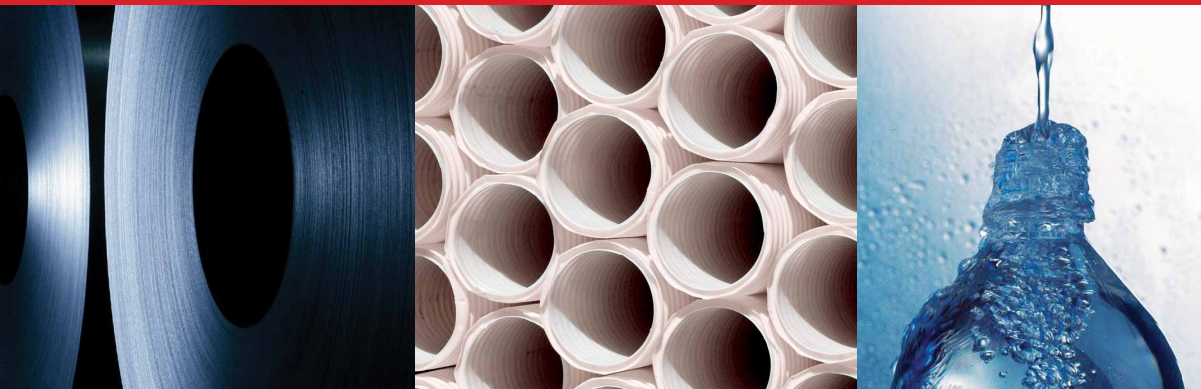


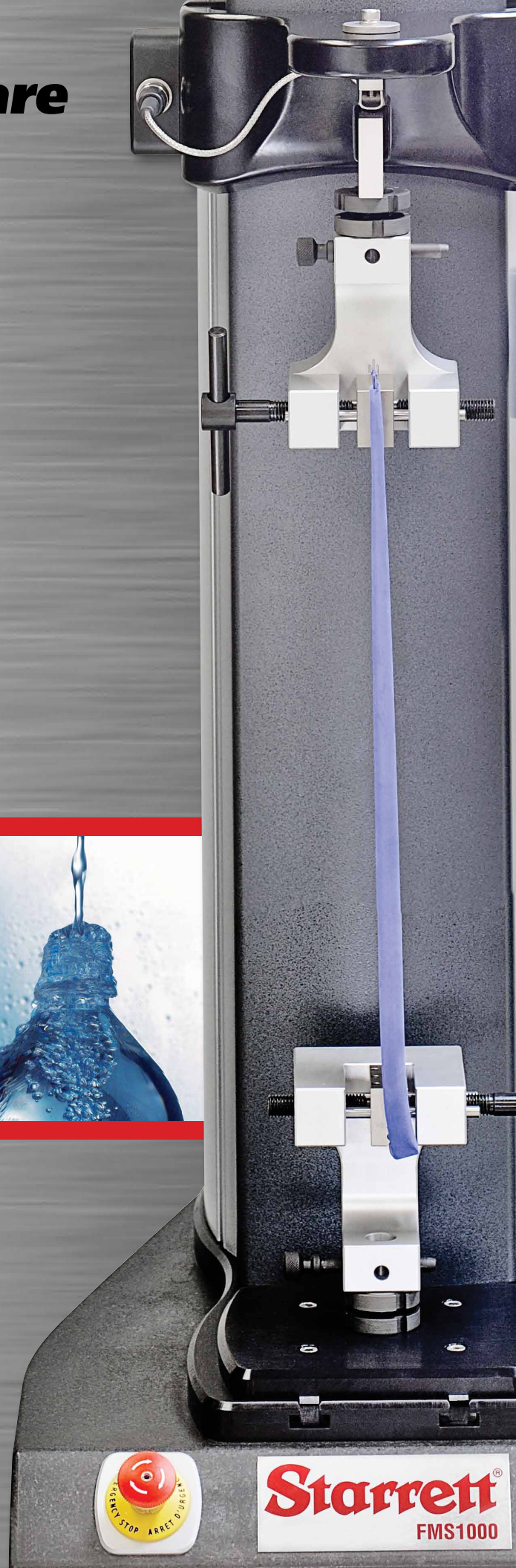
# **L2 Plus Series Software for Advanced Force Measurement**

## **Creating a Test**



# **Starrett®**

**The Better Solution**



**Starrett®**  
FMS1000



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### 3.0 Creating an L2 Plus Test Setup

All L2 Plus test setups have four basic sections:

- Pre Test
- Test
- Data
- Post Test

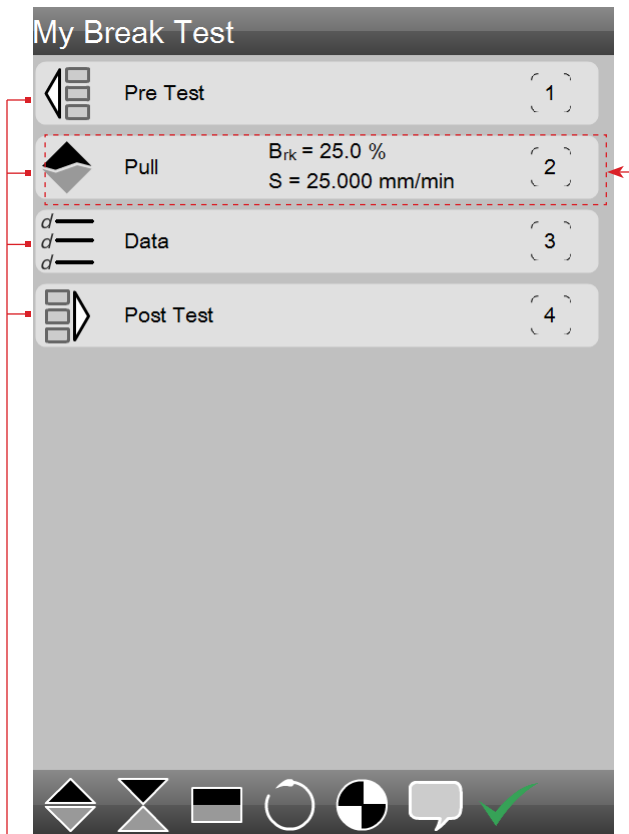
Each of these sections have a variety of options that you can use to create a simple single step test or a sophisticated multiple step test.

This section will describe each of the options within the four basic sections of an L2 Plus test setup.

### 3.1 Using the L2 Plus Test Builder Application

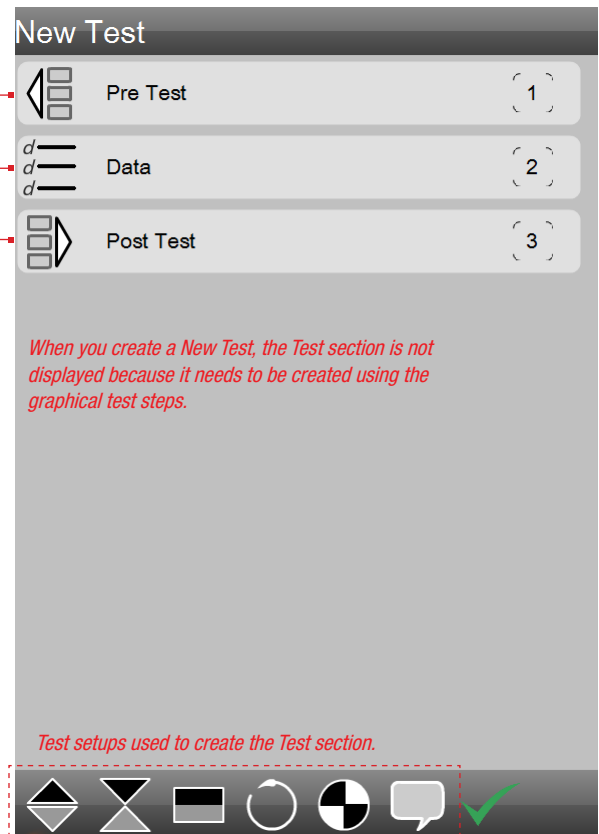
The L2 Plus Test Builder application is the primary method used to create an L2 Plus test setup. The L2 Plus Test Builder is a graphical test authoring application where you create your test by defining four sections of a test: Pre Test, Test, Data and Post Test.

When you create a New Test, you select the New Test symbol from the Home view. This launches a new test setup. The setup shows Pre Test, Data and Post Test. The Test step is not shown because you will need to create that section using the Test step tools.



L2 Plus Test Builder

Example test setup shows four common sections to all L2 Plus test setups



*When you create a New Test, the Test section is not displayed because it needs to be created using the graphical test steps.*

*Test setups used to create the Test section.*

L2 Plus Test Builder

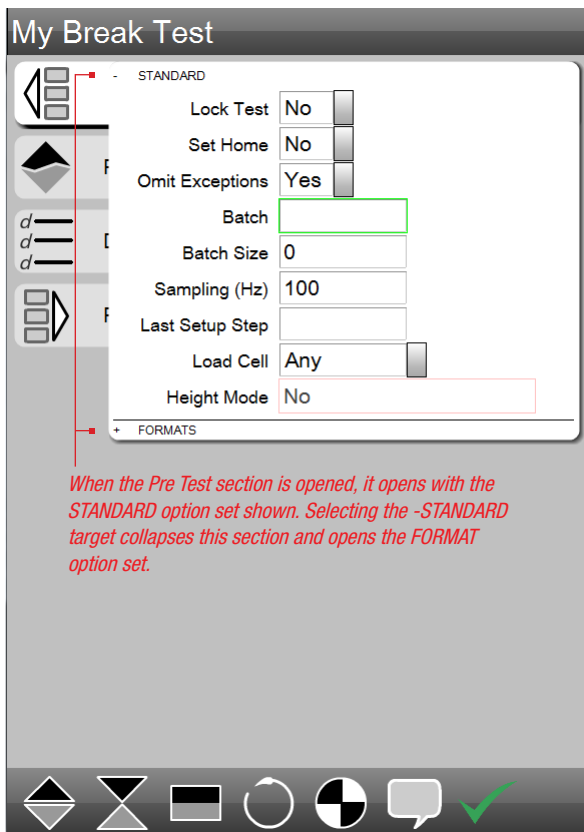
When New Test is selected, the Test section is not created yet

*Shown are four sections to the test setup called My Break Test:*

- Pre Test section
- Test section
- Data section
- Post Test section

## 3.2 Pre Test Step

The Pre Test step is where you define key aspects of your test setup that take place before the test sequence actually begins. The Pre Test step has two basic option sets: Standard and Format.



*When the Pre Test section is opened, it opens with the STANDARD option set shown. Selecting the -STANDARD target collapses this section and opens the FORMAT option set.*

*L2 Plus Test Builder - PRE TEST section  
Features two options sets: Standard and Format*

### 3.2.1 Standard Options

The Standard Pre Test options are the commonly used options that you configure for your test setup. The Standard options represent basic “rules” of how the test setup will perform and what happens when key actions occur. The Standard Pre Test options are discussed in detail in the following sections.

#### 3.2.1.1 Lock Test

The Lock Test option is used to lock the test setup so that only authorized users have the ability to make changes to this test setup. The Security Setting in the L2 Plus Main menu allows you to specify the authorizations/privileges for each user of your system. If the user has the privilege to Lock a test, then that user may specify Lock Test when creating a test setup.

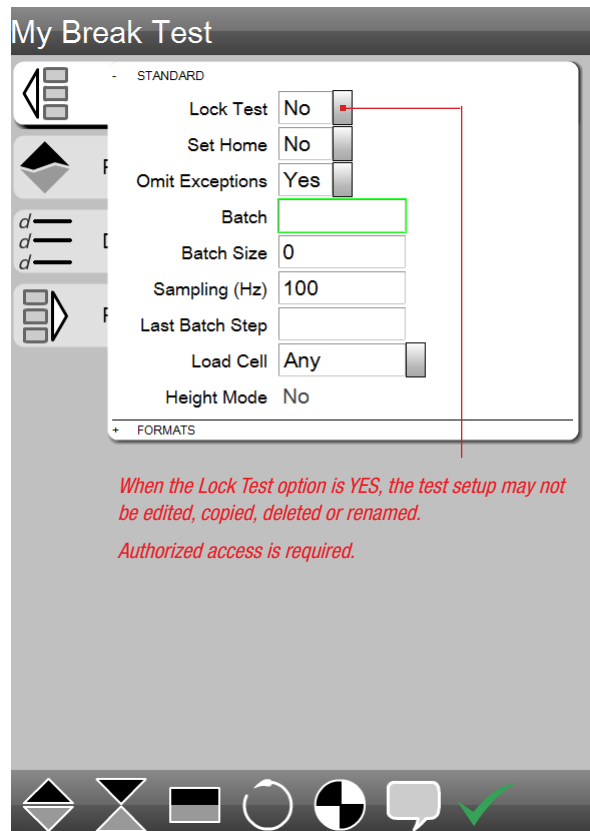
The default for Lock Test is NO. This means that the test setup is not locked and maybe edited, copied, deleted or renamed.

If the Lock Test option is YES, the creator of the test setup has locked the test setup- no one other than those with secure authorization are allowed to edit, copy, delete or rename this test. When a test setup is locked, a lock symbol appears next to the test setup name in the Home menu.



#### NOTE

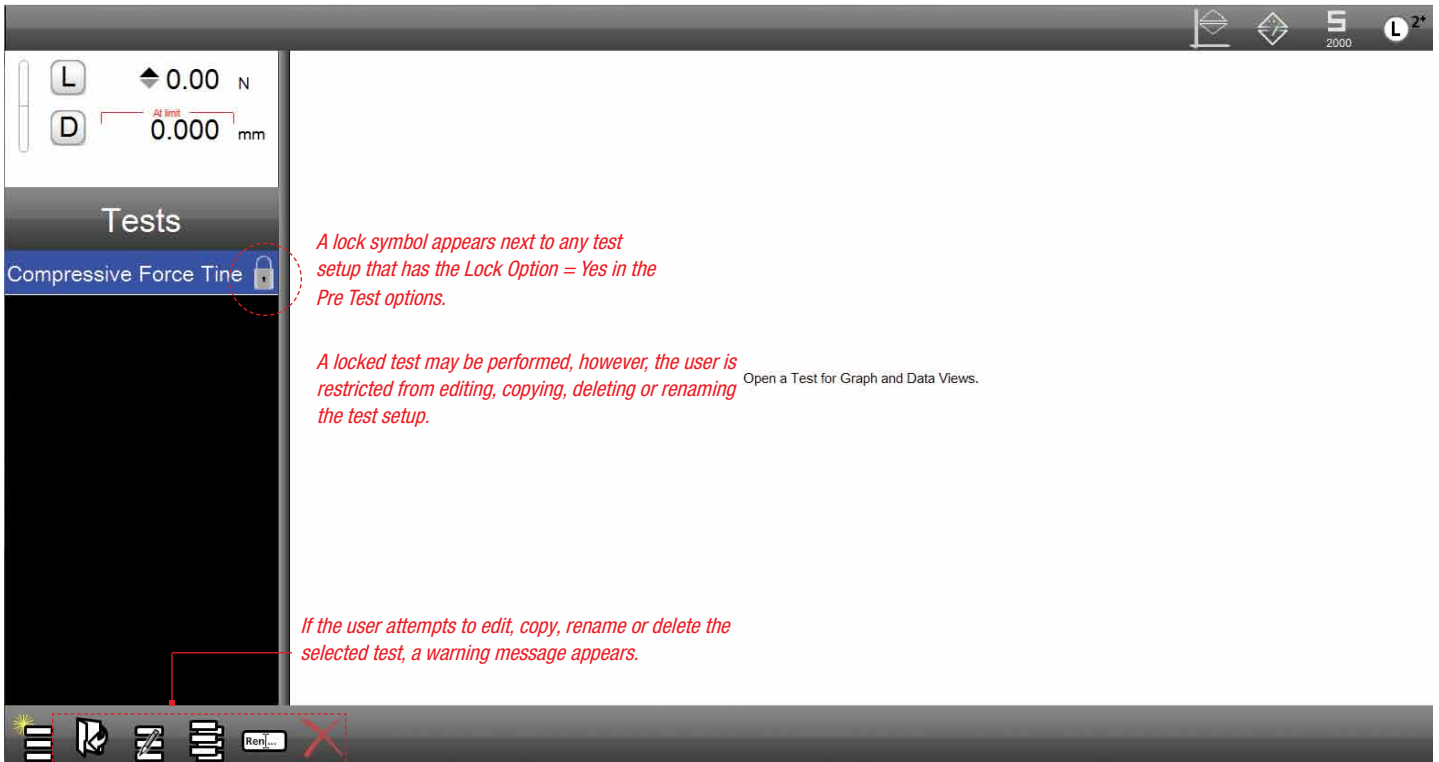
When a test setup is locked, it cannot be edited, copied, deleted or renamed unless the user has the proper security authorization.



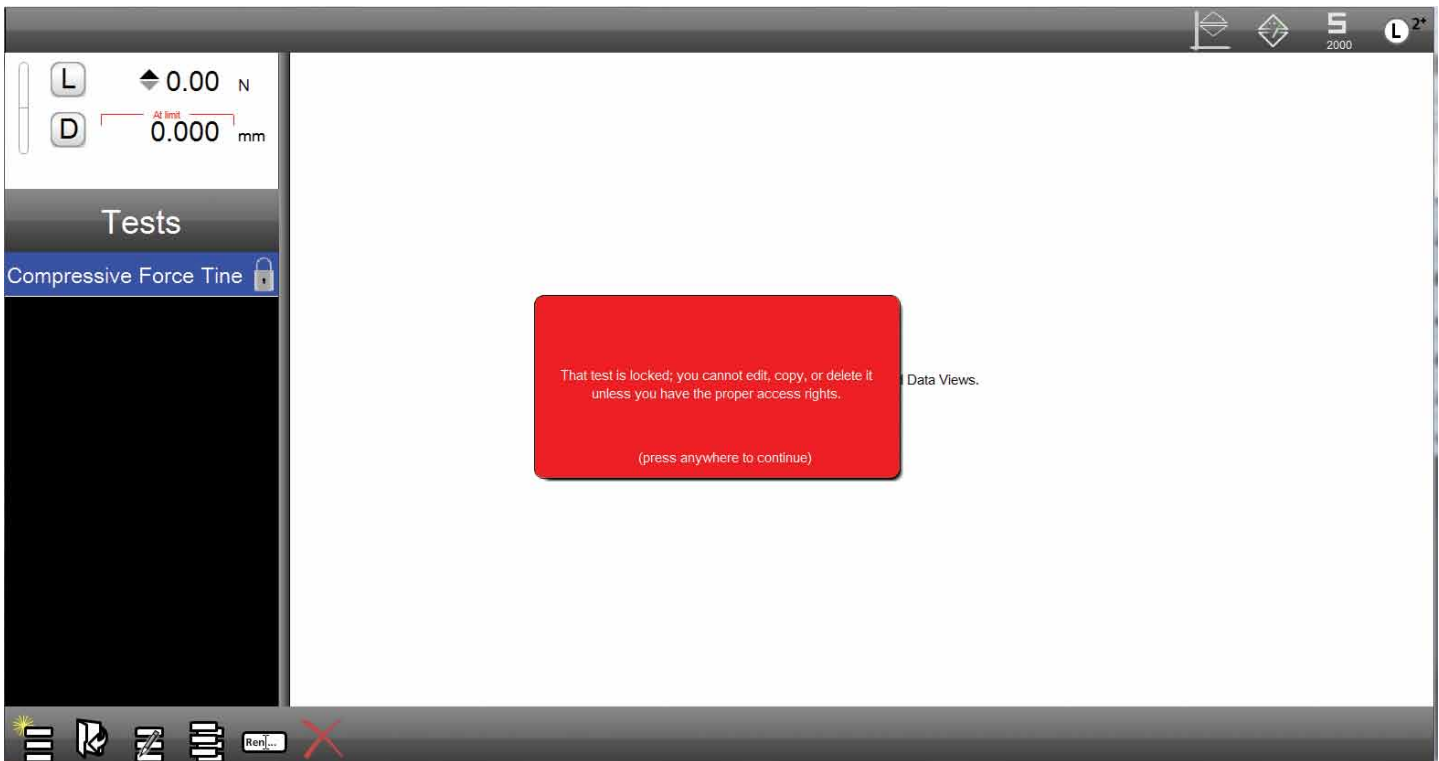
*When the Lock Test option is YES, the test setup may not be edited, copied, deleted or renamed.  
Authorized access is required.*

*L2 Plus Test Builder - PRE TEST section*

*Lock Test = Yes restricts editing to this test setup to authorized users*



*L2 Plus Home view  
Shows all test setups in the Test directory. Tests identified with Lock symbol cannot be edited*



*L2 Plus Home view  
Locked Test Warning Message*

### 3.2.1.2 Set Home

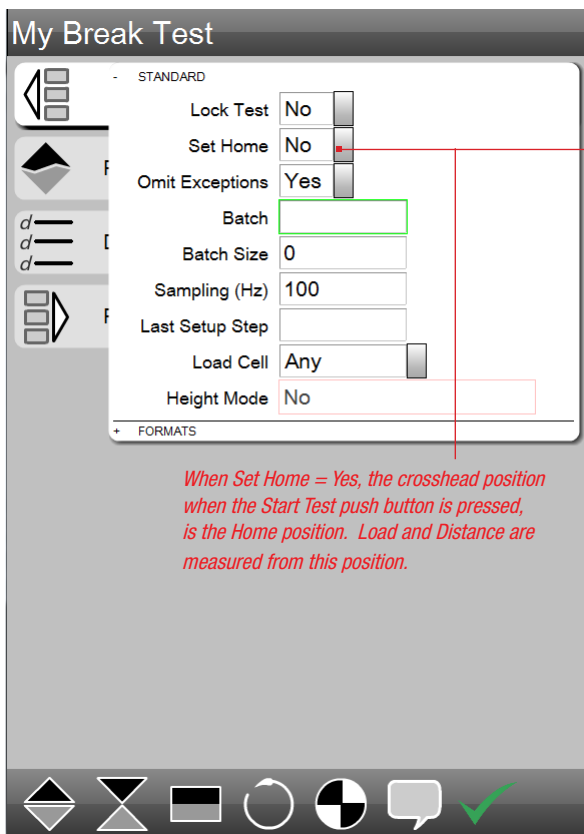
Home is the crosshead position where you want your test to start at. When Set Home = YES, the position where the crosshead is at when the Start Test push button is pressed is the Home position. Load and Distance are measured from this position.

If you prefer to Set Home manually using the Set Home target, the Set Home option should be NO. This requires the user to manually press the Set Home target before selecting Start Test.



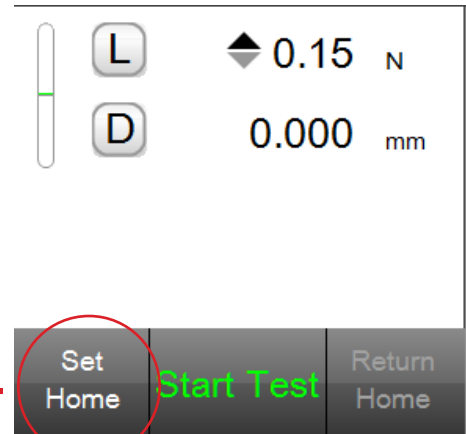
#### CAUTION

Use caution when using automatic Home positioning when the Set Home option is YES.



*When Set Home = Yes, the crosshead position when the Start Test push button is pressed, is the Home position. Load and Distance are measured from this position.*

*L2 Plus Test Builder - PRE TEST section  
Set Home = Yes automatically sets Home when the Start Test function is invoked*



*L2 Plus Controller view  
Manually Set Home by pressing Set Home target*

*When Set Home = No, the user must automatically set Home by pressing the Set Home target BEFORE selecting Start Test.*

### 3.2.1.3 Omit Exceptions

Exceptions are used in the individual test steps. Exceptions are protection mechanisms. An exception is an event, that when it occurs, causes the test run to automatically abort. For example, if you were performing a break test, you might want to include an exception based on distance. When the distance = x, stop the test because the break should have occurred before this distance was achieved.

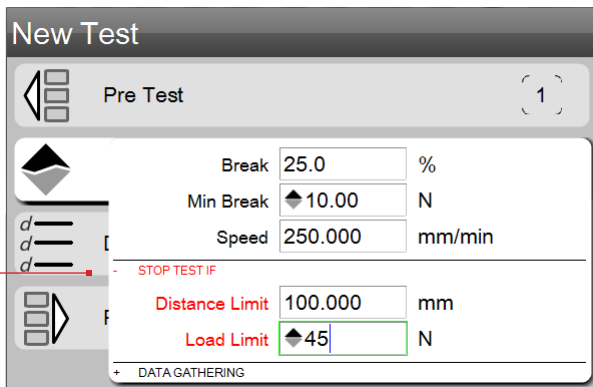
When an exception occurs, the test is aborted. No results are calculated and the run is identified in Red as an invalid test. When Omit Exceptions = YES, we omit all data for the invalid test- no data is saved.

In some situations, it may be desirable to save the data for a test that was ended due to an exception. In these situations, the Omit Exceptions function is used and the option is changed to NO. When Omit Exceptions = NO, we do not omit the data. Rather, we save the data until the test was aborted.



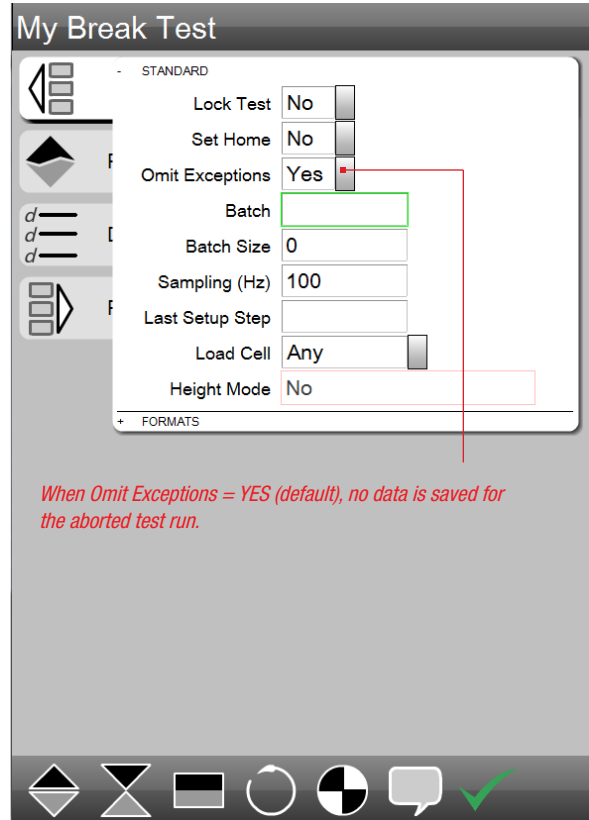
**NOTE**

Data is saved when the Export Raw option is Yes. If this option is No, no data is exported.



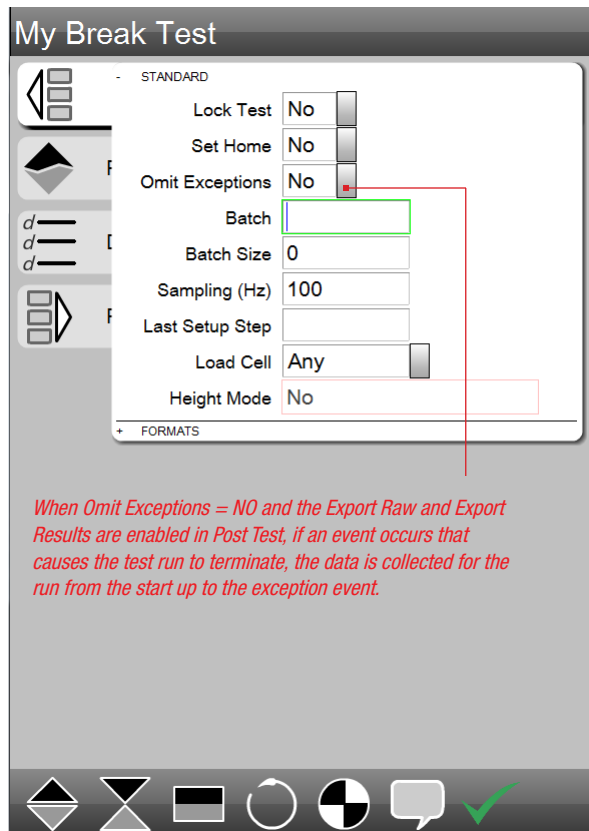
*L2 Plus Test Builder - Exception  
An Exception is used to denote when to terminate a test*

*Selecting the STOP IF function presents you with options for terminating a test. In the example, the break step will terminate if the Distance Limit of 100mm or the Load Limit of 45N are achieved before the sample breaks.*



*When Omit Exceptions = YES (default), no data is saved for the aborted test run.*

*L2 Plus Test Builder - Pre Test Omit Exception  
When YES, no data is collected for this run*



*When Omit Exceptions = NO and the Export Raw and Export Results are enabled in Post Test, if an event occurs that causes the test run to terminate, the data is collected for the run from the start up to the exception event.*

*L2 Plus Test Builder - Pre Test Omit Exception  
When NO, data and results may be available up to when the event occurred*



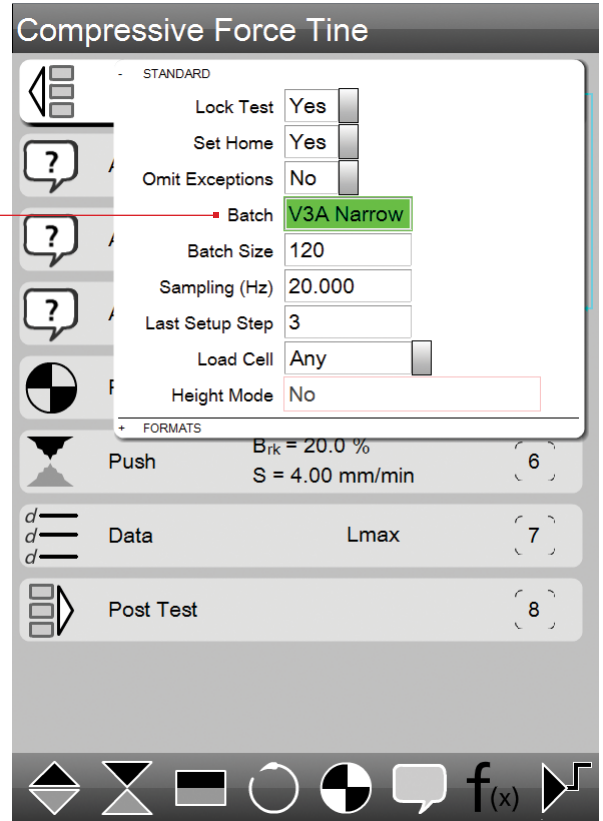
### 3.2.1.4 Batch Name

The Pre Test step lets you create a batch for your test runs. A batch may be used to categorize the test runs within a test setup. For example, you may have a common test setup, but you want to test a batch of samples coming from different lots. You can distinguish one lot from the other by using a Batch Name for each lot.

### 3.2.1.5 Batch Size

When you use a batch, you can specify the number of test runs you are going to perform within the batch. So, if you have many samples, you may need to test each of 10 samples for that lot. Your Batch Size will be identified as 10.

During your testing, once you complete test run 10, the L2 Plus software will ask if you want to continue with the current batch, which means you can add additional runs to the Batch, or you can decide to complete that lot and begin a new batch. If you decide to create a new batch, the name of the existing batch will be used with a suffix number 1. You may change the name of your Batch name if you wish.



L2 Plus Test Builder - Pre Test Batch setup  
Enter your Batch Name and Batch Size

The Batch Name is identified above each test run in the Runs List.

Batch	Run	Describe	Lot	Tine	Date	Comment
V3 Narrow Sample	20	Control Tine Force Test	Unknown. Sam	RB	11/5/14	
V3 Narrow Sample	21	Control Tine Force Test	Unknown. Sam	RF	11/5/14	
V3 Narrow Sample	22	Control Tine Force Test	Unknown. Sam	RB	11/5/14	
V3 Narrow Sample	23	Control Tine Force Test	Unknown. Sam	LF	11/5/14	
V3 Narrow Sample			Unknown. Sam	LB	11/5/14	
V3 Narrow Sample			Unknown. Sam	RF	11/5/14	
V3 Narrow Sample			Unknown. Sam	RB	11/5/14	
V3 Narrow Sample			Unknown. Sam	LF	11/5/14	
V3 Narrow Sample			Unknown. Sam	LB	11/5/14	
V3 Narrow Sample			Unknown. Sam	LF	11/5/14	
V3 Narrow Sample			Unknown. Sam	LB	11/5/14	
V3 Narrow Sample			Unknown. Sam	RF	11/5/14	
V3 Narrow Sample			Unknown. Sam	RB	11/5/14	
V3 Narrow Sample			Unknown. Sam	RF	11/5/14	
V3 Narrow Sample			Unknown. Sam	RB	11/5/14	
V3 Narrow Sample	35	Control Tine Force Test	Unknown. Sam	RF	11/5/14	
V3 Narrow Sample	36	Control Tine Force Test	Unknown. Sam	RB	11/5/14	

The last Batch has not been completed.  
Start a new Batch?

Resume Batch    New Batch

Test 36 of 120 for V3 Narrow Sample is complete.

L2 Plus Graph view

Shows how the Batch Name is used in the Runs List

### 3.2.1.6 Sampling Rate (Hz)

The Sampling Rate (Hz) option is the number of data points acquire during the test run per second. The factory default is 100 samples per second, which is approximately three to five times more data than systems that sample via RS232.

The Sampling Rate (Hz) option may be any value between 0.001 and 2000. Enter the value you require in the text block.



**NOTE**

The maximum duration for a test run is 48 hours. This applies to Hold and Cyclic steps. Adjusting the sampling rate to 0.5Hz will allow for a 48 hour test.



**NOTE**

The greater the sampling rate number the more susceptible the test run is to noise. So a higher number won't necessarily provide you with better results. High sampling rates are useful in detecting maximum points, but this can be susceptible to noise.



**NOTE**

If you are attempting to correlate new data from your L2 Plus system with data from an older machine that used RS232 or that had a lower sampling rate, you should set the Sampling Rate (Hz) to a lower number, e.g. 20. You can then compare and correlate. Modify the rate until you're historical data and new data correlate.

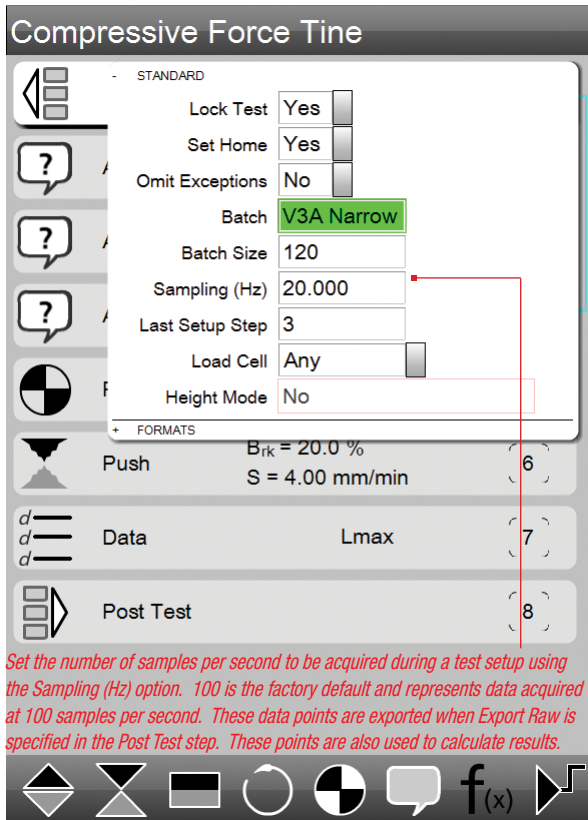


**NOTE**

The maximum number of data points that may be acquired for a test run is 100,000. Adjust your Sampling Rate to the desired duration while maintaining the limit on the number of data points acquired for your test.

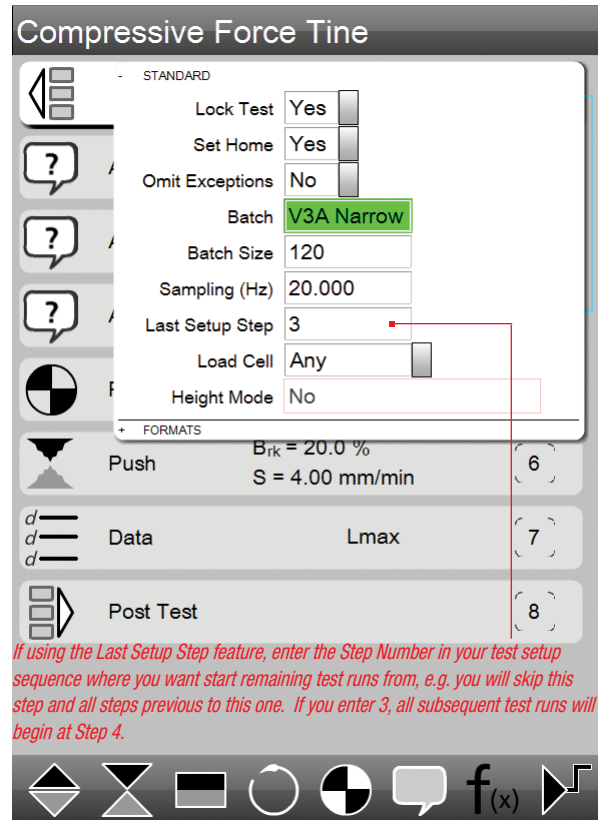
### 3.2.1.7 Last Setup Step

The Last Setup Step option is useful when you are performing the same test setup on multiple samples or parts ( a “batch” of parts). The ASK step may be used (at the beginning of the test setup) to ask questions that only need to be answered once, such as “Operator Name” or “Fixture ID”. These ASK steps will be skipped on the second and subsequent runs of the test if the Last Setup Step is set to the first step after them.



*Set the number of samples per second to be acquired during a test setup using the Sampling (Hz) option. 100 is the factory default and represents data acquired at 100 samples per second. These data points are exported when Export Raw is specified in the Post Test step. These points are also used to calculate results.*

L2 Plus Test Builder - Pre Test Data Sampling (Hz)  
This test has a Sampling Rate of 20 samples per second



*If using the Last Setup Step feature, enter the Step Number in your test setup sequence where you want start remaining test runs from, e.g. you will skip this step and all steps previous to this one. If you enter 3, all subsequent test runs will begin at Step 4.*

L2 Plus Test Builder - Pre Test Last Batch Step  
Enter the Step number that you want all subsequent test runs to start from

Previous Batches, each with 120 test runs display above the active batch. Selecting the "+" will expand so you can view all runs for the batch.

Compressive Force Tine

L 0.00 N  
D 0.00 mm

Set Home Start Test Return Home

$L_{max}$  184.67 N

The Batch ID V3 Narrow Sample is active and displaying Run #2 results.

Batch	Run	Describe	Lot	Tine	Date	Comment
V4 PM 340 T77	1 .. 120	0.000000000000	0.0000000000	0.000000	12/3/14 ...	
V4 PM 340 T77 1	1 .. 120	0.000000000000	0.0000000000	0.000000	12/3/14 ...	
V3 Narrow Sample	1	Control Tine Force Test	Unknown. Sam	RF	11/5/14	
V3 Narrow Sample	2	Control Tine Force Test	Unknown. Sam	RB	11/5/14	
V3 Narrow Sample	3	Control Tine Force Test	Unknown. Sam	LF	11/5/14	
V3 Narrow Sample	4	Control Tine Force Test	Unknown. Sam	LB	11/5/14	
V3 Narrow Sample	6	Control Tine Force Test	Unknown. Sam	RF	11/5/14	
V3 Narrow Sample	7	Control Tine Force Test	Unknown. Sam	RB	11/5/14	
V3 Narrow Sample	8	Control Tine Force Test	Unknown. Sam	LF	11/5/14	
V3 Narrow Sample	9	Control Tine Force Test	Unknown. Sam	LB	11/5/14	
V3 Narrow Sample	10	Control Tine Force Test	Unknown. Sam	RF	11/5/14	
V3 Narrow Sample	11	Control Tine Force Test	Unknown. Sam	RF	11/5/14	
V3 Narrow Sample	13	Control Tine Force Test	Unknown. Sam	RF	11/5/14	
V3 Narrow Sample	14	Control Tine Force Test	Unknown. Sam	RB	11/5/14	
V3 Narrow Sample	15	Control Tine Force Test	Unknown. Sam	LF	11/5/14	
V3 Narrow Sample	16	Control Tine Force Test	Unknown. Sam	LB	11/5/14	
V3 Narrow Sample	17	Control Tine Force Test	Unknown. Sam	LF	11/5/14	
V3 Narrow Sample	18	Control Tine Force Test	Unknown. Sam	LB	11/5/14	

Test 2 of 120 for V3 Narrow Sample.

L2 Plus Data View

Displays each Run of the Batch on a separate row

The test runs numbers per Batch ID BL-A4455 shows four (4) runs.

My Break Test

L 1.44 N  
D 0.000 mm

Set Home Start Test Return Home

Test 4 of 4 for BL-A4455 is complete.

The Batch is complete. Do you want to start a new Batch?

Resume Batch    New Batch

When using a Batch, the Batch ID appears above the test Run Number.

If you want to finish this Batch and begin a new Batch, select the New Batch target.

If you want to continue to test by adding another sample, select the Resume Batch target.

L2 Plus Full Graph View

Displays the graph of a selected Run. When a Batch is completed, a message is asked whether to Resume or create a New Batch

### 3.2.1.8 Load Cell

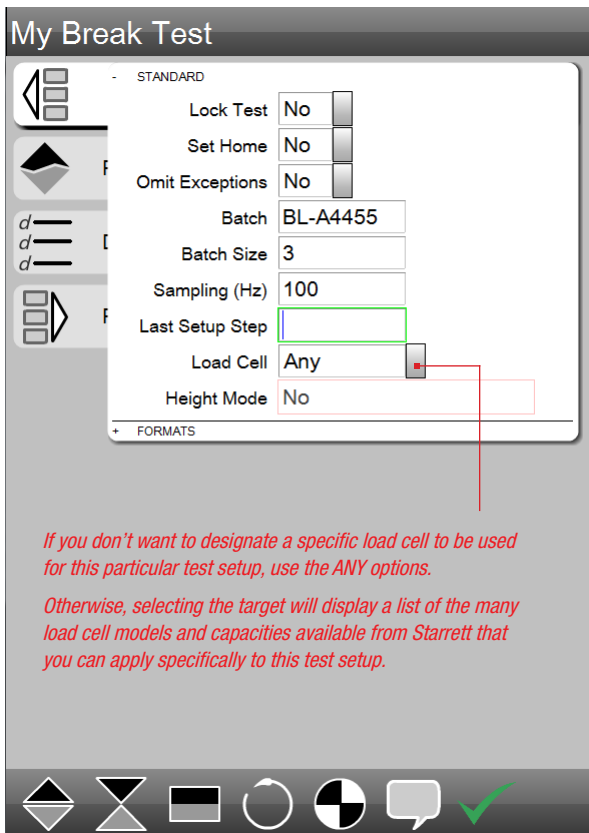
The Load Cell option allows you to select which load cell sensor model and capacity is to be used for your test setup. All load cell sensors are TEDs compatible. This means that they comply with IEEE 1451 and that the sensor will self-identify their model number, capacity and other key characteristics when they are connected to your Starrett testing frame. By specifying the load cell model, you can ensure that your test is always performed using the same sensor model and capacity. If you specify a Load Cell, the test will only be allowed to perform if that load cell is connected to your system.

This is an optional field that may be left blank. The default is ANY, which means any load cell sensor may be used for this test setup.

### 3.2.1.9 Height Mode

The L2 Plus system has two operating modes: Normal and Height mode. You must specify the mode prior to creating your test setup. Height mode is used when your testing involves going to a height limit measured from the bottom of the sample. When using Height mode, the system automatically finds the datum using a height datum routine. Height mode is useful when testing springs or other samples where height is an important measurement point.

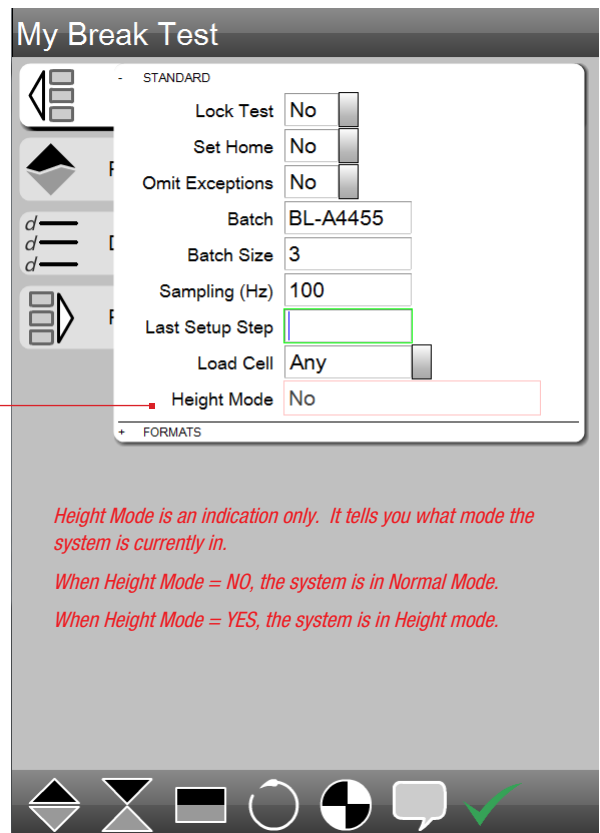
When the system is in Height mode, the Height Mode indicator will read YES. When in Normal Mode, the indicator will display NO.



*If you don't want to designate a specific load cell to be used for this particular test setup, use the ANY options. Otherwise, selecting the target will display a list of the many load cell models and capacities available from Starrett that you can apply specifically to this test setup.*

L2 Plus Test Builder - Pre Test Load Cell

You may select a specific load cell that is required to perform this test setup



*Height Mode is an indication only. It tells you what mode the system is currently in. When Height Mode = NO, the system is in Normal Mode. When Height Mode = YES, the system is in Height mode.*

L2 Plus Test Builder - Pre Test Load Cell

You may select a specific load cell that is required to perform this test setup



L2 Plus Test Mode- HEIGHT Mode



L2 Plus Test Mode- NORMAL Mode

*When Height Mode = NO, the system is in Normal Mode.*

### 3.2.2 Formats Options

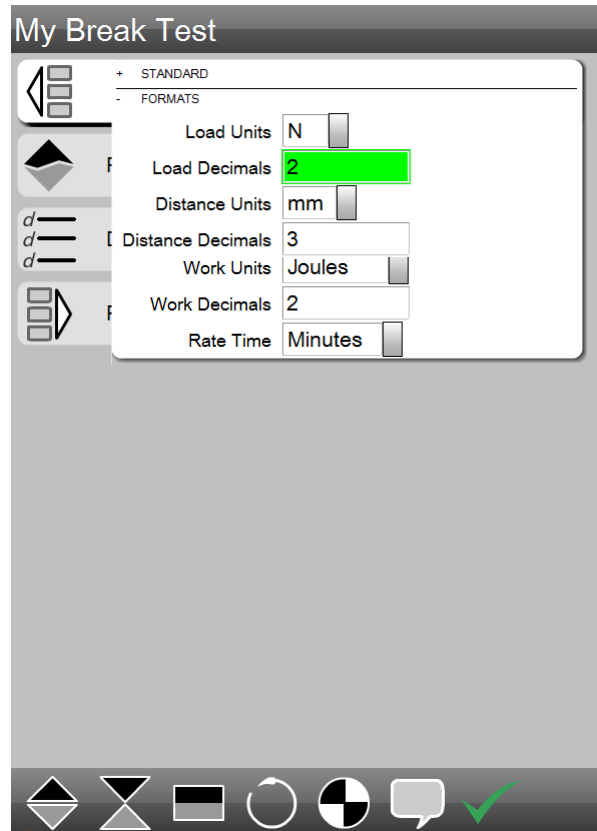
The Formats options within Pre Test is where you specify the units of measure that will be used. Each unit of measure type is also defined by how many decimals to display.

There are two categories of available units: SI/Metric and US/Imperial. Use the Desktop Settings function to choose which unit of measure type you want to use with your system.

The available units of measures are shown.

Unit of Measure	SI/Metric Set	US/Imperial Set
Load	N kgf	lbf
Distance	mm cm	in
Work	Joules Millijoules Kilojoules	inch-lb
Rate Time	Seconds Minutes	Seconds Minutes

L2 Plus Units of Measure



L2 Plus Test Builder - Pre Test Formats Options  
Specify Units and Display resolutions



L2 Plus Test Builder - DISPLAY FORMATS  
Use to specify global unit of measure sets, units and other display formats

### 3.3 Test Step

The Test step is where you create the sequence of movements that control the crosshead speed, direction and which are used to perform the test in the manner you require.

All steps within your test setup have a reference number. The reference number is the sequence in which the step takes place. The step reference is also used with scoping and helps identify how functions or formulas are to be performed within a test and between identified steps.

All test setups are a combination of steps. Steps are performed in sequential order. The Pre Test step is always step 1 whether or not any Pre Test options are used.

When you create a new test setup, the Pre Test is always step 1. The Data step is step 2 and the Post Test is step 3. However, a test cannot be performed until you add a movement step, therefore, a move step is inserted based on the type of test you want to perform. The move step is always added after step 1 (Pre Test) or step 2 (Sample) if a sample is used. Once a step is added, in this case a move step, the subsequent steps are incremented, e.g. step 2 (Data) becomes step 3. Steps continue to be incremented downward as more steps are added to your setup.



**NOTE**

All steps within a setup have a unique reference number. Pre Test is always step 1.

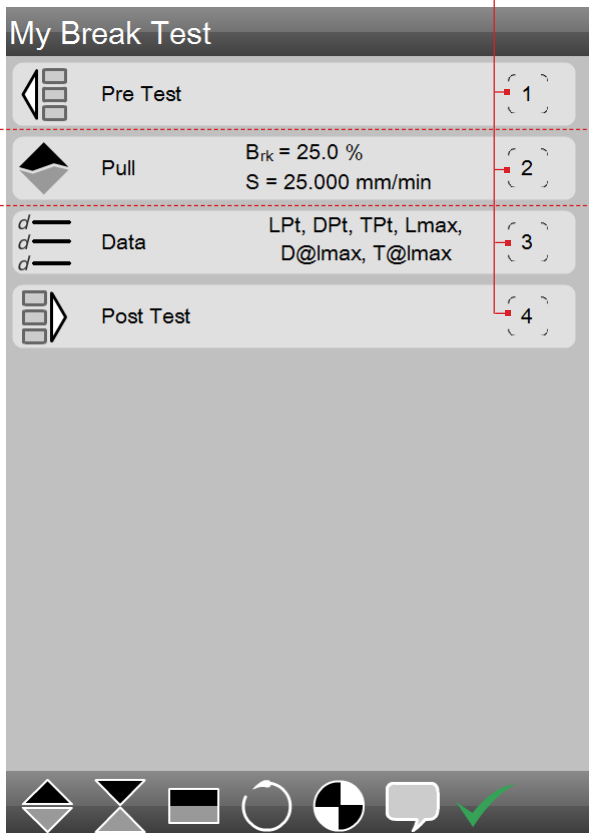
Step references are also displayed during the test in the status message. During your test, the status message will display the test step being performed. Once your test is completed, the message will read “Test is complete.”

The individual step types are displayed at the bottom of the setup view. The test step types are:

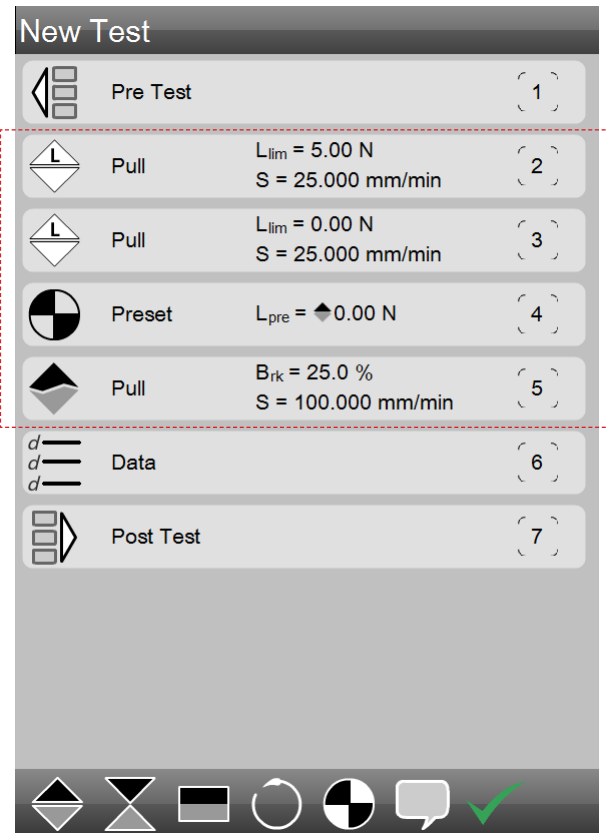
- Tensile Steps
- Compression Steps
- Hold Steps
- Cyclic Steps
- Ask Steps
- Datum Steps

All test steps are described in the following paragraphs.

*Step reference numbers*



*L2 Plus Test Builder - Test Stage  
Shows a single step test setup*



*L2 Plus Test Builder - Test Stage  
You may have multiple steps with a test setup*

### 3.3.1 Tensile Steps

Break and input tension steps always move the crosshead upwards. Tension movements are “pull” movements. L2 Plus Series supports four types of tension steps: Load, Distance, Break and Rate. You may have multiple tension steps within a test setup.

#### 3.3.1.1 Tensile to Load Step

The Tension Load Limit move causes the crosshead to typically move upward until it meets a load setpoint. You define the load target (setpoint), which is measured by the load cell sensor during your test. When this load is measured, the step concludes on to the next step or if no additional steps is in your sequence, the test ends.

- Select the Tension symbol
- Select the Tension Load symbol
- Enter your Load Target and Test Speed



**NOTE**  
Each test step may have an individual Test Speed.



**NOTE**  
If you have two load targets with the first target at 100N and the second target at 50N, the crosshead will move to 100N (upward) and then move to 50N (downward).

*These are the Exceptions for this step. An exception is an event. An exception stops the test. Exceptions are optional, but are recommended.*

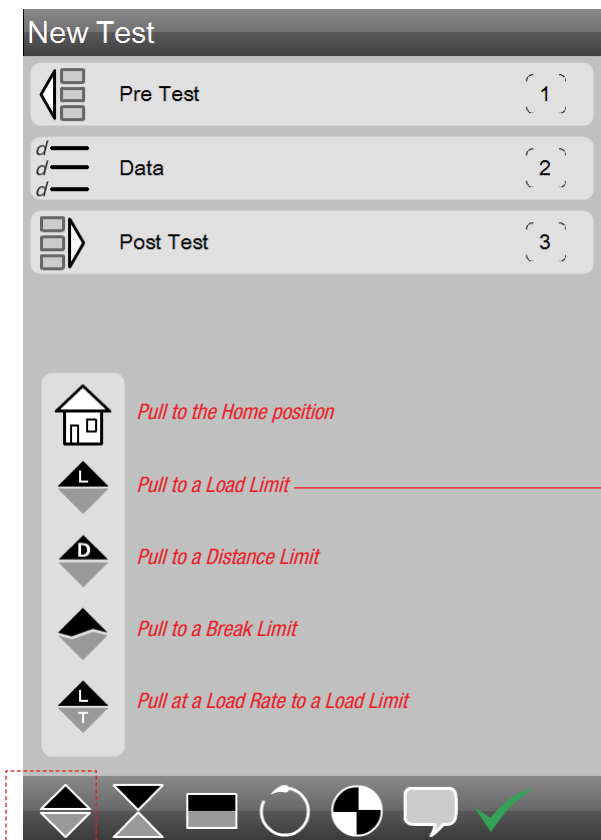
*Distance Limit - If the crosshead moves this distance and the Load Limit has not been achieved, the test will stop.*

*Break % - If the sample breaks the test will stop. A break is defined as when the load drops by this percentage value after a Minimum Load has been achieved and there is a maximum load measured.*

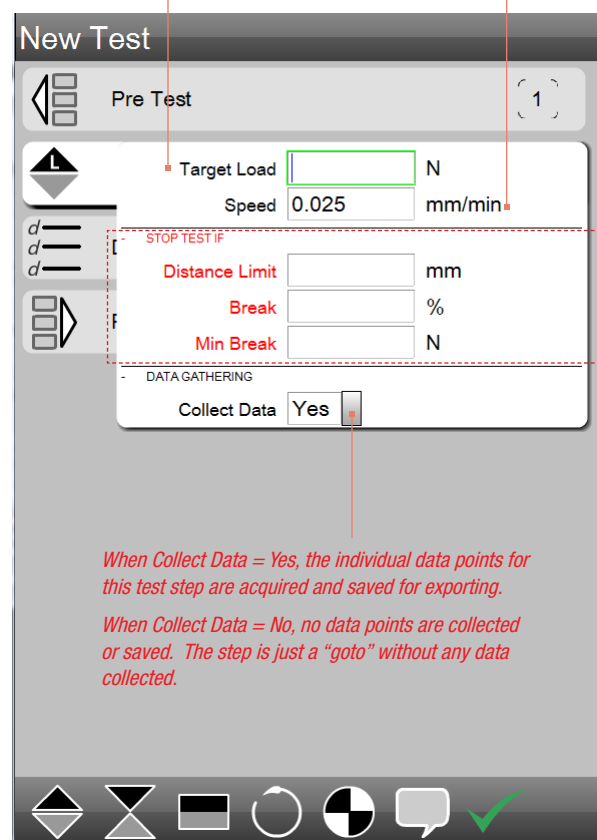
*Min Break - This is the minimum load that must first be achieved before the system begins to look for a Break % drop in load.*

*Enter the target Load Limit. This step will conclude when this load is achieved.*

*Enter the Speed. This is the velocity the crosshead will move at to the Limit.*



L2 Plus Test Builder - Tensile Step types



*When Collect Data = Yes, the individual data points for this test step are acquired and saved for exporting.*

*When Collect Data = No, no data points are collected or saved. The step is just a “goto” without any data collected.*

L2 Plus Test Builder - Tensile Load Limit  
Moves the crosshead until a Load is achieved

### 3.3.1.2 Tensile to Distance Step

The Tension Distance Limit move causes the crosshead to move upward until it meets a distance setpoint. You define the distance target (setpoint), which is measured by the encoder during your test. Once this distance is achieved, the test or the step is completed.

- Select the Tension symbol
- Select the Tension Distance symbol
- Enter your Distance Target and Test Speed



**NOTE**

Each test step may have an individual Test Speed.

*These are the Exceptions for this step. An exception is an event. An exception stops the test. Exceptions are optional, but are recommended.*

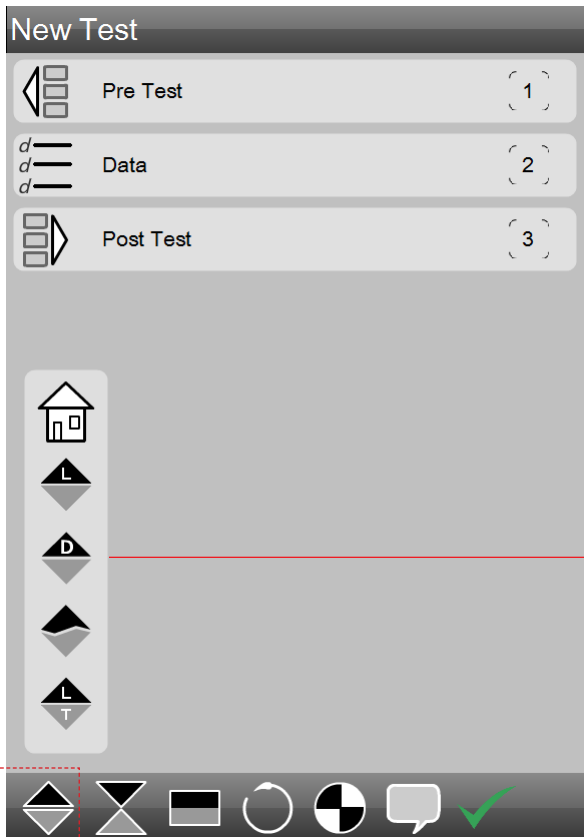
*Load Limit - If the crosshead moves and the measured load equals this limit, the crosshead will stop.*

*Break % - If the sample breaks the test will stop. A break is defined as when the load drops by this percentage value after a Minimum Load has been achieved and there is a maximum load measured.*

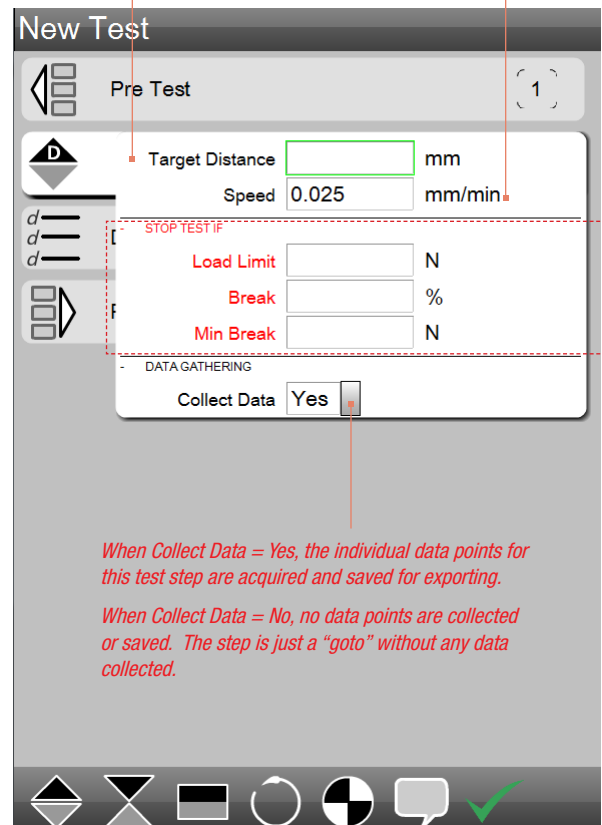
*Min Break - This is the minimum load that must first be achieved before the system begins to look for a Break % drop in load.*

*Enter the target Distance Limit. This step will conclude when this load is achieved.*

*Enter the Speed. This is the velocity the crosshead will move at to the Limit.*



L2 Plus Test Builder - Tensile Step types



*When Collect Data = Yes, the individual data points for this test step are acquired and saved for exporting.*

*When Collect Data = No, no data points are collected or saved. The step is just a "goto" without any data collected.*

L2 Plus Test Builder - Tensile Distance Limit  
Moves the crosshead until a Distance is achieved from Home



### 3.3.1.3 Tensile to Break Step

During a break test, the sample is pulled until the measured load drops by a % from the maximum load after a minimum load setpoint is achieved. This indicates a break event.

When you configure a break test, you specify the Break %. This is the percentage drop in load from a measured maximum load. For example, if the measured peak load is 100 lbf, and the Break % = 20%, the break load = 80 lbf.

The Minimum Break is the measured load that must first be achieved before the system starts looking for the break event. The minimum break protects against false break events in samples that exhibit significant load changes when under stress, e.g. peel tests.

- Select the Tension symbol
- Select the Tension Break symbol
- Enter your Break % (percentage drop from the peak load)
- Enter the Minimum Break value
- Enter the Test Speed



#### NOTE

All break tests use the % Drop algorithm to define a sample break for the purposes of completing a test setup. A Rate algorithm is available to determine a break measurement using the Graphic Analysis tools.

*These are the Exceptions for this step. An exception is an event. An exception stops the test. Exceptions are optional, but are recommended.*

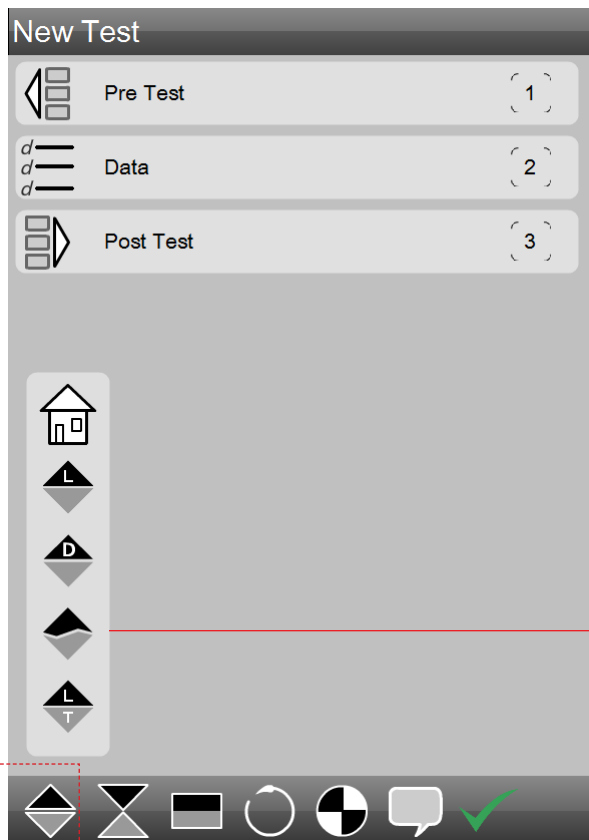
*Distance Limit - If the crosshead moves this distance and the Load Limit has not been achieved, the test will stop.*

*Load Limit - If the crosshead moves and the measured load equals this limit, the crosshead will stop.*

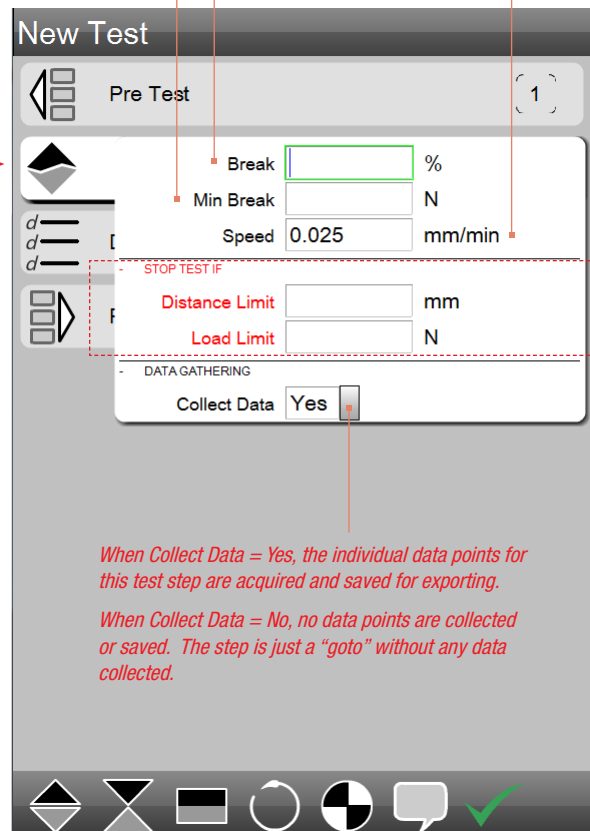
*Enter the load (Min Break) which is the starting load- where the search for a drop in load shall begin.*

*Enter % drop in load value. Measured from the maximum load achieved.*

*Enter the Speed. This is the velocity the crosshead will move at to the Limit.*



L2 Plus Test Builder - Tensile Step types



*When Collect Data = Yes, the individual data points for this test step are acquired and saved for exporting.*

*When Collect Data = No, no data points are collected or saved. The step is just a "goto" without any data collected.*

L2 Plus Test Builder - Tensile Break Limit  
Moves the crosshead until a Break is achieved

### 3.3.1.4 Tensile Load Rate

Load Rate control is an advanced test method where a limit is defined as “getting to a load setpoint in a specified rate of time”.

For example, you may configure a tensile step where you want the crosshead to go to a setpoint of 15 lbf in 5 seconds.

First, specify the tensile load rate step.

Next, enter the target load of 15 lbf.

Lastly, since our rate is based on minutes, we convert 5 seconds to minutes or 1/12 minutes. So, to get to 15 lbf in 5 seconds we multiply  $15 \times 12 = 180$  to establish a rate of 180 lbf/minute.

*These are the Exceptions for this step. An exception is an event. An exception stops the test. Exceptions are optional, but are recommended.*

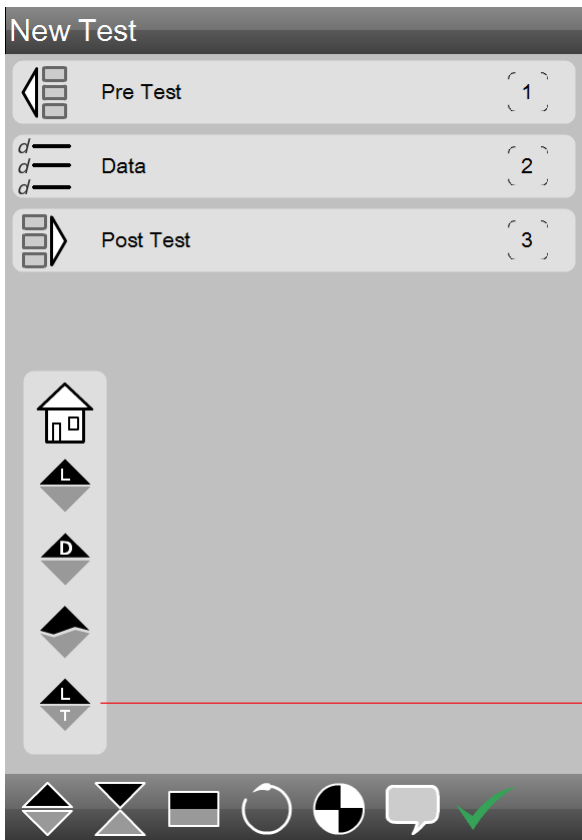
*Distance Limit - If the crosshead moves, and the measured distance equals this limit, the crosshead will stop.*

*Break % - If the sample breaks the test will stop. A break is defined as when the load drops by this percentage value after a Minimum Load has been achieved and there is a maximum load measured.*

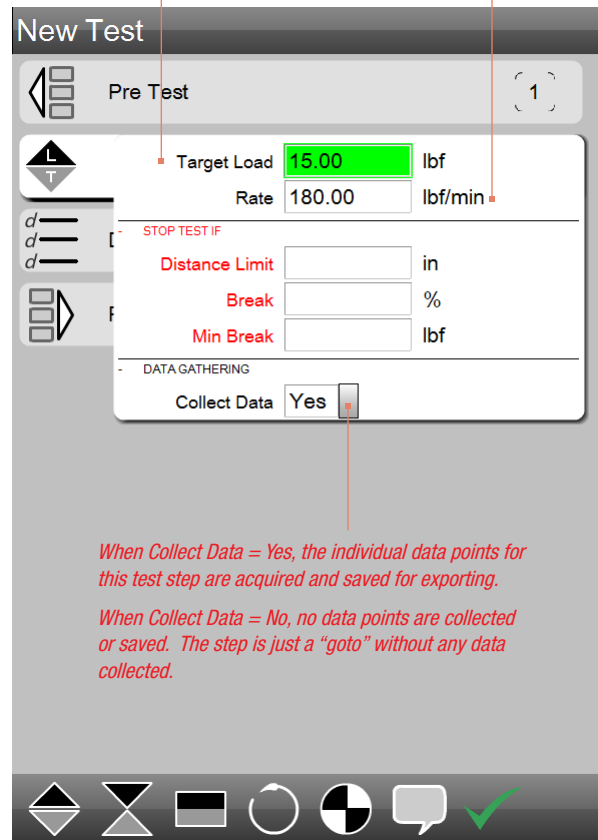
*Min Break - This is the minimum load that must first be achieved before the system begins to look for a Break % drop in load.*

*Enter the target Load Limit. This step will conclude when this load is achieved.*

*Enter the Rate. This is the velocity the crosshead will move at to the Limit.*



L2 Plus Test Builder - Tensile Step Types



*When Collect Data = Yes, the individual data points for this test step are acquired and saved for exporting.*

*When Collect Data = No, no data points are collected or saved. The step is just a “goto” without any data collected.*

L2 Plus Test Builder - Tensile Step Types  
Moves to a Load target at a specified Rate based on Load/minute

### 3.3.1.5 Tensile to Home Step

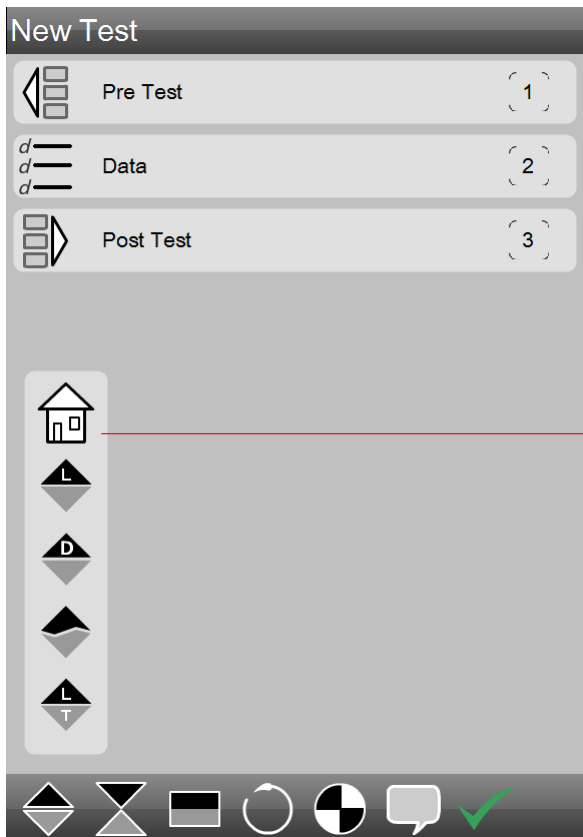
The Tensile to Home position requires that you establish a Home position prior to starting your test. This can be done simply by pressing the Set Home target or by establishing Home automatically when you start the test by configuring the Pre Test Set Home option to Yes.

This step will move the crosshead to the established Home position.

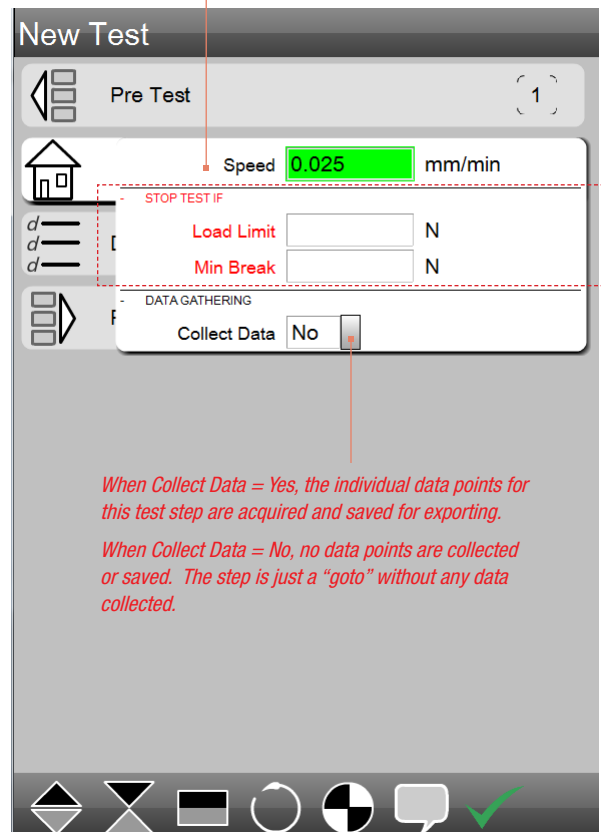
*These are the Exceptions for this step. An exception is an event. An exception stops the test. Exceptions are optional, but are recommended.*

*Load Limit - If the crosshead moves and the measured load equals this limit, the crosshead will stop.*

*Min Break - This is the minimum load that must first be achieved before the system begins to look for a Break % drop in load.*



L2 Plus Test Builder - Tensile Step Types



*Enter the Speed. This is the velocity the crosshead will move at to the Home position.*

*When Collect Data = Yes, the individual data points for this test step are acquired and saved for exporting.*

*When Collect Data = No, no data points are collected or saved. The step is just a "goto" without any data collected.*

L2 Plus Test Builder - Go to Home  
Moves the crosshead to the established Home position

### 3.3.2 Compression Steps

Compression steps move the crosshead in an downward direction. Compression movements are “push” movements. Your L2 Plus Series supports four types of compression steps: Load, Distance, Break/ Rupture and Rate. You may have multiple compression steps within a test setup.

#### 3.3.2.1 Compress to Load Step

The Compression Load Limit move causes the crosshead to move downward until it meets a load setpoint. You define the load target (setpoint), which is measured by the load cell sensor during your test. Once this load is achieved, the test or the step is completed.

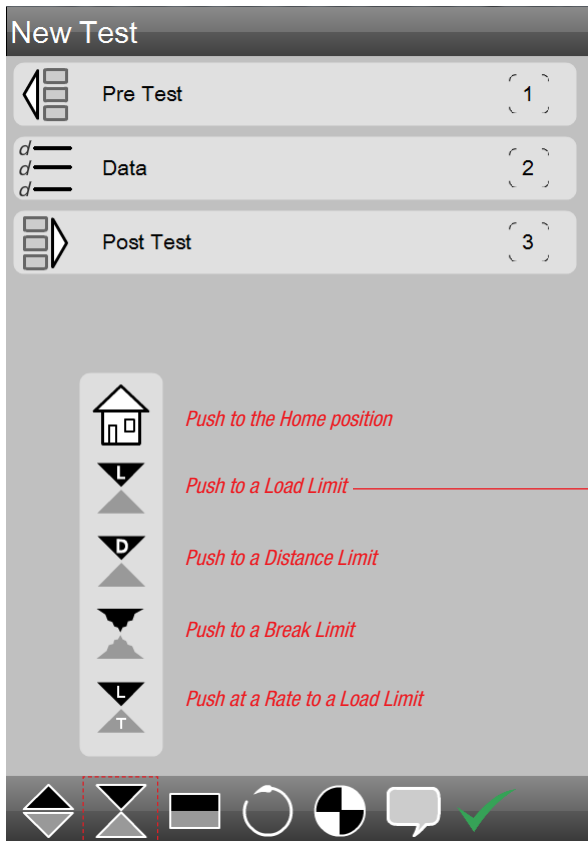
- Select the Compression symbol
- Select the Compression Load symbol
- Enter your Load Target and Test Speed

*These are the Exceptions for this step. An exception is an event. An exception stops the test. Exceptions are optional, but are recommended.*

*Distance Limit - If the crosshead moves this distance and the Load Limit has not been achieved, the test will stop.*

*Break % - If the sample breaks the test will stop. A break is defined as when the load drops by this percentage value after a Minimum Load has been achieved and there is a maximum load measured.*

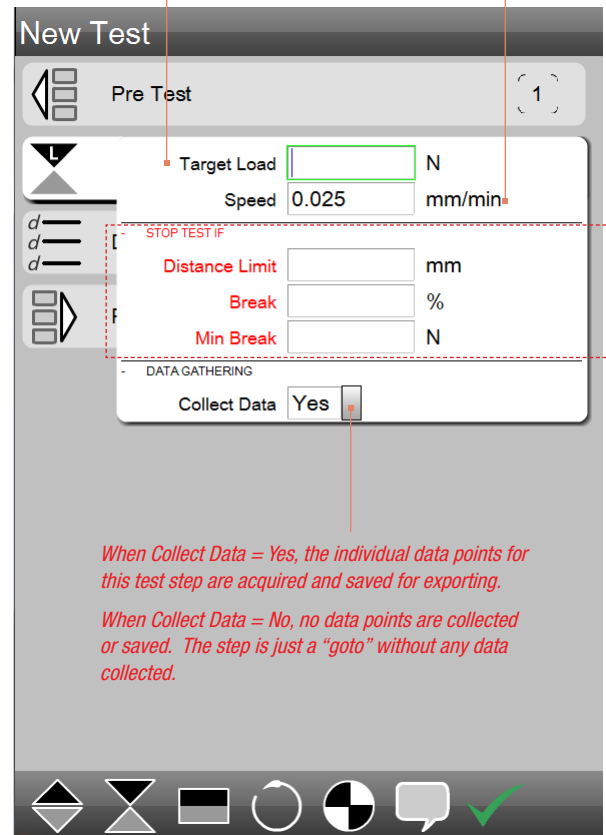
*Min Break - This is the minimum load that must first be achieved before the system begins to look for a Break % drop in load.*



L2 Plus Test Builder - Compression Step types

*Enter the target Load Limit. This step will conclude when this load is achieved.*

*Enter the Speed. This is the velocity the crosshead will move at to the Limit.*



*When Collect Data = Yes, the individual data points for this test step are acquired and saved for exporting.*

*When Collect Data = No, no data points are collected or saved. The step is just a “goto” without any data collected.*

L2 Plus Test Builder - Compression Load Limit  
Moves the crosshead until a Load is achieved

### 3.3.2.2 Compress to Distance Step

The Compression Distance Limit move causes the crosshead to move downward until it meets a distance setpoint. You define the distance target (setpoint), which is measured by the encoder during your test. Once this distance is achieved, the test or the step is completed.

- Select the Compression symbol
- Select the Compression Distance symbol
- Enter your Distance Target and Test Speed

*These are the Exceptions for this step. An exception is an event. An exception stops the test. Exceptions are optional, but are recommended.*

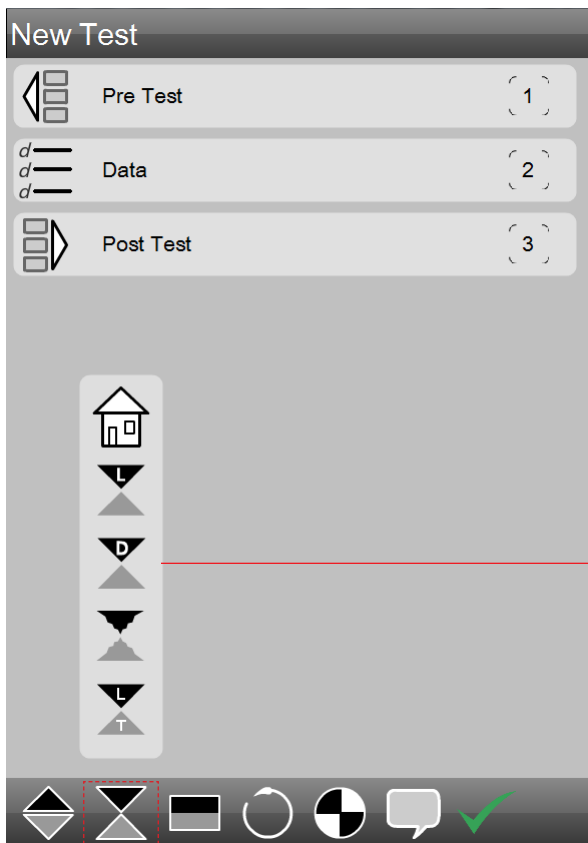
*Load Limit - If the crosshead moves and the measured load equals this limit, the crosshead will stop.*

*Break % - If the sample breaks the test will stop. A break is defined as when the load drops by this percentage value after a Minimum Load has been achieved and there is a maximum load measured.*

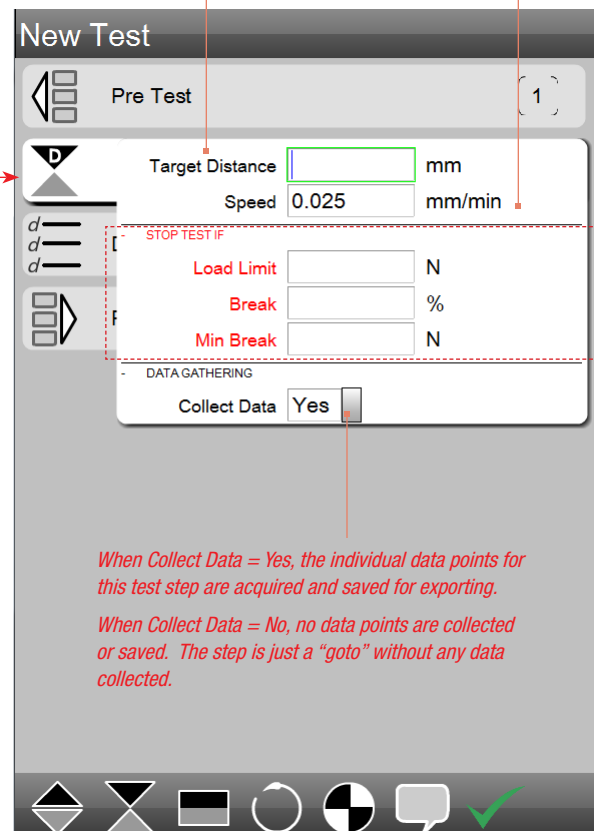
*Min Break - This is the minimum load that must first be achieved before the system begins to look for a Break % drop in load.*

*Enter the target Distance Limit. This step will conclude when this load is achieved.*

*Enter the Speed. This is the velocity the crosshead will move at to the Limit.*



L2 Plus Test Builder - Compression Step types



*When Collect Data = Yes, the individual data points for this test step are acquired and saved for exporting.*

*When Collect Data = No, no data points are collected or saved. The step is just a "goto" without any data collected.*

L2 Plus Test Builder - Compression Distance Limit  
Moves the crosshead until a Distance is achieved from Home

### 3.3.2.3 Compress to Break Step

During a break test, the sample is pulled until the measured load drops by a % from the maximum load after a minimum load setpoint is achieved. This indicates a break event.

When you configure a break test, you specify the Break %. This is the percentage drop in load from a measured maximum load. For example, if the measured peak load is 100 lbf, and the Break % = 20%, the break load = 80 lbf.

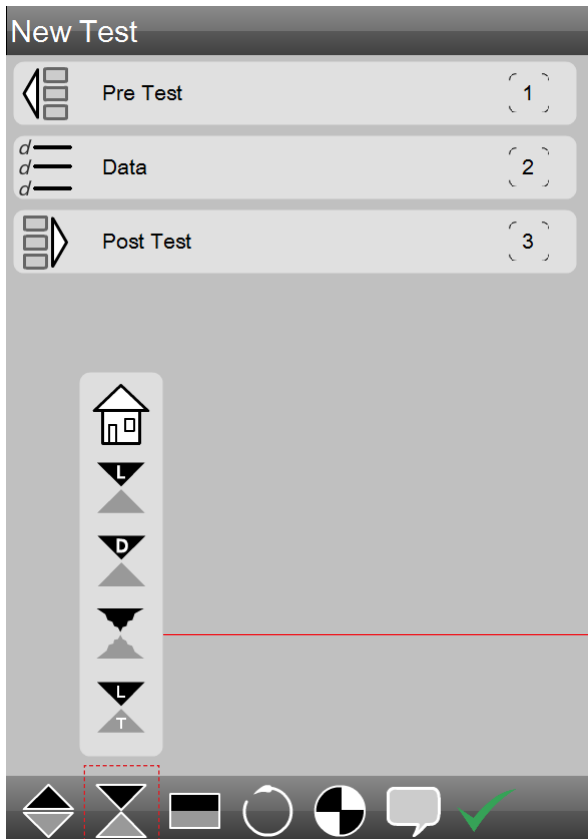
The Minimum Break is the measured load that must first be achieved before the system starts looking for the break event. The minimum break protects against false break events in samples that exhibit significant load changes when under stress, e.g. puncture and insertion tests.

- Select the Compression symbol
- Select the Compression Break symbol
- Enter your Break % (percentage drop from the peak load)
- Enter the Minimum Break value
- Enter the Test Speed

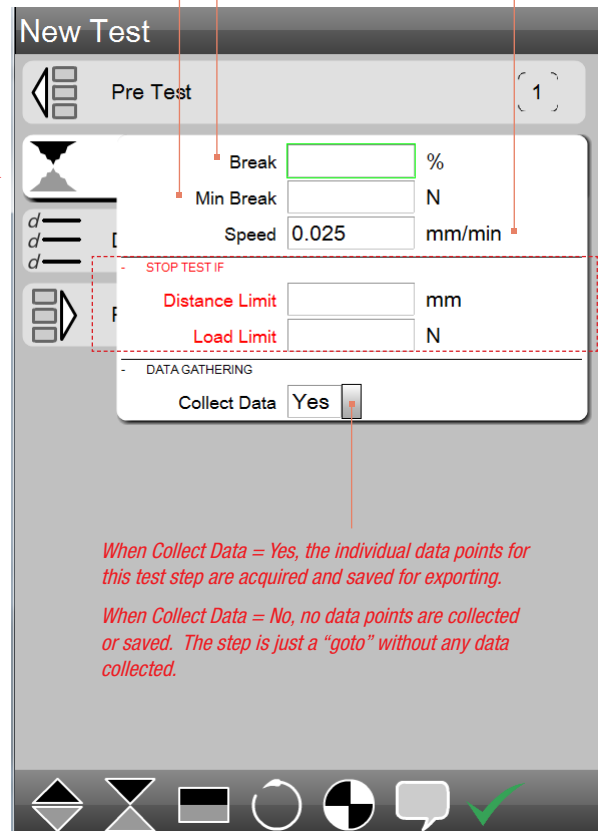
*These are the Exceptions for this step. An exception is an event. An exception stops the test. Exceptions are optional, but are recommended.*

*Distance Limit - If the crosshead moves this distance and the Load Limit has not been achieved, the test will stop.*

*Load Limit - If the crosshead moves and the measured load equals this limit, the crosshead will stop.*



L2 Plus Test Builder - Compression Step types



L2 Plus Test Builder - Compression Break Limit  
Moves the crosshead until a Break is achieved

### 3.3.2.4 Compress at a Load Rate

Load Rate control is an advanced test method where a limit is defined as “getting to a load setpoint in a specified rate of time”.

For example, you may configure a tensile step where you want the crosshead to go to a setpoint of 15 lbf in 5 seconds.

First, specify the tensile load rate step.

Next, enter the target load of 15 lbf.

Lastly, since our rate is based on minutes, we convert 5 seconds to minutes or 1/12 minutes. So, to get to 15 lbf in 5 seconds we multiply  $15 \times 12 = 180$  to establish a rate of 180 lbf/minute.

*These are the Exceptions for this step. An exception is an event. An exception stops the test. Exceptions are optional, but are recommended.*

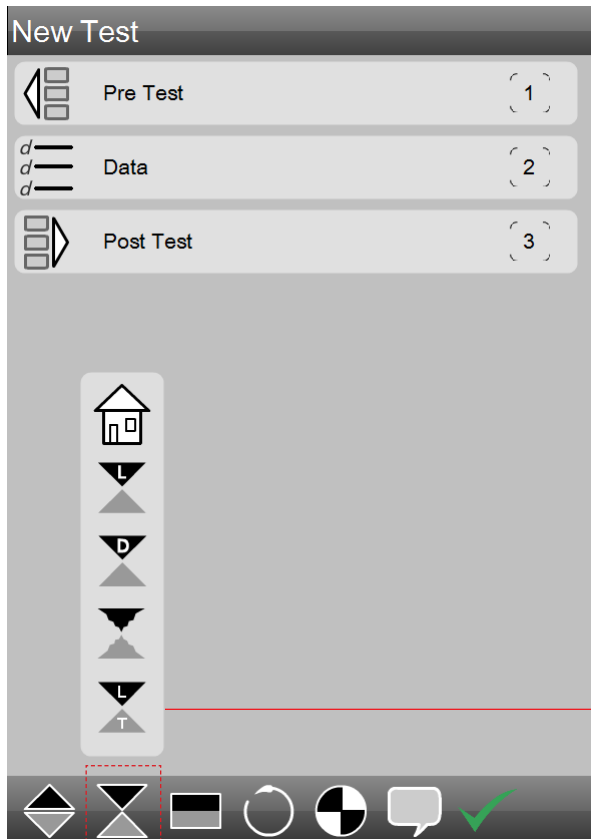
*Distance Limit - If the crosshead moves, and the measured distance equals this limit, the crosshead will stop.*

*Break % - If the sample breaks the test will stop. A break is defined as when the load drops by this percentage value after a Minimum Load has been achieved and there is a maximum load measured.*

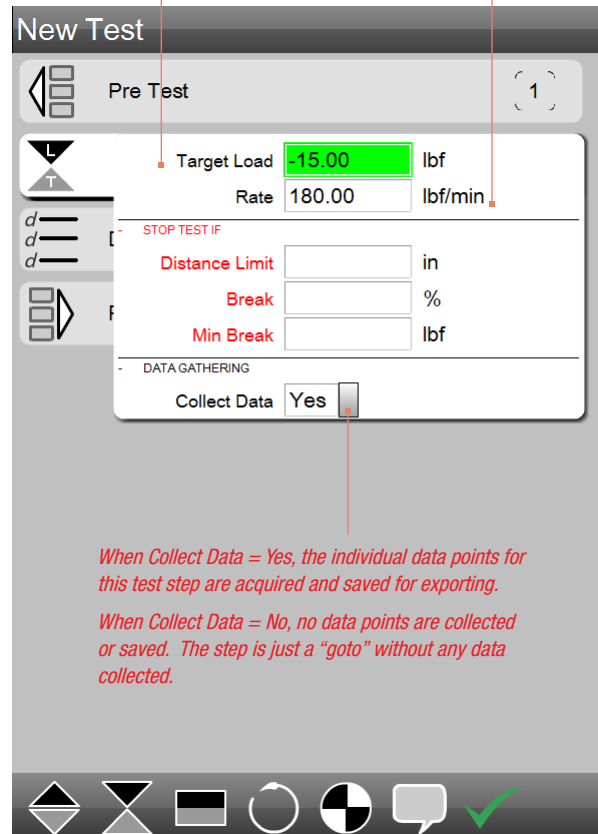
*Min Break - This is the minimum load that must first be achieved before the system begins to look for a Break % drop in load.*

*Enter the target Load Limit. This step will conclude when this load is achieved.*

*Enter the Rate. This is the velocity the crosshead will move at to the Limit.*



L2 Plus Test Builder - Compression Step types



*When Collect Data = Yes, the individual data points for this test step are acquired and saved for exporting.*

*When Collect Data = No, no data points are collected or saved. The step is just a “goto” without any data collected.*

L2 Plus Test Builder - Tensile Step Types  
Moves to a Load target at a specified Rate based on Load/minute

### 3.3.2.5 Compress to Home Step

The Compress to Home position requires that you establish a Home position prior to starting your test. This can be done simply by pressing the Set Home target or by establishing Home automatically when you start the test by configuring the Pre Test Set Home option to Yes.

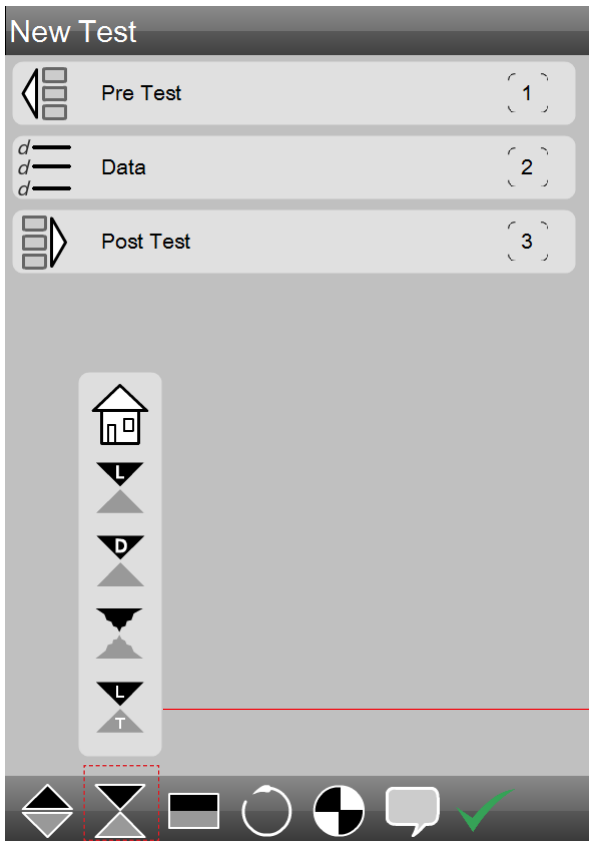
This step will move the crosshead to the established Home position.

*These are the Exceptions for this step. An exception is an event. An exception stops the test. Exceptions are optional, but are recommended.*

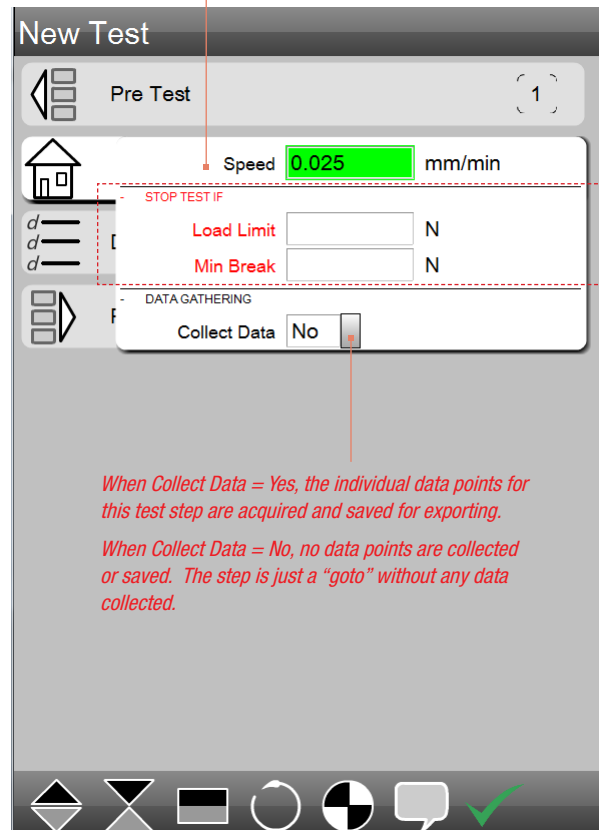
*Load Limit - If the crosshead moves and the measured load equals this limit, the crosshead will stop.*

*Min Break - This is the minimum load that must first be achieved before the system begins to look for a Break % drop in load.*

*Enter the Speed. This is the velocity the crosshead will move at to the Home position.*



L2 Plus Test Builder - Compression Step types



*When Collect Data = Yes, the individual data points for this test step are acquired and saved for exporting.*

*When Collect Data = No, no data points are collected or saved. The step is just a "goto" without any data collected.*

L2 Plus Test Builder - Go to Home  
Moves the crosshead to the established Home position



### 3.3.3 Hold Steps

You can perform constant load or constant distance tests using the Hold step. Creep and relaxation are typical applications that use a hold function.



**NOTE**

The maximum duration for a test is 48 hours.



**NOTE**

The maximum number of data points for a test is 100,000. Adjust the Sampling Rate (Hz) accordingly for your test.

#### 3.3.3.1 Hold at Load Step

When you want to hold a load, first create your step with a load variable; either a tension or compression load. Next, select the Load Hold step. Then specify the duration for your hold period. The maximum allowable hold duration is 48 hours (depending on test frame used).

- Select the test mode- either Tension or Compression
- Enter the Load Limit (target)
- Enter the Test Speed
- Select the Hold symbol
- Select the Load Hold symbol
- Enter the Hold Duration value

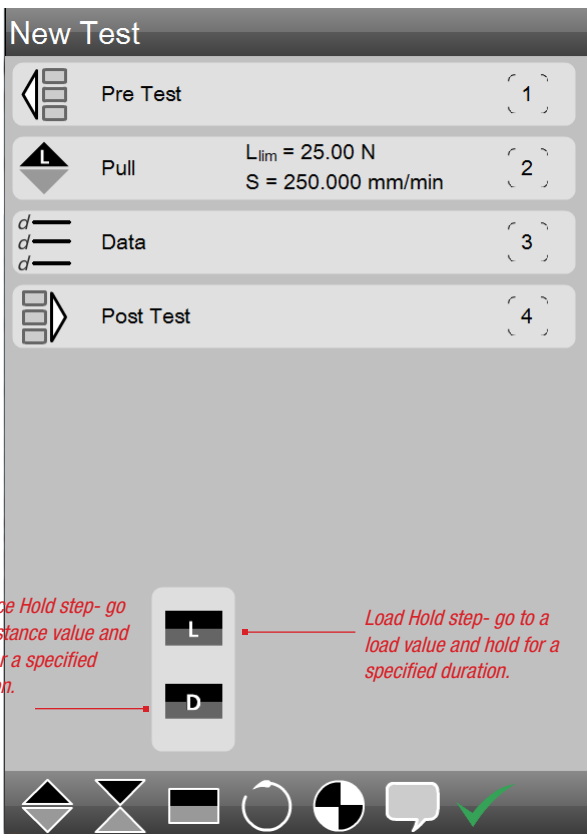
*Step Exceptions- use when you want the test to abort if one of these events occur.*

*Travel Limit exception- stop if the crosshead goes to this distance during the hold period.*

*Break exception- stop if a break event occurs. The Break % is the percentage drop in load from a highest load point.*

*Minimum break is used with a Break exception. This is the load that must be measured before looking for a break event.*

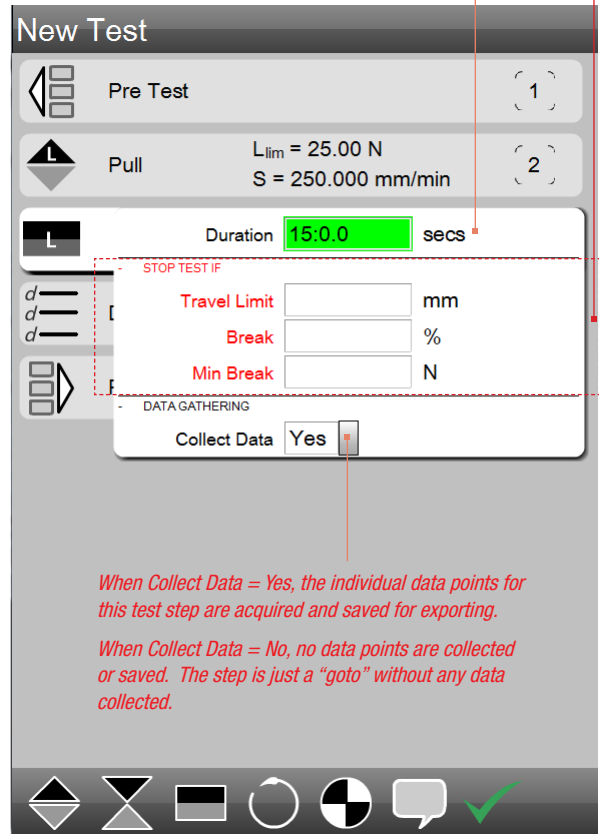
*The step preceding the Hold step will be the setpoint. Since the load limit is 25N and the hold duration is 15 seconds, the system will hold the sample at a constant load for 15 seconds.*



*Distance Hold step- go to a distance value and hold for a specified duration.*

*Load Hold step- go to a load value and hold for a specified duration.*

L2 Plus Test Builder - Hold Step types



*When Collect Data = Yes, the individual data points for this test step are acquired and saved for exporting.*

*When Collect Data = No, no data points are collected or saved. The step is just a "goto" without any data collected.*

L2 Plus Test Builder - Hold at Load

*Holds the crosshead at the target load for a specified time duration*

### 3.3.3.2 Hold at Distance Step

You may hold the crosshead at a Distance target to determine the effects the hold time has on the sample's load characteristic. The Distance Hold is performed together with an associated tension or compress to distance step. The maximum hold duration of 48 hours at full load capacity can be performed on any Starrett test frame with no cool down period required between hold steps.

- Select the test mode- either Tension or Compression
- Enter the Distance Limit (target)
- Enter the Test Speed
- Select the Hold symbol
- Select the Distance Hold symbol
- Enter the Hold Duration value



**NOTE**

The maximum duration for a test is 48 hours.



**NOTE**

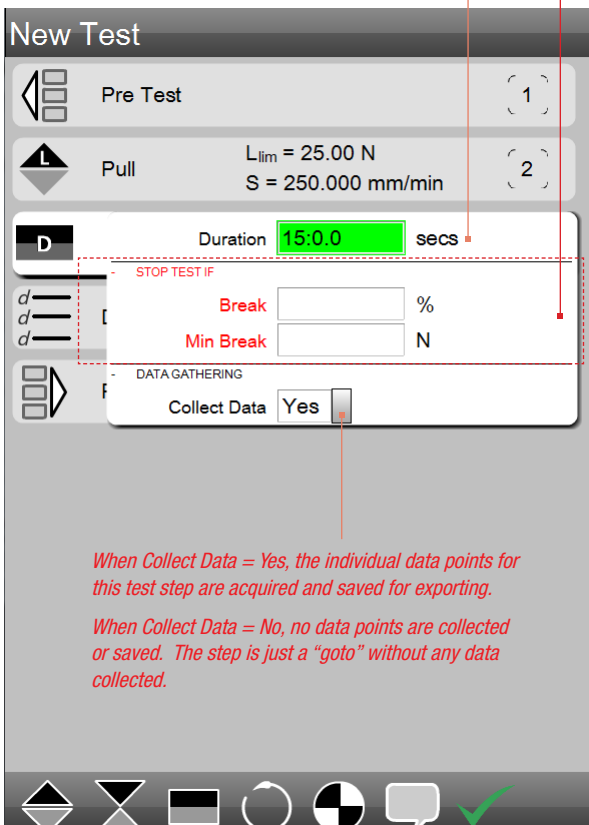
The maximum number of data points for a test is 100,000. Adjust the Sampling Rate (Hz) accordingly for your test.

*Step Exceptions- use when you want the test to abort if one of these events occur.*

*Break exception- stop if a break event occurs. The Break % is the percentage drop in load from a highest load point.*

*Minimum break is used with a Break exception. This is the load that must be measured before looking for a break event.*

*The step preceding the Hold step will be the setpoint. Since the load limit is 25N and the hold duration is 15 seconds, the system will hold the sample at a constant load, at this Distance, for 15 seconds.*



*When Collect Data = Yes, the individual data points for this test step are acquired and saved for exporting.*

*When Collect Data = No, no data points are collected or saved. The step is just a "goto" without any data collected.*

L2 Plus Test Builder - Hold at Load

*Holds the crosshead at the target load for a specified time duration*

### 3.3.4 Cycle Steps

L2 Plus Series can be used to perform cyclic testing. Cyclic tests occur between multiple steps where the actions of these steps are repeated either by a number of counts or by using a time period.



**NOTE**  
The maximum duration for a test is 48 hours.



**NOTE**  
The maximum number of data points for a test is 100,000. Adjust the Sampling Rate (Hz) accordingly for your test.



**NOTE**  
There is no need to have a cool down period when cycle testing with Starrett test frames.



**NOTE**  
You do not need to reduce your load capacity testing when performing cycle steps using Starrett test frames due to duty cycle limitations. You may cycle at full load capacity for up to 1000 cycles for 48 hours.

#### 3.3.4.1 Cycle for Count Step

When you cycle within a test, you must specify the step where you want your cycle to begin. You then specify the number of times you want the cycle to be performed. The minimum cycle count = 2. The maximum cycle count = 1000.

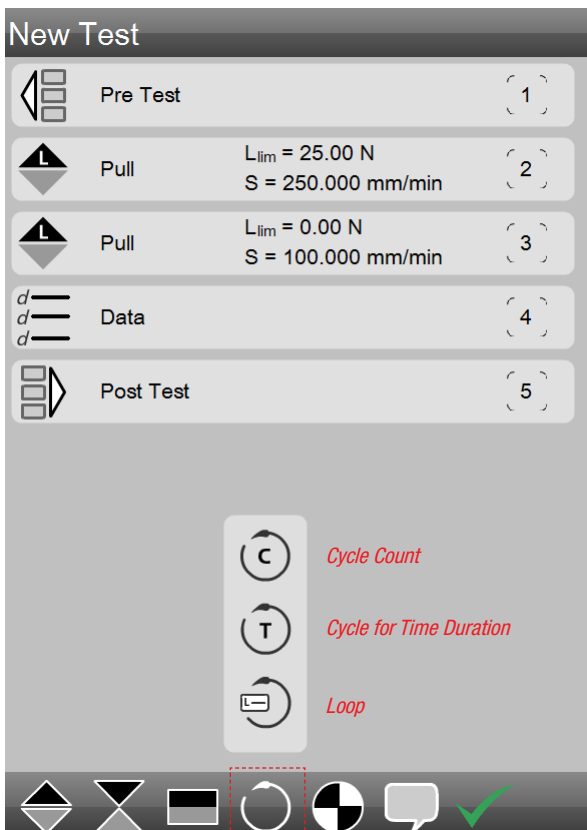


**NOTE**  
The maximum number of cycles is 1000.

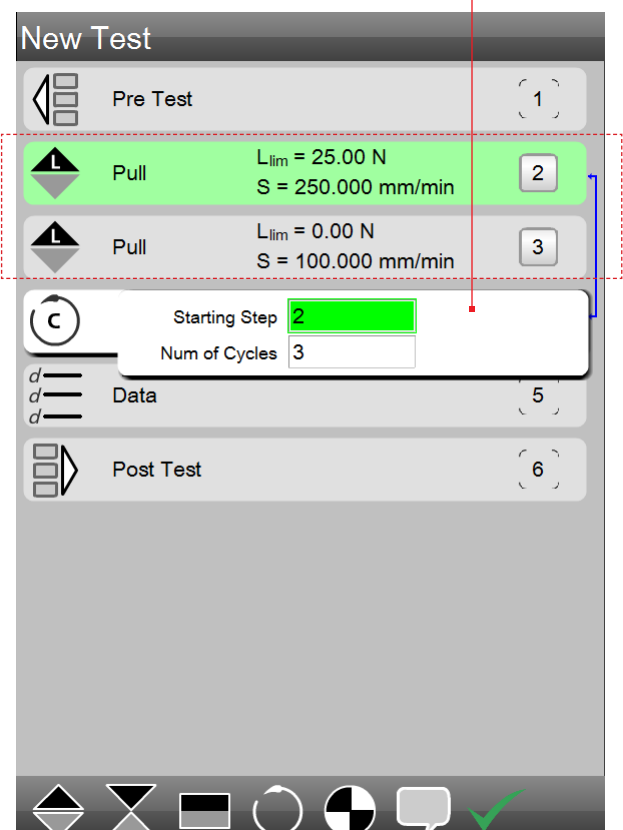
Typically, you will have at least two steps that you wish to cycle between, but you may have a series of steps that you can cycle. When multiple steps are cycled, you specify the first step and then all steps starting with the first step and the last step prior to the cycle move step will be performed.

- Select the Cycle symbol
- Select the Cycle Count symbol
- Select the first step where the cycle will begin
- Specify the number of counts that the cycle shall be performed

*This test setup with cycle three (3) times beginning with step 2 (Pull to 25N) and finishing with step 3 (Pull to 0N).*



L2 Plus Test Builder - Cycle Steps



L2 Plus Test Builder - Cycle Count Step  
Cycles selected steps for a number of cycles (counts)

### 3.3.4.2 Cycle for Duration Step

Instead for cycling your steps based on a count, you can cycle based on time. You may set a cycle time duration for up to 30 minutes. You enter time using minutes or seconds. If you want a 30 minute cycle time, you would enter the number 1800 (30 min x 60 sec = 1800 sec) or enter 30 then a decimal point.

- Select the Cycle symbol
- Select the Cycle Time symbol
- Select the first step where the cycle will begin
- Specify the Time Duration (in seconds) the cycle shall be performed



**NOTE**  
When you enter the Duration time, always enter using seconds.

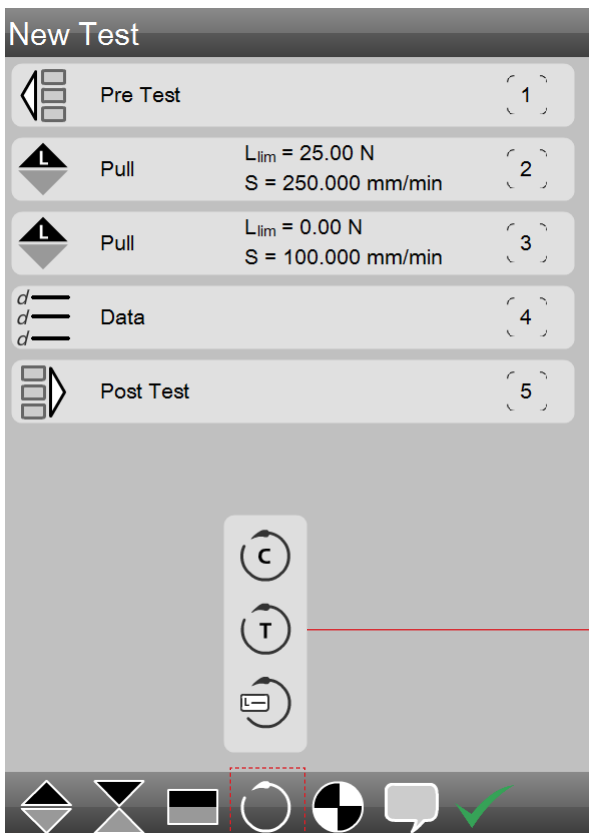


**NOTE**  
The maximum duration for a test is 48 hours.

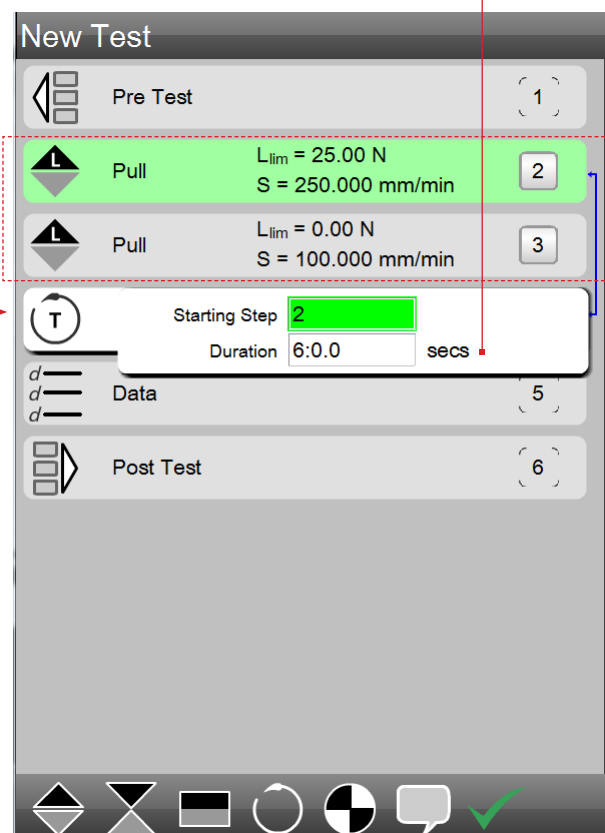


**NOTE**  
The maximum number of data points for a test is 100,000. Adjust the Sampling Rate (Hz) accordingly for your test.

*Enter the time as a whole number in seconds.  
28000 would represent 7 hrs and 46 minutes and 40 seconds.*



L2 Plus Test Builder - Cycle Steps



L2 Plus Test Builder - Cycle Time Step  
Cycles selected steps for a time duration

### 3.3.4.3 Cycle for Loop Step

When you use either Cycle Count or Cycle Time, you get a single result for the cycle. However, with a Loop step, you get a result for each step. If a step is repeated three (3) times, you will get three independent results recorded as individual Runs.

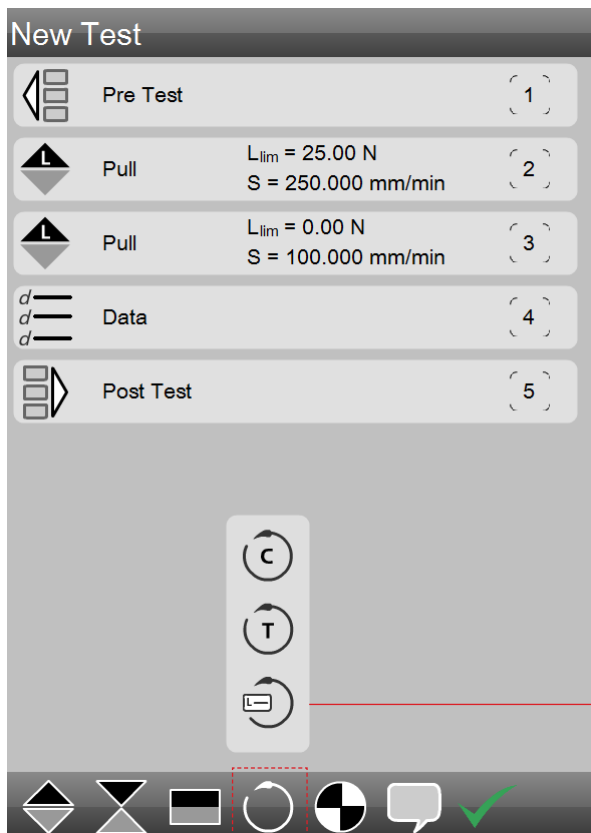


#### CAUTION

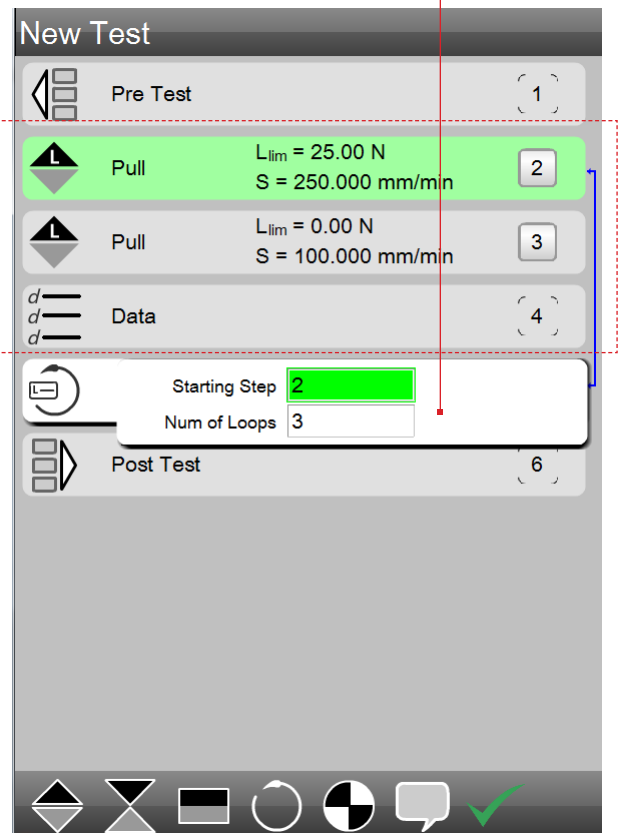
Using a Loop step with a Cycle step in a test is NOT PERMITTED.

*Notice in the Loop type of cycle, the Data step is also included in the cycle set. This is because with a loop test, you will get a separate test run with coefficients for each cycle.*

*In this example, the Number of Loops = 3. This means when this test has finished, there will be three separate test runs- each having its own measured results.*



L2 Plus Test Builder - Cycle Steps



L2 Plus Test Builder - Cycle Time Step  
Cycles selected steps for a time duration

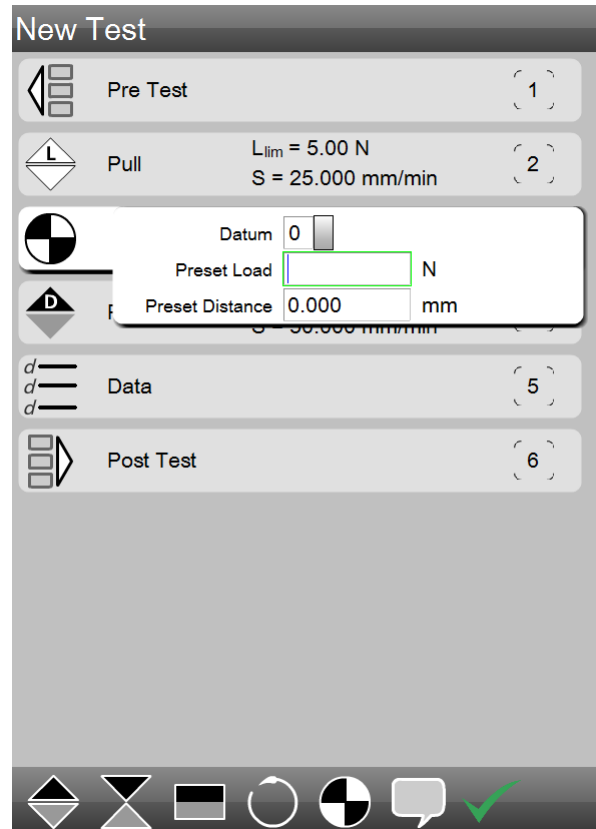
### 3.3.5 Datum Step

You may datum as part or your test. The primary datum is referred to as Datum #0. A second datum (available only during a test) is referred to as Datum #1. The Datum step sets a datum according to the position and load at the moment the Datum step is executed during a test. The distance and/or load may be preset to display a zero or non-zero value at the time.

You may use a second datum for load or position during a test for more complex applications. For example, Datum #1 may be used to determine the distance that corresponds to a creep rate.

- Pull to a load.
- Datum (set the datum to Datum #1) and zero the distance.
- Hold for 10 minutes.

The distance reported at the end of the Hold step is creep over 10 minutes.



*L2 Plus Test Builder - Datum Step  
Use a datum after a pre-conditioning step*

### 3.3.6 Prompt Steps

There are two forms of prompts available for your L2 Plus test setup.

- Ask Prompt
- Tell Prompt

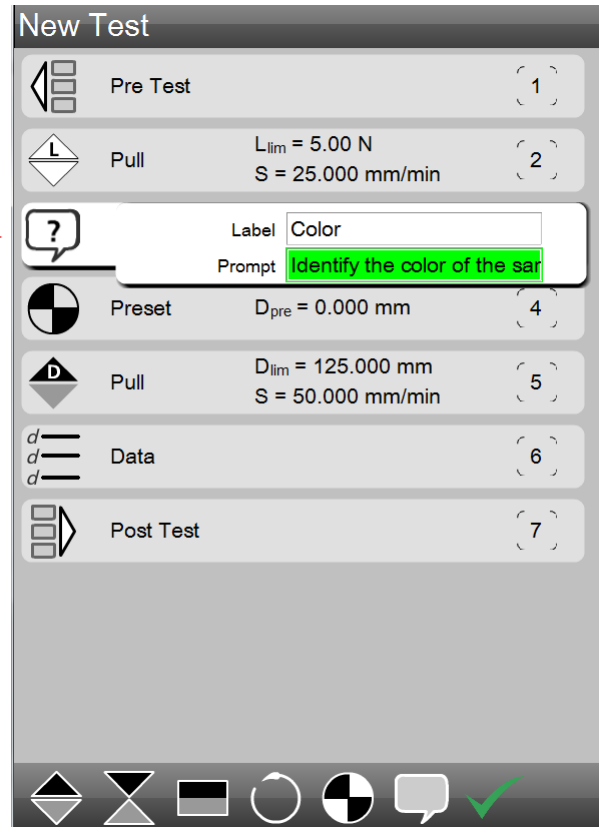
The Ask prompt requires a response from the operator.

The Tell prompt alerts the operator and requires no response from the operator.

#### 3.3.6.1 Ask Step

The Ask step is used to add a question that requires the operator to respond. Questions should always be short and require a single or few word response. The maximum number of characters, including spaces, for your question is 100.

The response is limited to a maximum number of characters, including spaces, to 16. Use the Ask coefficient to display the answer to your question.



L2 Plus Test Builder - Ask Step  
Requires an operator response



L2 Plus Test  
An ASK prompt is displayed requiring the operator to answer

### 3.3.6.2 Tell Step

The Tell Step is a message displayed for the user. Prompts can be used as reminders to the operator or used to give the user instructions during the test procedure.



**NOTE**

A prompt does not require an operator response.

When a prompt is used, you have the option to specify how long (duration) the prompt is to be displayed during your test procedure.

A prompt may have up to 100 characters (including spaces). The prompt duration (length of time displayed) may be up to 8 hrs. A step does not complete until the prompt has been displayed for its full duration or the user selects the check mark.

L2 Plus Test Builder - Prompt Step

L2 Plus Prompt  
Displays message to operator



### 3.3.7 Using Coefficients in Test Steps

Coefficients (results) from test steps may be used as inputs in other steps within your test setup. If a result from a step is to be used as an input, the step supplying the result must occur BEFORE the test step that will use the result.



**NOTE**

A result from a step may be used as an input in another test provided the result occurs BEFORE the input step.

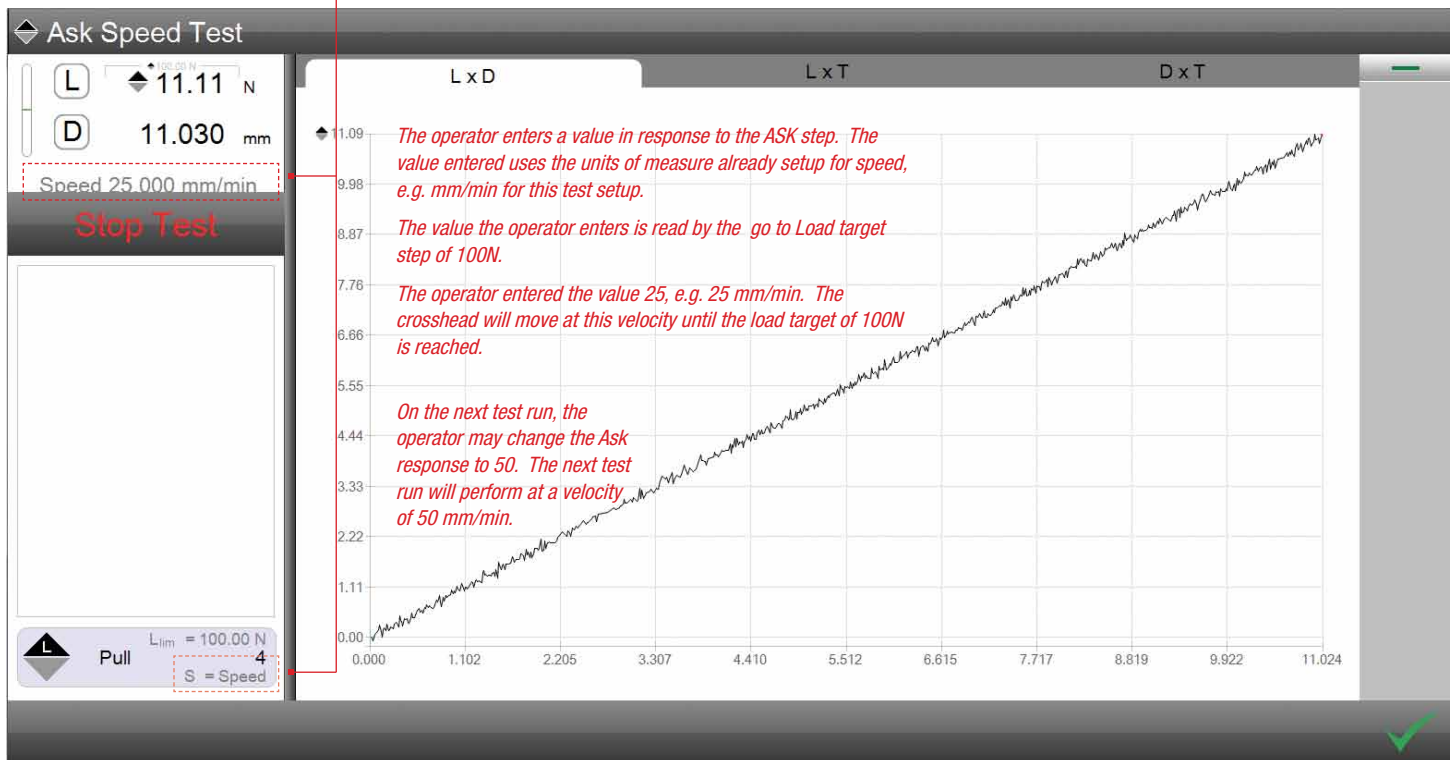
#### 3.3.7.1 Using Prompt Coefficients

You may use the answer to an Ask step as the input to a step that comes after the Ask step.

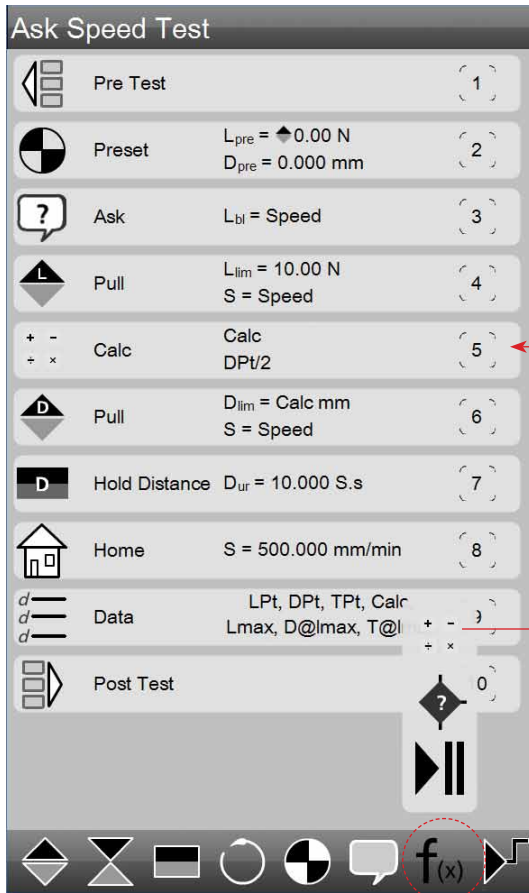
In this example, the test speed for the go to Load step is going to be changed by the operator in increments of 10% beginning with a starting test speed of 10 in/min. An Ask step is used that precedes the go to Load step. During the Ask step, the operator enters the new test speed for the load step.

L2 Plus Test Builder - Prompt Step  
Operator will enter the Speed required for a Go To Load step

L2 Plus Test Builder - Prompt Step  
The Speed value will come from the ASK Step labeled Speed

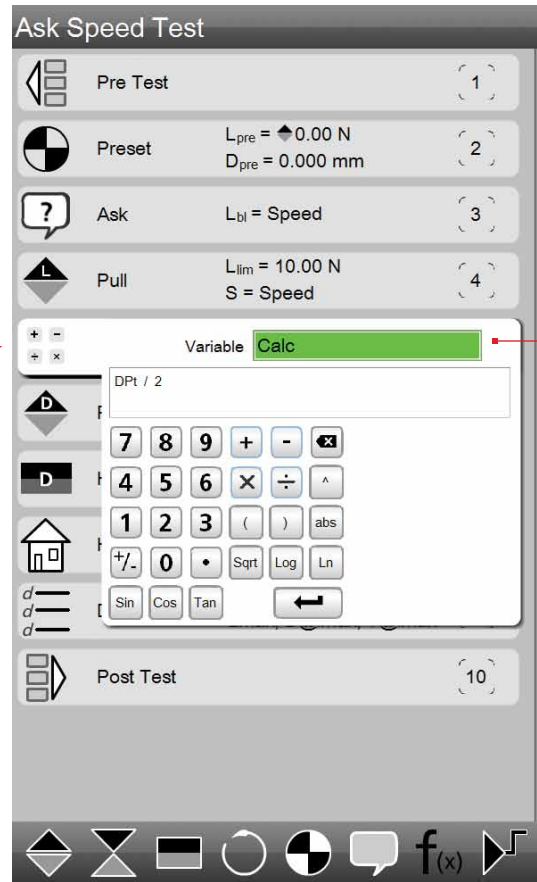


L2 Plus Test Run Full Graph  
Test Speed is set from a Previous ASK step answer



L2 Plus Test Builder

Shows Formula Step used as Input to Step #6



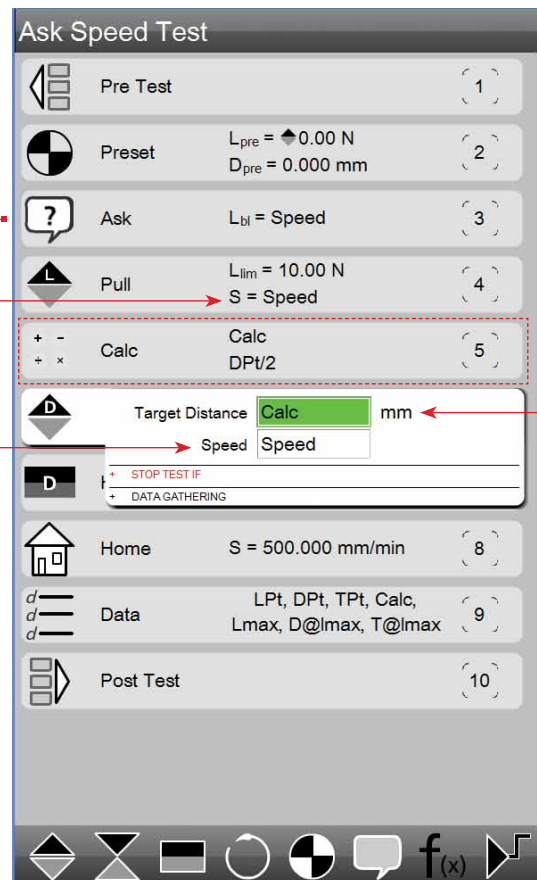
A formula is used to find a result (Calc) that is used as the input for the Distance target in Step 6.

The formula uses the initial Distance (DPT) and divides by 2.

The formula result is renamed "Calc".

Calc is used as the Distance target in Step 6.

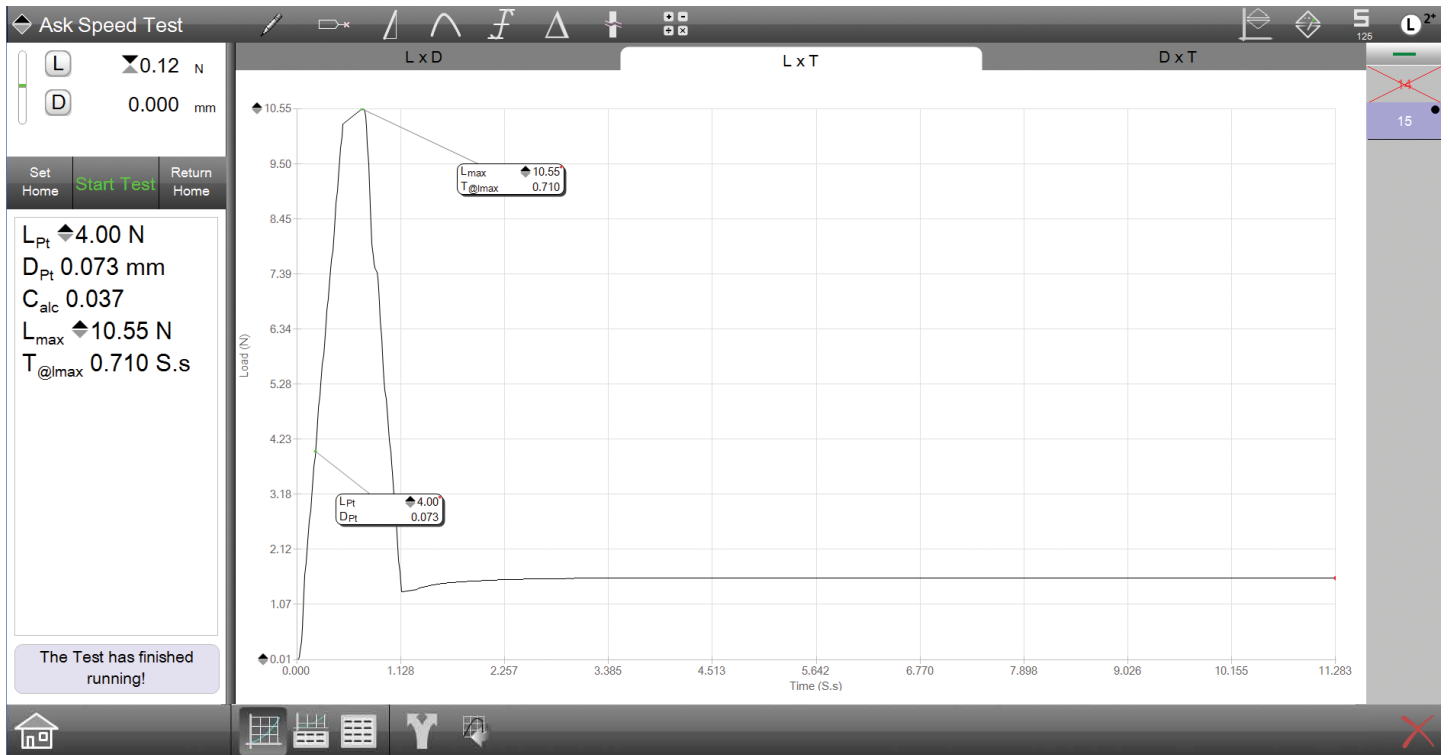
Speed, from the ASK Step 3 is used as the input for the Speed for Step 6.



### 3.3.7.2 Using Formula Coefficients

Before the results of a formula can be used as an input to another step, you must first perform a run where you have coefficients on which to use a formula. Consequently, a formula result cannot be used unless you have performed a run; obtained coefficients; and calculated a result based on a formula that uses those coefficients. The result of your formula may then be used as an input. All coefficients used in the formula must occur before the step using the formula result.

In this example we are using the result of a formula as the input for a go to Distance step.



*L2 Plus Test Run Full Graph  
Shows results after using a formula step (CALC)*

### 3.4 Data Step

The Data step is used to define the results you want to measure and report.

You may specify the coefficients (results) you want using the Data step prior to performing the test. Alternatively, you can defer specifying the coefficients you want until after the test run is complete and your graph trace is created. Then, using the Graphic Analysis tools, you can make your measurements on the graph, which automatically creates your coefficients.



**NOTE**

The Graph Analysis tools are used to create a coefficient.

#### New Test

Pre Test

Pull L<sub>lim</sub> = 25.00 N  
S = 50.000 mm/r

No data has been selected for

+ Add Data ...

Average

Delta

Formula

Minimum

Maximum

Peak

Point

Slope

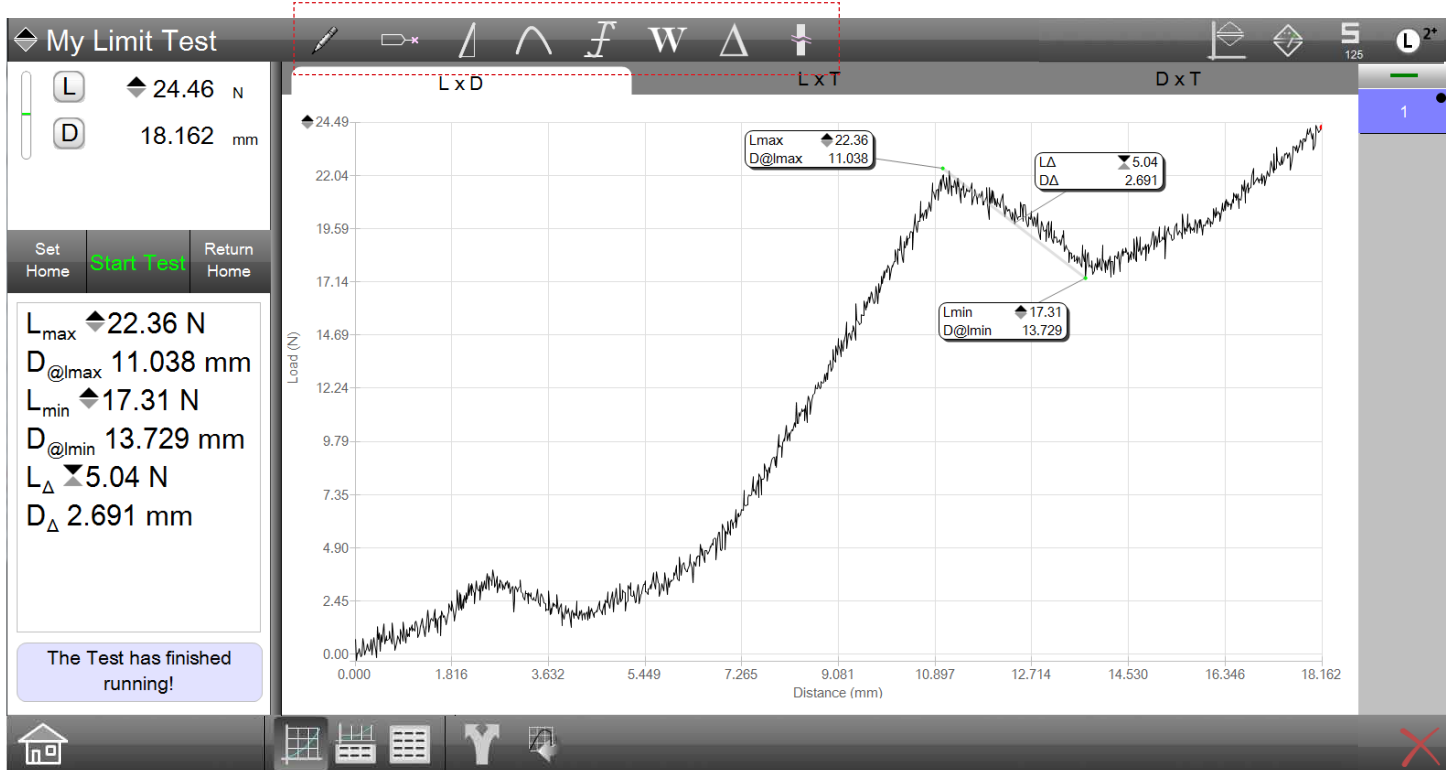
Valley

Work

*The Data step is used to show your results. You may measure from the graph using the Graph Analysis Tools are select the +Add Data function in the Data Step to select from common measurement methods.*

L2 Plus Test Builder - Data Step

*Use the Graph Analysis Tools to measure and display results.*



L2 Plus Full Graph view

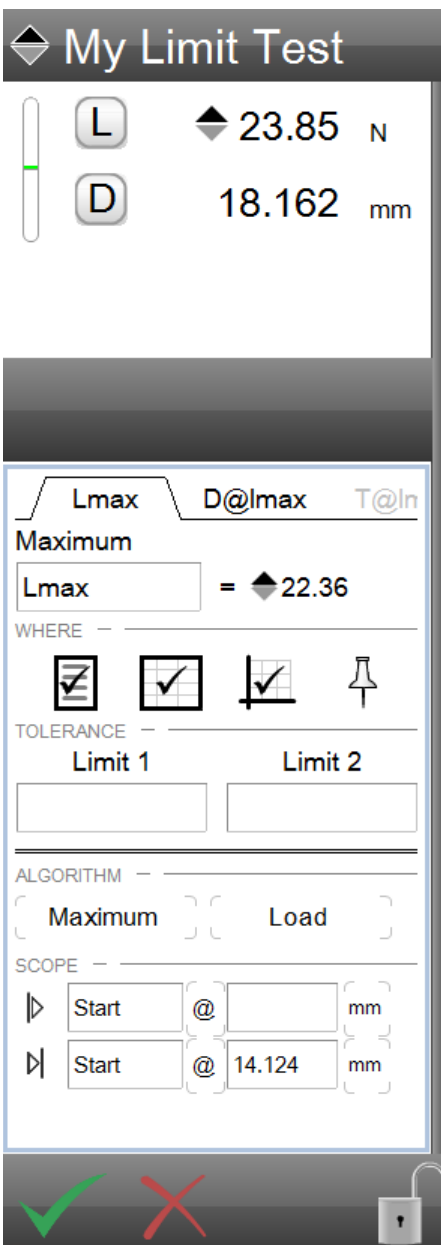
Displaying measured results (coefficients) with their markers indicating the values

### 3.4.1 Coefficient Definition

The term coefficient is used to represent a result. The result may be configured prior to the test in the Data step, or the result may be determined using the graph of your test and the associated analysis tools.



**NOTE**  
A coefficient is a result.



L2 Plus Data Definition menu for a Load Point

### 3.4.1.1 Coefficient Types

Coefficients are categorized into types according to their ability to measure a particular trait of your test result. These types also help you find the particular measurement result you are looking for.

Every coefficient has a Data Definition menu that permits you to customize the coefficient so you get the exact measurement result you need.



**NOTE**  
The Data Definition view for a coefficient displays “coefficient sets”. Included are the associated coefficients for a particular type. For example, for Maximum Load, also displayed in a separate tab is the coefficient for Distance @ Maximum Load and the coefficient for Time @ Maximum Load.

Coefficient types are listed in the following table.

Type	Function	
Point	Load	
	Distance	
	Slope Intersect	
Modulus/Slope	Slope Fit	
	Tangent Slope	
	Two Point Slope	
	Maximum Slope	
	Peak/Valley	
Peak/Valley	Maximum Peak	
	Maximum Valley	
	Minimum Peak	
	Minimum Valley	
	Number of Peaks (Count)	
	Number of Valleys (Count)	
	Average of Peaks	
	Average of Valleys	
	Minimum/Maximum/Average	Minimum Load
		Maximum Load
Average Load		
Minimum Distance		
Maximum Distance		
Work/Energy	Average Distance	
	Work	
	Hysteresis	
	Resilience	
	Hysteresis Loss	
Delta	Delta Load	
	Delta Distance	
	Creep- Load	
	Creep- Distance	
	Relaxation- Load	
	Relaxation- Distance	
	Break/Rupture	Break %Drop- Load
Break %Drop- Distance		
Break Rate- Load		
Break Rate- Distance		

### 3.4.1.2 Coefficient Naming

Coefficient names are abbreviations for what the result represents. For example, the coefficient name for Maximum Load is Lmax.

The coefficient name for the first Load point with a test run is LPt and if a second point for Load is measured, it will have the coefficient name of LPt2. Any additional Load points will be identified using 3,4,5, etc.



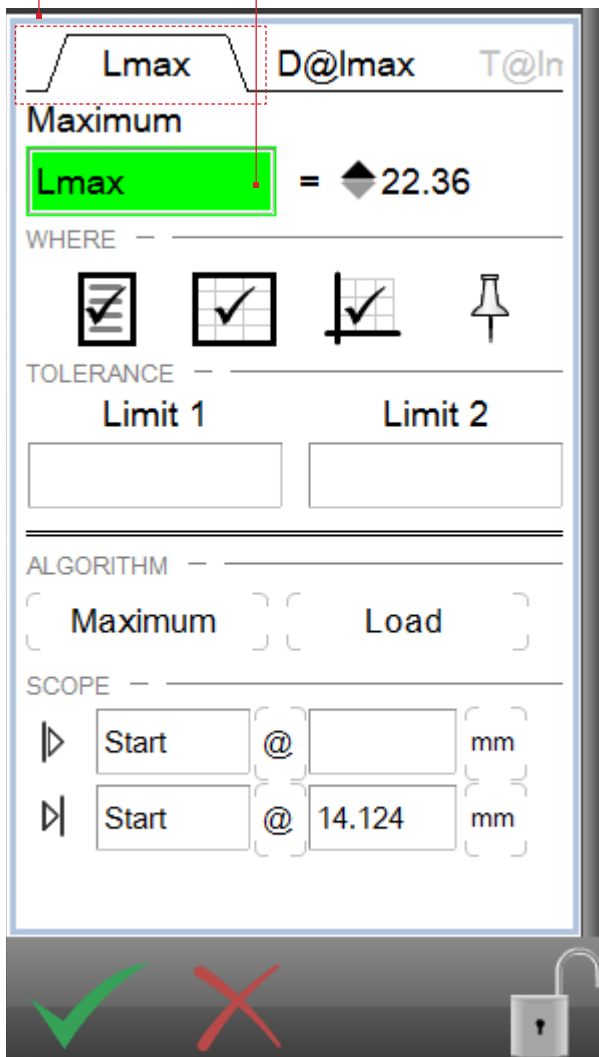
**NOTE**

Coefficient names may be up to 16 characters in length using alpha, numeric and space characters.

*The tab is used to select the active coefficient. Lmax is shown as the active coefficient for editing.*

*Coefficients have default names.*

*You may rename the coefficient using up to 15 character spaces.*



*L2 Plus Data Definition menu  
Rename your coefficient*

### 3.4.1.3 Display Coefficient Where Options

Coefficients can be display in the following views:

- Result view
- Full Graph view
- Data view
- Split Graph view

You specify where you want your coefficient to display using the WHERE function in the Data Definition.

#### Display on Result view

Select the Result symbol in the Data Definition menu for the displayed coefficient. This coefficient will display on the Results view.

#### Display on Data views

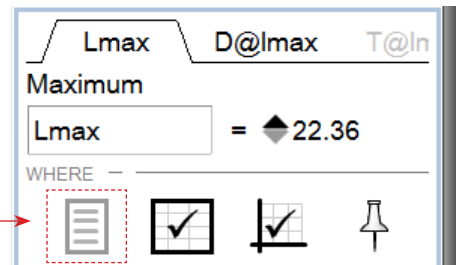
Select the Data symbol in the Data Definition menu for the displayed coefficient. This coefficient will display on the Data view and in the Split Graph view.

#### Display on a Graph

Select the Graph symbol in the Data Definition menu for the displayed coefficient. This coefficient will display on the Full Graph and the Split Graph views.

#### Pin Marker

When selected, the pin symbol causes the marker that displays the coefficient on the graph views to automatically be positioned. The marker is positioned in a “best fit location” so not to obscure other markers or the graph trace.



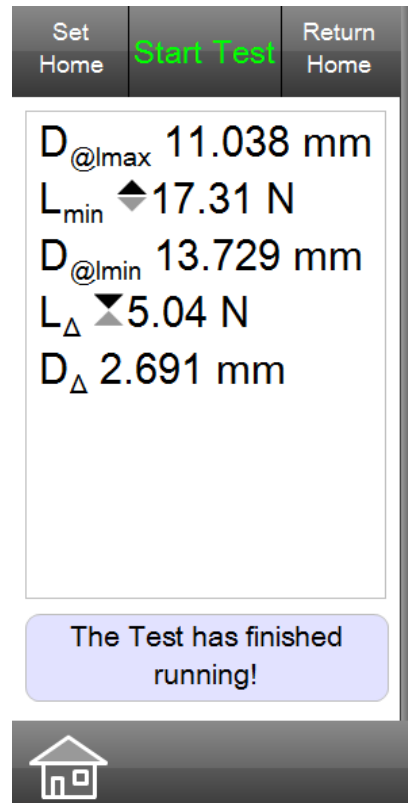
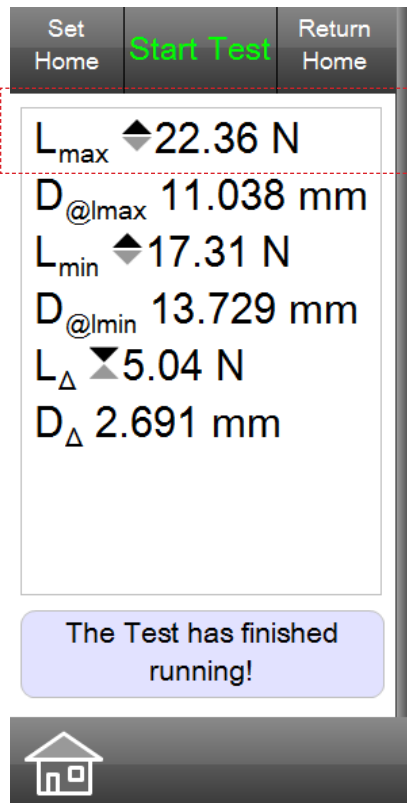
Display on Results View

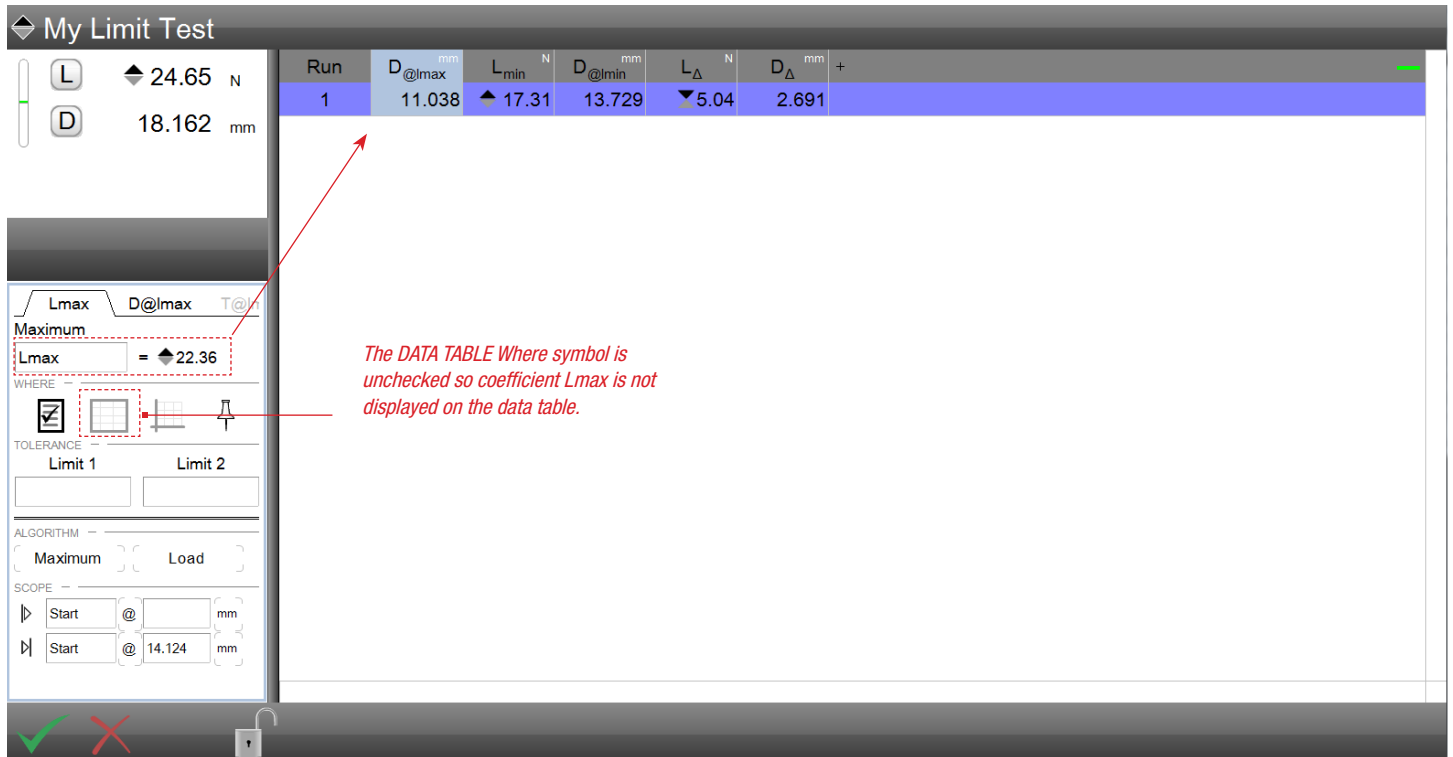
Display on Graph Views

Display on Data Views

*This shows coefficient Lmax displayed in Results view.*

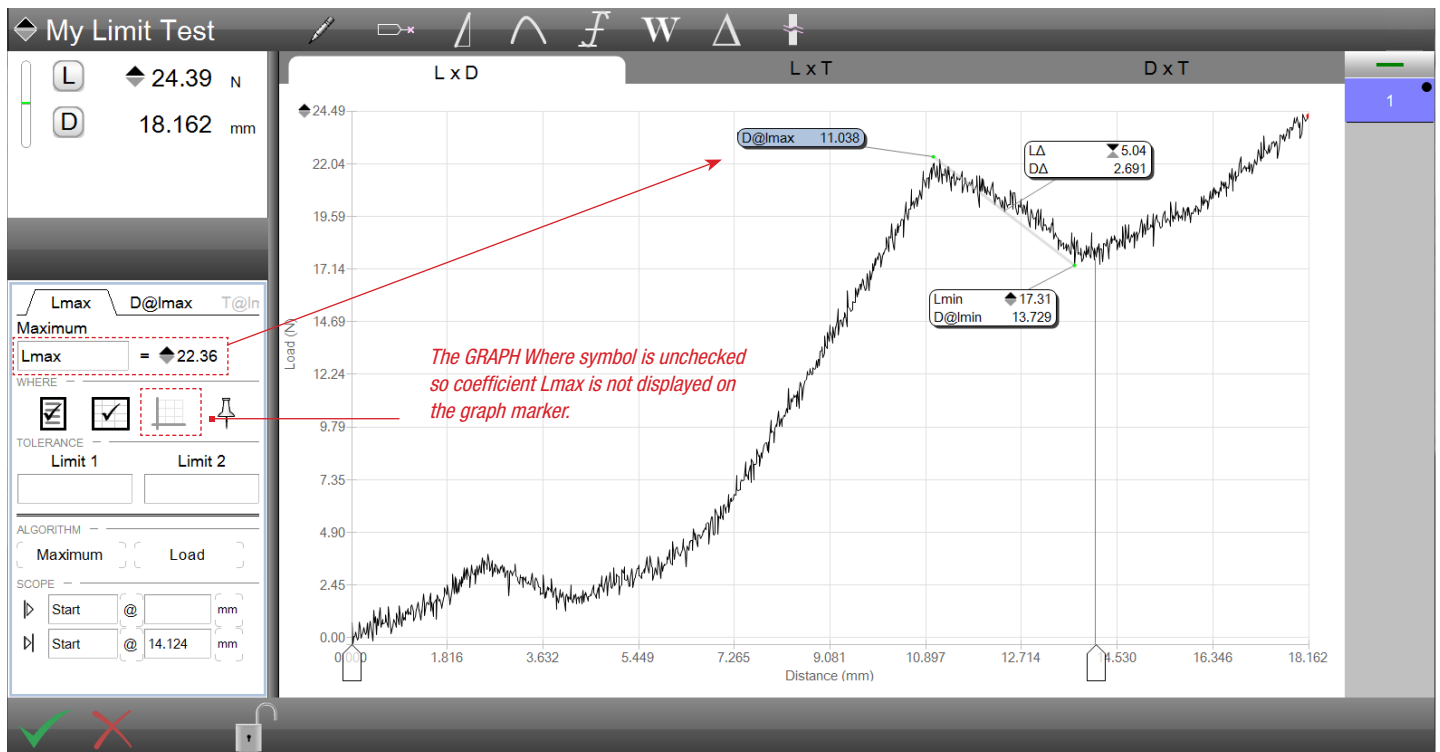
*If the WHERE function for the Results view is “unchecked”, the Lmax coefficient is NOT displayed (see the adjacent view). Lmax is not displayed.*





The DATA TABLE Where symbol is unchecked so coefficient Lmax is not displayed on the data table.

L2 Plus Full Data view  
Shows coefficient Lmax not being displayed in the table



The GRAPH Where symbol is unchecked so coefficient Lmax is not displayed on the graph marker.

L2 Plus Full Data view  
Shows coefficient Lmax not being displayed in the marker on the graph



### 3.4.1.4 Applying a Tolerance to a Coefficient

You may use the Tolerance option to establish a “pass or fail” metric for each coefficient.

When you set a Tolerance, you create a range within your data. When the coefficient is located within this range, the coefficient is viewed as a “pass” and displays in black text.

A “failed” result will display in red wherever the coefficient is displayed denoting that the result is “outside” the tolerance range.



**NOTE**

When a tolerance range is created, any result that equals the limits of the range or that reside within the range established by the two limits is views as a “pass” and displays in black text.

You set a tolerance range by entering the values for the Limit 1 and Limit 2. These values use the units of measure for the coefficient that is being defined.



**NOTE**

When using limits, the limit values are considered “pass” results. If the result equals the limit value, the result is a “pass” and the coefficient displays in black text.

When a tolerance is used, the Data view also displays a Tendency bar. The Tendency bar displays the coefficient and symbolizes where the result is relative to the tolerance- high side or low side of the tolerance limit range.

*L2 Plus Tolerance Setup  
For coefficient D@lmax*

Lmax / **D@lmax** / T@ln

**Maximum**  
D@lmax = 11.038

WHERE —

TOLEANCE —

Limit 1                      Limit 2

**12.000**                      12.250

---

ALGORITHM —

[ Maximum ]                      [ Load ]

SCOPE —

▶ Start @ [                      ] mm

▶ Start @ 14.124 mm

✓    ✗

**My Limit Test**

L 23.76 N  
D 18.162 mm

Set Home    Start Test    Return Home

L<sub>max</sub> 22.36 N  
D@lmax 11.038 mm  
L<sub>min</sub> 17.31 N  
D@lmin 13.729 mm  
L<sub>Δ</sub> 5.04 N  
D<sub>Δ</sub> 2.691 mm

The Test has finished running!

Run	D@lmax mm	L <sub>min</sub> N	D@lmin mm	L <sub>Δ</sub> N	D <sub>Δ</sub> mm	
1	11.038	17.31	13.729	5.04	2.691	—

Coefficient D@lmax has a tolerance range between 12.000mm and 12.250mm.  
Since the measured result for D@lmax is 11.038mm, the coefficient is displayed in red indicating an out-of-tolerance result.

L2 Plus Point Options Load x Distance

### 3.4.1.5 Coefficient Algorithms

All coefficients have algorithms. The algorithm is the method used to calculate a result for that coefficient. Select the algorithm option box to scroll thru the various methods that are available for your coefficient.

Each coefficient and each algorithm available for that coefficient are described in detail in the following sections.

Algorithms are discussed in more detail in the following sections.

Data Type	Algorithm	Variable
AVERAGE	Average	Load
	Average	Distance
DELTA	Delta	Load
	Delta	Distance
MINIMUM	Minimum	Load
	Minimum	Distance
MAXIMUM	Maximum	Load
	Maximum	Distance
PEAK	Numbered	Load
	Numbered	Distance
	Minimum	Load
	Minimum	Distance
	Count	Load
	Count	Distance
	Average	Load
	Average	Distance
POINT	Limit	Load
	Limit	Distance
	Limit	Time
	Slope Intersect	Load
	Slope Intersect	Distance
SLOPE	Slope Fit	Load/Distance
	Maximum Slope	Load/Distance
	Slope Tangent	Load/Distance
	Slope Two Point	Load/Distance
VALLEY	Numbered	Load
	Numbered	Distance
	Minimum	Load
	Minimum	Distance
	Count	Load
	Count	Distance
	Average	Load
Average	Distance	
WORK	Work	Load/Distance

*L2 Plus Algorithm Types*

### 3.4.1.6 Scoping a Coefficient

Scoping is the amount of data that you define that you want to use to determine your result. Scoping allows you to define the entire test data or a segment of the test data based on a Start, Finish, or another coefficient within your results.

Scoping is best performed as a post test data analysis feature where you can report results from within all of the raw data acquired for a step from your graph.

For example, suppose you create a test setup using a tension to distance step. Your distance limit is 10 inches. Normally, you would report the load at 10 inches using the Load (L) coefficient. During this test, the system acquired all of the time-based raw data for load and distance from the Start Test event to the End Test event (10 inch limit). Suppose you wanted to know the load at 250mS after the start of your test or 5 seconds from the end of the test? Suppose you wanted to know the load values at 2 inch, 4 inch, 6 inch or 8 inch? Suppose you wanted to know the distance at 5 lbf? Scoping can be used to answer each of these questions.

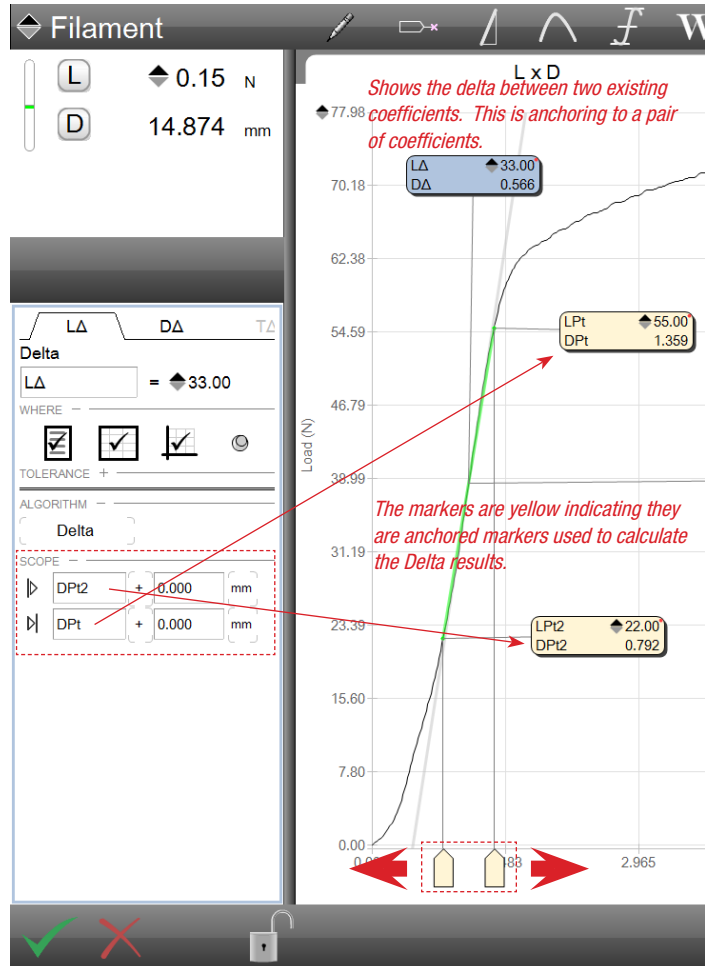
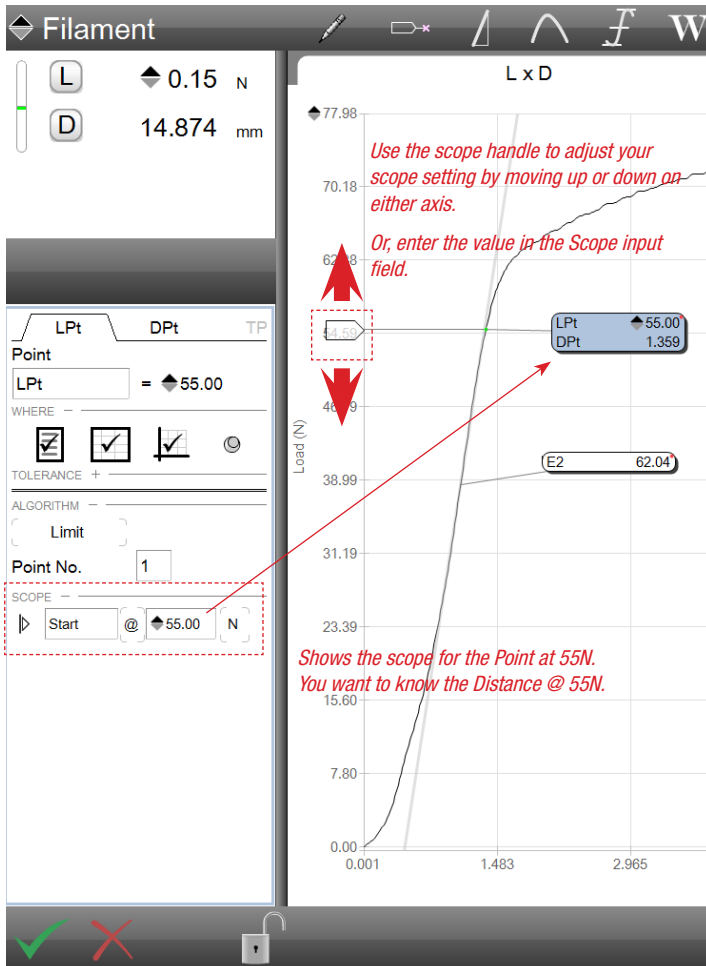
When a result or step is collecting data, the data is collected at the start of the result or step until the result's or step's conclusion. The data collected during a result or step forms an array of data: load/stress, distance/strain, and time.

Scoping has three operators that may be used:

Operator	Description
@	Use the @ sign to request the data at a specific location or reference.
+	The + sign uses the data AFTER this particular location or anchored reference.
-	The - sign uses the data BEFORE this particular location or anchored reference.

#### Scope Operators

When anchoring is used, you can measure a result using the + (after) or - (before) scoping operator. Anchoring is where you select an existing result on your graph trace for the purposes of measuring from this reference point. For example, you may want to measure the load, stress, distance or strain 100mS after the maximum tensile strength. Using scoping, you would first specify the maximum result using the Min/Max/Avg tool. Next, you would select the Point tool. When the Point tool is launched and the scope handle appears on the graph, you move the scope handle until it anchors to the maximum result. When anchoring occurs, the marker for the anchored result turns yellow in color. Then using the Data Definition menu for the new point target (100mS), you specify that using the + operator with a value of 100ms (0.01 S.s). The new marker for the point is generated and appears on the graph.



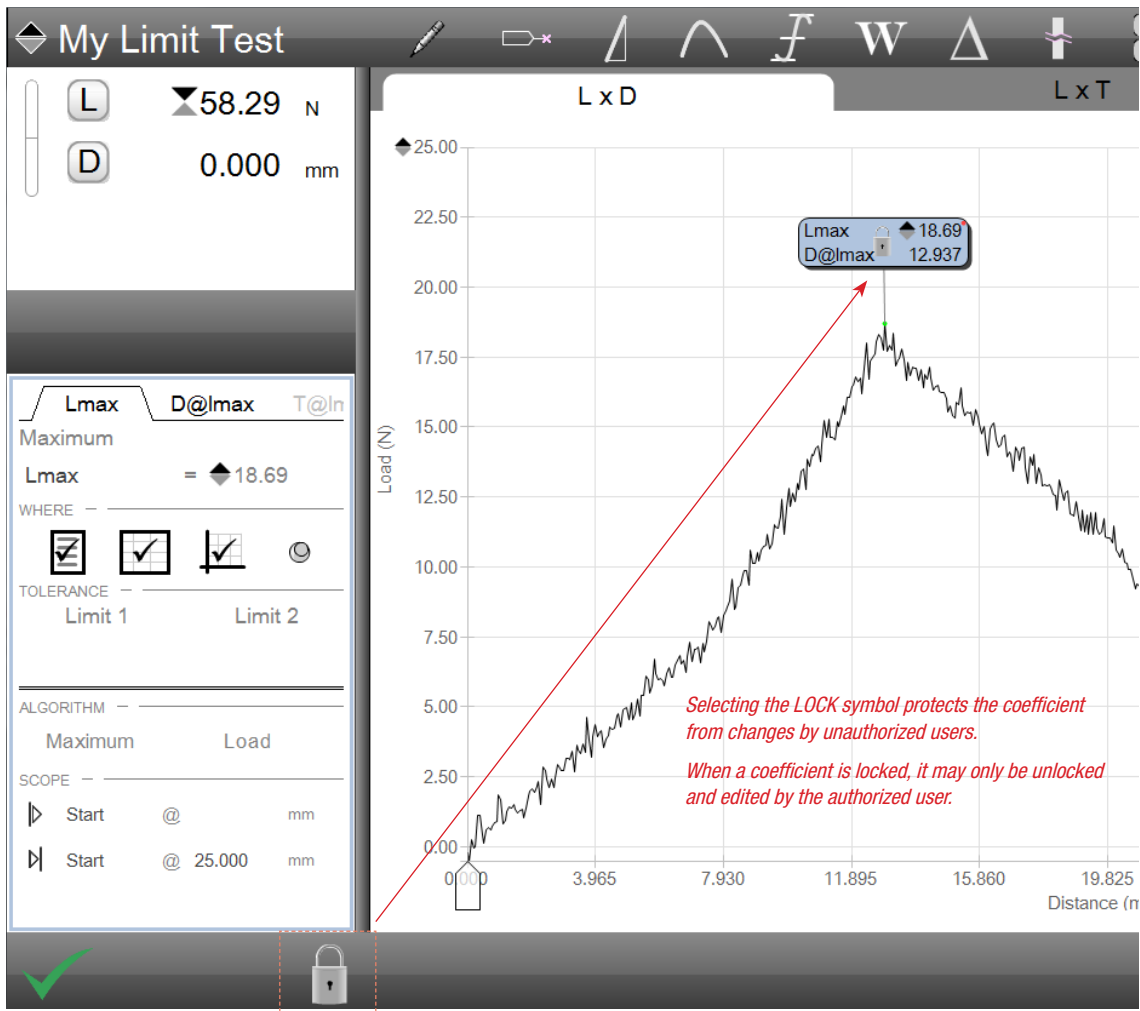
L2 Plus Scoping Examples  
Scope on a Point (left) and Scope using two existing Coefficients called anchors (right)

### 3.4.1.7 Locking a Coefficient

You may lock a coefficient using the Lock symbol. When you lock a coefficient, you prevent that coefficient from accidentally being deleted. When a coefficient is locked, the delete function (X) is removed and the marker is designed with a lock symbol.

To lock a coefficient, go to the Data Definition menu for the coefficient, select the coefficient to be locked and select the lock symbol.

To unlock a coefficient, go to the Data Definition menu for the coefficient that is locked and select the lock symbol.



L2 Plus Locked Coefficient

### 3.4.2 Point Coefficient

The Point coefficient is one of the most common coefficients used in L2 Plus. The Point coefficient lets you measure your data stream at a single point resolution.

The Point coefficient corresponds to the Point graph analysis tool. When this tool is used, you may obtain the measured result on a single point based on load, distance or time.

The Point coefficient has two algorithm choices: Limit and Slope Intersect.

Select the Algorithm option box to scroll through the available options for the Point coefficient.

#### 3.4.2.1 Point Limit Coefficient

The Point Limit coefficient lets you measure a single data point on your graph or for your data stream at a single point resolution. The Limit-type algorithm is used when you want to find a point based on a limit, e.g., at a Load Limit, at a Distance Limit, at a Time Limit. The limit is defined by the user.

Associated with the Limit type algorithm is the Point No. (Number).

The Point No. is used to define the “incident” where the point occurs. For example, if the Point No. = 1, the coefficient is finding the first (#1) point where the coefficient appears on the graph trace.

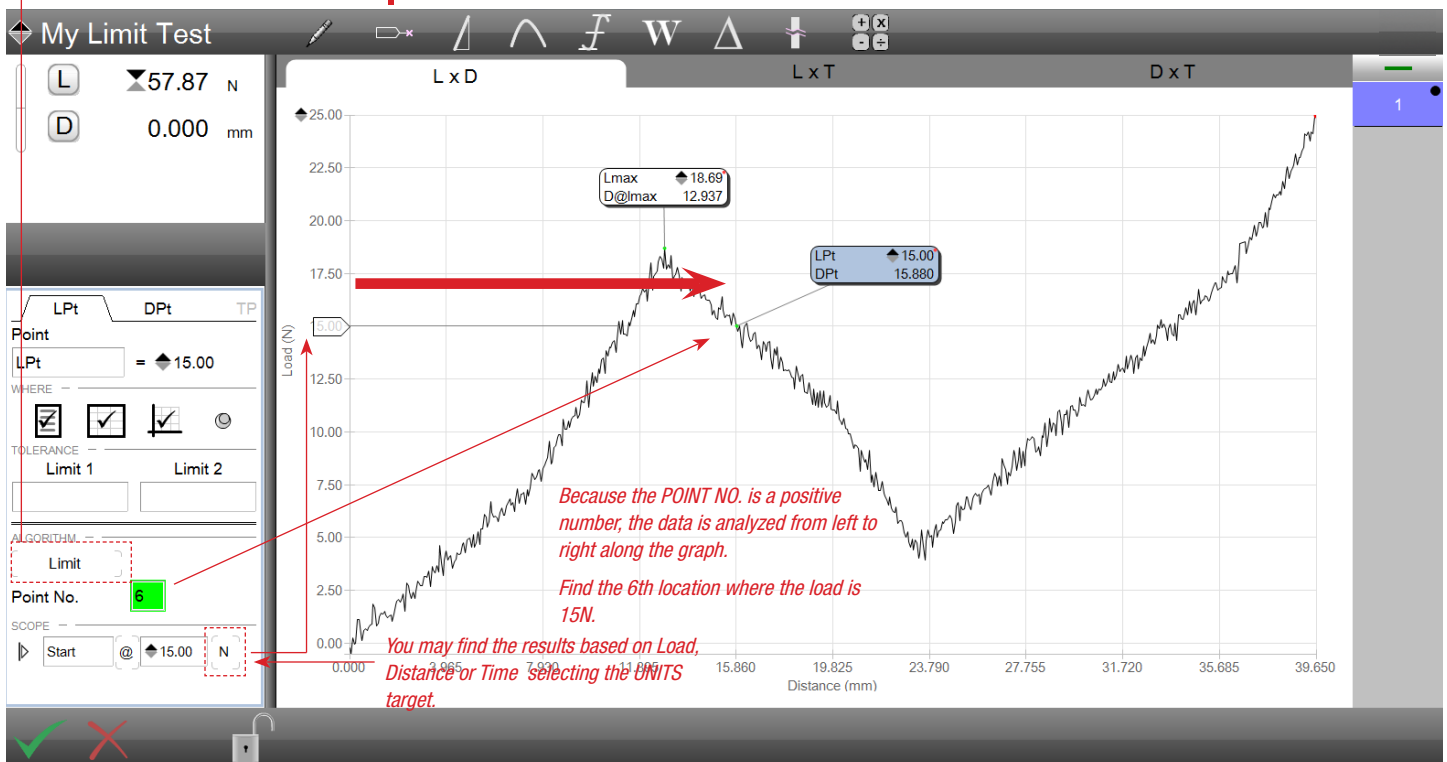
If the Point No. = 2, the coefficient will find the 2nd location where the defined limit appears on the graph trace. If there is no 2nd location, the marker will display XXXXX for values.

When a positive number is used to find a point in the data stream, the search begins at the Start of the test- in the left-most part of the graph trace.

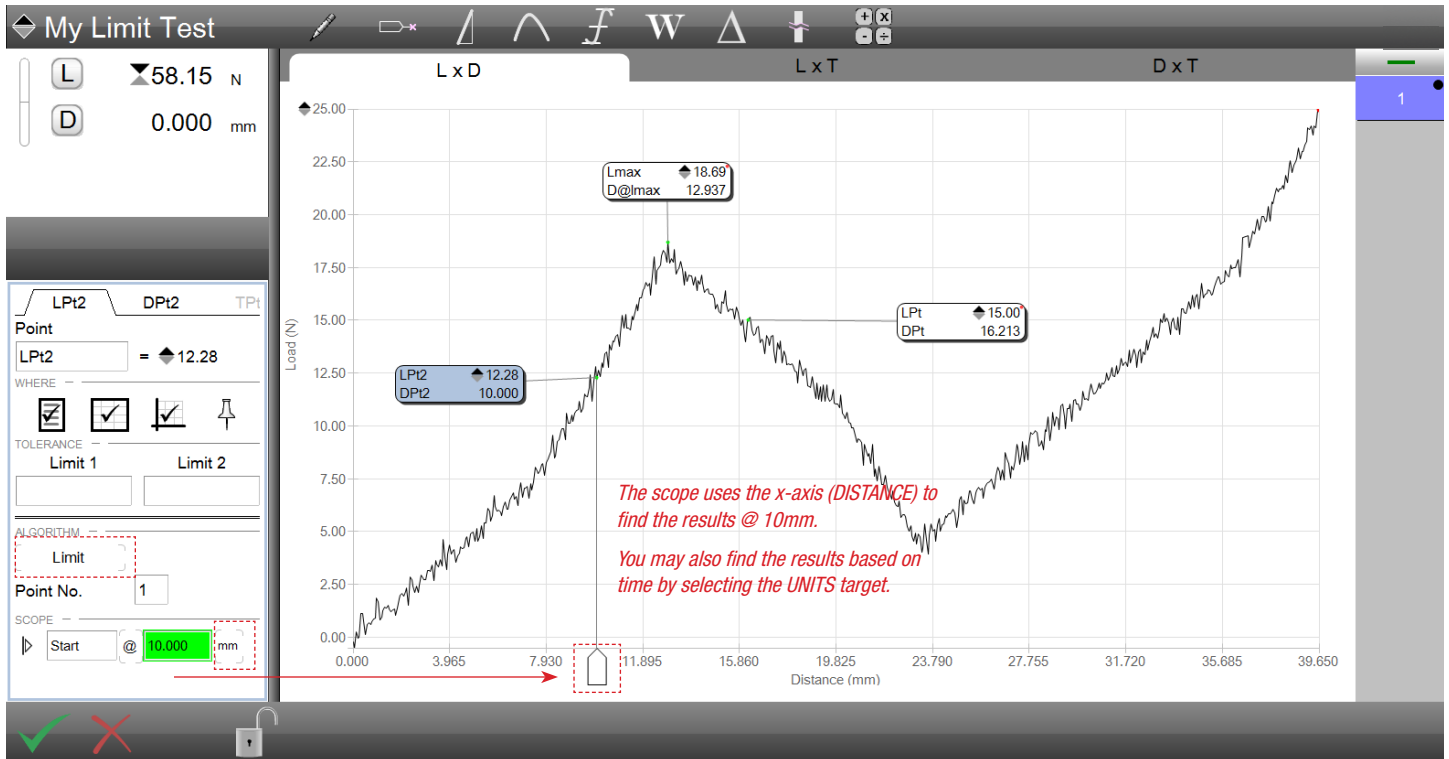
However, if you enter a Point No. = -1 (negative value), the data stream is analyzed from the right-most or Finished end of the test. Data is analyzed from right to left so the Point is identified as the first point from the end of the test.

#### Point Measuring Tools

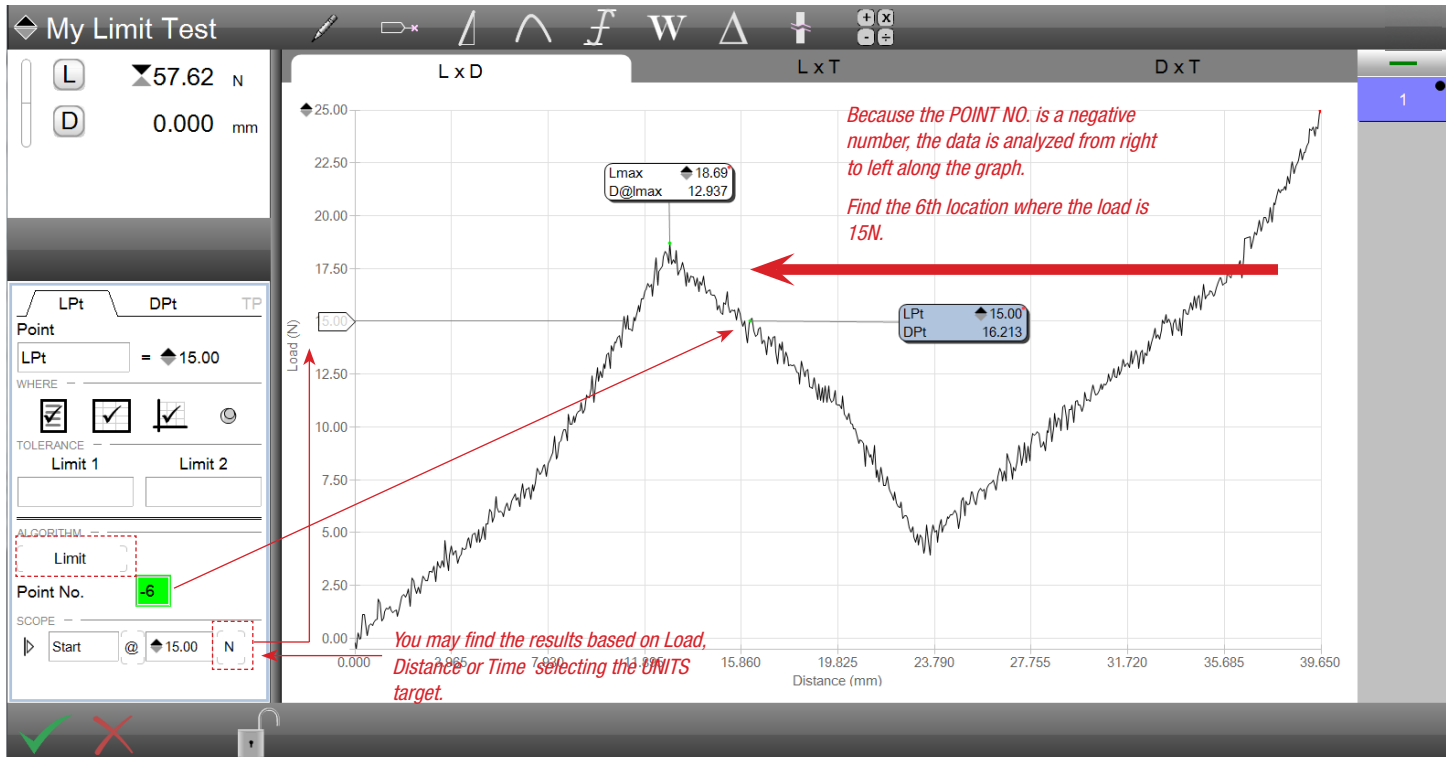
- Point Limit
- Slope Intersect Point



L2 Plus Point Limit Measurement  
Finding the results with a scope @ 15N



L2 Plus Point Limit Measurement  
 Finding the results with a scope @ 10mm



L2 Plus Point Limit Measurement  
 Finding the results with a scope @ 15N using a negative Point No.

### 3.4.2.2 Point Slope Intersect Coefficient

The Point Slope Intersect uses the slope you have specified on your graph. The slope must be determined first before you can specify a point using the Slope Intersect algorithm.

Slope intersect can be used on an extension spring, as an example, to determine the initial tension of the spring.

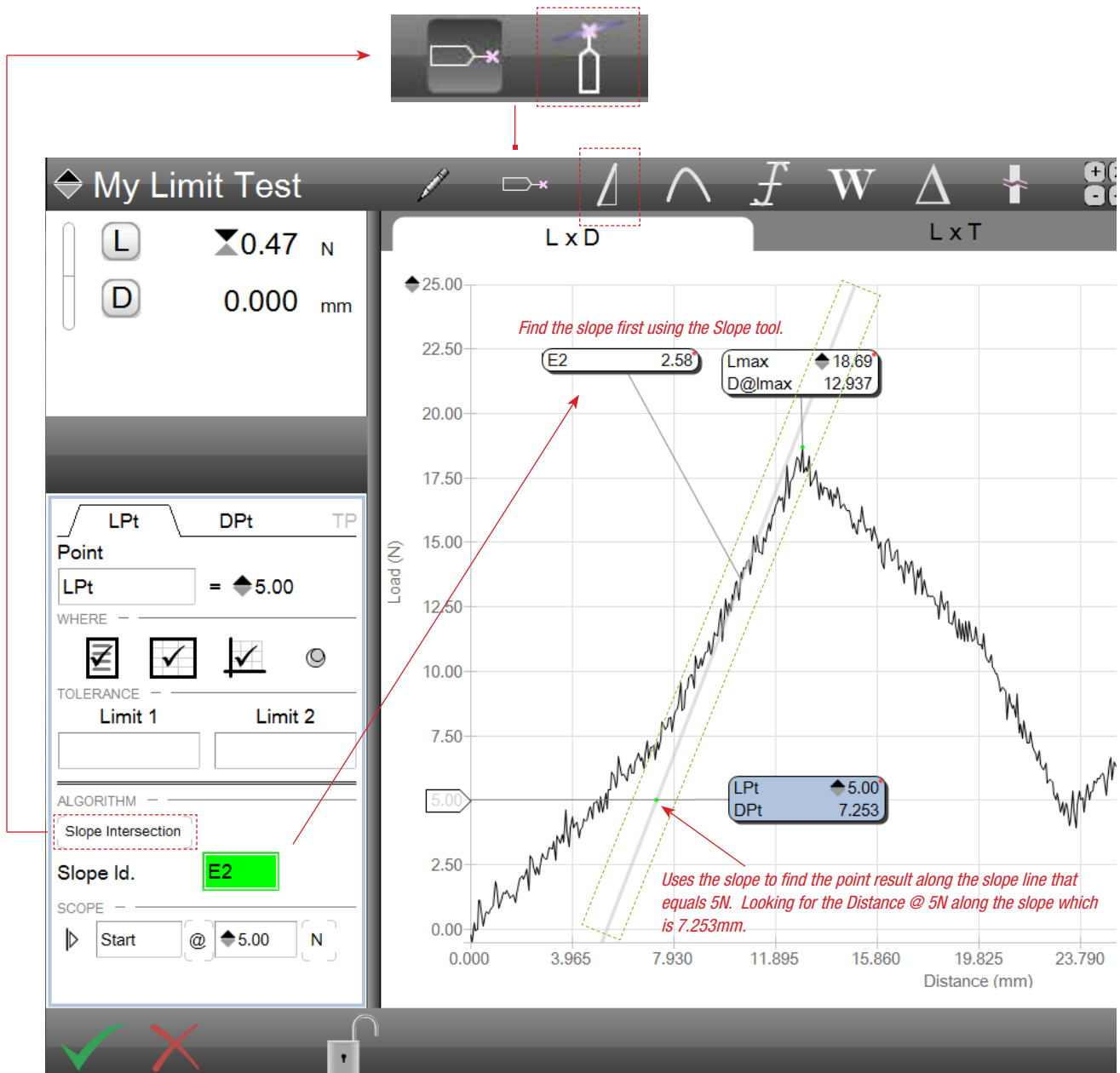


**NOTE**

Find the slope first using the Slope tool, before measuring using the Slope Intersect point.

*Point Measuring Tools*

- *Point Limit*
- *Slope Intersect Point*



L2 Plus Point Slope Intersect Measurement  
Finding the results with a scope @ 5N along the slope line associated with coefficient E2

### 3.4.3 Modulus/Slope Coefficient

Slope, also called Modulus in some industries, is used in load-distance applications in determining elastic or rate. The L2 Plus Series software offers four methods for determining modulus/slope:

- Slope Fit
- Maximum Slope
- Slope Tangent
- Slope Two-Point (Segment Slope, Chord Slope, Secant Slope)

Each of these are described in the following sections.

#### 3.4.3.1 Slope Auto Fit Coefficient

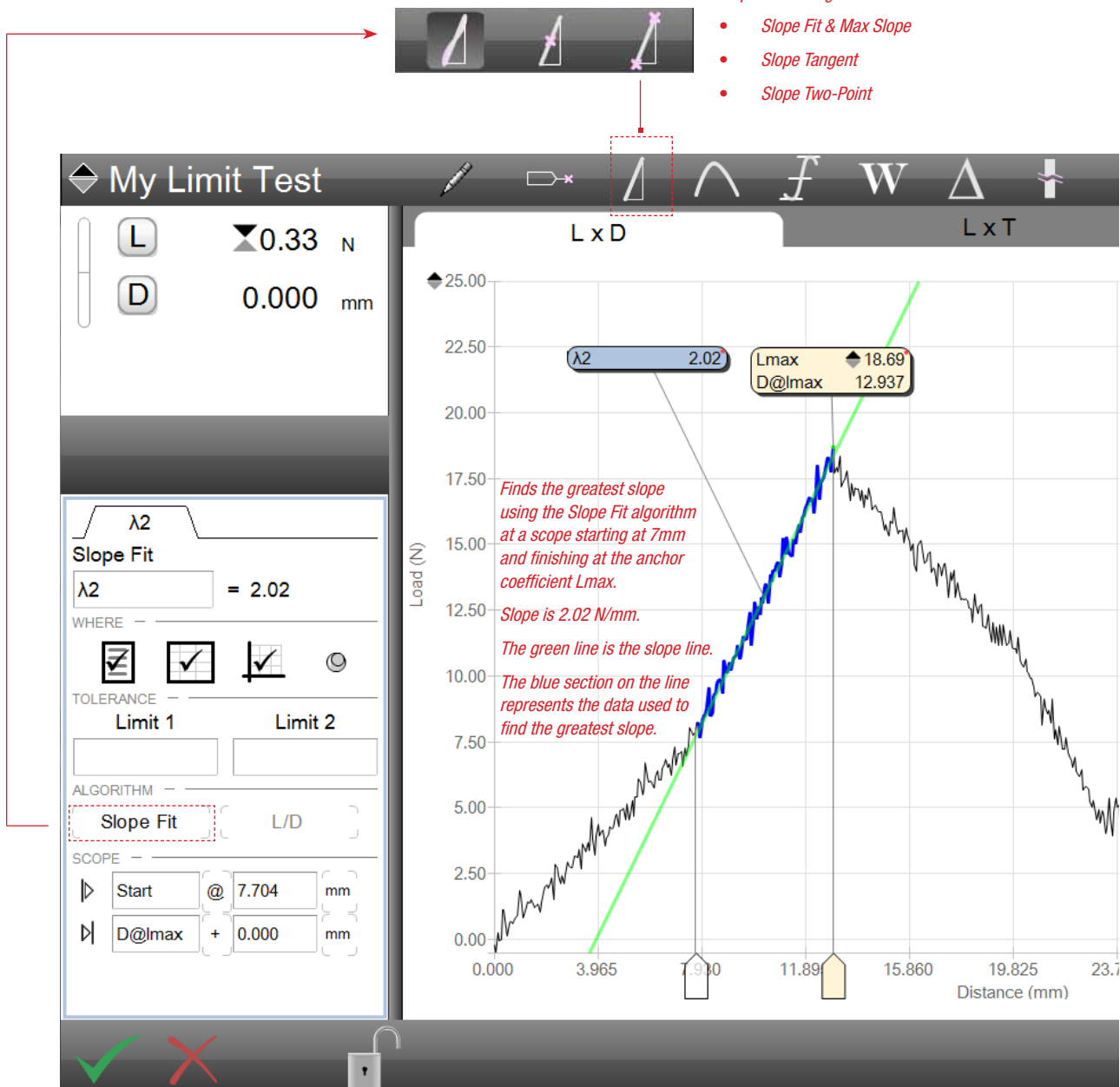
The Slope Fit coefficient for modulus/slope is a quick method that finds the slope on your load-distance graph using an automatic algorithm.

This algorithm evaluates the data points along the curve and looks at a specified number of segments that together form a straight line segment or modulus.

When you use the Auto Fit algorithm, you first perform your test to obtain your graph. Next, select the Auto Fit algorithm. The scope handles appear at the x-axis and default to the Start and Finish of the test data. You can reposition the scope handles to a particular location on the graph in order to obtain the modulus for that specific line segment.

*Slope Measuring Tools*

- Slope Fit & Max Slope
- Slope Tangent
- Slope Two-Point



L2 Plus Point Slope Fit Measurement  
Finding the results with a scope starting @ 7.04mm and finishing at Dlmax



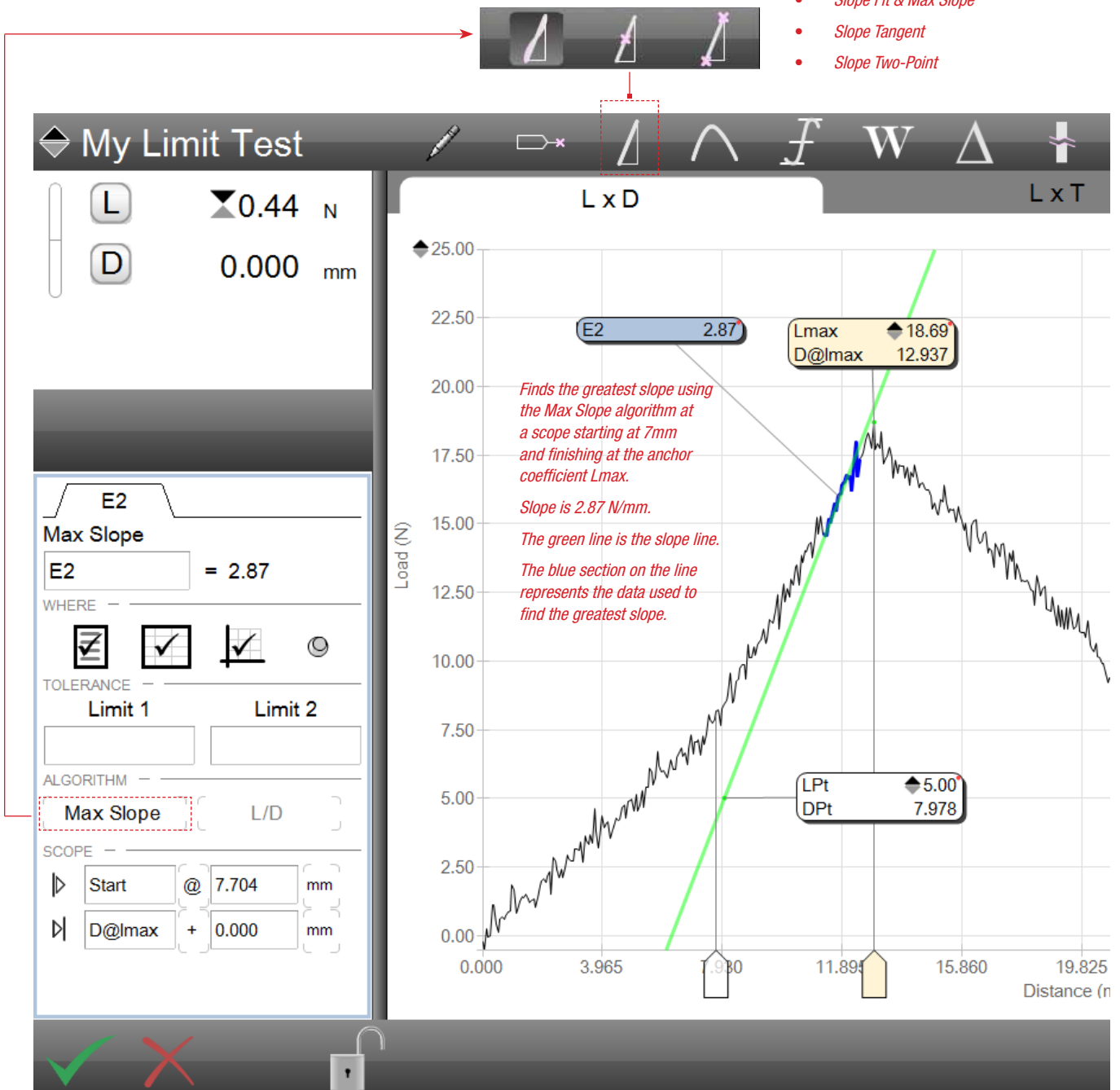
### 3.4.3.2 Maximum Slope

The maximum slope uses the same tool as the Slope Fit algorithm. The Maximum Slope algorithm finds the slope using all of the data within the scope segment. The algorithm uses all of the data and looks for the maximum slope.

The Maximum Slope algorithm differs slightly from the Slope Fit. The Slope Fit uses multiple segments of data and looks for changes within a set number of these segments. The Maximum Slope looks at the data only and doesn't use segmented data.

#### Slope Measuring Tools

- Slope Fit & Max Slope
- Slope Tangent
- Slope Two-Point



L2 Plus Point Maximum Slope Measurement  
Finding the results with a scope starting @ 7.04mm and finishing at Lmax

### 3.4.3.3 Slope Tangent Coefficient

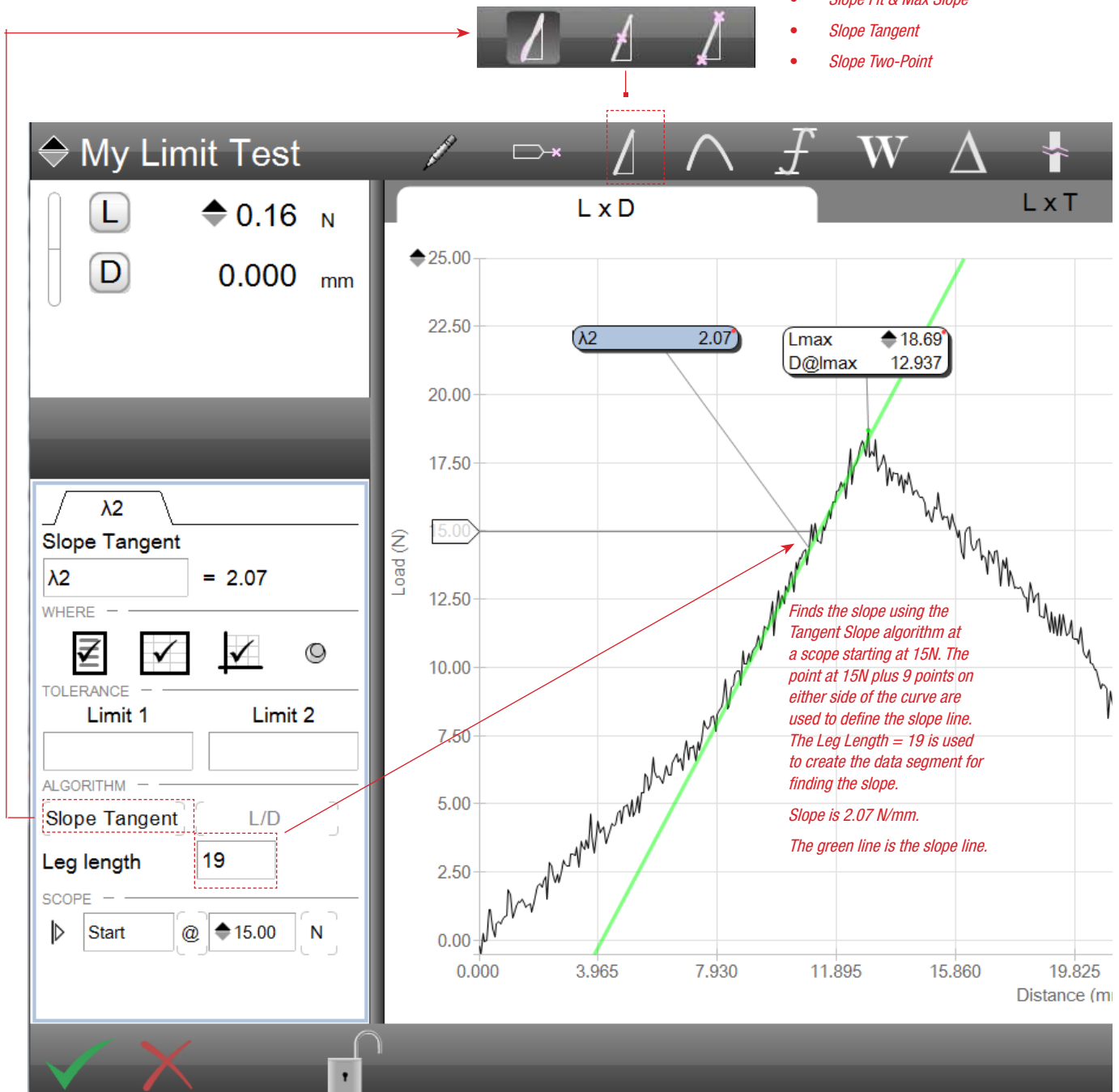
The tangent option lets you find the modulus/slope using a point on the graph and a line segment drawn that is tangent to this point.

And because you cannot draw a slope based on a single point, the tangent option includes an attribute called Leg Length.

The Leg Length value is the number of data points on either end of the point you specified. Using these extra data points, a line segment can effectively be drawn in order to create a tangent line segment and resulting modulus.

*Slope Measuring Tools*

- Slope Fit & Max Slope
- Slope Tangent
- Slope Two-Point



L2 Plus Point Tangent Slope Measurement  
Finding the results with a scope starting @ 15N

### 3.4.3.4 Slope Two Point Segment Coefficient

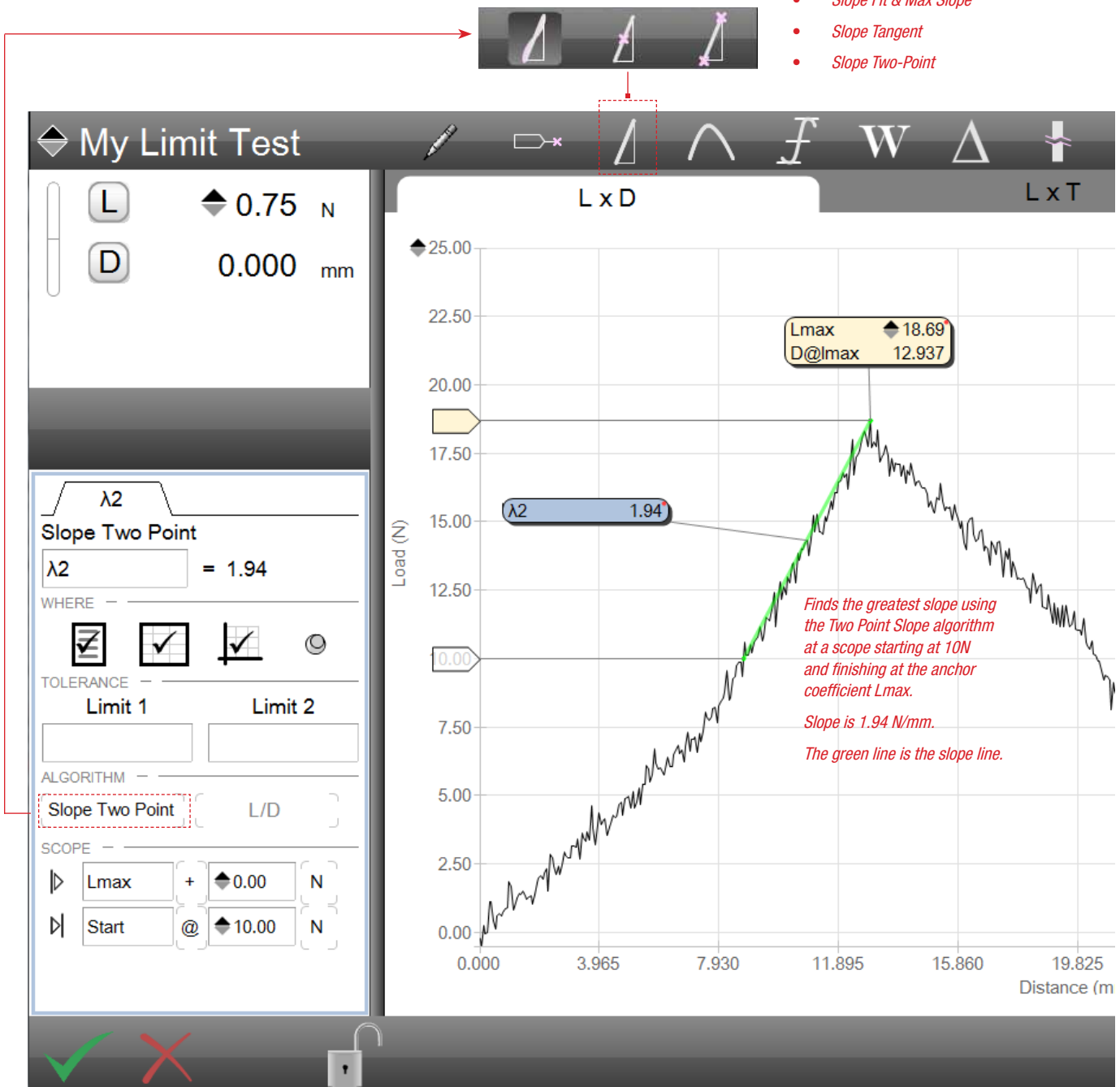
The two point modulus algorithm allows you to construct a modulus line between two points that you specify.

This method is often used and expressed as Chord modulus or Segment modulus where the line is constructed between two data points.

With the two point algorithm, you position the scope handles at the two points representing the Start and Finish positions for the modulus to be drawn between.

#### Slope Measuring Tools

- Slope Fit & Max Slope
- Slope Tangent
- Slope Two-Point



L2 Plus Point Two Point Slope Measurement  
Finding the results with a scope between 10N and Lmax

### 3.4.4 Peak & Valley Coefficients

The Peak & Valley coefficients are used with applications that exhibit a cyclic graph form, such as those found in peel and adhesive testing. The Peak & Valley measurements include finding the maximum peak or the minimum valley; the average of selected peaks/valleys; or just simply finding the number of peaks or valleys based on load sensitivity.

When Peak results are required, you will select above the graph curve. Selecting below the graph curve will deliver valley results.

Sensitivity is used to specify the region that defined a peak or valley. Sensitivity is associated with the load data and is represented as a percent value of the load data for the graph.

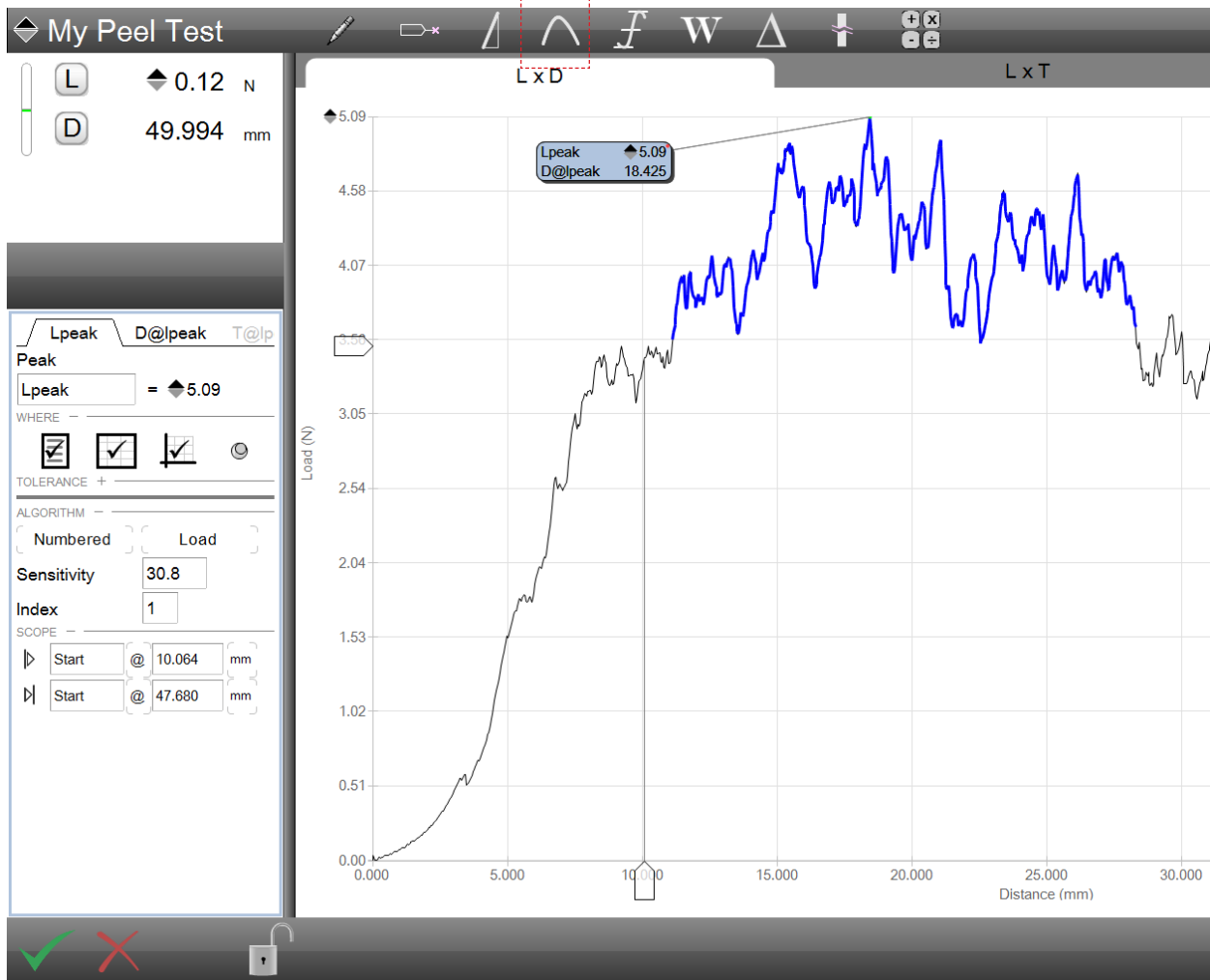
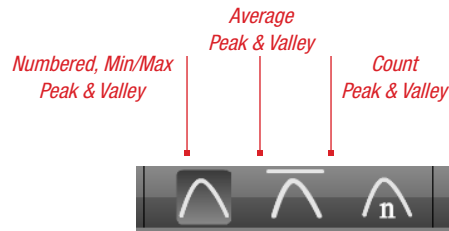
Sensitivity is a percent of the load where the measured load data on either side of the peak or valley are equal to or less than the Sensitivity setpoint. If the Sensitivity = 10, the data stream within the scope range is analyzed and the peak or valley is identified where the load on the incline side of the peak was 10 and the opposite side of the peak was also 10. If the incline side was 10 and the decline side was 9, the data segment would not qualify as a peak or a valley.

Sensitivity is used to evaluate a graph curve and identify the data points within the data stream that increase and decrease at the sensitivity value you are using or at a value greater than the specified sensitivity.



**NOTE**

Load Sensitivity is used to define what qualifies as a peak or a valley. The two sides of the peak or valley must be equal to or less than the Sensitivity setpoint.

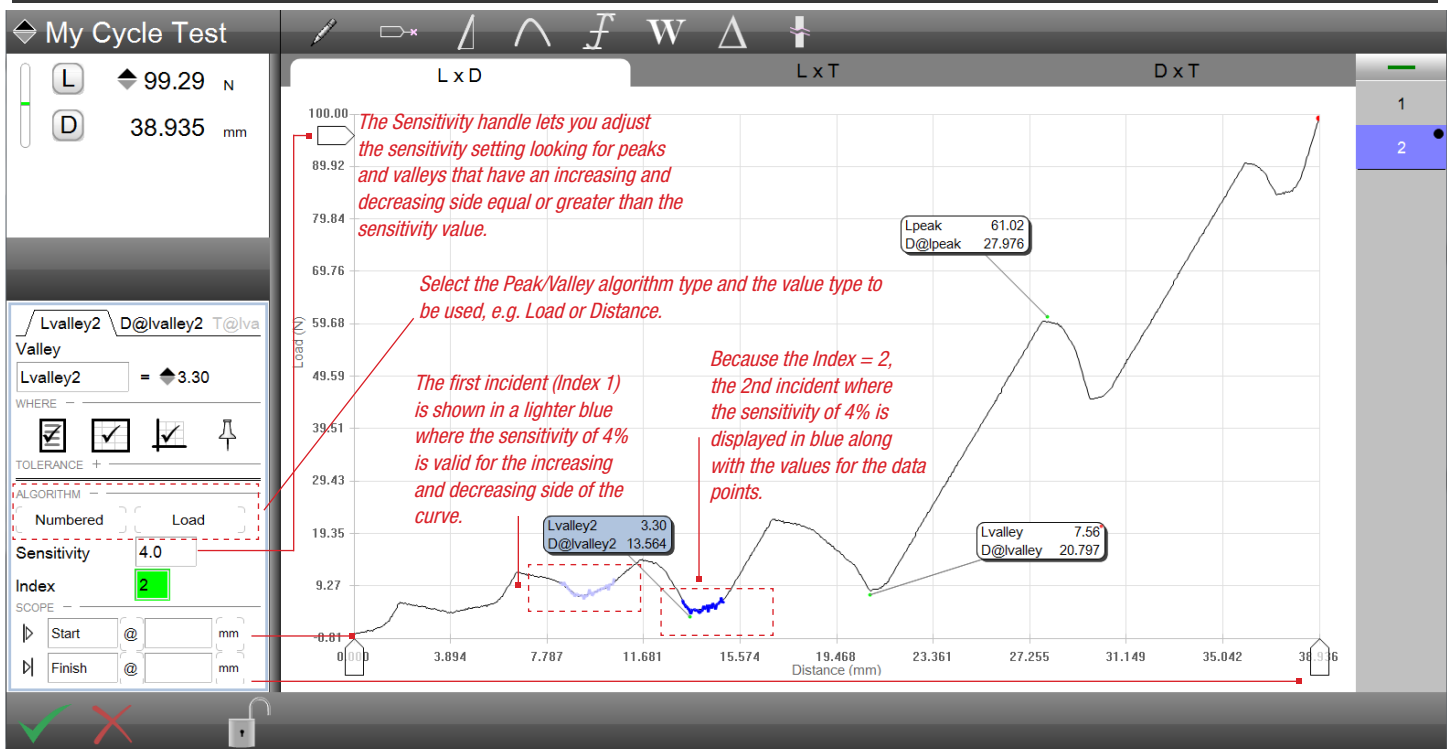
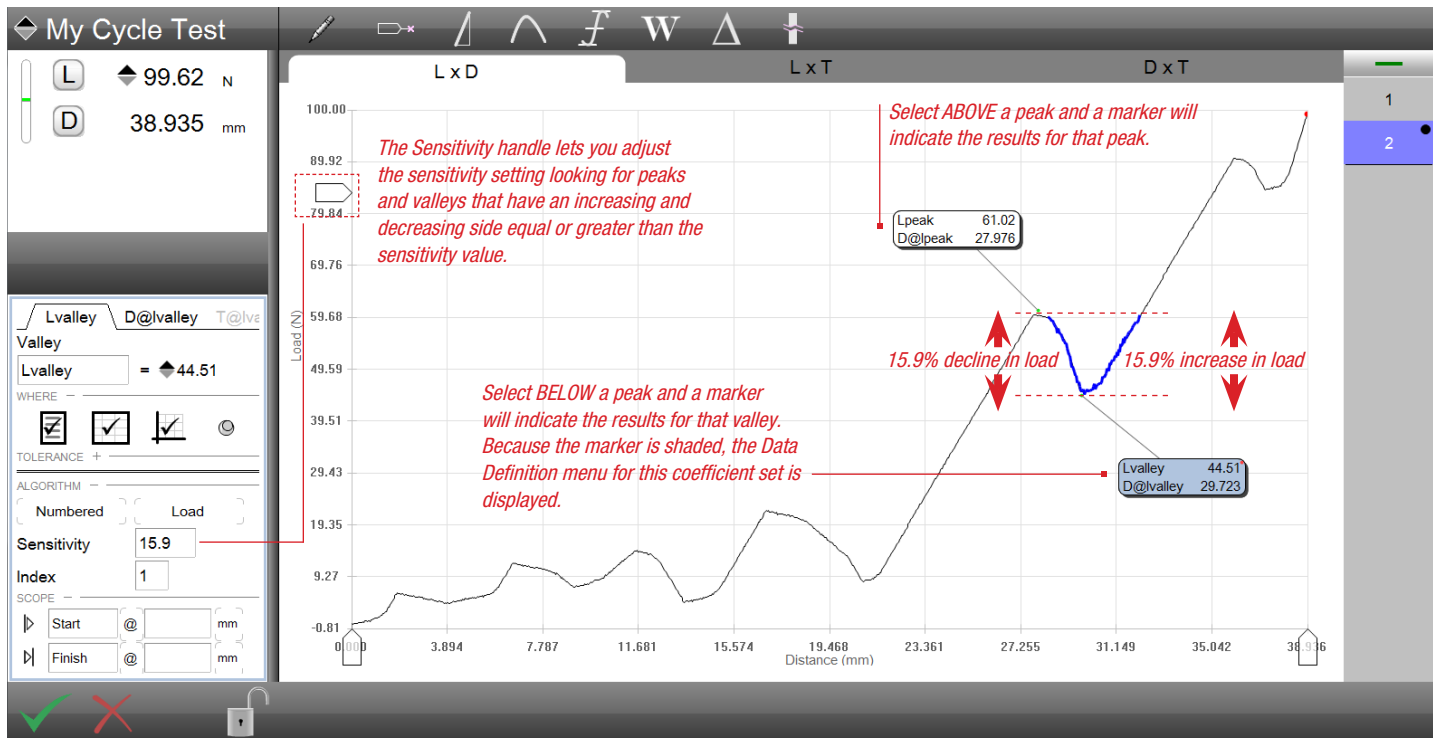


L2 Plus Peak Measurement on an adhesive test

### 3.4.4.1 Numbered Peak/Valley Coefficient

The Numbered Peak/Valley coefficient reports the peak when you select above a peak on the graph or the valley when you select below a valley on the graph.

Use the sensitivity holder to move upward to reduce the sensitivity. When you decrease/increase the sensitivity the L2 Plus Series software will find the peak or valley that meets the sensitivity setting and highlight that location on your graph in blue.



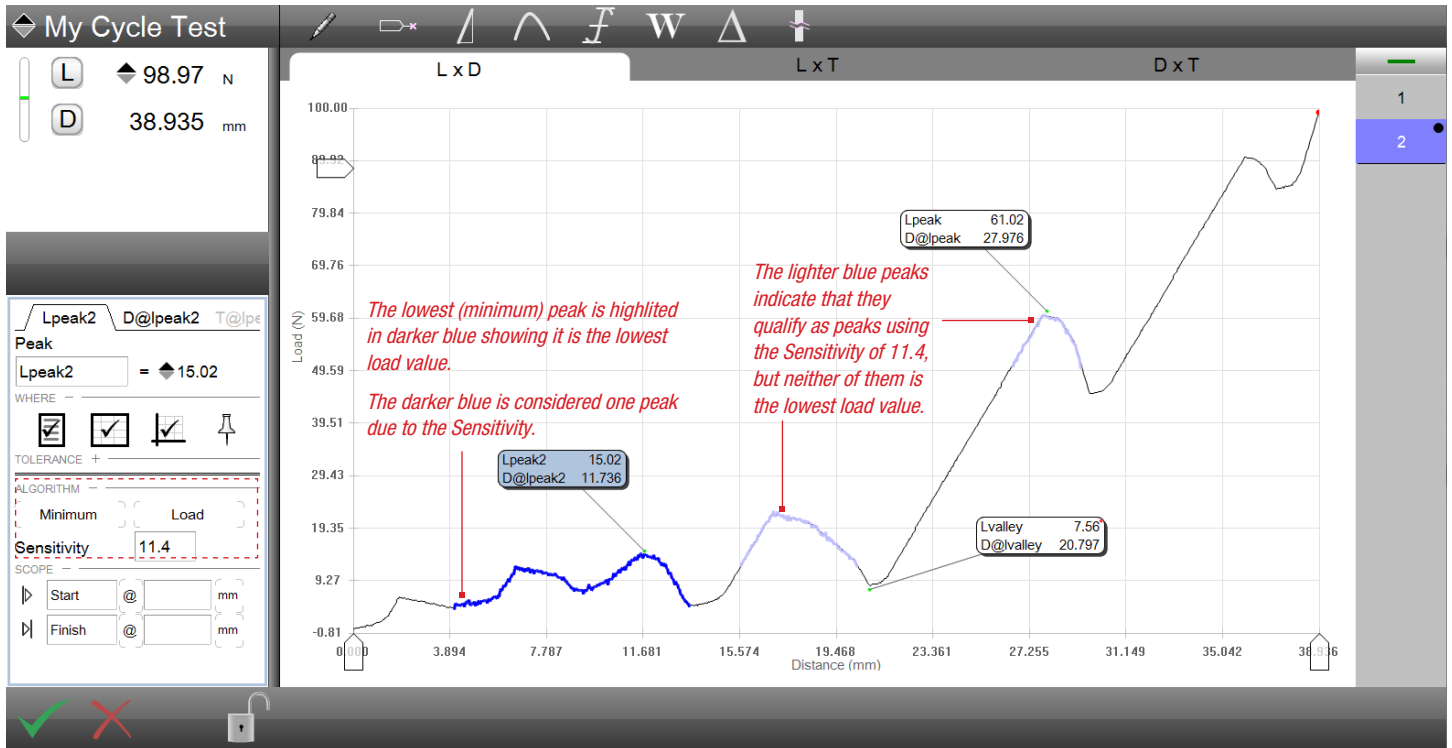
L2 Plus Graph Peak & Valley  
Shows a Numbered Valley with a Sensitivity of 4%

### 3.4.4.2 Peak/Valley Maximum/Minimum Coefficient

This algorithm for peaks & valleys finds all of the peaks or all of the valleys within the scope range you specify for your test that satisfy the sensitivity setting.

Selecting above the graph will display the Minimum results while selecting below the graph will display the Maximum results.

All peaks and all valleys are displayed when using this algorithm.



L2 Plus Graph Peak & Valley Shows Minimum and Maximum Peaks

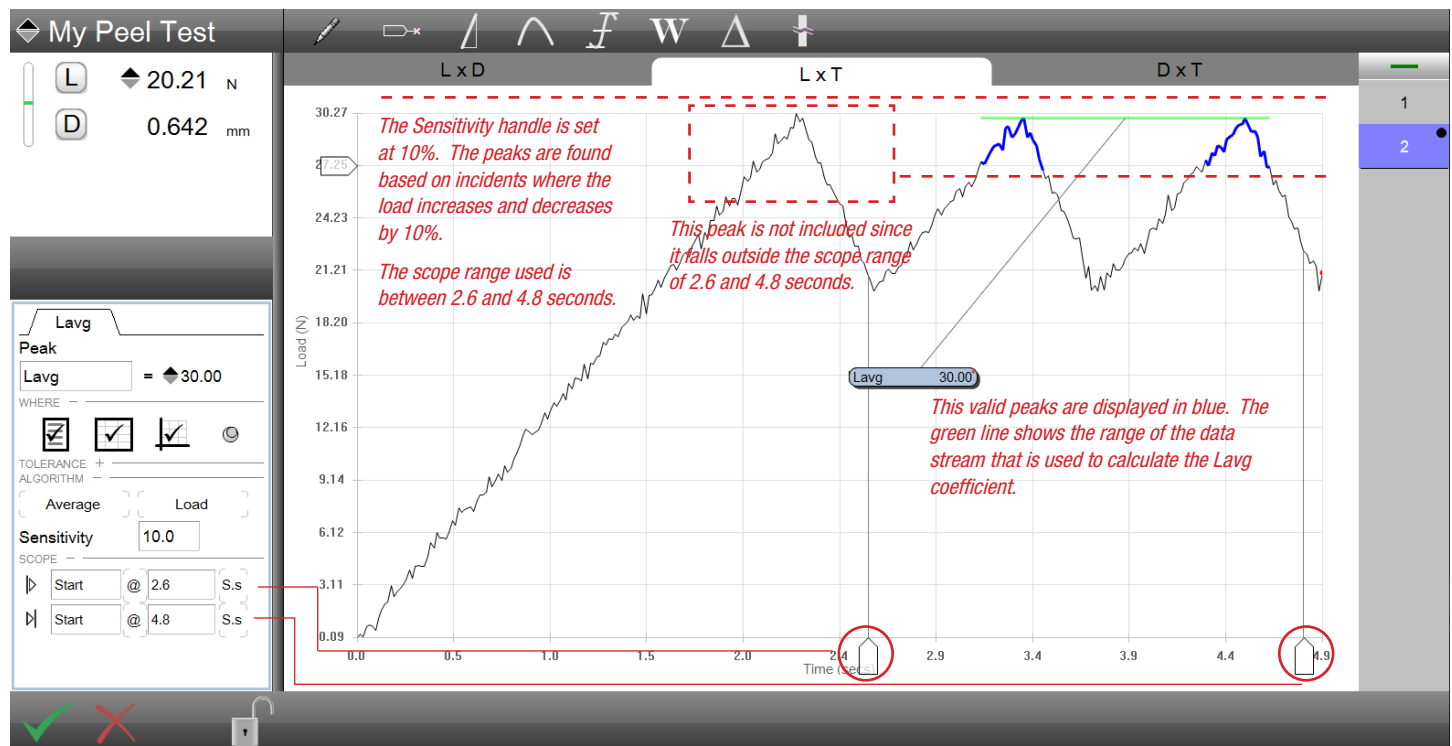
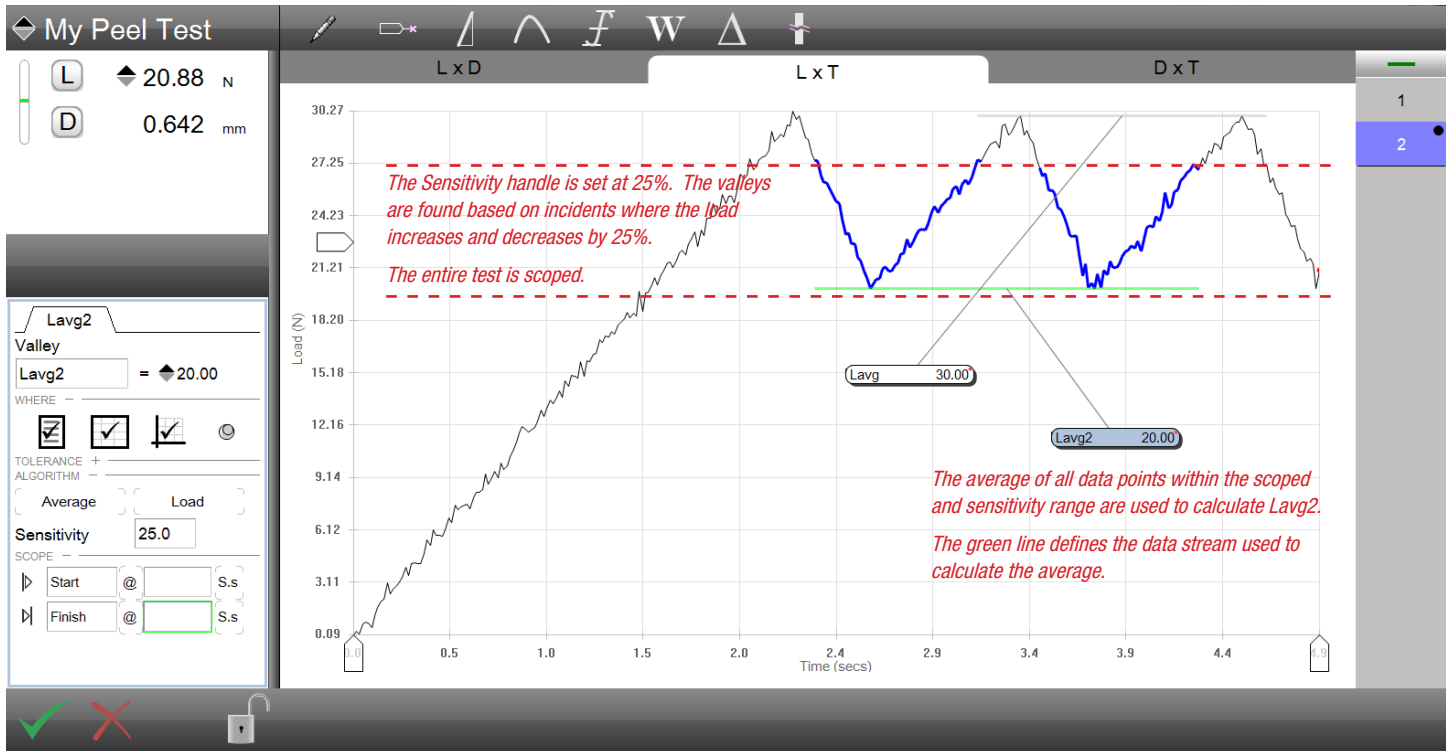
### 3.4.4.3 Peak/Valley Averaging Coefficient

The Averaging coefficient for peaks and valleys lets you find the average load, stress, distance or strain for all peaks and valleys or for peaks and valleys within a range.

For example, you may get the average load of all peaks within a peel test graph, or specify the average of selected peaks within the data stream of your test.

Above  
L2 Plus Peak & Valley test showing Average Valleys

Bottom  
L2 Plus Peak & Valley test showing Average Peaks

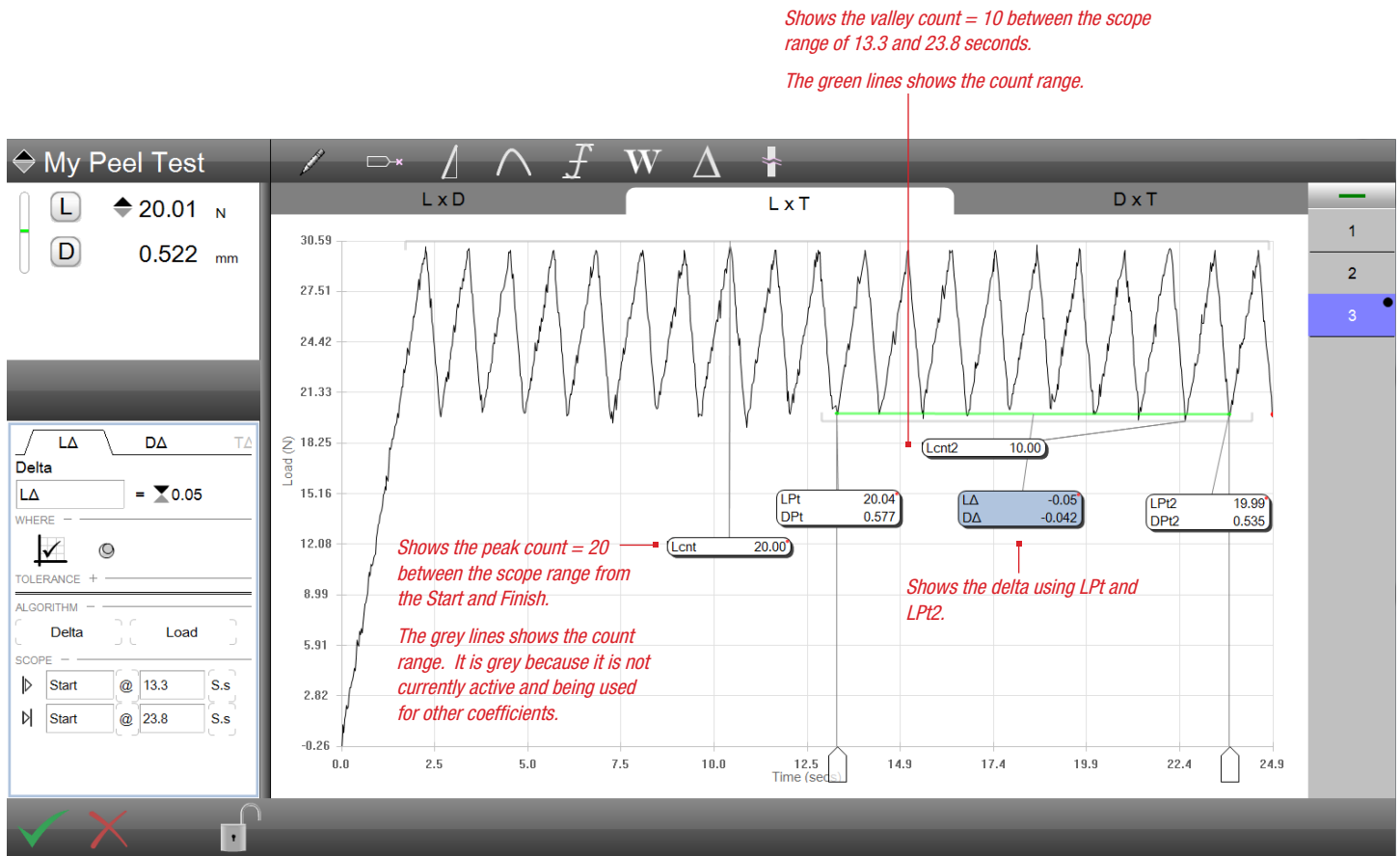


### 3.4.4.4 Peak/Valley Count Coefficient

The Count coefficient counts the number of peaks or valleys within your test or within your specified scope range.

Sensitivity is used to define what is classified as a peak or a valley.

You can use the peak or valley numbers as anchors to calculate delta or averages. For example, you may want to calculate the delta in load between the first peak and the 10th peak within your test range.



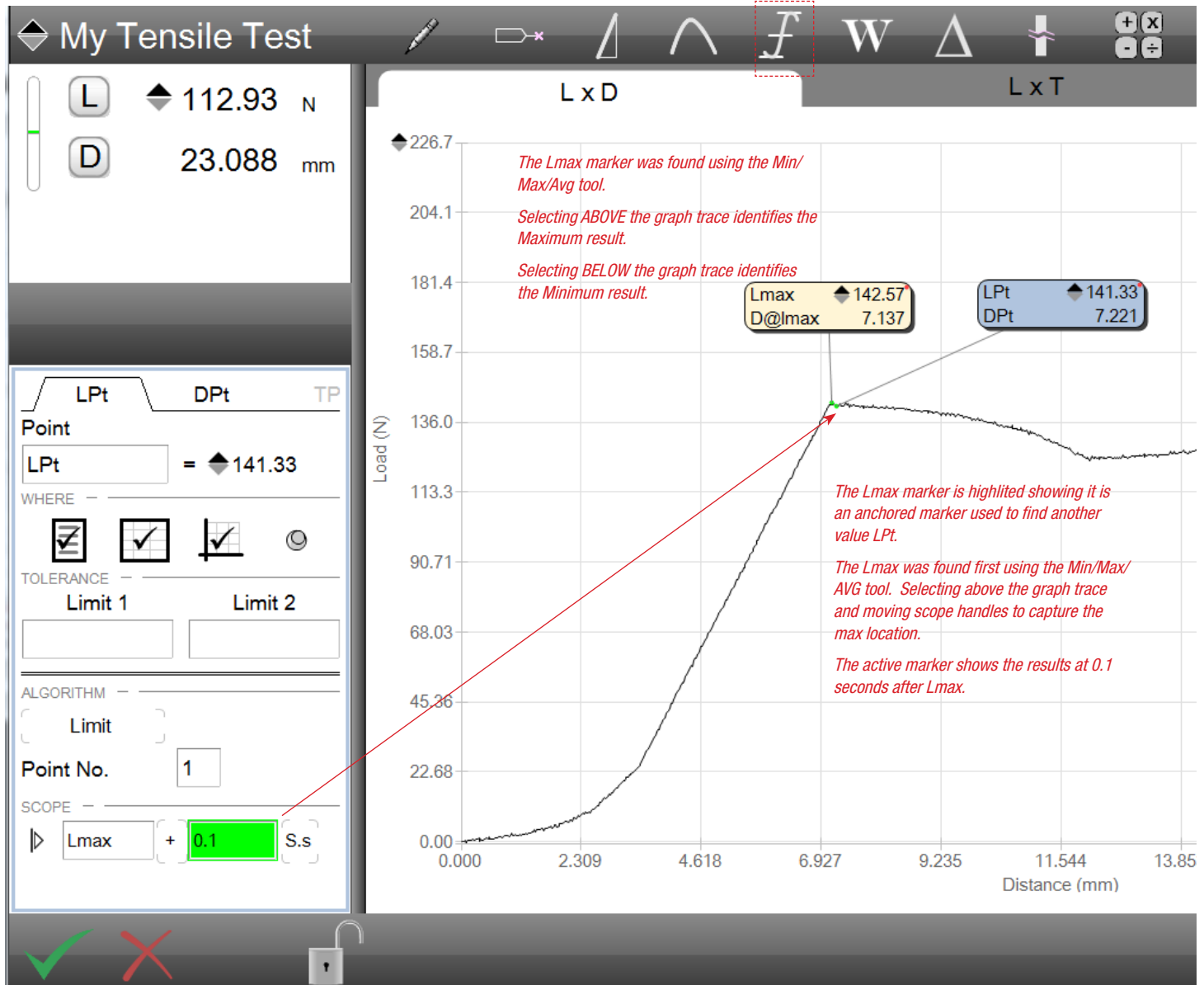
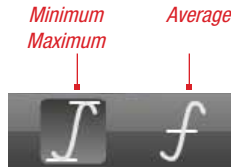
*L2 Plus Peak & Valley test showing Counts for the number of valleys in a scope range  
Delta load is calculated between the first and last valley within the range*



### 3.4.5 Minimum/Maximum/Averaging Coefficients

The Min/Max/Avg result is likely one of the most frequently used coefficients. It allows you to find the maximum values within a test or a range such as tensile strength or bulk strength.

And like the example shown below, the maximum or minimum values from this coefficient may be used as an anchor on which to determine other values within your data stream, such as the load or stress 100ms after the maximum load or stress.



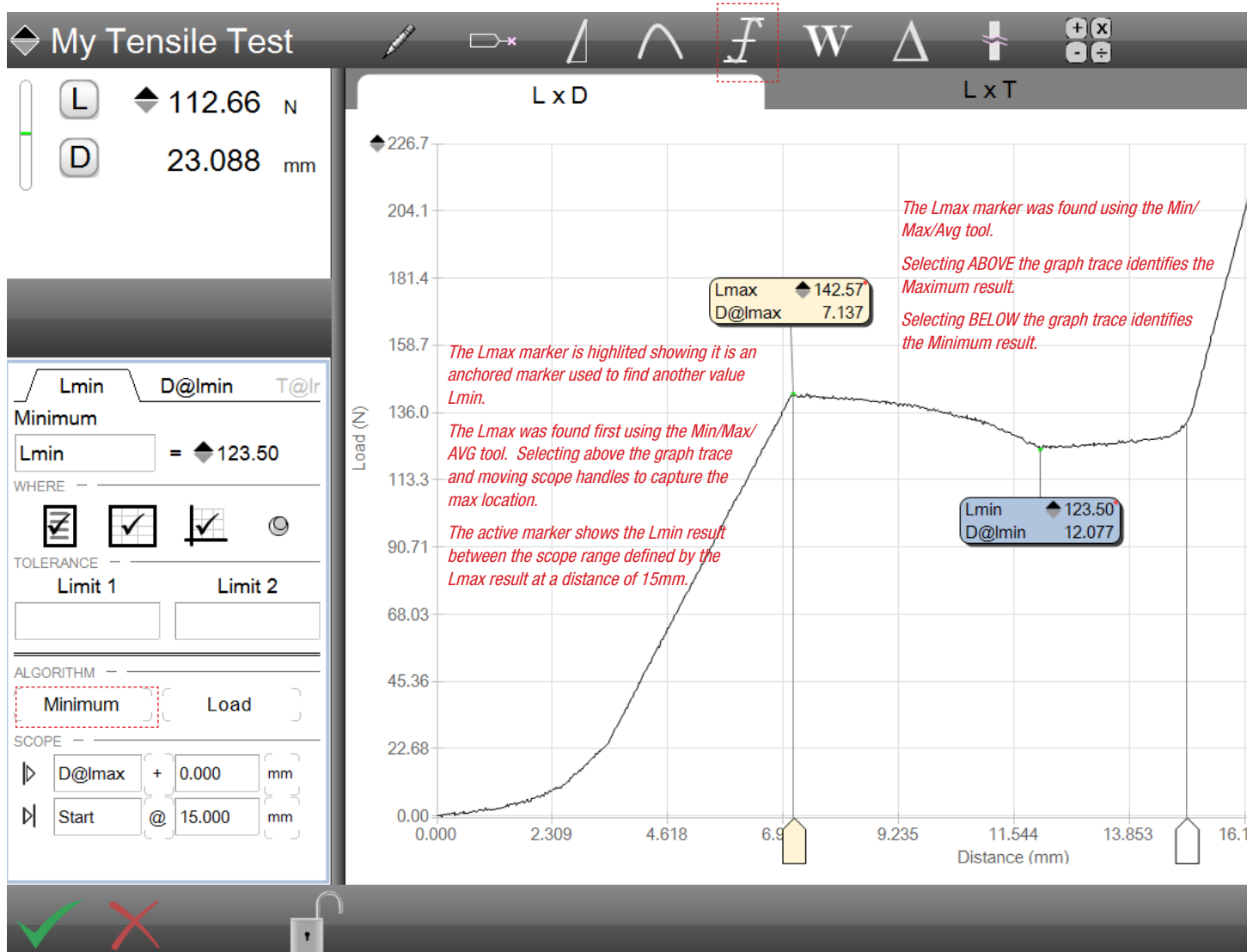
L2 Plus Tensile test  
Using Lmax marker, calculated the load at 1 second after the maximum

### 3.4.5.1 Minimum/Maximum Coefficients

The Min/Max algorithms find the minimum or maximum results for your test range. Your test range can be the entire test or a segment within your test that you scope.

To find the minimum result, select below the graph and a marker showing the Lmin is displayed with the associated Distance value.

To find the maximum result, select above the graph and a marker showing the Lmax is displayed with the associated Distance value.



L2 Plus Tensile test  
The Lmin was found by selecting below the graph trace

### 3.4.5.2 Averaging Coefficient

The Average algorithm should be used on non-peak & valley graphs where you are interested in determining the average load, stress, strain and distance.

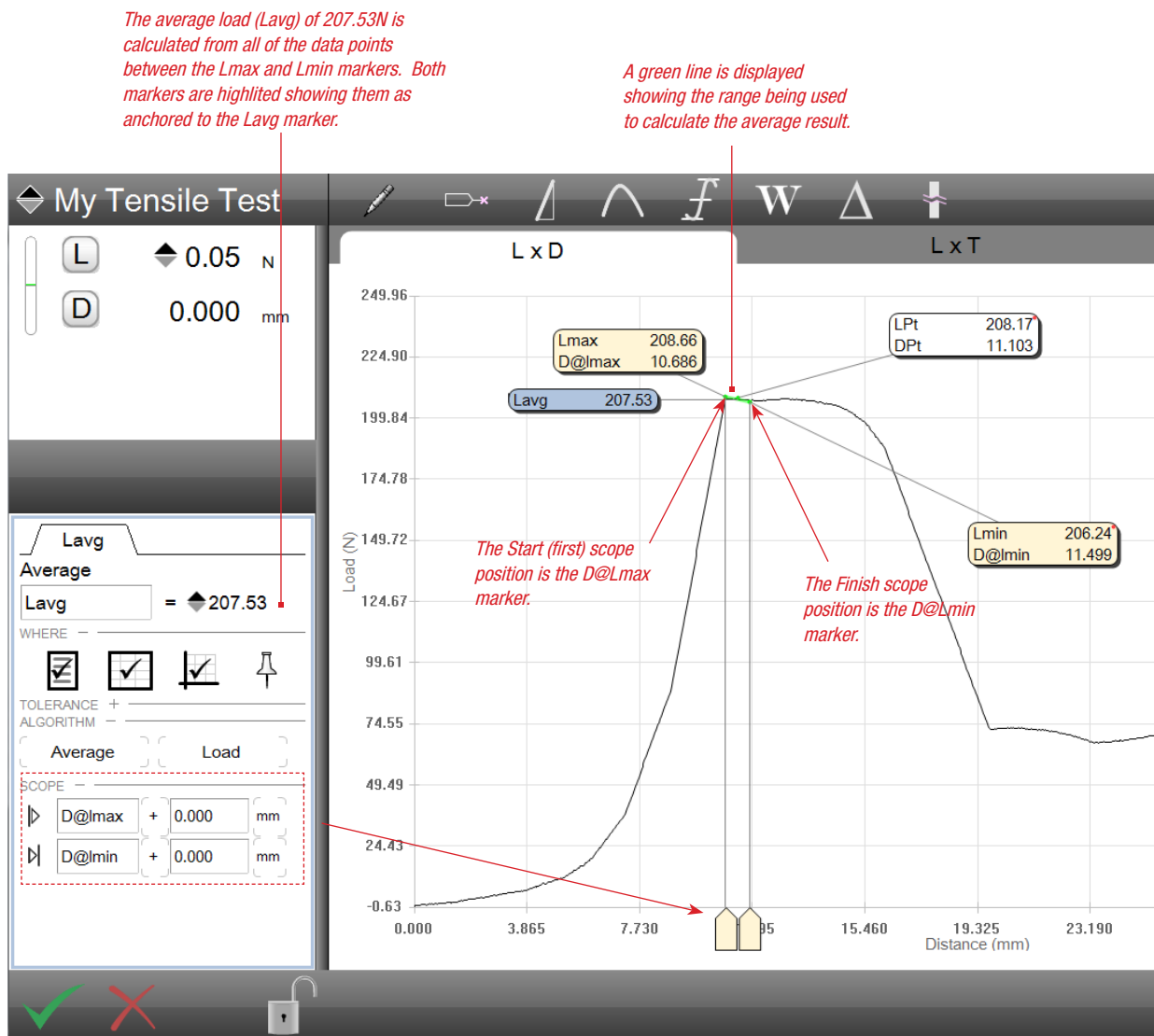


**NOTE**  
Peak & Valley analysis has its own unique averaging tool.

When the Average algorithm is used, scope handles appear. These scope handles may appear as a single handle because they are presented initially one atop the other.

Moving the scope handle will present the other handle. A green line is drawn showing the portion of the data stream that is being used to calculate the average.

The average is calculated using all of the data points defined by your scope range.



L2 Plus Tensile test  
Finding the Average load between  $D@L_{max}$  and  $D@L_{min}$

### 3.4.6 Work Coefficient

Work or sometimes referred to as Energy is used to determine the resilience of a material.

Work is calculated as the area under the graph. The area may be calculated for the entire test range or to a scope range you specify.

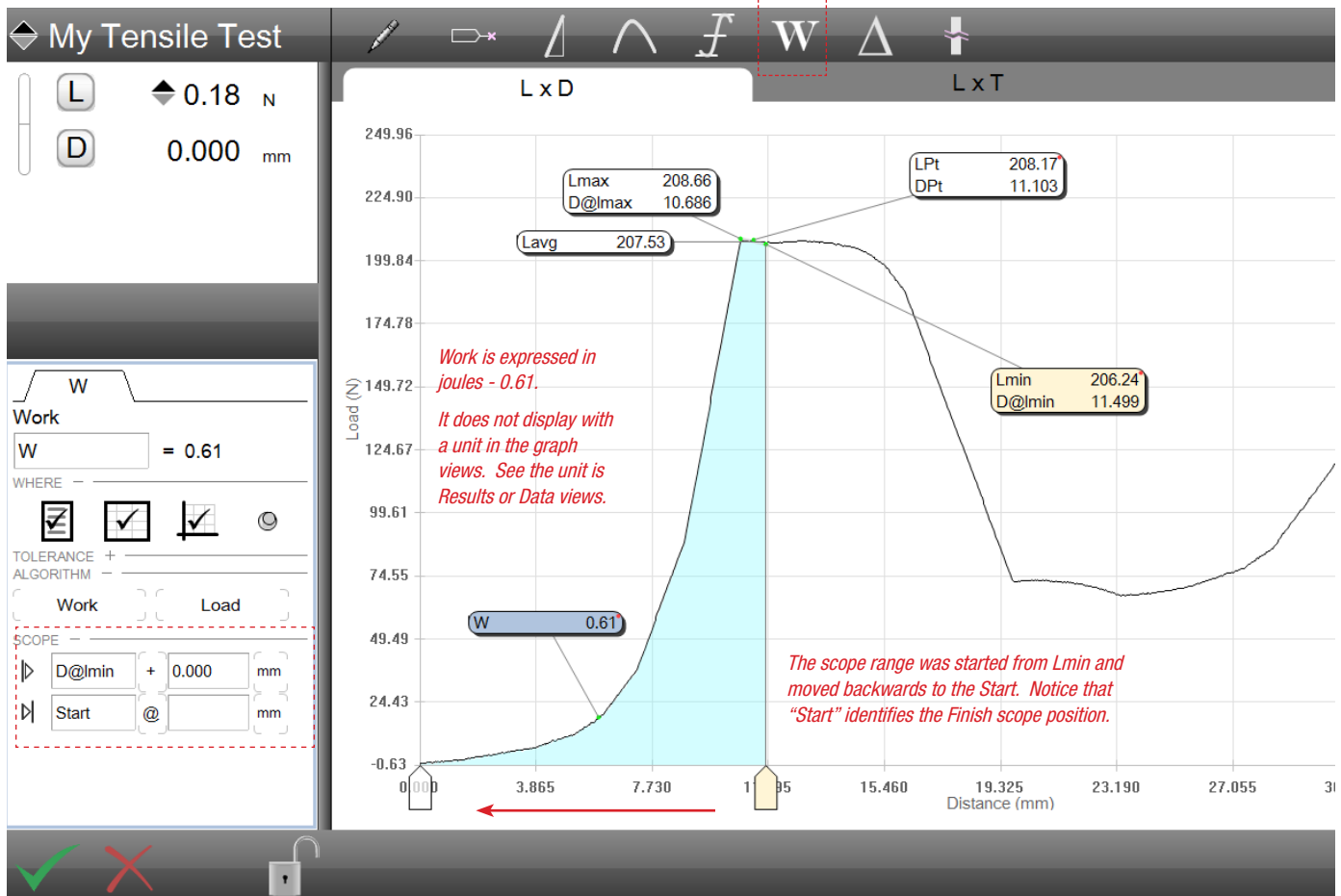
Work may be specified in Joules or Millijoules.

Select the Work graph analysis tool. Next, select below the graph. Arrange the scope handles to the range you are interested. The area is displayed in blue.



**NOTE**

1 joule equals 1000 newtons millimeter



L2 Plus Tensile test

Finding the Energy from the Start of the test to D@Lmin expressed as 0.61 joules

### 3.4.7 Delta Coefficient

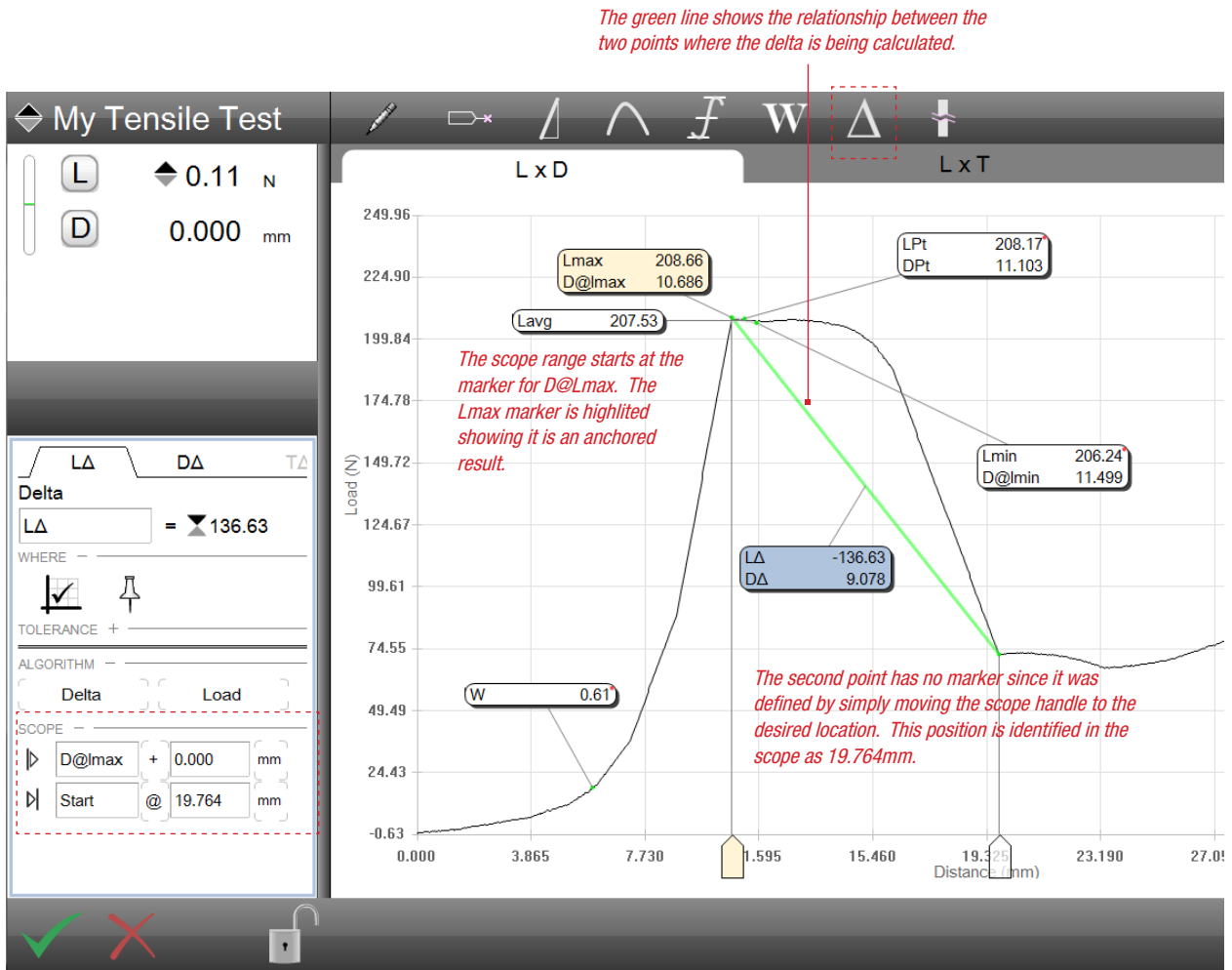
The Delta coefficient is used to determine the differences between two values. This difference may be constructed from within a test using the scope range. Or, you may use the overlay feature and determine the differences between points on two separate graphs within the same test setup.

Select the Delta graph analysis tool. A green line is automatically drawn from the Start to Finish scope positions. Adjust the scope handles to the locations you want to determine the delta.

You can determine the delta between markers and between a marker and a point of the graph without a marker.

If using overlays, first specify the overlay function by pressing the single green bar above the Runs List. Next, select your two runs you want to compare.

Next, select the Overlay analysis tool, then use the Point tool to measure the delta along the two graphs.



L2 Plus Tensile test  
Finding the Delta between marker D@Lmax and a point on the curve

### 3.4.8 Break Coefficient

The Break tool features two methods for identifying a material break: %Drop and Rate.

Break testing identifies when the material fractures or ruptures and provides a curve that can be used to identify the maximum stress, strain, load or distance prior to the break event.

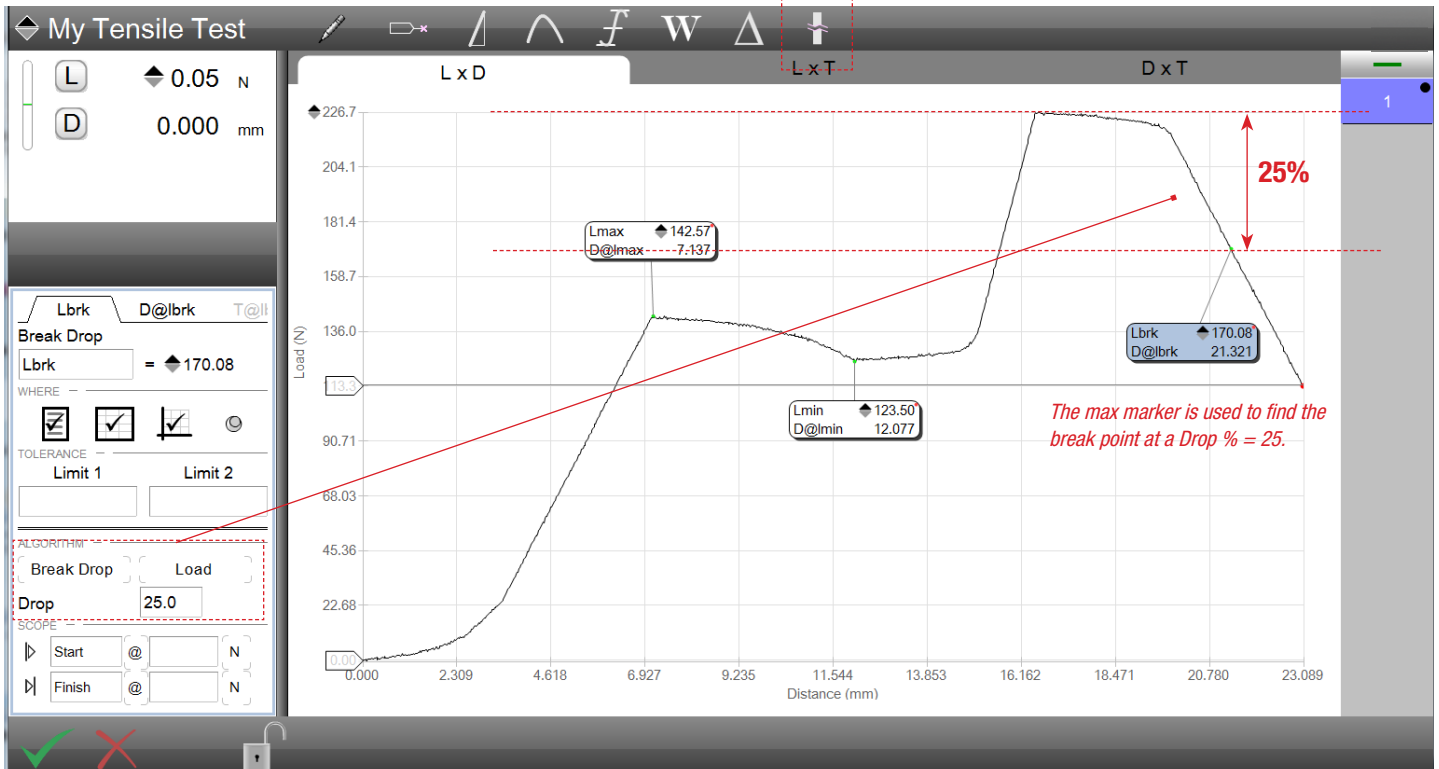
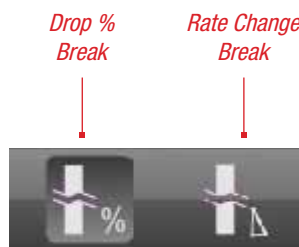
Both forms for break identification may be used in either tensile or compressive directions.

### 3.4.8.1 Break %Drop Coefficient

The Drop % algorithm is the more commonly used method for determining a sample break.

This method first looks for the maximum stress or load. Once the maximum load is determined, the algorithm next looks for a % drop in load. So, if the maximum load was measured as 100N, and the load dropped to 80N, that is a 20% drop in load.

The % Drop method is used in the L2 Plus test setup steps for both tensile and compressive limits. This terminates or completes a test run when the maximum load is measured and the load drops by the specified percent value.



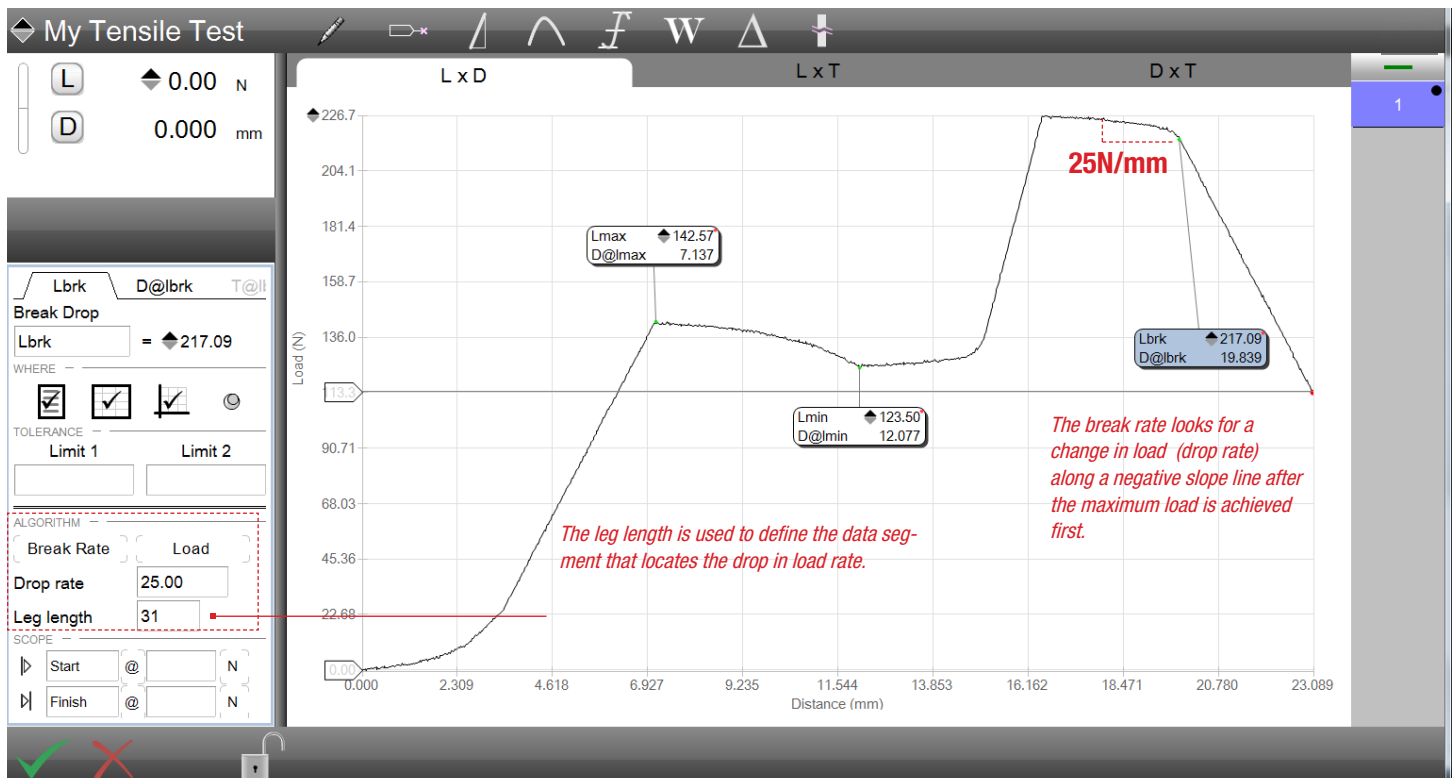
L2 Plus Break Test  
Using %Drop method for determining the break load

### 3.4.8.2 Break Rate Coefficient

The Break Rate algorithm looks at the slope along the stress-strain curve to determine the break point. Using a user-defined break rate, the algorithm first finds the maximum load point. After this point, the algorithm looks for the first occurrence where the break rate appears and marks that point as the break point.

The Break Rate is determined as the change in load divided by the change in distance. So, if the Break Rate is 25, the break result is the point in the data stream where the load rate changed at a rate of 25N/mm.

The Leg Length is used to help counter any noise issues along the graph trace. A Leg Length of 31 uses one point along the slope created by the Break Rate point and then 15 points on either side to create a slope line.



L2 Plus Break Result  
Shows Break point using Break Rate algorithm

## 3.5 Offline Test Creation

Test setups will appear in red text if the test was created on a system that is improperly licensed, or a system that is incompatible with your version of L2 Plus software.

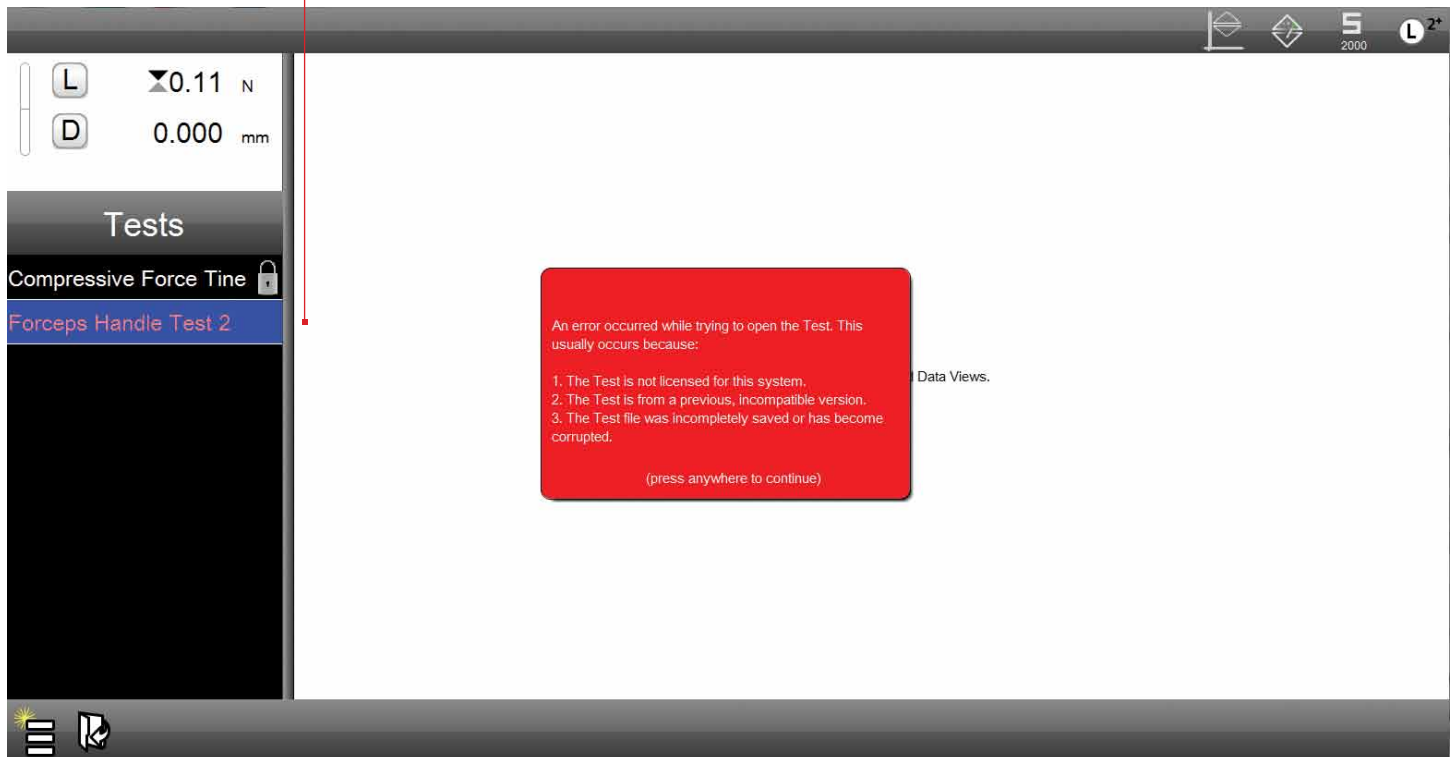
If a test setup is created on a computer that is not connected to a Starrett test frame, or if the test is created on an illegal computer with unlicensed software, the test setup will appear in the main test menu, but it cannot be opened.



### NOTE

Test setups may only be created on a licensed computer for use with L2 Plus software.

*If a test is imported from an unlicensed L2 Plus system, the test setup will display in red text. The test cannot be opened unless the computer is licensed for L2 Plus software.*



*L2 Plus Test Setup Menu Shows Unlicensed Test Setup*





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