on the computer for access to network printers, archiving, and communications.

SIMPLE TEST SETUP

LabMaster for Windows® software provides a user-friendly graphic interface. Program the desired shutoff based on torque, angle of turn, clamp load, or yield; and program drive tool speed for multi-stage tightening. Quickly revive existing test setups, select different sensors, or adjust the built-in test modes to meet specific test requirements. The test setup directory simplifies testing by providing access to all pertinent setup files as well as previously recorded graphic and numeric data.

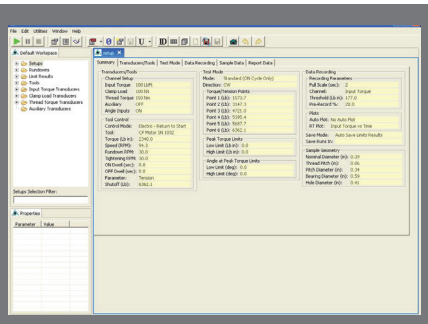
EASY OPERATION

Once the test is set up, the LabMaster Professional module conducts all motor control and data acquisition operations. A special drive motor override safety feature terminates the test if transducer or load cell capacities are exceeded. Recorded data is then displayed and managed via PC for access to network printers, archiving, and communications.

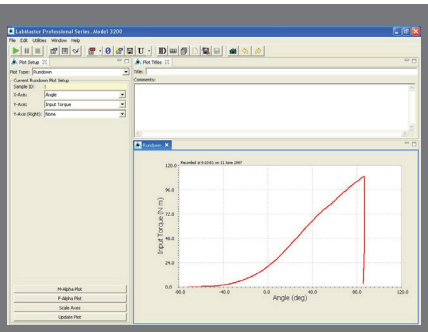
COMPREHENSIVE DATA

A LabMaster Professional system, with a torque-tension research head and a torque-angle sensor, can measure and calculate the following metrics. Friction coefficients are calculated per DIN946 and ISO 16047.

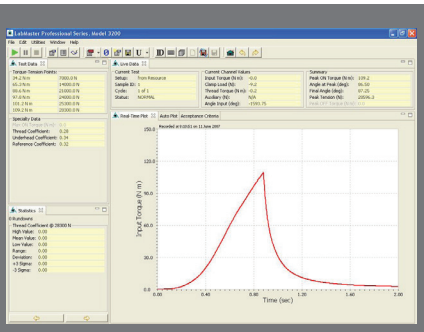
- Input torque
- Clamp force
- Thread friction torque
- Underhead friction torque
- Angle of fastener rotation
- Torque tension coefficient (K from T=KDF)
- Thread friction coefficient
- Underhead friction coefficient
- Reference, or total, friction coefficient



Setup Summary Screen



Real-Time Plot Screen



Graphic Data Screen

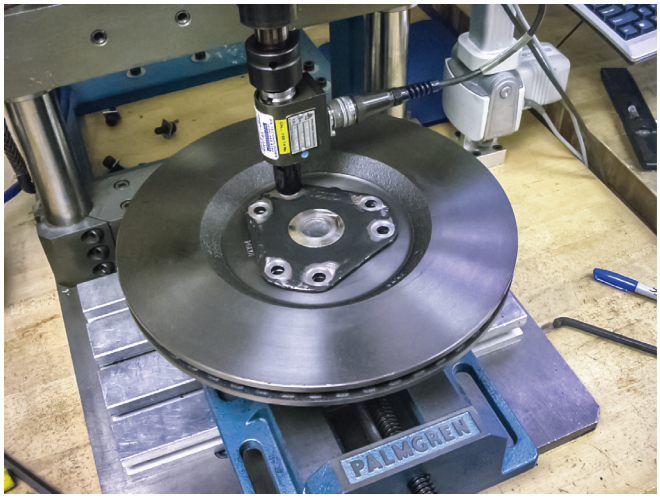
MULTIPLE INPUTS

Four analog inputs are available on the LabMaster Professional module to accept data signals from the following:

- Transducers
- Strain gages
- Load cells
- Torque cells
- Force washers
- Bolt extensiometers
- Ultrasonic devices
- Any 10 V analog device

MEASUREMENTS SIMPLIFIED

- **High Speed Sampling** – A data acquisition card provides high-speed sampling of up to 4000 Hz (software selectable). Sampling can be done versus a time or angle basis.
- **Statistical Calculations** – Provides variety of statistical reports in numeric and graphic form are available Statistical plots of ±3 sigma mean curves offer an insightful data summary.
- **Real-Time Display** – The LabMaster Professional and the LabMaster for Windows® testing software provide real-time display during the test. A user-selectable automatic data save feature for both numeric and graphic data speeds testing time.
- **Variety of Plots** – After the test is completed, rundown data and plots may be viewed on the computer display, printed as hard copy, and/or saved for later data analysis. Numerous configurable plots can be generated.
- **Complete Test Systems** – A complete torque-tension test system will typically include a rotary torque-angle transducer, a thread torque-tension research head, a DC electric tool and controller, and a printer for numeric and graphic data reports, all of which are available from RS Technologies.
- **Options** – Optional features include an auxiliary input for an ultrasonic interface, and a tabletop or mobile test cart.



SPECIFICATIONS

LabMaster Professional	
4-channel High-speed Data Acquisition Card	
Servo Control Card	
Four Inputs for Transducers, Load Cells, or Other Devices	
USB Port for Connection to Desktop or Laptop Computer Running LabMaster for Windows® Software	
Analog Input	
Number of Channels	4
Signal Conditioning	Full Bridge Strain Gage Transducer Compatible
Sensitivity	1 - 4 mV/V, and ±10 VDC
Excitation	10 VDC
Encoder Input	
Number of Channels	1
Counter Resolution	32-bit
Input Frequency	1000 kHz Maximum
Excitation	5 VDC
Digital I/O	
Outputs	7-bits
Inputs	8-bits
Compatibility	TTL
Optical Isolation	Available
Computer Requirements	
Windows® XP, 7, or 10	
6 GB RAM	
60 GB Hard Drive	
CD-ROM Drive	
USB 2.0 Port	
Supplied Accessories	
Power Cord, USB Cable, Testing Software Installation Discs, Instruction Manual, A2LA Accredited Calibration Certificate	
Recommended Accessories	
Rotary Torque Angle Transducers, Thread Torque Clamp Force Load Cell, DC Drive Motor & Controller, Fixture Assembly, Portable Test Cart	

LABMASTER PORTABLE

The LabMaster Portable is an advanced, multi-purpose system designed to test threaded fasteners, analyze bolted joints, and certify power tools. It's comprised of two components: the LabMaster Portable module that contains data acquisition and a laptop or desktop PC running the LabMaster for Windows® testing software. The module and computer interface using a USB port. LabMaster for Windows® software provides a user-friendly graphic interface. The test setup directory simplifies testing by providing access to all pertinent setup files as well as previously recorded graphic and numeric data. Quickly retrieve or edit existing test setups, select different sensors, or adjust the built-in test modes to meet specific test requirements.

Once the test is set up, the system conducts all data acquisition operations. Recorded data is then displayed and managed via PC for access to network printers, archiving, and communications. Four analog inputs are available on the LabMaster Portable module to accept data signals from transducers, strain gages, load cells, torque cells, force washers, bolt extensiometers, ultrasonic devices, and any 10 V analog device.

COMPREHENSIVE DATA

A LabMaster Portable system, with a torque-tension research head and a torque-angle sensor, can measure and calculate the following metrics. Friction coefficients are calculated per DIN946 and ISO 16047.

- Input torque
- Clamp force
- Thread friction torque
- Underhead friction torque
- Angle of fastener rotation
- Torque tension coefficient (K from T=KDF)
- Thread friction coefficient
- Underhead friction coefficient
- Reference, or total, friction coefficient

MEASUREMENTS SIMPLIFIED

- **High-Speed Sampling** – The LabMaster Portable includes a data acquisition card which provides high-speed sampling of up to 4000 Hz (software selectable). Sampling can be done versus a time or angle basis.
- **Statistical Calculations** – A variety of statistical reports in numeric and graphic form are available. Statistical plots of ±3 sigma mean curves provide an insightful data summary.
- **Real-TIme Display** – The LabMaster Portable and the LabMaster for Windows® testing software provide real-time display during the test. A user-selectable automatic data save feature for both numeric and graphic data speeds testing time.
- **Variety of Plots** – After the test is completed, rundown data and plots may be viewed on the computer display, printed as hard copy, and/or saved for later data analysis. Numerous configurable plots can be generated.
- **Options** – Optional features include an auxiliary input for an ultrasonic interface, and a tabletop or mobile test cart.

SPECIFICATIONS	
Inputs	
Four Inputs for Transducers, Load Cells, and/or Other Devices	
USB Port for Connection to Desktop or Laptop Computer Running LabMaster for Windows® Software	
Analog Input	
Number of Channels	4
Signal Conditioning	Full Bridge, Strain Gage, Transducer Compatible
Sensitivity	1 mV/V to 4 mV/V, and ±10 VDC
Excitation	10 VDC
Encoder Input	
Number of Channels	1
Counter Resolution	32-bit
Input Frequency	1000 kHz Maximum
Excitation	5 VDC
Computer Requirements	
Windows® 7 or 10 64-BIT	
8 GB RAM	
60 GB Hard Drive	
USB 2.0 Port	
Power Requirement	
110 VAC / 220 VAC	
Supplied Accessories	
Power Cord, USB Cable, Testing Software Installation Media, Instruction Manual, A2LA Accredited Calibration Certificate	
Recommended Accessories	
Rotary Torque-Angle Transducer, Threaded Torque-Tension Fastener Load Cell, Fastener Force Washers	

PORTABLE DATA RECORDER

Model 962 Portable Data Recorder is a battery-operated, transient recorder with two transducer inputs that can be used with torque-only, torque-angle, or load transducers. It can serve as a portable threaded fastener laboratory for measuring fastener torque, angle of turn, and clamp load. Ideal for performing fastener analysis, for auditing and certifying power tools, and for testing hand torque wrenches; Model 962 is a cost effective, versatile, and easy-to-use recorder that can collect numeric peak data, XY graphic plots, and store on a USB memory drive. Data can be easily displayed or printed on a PC running FastPlot2 software. Setup and calibration menus assure ease of operation, and the unit can be used with all RS Technologies' rotary torque-angle and clamp force transducers and other conventional and industry-standard strain gage transducers.

STATISTICS

After three rundowns, Model 962 updates statistics including standard deviation and Cpk. It also flags data as being high or low depending upon the programmed engineering limits.

DATA AND COMMUNICATIONS

Graphic plots, numeric data reports, and statistics are printed via the parallel port. Download data to a PC for further analysis using the optional FastPlot2 software.

REAL-TIME PLOTTING CAPABILITIES

Model 962 captures real-time and peak readings for torque-angle, torque-clamp load, or torque-time and displays or plots one of the following, based upon the instrument setup:

- Torque vs. Time
- Torque vs. Angle
- Torque & Angle vs. Time
- Torque & Clamp Force vs. Time
- Torque & Clamp Force vs. Angle
- Clamp Force vs. Torque
- Tool RPM vs. Time
- Tool RPM vs. Angle

SPECIFICATIONS		
Performance		
Torque and Force Input Channels		
Input Range	±2.5 mV/V, ±4.5 mV/V, ±5 VDC	
Excitation	5 VDC, 120 mA Maximum	
Resolution	21 -bit	
Non-linearity	0.25% Maximum (F.S.)	
Frequency Response	10 kHz	
Positive Voltage Peak Trap Circuit	7 ms Reset Time	
Peak Threshold	Software Programmable	
Peak Reset	Manual or Software Programmable (Automatic Reset)	
Angle Input Channel		
Type	Quadrature A/B Track	
Excitation	5 VDC	
Input Frequency	1000 kHz Maximum	
Physical		
Temperature Range	+32 to +158 °F (0 to +70 °C)	
Display		
Viewing Area	4.85 x 2.68 in (123 x 68 mm)	
Resolution	240 x 128 Pixels, Backlit LCD	
Battery		
Indication	Battery Low Indication	
Battery Life	8 Hours Maximum, Continuous Use	
Charge Time	3.5 Hours, Maximum	
Dimensions		
Size (W x D x H)	10.12 x 8.50 x 3.25 in	257.0 x 215.9 x 85.1 mm
Weight	6.0 lb	2700 gm
Mating Connectors		
Channel 1 and Channel 2	DB, 15 Pins	
TTL/IO	DB, 25 Pins	
USB Port A	A Type	
USB Port B	B Type	
Supplied Accessories		
FastPlot2 Upload/Graphing Utility for PC Running Windows® 7/10, Battery Charger, USB Cable, 8GB USB Memory Drive, Instruction Manual, Carrying Case, & A2LA Accredited Calibration Certificate		

ROTARY TORQUE TRANSDUCERS

Series PC9000 Rotary Torque Sensors are widely used in the fastener assembly market to verify the performance of hand and power torque tools. The durable, strain gage-based transducers are fitted on the output drive of the hand or power tool and measure the torque applied by the tool to the fastener on an actual assembly. This measurement provides important information about tool shut off and can assist in establishing specifications for proper assembly. When equipped with an optional angle encoder, the rotary torque transducer can also measure the angle of fastener rotation which is an important indication of joint integrity.

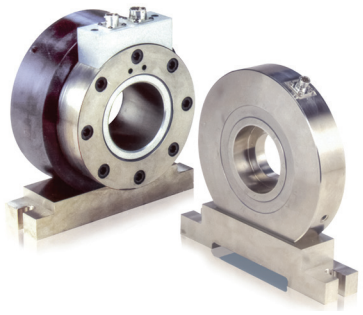
TORQUE ONLY PERFORMANCE*			
Model	**Drive Size**	**Capacity**	
039030-50002	¼-inch Hex	32 ozf-in	(0.2 Nm)
039030-50021	¼-inch Hex	20 lbf-in	(2.3 Nm)
039025-50051	¼-inch Square	50 lbf-in	(5.7 Nm)
039030-50101	¼-inch Hex	100 lbf-in	(11.3 Nm)
039025-50101	¼-inch Square	100 lbf-in	(11.3 Nm)
039037-50022	⅜-inch Square	200 lbf-in	(22.6 Nm)
039037-50051	⅜-inch Square	50 lbf-ft	(68 Nm)
039050-50101	½-inch Square	100 lbf-ft	(136 Nm)
039050-51201	½-inch Square	148 lbf-ft	(200 Nm)
039075-50301	¾-inch Square	300 lbf-ft	(406 Nm)
039075-51501	¾-inch Square	369 lbf-ft	(500 Nm)
039075-53601	¾-inch Square	600 lbf-ft	(814 Nm)
039001-53102	1-inch Square	1000 lbf-ft	(1356 Nm)
039001-01302	1-inch Square	2213 lbf-ft	(3000 Nm)
039001-53033	1-inch Square	3000 lbf-ft	(4068 Nm)
TORQUE-ANGLE PERFORMANCE*			
Model	**Drive Size**	**Capacity**	
039230-50002/B	¼-inch Hex	32 ozf-in	(0.23 Nm)
039230-50021/B	¼-inch Hex	20 lbf-in	(2.3 Nm)
039225-50051/B	¼-inch Square	50 lbf-in	(5.7 Nm)
039230-50101/B	¼-inch Hex	100 lbf-in	(11.3 Nm)
039225-50101/B	¼-inch Square	100 lbf-in	(11.3 Nm)
039237-50022/B	⅜-inch Square	200 lbf-in	(22.6 Nm)
039237-50051/B	⅜-inch Square	50 lbf-ft	(68 Nm)
039250-50101/B	½-inch Square	100 lbf-ft	(136 Nm)
039250-51201/B	½-inch Square	148 lbf-ft	(200 Nm)
039275-50301/B	¾-inch Square	300 lbf-ft	(406 Nm)
039275-51501/B	¾-inch Square	369 lbf-ft	(500 Nm)
039275-53601/B	¾-inch Square	600 lbf-ft	(814 Nm)
039201-53102/B	1-inch Square	1000 lbf-ft	(1356 Nm)
039201-01302/B	1-inch Square	2213 lbf-ft	(3000 Nm)
039201-53302/B	1-inch Square	3000 lbf-ft	(4068 Nm)

*Options for 15, 10 000, and 24 000 Nm available on pcb.com

SPECIFICATIONS	
Performance	
Torque	
Output at Rated Capacity	2 mV/V ≤ 0.25% FS
Shunt Calibration	Matched 2mV/V ≤ 0.25% with 43.575 kOhm Precision Resistor
Interchangeability	Matched for mV/V and Shunt Calibration ≤ 0.30% FS
Non-Linearity	≤ 0.25% FS
Hysteresis	≤ 0.25% FS
Excitation Voltage [1]	10 VDC
Bridge Resistance	350 Ohm
Compensated Temperature Range	+70 to +150 °F (+21 to +66 °C)
Operating Temperature Range	0 to +200 °F (-18 to +93 °C)
Connector	PT02H-12-10P
Angle	
Magnetic Encoder	¼", ⅜" and ½" Drive – 368 Poles, ¾" Drive – 544 Poles, 1" and 1-½" Drive – 720 Poles, 2-½" Drives – 900 Poles
Output	A-B Track 90 Degrees Phase Difference Flat Over Operating Speed Range
Counts Per Resolution (CPR), Resolution w/Quadrature	¼", ⅜", ½" Drive – 1472, ¼ Degree, ¾" Drive – 2176, ⅙ Degree, 1" and 1-½" Drive – 2880, ⅛ Degree, 2-½" Drive 3600, ⅒ Degree
Output Voltage	High 5.0 V, Low 0.5 V
Power Required	5 VDC @ 120 mA Maximum
Recommended Maximum RPM	
¼-inch Drive	5000
⅜-inch Drive	2500
½-inch Drive	2500
¾-inch Drive	2000
1-inch Drive	1000
1 ½-inch Drive	750
2 ½-inch Drive	500
Supplied Accessories	
Shunt Calibration Resistor, A2LA Accredited Calibration Certificate	

[1] Calibrated at 10 VDC, usable 5 to 20 VDC or VAC RMS

FASTENER TENSION & TORQUE-TENSION LOAD CELLS



Series FT9000 & FTA9000 Fastener Tension and Fastener Torque-Tension Load Cells use a full bridge strain gage design. This complete line of fastener testing load cells provides a signal proportional to the tension developed in a test fastener when the tightening torque is applied. In addition, the fastener torque-tension version, also referred to as a research head, measures the thread torque (pitch torque plus thread friction torque) at the same time. The tension or torque-tension output signals from either type of load cell are read using a conventional strain gage readout device or recorded by a data acquisition system. These load cells serve as an integral part of a torque-tension fastener test system when used with a torque-angle sensor and a suitable data acquisition instrument; Model 962 Portable Data Recorder, Model 3210 LabMaster Portable, or Model 3200 LabMaster Professional, available from RS Technologies, are recommended.

COMMON SPECIFICATIONS	
Output at Rated Capacity	2 mV/V
Non-linearity	±0.2% FS
Overload Capacity	50% FS
Hysteresis	± 0.2% FS
Excitation Voltage [1]	±10 VDC
Bridge Resistance	350 Ohms, Full Bridge, Bonded Strain Gage
Supplied Accessories	
Shunt Calibration Resistor, A2LA Accredited Calibration Certificate	

[1] Calibrated at 10 VDC, usable 5 to 20 VDC or VAC RMS

SERIES FT9000 FASTENER TENSION LOAD CELLS	
Model	**Capacity**
059810-01153	3372 lbf (15 kN)
059810-01253	5620 lbf (25 kN)
059810-01104	22 klbf (100 kN)
059810-01304	67 klbf (300 kN)
059810-01504	112 klbf (500 kN)

SERIES FTA9000 FASTENER TENSION LOAD CELLS		
Model	**Thread Torque Capacity**	**Fastener Tension Capacity**
059400-01024	15 lbf-ft (20 Nm)	4496 lbf (20 kN)
059500-01044	44 lbf-ft (60 Nm)	8992 lbf (40 kN)
059600-01104	110 lbf-ft (150 Nm)	22 klbf (100 kN)
059625-01304	590 lbf-ft (800 Nm)	67 klbf (300 kN)
059650-01604	1475 lbf-ft (2000 Nm)	135 klbf (600 kN)
059720-01095	2950 lbf-ft (4000 Nm)	202 klbf (900 kN)
059740-01185	5900 lbf-ft (8000 Nm)	405 klbf (1800 kN)

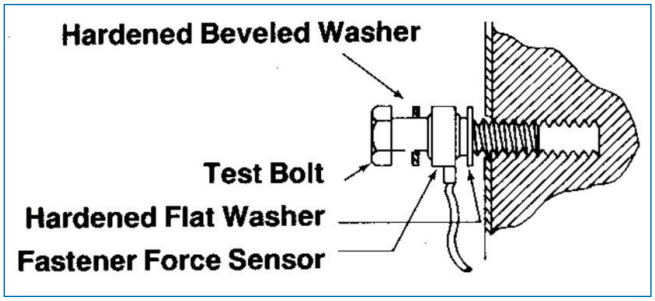
RECOMMENDED ACCESSORIES	
Model	**Description**
080962-01000	Model 962 Recorder
083210-01000	Model 3210 LabMaster Portable
083200-01000	Model 3200 LabMaster Professional
099404-30610	Cable (Series FT9000)
099404-30566	Cable (Series FTA9000)

LOAD WASHERS

Series FT4000 Load Washer Transducers are miniature load cells designed specifically for measuring fastener clamping forces. The design provides high stiffness in a small package, making these load cells ideal for static and dynamic measurements on fasteners, or structural test applications where space limitations exist. Load washer transducers come in a variety of English and Metric sizes. All transducers are carefully sealed and thoroughly tested prior to shipment. Two hardened steel washers are provided with each unit and should be mounted on both sides of the transducer to minimize any transmitted rotational effects or spot loading. Please refer to the illustration below more information.

Series FT4000 Load Washer Transducers can be used along with rotary torque or torque-angle torque sensors and a data acquisition instrument to acquire fastener testing data; Model 962 Portable Data Recorder is recommended. If fastener clamp load alone is required, Model 920 Portable Digital Transducer Instrument can quickly capture and record the data.

NOTE: Fastener Load Washers are not designed for use as high-accuracy clamp force measurement devices.

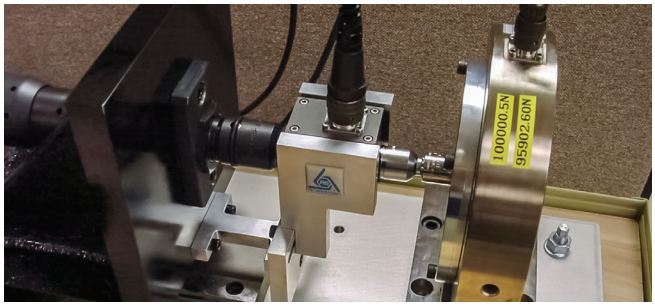


COMMON SPECIFICATIONS	
Construction	Steel Flexure, Aluminum Cover
Output at Rated Capacity	1.5 mV/V Nominal
Overload Capacity	150% FS
Non-linearity	±5.0% FS
Hysteresis	±5.0% FS
Zero Offset	±5.0% FS
Excitation Voltage	10 VDC, Maximum
Bridge Resistance	350 Ohms
Operating Temperature Range	0 to +200 °F -18 to +93 °C
Supplied Accessories	
One Pair Hardened Grounded Washers, Shunt Calibration Resistor, & A2LA Accredited Calibration Certificate	

ENGLISH SIZES (IN)					
Model	**Bolt Size (in)**	**Capacity**	**Inner Diameter**	**Outer Diameter**	**Height**
054103-01252	#10	2 500 lbf	0.196	0.625	0.255
054104-01502	¼	5 000 lbf	0.257	0.674	0.255
054105-01802	5/16	8 000 lbf	0.321	0.809	0.317
054106-01103	⅜	10 klbf	0.382	0.842	0.380
054107-01153	7/16	15 klbf	0.444	0.943	0.420
054108-01203	½	20 klbf	0.507	1.111	0.455
054109-01253	9/16	25 klbf	0.570	1.213	0.495
054110-01303	⅝	30 klbf	0.636	1.350	0.525
054112-01403	¾	40 klbf	0.757	1.620	0.595
054114-01603	⅞	60 klbf	0.882	1.888	0.665
054116-01803	1	80 klbf	1.006	2.160	0.735

METRIC SIZES (MM)					
Model	**Bolt Size (mm)**	**Capacity**	**Inner Diameter**	**Outer Diameter**	**Height**
054206-01203	6	20 kN	6.17	17.12	6.48
054208-01353	8	35 kN	8.15	20.55	9.65
054210-01543	10	54 kN	10.19	23.95	10.69
054212-01084	12	80 kN	12.19	28.22	11.56
054214-01114	14	110 kN	14.15	30.81	12.57
054216-01144	16	140 kN	16.15	34.29	13.34
054218-01184	18	180 kN	18.16	41.15	15.11
054220-01224	20	220 kN	20.17	41.15	15.11
054222-01274	22	270 kN	22.17	47.96	16.89
054224-01324	24	320 kN	24.18	54.86	18.67
054230-01804	30	400 kN	30.20	60.45	22.23

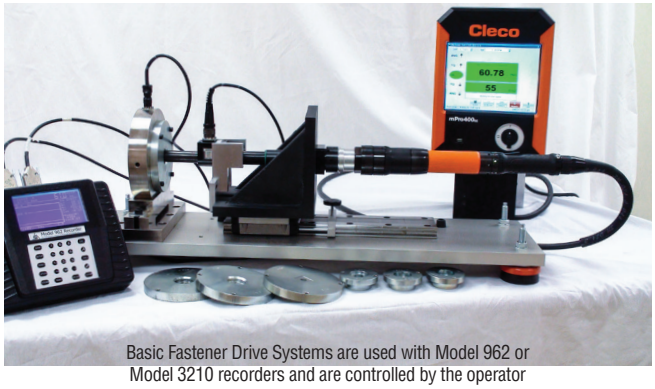
FASTENER DRIVE SYSTEM



Fastener Drive Systems are available in a variety of speed and torque configurations, depending upon the size and type of fasteners and testing requirements. The systems are comprised of a rugged, heavy-duty industrial DC brushless electric motor and a dependable servo controller that together provide the precise and accurate torque and speed that is required for threaded fastener testing. The system can be supplemented with torque multipliers to extend their torque and speed range.

Fastener Drive Systems are used in conjunction with RS Technologies' Model 3200, LabMaster Professional, to provide control. Model 3200 is an advanced multipurpose system designed to perform automated threaded fastener testing and joint analysis. When the Fastener Drive System is used with the LabMaster Professional, the unit provides real-time data display as well as printing, plotting, and automatic data storage capabilities.

A complete test system also includes a rotary torque-angle transducer, a combination tread torque and clamp force transducer, a text fixture assembly for mounting all components, and a printer for data reports and plots.



Basic Fastener Drive Systems are used with Model 962 or Model 3210 recorders and are controlled by the operator

LabMaster test system drive motors are programmed for operation using the Labmaster for Windows® testing software.

FASTENER DRIVE SYSTEM			
Model	**Max Speed (RPM)**	**Torque Output**	**Max Fastener Size**
089200-00524	329 RPM	75 lbf-ft 102 Nm	M7 (5⁄16")
089200-00526	219 RPM	113 lbf-ft 153 Nm	M10 (3⁄8")
089200-00528	220 RPM	192 lbf-ft 260 Nm	M12 (1⁄2")
089400-00606*	149 RPM	396 lbf-ft 537 Nm	M16 (5⁄8")
089600-00621*	102 RPM	576 lbf-ft 781 Nm	M18 (11⁄16")
089800-00631*	102 RPM	791 lbf-ft 1073 Nm	M20 (13⁄16")
089120-01000*	74 RPM	1095 lbf-ft 1485 Nm	M22 (7⁄8")

*Calibrated at 10 VDC, usable 5 to 20 VDC or VAC RMS

BASIC FASTENER DRIVE SYSTEM			
Model	**Max Speed (RPM)**	**Torque Output**	**Max Fastener Size**
08-CLEC-A0MTR	320	115 Nm (85 lbf-ft)	M10 (3⁄8")
08-CLEC-00MTR	245	150 Nm (111 lbf-ft)	M10 (3⁄8")
08-CLEC-01MTR	115	285 Nm (210 lbf-ft)	M12 (1⁄2")
08-CLEC-02MTR	67	475 Nm (350 lb-ft)	M14 (9⁄16")
08-CLEC-03MTR	33	848 Nm (625 lb-ft)	M18 (11⁄16")

FIXTURE ASSEMBLIES

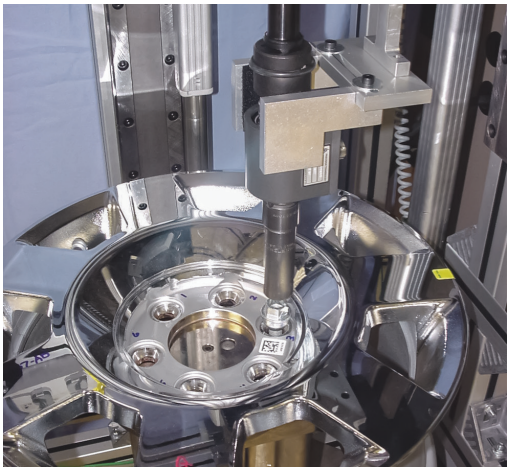
- Measure and record torque, angle, and tension characteristics of threaded fasteners
- Verify threaded fastener torque-angle-tension calculations
- Test actual fasteners in a laboratory environment

A typical Fastener Test Stand for fastener sizes up to M12 (9/16 inch), provides a linear slide bearing mount for the fastener drive motor and rotary torque-angle sensor, and stationary mounting for the torque-tension research head. When used with a Model 3200 LabMaster, it is ideal for conducting torque-tension testing on all types of threaded fasteners. The LabMaster is an advanced multi-purpose system designed to perform dynamic threaded fastener testing and joint analysis. It provides real-time data display as well as printing, plotting, and automatic data storage capabilities. A complete fastener test system includes a DC electric tool and controller, a rotary torque-angle transducer, a combination thread torque and clamp force transducer, and a printer for data reports and plots.

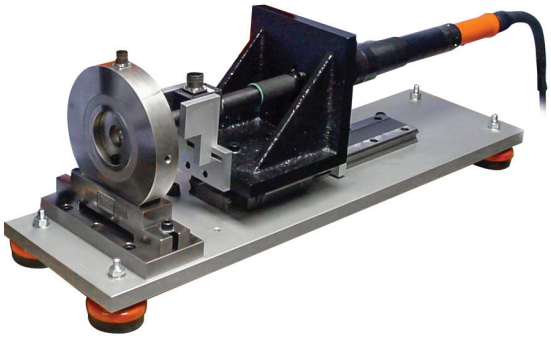
The standalone Fastener Test Stand for fastener sizes up to M33 (1-3/8 inch), provides sturdy mounting for the fastener drive motor system, rotary torque-angle sensors, and torque multiplier (if needed) The torque-tension research head or clamp force load cell is mounted on a dual slide assembly. When teamed with a Model 3200 LabMaster data recorder, it is ideal for conducting research on large threaded fasteners.

The Automotive Wheel Nut Test Stand, for Vehicle Wheels up to 28 inches in diameter, when teamed with a Model 3200 LabMaster Professional, is ideal for conducting research on passenger car and light truck wheels and wheel nuts. It is a complete, automated threaded fastener test stand.

MODEL	DESCRIPTION
109100-01440	Tabletop Slide Fixture Assembly, Single Motor Slide, Short Base
109175-37013	Tabletop Slide Fixture Assembly, Single Motor Slide, Long Base
109480-34033	Tabletop Slide Fixture Assembly, Dual Load Slide, Long Base
109480-32025	Free-standing Fastener Test Stand, Dual Load Cell Slide
102145-54006	Automotive Wheel Nut Test Stand, Motorized Tool Slide
100135-10000	Portable Tool Cart

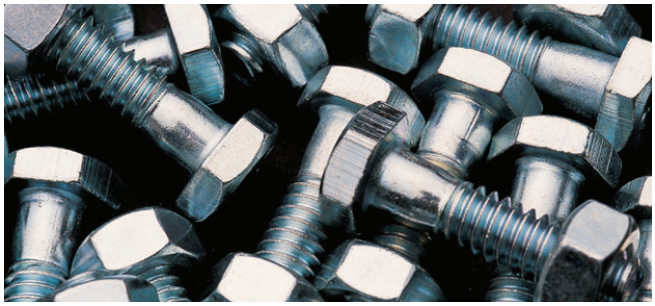


Model 102145-54006 Wheel Nut Test Stand



Model 109100-01440 Fixture Assembly

ACCESSORIES



FASTENER TEST SYSTEM ACCESSORIES	
Model	**Description**
089504-10000	Fastener Test System Printer
099600-30131	Strain Gage Bridge Input Junction Box, for Use with Non-Standard Transducers and Load Cells
086000-31837	Precision Strain Gage Calibrator, for Field Instrument Calibration
102145-00001	Snap-On X-4 Torque Multiplier (240 ft-lb max. input/1,000 ft-lb max. output)
102145-G1000	Industrial Torque Multiplier w/mounting hardware (500 ft-lb max. input/2000 ft-lb max. output) Geartronics 4:1
102145-G2500	Industrial Torque Multiplier w/mounting hardware (1327 ft-lb max. input/8000 ft-lb max. output) Geartronics 6:1

FASTENER TEST SYSTEM CABLES	
Model	**Description**
099404-30610	DB-15P to Bendix 4S, Model 962/Model 3200 to 4-pin Load Cell, 10-ft straight
099404-34011	DB-15P to Bendix 4S, Model 962 to 4-pin Load Cell, 3-ft straight
099404-30563	DB-15P w/Screw Clip to Bendix 10S, Model 962/Model 3200 to Torque-Angle Transducer, 10-ft straight
099504-31843	DB-15P to Bendix 6S, Model 962/Model 3200 to 6-pin Transducer, 10-ft straight
099404-30566	(2) DB-15P to Bendix 10S, Model 3200 to Torque-Tension Load Cell, 10-ft straight
093210-49585	PT-10P to PT-10S, Model 3210 to Torque Angle Transducer, 10-ft straight
093210-49586	PT-10P to PT-10S, Model 3210 to Torque Tension Load Cell, 10-ft straight
093210-49587	PT-10P to PT-4S, Model 3210 to 4 Pin Torque Transducer or Load Cell, 10-ft straight

FASTENER TEST SYSTEM FIXTURES & CART	
Model	**Description**
109100-01440	Table Top Slide Assembly, Single Motor Slide, Short Base
109480-34033	Tabletop Slide Fixture Assembly, Dual Load Cell Slide, Long Base
109480-32436	Medium Free-Standing A-Frame Test Stand, includes Slide Assembly
109483-32025	Large Free-Standing Test Stand, includes Slide Assembly
100135-10000	Portable Tool Cart

FASTENER TENSION & FASTENER TORQUE-TENSION LOAD CELL PLATE SETS

ENGLISH SIZES	
Model	**Description**
1000M6-30429	M6 Plate Set
1000M8-30430	M8 Plate Set
100M10-30431	M10 Plate Set
100M12-30432	M12 Plate Set
100M14-30433	M14 Plate Set
100M16-30434	M16 Plate Set
100M18-30435	M18 Plate Set
100M20-30436	M20 Plate Set
100M22-30438	M22 Plate Set
100M25-30437	M25 Plate Set
100M27-30440	M27 Plate Set
100M30-30443	M30 Plate Set
100008-02000	#8 Plate Set
100010-02000	#10 Plate Set
METRIC SIZES	
Model	**Description**
100250-02000	¼-inch Plate Set
100313-02000	5/16-inch Plate Set
100375-02000	3/8-inch Plate Set
100500-02000	7/16-inch Plate Set
100563-02000	½-inch Plate Set
100625-02000	9/16-inch Plate Set
100750-02000	5/8-inch Plate Set
100875-02000	¾-inch Plate Set
101000-02000	7/8-inch Plate Set
101125-02000	1-inch Plate Set
101250-02000	1 1/8-inch Plate Set
100010-02000	1 ¼-inch Plate Set
101500-02000	1 ½-inch Set

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