L3 Series Software for Material Testing

Using the Graphic Analysis Tools
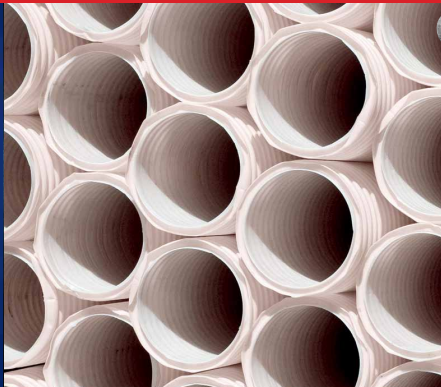
Starrett®

The Better Solution

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5.0 L3 Graph Analysis Tools

5.1 Introduction

Analysis and the finding of results are normally done using the L3 Graph Analysis Tools located in the upper tool bar.

After a Run is completed and the graph drawn, you use these tools to obtain your results (coefficients). Or, you can perform all of the runs within a Batch, and then use the Graph Analysis Tools to measure your results on a selected run. Once a result is measured on one run, that results is automatically measured on all runs within the batch.

NOTE
When you measure for a result on a run within a batch or within a test setup, that result is automatically measured on all of the other runs within the batch or all runs in your Runs List.

Similarly, if you delete a result on a run within a batch or within a test setup, that result is automatically deleted on all of the other runs with the batch or all runs in your Runs List.

5.2 Graph Analysis Tools

A set of graph analysis tools are displayed in the header tool bar above the graph window. These tools allow you to measure results using the graph trace for your run. Each of these tools will be discussed in detail in this section.

The L3 graph analysis tools are:
- Annotation Tool
- Point Tool
- Slope (Modulus) Tool
- Peak & Valley Tool
- Min/Max/Avg Tool
- Work Tool
- Delta Tool
- Break Tool
- Formula Tool

5.3 Data Definition Menu

When a graph analysis tool is used, it lets you specify the type of measurement you want. Measurements and results are called coefficients. There are a large variety of coefficients available in your L3 Series software. Each coefficient has a Data Definition menu that lets you specify the following for that coefficient:
- Coefficient name
- Where the coefficient will be displayed
- A Tolerance Range for the coefficient
- The algorithm used to calculate the coefficient
- The scope range for the coefficient

Each of these attributes of a coefficient will be described in detail in this section.

Data Definition Menu - L3 Point
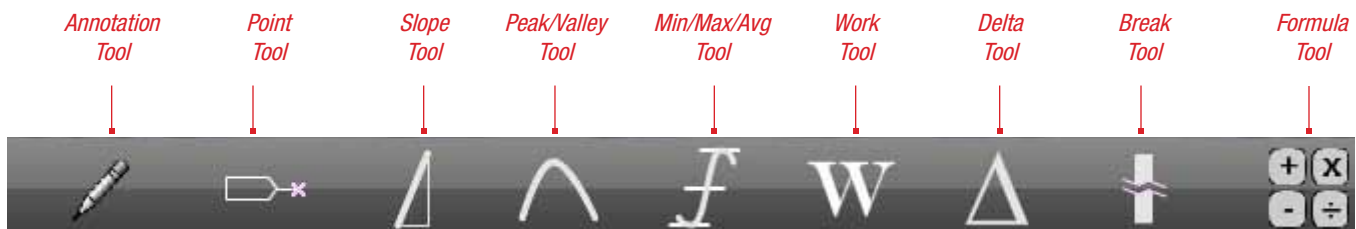
Graph Analysis Tools

5.3.1 Coefficient Sets

When the Data Definition menu is displayed for a coefficient, tabs located at the top of the menu show the coefficients available. Coefficients are often displayed in sets. Sets are used to display the results that can be viewed in the graph or in the data table. Coefficients are displayed in a "marker" located on the graph with a leader line to the exact point where the result is taken.

You can setup each coefficient by selecting the tab and then configuring its attributes including Name, Where, Tolerance, Algorithm and Scope.

NOTE
Selecting the marker on the graph will launch the Data Definition menu for that coefficient.

5.3.2 Coefficient Naming

All coefficients have a default name. The name is actually abbreviated and designed to provide a descriptive tag to the coefficient.

The coefficient name may be changed by the user.

The coefficient name may be up to 12 characters in length. It may use spaces, numerics and alphabetical characters. Special characters may be used for naming using the Ctrl+ key as follows:

To rename a coefficient, select the coefficient name text block. Enter the new name using your keyboard.
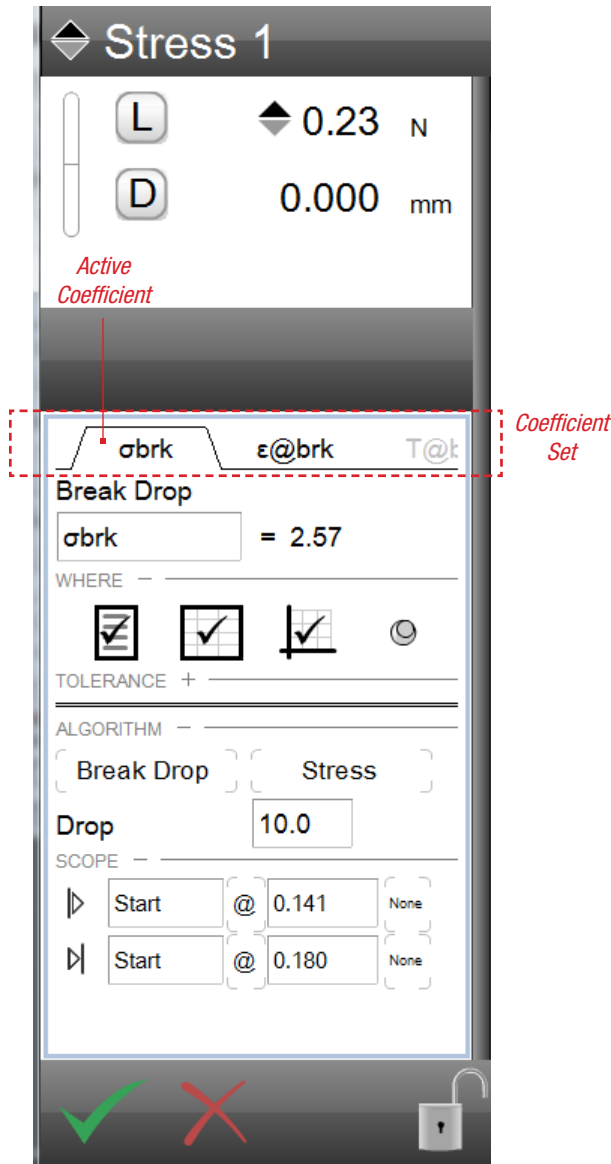
The coefficient may be renamed using up to 8 characters including spaces, numerics or alphas.
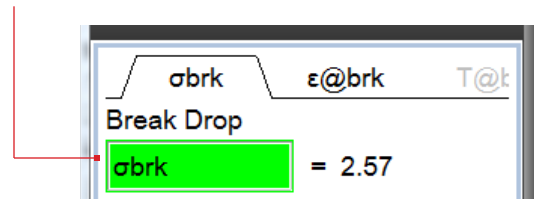
Data Definition Menu
Rename a Coefficient

Data Definition Menu - L3 Break

5.3.3 Using Where Function

The Where function is used to configure "where" the coefficient will appear. There are four attributes for Where and each has its own symbol in the Data Definition menu:

- Result view
- Data view
- Graph view
- Stick Pin

Selecting the symbol enables or disables the function. A check mark displays atop the symbol when enabled.

When the Result view is highlited, the coefficient will be displayed in the Results view.

When the Data view is highlited, the coefficient will be displayed on all Data views.

When the Graph view is highlited, the coefficient will be displayed on all Graph views.

When the "Stick Pin" is highlited, the marker used to display the coefficient on a graph view is automatically placed at a "best location" by the software. You have the option to move the marker by selecting the marker and repositioning to a preferred location.

Shows the Graph enabled for Where. This means that the highlited coefficient (LPt) will display in the marker on a graph view.

The check mark displayed over the Graph icon indicates that the Where for the Graphs is enabled.

Shows the Graph disabled for Where. This means that the highlited coefficient (LPt) will NOT display in the marker on a graph view. Note the marker is only displaying the result for the DPt coefficient.

The check mark is NOT displayed over the Graph icon, therefore the highlited coefficient (LPt) will not display in the marker.
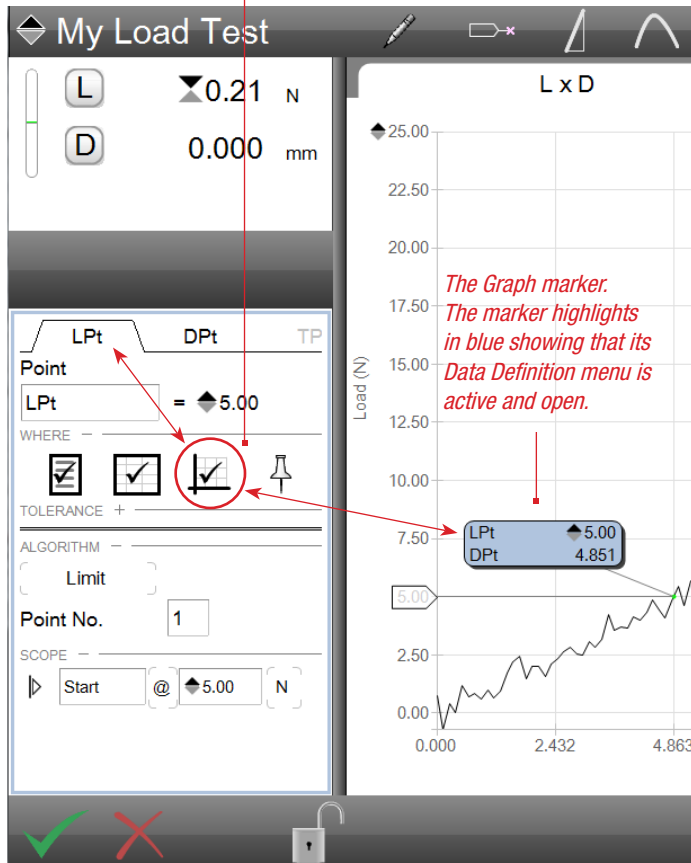
The Graph marker. The marker highlights in blue showing that its Data Definition menu is active and open.
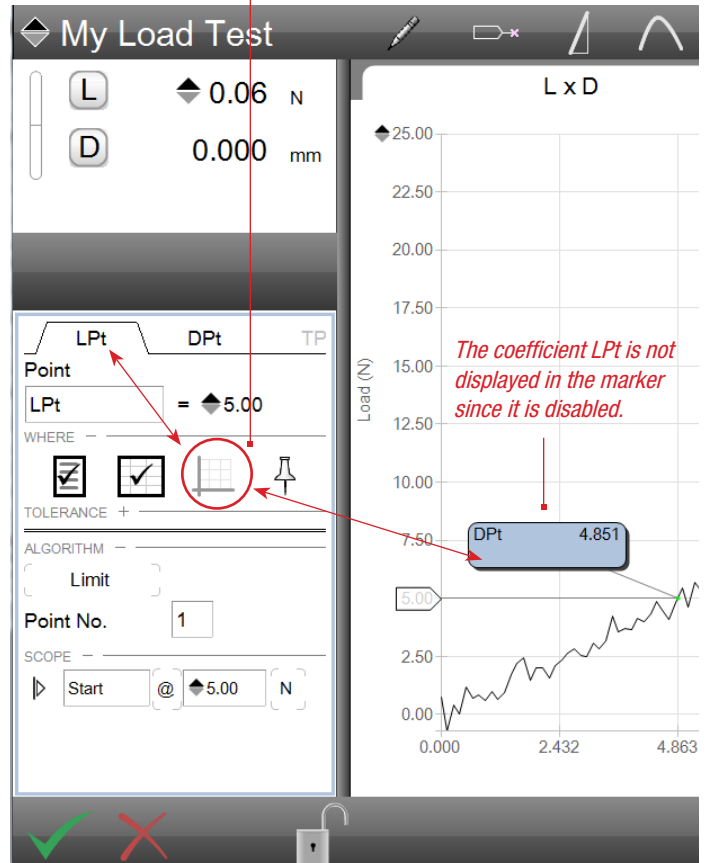
The coefficient LPt is not displayed in the marker since it is disabled.

Data Definition Menu
Using Where function to show where coefficient is displayed

5.3.4 Using Tolerances

Coefficients may make use of tolerances to indicate a "pass" or "fail" result.

When Tolerance is selected, you specify two limits to create a "tolerance range". If the coefficient result equals or falls within the tolerance range values, the coefficient will display in black text indicating a "passed" or "in-tolerance" result.

If, however, the result falls outside of the tolerance range, the result will display in red text indicating an "out-of-tolerance result" or a "failed" result.

NOTE
The units of measure for the tolerance range is automatically the same as the units of measure for the result being toleranced.

NOTE
You can view to Tolerance view to see a tendency graph showing your result with respect to the tolerance range.

The measured result for DPt is 4.851mm. This falls within the tolerance range of 4.500 to 5.000.
Therefore, the result is within tolerance (pass) and is displayed in black text.

The measured result for DPt is 4.851mm. This falls outside the tolerance range of 4.500 to 4.750.
Therefore, the result is out-of-tolerance (fail) and is displayed in red text.
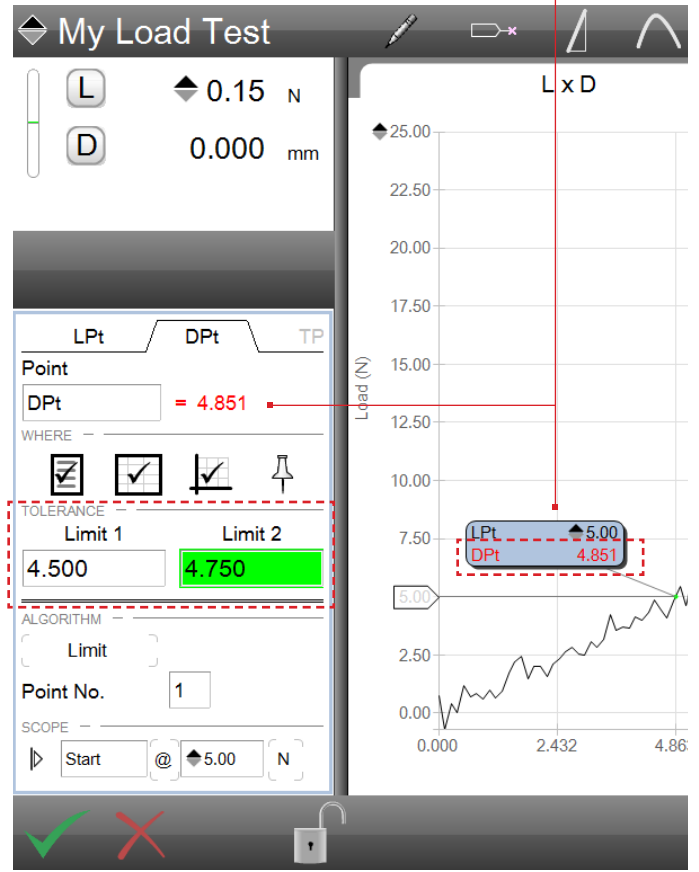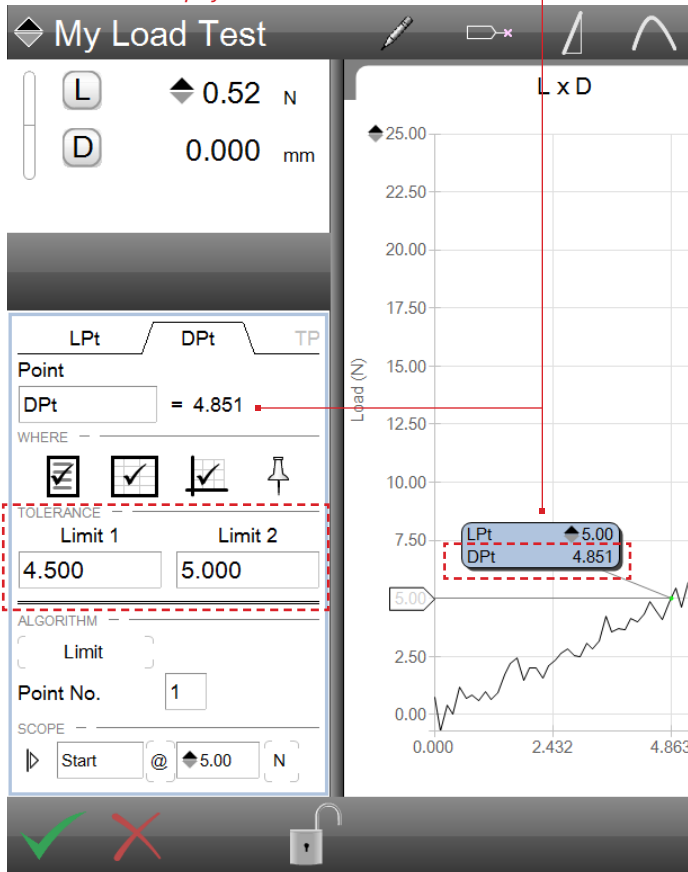
Data Definition Menu
Using Tolerance to set limits on the coefficient DPt

5.3.5 Selecting Algorithms

Algorithms are the methods available for a coefficient to calculate a result. Most coefficients have multiple algorithms which the user may choose from.

Algorithms may also have dependent variables that may also be selected.

Select the algorithm by selecting the algorithm block and then select the dependent variable associated with the variable.

NOTE
Algorithms are discussed in more detail in the following sections.

Select the Delta algorithm and the Load dependent variable. This will measure the difference (delta) between two points on the graph.

The two yellow highlited markers indicate they are anchored and used to calculate the Delta algorithm for Load. The ΔL (delta Load) is displayed as a result.
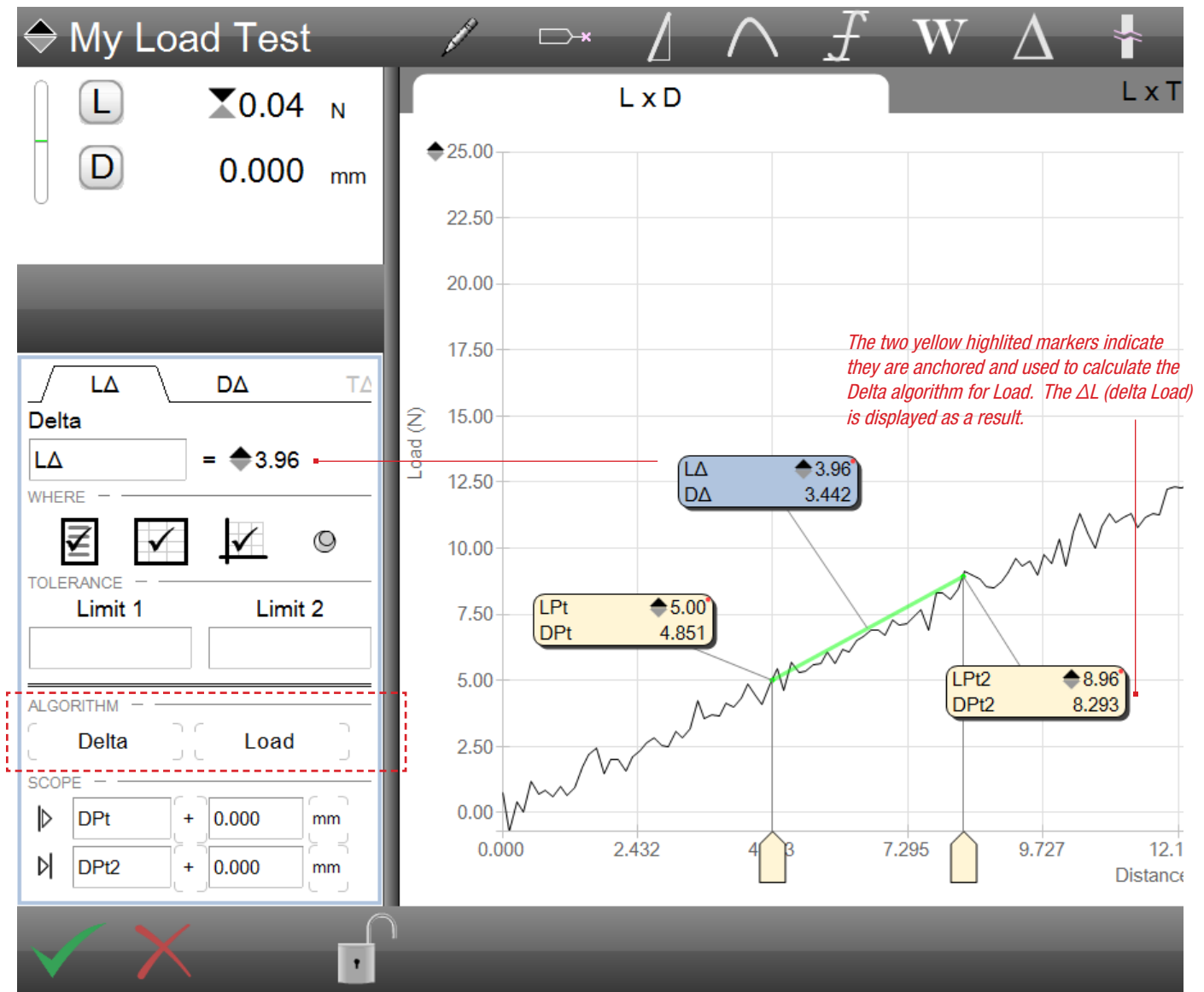
Data Definition Menu
Using Delta algorithm on Load variable

5.3.6 Using Scoping

The scope function is used to define the range or location within your graph and data points where a result is to be measured.

Coefficients may have a single or pair of scope settings.

Scope handles appear on the graph and correspond to the scope settings. Moving the scope handles causes the scope settings to change accordingly.

Scope settings have three types of operators:

The "@" operator specifies that the result should be measured "at this specific point".

The "+" operator specifies that the result should be measured "AFTER" the specified scope setting. For example, you might want to know the stress value 100mS after the maximum load value of your test. You would use the "+" operator to specify a measurement 100mS after the coefficient Lmax (Maximum Load).

The "-" operator specifies that the result should be measured "BEFORE" the specified scope setting. So to measure the stress value at 100mS before the maximum load value, you would use the "-" operator.

Scope settings have multiple units of measure on which the scope setting can be associated.

NOTE
Scope settings can be set using the scope handles and be based on the data stream used to draw your graph, e.g. the x-axis and y-axis data.

NOTE
Scope settings can be set using the coefficients as the START and FINISH of your scope segment.

The scope operator is positive (+).
The start of my scope is coefficient LPt.
The result will be the load value 100mS after LPt.
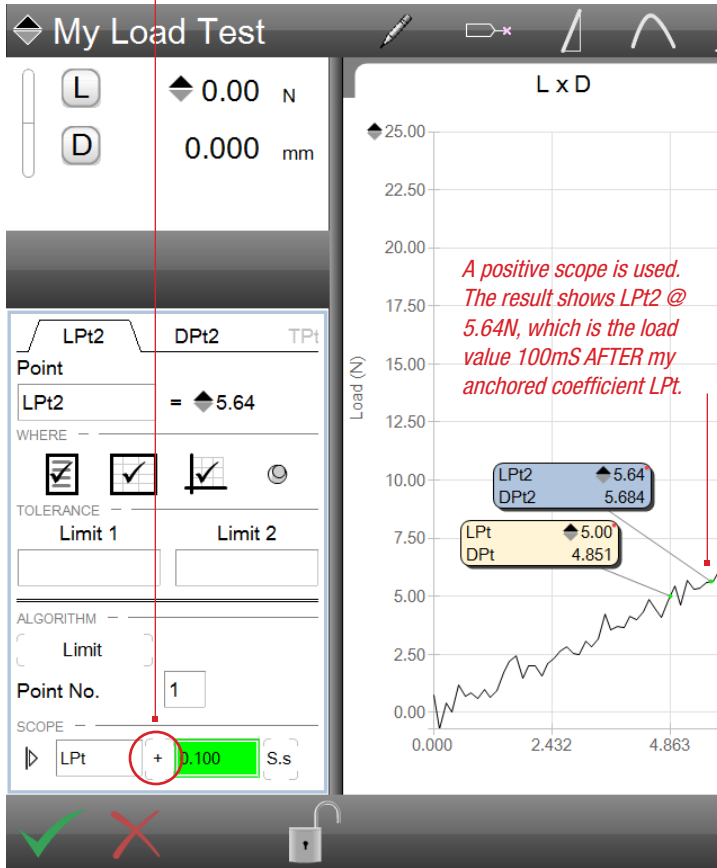
A positive scope is used. The result shows LPt2 @ 5.64N, which is the load value 100mS AFTER my anchored coefficient LPt.

The scope operator is negative (-).
The start of my scope is coefficient LPt.
The result will be the load value 100mS before LPt.
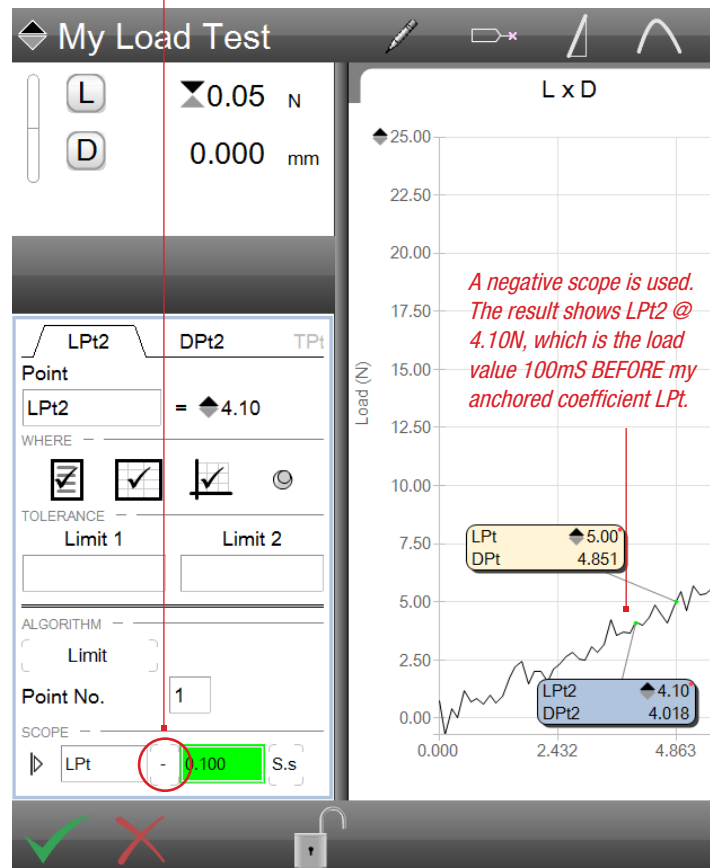
A negative scope is used. The result shows LPt2 @ 4.10N, which is the load value 100mS BEFORE my anchored coefficient LPt.

Data Definition Menu
Using Scope to find a new result

5.4   L3 Testing Modes

L3 systems use stress, load, strain, distance and time for measurement and analysis. When in stress-strain mode, the coefficients and graph types are automatically set to measure stress-strain results. When stress-strain is used, the available graphs for analysis are:

- Stress x Strain (σ x ε)
- Stress x Time (σ x T)
- Strain x Time (ε x T)

NOTE
In order to perform a stress-strain test and to measure for stress and strain results, you must have used the Sample Definition Step in your test setup.
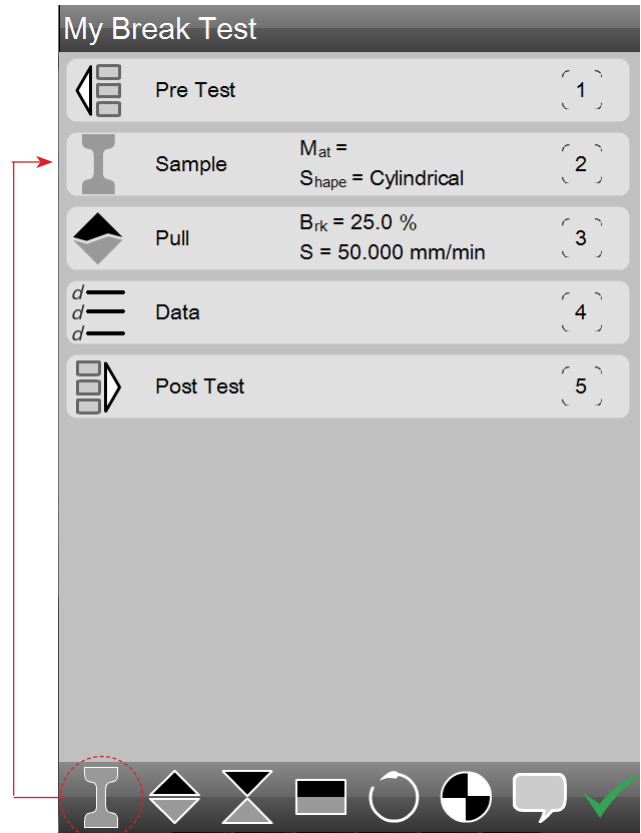
Test Setup
With a Sample Definition step
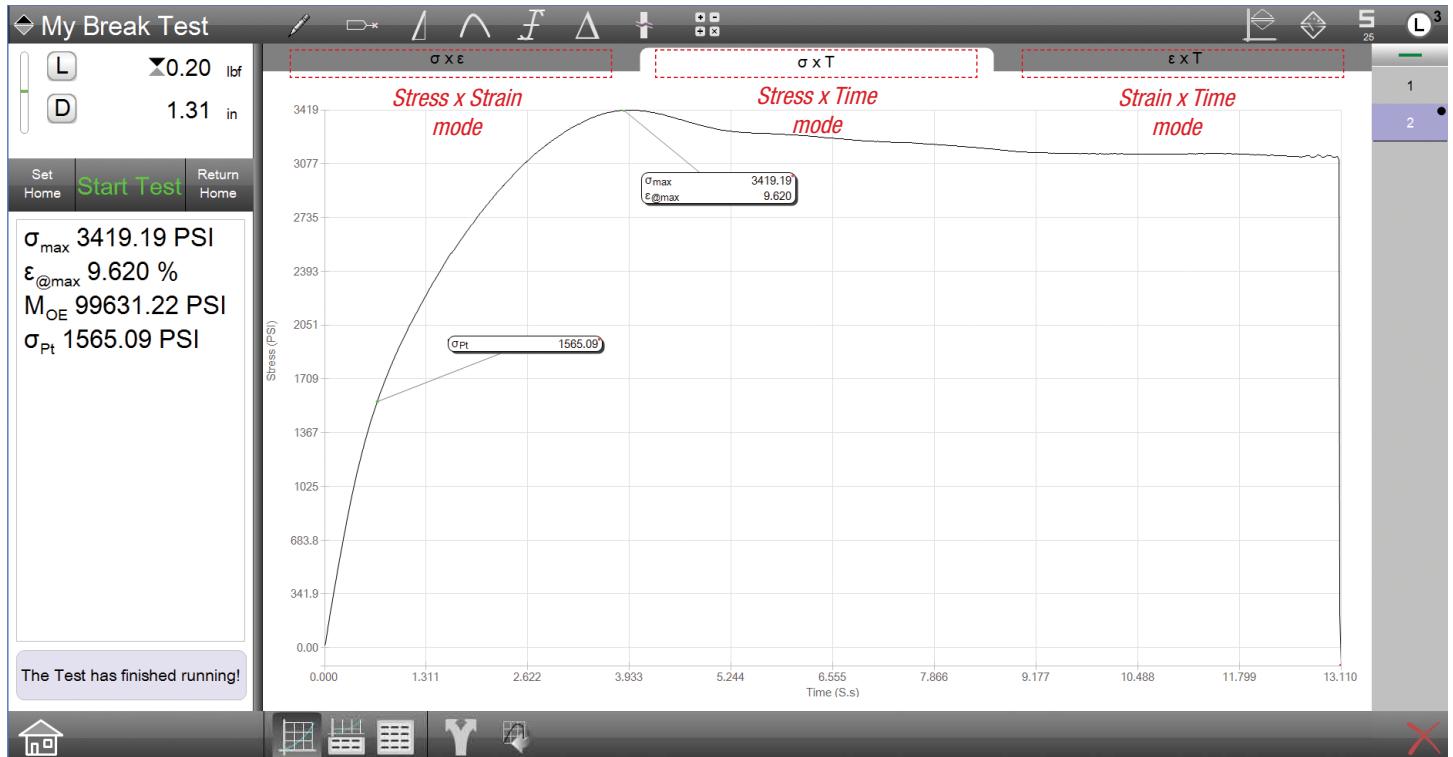
Full Graph view
Show Stress results using Stress x Time graph

When in load-distance mode, the coefficients and graph types are automatically set to measure load-distance results. When load-distance is used, the available graphs for analysis are:

- Load x Distance (L x D)
- Load x Time (L x T)
- Distance x Time (D x T)

NOTE
When no Sample Definition step is used in your test setup, the measurements and graphs are load-distance based. There is no ability to measure stress or strain.

Test Setup
Without Sample Definition step
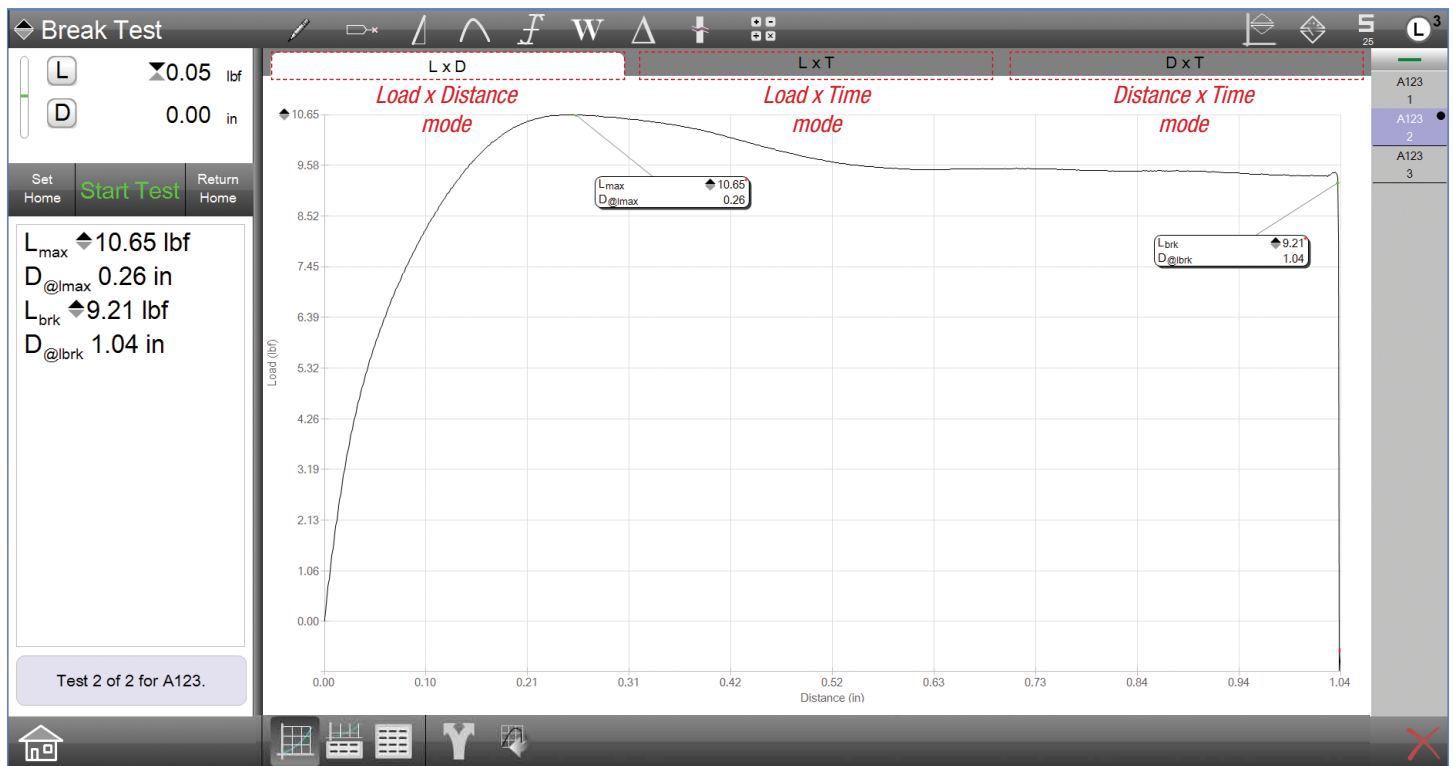
Full Graph view
Graph options are Load-Distance-Time based (No Sample Definition Step)

5.5   Using the Point Tool

The Point tool lets you measure any point along your graph trace. The graph trace for a Run is comprised of points based on the Sampling Rate you have specified for your test setup.

The Point tool is used in Load-Distance modes. And the Point tool may be scoped along either the y-axis (Load) or on the x-axis (Distance, Time).

All Point measurements have a specified Scope. The scope allows you to further define where a point is measured. Using the Scope units, you may define the scope for your point based on load, distance or time. For example, if you want to measure a point that is 100mS after the maximum load on your graph, you can set the maximum load coefficient (Lmax) as an anchor for your point, and then set the scope at 0.1 seconds after the anchor. This will give you a result for load that is 100mS after your maximum load result.

Point Tool types

Active coefficient is LPt.

Limit point algorithm being used to find the Distance (DPt) at a load limit target of 50N.
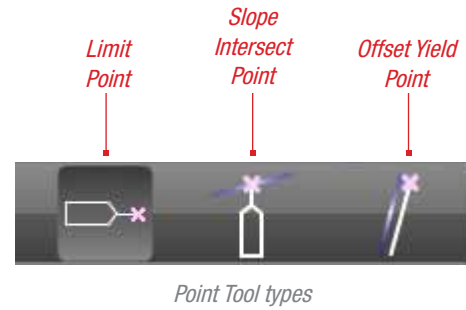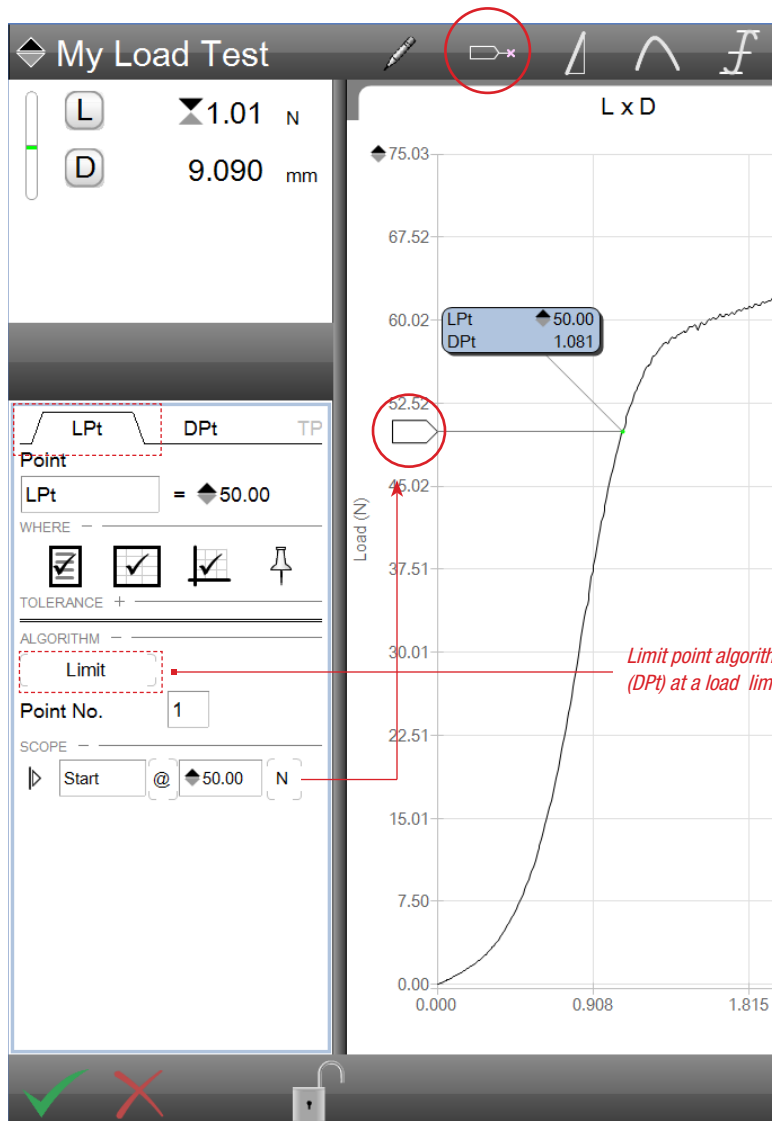
Load Limit Point Data Definition Menu
Showing result at 50N Load Limit

5.5.1 Limit Algorithm

The Limit algorithm lets you find a specific load, distance or time point on your graph.

Select the Point tool and select the Limit algorithm. A scope handle will appear on either the y-axis or x-axis. You can adjust to where on the graph you want to measure. And you can adjust your scope using the Scope entry field and base your scope on load, distance or time.

NOTE
Selecting above the graph trace will set the scope on the y-axis.
Selecting below the graph trace will set the scope on the x-axis.
You can reposition the scope handle by moving it onto either axis.
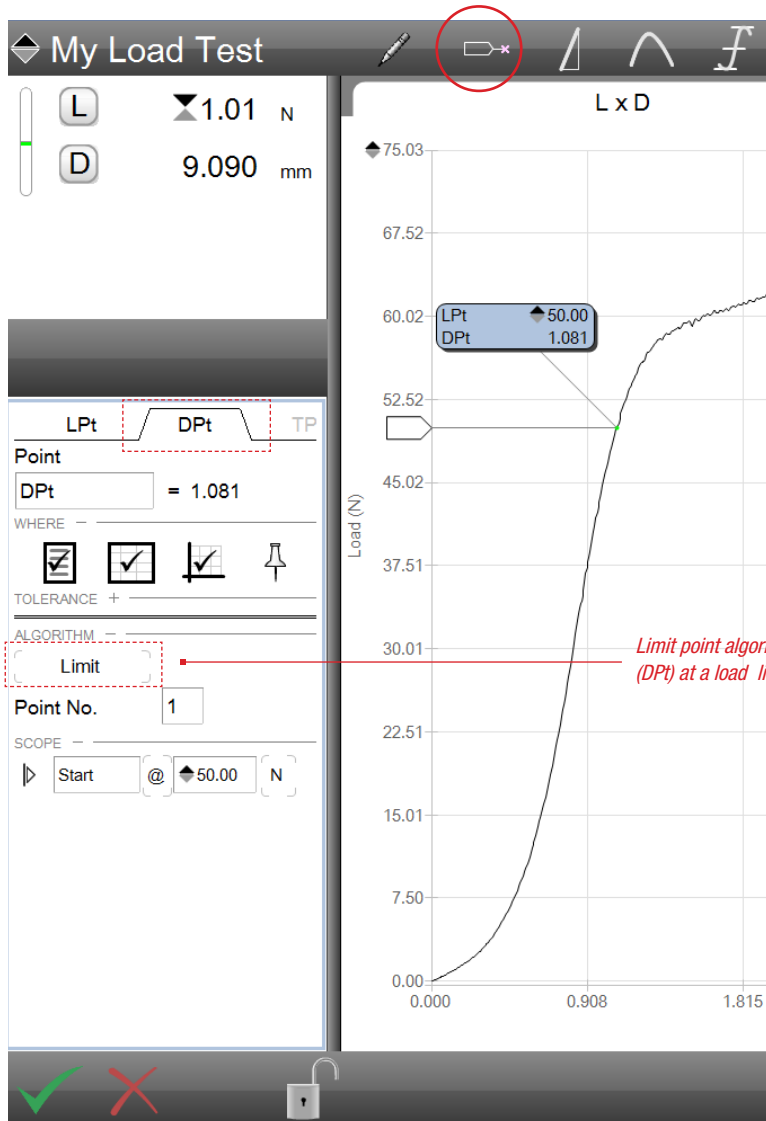
Active coefficient is DPt.

Limit point algorithm being used to find the Distance (DPt) at a load limit target of 50N.

Distance Limit Point Data Definition Menu
Showing result at 50N Load Limit

5.5.1.1 Point Number

The Point Number default is 1. This means that the L3 software will find the first point, measuring from left-to-right on the graph that meets your point setup.

If the Point Number is 2, the L3 software will find the second point on your graph (looking at all data points from left-to-right) that equals your Point setup.

If the Point Number is -1, the L3 software will find the first point, measuring from right-to-left on the graph that meets your point setup.

NOTE
Positive Point Numbers measure from left-to-right along the graph.
Negative Point Numbers measure from right-to-left along the graph.
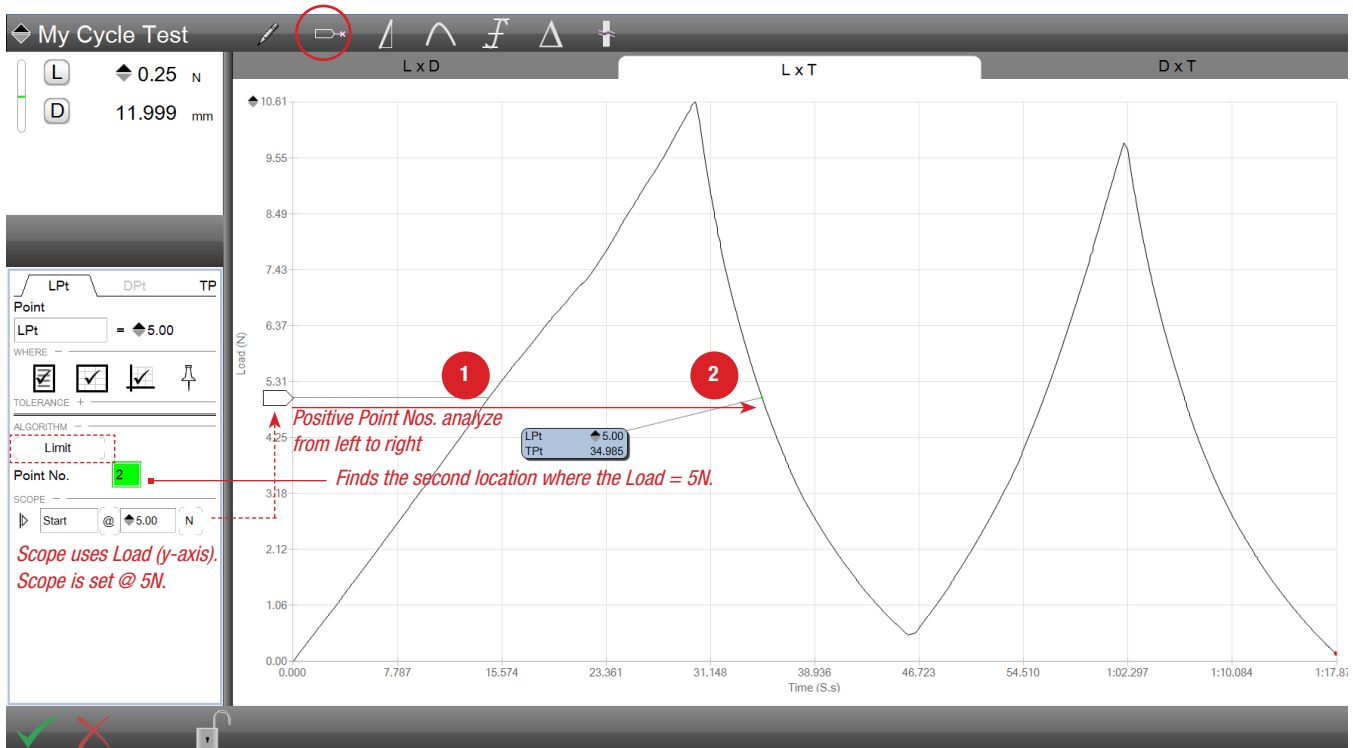
Load Point at Point No. 2
Measures from left to right

My Cycle Test

L ▲ 0.26 N
D 11.999 mm

| LPt | DPt | TP |

Point
LPt = ▲ 5.00

WHERE

TOLERANCE +

ALGORITHM
Limit
Point No. 1

SCOPE
Start @ ▲5.00 N

L x D   L x T   D x T

Positive Point Nos. analyze from left to right

LPt ▲5.00
TPt 14.632

Finds the first location where the Load = 5N.
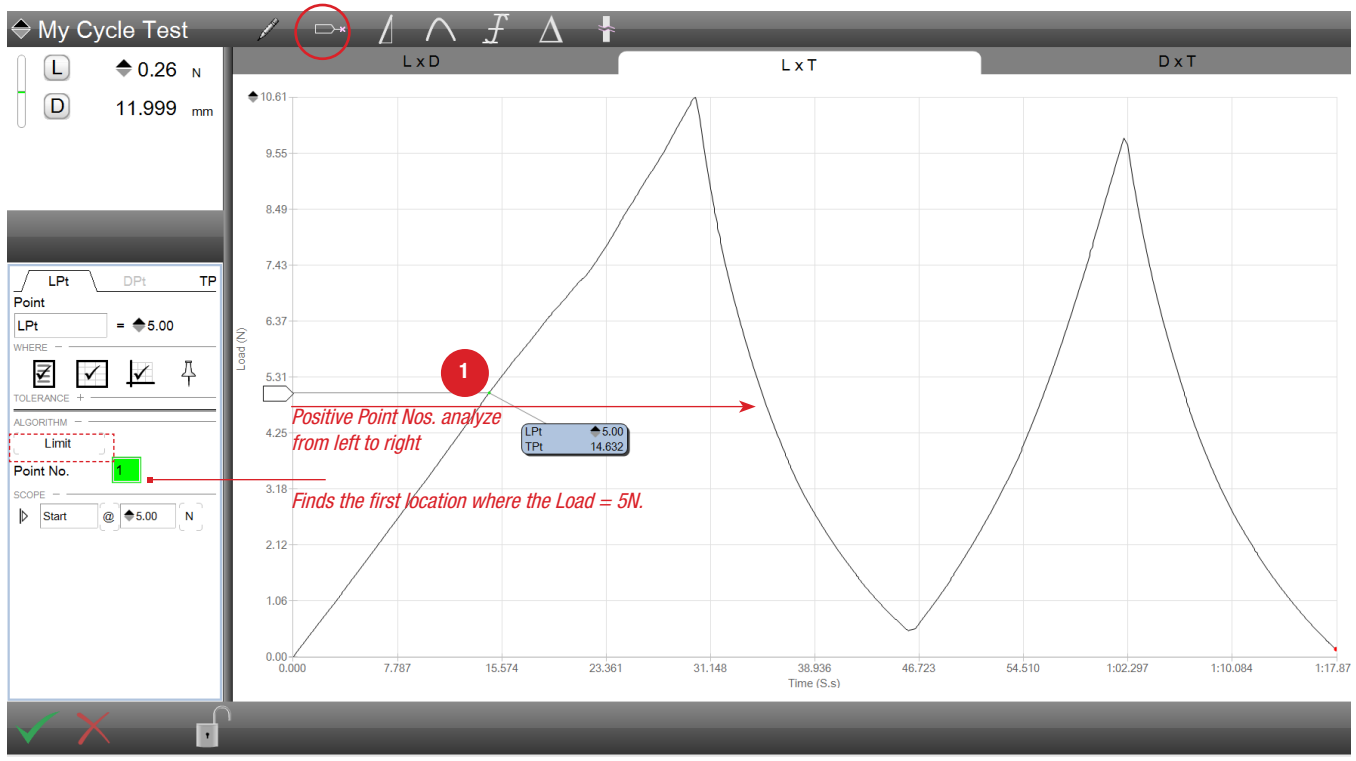
Load Point at Point No. 1
Measures from left to right

My Cycle Test

L ▲ 0.23 N
D 11.999 mm

| LPt | DPt | TP |

Point
LPt = ▲ 5.00

WHERE

TOLERANCE +

ALGORITHM
Limit
Point No. -4

SCOPE
Start @ ▲5.00 N

L x D   L x T   D x T

-4   -3   -2   -1

Negative Point Nos. analyze from right to left

LPt ▲5.00
TPt 14.632

Finds the fourth location where the Load = 5N.
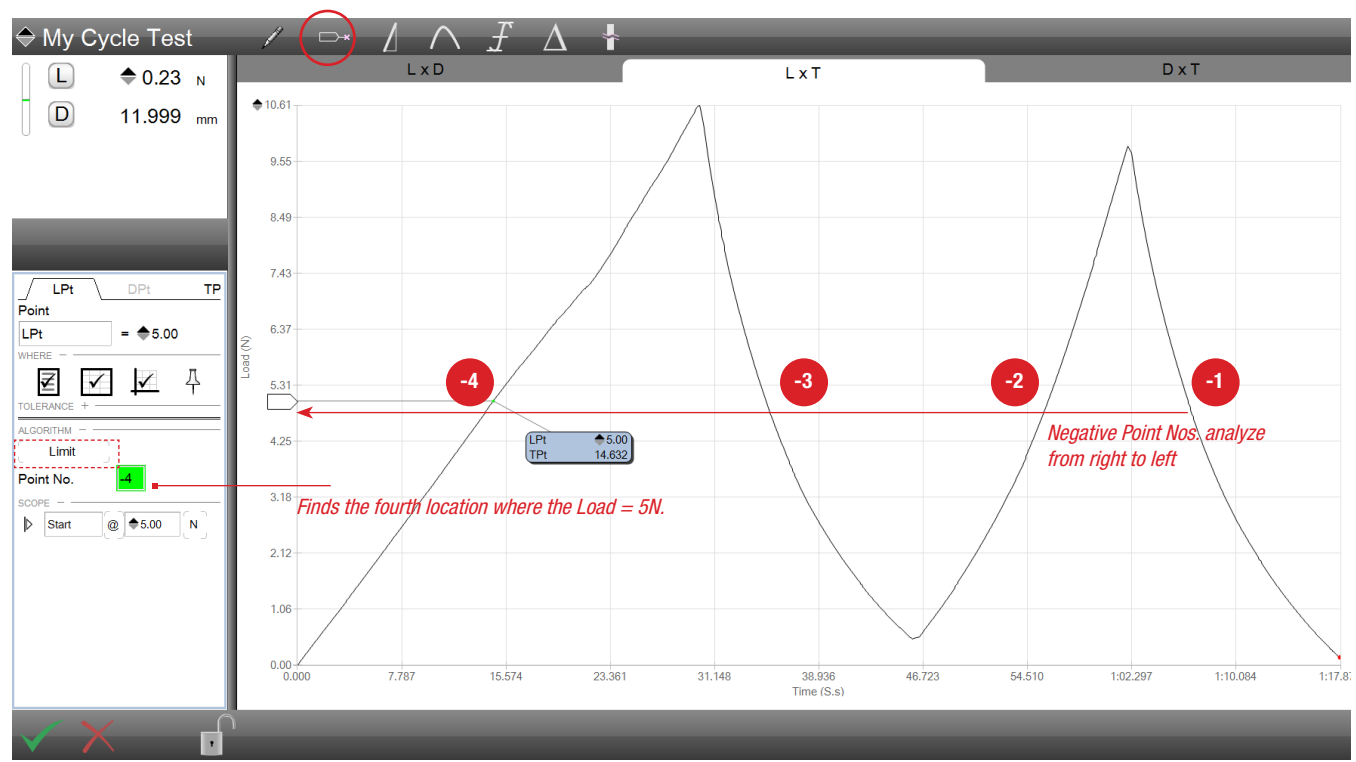
Load Point at Point No. -4
Measures from right to left

5.5.1.2　　Scope

The Scope setup for your Limit may be based on load, distance or time. Select the Units you want the scope to be calculated from.

Use the "@" operator to set the scope "at a specific scope point".

Use the "+" operator to set the scope "at a position AFTER a specific scope point". The AFTER scope function should be used with another anchored results. For example, finding the Point 100ms AFTER (+) the maximum load value. The maximum load value would be the anchored coefficient and displays in yellow when anchored.

Use the "-" operator to set the scope "at a position BEFORE a specific scope point". The BEFORE scope function should be used with another anchored results. For example, finding the Point 100ms BEFORE (-) the maximum load value. The maximum load value would be the anchored coefficient and displays in yellow when anchored.
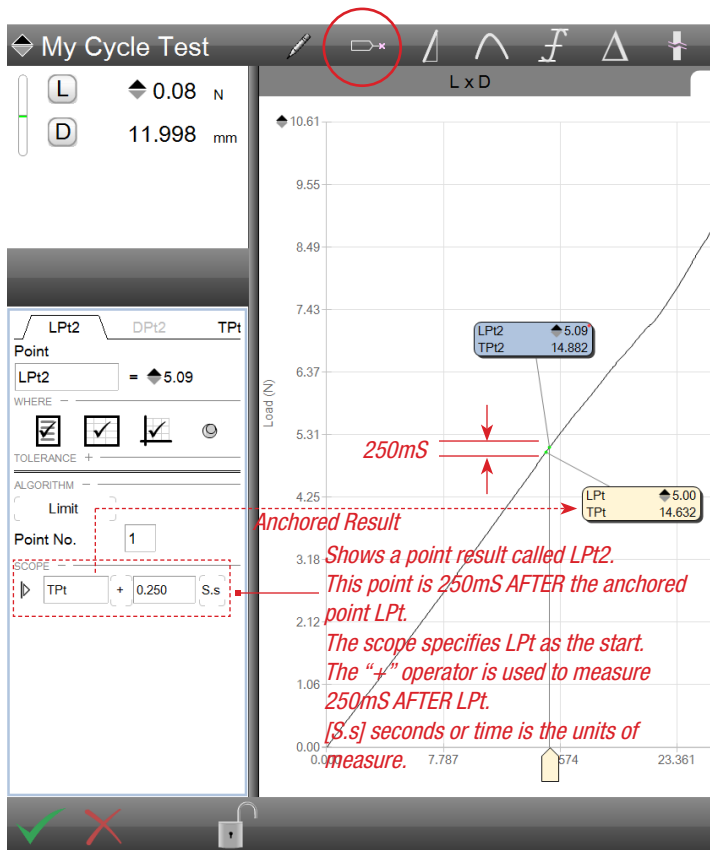
Limits Using an Anchored Point
Locates the LPt2 @ 250ms after (+) LPt
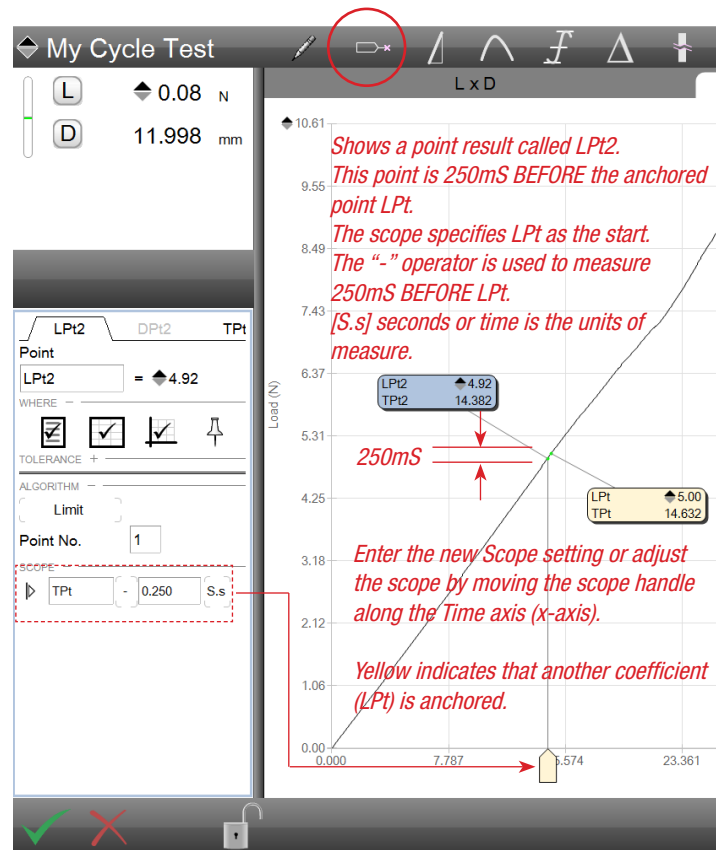
Limits Using an Anchored Point
Locates the LPt2 @ 250ms before (-) LPt

5.5.1.3   Point Number Name

When a Point is specified, the Data Definition menu displays three tabs. Each tab corresponds to the coefficient set for that point with a Load Point, Distance Point and Time Point. These points have default names as follows:

- Load Point = LPt
- Distance Point = DPt
- Time Point = TPt

When more than one set of points is used in the graph trace, each subsequent point is named with a number. For example, LPt2.

You can rename your Points using up to 8 alpha, numeric or space characters.

NOTE
Coefficient names may be up to 8 characters in length.
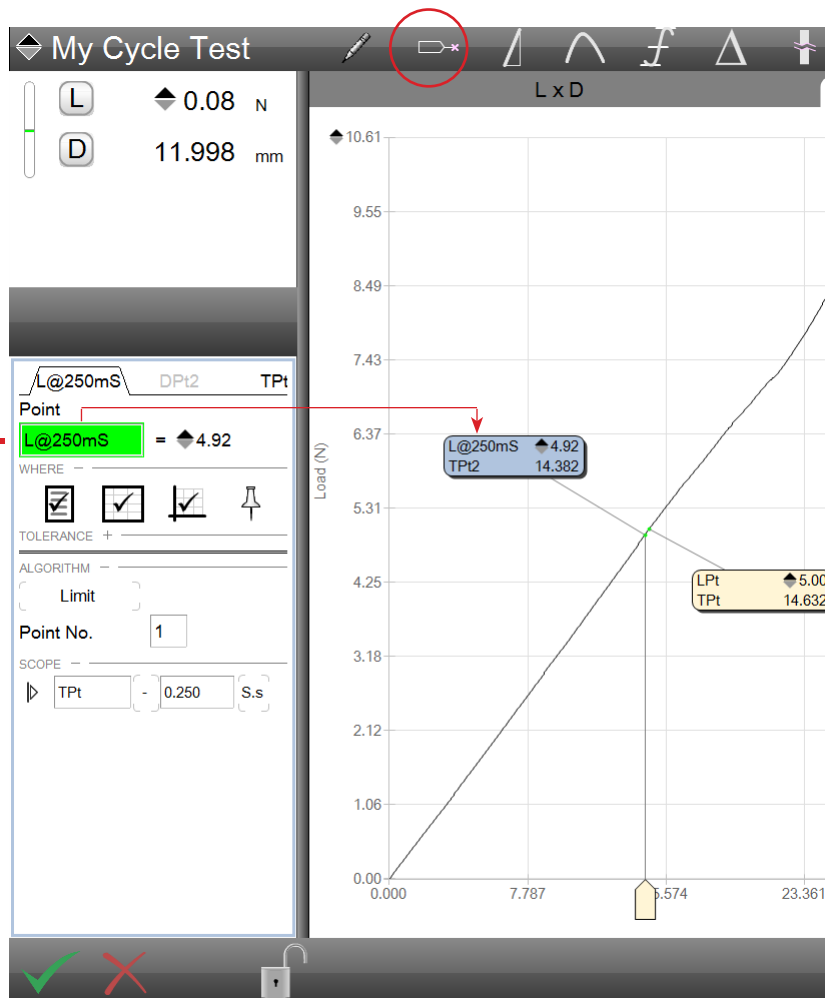
Rename your coefficient. This new name will appear on all specified views- Result view, Graph views and Data views.

Rename a Coefficient

5.5.1.4 Point Number Where

The WHERE function is used to specify where you want the coefficient (result) to display. There are three locations where a result can display:

- Results View
- Graph Views using a Marker
- Data Views (a column within the table)

The Where function also includes "Stick Pin" symbol. When this is used, the marker for this coefficient on any graph view is automatically placed by the software. You are able to move the marker to a preferred position, however, when the "stick pin" symbol is selected, the marker is automatically placed in a "best fit location" on your graph.

Graph views- because it is checked, the active coefficient (L@250mS) will display on all Graph views.

Results view. Unchecked, so doesn't appear.

Data views- because it is checked, the active coefficient (L@250mS) will display on all Data views (tables).

Shown is a cut-away of the Data Definition menu.
The WHERE section lets you define "where" you want the coefficient displayed. There are three options:
Results view- note that the symbol has no check and is greyed out. It doesn't appear in the Results view.
Data views- because it is checked, the active coefficient (L@250mS) will display on all Data views (tables).
Graph views- because it is checked, the active coefficient (L@250mS) will display on all Graph views.

Using WHERE Function
Specifies "where" a coefficient is displayed

5.5.1.5   Point Number Tolerance

Your result (coefficient) can make use of a tolerance to distinguish the result as either a "pass" or "fail" relative to your tolerance limits.

When you use a tolerance, you specify two tolerance limits. If your result equals or falls within the range created by these two tolerances, the result is displayed in black text and is deemed a "pass". If the result falls outside the tolerance range, the result displays in red text and is deemed a "fail".

Your L3 Series software also features a Tolerance view (TOL) that displays a tendency graph for the result. This graph displays whether the actual result is at the high or low end of the tolerance range you have established.
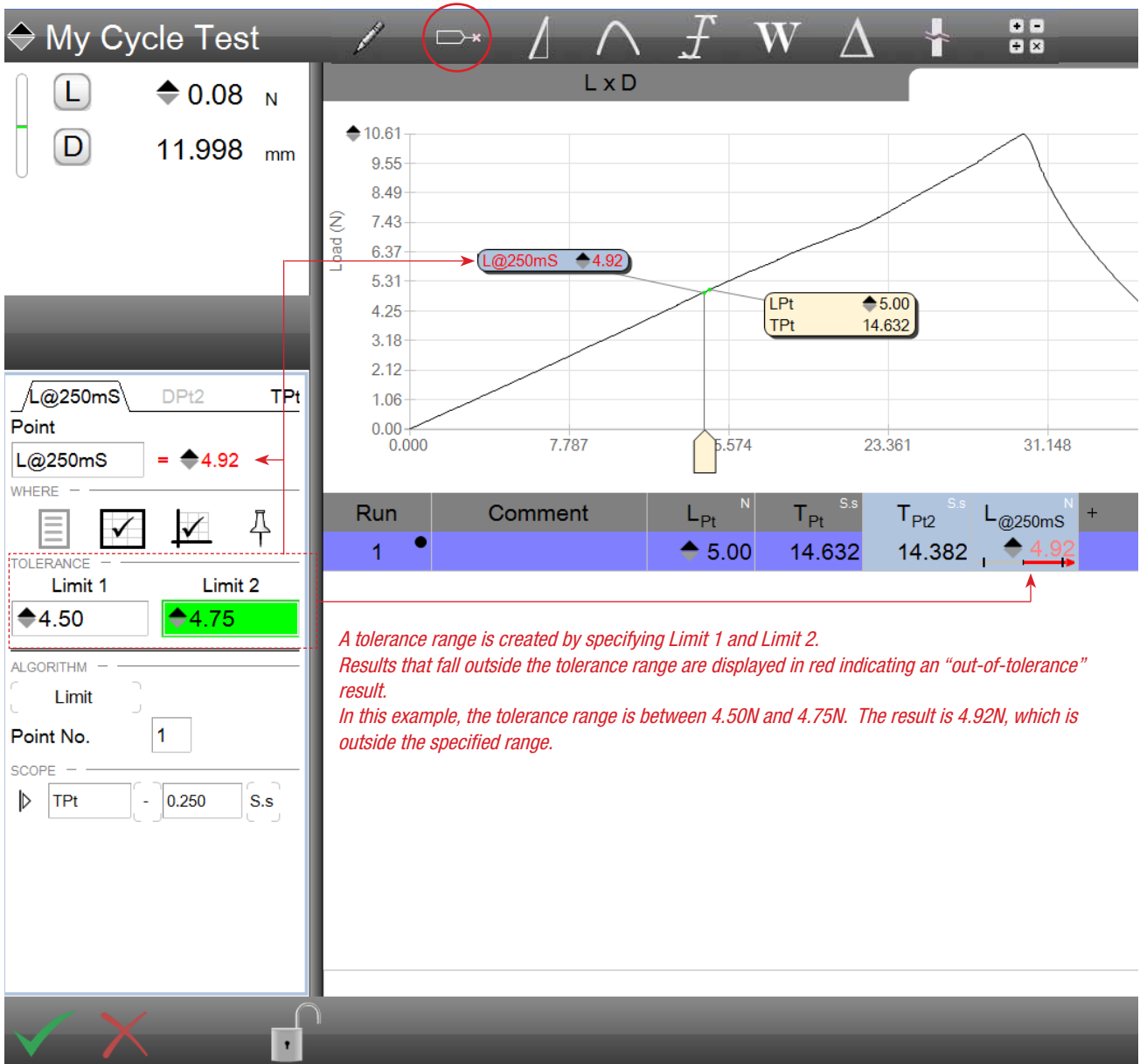
A tolerance range is created by specifying Limit 1 and Limit 2.
Results that fall outside the tolerance range are displayed in red indicating an "out-of-tolerance" result.
In this example, the tolerance range is between 4.50N and 4.75N. The result is 4.92N, which is outside the specified range.

Using Tolerance Function
Specifies "in-tolerance" limits

5.5.2 Slope Intersect Point Algorithm

The Slope Intersect algorithm is a point result. This is used in conjunction with the Slope tool. The Slope tool is used to find the slope of your graph trace for a segment that you specify using scoping.

The Slope Intersect may be used with either a stress-strain or load-distance test.

The Slope Intersect algorithm lets you find a point along your slope line as opposed to finding a point along the curve created by your measured data stream.

NOTE

This point uses the slope line as opposed to the data line on your graph. It is a derived result based on the slope line created on your load-distance curve.
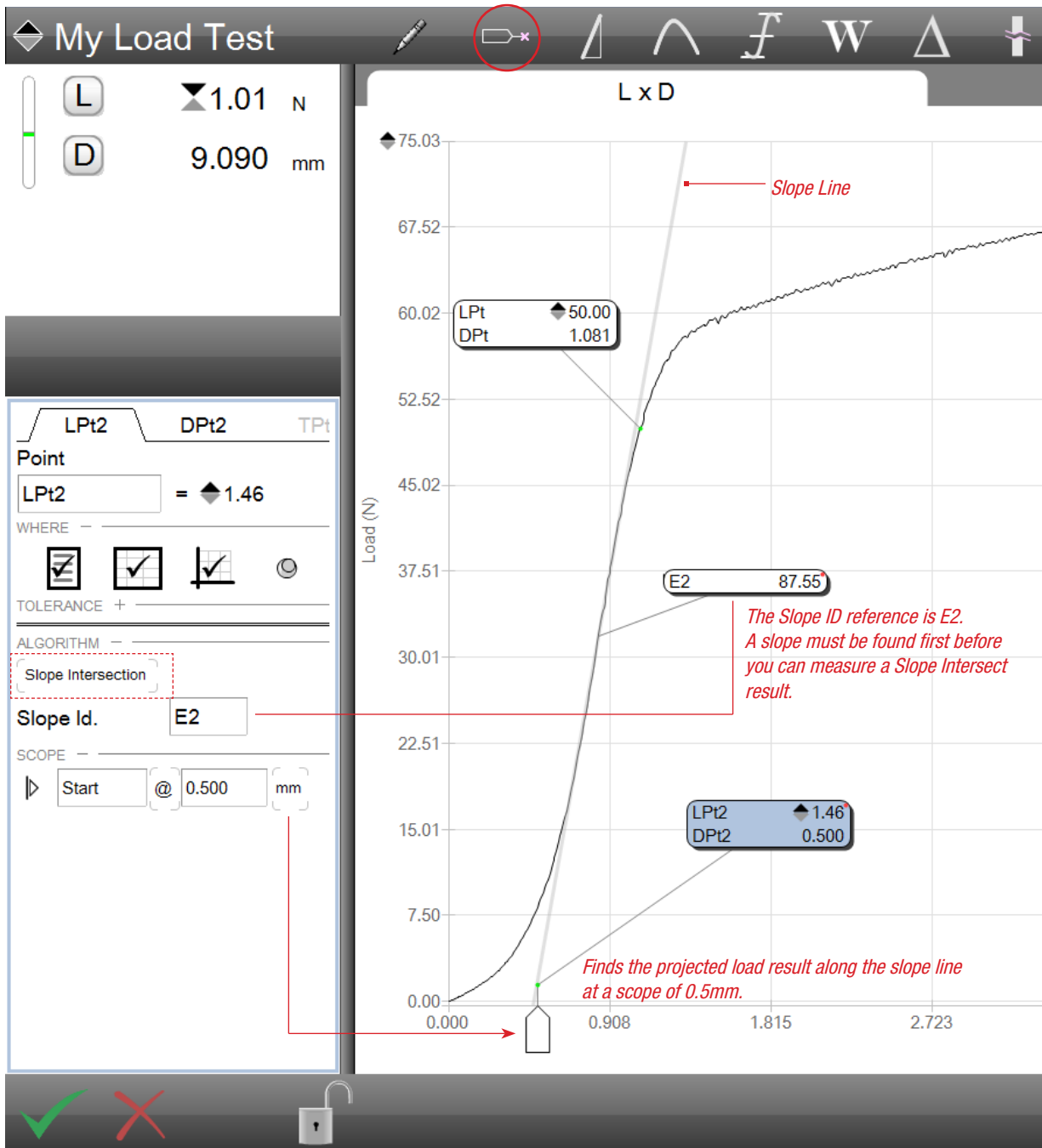
Using Point Slope Intersect
Indicates the result along a slope line

5.5.2.1 Slope (Modulus) ID

The Slope ID is the identifier of the slope line that will be used to obtain the Slope Intersect point. Because your graph may have more than one slope line, L3 Series software requires that you specify the slope line to be used.

5.5.2.2 Slope (Modulus) Intersect Scope

The Slope Intersect point may be scoped using the y-axis or x-axis. If the scope uses the y-axis, the load is used to find the distance along the slope line.

If the scope uses the x-axis, the load is used to find the load along the slope line.

5.5.2.3 Slope (Modulus) Intersect Name

The Slope Intersect name is the point name. The default name for this result in the same for a point, e.g. LPt.

It may be useful to rename this point to show its a point constructed by the slope line. For example, using the slope symbol (λ), you might want to use the Slope ID with your name, λ2Pt1.

5.5.2.4 Slope (Modulus) Intersect Where

The WHERE function is used to specify where you want the Slope Intersect point coefficient (result) to display. Display the point on any of these views:
- Results View
- Graph Views using a Marker
- Data Views (a column within the table)

5.5.2.5 Slope (Modulus) Intersect Tolerance

Your point result (coefficient) can make use of a tolerance to distinguish the result as either a "pass" or "fail" relative to your tolerance limits.

When you use a tolerance, you specify two tolerance limits. If your result equals or falls within the range created by these two tolerances, the result is displayed in black text and is deemed a "pass". If the result falls outside the tolerance range, the result displays in red text and is deemed a "fail".

Your L3 Series software also features a Tolerance view (TOL) that displays a tendency graph for the result. This graph displays whether the actual result is at the high or low end of the tolerance range you have established.

5.5.3   Offset Yield Point Algorithm

The Offset Yield algorithm is a point result. This is used in conjunction with the Slope/Modulus tool. The Slope tool is used to find the slope of your graph trace for a segment that you specify using scoping.

The Offset Yield may be used with stress-strain test.

The Offset Yield algorithm lets you find a point along your slope line that is parallel to the slope line and that is offset from the slope line by a percent of the strain. Where the offset line intersects your data trace is the offset point.

NOTE
This point uses the slope line as opposed to the data line on your graph. The offset line is drawn parallel to the slope line with a percent offset based on strain.

5.5.3.1   Offset Yield ID

The Offset Yield ID is the identifier of the line that will be used to obtain the Slope Intersect point. Because your graph may have more than one slope line, L3 Series software requires that you specify the slope line to be used.

5.5.3.2   Offset Yield Scope

The Offset Yield point may be scoped based on a percent of the strain value (Offset) and referenced to the slope line. You may vary the percent offset if necessary.

5.5.3.3   Offset Yield Name

The Offset Yield name is the point name. The default name for this result in the same for a point, e.g. σPt.

It may be useful to rename this point to show its a point constructed by the slope line. For example, you might want to name as the Tensile Strength at 0.2% (TS@0.2%).
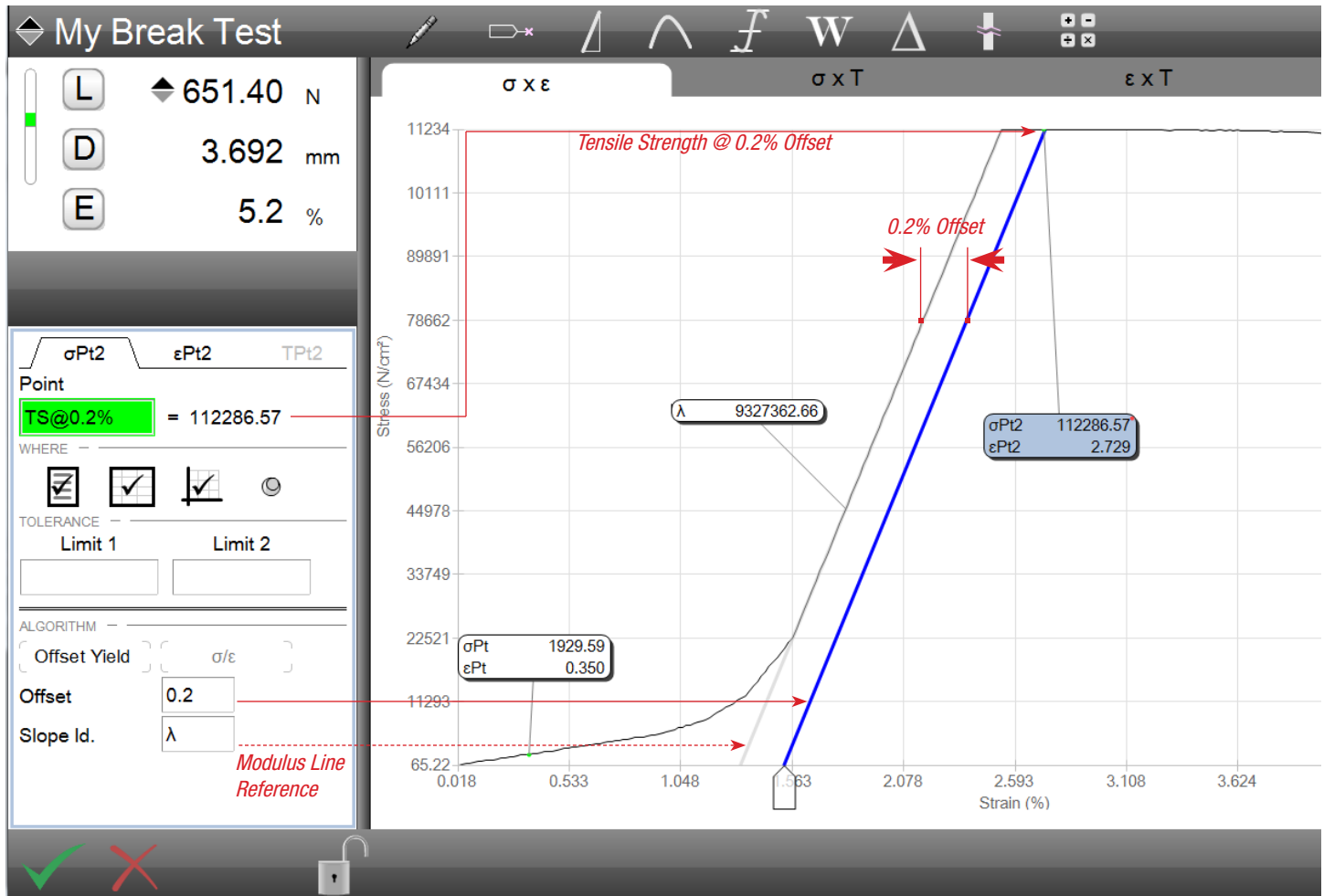
Using Point Offset Yield
Finds the Offset point based on the modulus line

5.5.3.4   Offset Yield Where

The WHERE function is used to specify where you want the Offset Yield point coefficient (result) to display. Display the point on any of these views:

- Results View
- Graph Views using a Marker
- Data Views (a column within the table)

5.5.3.5   Offset Yield Tolerance

Your point result (coefficient) can make use of a tolerance to distinguish the result as either a "pass" or "fail" relative to your tolerance limits.

When you use a tolerance, you specify two tolerance limits. If your result equals or falls within the range created by these two tolerances, the result is displayed in black text and is deemed a "pass". If the result falls outside the tolerance range, the result displays in red text and is deemed a "fail".

Your L3 Series software also features a Tolerance view (TOL) that displays a tendency graph for the result. This graph displays whether the actual result is at the high or low end of the tolerance range you have established.

Tolerance Limits on Offset Yield Point
Result is outside the Tolerance Range, displays Red for "out-of-tolerance"

5.6 Using the Slope (Modulus) Tool

The Slope or Modulus Tool is used to find the slope along the curve in your graph or to determine results such as the elastic modulus of a material.

L3 Series software has four (4) algorithms that you may use to find the slope or modulus along your data curve: Automatic Fit, Maximum, Tangent and Two-point also known as Chord or Segment slope.

Slope Measurement Tools
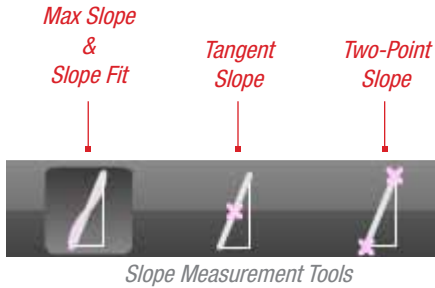
5.6.1 Maximum Slope Algorithm

The Maximum Slope algorithm uses all of the data within a segment that you specify using scope up to the greatest stress or load value measured within that segment.

The Maximum Slope algorithm uses all of the data points within your segment and looks for the greatest stress or load value first. It then calculates the slope from this greatest value. Because it is possible to have multiple peaks within your graph, the Maximum Slope algorithm will evaluate the data and find the greatest value within the entire data stream.

The Maximum Slope algorithm draws the slope or modulus line on the graph in green and calculates the elastic modulus for stress-strain.
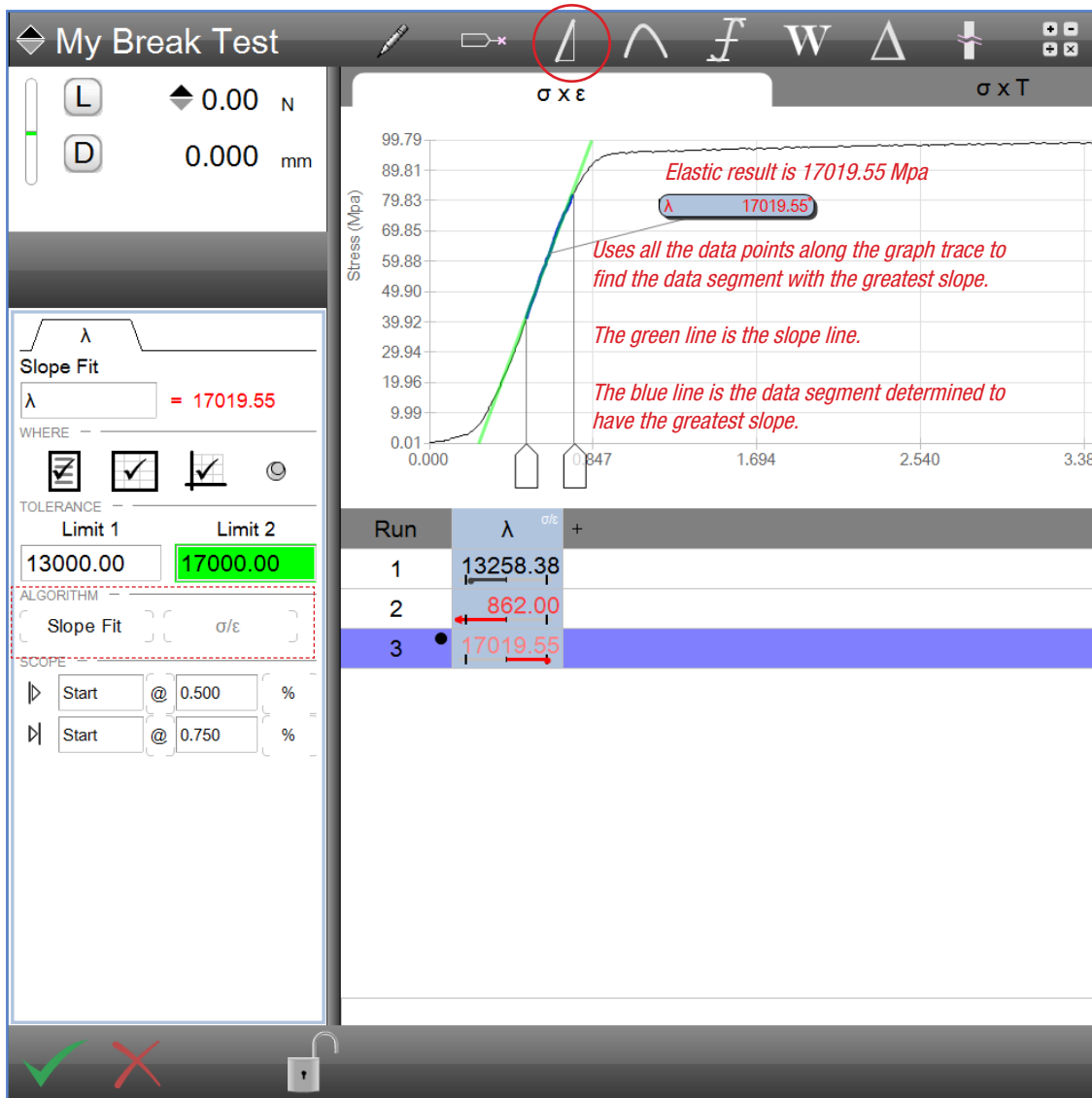
Using Automatic Slope (Fit)
Indicates the elastic result along a blue slope line

5.6.1.1 Maximum Slope Scope

The scope for maximum slope may be based on a specific point, such as the proportional limit. Or, you may find it better to position the scope handles for your maximum slope along the x-axis until the slope line is drawn based on your data.

As you position the scope handles, you will notice that the blue line segment changes to highlight the data representing the greatest slope.

5.6.1.2 Maximum Slope Name

The maximum slope name may be changed from its default of lambda (λ) to a name of your choosing.

The maximum slope name may be up to 8 characters in length.

NOTE
Use the Ctrl key + l to display λ.

5.6.1.3 Maximum Slope Where

The WHERE function is used to specify where you want the Maximum Slope and corresponding elastic point coefficient (result) to display. Display the point on any of these views:
- Results View
- Graph Views using a Marker
- Data Views (a column within the table)

5.6.1.4 Maximum Slope Tolerance

Your elastic result (coefficient) can make use of a tolerance to distinguish the result as either a "pass" or "fail" relative to your tolerance limits.

When you use a tolerance, you specify two tolerance limits. If your result equals or falls within the range created by these two tolerances, the result is displayed in black text and is deemed a "pass". If the result falls outside the tolerance range, the result displays in red text and is deemed a "fail".

Your L3 Series software also features a Tolerance view (TOL) that displays a tendency graph for the result. This graph displays whether the actual result is at the high or low end of the tolerance range you have established.

Maximum Slope
Shows elastic using the entire data stream from the Start to the Finish of the test

5.6.2 Tangent Slope Algorithm

The tangent slope or initial tangent is the slope of the line drawn tangent to a point or leg on the load-distance curve. The tangent slope is useful in describing the behavior of materials that have been stressed beyond the elastic region and that exhibit curves that make other types of modulus determination difficult.

The tangent slope is determined at a point on the curve and by the user defining a Leg Length.

Tangent Slope

Slope Measurement Tools

5.6.2.1 Leg Length

The Leg Length establishes how many data points on either side of the tangent point are used to calculate the slope line. A leg length is used since a slope line cannot be drawn based on a single point. The greater the value of the leg length, the more data points are used to draw the modulus and to obtain the result.

NOTE
The greater the leg length, the greater the number of data points are used to establish the slope line. When the leg length = 19, 9 data points on either side of your reference point are used to construct the modulus line.

5.6.2.2 Tangent Slope Scope

The scope for tangent slope is based on a specific point and a specified leg length.

As you position the scope handle, you will notice that the blue line segment created using the leg length changes to highlight the data representing the greatest slope.

The elastic is 6736.30 Mpa.

The x-axis (Distance) is used for scope.

The modulus line (green) is constructed along the curve and is scope from the Strain point at 0.942%. The Leg Length of 19 creates a line segment with 9 points on either side of the Strain point. This draws the modulus line.

Tangent Slope
Shows elastic at tangent point

5.6.2.3 Tangent Slope Name

The tangent slope name may be changed from its default of lambda (λ) to a name of your choosing.

The maximum slope name may be up to 8 characters in length and may use special characters.

NOTE
Use the Ctrl key + I to display λ.

5.6.2.4 Tangent Slope Where

The WHERE function is used to specify where you want the Tangent Slope and corresponding elastic coefficient (result) to display. Display the point on any of these views:

- Results View
- Graph Views using a Marker
- Data Views (a column within the table)

5.6.2.5 Tangent Slope Tolerance

Your elastic result (coefficient) can make use of a tolerance to distinguish the result as either a "pass" or "fail" relative to your tolerance limits.

When you use a tolerance, you specify two tolerance limits. If your result equals or falls within the range created by these two tolerances, the result is displayed in black text and is deemed a "pass". If the result falls outside the tolerance range, the result displays in red text and is deemed a "fail".

Your L3 Series software also features a Tolerance view (TOL) that displays a tendency graph for the result. This graph displays whether the actual result is at the high or low end of the tolerance range you have established.


The tolerance range is between 75.00 and 80.00. Since the result is 76.87N/mm, the result is within tolerance and displays in black text.

Split Graph-Data View
Shows WHERE results are displayed and tolerance setting for the slope coefficient

5.6.3 Two-point Slope (Modulus) Algorithm

The two-point algorithm constructs a modulus line between two user-defined points on the load-distance curve. The two-point algorithm is also called the Chord or Segment slope.

Once the curve is drawn, you can adjust your scope handles to create your modulus line. The elastic result is calculated using this line represented as a green line along your data.

5.6.3.1   Two-point Slope Scope

The scope for a segment or two-point slope is based on two specific points that defined the end points of a line segment.   This line segment is the chord or two-point modulus.

As you position the scope handles, the green line representing the modulus repositions itself along the curve. You can adjust the scope handles or enter the start and ending values in the Data Definition menu for the two-point slope algorithm. The elastic is calculated within the segment.

Two-Point Slope

Slope Measurement Tools
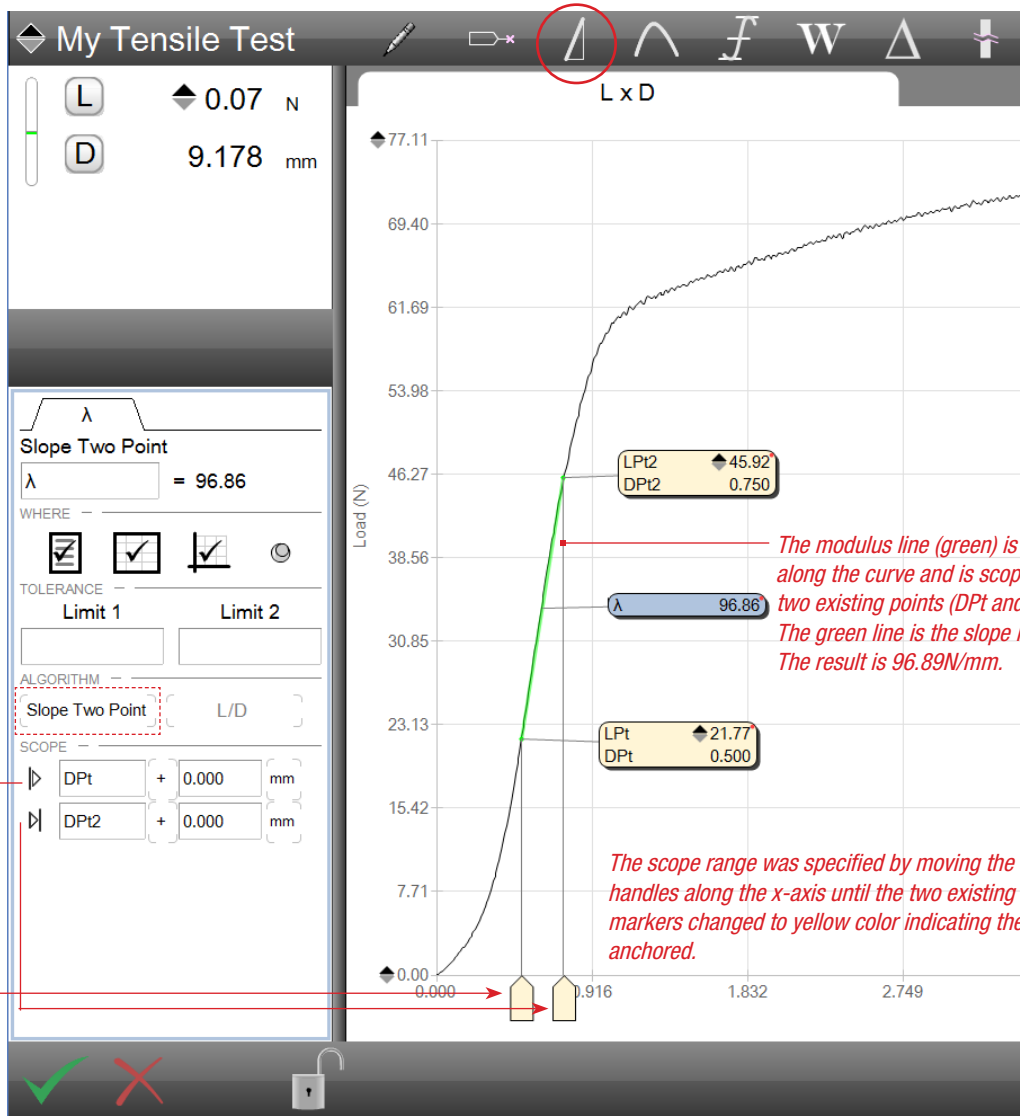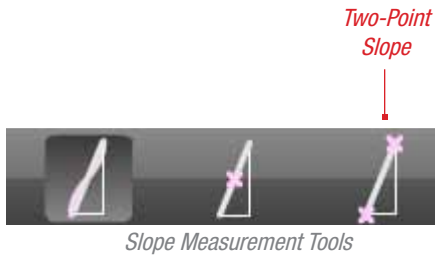
The modulus line (green) is constructed along the curve and is scoped between two existing points (DPt and DPt2).
The green line is the slope line.
The result is 96.89N/mm.

The scope range was specified by moving the scope handles along the x-axis until the two existing markers changed to yellow color indicating they are anchored.

Two-Point Slope
Shows elastic using two anchor points

5.6.3.2　　Two-point Slope Name

The two-point slope name may be changed from its default of lambda (λ) to a name of your choosing.

The maximum slope name may be up to 8 characters in length and may use special characters.

NOTE
Use the Ctrl key + l to display λ.

5.6.3.3　　Two-point Slope Where

The WHERE function is used to specify where you want the Two-point Slope and corresponding elastic coefficient (result) to display. Display the point on any of these views:
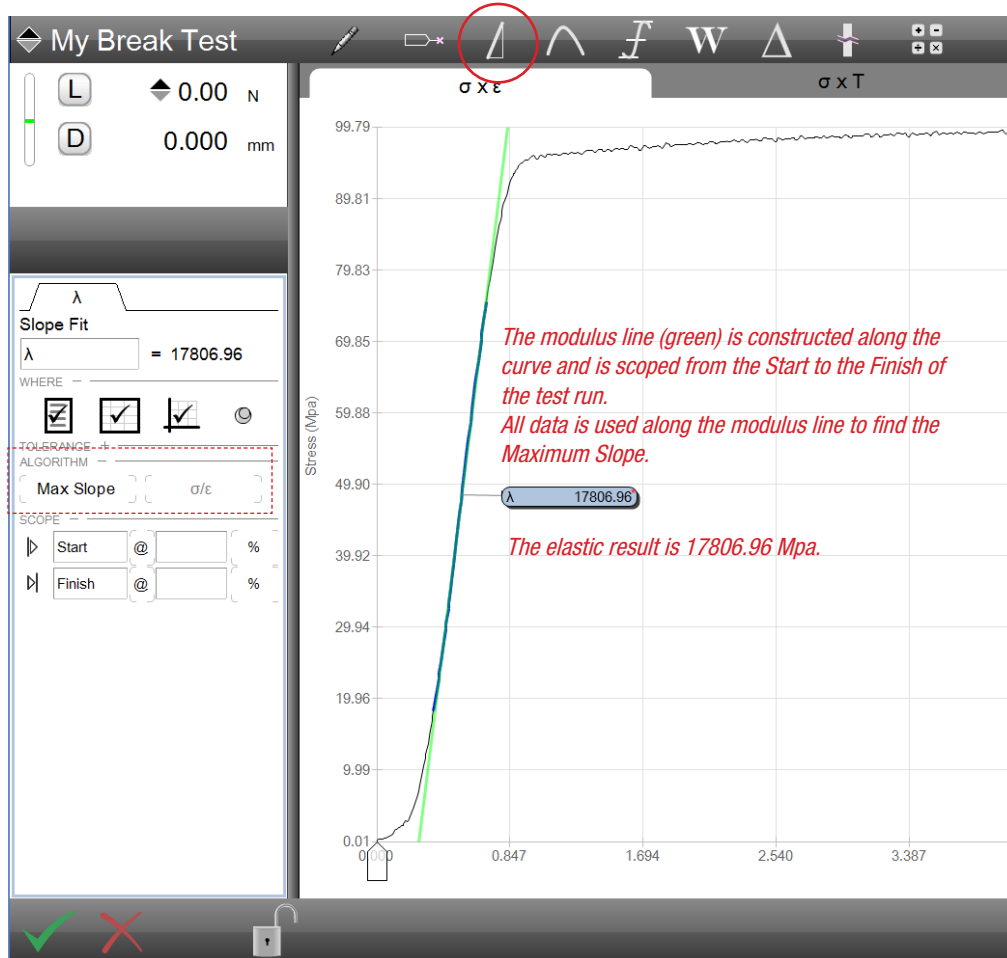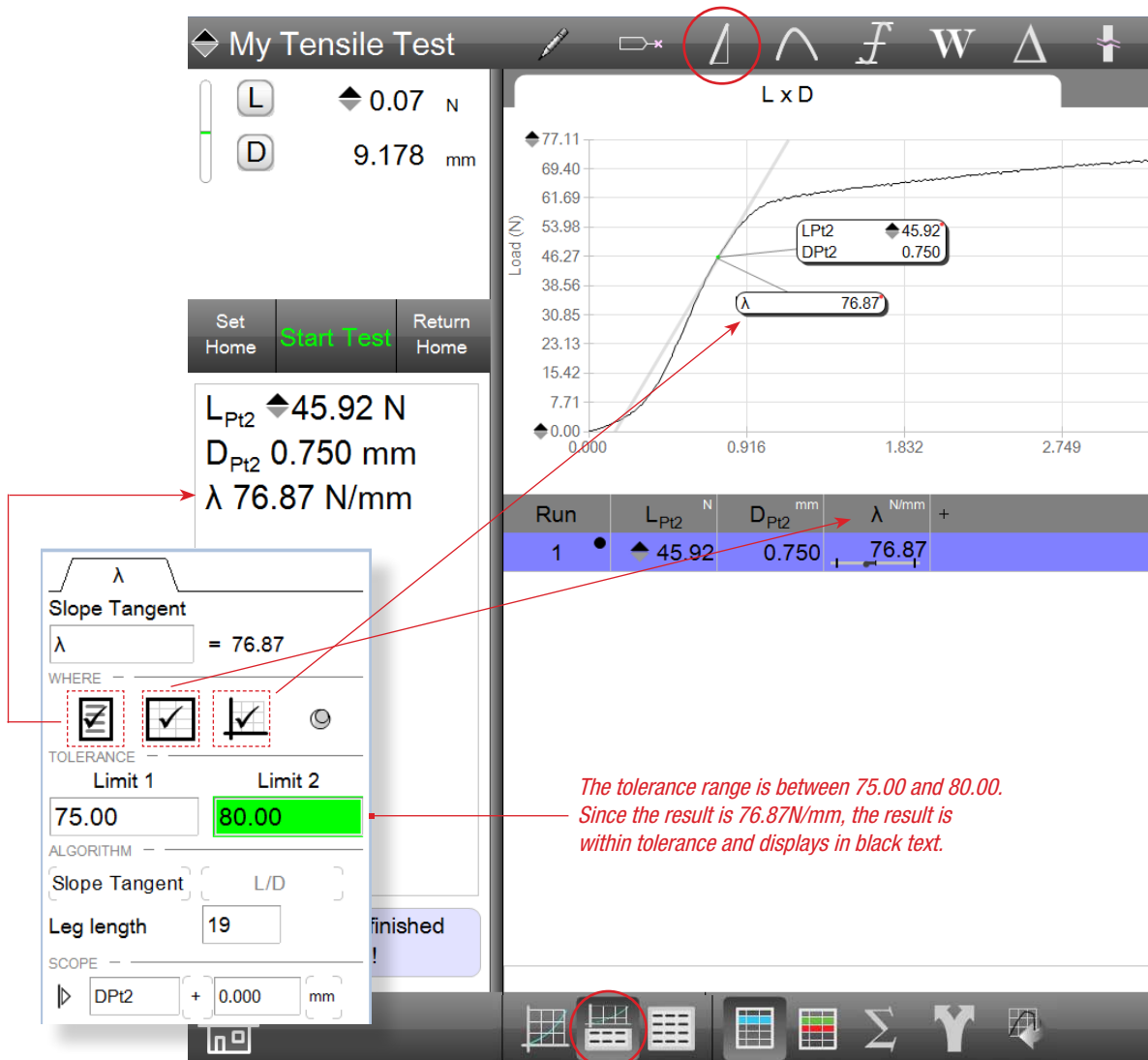
- Results View
- Graph Views using a Marker
- Data Views (a column within the table)

5.6.3.4　　Two-point Slope Tolerance

Your elastic result (coefficient) can make use of a tolerance to distinguish the result as either a "pass" or "fail" relative to your tolerance limits.

When you use a tolerance, you specify two tolerance limits. If your result equals or falls within the range created by these two tolerances, the result is displayed in black text and is deemed a "pass". If the result falls outside the tolerance range, the result displays in red text and is deemed a "fail".

Your L3 Series software also features a Tolerance view (TOL) that displays a tendency graph for the result. This graph displays whether the actual result is at the high or low end of the tolerance range you have established.

Two Point Slope (Chord Modulus)
Shows elastic using two specified points

5.6.4 Slope (Modulus) Fit Algorithm

The automatic Slope Fit algorithm uses a least square fit between the two scope locations that you define on your graph. The Slope Fit algorithm uses the first data point and maximum load point and then divides the data into equal regions with no overlap. A least squares fit is applied to all points in each region to determine the individual slopes within the region. The region with the highest slope is assigned the slope on which elastic is determined.

Max Slope
&
Slope Fit

Slope Measurement Tools

5.6.4.1 Slope Fit Scope

The scope for the automatic fit slope is based on two specific points that defined the end points of a line segment.   One point is the maximum load value on the curve.

As you position the scope handles, the green line representing the modulus repositions itself along the curve. You can adjust the scope handles or enter the start and ending values in the Data Definition menu for the two-point slope algorithm. The elastic is calculated within the segment.

The modulus line (green) is constructed within the scope range.

The blue line represents the line segment used to determine the greatest slope.

The scope range was specified by moving the scope handles along the x-axis until the two existing markers changed to yellow color indicating they are anchored.
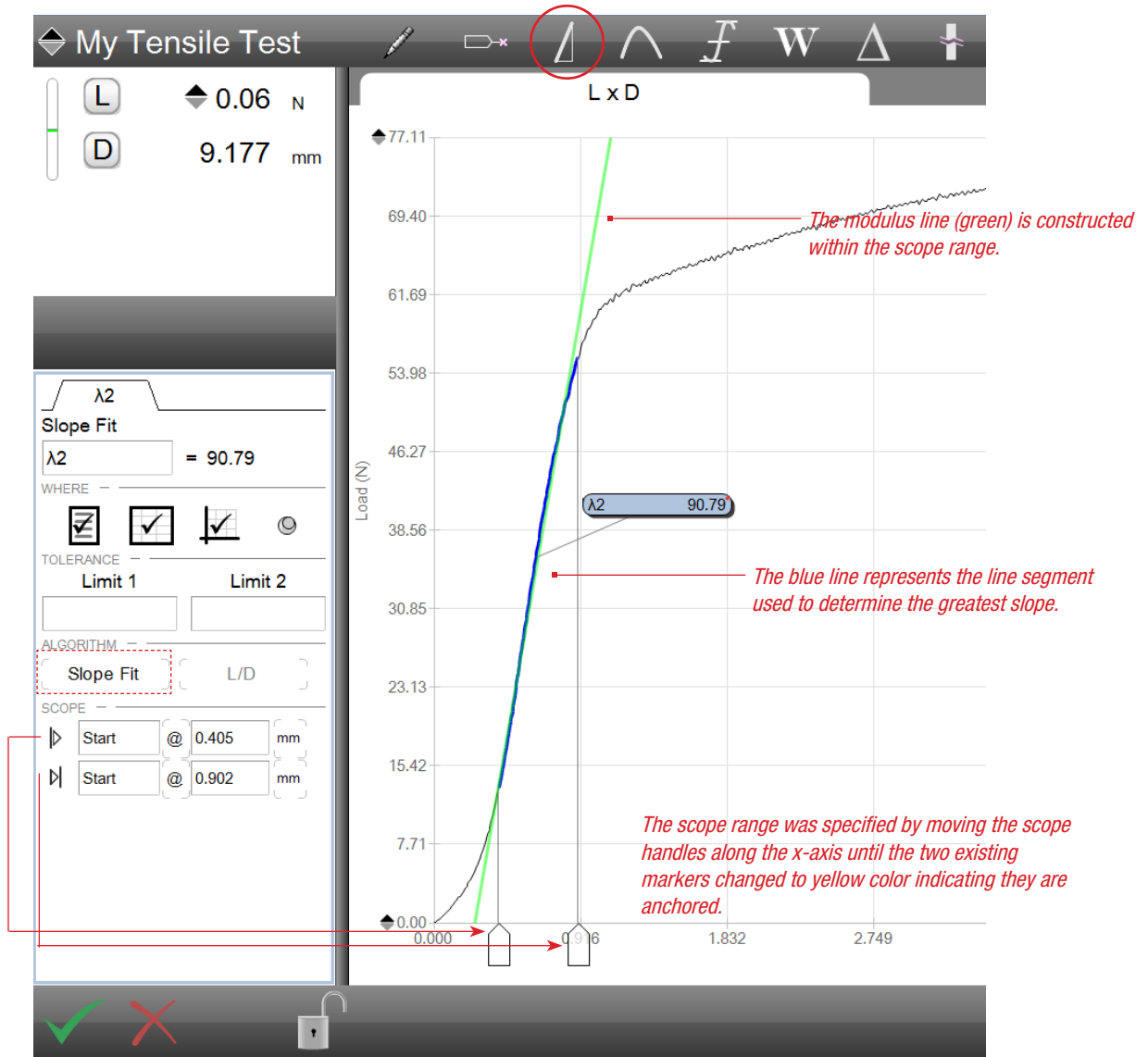
Slope Fit
Shows elastic using entire data stream

5.6.4.2　　　Slope Fit Name

The automatic fit slope name may be changed from its default of lambda to a name of your choosing.

The maximum slope name may be up to 8 characters in length and may use special characters.

NOTE
Use the Ctrl key + I to display λ.

5.6.4.3　　　Slope Fit Where

The WHERE function is used to specify where you want the automatic Fit Slope and corresponding elastic coefficient (result) to display. Display the point on any of these views:
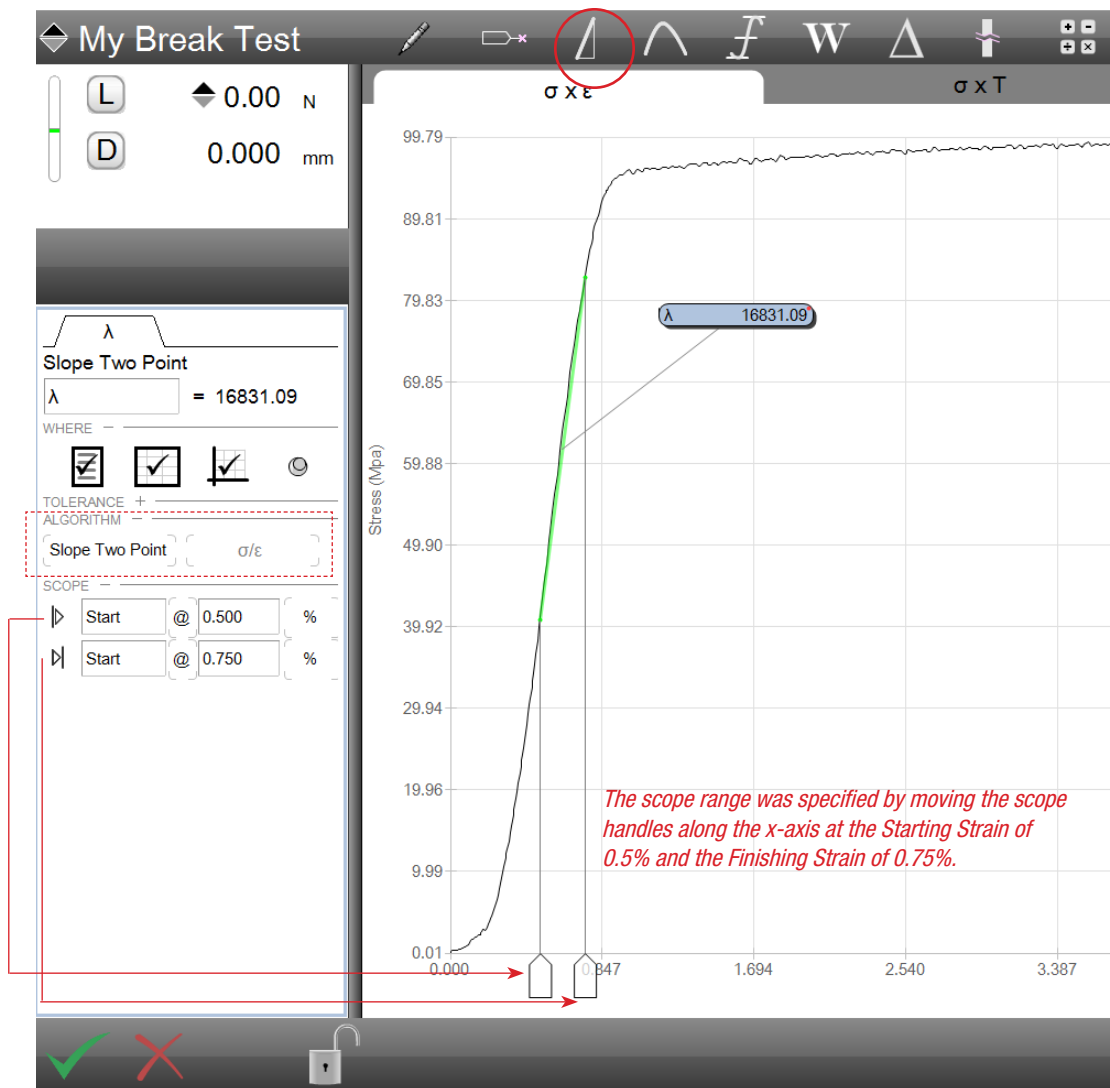
- Results View
- Graph Views using a Marker
- Data Views (a column within the table)

5.6.4.4　　　Slope Fit Tolerance

Your elastic result (coefficient) can make use of a tolerance to distinguish the result as either a "pass" or "fail" relative to your tolerance limits.

When you use a tolerance, you specify two tolerance limits. If your result equals or falls within the range created by these two tolerances, the result is displayed in black text and is deemed a "pass". If the result falls outside the tolerance range, the result displays in red text and is deemed a "fail".

Your L3 Series software also features a Tolerance view (TOL) that displays a tendency graph for the result. This graph displays whether the actual result is at the high or low end of the tolerance range you have established.

Slope Fit
Shows Split Graph Data view with Tolerance on elastic

5.7   Using Peak & Valley Tools (Peel and Cyclic Testing)

Peel tests have characteristically noise curves with multiple peaks and valleys. With L3 Series software, you can easily and quickly analyze your peel data results and determine such results as the number of peaks and valleys for a segment; the minimum or maximum load or stress values within a segment or for the entire test. You can determine the average values for a segment or for the entire test.

The tools available for peak & valley analysis are ideal for peel testing, coefficient of friction testing or for applications utilizing cyclic testing.

Numbered Peak Valley   *Average Peak Valley*   *Count Peak Valley*

Peak/Valley Tools

The bright blue peak is Peak #10 (Index) with a load result of 6.71N.

Peaks are identified based on load sensitivity. All peaks for the scope range are highlited.

The scope range begins at the Start and finishes at 15.000mm.

Slope Fit
Shows elastic using entire data stream

5.7.1 Numbered Algorithm

The Numbered algorithm is used to find the maximum peak or valley within a specified scope range and that meet a specified sensitivity.

Selecting above the curve will report using the peaks data, while selecting below the curve will report the valleys data.

The numbered algorithm may be used for load or distance.

5.7.1.1 Sensitivity

Sensitivity is a percent value. It is the percent that qualifies a peak or a valley based on an equal percentage rise and fall. For example a sensitivity of 25 would look at all data within a defined scope region where the data for a rise and fall is at least 25% of greater. When the portion of the curve qualified against the sensitivity, it is highlited in blue.

If a rise on the curve for load was 25% (an increase in load from the start of the rise to the end of the rise (peak), and the fall on the curve was less than 25%, this portion of the curve would not qualify, therefore, the segment on the curve is not a valid peak and valley. This portion of the curve would not highlight in blue.

5.7.1.2 Index

The Index default value is 1. An Index = 1 means that the result is measured at the first incident (looking at the data from left to right) on the curve where the Sensitivity qualification is met.

If the Index value is 2, the data stream on the curve is evaluated for sensitivity to determine which peaks and valleys are qualified, and then it looks for the second incident to report the maximum peak or maximum valley.

You may use a negative Index number (e.g. -1). When a negative index is used, the data is evaluated from right to left.

Sensitivity
Used to qualify what is or isn't a Peak or Valley
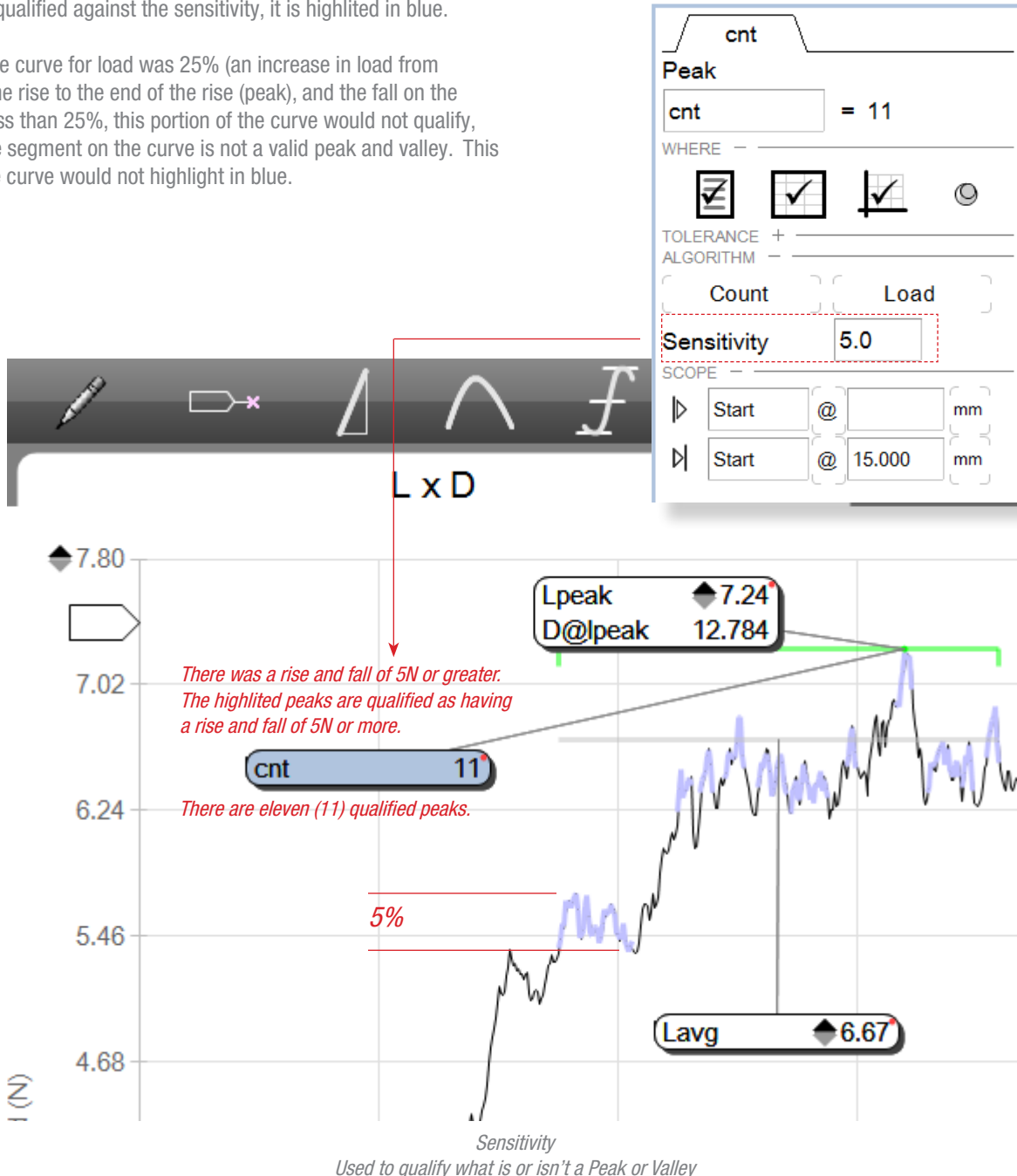
5.7.1.3   Numbered Algorithm Scope

The scope for the Numbered Peak & Valley algorithm is based on two specific points that defined the end points of a data segment.

You may position the scope handles along either the y-axis or x-axis to define the data segment where you are interested in analyzing.

Or, you may implicitly specify your start and end scope points using values or other coefficients that can be used as anchors. Anchored coefficients display in yellow.

5.7.1.4   Numbered Algorithm Name

The Numbered algorithm name may be changed from its default.

The result name may be up to 8 characters in length and may use special characters.

5.7.1.5   Numbered Algorithm Where

The WHERE function is used to specify where you want the Numbered result to display. Display the point on any of these views:
- Results View
- Graph Views using a Marker
- Data Views (a column within the table)

5.7.1.6   Numbered Algorithm Tolerance

Your Numbered result (coefficient) can make use of a tolerance to distinguish the result as either a "pass" or "fail" relative to your tolerance limits.

When you use a tolerance, you specify two tolerance limits. If your result equals or falls within the range created by these two tolerances, the result is displayed in black text and is deemed a "pass". If the result falls outside the tolerance range, the result displays in red text and is deemed a "fail".

Your L3 Series software also features a Tolerance view (TOL) that displays a tendency graph for the result. This graph displays whether the actual result is at the high or low end of the tolerance range you have established.
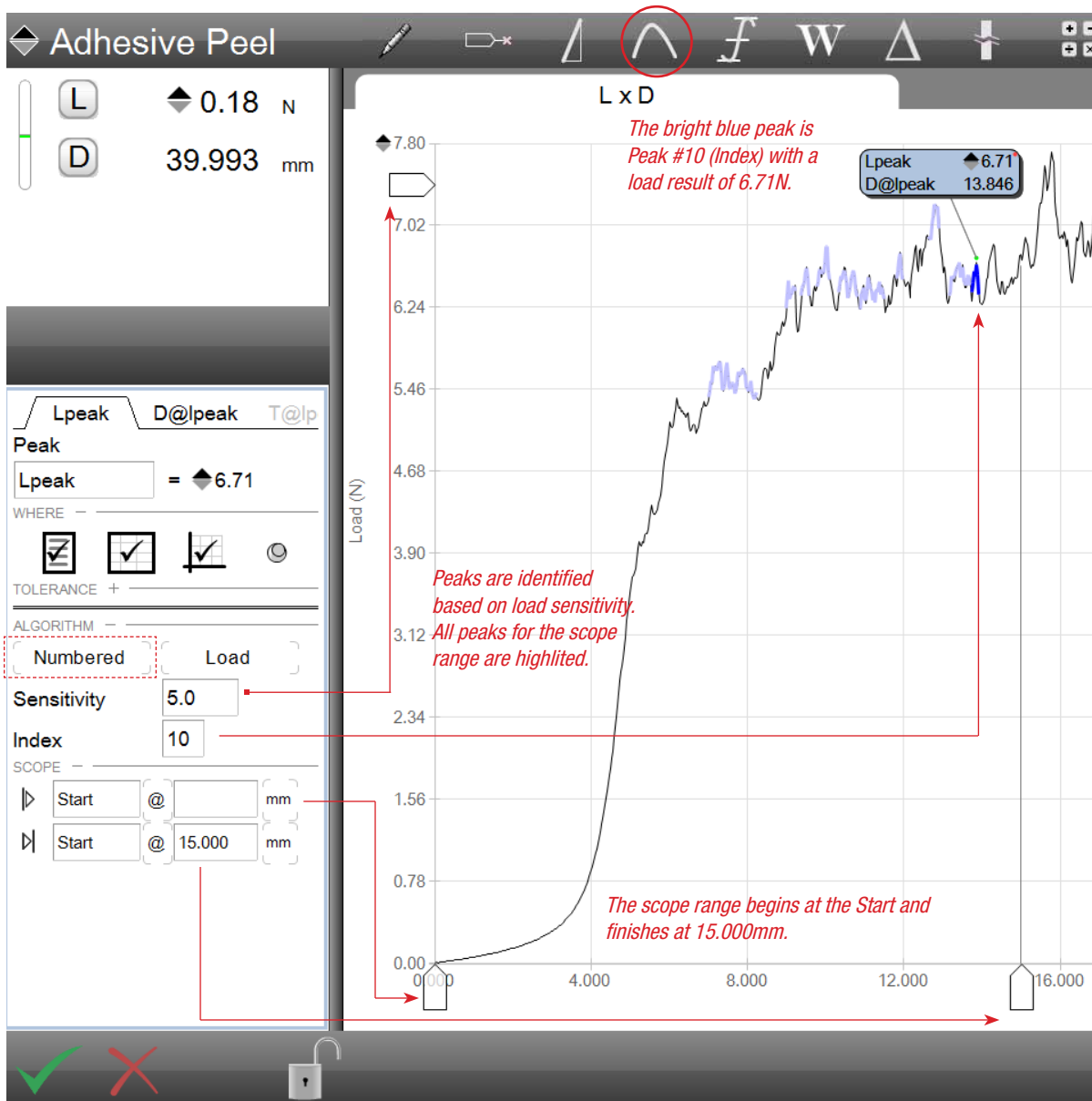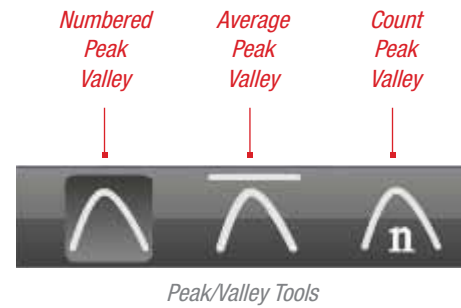

Minimum load tolerance is 5N. Results display in red for out-of-tolerance results. Load less than 5N.

Out-of-tolerance results displayed in red on all views: Result view, Graph and Data table.

Batch	Run	L$_{peak}$ N	D$_{@lpeak}$ mm	c$_{nt}$	+
TP4455	1	1.65	5.672	12	
TP4455	2	4.16	2.361	10	
TP4455	3	2.03	5.586	5	
TP4455	4	4.55	9.188	6	
TP4455	5	2.42	9.255	3	
TP4455	6	5.74	7.303	11	

Test 4 of 5 for TP4455.

Graph-Data view is selected

Standard view is selected

Where is setup to display Lpeak on:
- *Results view*
- *Graph views*
- *Data views*

Minimum Peak Result views
Displays on Result view and Split Graph-Data view

5.7.2 Minimum Algorithm (Peak)

The Minimum algorithm finds the minimum or lowest measured result within a scope segment or for the entire test. Selecting above the curve will let you look for the minimum peak loads. Setting the sensitivity will define the peaks that qualify and based on these qualified peaks, the algorithm will find and report the peak having the minimum load or stress value for all of these peaks.

5.7.2.1   Sensitivity

Sensitivity is a percent value. It is the percent that qualifies a peak or a valley based on an equal percentage rise and fall. For example a sensitivity of 5 would look at all data within a defined scope region where the data for a rise and fall is at least 5% of greater. When the portion of the curve qualified against the sensitivity, it is highlited in blue.

If a rise on the curve for load was 5% (an increase in load from the start of the rise to the end of the rise (peak), and the fall on the curve was less than 5%, this portion of the curve would not qualify, therefore, the segment on the curve is not a valid peak and valley. This portion of the curve would not highlight in blue.

5.7.2.2   Minimum Algorithm Scope

The scope for the Minimum algorithm is based on two specific points that defined the end points of a data segment.

You may position the scope handles along either the y-axis or x-axis to define the data segment where you are interested in analyzing.

Or, you may implicitly specify your start and end scope points using values or other coefficients that can be used as anchors. Anchored coefficients display in yellow.

5.7.2.3   Minimum Algorithm Name

The Minimum algorithm name may be changed from its default of Lpeak when based on load. For example, you may rename Lmin.

The result name may be up to 8 characters in length and may use special characters.
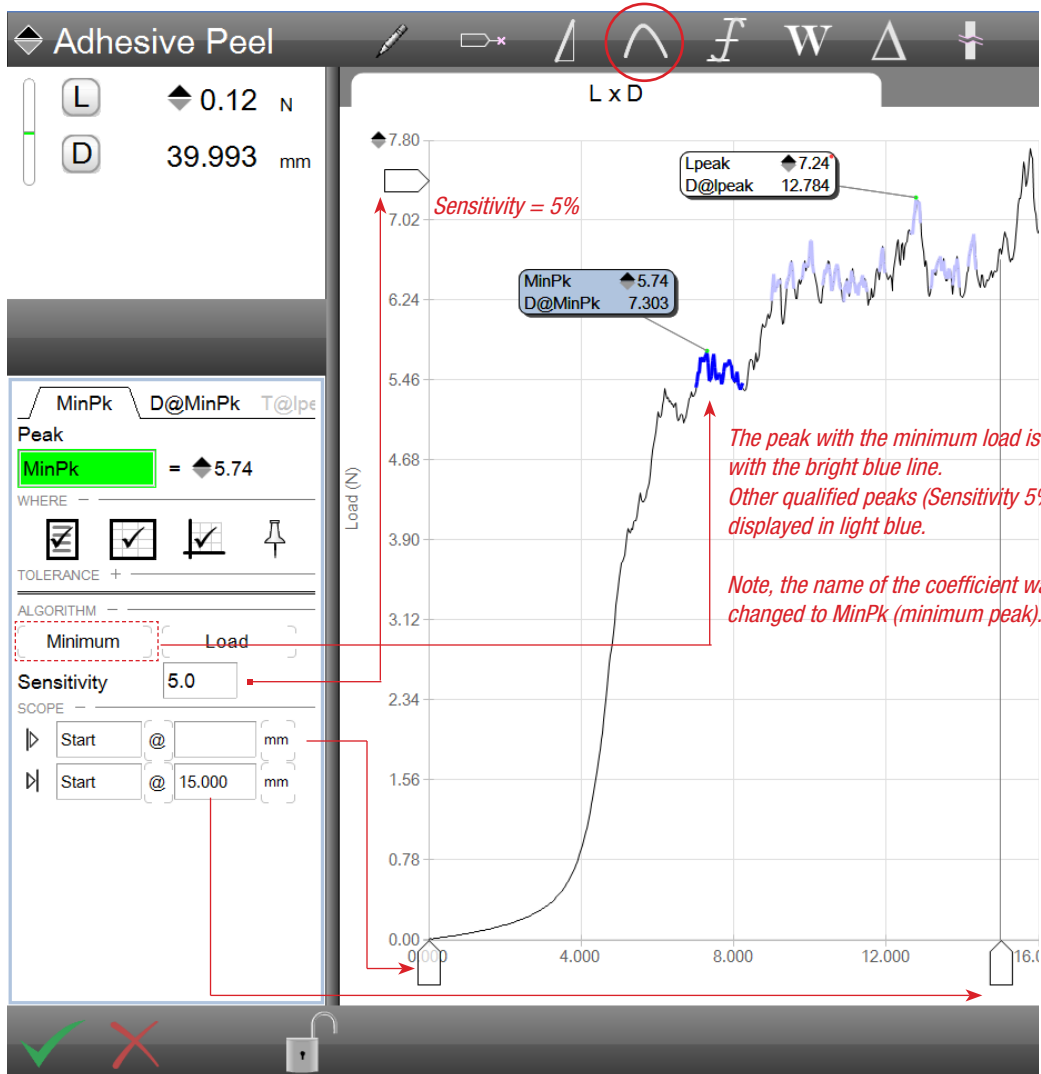
Minimum Peak
Shows the minimum peak within the scope range

5.7.2.4   Minimum Algorithm Where

The WHERE function is used to specify where you want the Minimum result to display. Display the point on any of these views:

- Results View
- Graph Views using a Marker
- Data Views (a column within the table)

5.7.2.5   Minimum Algorithm Tolerance

Your Minimum result (coefficient) can make use of a tolerance to distinguish the result as either a "pass" or "fail" relative to your tolerance limits.

When you use a tolerance, you specify two tolerance limits. If your result equals or falls within the range created by these two tolerances, the result is displayed in black text and is deemed a "pass". If the result falls outside the tolerance range, the result displays in red text and is deemed a "fail".

Your L3 Series software also features a Tolerance view (TOL) that displays a tendency graph for the result. This graph displays whether the actual result is at the high or low end of the tolerance range you have established.

Batch	Run	L_{valley} N	$D_{@lvalley}$ mm	L_{peak} N
TP4455	1	1.81	19.352	1.65
TP4455	2	5.12	27.860	4.16
TP4455	3	2.88	39.682	2.03
TP4455	4	4.25	31.858	4.36
TP4455	5	3.98	35.169	2.42
TP4455	6	5.53	34.545	5.74

The coefficient Lpeak has a tolerance range between 4.00 and 5.00N. Results equal to or within this range display black indicating an "in-tolerance" result. Results outside this range display red indicating an "out-of-tolerance" result.

Minimum Peak with Tolerance
Out-of-tolerance results display in red text

5.7.3   Maximum Algorithm (Valley)

The Maximum algorithm finds the maximum or greatest measured result within a scope segment or for the entire test. Selecting below the curve will let you look for the maximum valley loads. Setting the sensitivity will define the valleys that qualify and based on these qualified peaks, the algorithm will find and report the valley having the maximum load value for all of these valleys.

5.7.3.1   Sensitivity

Sensitivity is a percent value. It is the percent that qualifies a peak or a valley based on an equal percentage rise and fall. For example a sensitivity of 5 would look at all data within a defined scope region where the data for a rise and fall is at least 5% of greater. When the portion of the curve qualified against the sensitivity, it is highlited in blue.

If a rise on the curve for load was 5% (an increase in load from the start of the rise to the end of the rise (peak), and the fall on the curve was less than 5%, this portion of the curve would not qualify, therefore, the segment on the curve is not a valid peak and valley. This portion of the curve would not highlight in blue.

5.7.3.2   Maximum Algorithm Scope

The scope for the Maximum algorithm is based on two specific points that defined the end points of a data segment.

You may position the scope handles along either the y-axis or x-axis to define the data segment where you are interested in analyzing.

Or, you may implicitly specify your start and end scope points using values or other coefficients that can be used as anchors. Anchored coefficients display in yellow.

5.7.3.3   Maximum Algorithm Name

The Maximum algorithm name may be changed from its default of Lvalley when based on load. For example, you may rename Lmax.

The result name may be up to 8 characters in length and may use special characters.

Maximum Valley

5.7.3.4 Maximum Algorithm Where

The WHERE function is used to specify where you want the Maximum result to display. Display the point on any of these views:

- Results View
- Graph Views using a Marker
- Data Views (a column within the table)

5.7.3.5 Maximum Algorithm Tolerance

Your Maximum result (coefficient) can make use of a tolerance to distinguish the result as either a "pass" or "fail" relative to your tolerance limits.

When you use a tolerance, you specify two tolerance limits. If your result equals or falls within the range created by these two tolerances, the result is displayed in black text and is deemed a "pass". If the result falls outside the tolerance range, the result displays in red text and is deemed a "fail".

Your L3 Series software also features a Tolerance view (TOL) that displays a tendency graph for the result. This graph displays whether the actual result is at the high or low end of the tolerance range you have established.

Out-of-tolerance results display red on all views: Result view, Graph views, and Data views.

Batch	Run	L_{valley} N	$D_{@lvalley}$ mm	$L_{valley2}$ N	+
TP4455	1	1.81	19.352	3.29	
TP4455	2	5.12	27.860	6.52	
TP4455	3	2.88	39.682	4.75	
TP4455	4	4.25	31.858	4.37	
TP4455	5	3.98	35.169	3.83	
TP4455	6	5.53	34.545	6.85	

The active Run #6 shows Lvalley2 is within the specified tolerance range.

Maximum Valley with Tolerance
Out-of-tolerance results display in red text

5.7.4 Count Algorithm

The Count algorithm determines the number of peaks or the number of valleys. Selecting above the curve will measure for peaks, while selecting below the curve will measure for valleys.

Peaks and valleys are determined based on the scope segment and the sensitivity you specify.

5.7.4.1 Sensitivity

Sensitivity is a percent value. It is the percent that qualifies a peak or a valley based on an equal percentage rise and fall. For example a sensitivity of 5 would look at all data within a defined scope region where the data for a rise and fall is at least 5% of greater. When the portion of the curve qualified against the sensitivity, it is highlited in blue.

If a rise on the curve for load was 5% (an increase in load from the start of the rise to the end of the rise (peak), and the fall on the curve was less than 5%, this portion of the curve would not qualify, therefore, the segment on the curve is not a valid peak and valley. This portion of the curve would not highlight in blue.

5.7.4.2 Count Algorithm Scope

The scope for the Count algorithm is based on two specific points that defined the end points of a data segment.

You may position the scope handles along either the y-axis or x-axis to define the data segment where you are interested in analyzing.

Or, you may implicitly specify your start and end scope points using values or other coefficients that can be used as anchors. Anchored coefficients display in yellow.

5.7.4.3 Count Algorithm Name

The Count algorithm name may be changed from its default of Lcnt when based on load. For example, you may rename L#.

The result name may be up to 8 characters in length and may use special characters.

Count
Peak
Valley

Peak/Valley Tools

Peel test using Peak/Valley Measurement
Shows the number of Valleys (Count) for the scope segment and a sensitivity of 5%

5.7.4.4 Count Algorithm Where

The WHERE function is used to specify where you want the Count result to display. Display the point on any of these views:
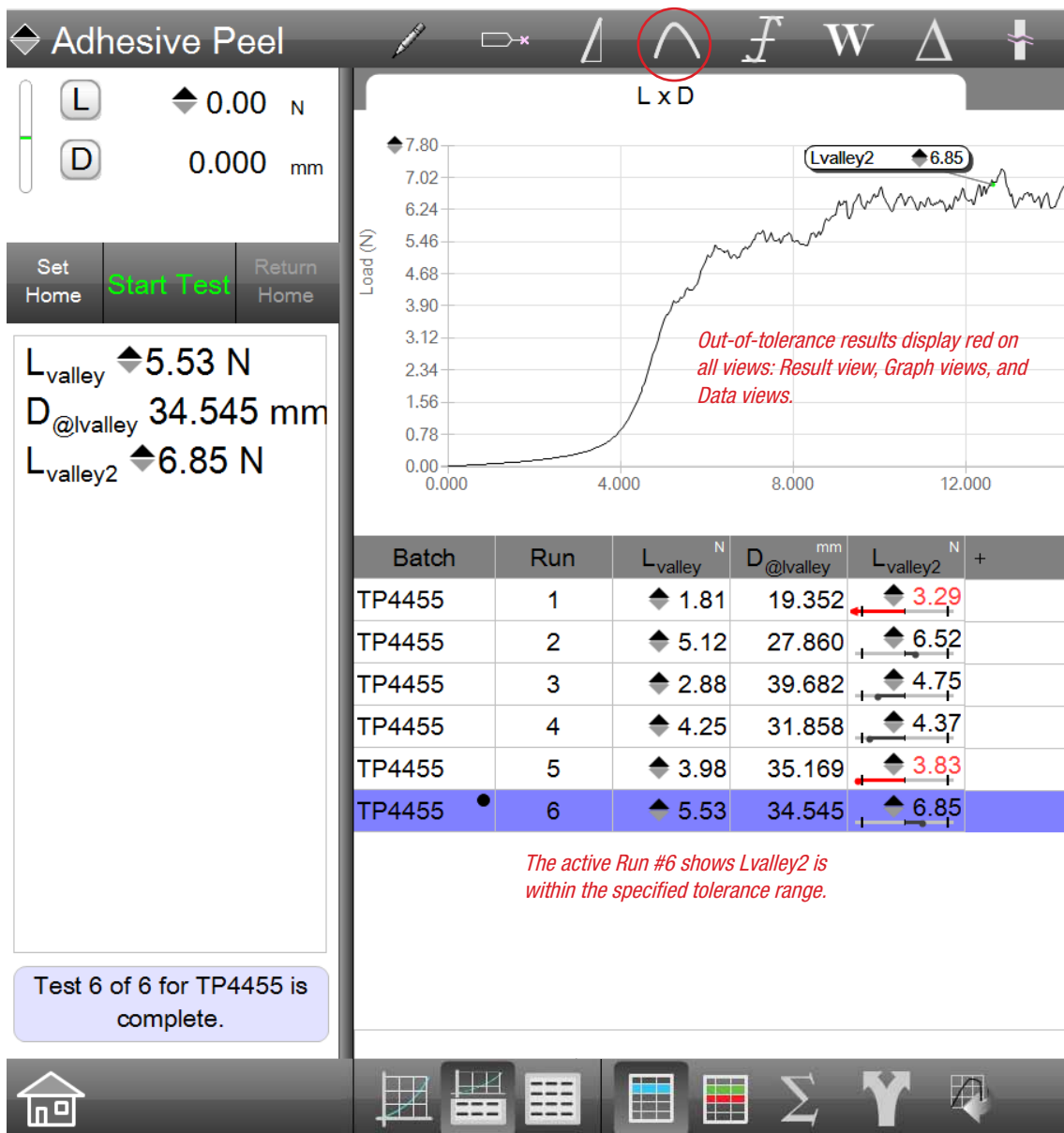
- Results View
- Graph Views using a Marker
- Data Views (a column within the table)

5.7.4.5 Count Algorithm Tolerance

Your Count result (coefficient) can make use of a tolerance to distinguish the result as either a "pass" or "fail" relative to your tolerance limits.

When you use a tolerance, you specify two tolerance limits. If your result equals or falls within the range created by these two tolerances, the result is displayed in black text and is deemed a "pass". If the result falls outside the tolerance range, the result displays in red text and is deemed a "fail".

Your L3 Series software also features a Tolerance view (TOL) that displays a tendency graph for the result. This graph displays whether the actual result is at the high or low end of the tolerance range you have established.

Count Display
The WHERE setting displays Count on the Results view and Graph

5.7.5   Averaging Algorithm

The Average algorithm averages the peaks or the valleys within your scope segment. Selecting above the curve will measure the average of peaks while selecting below the curve will measure the average of valleys.

The peak average is calculated by adding the highest value with each peak and dividing by the number of qualified peaks based on the sensitivity.

The valley average is calculated by adding the lowest value with each valley and dividing by the number of qualified valleys based on the sensitivity.

5.7.5.1   Sensitivity

Sensitivity is a percent value. It is the percent that qualifies a peak or a valley based on an equal percentage rise and fall. For example a sensitivity of 5 would look at all data within a defined scope region where the data for a rise and fall is at least 5% of greater. When the portion of the curve qualified against the sensitivity, it is highlited in blue.

If a rise on the curve for load was 5% (an increase in load from the start of the rise to the end of the rise (peak), and the fall on the curve was less than 5%, this portion of the curve would not qualify, therefore, the segment on the curve is not a valid peak and valley. This portion of the curve would not highlight in blue.

5.7.5.2   Averaging Algorithm Scope

The scope for the Average algorithm is based on two specific points that defined the end points of a data segment.

You may position the scope handles along either the y-axis or x-axis to define the data segment where you are interested in analyzing.

Or, you may implicitly specify your start and end scope points using values or other coefficients that can be used as anchors. Anchored coefficients display in yellow.

Average
Peak
Valley

Peak/Valley Tools
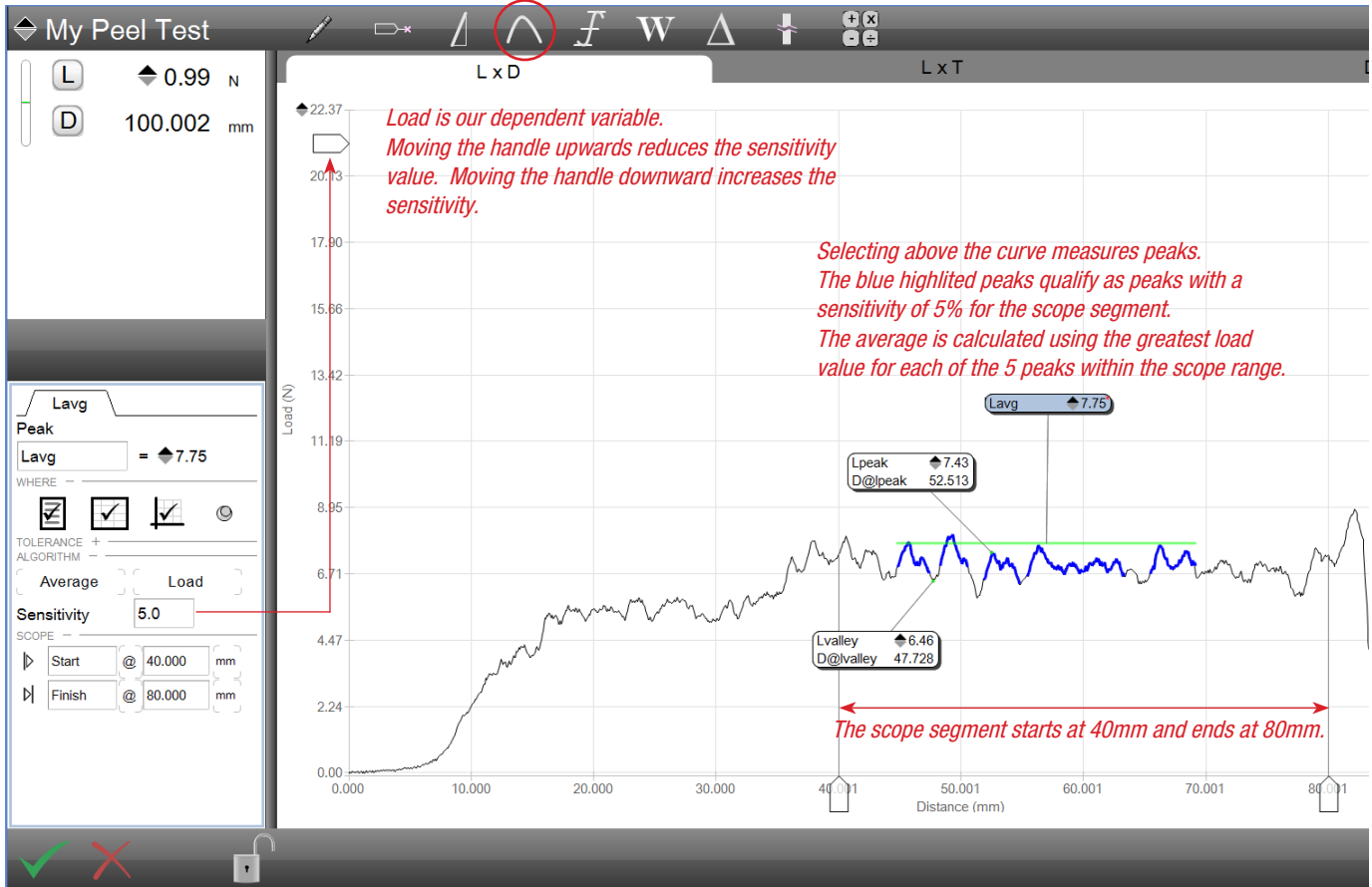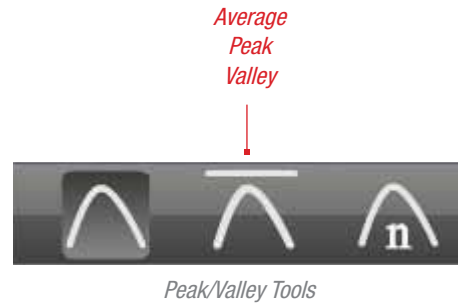
Peel test using Peak/Valley Measurement
Shows the Load Average of Peaks for the scope segment (40-80mm) and a sensitivity of 5%

5.7.5.3 Averaging Algorithm Name
The Average algorithm name may be changed from its default of Lavg when based on load. For example, you may rename Lmean.

The result name may be up to 8 characters in length and may use special characters.

5.7.5.4 Averaging Algorithm Where
The WHERE function is used to specify where you want the Average result to display. Display the point on any of these views:
• Results View
• Graph Views using a Marker
• Data Views (a column within the table)

5.7.5.5 Averaging Algorithm Tolerance
Your Average result (coefficient) can make use of a tolerance to distinguish the result as either a "pass" or "fail" relative to your tolerance limits.

When you use a tolerance, you specify two tolerance limits. If your result equals or falls within the range created by these two tolerances, the result is displayed in black text and is deemed a "pass". If the result falls outside the tolerance range, the result displays in red text and is deemed a "fail".

Your L3 Series software also features a Tolerance view (TOL) that displays a tendency graph for the result. This graph displays whether the actual result is at the high or low end of the tolerance range you have established.

5.8   Using Min/Max/Avg Tool

One of the more commonly used analysis tools is the Min/Max/Avg tool. It often used to measure the maximum stress or load values, or to measure the average of all data points within a scope segment.

The Min/Max/Avg tool may be used with load, distance and time.

The Min/Max/Avg tool has two functions. Min/Max is one function. Selecting above the curve will deliver the Maximum result, while selecting below the curve will report the Minimum results.

The Average function calculates the average of all data points within the scope segment. The average can be load or distance.

5.8.1   Maximum Algorithm

The Maximum algorithm is sometimes called the peak, but it should not be confused with peak when using peak & valleys.

The Maximum algorithm is the greatest value of a variable within the data stream for a scope segment. The scope segment may be the entire test duration or a segment within the duration.

The Maximum algorithm reports the greatest value of load or distance for your test setup.

Min/Max
Function

Average
Function

Min/Max/Avg Tool Types
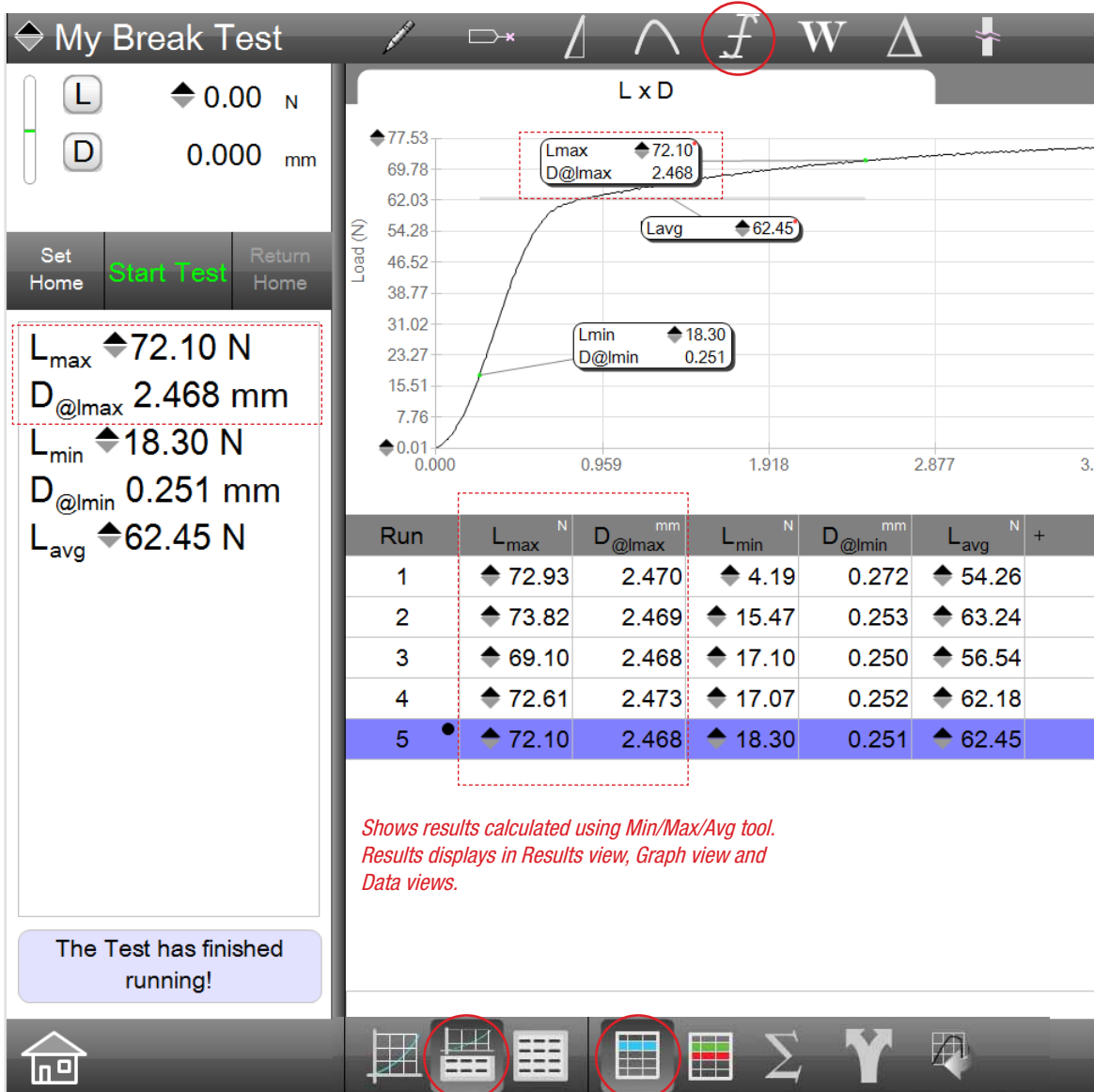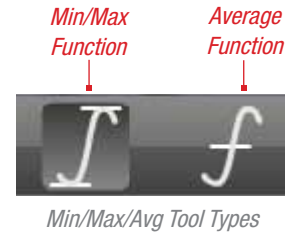
*Shows results calculated using Min/Max/Avg tool.
Results displays in Results view, Graph view and Data views.*

*Break Test
Shows results using Min/Max/Avg functions*

5.8.1.1   Maximum Algorithm Scope

The scope for the Maximum algorithm is based on two specific points that defined the end points of a data segment.

You may position the scope handles along either the y-axis or x-axis to define the data segment where you are interested in analyzing.

Or, you may implicitly specify your start and end scope points using values or other coefficients that can be used as anchors. Anchored coefficients display in yellow.

5.8.1.2   Maximum Algorithm Name

The Maximum algorithm name may be changed from its default of Lmax when based on load. For example, you may rename Lpeak.

The result name may be up to 8 characters in length and may use special characters.

5.8.1.3   Maximum Algorithm Where

The WHERE function is used to specify where you want the Maximum result to display. Display the point on any of these views:
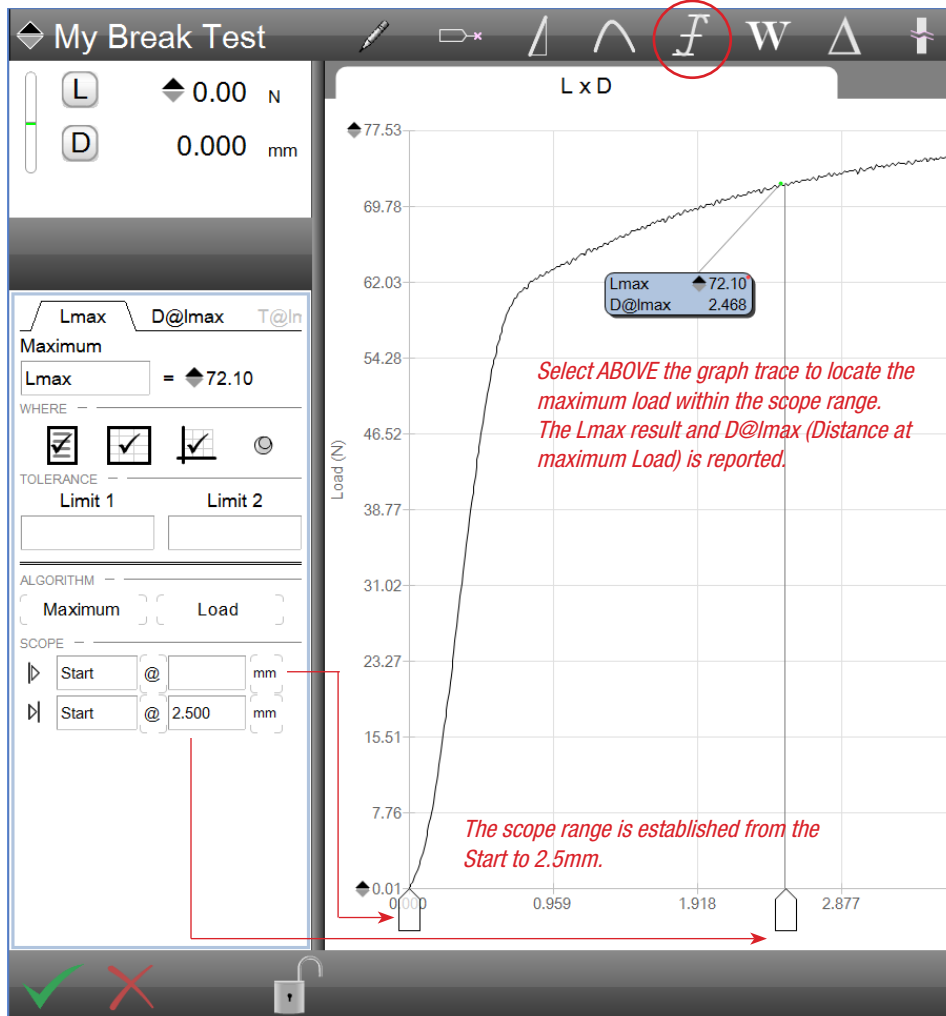- Results View
- Graph Views using a Marker
- Data Views (a column within the table)

5.8.1.4   Maximum Algorithm Tolerance

Your Maximum result (coefficient) can make use of a tolerance to distinguish the result as either a "pass" or "fail" relative to your tolerance limits.

When you use a tolerance, you specify two tolerance limits. If your result equals or falls within the range created by these two tolerances, the result is displayed in black text and is deemed a "pass". If the result falls outside the tolerance range, the result displays in red text and is deemed a "fail".

Your L3 Series software also features a Tolerance view (TOL) that displays a tendency graph for the result. This graph displays whether the actual result is at the high or low end of the tolerance range you have established.

Break Test
Shows Lmax result for specified scope range

5.8.2 Minimum Algorithm

The Minimum algorithm is the lowest value of a variable within the data stream for a scope segment. The scope segment may be the entire test duration or a segment within the duration.

The Minimum algorithm reports the lowest value of load or distance for your test setup.

Select below the curve to find the Minimum result for the scope range specified.

5.8.2.1   Minimum Algorithm Scope

The scope for the Minimum algorithm is based on two specific points that defined the end points of a data segment.

You may position the scope handles along either the y-axis or x-axis to define the data segment where you are interested in analyzing.

Or, you may implicitly specify your start and end scope points using values or other coefficients that can be used as anchors. Anchored coefficients display in yellow.

The scope range is normally not at the start of the test since the minimum result would be zero or at the load when the test started.

5.8.2.2   Minimum Algorithm Name

The Minimum algorithm name may be changed from its default of Lmin when based on load.

The result name may be up to 8 characters in length and may use special characters.
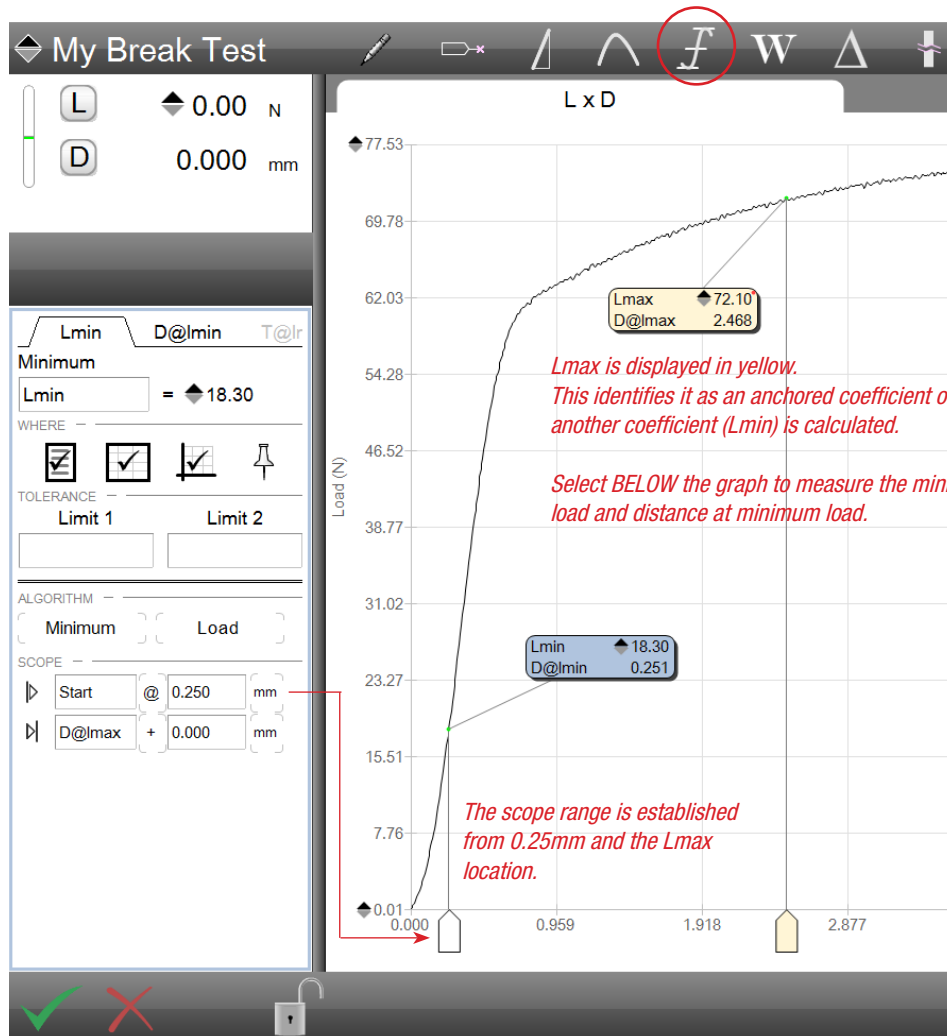
Break Test
Shows Lmax result for specified scope range

5.8.2.3   Minimum Algorithm Where

The WHERE function is used to specify where you want the Minimum result to display. Display the point on any of these views:
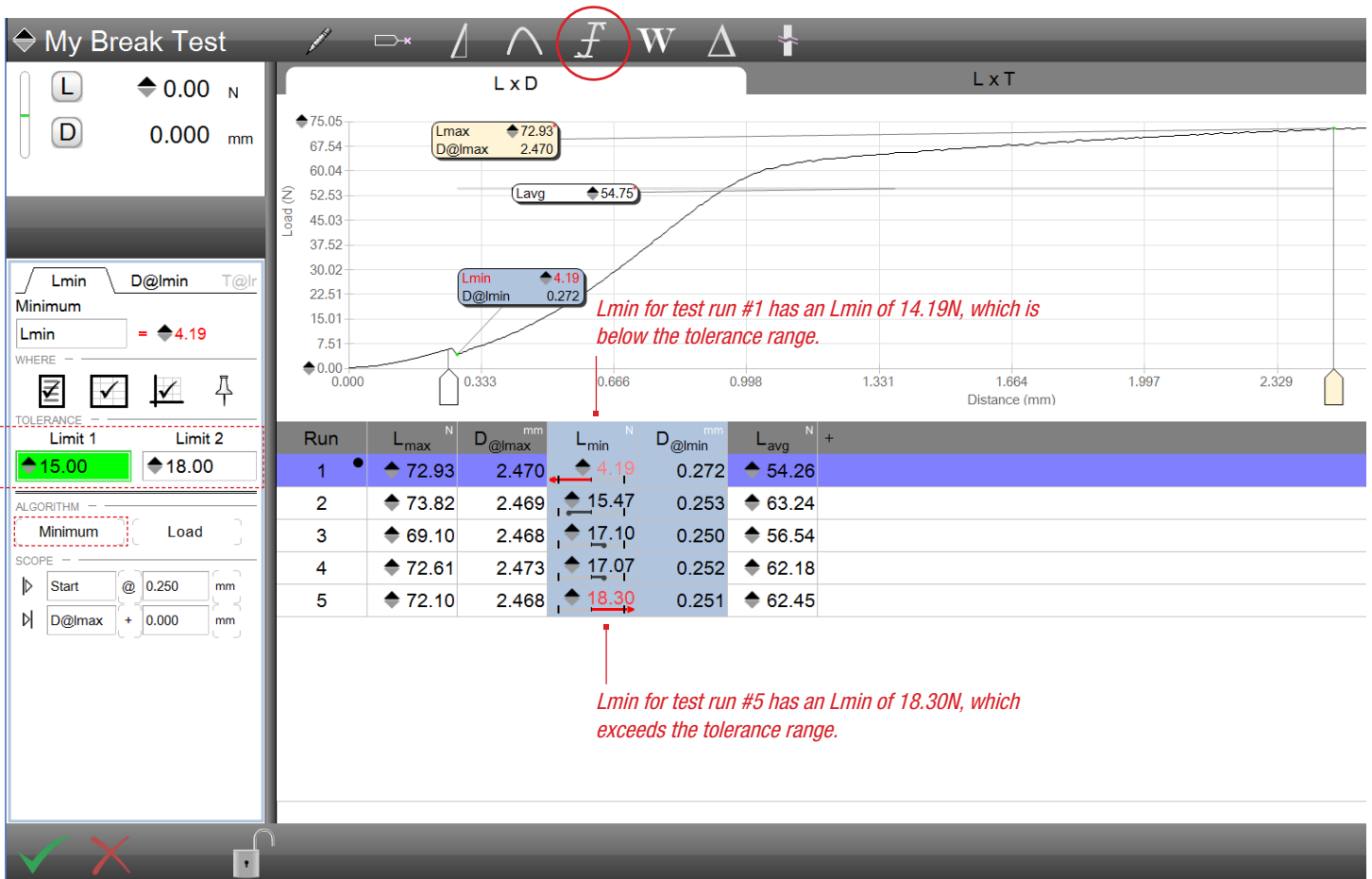
- Results View
- Graph Views using a Marker
- Data Views (a column within the table)

5.8.2.4   Minimum Algorithm Tolerance

Your Minimum result (coefficient) can make use of a tolerance to distinguish the result as either a "pass" or "fail" relative to your tolerance limits.

When you use a tolerance, you specify two tolerance limits. If your result equals or falls within the range created by these two tolerances, the result is displayed in black text and is deemed a "pass". If the result falls outside the tolerance range, the result displays in red text and is deemed a "fail".

Your L3 Series software also features a Tolerance view (TOL) that displays a tendency graph for the result. This graph displays whether the actual result is at the high or low end of the tolerance range you have established.

Break Test
Shows Lmin result for specified scope range with tolerances

5.8.3 Average Algorithm

The Average algorithm calculates the load for all of the data points within the scope range. The average load or distance may be calculated.

The Average algorithm differs from the Average Peak & Valley algorithm. The Average Peak & Valley algorithm is the average of only the peaks or valleys. The Average algorithm is the average of all data points within your scope range.

> **NOTE**
> The Average algorithm is the average of all data points for your specified scope range.

5.8.3.1 Average Algorithm Scope

The scope for the Average algorithm is based on two specific points that defined the end points of a data segment.

You may position the scope handles along either the y-axis or x-axis to define the data segment where you are interested in analyzing.

Or, you may implicitly specify your start and end scope points using values or other coefficients that can be used as anchors. Anchored coefficients display in yellow.

The scope range is normally not at the start of the test since the minimum result would be zero or at the load when the test started.

5.8.3.2 Average Algorithm Name

The Average algorithm name may be changed from its default of Lavg when based on load.

The result name may be up to 8 characters in length and may use special characters.
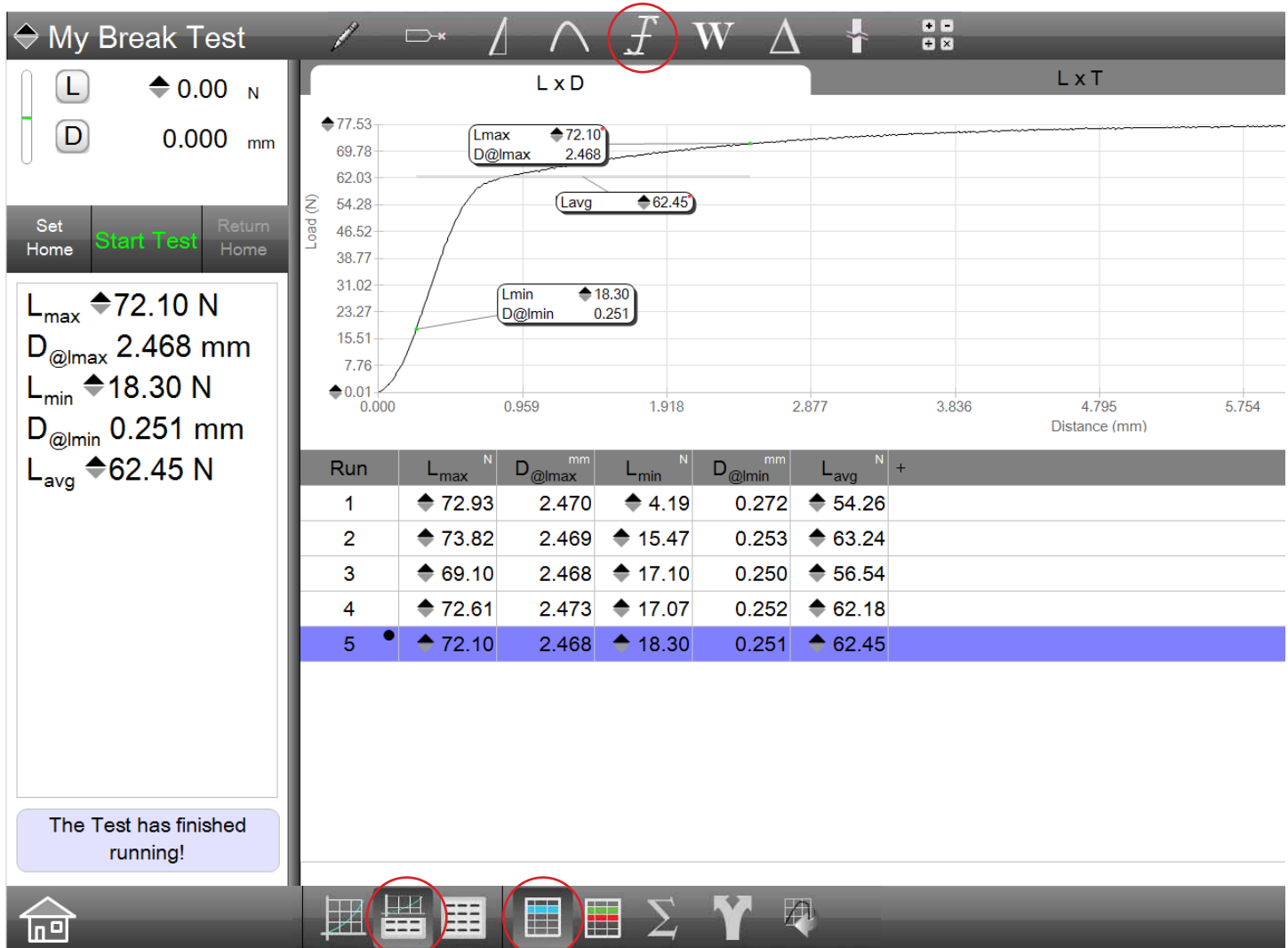
Break Test
Shows Lavg result for specified scope range

5.8.3.3 Average Algorithm Where

The WHERE function is used to specify where you want the Average result to display. Display the point on any of these views:
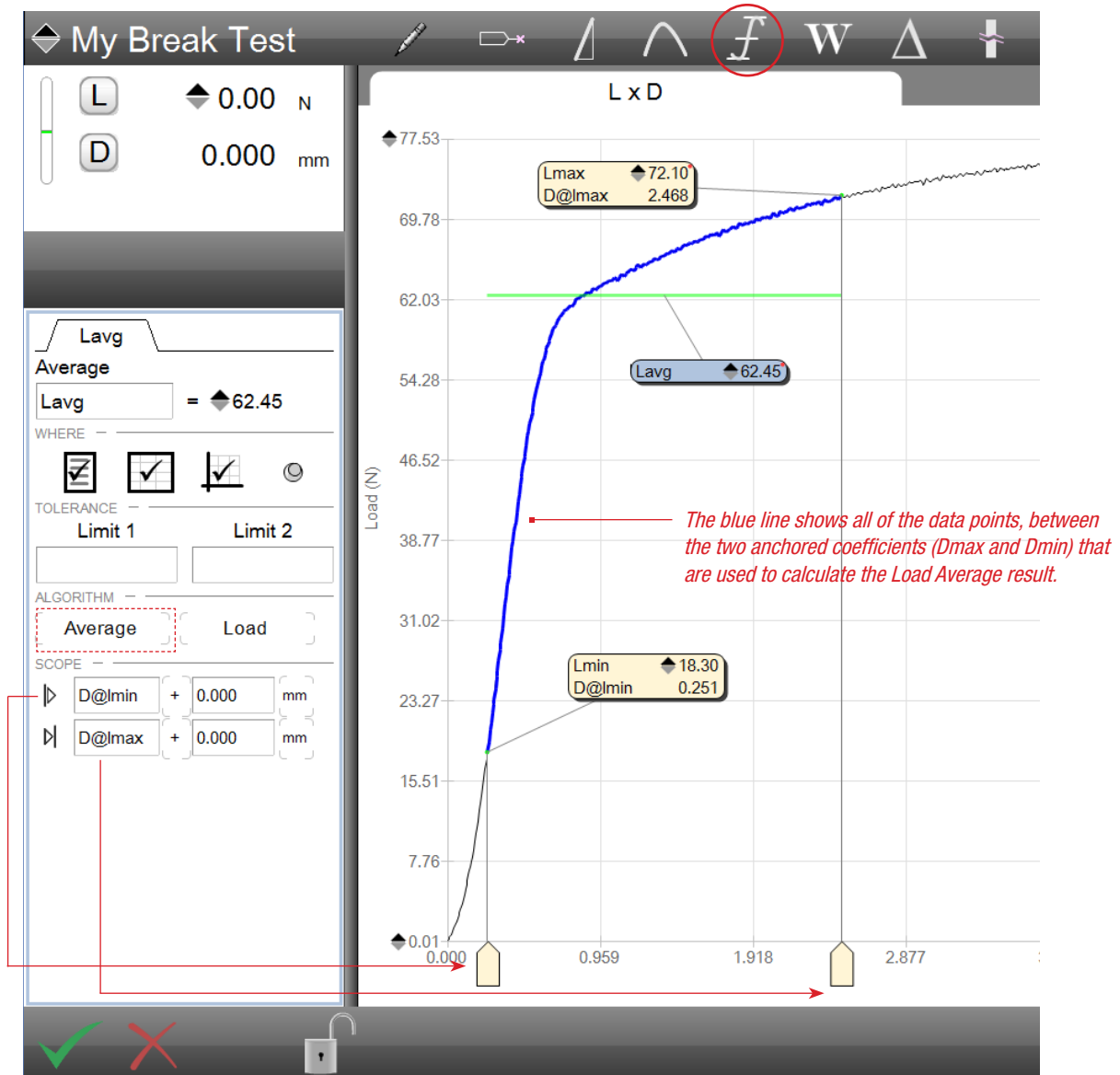
• Results View
• Graph Views using a Marker
• Data Views (a column within the table)

5.8.3.4 Average Algorithm Tolerance

Your Average result (coefficient) can make use of a tolerance to distinguish the result as either a "pass" or "fail" relative to your tolerance limits.

When you use a tolerance, you specify two tolerance limits. If your result equals or falls within the range created by these two tolerances, the result is displayed in black text and is deemed a "pass". If the result falls outside the tolerance range, the result displays in red text and is deemed a "fail".

Your L3 Series software also features a Tolerance view (TOL) that displays a tendency graph for the result. This graph displays whether the actual result is at the high or low end of the tolerance range you have established.

The blue line shows all of the data points, between the two anchored coefficients (Dmax and Dmin) that are used to calculate the Load Average result.

Lavg Data Definition Menu
Shows Lavg result for specified scope range between anchored Lmin and Lmax

5.9 Using the Work Tool

Work or sometimes referred to as energy, is a characteristic of resilience or the ability of the material being tested to absorb energy. The Work algorithm calculates the area beneath the load-distance curve. The area is calculated within the scope range specified.

5.9.1 Work Algorithm

The Work algorithm calculates the area beneath the load-distance curve.

When the Work function is selected, you specify the scope range and the area beneath the curve for your range is highlited in blue.

5.9.1.1 Work Algorithm Scope

The scope for the Minimum algorithm is based on two specific points that defined the end points of a data segment.

You may position the scope handles along either the y-axis or x-axis to define the data segment where you are interested in analyzing.

Or, you may implicitly specify your start and end scope points using values or other coefficients that can be used as anchors. Anchored coefficients display in yellow.

The scope range is normally not at the start of the test since the minimum result would be zero or at the load when the test started.

5.9.1.2 Work Algorithm Name

The Work algorithm name may be changed from its default of W to Energy or N-m.

The result name may be up to 8 characters in length.

5.9.1.3 Work Algorithm Where

The WHERE function is used to specify where you want the Work result to display. Display the point on any of these views:
- Results View
- Graph Views using a Marker
- Data Views (a column within the table)
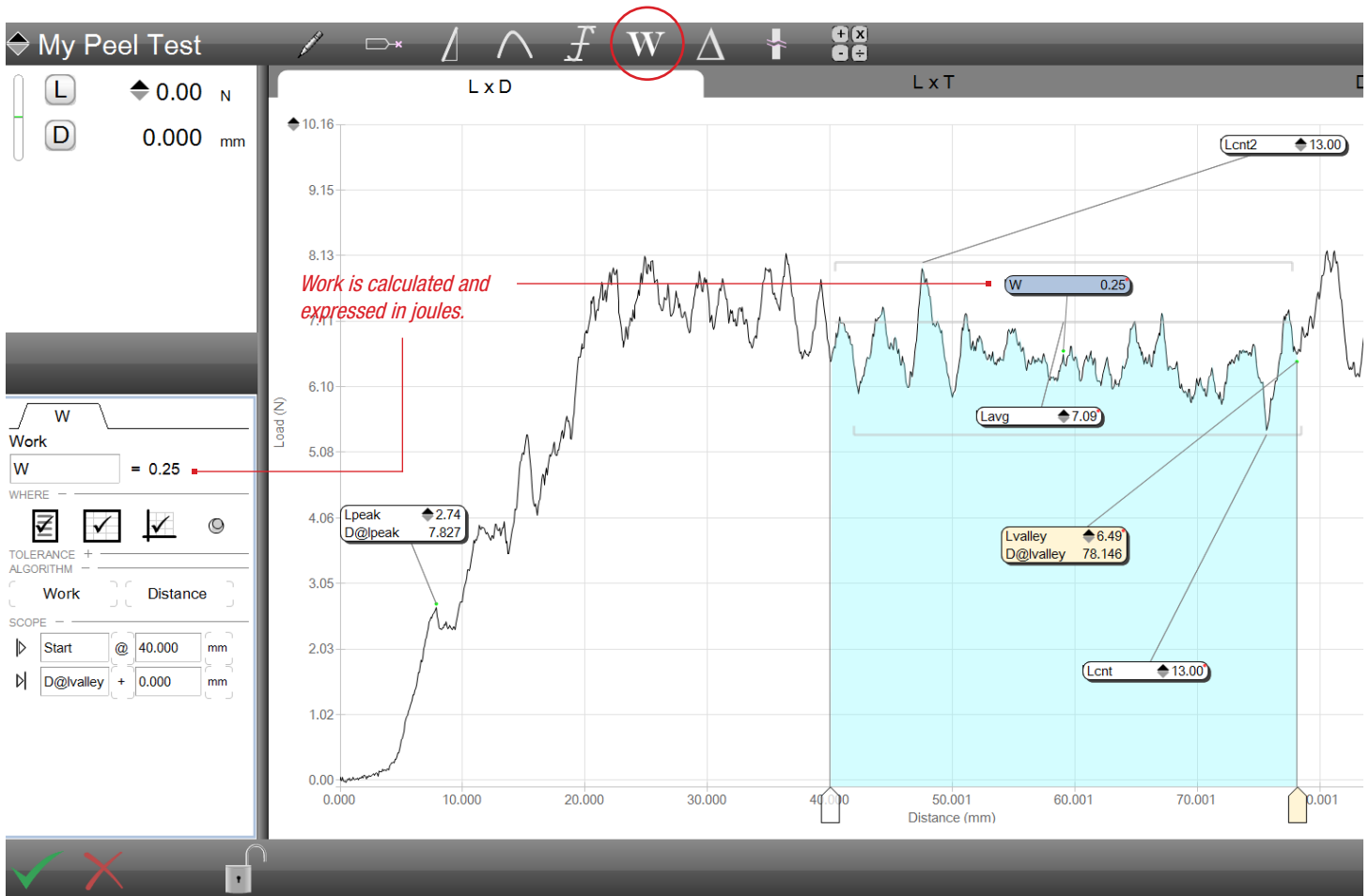
Load-Distance Testing Mode
Shows the Work within the scope segment starting at 40mm and ending at the D@lvalley result

5.9.1.4   Work Algorithm Tolerance

Your Work result (coefficient) can make use of a tolerance to distinguish the result as either a "pass" or "fail" relative to your tolerance limits.

When you use a tolerance, you specify two tolerance limits. If your result equals or falls within the range created by these two tolerances, the result is displayed in black text and is deemed a "pass". If the result falls outside the tolerance range, the result displays in red text and is deemed a "fail".

Your L3 Series software also features a Tolerance view (TOL) that displays a tendency graph for the result. This graph displays whether the actual result is at the high or low end of the tolerance range you have established.

5.10 Using the Delta Tool

The Delta tool is used to measure or compare the differences between two variables. These variables can be load or distance.

The Delta tool is ideal for creep and relaxation testing or on applications where you simply want to measure the change within a scope range.

5.10.1 Delta Algorithm

The Delta algorithm measures the difference or change between two results. The scope segment may be the entire test duration or a segment within the duration.
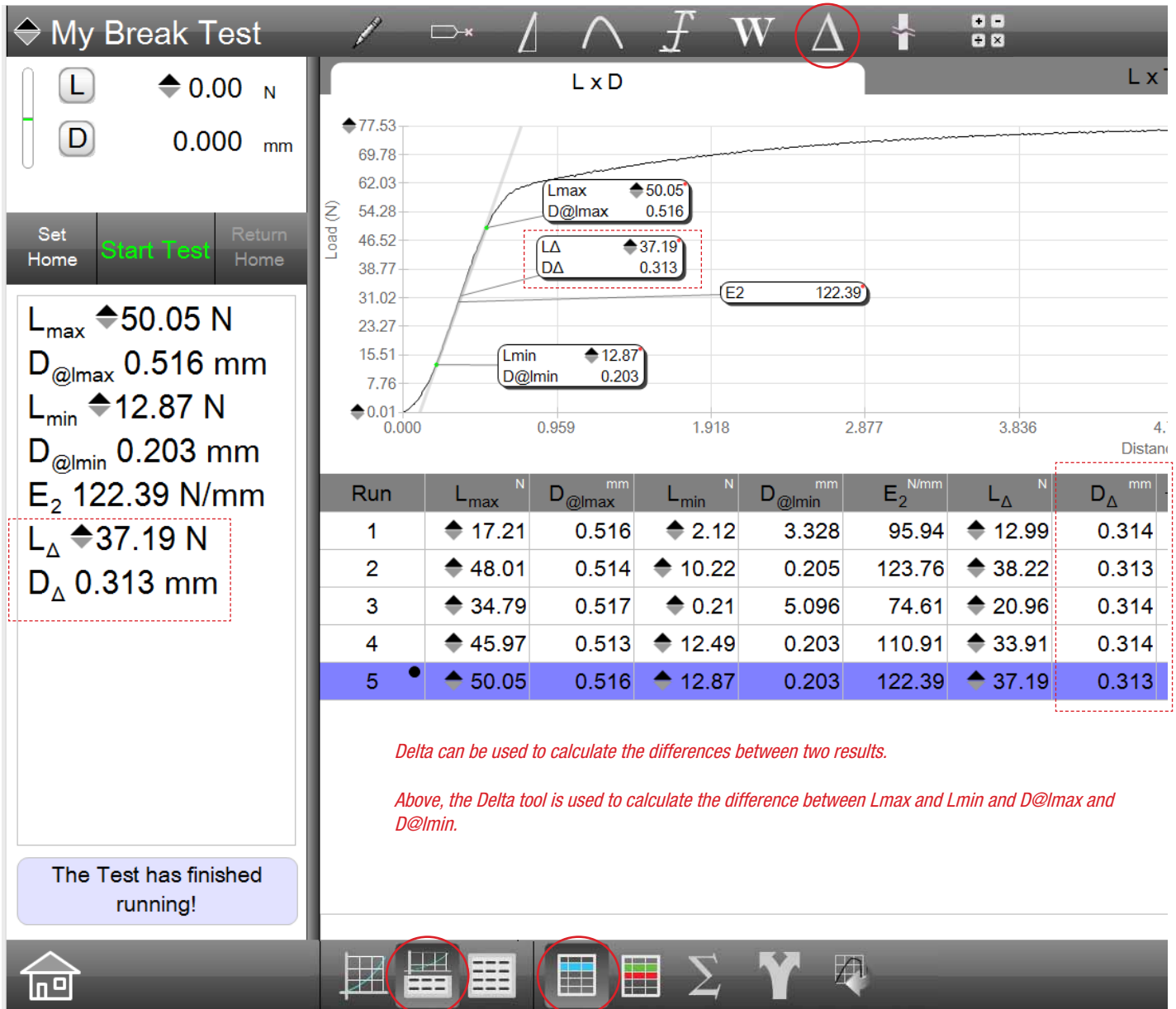
5.10.1.1 Delta Algorithm Scope

The scope for the Delta algorithm is based on two specific points that defined the end points of a data segment.

You may position the scope handles along either the y-axis or x-axis to define the data segment where you are interested in analyzing.

Or, you may implicitly specify your start and end scope points using values or other coefficients that can be used as anchors. Anchored coefficients display in yellow.

The scope range is normally not at the start of the test since the minimum result would be zero or at the load when the test started.

Run	L_{max} N	$D_{@lmax}$ mm	L_{min} N	$D_{@lmin}$ mm	E_2 N/mm	L_Δ N	D_Δ mm
1	17.21	0.516	2.12	3.328	95.94	12.99	0.314
2	48.01	0.514	10.22	0.205	123.76	38.22	0.313
3	34.79	0.517	0.21	5.096	74.61	20.96	0.314
4	45.97	0.513	12.49	0.203	110.91	33.91	0.314
5	50.05	0.516	12.87	0.203	122.39	37.19	0.313

Delta can be used to calculate the differences between two results.

Above, the Delta tool is used to calculate the difference between Lmax and Lmin and D@lmax and D@lmin.

Delta Result
Shows results including the Delta Load and Distance between Lmax and Lmin

5.10.1.2   Delta Algorithm Name

The Delta algorithm name may be changed from its default of ΔL to LCreep.

The result name may be up to 8 characters in length.

NOTE
Use the Ctrl key + d to display Δ

5.10.1.3   Delta Algorithm Where

The WHERE function is used to specify where you want the Delta result to display. Display the point on any of these views:
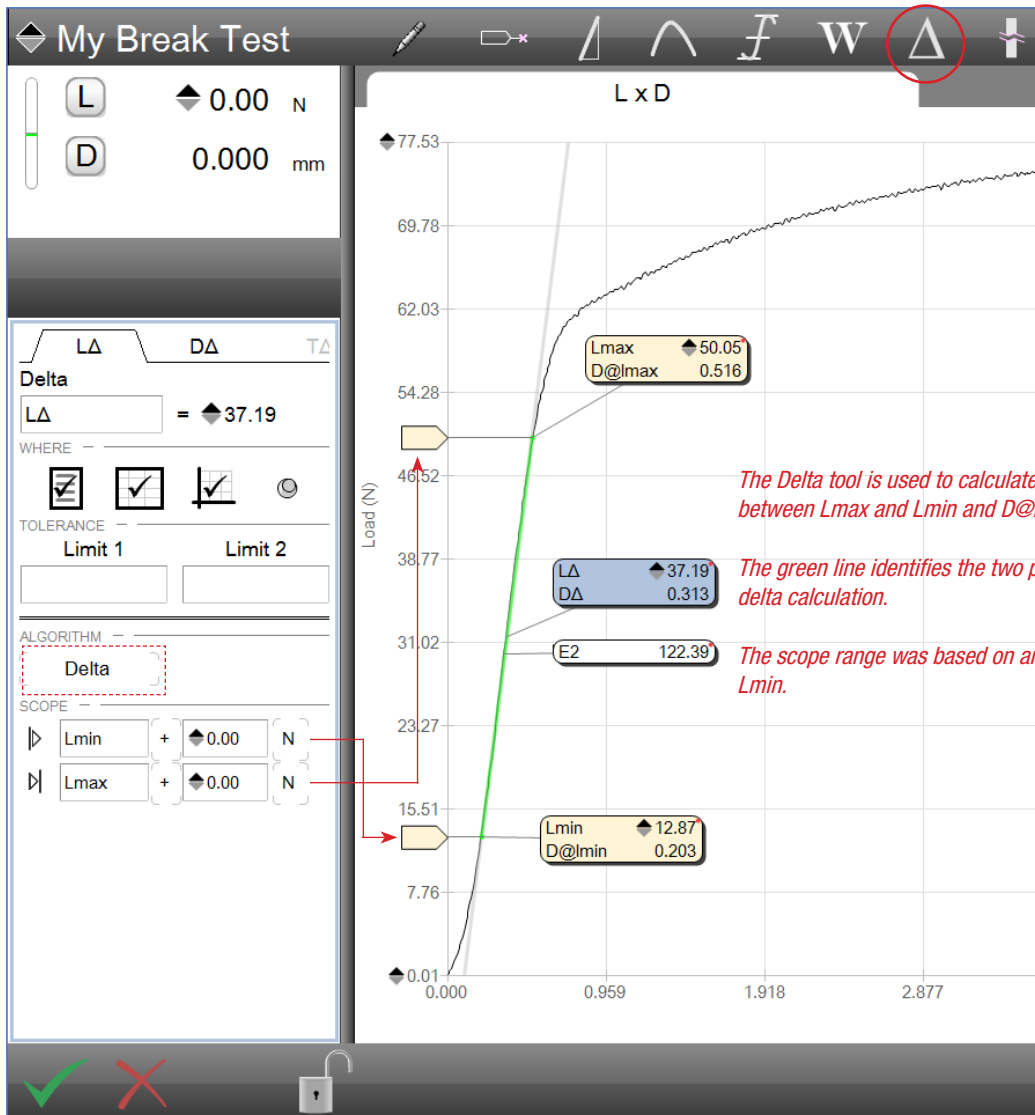- Results View
- Graph Views using a Marker
- Data Views (a column within the table)

5.10.1.4   Delta Algorithm Tolerance

Your Delta result (coefficient) can make use of a tolerance to distinguish the result as either a "pass" or "fail" relative to your tolerance limits.

When you use a tolerance, you specify two tolerance limits. If your result equals or falls within the range created by these two tolerances, the result is displayed in black text and is deemed a "pass". If the result falls outside the tolerance range, the result displays in red text and is deemed a "fail".

Your L3 Series software also features a Tolerance view (TOL) that displays a tendency graph for the result. This graph displays whether the actual result is at the high or low end of the tolerance range you have established.

Delta Result Data Definition Menu
Calculates the delta between two anchored results

5.10.2   Using the Delta in Multi-Run Mode

L3 Series software also lets you find the difference in results between multiple runs. The Multi-Run mode performs as a graphical statistical analysis by comparing runs to one another using the graph and special Multi-Run graph analysis tools.

NOTE
Use the Multi-run view option by selecting the green bar above the Runs List.

Using the Multi-run view, select multiple runs from the same batch from the Runs List. The graph traces for each run are displayed together in a single view.

Next, select the Multi-run Analysis Tool.

Next, select within the graph and make a comparison between both runs and points along both data streams.
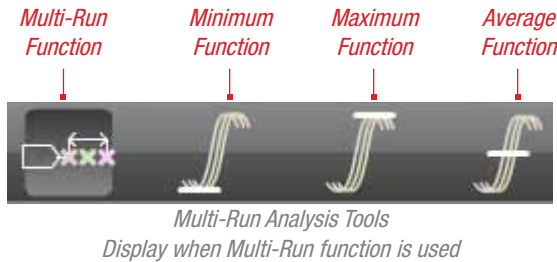
With the Multi-Run tools selected, you can now perform the following:
- Find the Delta between multiple runs
- Find the Minimum results between multiple runs
- Find the Maximum results between multiple runs
- Find the Average result between multiple runs

NOTE
You cannot use anchored markers when in Multi-Run mode.

Multi-Run Function   Minimum Function   Maximum Function   Average Function

Multi-Run Analysis Tools
Display when Multi-Run function is used

When the double line is displayed, multiple graph traces are displayed for the highlited test runs.

Test Run #3 and #5 are selected.

The black dot indicates #3 is the active test run.

When the single line is displayed, a single graph trace is displayed for the highlited test run.
Test Run #5 is selected.
The black dot indicates this is the active test run being displayed by the graph.

The black dot indicates #3 is the active test run.

Multi-Run Graph View

5.10.2.1 Delta Between Runs

Once multiple runs have been selected and are being displayed together on your graph, you can select the Multi-Run analysis tool.

You can find the delta L and delta D between your runs by pressing or selecting along either the Load axis (y-axis) or the Distance axis (x-axis). The delta finds a point, e.g. ΔL or ΔD.

Once you have made your selection, you can determine the delta between the first run and the last run in your set of multiple runs.

The delta is measured from the first run, defined as the graph trace on the left-most side, to the last run, defines as the graph trace on the right-most side.

If you want to find the ΔL, select along the x-axis (Distance) and adjust your scope range along the x-axis (Distance).

You'll see a blue line being drawn between the first and last run. This blue line measures and calculates the result between these runs.

If you want to find the ΔD, select along the y-axis (Load) and adjust your scope range along the y-axis (Load).
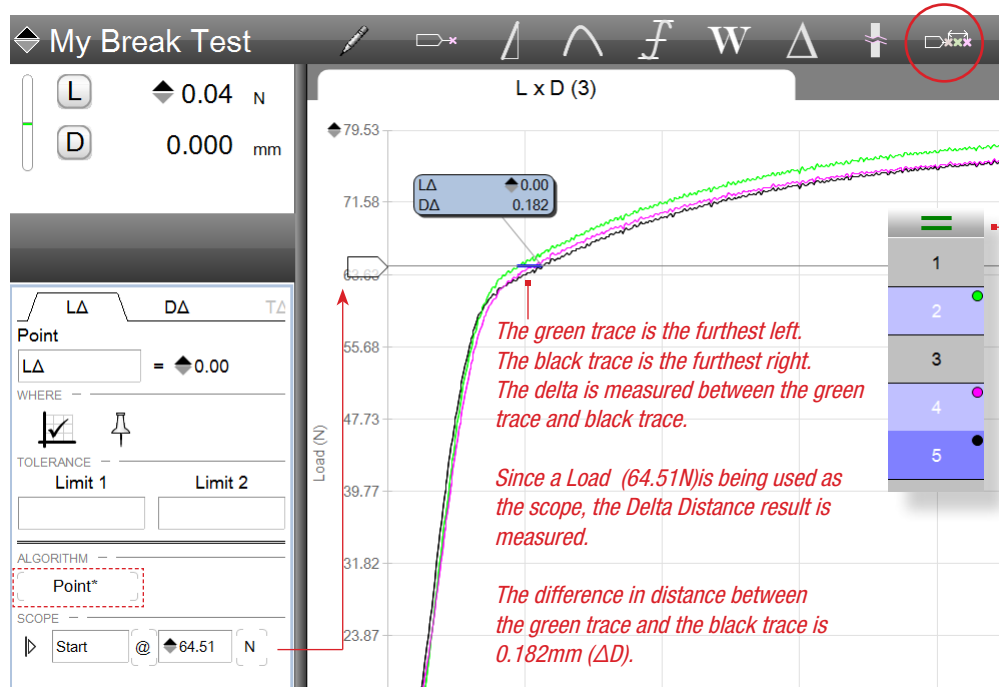
Multi-Run Graph View
Finding Delta Distance between all selected Runs

5.10.2.2　　Minimum Multi Runs

The Minimum tool for multiple run analysis is used to find the test run with the lowest value from all data streams of all runs that are displayed together.

For example, you may wish to find the test run with the lowest load result at a specified distance point.

The green trace is the furthest left.
The black trace is the furthest right.
The delta is measured between the green trace and black trace.

Since a Distance (2.150mm) is being used as the scope, the Delta Load result is measured.

The difference in load between the green trace and the black trace is 1.64N(ΔL).
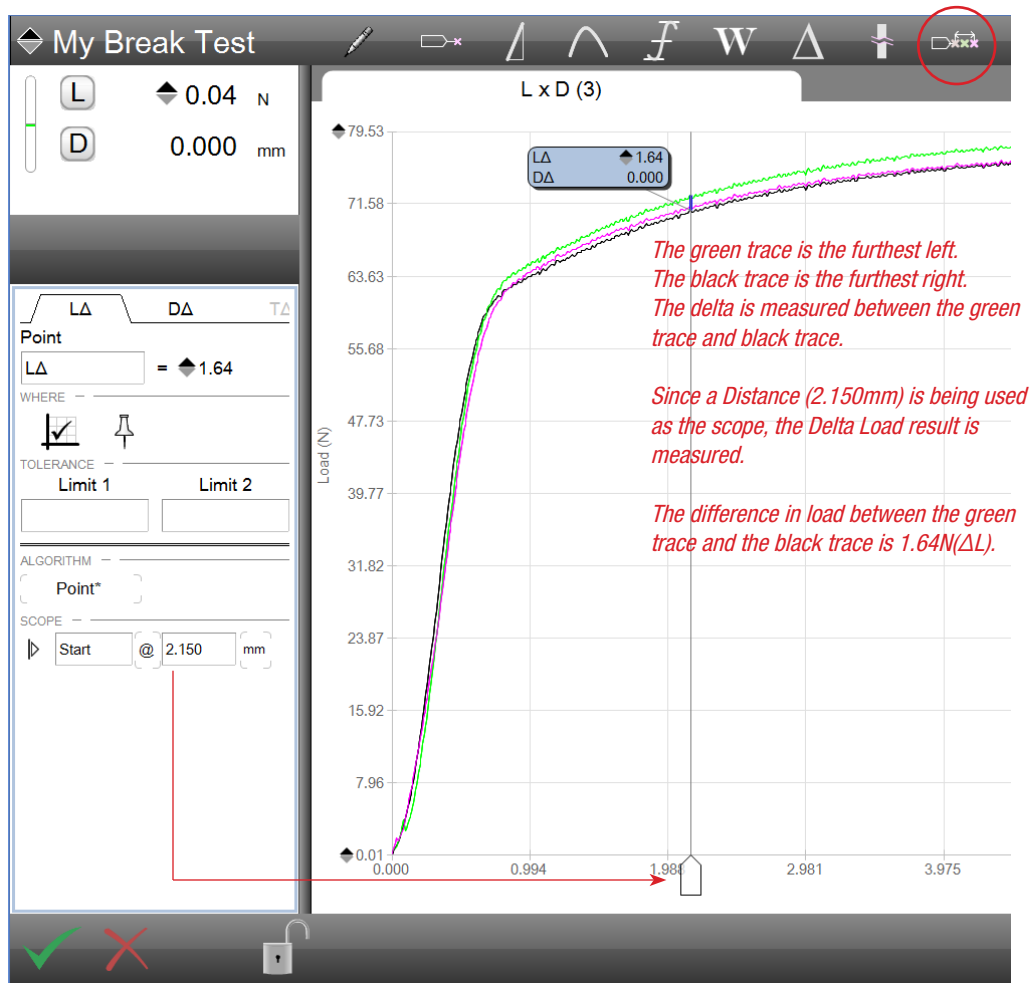
Multi-Run Graph View
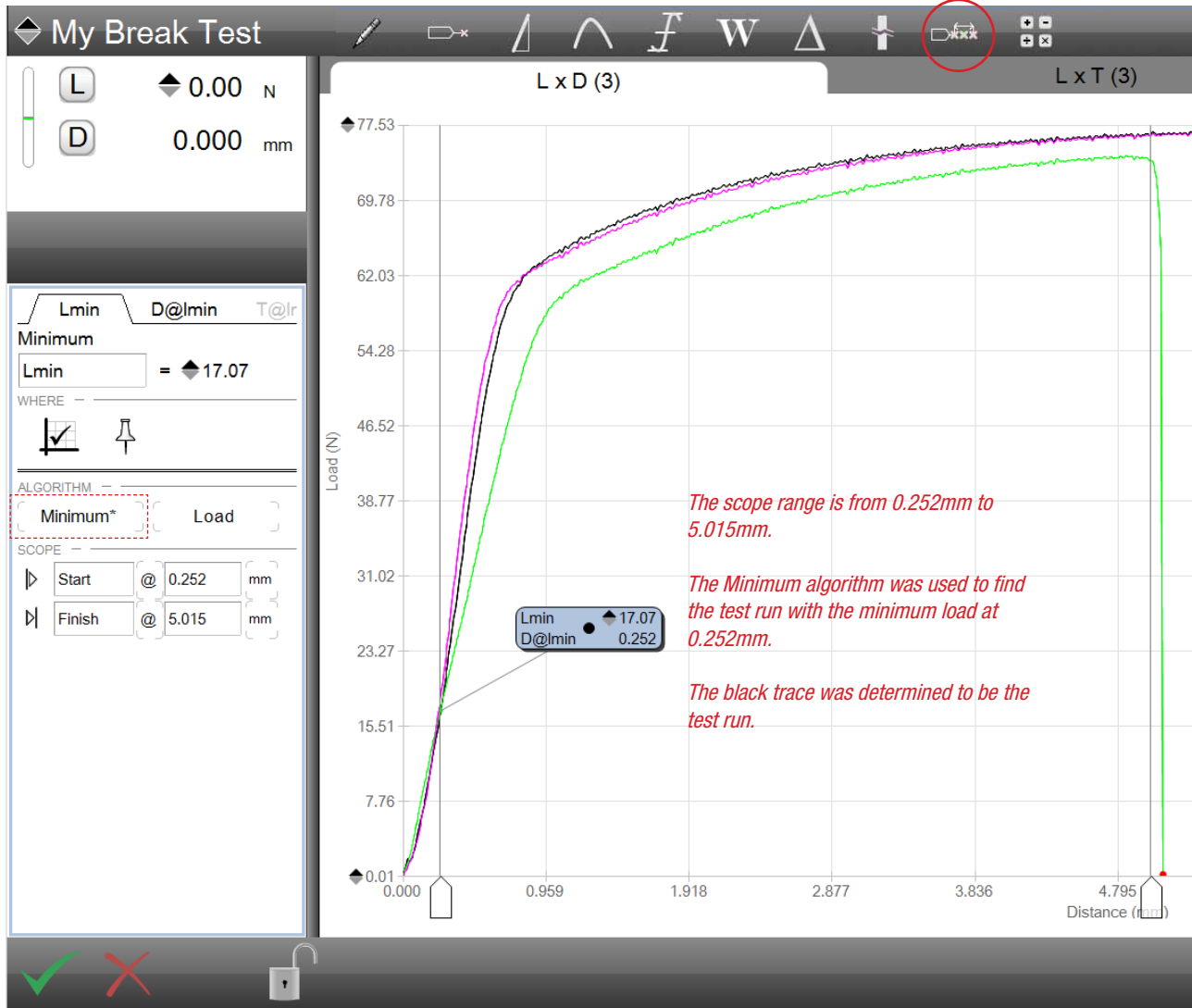*Finding Delta Load between all selected Runs*

5.10.2.3   Maximum Multi Runs

The Maximum tool for multiple run analysis is used to find the test run with the greatest value from all data streams of all runs that are displayed together.

For example, you may wish to find the test run with the greatest load result at a specified distance point.
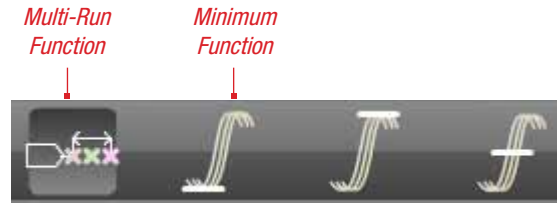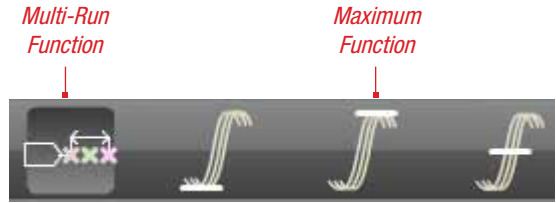

Multi-Run Analysis Tools
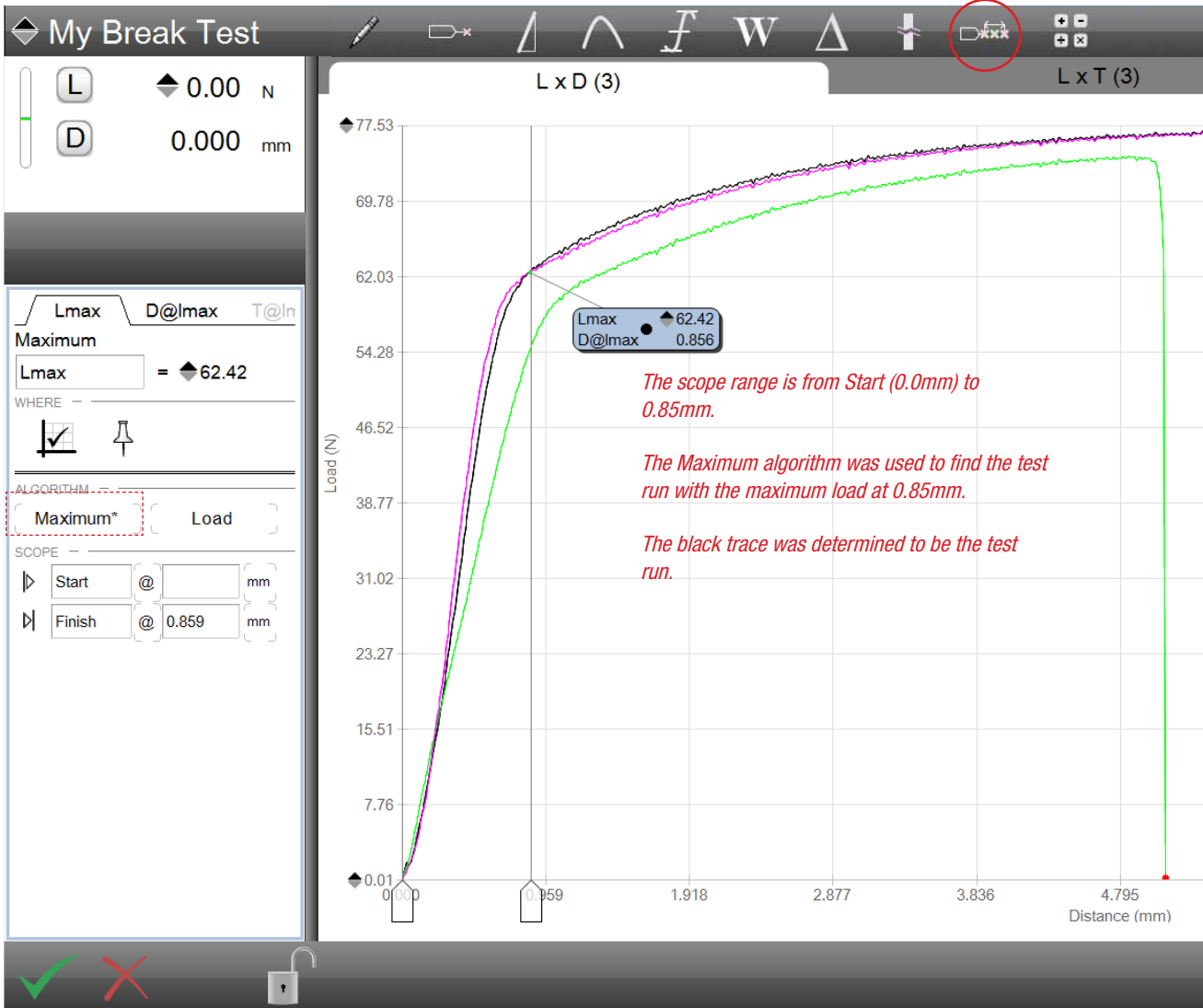*Display when Multi-Run function is used*

Multi-Run Graph View
Finding Test Run with Minimum Load between all selected Runs

5.10.2.4   Average Multi Runs

The Average tool for multiple run analysis is used to find the average of all test runs that are displayed together.

Multi-Run Analysis Tools
Display when Multi-Run function is used

Multi-Run Graph View
Finding Test Run with Maximum Load between all selected Runs

Multi-Run Function

Average Function

Multi-Run Analysis Tools
Display when Multi-Run function is used
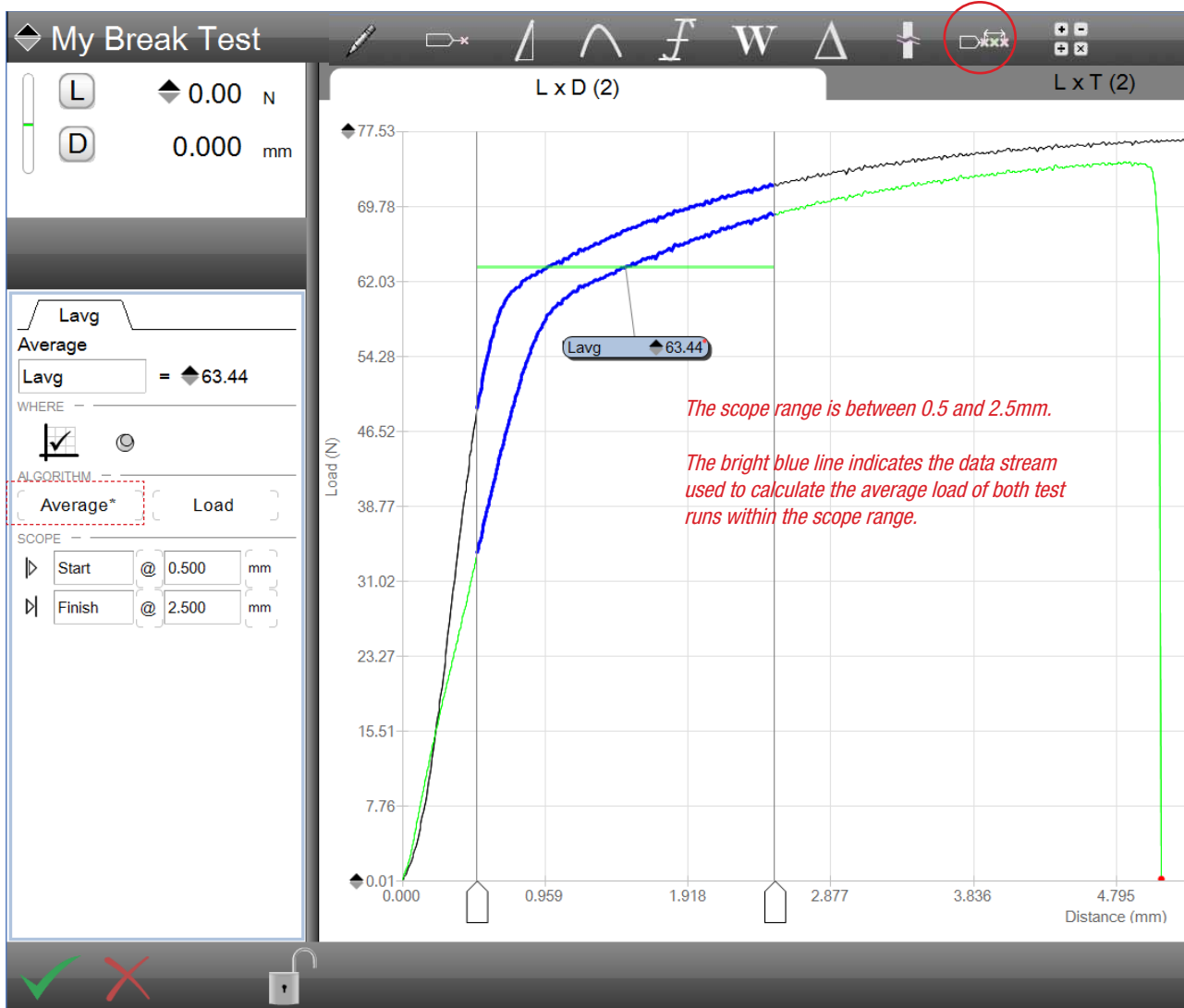
The scope range is between 0.5 and 2.5mm.

The bright blue line indicates the data stream used to calculate the average load of both test runs within the scope range.

Multi-Run Graph View
Finding Average Load between all selected Runs

5.11   Using the Break Tool

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 load or distance prior to the break event.

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

5.11.1 Drop % Algorithm

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 L3 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 be the specified percent value.

5.11.1.1   Drop %

The Drop % is the value that the load decreases AFTER achieving its maximum value. The maximum value must first be met, then the algorithm will evaluate the data after the maximum value and will identify the point where the reduction in load equals the Drop %.

> **NOTE**
> The Drop % is the percentage reduction in load AFTER first achieving its maximum load or distance value.

5.11.1.2   Drop % Algorithm Scope

The scope for the Drop % algorithm is based on two specific points that defined the end points of a data segment. The scope segment is normally after the maximum load value that was measured and prior to where the load or distance returned to zero.

You may position the scope handles along either the y-axis or x-axis to define the data segment where you are interested in analyzing.

Or, you may implicitly specify your start and end scope points using values or other coefficients that can be used as anchors. Anchored coefficients display in yellow. It is common to determine the maximum load and distance and then use the Drop % as an anchor on the Lmax marker.
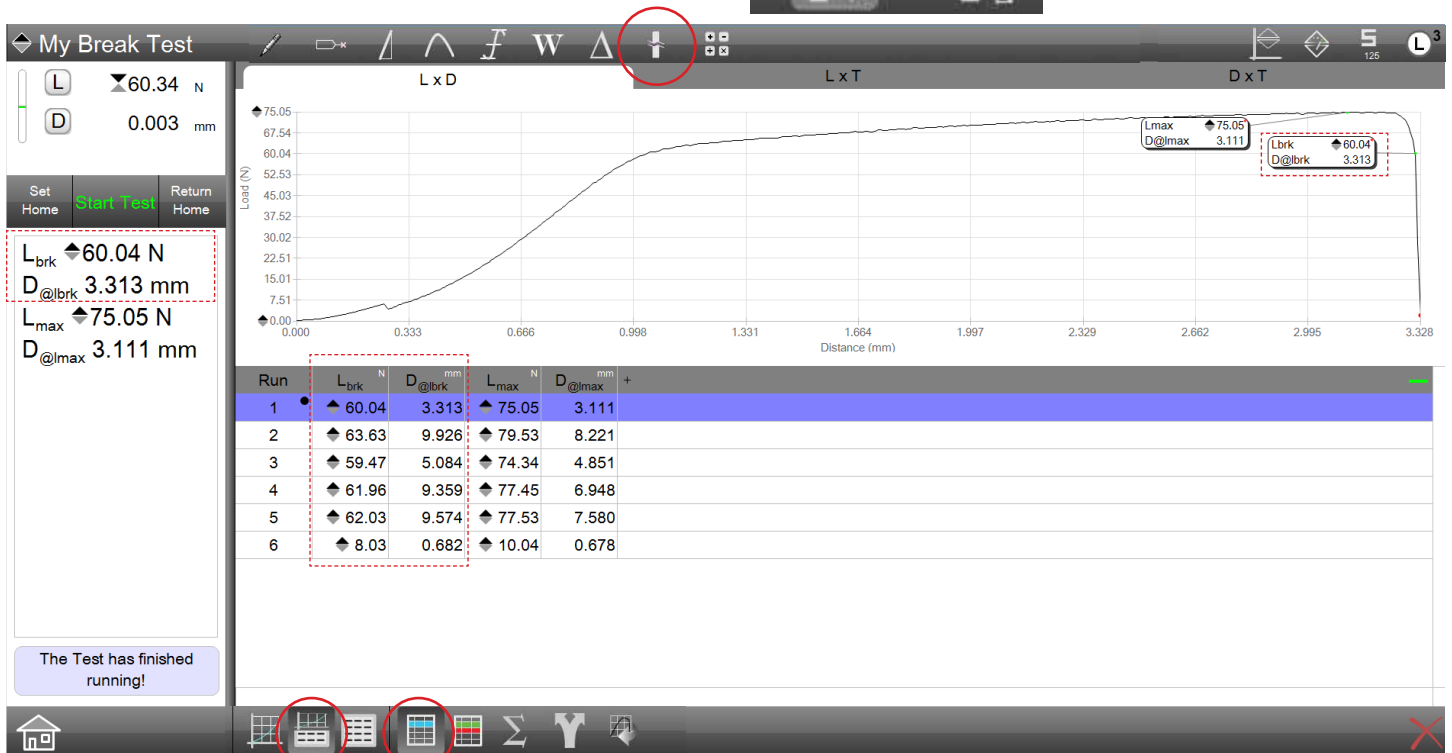
Split Graph - Data View
Finding Break load using a % Drop in load after Lmax

5.11.1.3 Drop % Algorithm Name

The Drop % algorithm name may be changed from its default of Lbrk to L%brk.

The result name may be up to 8 characters in length.

5.11.1.4 Drop % Algorithm Where

The WHERE function is used to specify where you want the Delta result to display. Display the point on any of these views:

- Results View
- Graph Views using a Marker
- Data Views (a column within the table)

5.11.1.5 Drop % Algorithm Tolerance

Your Drop % result (coefficient) can make use of a tolerance to distinguish the result as either a "pass" or "fail" relative to your tolerance limits.

When you use a tolerance, you specify two tolerance limits. If your result equals or falls within the range created by these two tolerances, the result is displayed in black text and is deemed a "pass". If the result falls outside the tolerance range, the result displays in red text and is deemed a "fail".

Your L3 Series software also features a Tolerance view (TOL) that displays a tendency graph for the result. This graph displays whether the actual result is at the high or low end of the tolerance range you have established.
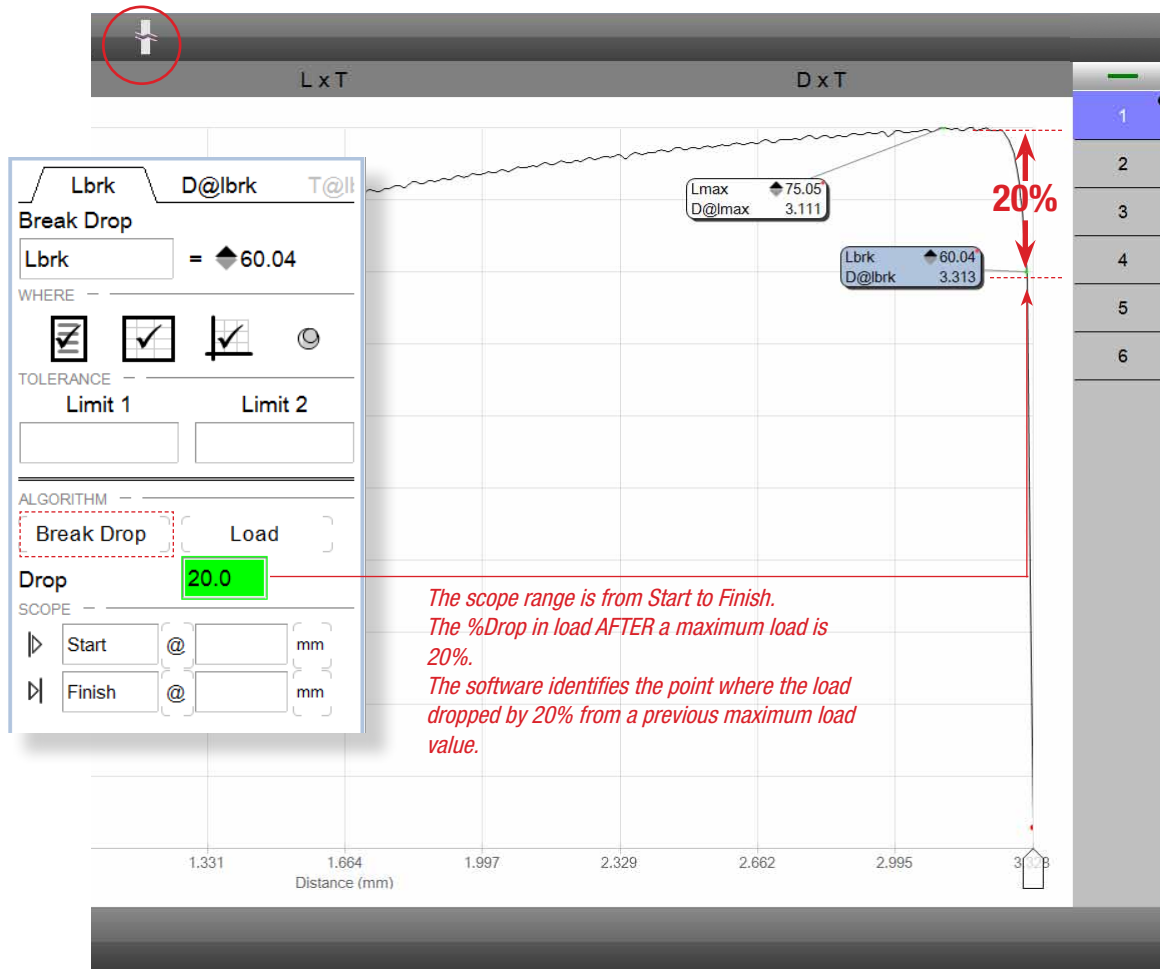
Data Definition Menu
Finding Break load using a % Drop in load after Lmax

5.11.2 Break Rate Algorithm

The Break Rate algorithm looks at the slope along the load-distance 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.

5.11.2.1 Break Rate

The Break Rate represents the slope used to find the break point along the curve. The Break Rate is the load/distance rate on the curve. A Break Rate of 10.000 will look for the point after the maximum load where the rate of 10N/mm occurs.

5.11.2.2 Leg Length

Specifying the Leg Length helps to counter the effects of noise. Because certain materials exhibit a fairly noisy curve, it would be easy to mistakenly identify a break rate at a correct rate, but that is not at a correct break point if only a single break rate point is used.

The Leg Length extends the data points that are examined for the break rate change and allows a more precise break location to be determined.

5.11.2.3 Break Rate Algorithm Scope

The scope for the Break Rate algorithm is based on two specific points that defined the end points of a data segment. The scope segment is normally after the maximum load value that was measured and prior to where the stress or strain returned to zero.

You may position the scope handles along either the y-axis or x-axis to define the data segment where you are interested in analyzing.

Or, you may implicitly specify your start and end scope points using values or other coefficients that can be used as anchors. Anchored coefficients display in yellow.

5.11.2.4 Break Rate Algorithm Name

The Break Rate algorithm name may be changed from its default of Lbrk to Lrate.

The result name may be up to 8 characters in length.
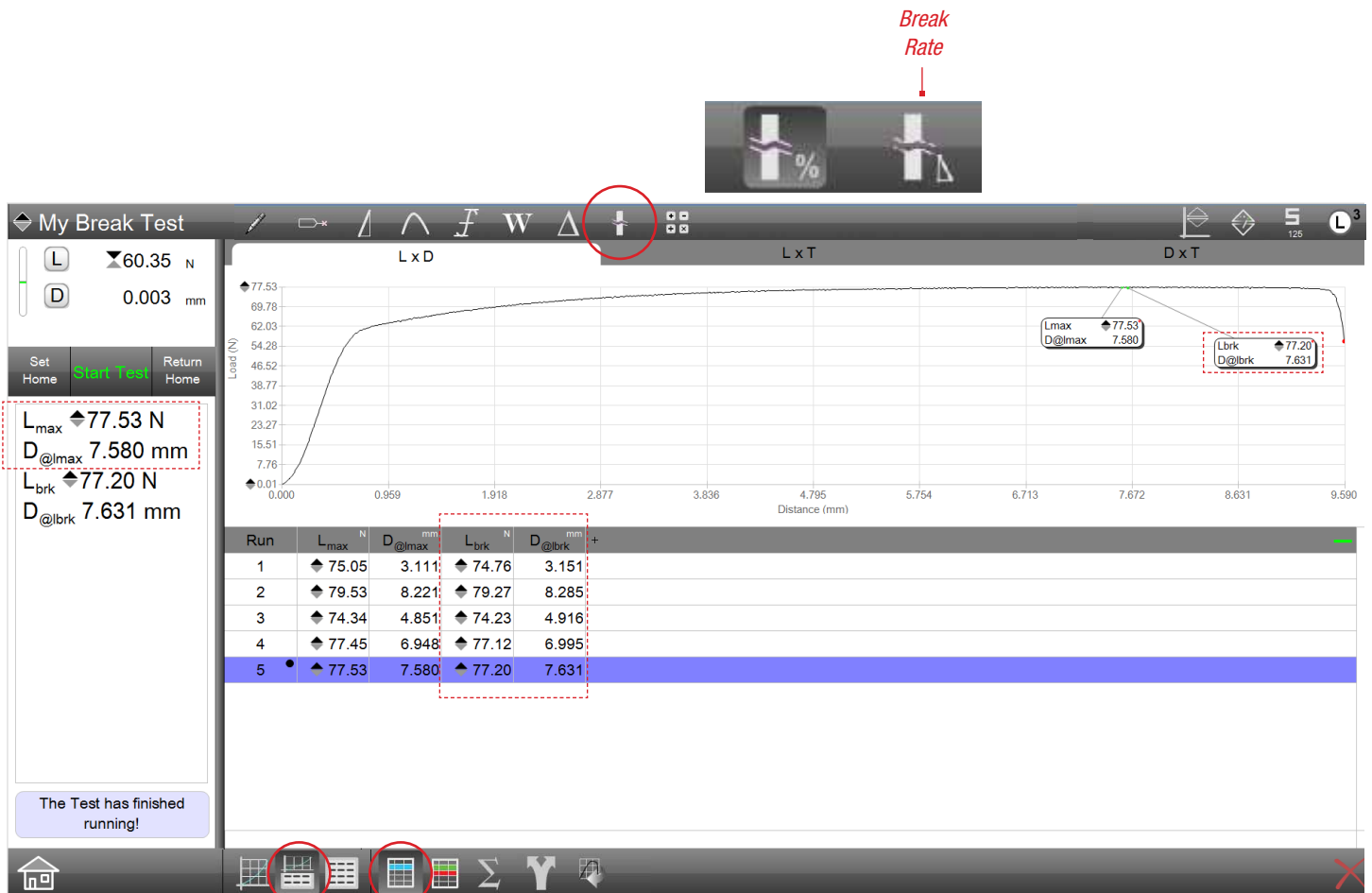
Split Graph - Data View
Finding Break load using a Rate (N/mm) in load after Lmax

5.11.2.5   Break Rate Algorithm Where

The WHERE function is used to specify where you want the Break Rate result to display. Display the point on any of these views:
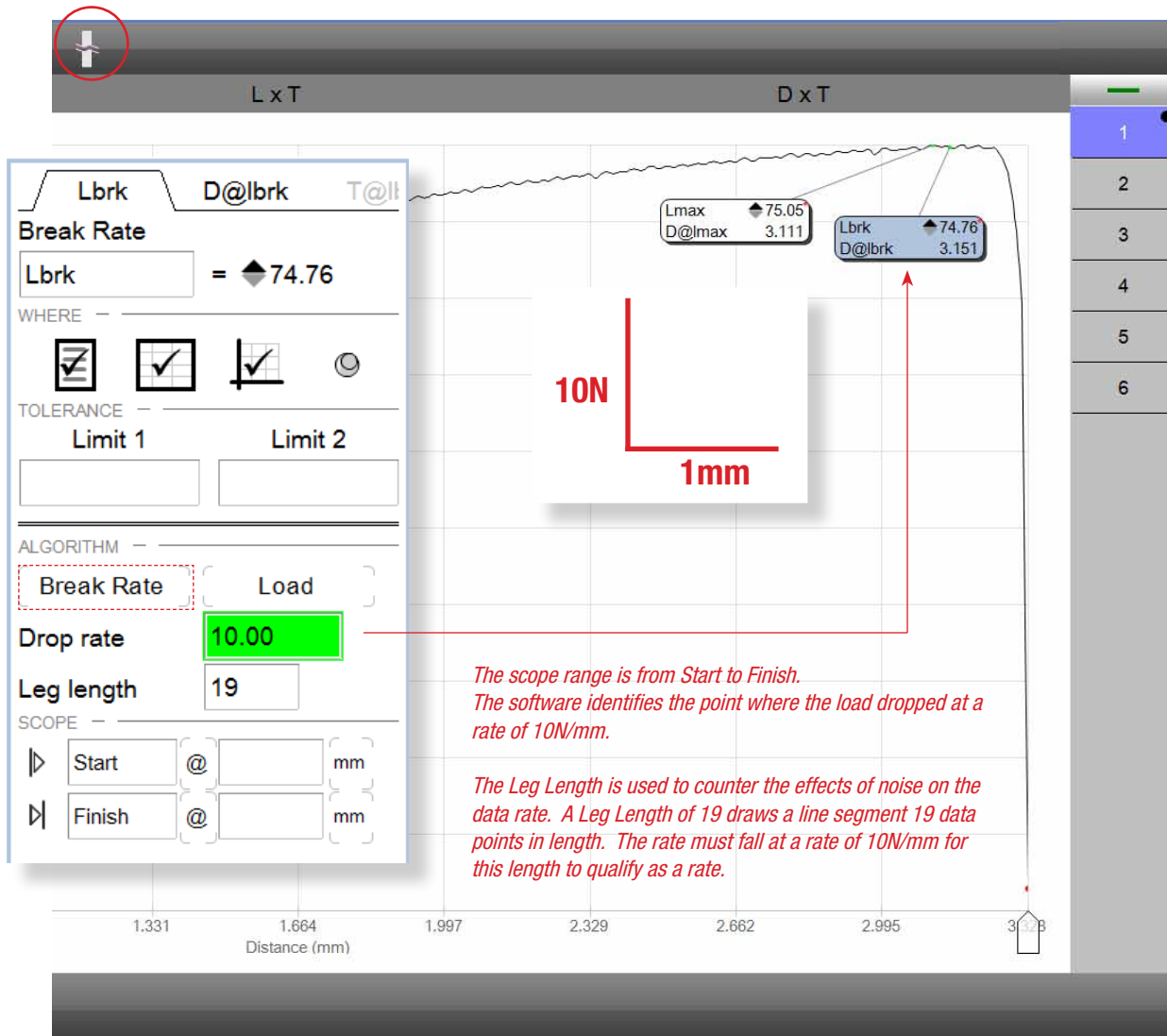
• Results View
• Graph Views using a Marker
• Data Views (a column within the table)

5.11.2.6   Break Rate Algorithm Tolerance

Your Break Rate result (coefficient) can make use of a tolerance to distinguish the result as either a "pass" or "fail" relative to your tolerance limits.

When you use a tolerance, you specify two tolerance limits. If your result equals or falls within the range created by these two tolerances, the result is displayed in black text and is deemed a "pass". If the result falls outside the tolerance range, the result displays in red text and is deemed a "fail".

Your L3 Series software also features a Tolerance view (TOL) that displays a tendency graph for the result. This graph displays whether the actual result is at the high or low end of the tolerance range you have established.

Data Definition Menu
Finding Break load using a Drop Rate (N/mm) in load after Lmax

5.12   Using the Annotation Tool

The Annotation tool lets you enter comments on your graph views. Select the Annotation tool to launch the Annotation Data Definition menu. Enter your comment into the Text Entry Block. You can name the Annotation like any other coefficient.

5.12.1 Annotation Text Entry Block

The maximum number of characters for an annotation is 200.

Enter the annotation into the Text Entry block after selecting the Annotation tool and then selecting inside the graph (anywhere).

5.12.2 Text Color

The annotation text may be displayed in black (default), red, green. blue or yellow.

5.12.3 Annotation Results

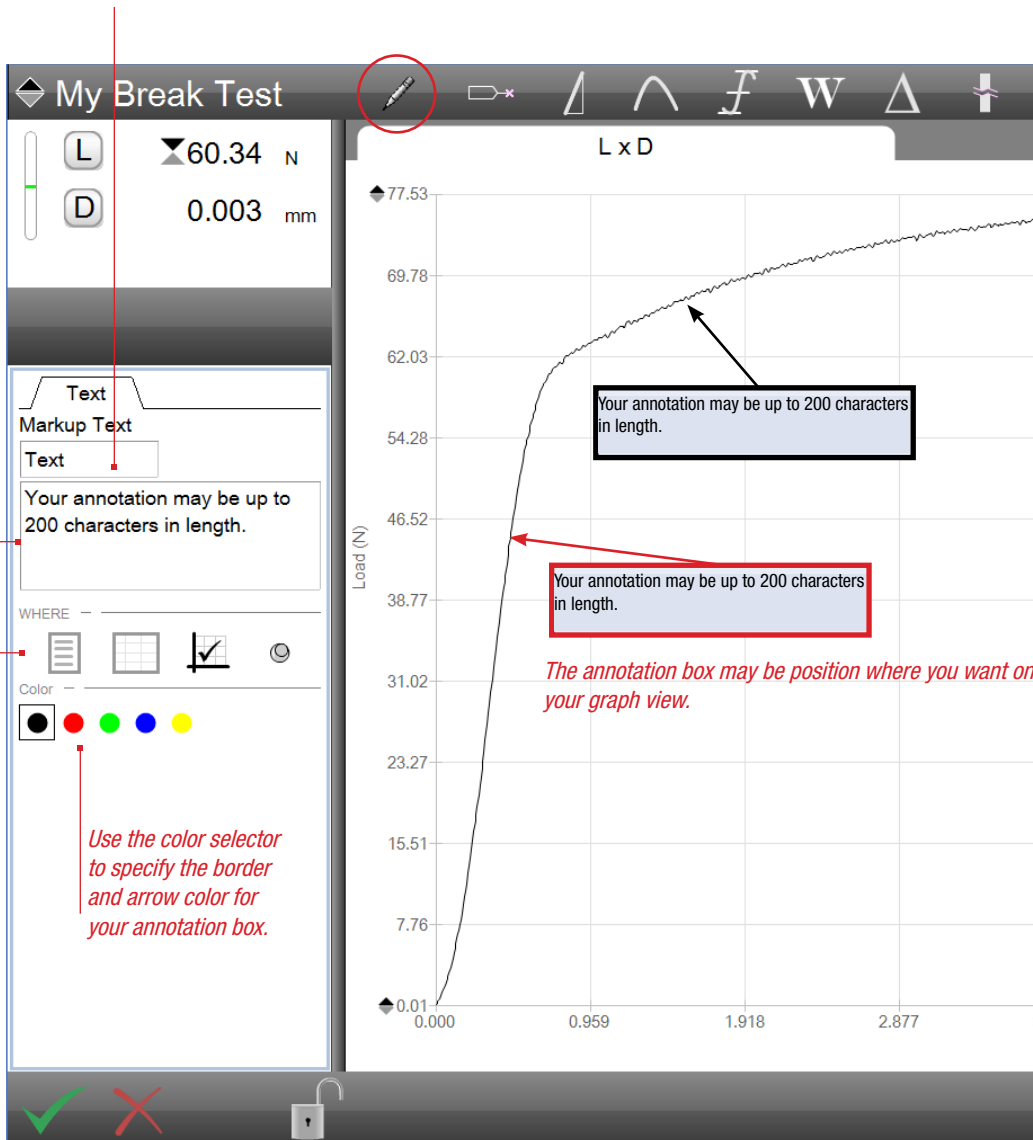The default coefficient name is TEXT.

The annotation may appear in the Results view, on graphs as a marker and in Data views as a column.

Name you annotation as a coefficient. This name will be used in the Data views or Result view for identification.

Enter your annotation into the Text Entry box. Up to 200 characters may be used, including spaces.

You have the option to display your annotation in your Results view or Data views using the WHERE function.

Use the color selector to specify the border and arrow color for your annotation box.

My Break Test

L   ⏬60.34 N
D   0.003 mm

L x D

Text
Markup Text
Text
Your annotation may be up to 200 characters in length.

WHERE

Color

Your annotation may be up to 200 characters in length.

Your annotation may be up to 200 characters in length.

The annotation box may be position where you want on your graph view.

Load (N)

77.53
69.78
62.03
54.28
46.52
38.77
31.02
23.27
15.51
7.76
0.01

0.000   0.959   1.918   2.877

Data Definition Menu
Finding Break load using a Drop Rate (N/mm) in load after Lmax

5.13 Formula Builder Tool

The Formula Builder tool lets you construct arithmetic expressions using your coefficients.

The Formula Builder features an expression box where you enter the formula you want to use to calculate a new result using arithmetic, logarithmic or trigonometric functions.

Formula Builder operators are:

Arithmetic	Trigonometric	Logarithmic
Add (+)	Sine (Sin)	Log (log)
Subtract (-)	Cosine (Cos)	Natural Log (Ln)
Multiple (x)	Tangent (Tan)	
Divide (÷)		
Absolute (abs)		
Exponent (^)		
Square Root (√)		

The example shows a peel test. The Max Tool was used to measure four specific peaks. Their Lmax coefficients are shown on the markers and in the Data view table.

Using the Formula Builder tool, you select each coefficient using the Data table header.

Start by selecting the open parenthesis symbol, then select each Lmax coefficient, followed by the closed parenthesis symbol, followed by the division symbol, followed by entering the numeric "4" using the Formula Builder key set. The result coefficient for a formula = F.
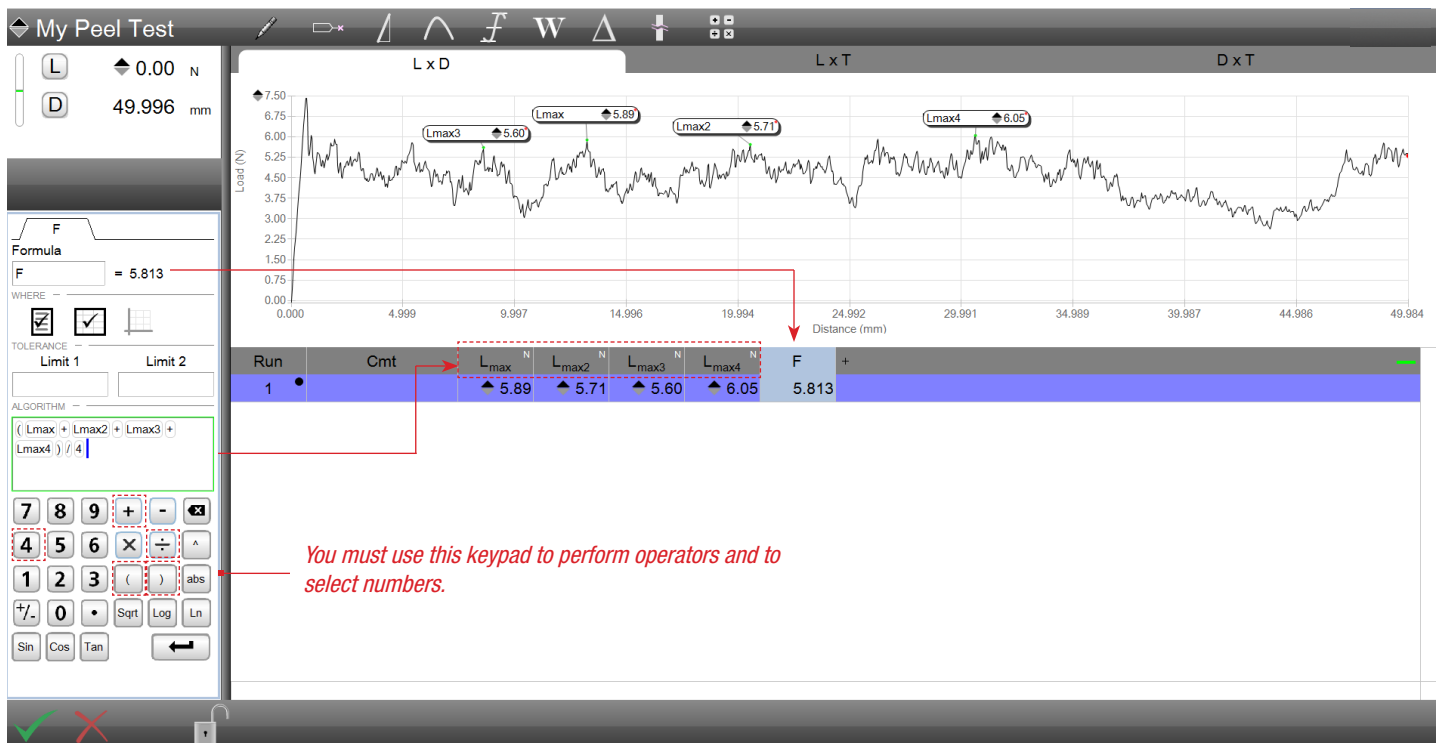
NOTE
You must use the numeric keypad on the Formula Builder Data Definition menu when you enter numeric values, e.g. when you enter the "4" to find the average of the four Lmax coefficients in the example.

L3 Formula Builder
Data Definition Menu

You must use this keypad to perform operators and to select numbers.
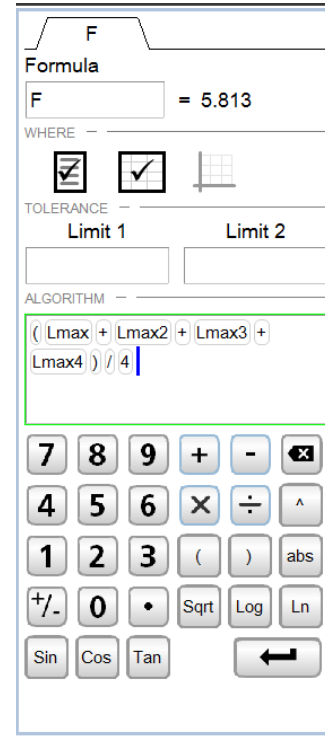
L3 Formula Builder
Finding the average peaks for a peel test

5.14   Using Archived Test Runs for Analysis

You may use the offline archive function to compare historical run results to current and active runs. Comparing archived runs with active runs should be performed using the Multi-view function.

5.14.1   Archived Test Runs

When a Runs Limit is met, the oldest test run is moved to the Archive directory within your Metlogix directory. The archived run may then be opened using the Offline tool, which when selected, opens the Archive directory. From the Archive directory, you may select any test run. Selecting Open, the archived test run is placed in your active Runs List. Archived runs have a prefix "T". For example, when you load an archived run onto your active Runs List, the first archived run will display was "T-1".

NOTE
Any test run within your Archive directory may be impored to your active test and Runs List. Use care to make sure you are importing test runs that are associated with your current test setup and your current Runs List.
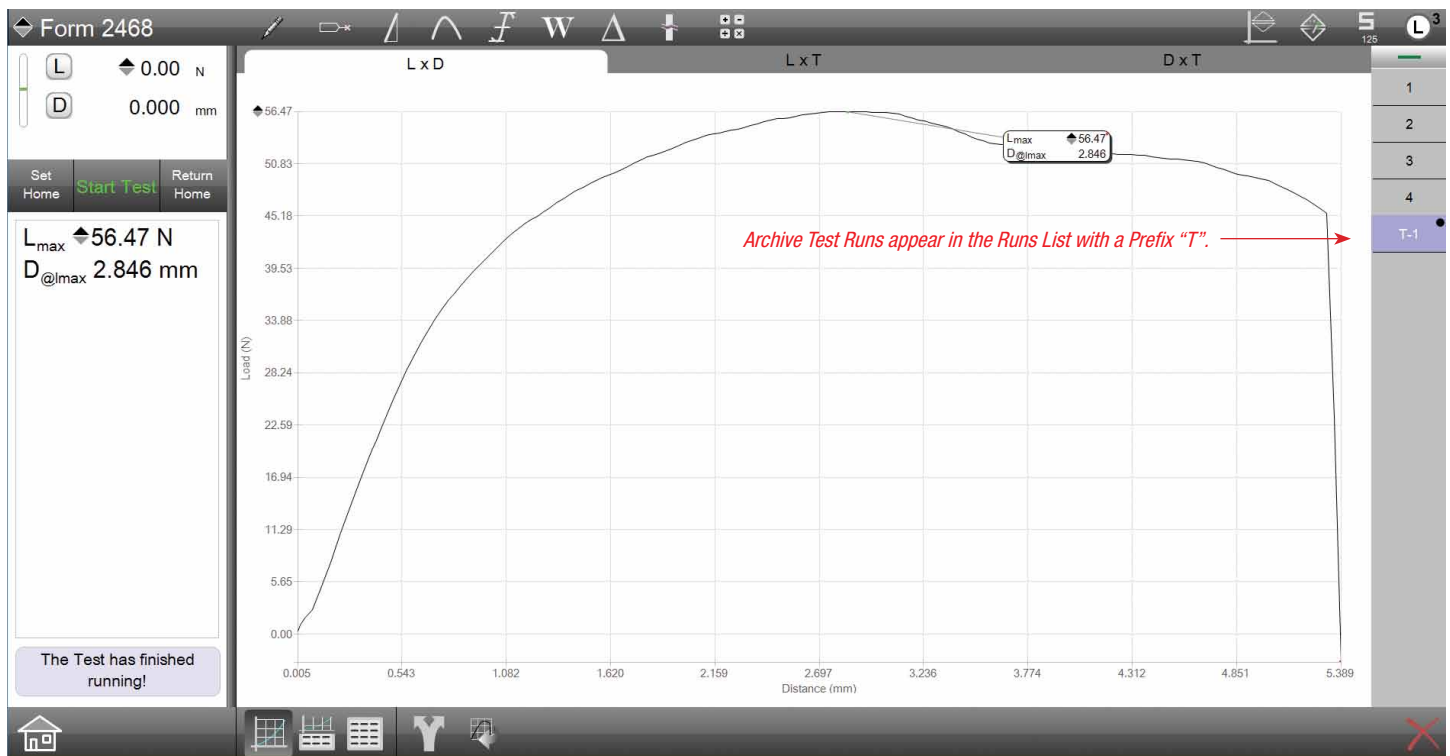
Full Graph showing Archived Run for analysis and comparison to Active Runs

5.14.2   Importing an Archived Run

Selecting the Archive function will open the Archive within the Metlogix directory, or where you have the Archive directory mapped to on your network.

To import an archived test run, select a run from the list. You may select more than one. The selected run does not need to be from the same test setup either.

NOTE
You may select any test run from the Archive directory. The selected test run does not have to have been created using the test setup associated with the active test runs.

Full Graph showing Archived Runs sub-directory

Delete an imported test run like any test run using the Delete function.

Select ARCHIVE function.

Opens the Archives sub-directory.

Select the test runs you want to import.

Select Open.

5.14.3   Analyzing with an Archived Run

When an archived test run is imported to your active Runs List, the graph and data that make up the graph are copied to your L3 system. You can then use your measurement tools to take new measurements. Or, you can use the measurements from your current active test runs to compare results with historical runs.

It may be necessary to re-measure results in the archived Run. Normally, when the archived Run is imported, the results associated with the current test Runs are automatically calculated and displayed with the archived Runs graph.

NOTE
When importing an archived Run, the archived Run may first show "XXX.X" for its coefficients. You may need to "re-link" the archived Run. You may do so, by simply choosing one of the active test runs, and then the archived run while in Multi-view.
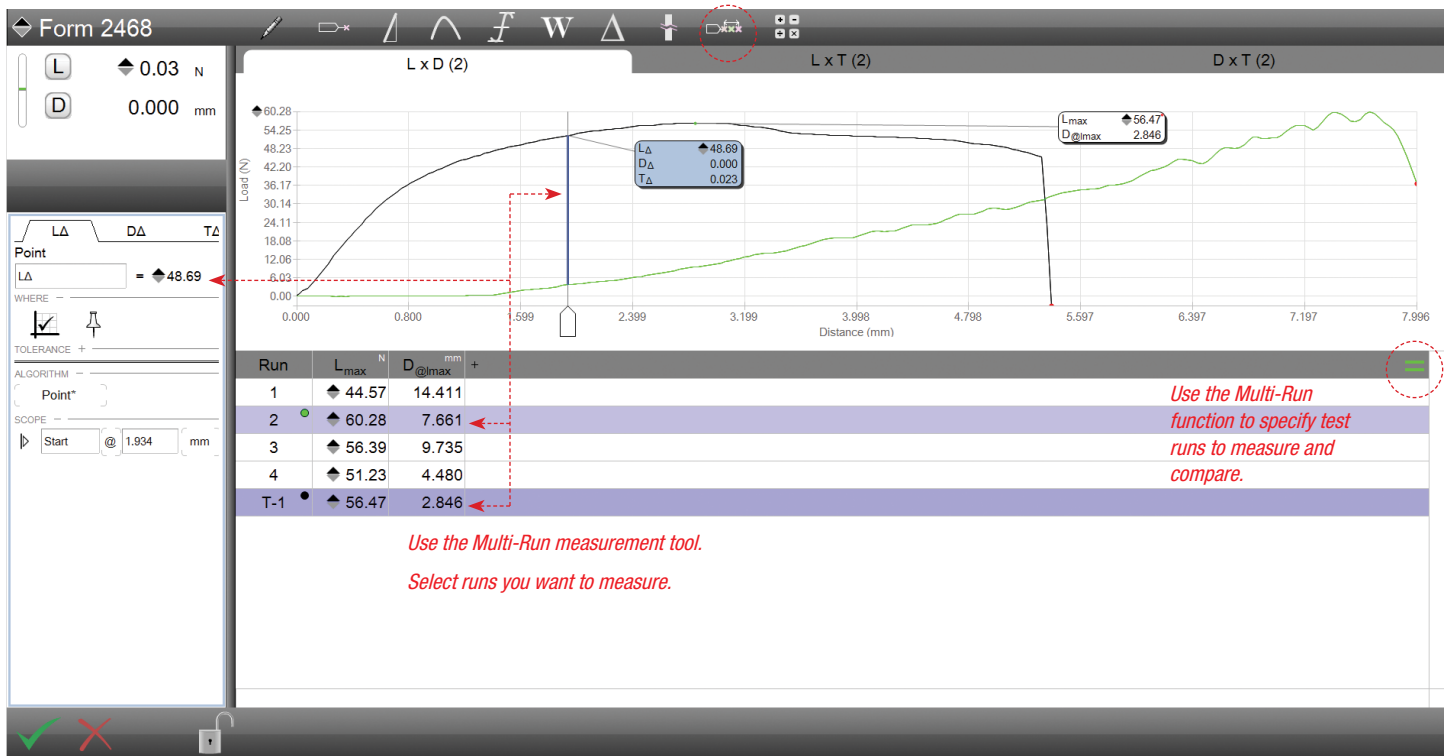
Split Graph showing Measurement between Archive Run # T-1 and Active Run #2

5.14.4 Statistics using an Archived Run

Statistics may be re-calculated to include your Archived Run. You must select the archived Run with any of the active Runs you want statistical calculations for.

If the archived Run is not selected, its measured results are not included in your statistical results. Only the results from your active Runs List will be used to calculate statistics.

NOTE
An imported archive test run does not affect the statistics in your active test.

If you want to include the archived test run in your statistical calculation, you must use the multirun function and select the runs you want used for statistical calculations.
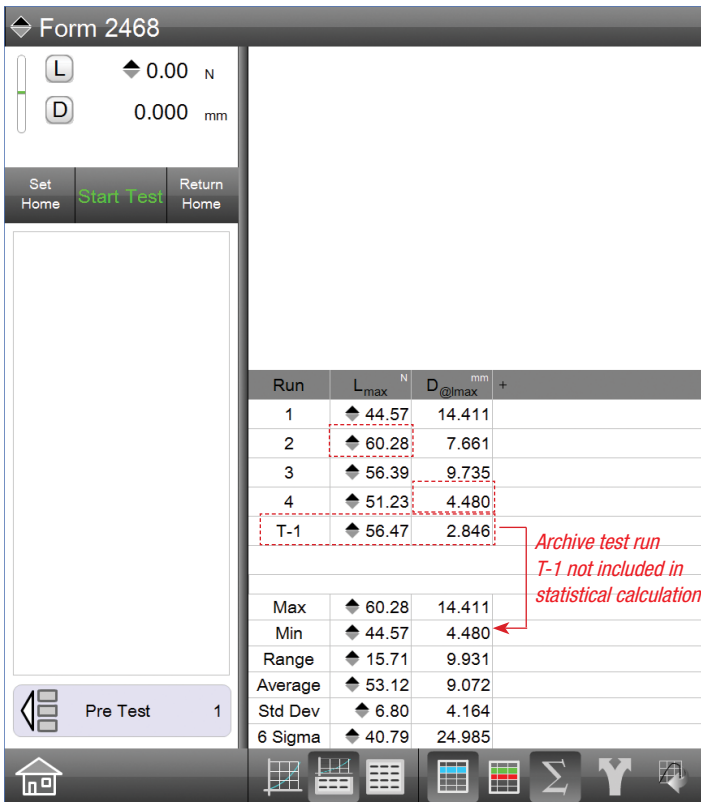
5.14.5 Removing (Deleting) an Archived Run

Remove the archive test run using the delete function on the display view. When the archived test run is deleted, it is deleted from the Runs List. The archived test run is not deleted from the source Archive directory.
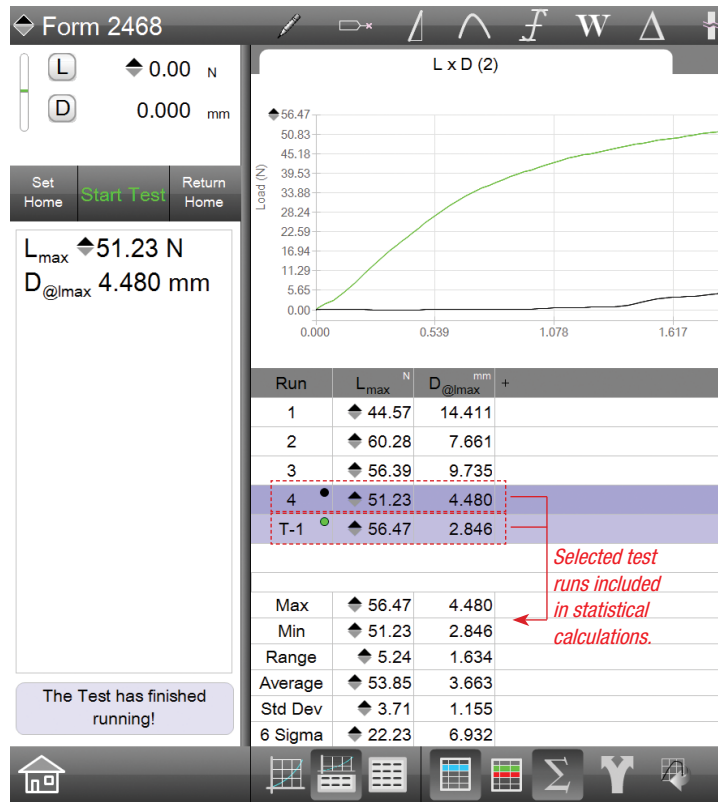
NOTE
When you delete an archived run from a display view, the archived test run is removed from the Runs List. It is not permanently deleted from the Archive directory.

Run	L_{max} N	$D_{@lmax}$ mm	+
1	44.57	14.411	
2	60.28	7.661	
3	56.39	9.735	
4	51.23	4.480	
T-1	56.47	2.846	
Max	60.28	14.411	
Min	44.57	4.480	
Range	15.71	9.931	
Average	53.12	9.072	
Std Dev	6.80	4.164	
6 Sigma	40.79	24.985	

Archive test run T-1 not included in statistical calculations.

Statistics calculated on Active Test Runs #1 - 4
Archive Test Run T-1 Not Included

Run	L_{max} N	$D_{@lmax}$ mm	+
1	44.57	14.411	
2	60.28	7.661	
3	56.39	9.735	
4	51.23	4.480	
T-1	56.47	2.846	
Max	56.47	4.480	
Min	51.23	2.846	
Range	5.24	1.634	
Average	53.85	3.663	
Std Dev	3.71	1.155	
6 Sigma	22.23	6.932	

Selected test runs included in statistical calculations.

Statistics calculated on selected Test Runs
Archive Test Run #T-1 and Active Run #4

FORCE MEASUREMENT SOLUTIONS