

L1 FORCE MEASUREMENT

Force Testing Systems

Digital Force Testers

Load Cell Sensors

Force Gages

Manual Force Testers

Accessories



STARRETT INNOVATION. PRECISION.

Starrett L1 solutions are engineered to meet the requirements for fast, efficient, high-volume production testing. Combining functionality with affordability, our L1 solutions ensure accuracy, precision, reliability and repeatability for quality control, incoming inspection, engineering and research and development.

When you need an easy-to-use and reliable solution for your force measurement applications, you can rely on Starrett- a trusted leader in measurement and innovation for over 135 years.

The L1 force products consist of:

- L1 Systems for computer-controlled force measurement
- FMM Digital Force Testers
- DFC and DFG Digital Force Gages
- BLC Load Cell Sensors
- MTL and MTH manually-operated force testers

ACCURATE. EASY-TO-USE. REPEATABLE. RELIABLE.



CREATE. TEST. ANALYZE. REPORT.



L3 SYSTEMS

L3 Systems are optimized for users involved with material testing and characterization- the research engineer, the design engineer, the quality control technician, the test technician and others.



L2 PLUS SYSTEMS

L2 Plus Systems provide engineering and quality personnel with an easy-to-use, yet comprehensive solution for complex force analysis and measurement.



L2 SYSTEMS

L2 Systems are ideal for demanding force measurement testing. Create complex testing methods or use our standard test templates for all types of force measurement applications.



S2 SYSTEMS

S2 Systems are application-specific solutions for testing compression and extension springs. Measure spring rate, spring constant, initial tension, free length and more. - fast and efficiently.

FORCE TESTING SYSTEMS

L1 SYSTEMS

Starrett L1 Systems represent our most-basic, computer-based force testing solution. Optimized for production and quality control testing, they are designed to be easy to setup, operate and maintain.

L1 Systems can be used to perform a wide variety of testing methods including:

- Load Limit Testing
- Distance Limit Testing
- Break Limit Testing
- Cyclic Count Testing
- Cyclic Duration Testing
- Constant Load Testing
- Constant Distance Testing

BASIC ARCHITECTURE

Your Starrett L1 System is comprised of the following:

- FMM Digital Force Tester
- Base clevis adapter kit
- USB 2.0 communication cable
- BLC Load Cell Sensor
- Load cell mounting block
- 2-in-1 Windows® 10 Tablet Computer
- Table computer to column mounting fixture
- L1 Application Software

Communication between the hardware is USB 2.0.

The 2-in-1 L1 tablet features a 10", high-resolution, touchscreen, color display with three USB 2.0 ports.

The L1 application software lets you create your test methods quickly using test templates that guide you through the test setup process. Create common test methods in seconds.

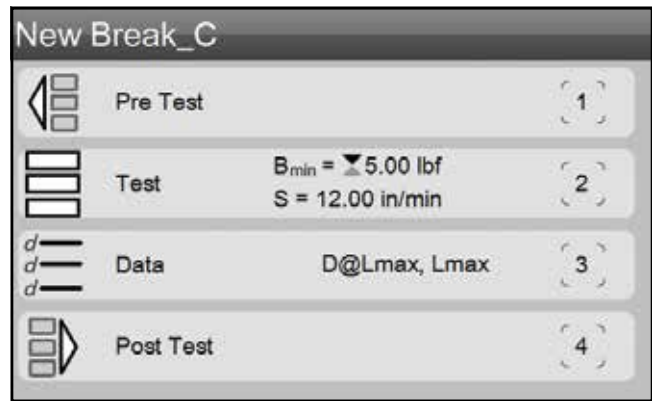


L1-550 system with FMM-550 test frame and L1 tablet and software. Test fixture and BLC Series load cell sensor are optional.

L1 TEST TEMPLATES

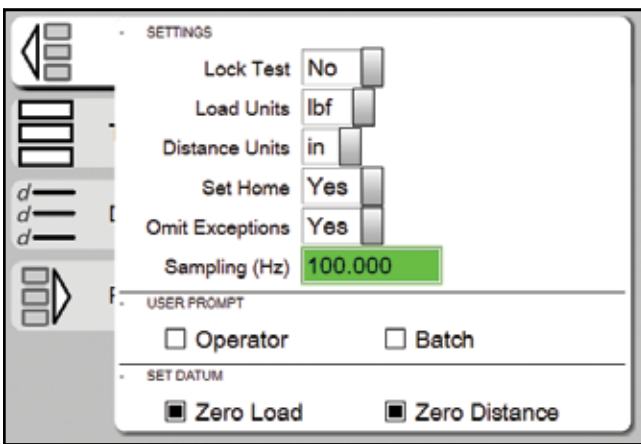
The L1 System includes a set of common force measurement test templates. The templates have a common format consisting of these four test setup stages.

- Pre Test
- Test
- Data
- Post Test



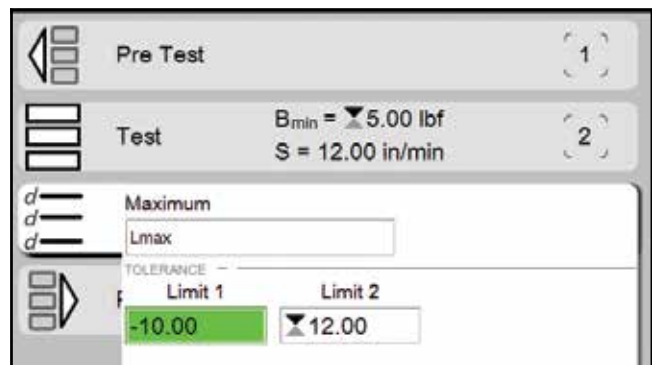
TEST SETUP ARCHITECTURE

All test setups include four common, easy-to-understand, menu-guided stages: Pre Test, Test, Data and Post Test.



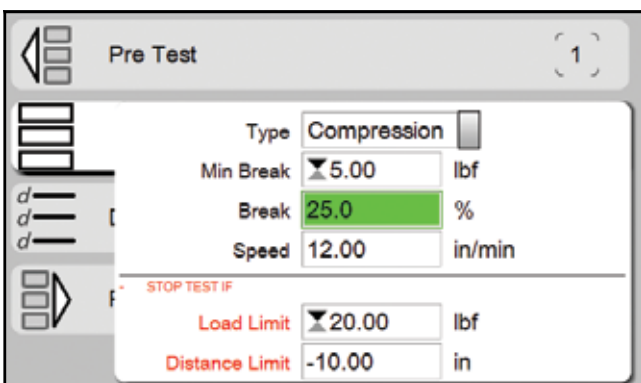
PRE TEST STAGE

The Pre Test stage supplies options you would perform prior to testing, for example, specifying the units needed to measure load and distance.



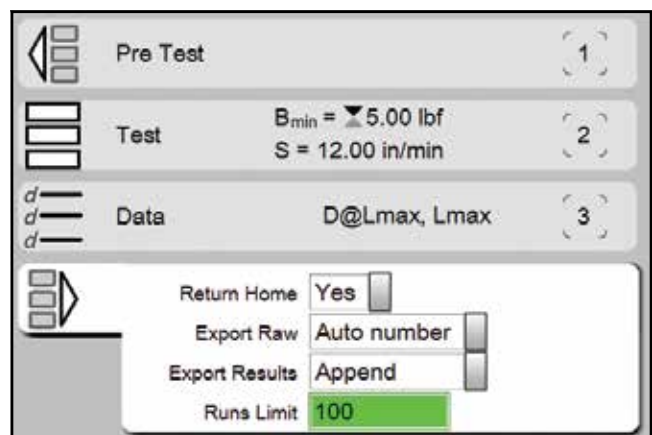
DATA STAGE

The Data stage is where you specify what results you want. For example, you can select Maximum Load, Distance @ Maximum Load, Distance @ Load Limit, Load @ Distance Limit and more. A list of values is displayed and you simply select the result you want. The Data stage is also where you can utilize tolerance limits for immediate "Pass/Fail" identification.



TEST STAGE

The Test stage is where you specify your testing requirements- what load you are using, what distance your crosshead will move, how fast your test speed is. Plus, you can easily add "exceptions". Exceptions are events that can be used to automatically stop your test, if they occur.



POST TEST STAGE

The Post Test stage lets you define what you want to do when the test concludes. You can export raw data or just the results and send to a network server. You can easily export directly to Microsoft® Excel® for custom report generation or analysis. Export information is saved as a .csv format for easy integration.

FORCE TESTING SYSTEMS

L1 ACCURATE MEASUREMENTS

When your L1 test method concludes, you can see the results you specified in your setup. Your L1 System will display results in these formats:

- Results View
- Graph View
- Data View
- Tolerance View
- Statistics View

RESULTS VIEW

Your results are displayed in a large, easy-to-read format organized for quick interpretation. The result and associated units of measure are displayed. During testing the active load and distance measurement is displayed. The crosshead speed and direction of travel is also displayed so the operator is aware of the current test status.

GRAPH VIEW

Load, Distance and Time can be used to view the data points used for your test. You may sample at rates up to 1000Hz and display your graph profile for your test. You can select a point on the graph and see the associated load, distance and time. You can also overlay multiple graphs to make graphical comparisons.

Your Test Name is displayed as well as the type of test: compression or tension.

DATA VIEW

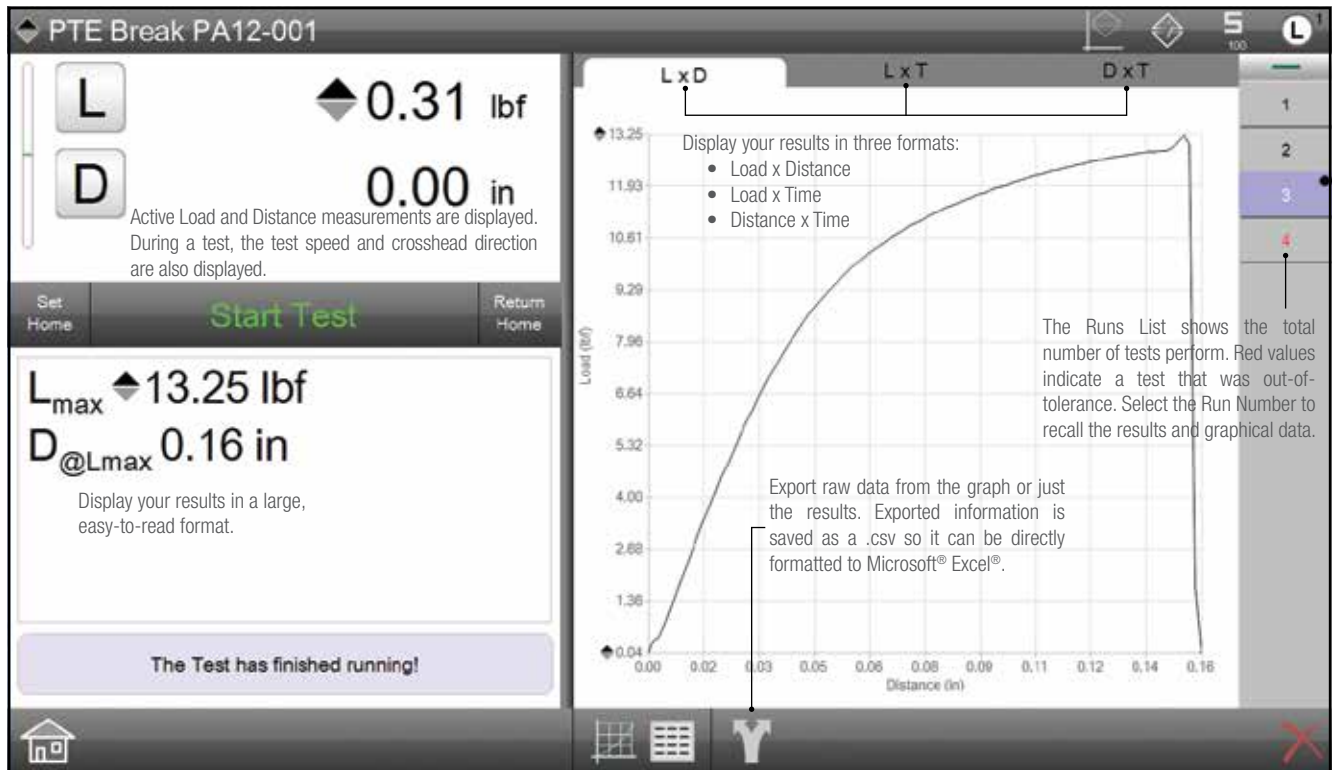
Results can be displayed in a tabular format. This is ideal for a quick comparison of each test in a batch of tests performed throughout the shift or day. You can export directly from the Data view to Microsoft® Excel®.

TOLERANCE VIEW

When tolerance limits are used for "Pass/Fail" analysis, you can see your tolerance limits compared to actual results. You also see "Pass" or "Fail". Failed results are displayed in red text. And we supply a deviation bar graph that shows where your results measured compared to your tolerance limits.

STATISTICS VIEW

Common statistics such as mean, maximum, minimum, standard deviation and six sigma may be displayed for all test results.



When the test concludes, your L1 software shows your results in numerical and graphical formats. Essential measurements are displayed in easy-to-interpret formats. You can Start and Stop a test using the touchscreen display; manually set the home position and return the crosshead to home position, and zero your load (L) and distance (D) measurements.



Compare the graphical results of multiple tests that you select. Individual graphs are color-coded and referenced to the test in the Runs List. You can also retrieve archived tests for making a graphical comparison. For example, you can compare a "benchmark" result from a year ago to a current result.

◆ PTE Break PA12-001

L 0.31 lbf
D 0.00 in

Start Test

L_{max} 15.65 lbf
D_{@Lmax} 4.35 in

The Test has finished running!

| Run | Coef | Units | Actual | Limit 1 | Limit 2 | Deviation | P/F |
|-----|--------|-------|--------|---------|---------|-----------|------|
| 1 | Lmax | lbf | 12.87 | 10.00 | 15.00 | →→→ | Pass |
| 1 | D@Lmax | in | 3.19 | | | | |
| 2 | Lmax | lbf | 12.97 | 10.00 | 15.00 | →→→ | Pass |
| 2 | D@Lmax | in | 3.10 | | | | |
| 3 | Lmax | lbf | 13.25 | 10.00 | 15.00 | →→→ | Pass |
| 3 | D@Lmax | in | 0.16 | | | | |
| 4 | Lmax | lbf | 15.65 | 10.00 | 15.00 | →→→ | Fail |
| 4 | D@Lmax | in | 4.35 | | | | |

Select the Data view and view results in a tabular format. Easily switch to Graph view by selecting the Graph symbol.

"Pass" and "Fail" status is immediate when using tolerances. Out-of-tolerance results are displayed in red.

Display results in a tabular format complete with your tolerance limits. Test results that are out-of-tolerance are prominently displayed in red. Out-of-tolerance results are identified in the table, large results view and on the graph view in the Runs List. You can also display statistics on selected test runs. Calculate and display Minimum, Maximum, Mean and Standard Deviation with a single click.

DIGITAL FORCE TESTERS

FMM DIGITAL FORCE TESTERS

FMM Digital Force Testers may be used with L1 software or with a Starrett DFC or DFG digital force gage. FMM digital force testers are compact and ideal for high-volume, lean manufacturing production.

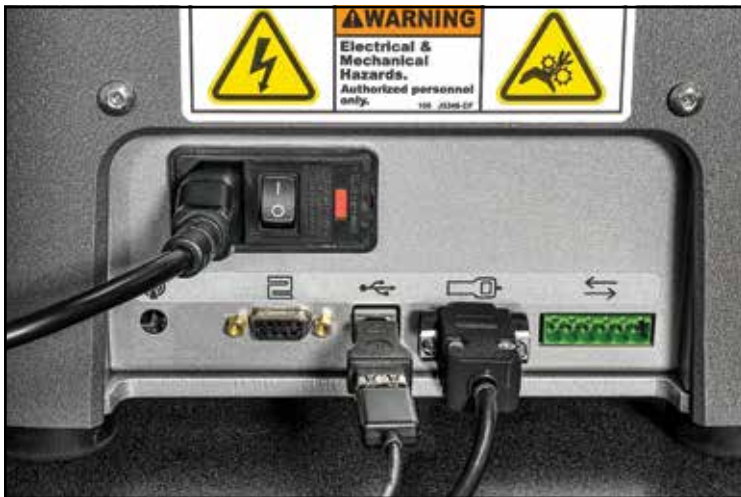
FMM testers are available in three capacities: 110lbf (500N), 330lbf (1500N) and 550lbf (2500N). Two travel lengths are available for all capacities: standard travel at 20" (508mm) and extended travel at 30" (762mm). Crosshead speeds are controlled locally and can be set from 0.002 to 40 inch/min (0.05 to 1016mm/min). A high-resolution OLED display shows distance measurements with accuracy better than 20µm (0.0008 inch). Travel limits help prevent load sensor overloading.

The FMM force tester can be controlled using L1 software for limit, cycling, hold and coefficient of friction testing.

The FMM force tester can also be controlled using a DFC digital force gage. The DFC force gage serves as a universal controller where it is used to setup the force tester's distance limits, crosshead direction and crosshead velocity for a test.

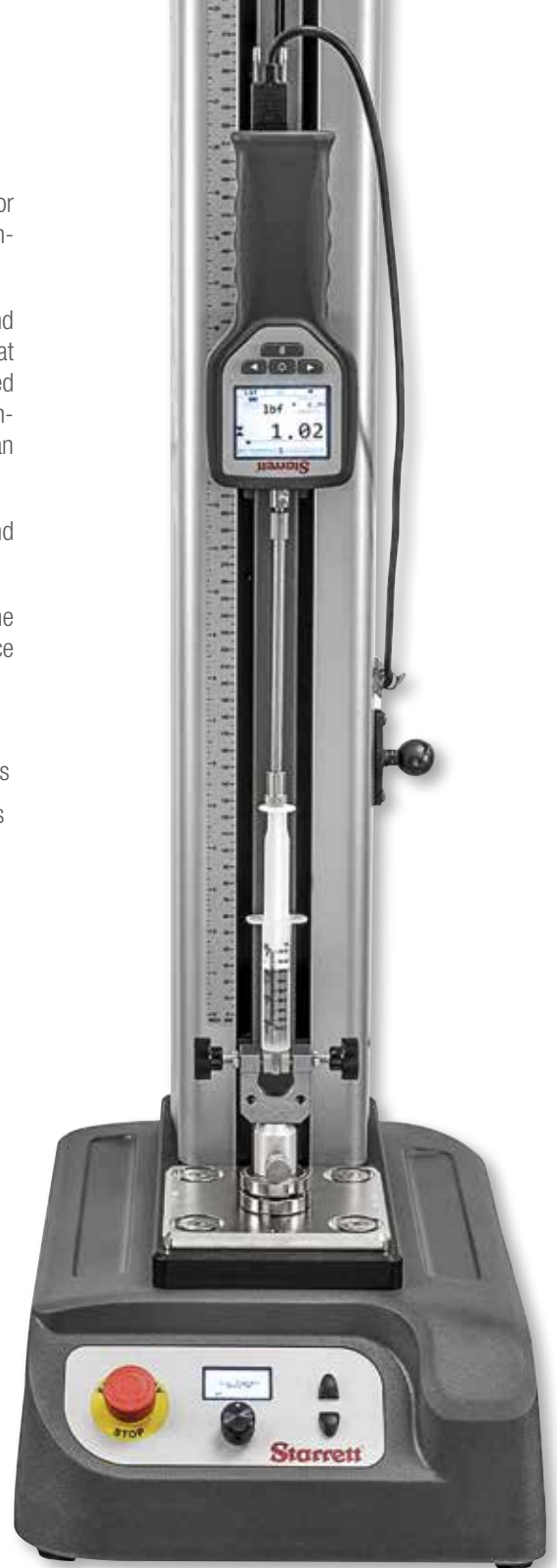
FEATURES

- Ideal for tension, compression, flexural, cyclic, shear, and friction applications
- Use with L1 software and 2-in-1 tablet PC or with DFC and DFG force gages
- Multiple, Easy-to-Use Operating Modes
 - Manual
 - Automatic
 - Continuous
 - Gage Control (DFC force gage controls FMM tester)
 - Software Control (L1 system control)



Interface connections and communications are clearly shown on the back panel.

Source power may be 100-240V- no jumpers required or configuration needed.





FEATURES

- Crosshead position accuracy is better than 20µm (0.0008 in)
- Two column heights and travels:
 - Standard Travel 20" (508mm)
 - Extended Travel 30" (762mm)
- Three force capacities:
 - 110 lbf (500N)
 - 330 lbf (1500N)
 - 550 lbf (2500N)
- Reference distance travel ruler
- Cycle for 99,999 counts or seconds (72 hours)
- Hold at load or duration for up to seconds (72 hours)
- Compact design is ideal for small work space and for lean manufacturing environments
- Adjustable base adapter ensure correct sample alignment
- Standard metric base with M4, M6, M10 and M12 threads
- Optional imperial base with #10-32, 5/16-18, 1/4-28 and 1/2-20 threads
- USB 2.0 and RS-232 Communications
- Configurable crosshead speeds from:
 - 0.002 to 40 in/min
 - 0.05 to 1000 mm/min
- Crosshead speed accuracy is better than 0.1% at full speed, full load
- Adjustable, magnetic travel limits
- Quiet operating even at full speed, full load
- Easily upgrade from force gage control to computer-based operation using L1 software and 2-in-1 tablet PC
- Two mounting blocks for:
 - Force gage mounting
 - BLC load cell mounting
- Four configurable 0-24Vdc digital I/O channels for switch testing or use with annunciators and status lamps
- Base clevis adapter kit supplied standard
- Cast-aluminum base with bench clips to secure to work space if needed
- Easy-to-use jog keys with excellent tactile feedback
- Speed selection dial with high resolution display

DIGITAL FORCE TESTERS

SPECIFICATIONS

| | | Standard Travel | | | Extended Travel | | |
|-------------------------------------|----------|--|---------------|---------------|-----------------|---------------|---------------|
| Models | | FMM-110 | FMM-330 | FMM-550 | FMM-110X | FMM-330X | FMM-550X |
| Load Capacity, Full Scale | Lbf | 110 | 330 | 550 | 110 | 330 | 550 |
| | N | 500 | 1500 | 2500 | 500 | 1500 | 2500 |
| | Kgf | 50 | 150 | 250 | 50 | 150 | 250 |
| Crosshead Speed, Minimum | inch/min | 0.002 | | | | | |
| | mm/min | 0.05 | | | | | |
| Crosshead Speed, Maximum | inch/min | 40 | | | | | |
| | mm/min | 1000 | | | | | |
| Maximum Speed, Full Load | inch/min | 40 | | | | | |
| | mm/min | 1000 | | | | | |
| Accuracy- Speed | | Better than 0.1% of test speed | | | | | |
| Accuracy- Crosshead Position | inch | Better than 0.0008 | | | | | |
| | mm | Better than 0.02mm | | | | | |
| Travel Resolution | inch | 0.001 | | | | | |
| | mm | 0.025 | | | | | |
| Axial Frame Stiffness | lbf/in | 13,750 | 17,368 | 17,742 | 12,222 | 13,750 | 14,865 |
| | kN/mm | 2.5 | 3.1 | 3.1 | 2.2 | 2.5 | 2.5 |
| Cycling, Maximum | Counts | 99,999 | | | | | |
| | Duration | 27 hours | | | | | |
| Constant Hold, Maximum | Duration | 27 hours | | | | | |
| Vertical Test Space ¹ | inch | 22 | | | 32 | | |
| | mm | 559 | | | 813 | | |
| Crosshead Travel | inch | 20 | | | 30 | | |
| | mm | 508 | | | 762 | | |
| Communication | | USB 2.0, RS-232, | | | | | |
| Input/Output Channels | | 0 - 24Vdc (independent, configurable) | | | | | |
| Power | | Single Phase Voltage (Vac) +10% 110, 120, 220, 230, 240 50/60 Hz | | | | | |
| Using 117V Mains at Full Scale Load | | 0.09A Holding | 0.11A Holding | 0.18A Holding | 0.09A Holding | 0.11A Holding | 0.18A Holding |
| | | 10.5 Watts | 12.9 Watts | 21.1 Watts | 10.5 Watts | 12.9 Watts | 21.1 Watts |
| Operating Temperature | °F | +40 to +110 | | | | | |
| | °C | +5 to +43 | | | | | |
| Humidity | | 10 to 90%, non-condensing | | | | | |
| Throat | inch | 3.9 | | | | | |
| | mm | 100 | | | | | |
| Height | inch | 37 | | | 47 | | |
| | mm | 940 | | | 1194 | | |
| Width | inch | 11.5 | | | | | |
| | mm | 292 | | | | | |
| Depth | inch | 16.5 | | | | | |
| | mm | 419 | | | | | |
| Base Plate Threads | inch | #10-32, 5/16-18, 1/4-28, 1/2-20 (optional) | | | | | |
| | mm | M4, M6, M10, M12 (standard) | | | | | |
| Weight (approx.) | lbs | 80 | | | 95 | | |
| | kgs | 36.3 | | | 43 | | |
| CE Compliance | | Meets all relevant CE standards for safety, immunity, noise | | | | | |

NOTES

Total vertical space is the distance from the top surface of the base plate to the bottom surface of the crosshead.



The standard base plate features four hole patterns for mounting fixtures; M4, M6, M10 and M12. An optional imperial base plate features #10-32, 5/16-18, 1/4-28, and 1/2-20. The base plate can be easily positioned to ensure correct sample alignment.



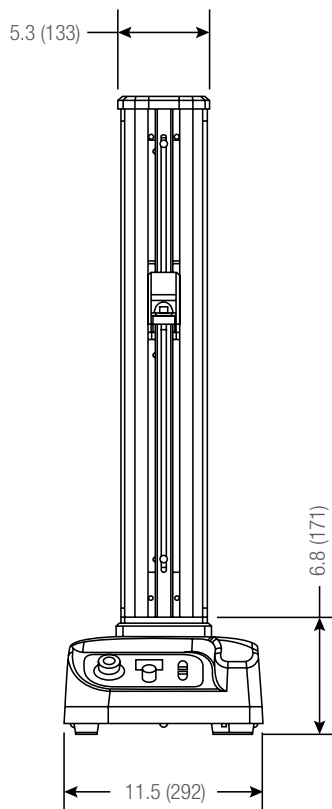
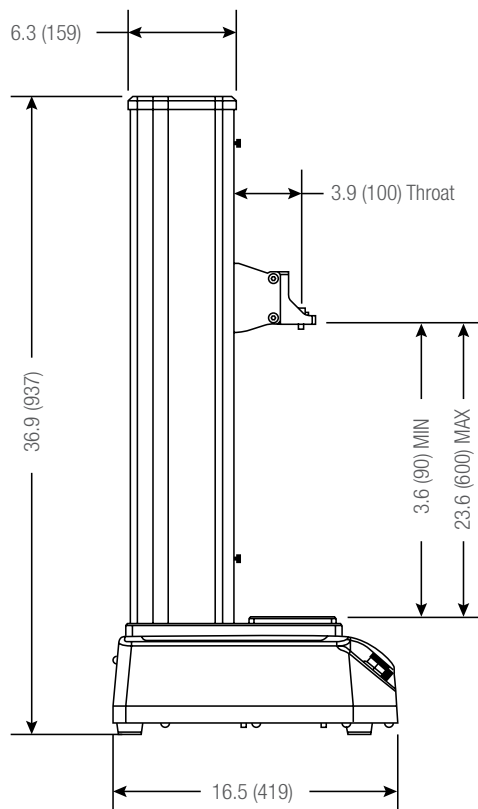
Two mounting blocks are available for attaching a Starrett force gage or the BLC Series load cell. The blocks attach easily and securely to the crosshead and ensure correct center line alignment.



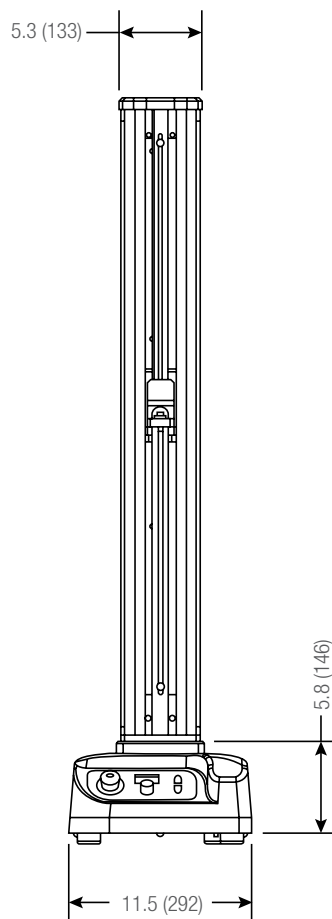
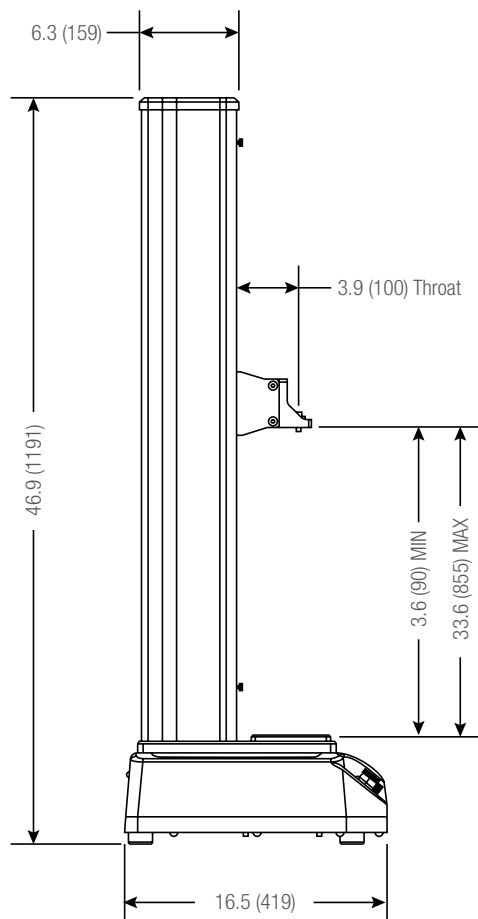
A stainless steel clevis set is included with the FMM test frame base. The clevis will accept 15.9mm diameter test fixtures. The clevis set includes the clevis, locking rings, grip pin and a spanner wrench.

DIMENSIONS

STANDARD TRAVEL



EXTENDED TRAVEL



LOAD CELL SENSORS

Starrett offers a full range of precision load cell sensors for material testing, force analysis and force measurement applications. Starrett load cells are compliant with IEEE 1451.4 and meet or exceed ASTM E4, BS 1610, ISO 7500-1 and EN 10002-2.

Measurement accuracies of $\pm 0.05\%$ of reading down to 1/100 of sensor capacity may be achieved. Sensors are supplied with a NIST-traceable Certificate of Calibration.

BLC LOAD CELL SENSORS

Starrett BLC load cell sensors are full-bridge, temperature compensated, strain gage instruments designed and optimized for basic force testing applications. These S-beam sensors feature high axial stiffness and minimal deflection at full capacity which leads to improved measurement accuracy.

The BLC sensors are general purpose sensors available in capacities from 2lbf to 500lbf (10 to 2500N). These sensors are used exclusively with L1 Systems.



BLC Series - Basic Force Measurement S-beam Sensors

| Model Number | Load Capacity | | | Safe Overload % Full Scale | Full Scale Deflection | | Height | | Width | | Thread mm |
|--------------|---------------|-----|-----|-------------------------------|-----------------------|------|--------|------|-------|------|---------------|
| | N | KGF | LBF | | in | mm | in | mm | in | mm | |
| BLC-2 | 10 | 1 | 2 | 150 | 0.009 | 0.22 | 3.0 | 76.2 | 3.0 | 76.2 | M6 x 1-6H |
| BLC-5 | 20 | 2 | 5 | 150 | 0.008 | 0.21 | 3.0 | 76.2 | 3.0 | 76.2 | M6 x 1-6H |
| BLC-10 | 50 | 5 | 10 | 150 | 0.007 | 0.18 | 3.0 | 76.2 | 3.0 | 76.2 | M6 x 1-6H |
| BLC-20 | 100 | 10 | 20 | 150 | 0.007 | 0.18 | 2.0 | 50.8 | 2.0 | 50.8 | M6 x 1-6H |
| BLC-50 | 250 | 25 | 50 | 150 | 0.006 | 0.15 | 2.0 | 50.8 | 2.0 | 50.8 | M6 x 1-6H |
| BLC-100 | 500 | 50 | 110 | 150 | 0.003 | 0.08 | 2.0 | 50.8 | 2.0 | 50.8 | M6 x 1-6H |
| BLC-200 | 1000 | 100 | 225 | 150 | 0.003 | 0.08 | 2.0 | 50.8 | 2.0 | 50.8 | M6 x 1-6H |
| BLC-500 | 2500 | 250 | 550 | 150 | 0.005 | 0.13 | 2.0 | 50.8 | 2.0 | 50.8 | M12 x 1.75-5H |

NOTES

Load measurement accuracy is $\pm 0.1\%$ of load cell capacity. Display resolution is 10,000:1.

Starrett recommends on-site verification of accuracy during installation. Sensor calibration should be performed at least annually.

SERVICES

CALIBRATION, FIELD SERVICE, FACTORY SERVICE

Starrett can provide all levels of service for your material test and force measurement systems. We can supply a comprehensive range of calibration and verification services to ensure that your testing meets the requirements of international testing standards. Calibrations can be performed to ASTM E4 for load and ASTM E2658 for displacement or to equivalent standards from ISO, BS, DIN and more. Speed, stress and strain verifications can be performed on-site by technicians accredited to ISO 17025.

Preventative maintenance programs, field and factory repair services are available to ensure that your systems perform to their published specifications.

Starrett can provide factory services including load cell calibrations, test frame repair and reconditioning. All Starrett load cell sensors are supplied with a NIST-traceable Certificate of Calibration.

Your Starrett representative can provide on-site training to your personnel to help ensure that your system operates to its published specification. Our training also provides your operators with the knowledge needed to perform your testing in a safe and efficient manner. Our objectives are to help you make your products better through improved resource utilization, increased throughput and optimized efficiency.



| Lx System Product Comparisons and Capabilities | | | | | |
|--|----|---------|----|----|----|
| Target Applications | L3 | L2 Plus | L2 | S2 | L1 |
| Use for Stress, Strain and Material Testing applications | ○ | | | | |
| Use for Advanced Load, Distance and Force Analysis applications | ○ | ○ | | | |
| Use for Basic Load, Distance and Force Measurement applications | ○ | ○ | ○ | | ○ |
| Use for Advanced Extension and Compression Spring applications | ○ | ○ | | | |
| Use for Basic Extension and Compression Spring applications | | | | ○ | |
| User Interface | | | | | |
| All-In-On Computer Workstation, Windows® OS | ○ | ○ | | | |
| Tablet Computer, Windows® OS | | | ○ | ○ | ○ |
| Software Applications | | | | | |
| Test Builder | ○ | ○ | ○ | ✱ | |
| Force Quick Test Templates | | | ○ | | ○ |
| Spring Quick Test Templates | | | | ○ | |
| Formula Builder | ○ | ✱ | ✱ | ✱ | |
| Automation Builder | ✱ | ✱ | ✱ | ✱ | |
| Measurement Methodology | | | | | |
| Measure results using the graph | ○ | ○ | | | |
| Measure results using a List of Value menu | ○ | ○ | ○ | ○ | |
| Create Test Setups using Graphical Test Methods (No programming) | ○ | ○ | ○ | □ | |
| Create Test Setups using Quick-Test Templates | | | ○ | ○ | ○ |
| Test Methods | | | | | |
| Tensile Testing, Load, Distance, Break, Rate | ○ | ○ | ○ | □ | ○ |
| Compression Testing, Load, Distance, Break, Rate | ○ | ○ | ○ | □ | ○ |
| Hold Testing, Load, Distance for Duration or Event | ○ | ○ | ○ | □ | ○ |
| Cyclic Testing for Duration, Count, Loop or Event | ○ | ○ | ○ | □ | ○ |
| Shear Testing | ○ | ○ | | | |
| Flexural Testing | ○ | ○ | | | |
| Peel Testing | ○ | ○ | | | |
| Coefficient of Friction Testing | ○ | ○ | | | |
| Spring Testing | ○ | ○ | | ○ | |
| Measurement Capabilities | | | | | |
| Measure Stress, Strain, Elongation, Strengths | ○ | | | | |
| Measure Offset Yield | ○ | | | | |
| Measure Modulus (Elastic, Chord, Tangent) | ○ | | | | |
| Measure Strain and Elongation using Extensometer(s) (requires MMx test frames) | ○ | | | | |
| Measure Energy, Work, Resilience | ○ | ○ | | | |
| Create Mathematical Expressions using Algebraic, Trigonometric and Logarithmic functions | ○ | ▷ | | | |
| Create Basic Expressions using Add, Subtract, Multiple and Divide | ○ | ▷ | ▷ | ▷ | |
| Use Digital I/O | ▷ | ▷ | ▷ | ▷ | |
| Use Analog I/O (requires MMx test frames) | ▷ | ▷ | | | |
| Use Command and Conditional Logic | ▷ | ▷ | ▷ | ▷ | |
| Measure Load, Distance, Time | ○ | ○ | ○ | ○ | ○ |
| Measure Minimum, Maximum and Averages | ○ | ○ | ○ | ○ | ○ |
| Measure Slopes and Intersections | ○ | ○ | | | |
| Measure Peaks, Valleys, Counts, Averages | ○ | ○ | | | |
| Measure Break, Rupture | ○ | ○ | ○ | □ | ○ |
| Measure Delta between results within a test | ○ | ○ | ○ | | |
| Measure results within multiple test runs simultaneously (multiview) | ○ | ○ | | | |
| Measure Spring Rate, Spring Constant | ○ | ○ | | ○ | |
| Reporting and Exporting Data | | | | | |
| Print using standard reports, graph, batch, tolerance, statistics | ○ | ○ | ○ | ○ | ○ |
| Export results/data in .csv for custom reporting | ○ | ○ | ○ | ○ | ○ |
| Export results/data in .csv for integration with SPC software | ○ | ○ | ○ | ○ | ○ |
| Include tolerances on any result | ○ | ○ | ○ | ○ | ○ |

Note: FMM frames run L1 software only

L3, L2 Plus, L2 and S2 software require a FMS, MMS, FMD or MMD frame

○ = Standard

✱ = Optional

□ = Requires Test Builder application

▷ = Requires Automation Builder application

DIGITAL FORCE GAGES

FOR ADVANCED AND BASIC TESTING APPLICATIONS

Starrett digital force gages can be used as handheld force gages for basic applications or as a force sensor when used with a FMM Digital Force Tester, MTL and MTH Manual Tester. Listed are the various test methods that can be performed:

- **Limit Testing** - Use load, distance or a break condition and report results at the limit including maximum load and distance at maximum load.
- **Load Average Testing** - The load average test measures the load from the start and end of a test sequence.
- **Time Average Testing** - Set a time duration for a test. When load is measured at the start of the test, the test concludes at the end of the time duration. Average load is measured.
- **Cyclic Count Testing** - Define the number of cycles, up to 99,999 to be completed.
- **Cyclic Duration Testing** - Define the duration of cycles, up to 27 hours to be completed.
- **Constant Hold Testing** - Hold at a distance or load for creep and relaxation results. The maximum duration is 27 hours.
- **Contact Closure/Switch Testing** - Uses the DFC force gage to signal when an electronic switch is opened or closed as load is applied or removed.

| Tests | |
|-----------|---------|
| Test Mode | |
| Distance | |
| Type | Tension |
| Target | 50.00 |
| Speed | 25.00 |

Easy Test Setup

As a controller, the DFC can be used to measure load and control the FMM Test Frame. Create Load, Distance and Break Limit test methods in seconds.

| | | |
|---|---|----------|
| ▶ | ☰ | ▼ 3 |
| ▭ | ⊕ | 50.00mm |
| L | ↕ | 50.20 N |
| D | | 50.00 mm |

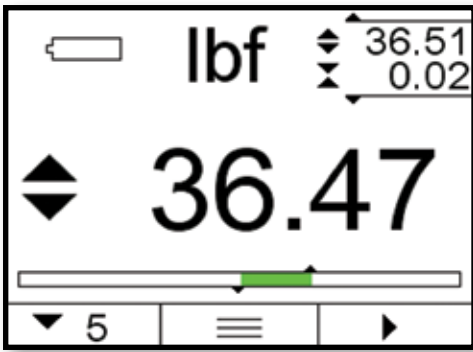
Comprehensive Results

At the completion of your test, the DFC will display load and distance results. These can be saved to memory or exported for reporting.

DFC SERIES DIGITAL FORCE CONTROLLER

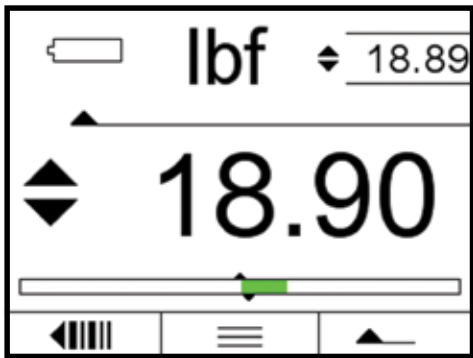
The DFC is a revolutionary concept for force measurement using a handheld force gage. The DFC may be used as a high-accuracy handheld force gage or as a digital controller for use with the FMM Digital Force Testers. The DFC can serve as a universal interface where you set up your tests and where you configure load limits, distance limits, break limits, crosshead travel direction, crosshead speed and more. The DFC features a measurement accuracy of 0.1% full scale with internal data sampling at 25kHz. Display resolution is 10,000:1. The DFC features Bluetooth®, USB and RS-232 communications plus digital I/O.





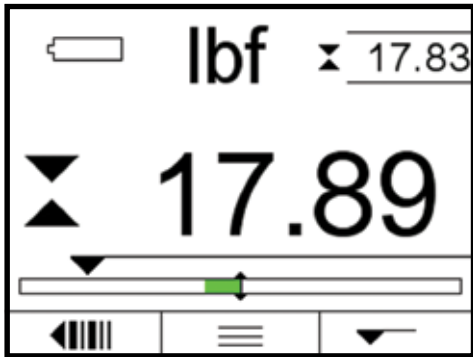
Real Time View

Primary window shows active load being applied to the load cell. The secondary windows shows the measured peak in tension made - 36.51lbf.



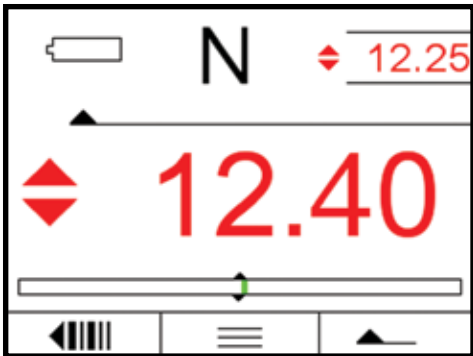
Tension Peak View

Shows maximum load measured in primary window. Secondary window shows real time load.



Compression Peak View

Shows maximum load measured in primary window. Secondary window shows real time load.



Tolerance View

When a tolerance is used, out-of-tolerance results display in red.

DFG DIGITAL FORCE CONTROLLER

The DFG is our basic force gage. The gage measures force at an accuracy of better than 0.2% full scale.

The DFG is ideal for basic tensile and compression testing. Test setup and operation is fast, efficient and easy for anyone. The DFG display shows the test direction and dynamic load during testing. Results are displayed at the completion of testing, including "Pass-Fail" when tolerance is applied. The gage will display statistics when results are saved to the gage's internal memory. Store up to 50 test results in local memory.



FEATURES

- Use as handheld instrument or mount to Starrett test frames: FMM, MTL and MTH.
- Excellent display resolutions:
 - DFC 10,000:1
 - DFG 5,000:1
- Precise and accurate load measurements:
 - DFC 0.1% full scale
 - DFG 0.2% full scale
- Load sensors have safe overload rating of 200%
- High-resolution OLED color display with adjustable backlight and Auto Off feature
- Supplied with NIST-traceable Certificate of Calibration
- 3-year warranty
- Metric threads for screw-on attachments. Can be fitted with clevis adapters that fit hundreds of Starrett test fixtures.
- A primary and secondary display window shows your results. Out-of-tolerance results display in red.
- Adjustable sampling rates help you capture peak loads. Filters can be applied to peak and display values.
- Multiple display languages.
- Battery provides more than 30 hours of continuous operation. Charge battery using USB cable.
- Change display (Flip feature) orientation without having to expose electronics.
- Easy-to-use multi-function keypad. Softkeys are programmable to your most used functions.
- Programmable sounds for alarms, such as an out-of-tolerance result
- Cast-aluminum housing
- Comfort grip for handheld testing applications.



The USB connection is used for charging the battery or for transmitting data to a personal computer. The RS-232 cable is used for connection to the Starrett FMM Series digital tester. The DFC Series also has Bluetooth®.



DIGITAL FORCE GAGES

SPECIFICATIONS

| Digital Force Gages | | |
|--|-----------------------------|------------|
| Specification | DFC Series | DFG Series |
| Accuracy, Full Scale | 0.1% | 0.2% |
| Data Sampling (Hz) | 25,000 | 10,000 |
| Display Resolution | 10,000:1 | 5,000:1 |
| Safe Overload, Full Scale | 200% | 200% |
| Maximum Tare | 10% | 10% |
| Communications | | |
| Bluetooth® | Yes | No |
| USB 2.0 | Yes | Yes |
| RS-232 | Yes | Yes |
| Digital I/O | 2 channels | No |
| Memory, maximum results saved in gage | 99 | 50 |
| Operating Mode | | |
| Machine Control ¹ | Yes | No |
| Real Time | Yes | Yes |
| Peak Compression | Yes | Yes |
| Peak Tension | Yes | Yes |
| Load Limit | Yes | Yes |
| Break Limit | Yes | No |
| Load Average | Yes | No |
| Load-Time Average | Yes | No |
| Cyclic Count (99,999 maximum) | Yes | No |
| Cyclic Duration (27 hours) | Yes | No |
| Hold Duration (27 hours) | Yes | No |
| Contact Closure | Yes | No |
| Power, Environmental | | |
| Battery Type | Lithium Ion | |
| Battery Life, typical @ 20% brightness | >30 hours | |
| Charge Time, using 110/240V Mains | <3 hours | |
| Display | OLED High Resolution | |
| Operating Temperature | 40°F to 110°F (4°C to 43°C) | |
| Thread, for adapters | Metric M6, M10 | |
| Instrument Weight (approx.) | 3lbs (1.36kgs) | |

NOTES

1. Machine control is exclusive to the DFC. When connected to the FMM Digital Force Tester, configuration of force gage and tester is performed through the gage.

ACCESSORY KITS

The DFC and DFG Force Gages are supplied with a complete accessory kit. The kit includes a hook, notch, chisel, flat, chisel and point adapter. A 6" extension rod is included. Adapter materials are stainless steel. Aluminum is used for 2lbf (10N) and 10lbf (50N) capacities.

Included with the force gage is a carrying case, USB cable, a set of testing accessories, a Quick Reference Guide and NIST-traceable Certificate of Calibration.



Force gage standard accessories

| DFC - Advanced Force Controller | | | | | | | | | | |
|---------------------------------|---------------|-----|-----|------|--------|----------------------------|-----------------------|------|--------------|---------------|
| Model Number | Load Capacity | | | | | Safe Overload % Full Scale | Full Scale Deflection | | Thread mm | Accessory Kit |
| | N | KGF | LBF | OZF | GF | | in | mm | | |
| DFC-2 | 10 | 1 | 2 | 32 | 900 | 200 | 0.013 | 0.33 | M6 x 1-6H | SPK-FG-A |
| DFC-5 | 20 | 2 | 5 | 80 | 2200 | 200 | 0.007 | 0.18 | M6 x 1-6H | SPK-FG-A |
| DFC-10 | 50 | 5 | 10 | 160 | 5000 | 200 | 0.006 | 0.15 | M6 x 1-6H | SPK-FG-S |
| DFC-20 | 100 | 10 | 20 | 320 | 10,000 | 200 | 0.008 | 0.20 | M6 x 1-6H | SPK-FG-S |
| DFC-50 | 250 | 25 | 50 | 800 | 25,000 | 200 | 0.015 | 0.39 | M6 x 1-6H | SPK-FG-S |
| DFC-100 | 500 | 50 | 110 | 1600 | 50,000 | 200 | 0.024 | 0.60 | M6 x 1-6H | SPK-FG-S |
| DFC-200 | 1000 | 100 | 225 | - | - | 200 | 0.021 | 0.54 | M6 x 1-6H | SPK-FG-M |
| DFC-500 | 2500 | 250 | 550 | - | - | 200 | 0.028 | 0.70 | M10 x 1.5-5H | SPK-FG-L |

NOTES

Load measurement accuracy is $\pm 0.1\%$ of load cell capacity. Display resolution is 10,000:1.

| DFG - Basic Force Controller | | | | | | | | | | |
|------------------------------|---------------|-----|-----|------|--------|----------------------------|-----------------------|------|--------------|---------------|
| Model Number | Load Capacity | | | | | Safe Overload % Full Scale | Full Scale Deflection | | Thread mm | Accessory Kit |
| | N | KGF | LBF | OZF | GF | | in | mm | | |
| DFG-10 | 50 | 5 | 10 | 160 | 5000 | 200 | 0.006 | 0.15 | M6 x 1-6H | SPK-FG-S |
| DFG-20 | 100 | 10 | 20 | 320 | 10,000 | 200 | 0.008 | 0.20 | M6 x 1-6H | SPK-FG-S |
| DFG-50 | 250 | 25 | 50 | 800 | 25,000 | 200 | 0.015 | 0.39 | M6 x 1-6H | SPK-FG-S |
| DFG-100 | 500 | 50 | 110 | 1600 | 50,000 | 200 | 0.024 | 0.60 | M6 x 1-6H | SPK-FG-S |
| DFG-200 | 1000 | 100 | 225 | - | - | 200 | 0.021 | 0.54 | M6 x 1-6H | SPK-FG-M |
| DFG-500 | 2500 | 250 | 550 | - | - | 200 | 0.028 | 0.70 | M10 x 1.5-5H | SPK-FG-L |

NOTES

Load measurement accuracy is $\pm 0.2\%$ of load cell capacity. Display resolution is 5,000:1.

MANUAL FORCE TESTERS

MTL MANUAL TESTERS

The MTL Manual Testers are single column, manually-operated force testers. These testers operate with a quick-action lever in either tension or compression directions. Two models are available- the MTL-110 and MTL-330. Force measurement is performed using a Starrett DFC or DFG digital force gage.

MTL-110

The MTL-110 can measure force up to 110lbf (500N, 50kgf). This tester is ideal for component testing and its compact design fits small work spaces. The MTL-110 has a 6" (152mm) stroke. The tester's quick-action lever moves the rack and pinion crosshead 3" (76mm) per revolution. The lever may be positioned anywhere along the 20" (508mm) column, and with a 6" (152mm) throat, large samples can be accurately tested. Options include a digital scale for measuring deflection distance. The base adapter adjusts to accommodate different gage models.

MTL-330

The MTL-330 can measure force up to 330lbf (1500N, 150kgf). This tester can be used for tensile and compression testing applications, and is ideal for spring testing. Fit the MTL-330 with a Starrett digital force gage and optional digital scale to determine spring rates, initial tension and more. The MTL-330 can be easily mounted to your workbench for secure testing.

Like the MTL-110, the quick-action lever moves the rack and pinion crosshead 3" (76mm) per revolution. The lever may be positioned anywhere on the 30" (762mm) column, and with a 4" (102mm) throat, large samples can be accurately tested. Optional gage adapter kits are available for use with non-Starrett force gages.

The MTL may be equipped with optional legs so that you can test in a horizontal position.

FEATURES

- Two Capacities: 110lbf, 330lbf (500N, 1500N)
- Compact Design is Ideal for Lean Manufacturing Environments
- Lever-type, Quick-action Crosshead Movement
- Precision Rack and Pinion
- Excellent Position Resolution: Single Rotation for 3" (75mm)
- Adjustable Gage Mounting



| MTL Series - Manual Force Tester, Lever Control | | | | | | | | | | | | |
|---|---------------|-----|-----|------------------|-----|---------------------|----|--------|-----|--------|-----|------------|
| Model Number | Load Capacity | | | Crosshead Travel | | Resolution/Rotation | | Throat | | Weight | | Thread |
| | N | KGF | LBF | in | mm | in | mm | in | mm | lbs | kgs | mm |
| MTL-110 | 500 | 50 | 110 | 6 | 152 | 3 | 76 | 4 | 102 | 18 | 8.2 | M6, #10-32 |
| MTL-330 | 1500 | 150 | 330 | 6 | 152 | 3 | 76 | 4 | 102 | 20 | 9.1 | M10 |

MTH MANUAL TESTERS

The MTH Manual Tester is a single column, manually-operated force tester. The MTH has a load measurement capacity of 550lbf (2500N, 250kgf) and can be used for compression or tensile testing. The mechanical advantage afforded by the MTH-550's precision, high-resolution worm gear design lets you test effortlessly. One rotation of the hand wheel positions the crosshead 0.03" (0.75mm). Total stroke for the MTH-550 is 4" (102mm). Force measurement is performed using a Starrett digital force gage.

The MTH-550 is an ideal, affordable solution for spring testing. Fit the MTH-550 with a digital force gage and optional digital scale to determine spring rates, initial tension and more.

The hand wheel may be positioned anywhere along the 30" (762mm) column, and with a 4" (102mm) throat, large samples can be accurately tested. The base may be permanently affixed to your workbench. Optional gage adapter kits are available for use with non-Starrett force gages. Quick-change clevis adapters let you mount a large selection of Starrett testing fixtures.

FEATURES

- Tension or Compression Testing
- Excellent for Cost-Effective Spring Testing
- Effortless Crosshead Movement
- Precision Worm Gear Design
- Excellent Position Resolution: Single Rotation for 0.03" (0.75mm)
- 30" (762mm) Column Height, 15" (380mm) Working Area
- Adjustable Gage Mounting



The MTH-550 may be equipped with optional legs so that you can test in a horizontal position.



| MTH Series - Manual Force Tester, Hand wheel Control | | | | | | | | | | | | |
|--|---------------|-----|-----|------------------|-----|---------------------|------|--------|-----|--------|-----|--------------|
| Model Number | Load Capacity | | | Crosshead Travel | | Resolution/Rotation | | Throat | | Weight | | Thread |
| | N | KGF | LBF | in | mm | in | mm | in | mm | lbs | kgs | |
| MTH-550 | 2500 | 250 | 550 | 4 | 102 | 0.03 | 0.75 | 4 | 102 | 22 | 10 | M10 x 1.5-5H |

ACCESSORIES

TEST FIXTURES, SHIELDS

TEST FIXTURES

Starrett offers a full range of test fixtures, grips and accessories. Test fixtures are compatible with all Starrett systems and test frames. Starrett can also engineer and supply custom test fixtures to your exact requirements.

TYPES

- Button Head
- Compression Cages
- Flexural
- Hydraulic
- Peel
- Platens
- Pneumatic
- Ribbon
- Roller
- Scissor
- Shear
- Vice-action
- Wedge-action

SPLINTER SHIELDS

Optional splinter shields are available for both single and dual column testers. Shields feature electronic interlocks and are constructed of shatter-resistant aerospace acrylic. Shields are normally custom made to your exact requirements.



Starrett can supply a wide assortment of testing fixtures that comply with international testing standards from ASTM, ISO, DIN, TAPPI and more. We can also supply custom test fixtures for difficult sample shapes.



APPLICATIONS

STARRETT KNOWS FORCE ANALYSIS AND MEASUREMENT

Tensile testing



Identifying tensile force characteristics such as peak load is critical in validating a product's safety and application. Whether it's consumer products, medical products, packaging materials or fasteners used in the building trades, tensile testing is a fundamental measurement available on all Lx systems.

Shear testing



Shear tests help measure the deformable mechanical properties of cosmetics, plastics, composites, fluids and other samples. Lap shear testing can be used to measure mechanical weld strength or the adhesive strength of epoxies.

Peel testing



Adhesive strength properties are measured to understand the bonding capabilities of coatings and glues on various types of materials- from paper to substrates to building materials. Both 90° and 180° testing can be performed to measure the peak holding strengths under standard test methods such as ASTM F88.

Compressive testing



Compressive loads are important in evaluating packaging designs, such as top load testing. Core sampling of concrete-based products are measured to determine their strength. And springs are analyzed under load to determine spring rate based on free length.

Flexural testing



Flexural strength and material stiffness represent the combined effects of a sample's basic tensile, compressive and shear characteristics. Composites, wood products, paper products can be tested in both 3- and 4-point methods to determine their stiffness and resilience.

Coefficient of friction testing



ASTM D1894 is a common test method for measuring coefficient of friction. Materials such as plastic sheeting can be tested to measure both the static and kinetic frictional characteristics. Other materials, such as flooring products are tested to determine their slip resistance and safety under various environmental conditions.

Break, Fracture and Rupture testing



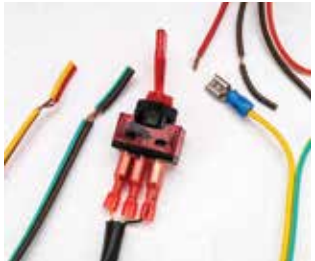
Destructive testing can involve tensile, compressive, shear and other test methods where the product is tested to failure. Often this testing is used to determine the "peak" measurements that occur prior to the break event. Lx system allow you to measure precisely based on stress, strain, load, displacement and time.

Load rate testing



Load hold testing is a more complex testing method compared to testing to a set point at a specific velocity. Load hold testing can be used on consumer products, such as children's attire, to measure the pull strength of buttons and their resistance to breaking loads.

Contact closure testing



The "make and break" load for an electrical switch can be measured precisely. Load is applied to the switch and the peak load is measured when the switch closes/opens. This type of application can be tested on keypads, membranes and other materials that utilize a resistance change.

Insertion/Extraction testing



Insertion/extraction testing is performed on electronic components like jacks, medical devices, consumer products, and more. The loads are measured in both directions- tensile and compressive to determine the sample's characterization for the application and for product life-cycle determination.

Creep and Relaxation testing



Foam is a material where its deformation while under an applied load below its yield strength is measured and analyzed. Knowing the material's ability to maintain its specified deformation is important for comfort and longevity in its intended application.

Spring testing



Compression and extension springs are evaluated for spring rate and spring constant. Using free length or specified lengths at load targets, it's important to verify the performance of springs to ensure reliability for the intended application whether it's for aerospace or consumer products like mattresses.

FACTORIES AROUND THE WORLD



1-Athol, Massachusetts, USA



2-Laguna Hills, California, USA



3-Waite Park, Minnesota, USA



4-Cleveland, Ohio, USA

FACTORIES



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Band Saw Blades

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