



Video Inspection Software

User's Guide

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June 2011 Issue 1 PN# 15001-00
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Features of the M2 VED Video Measuring Solution

- **Designed for Multi-Touch software control:** In addition to conventional mouse interface, the expanded Multi-Touch logic allows for versatile pan and zoom of both live video feeds and active part view with a pinch, swipe, or press.
- **Advanced probe toolbox:** The Vtouch™ video probe provides industry first video touch probe functionality, with simple acquisition of points on a feature's edge, just a press or click away.
- **Graphics-based “Part View” constructions:** Generate popular construction types, like Distances and Tangent Lines, from within the graphical part view itself.
- **Industry-leading support for additional tolerance conventions:** Tolerances can be applied in the standard feature to feature fashion, or by using a more traditional “place tolerancing” system. Engineering drawings may indicate that all features reported to 2 significant digits will get one tolerance value, where all features reported to 3 digits will get another. The M2 software allows for the entry and application of universal tolerance values according to these feature resolution groupings.
- **Feature Detail Graphics:** Individual feature views provide informative drawings displaying point cloud distributions, as well as nominal deviations, and tolerance results. Scroll through your measured features list from this view for a feature by feature display of Actual, Nominal, Tolerance, Deviation and Data Fit Type information.
- **Support for all current industry standard software methodologies for Stage and Camera calibration:** Simple machine/camera calibration can be achieved using popular machine and video correction methods. (LEC, SLEC, NLEC, Orthogonality, Pixel Size, Camera Skew, Field of View).
- **Industry leading Operating System platform:** The Windows® 7 operating system represents the current enterprise solution for personal computer based software operating systems. You gain the performance and reliability of a globally recognized software solution as part of you measuring machine package.
- **Additional Windows based functionality:** Other Windows functionality may also be utilized to meet and address specific application requirements. Flexibility in exporting data, printing reports and interfacing to third party windows applications will be enhanced under this widely supported operating system.

Welcome!

Thank you for choosing to learn more about the M2 Video Inspection Software package. The following guide will present and explain the nine (9) key concepts and procedures of the M2 software package.

This guide will:

- Serve as a syllabus for understanding the core fundamental concepts of the M2 video inspection software.
- Provide a quick reference format for seeking help on a particular procedure from within a topic.
- Present in a logical learning flow, necessary for understanding any piece of measuring software.

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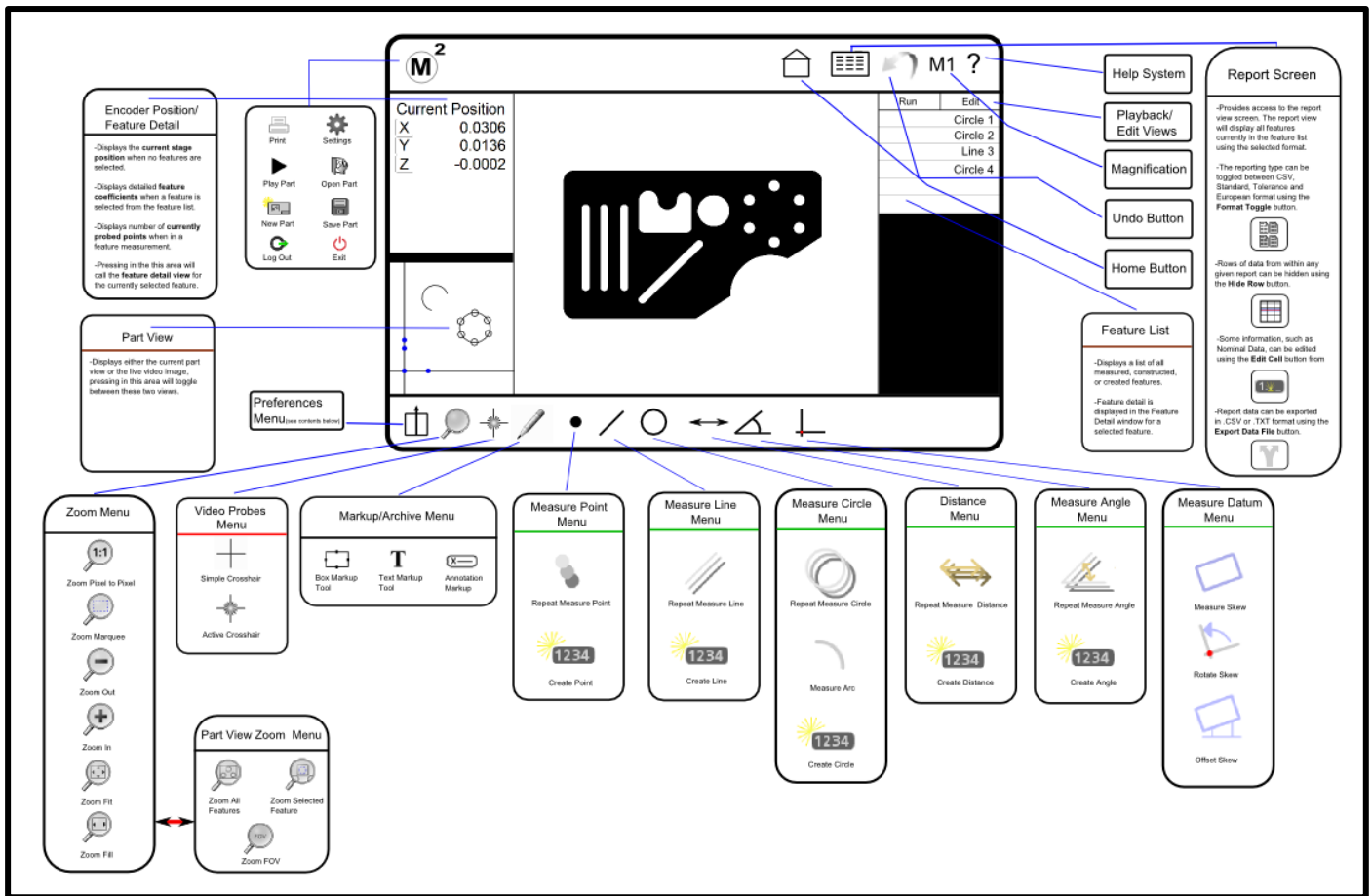
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Section 1: Introduction to the User Interface (UI)

This section describes the main M2 software interface. The diagram below illustrates basic button function information and button location for various M2 software commands. These button commands and their functions are enlarged for additional detail below the diagram.

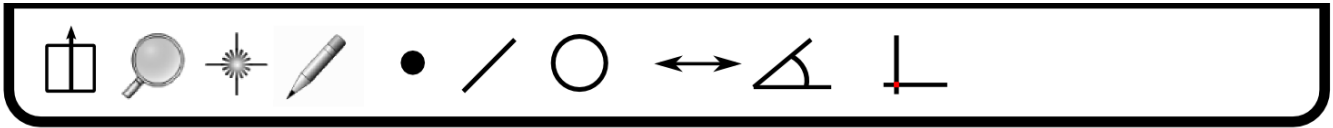


Navigating with the M2 “Viewports”

The M2 software contains three (3) main viewports, one (1) large viewport, seen above displaying the sample part, and two (2) small viewports, along the left side of the screen, that default to Current Position/Feature detail and Part View. Both the Part View and the Feature Detail screens can be switched to occupy the large viewport by simply clicking or pressing within the viewport.

Example: If you were to press in the Part View viewport on the software screen shown above, the Part View would occupy the large viewport, and the live video feed would “swap” to the small viewport that previously contained the part view.

The M2 Toolbar Buttons



Order below is according to the “toolbar” image above (left to right).

- **Preferences Menu:** Provides access to configured preference selection items, including unit type, reference frame selector, and the on-screen keyboard launcher. (These items are configured in “Settings”-“Desktop”).
- **Zoom Menu:** Provides access to Live Video or Part View Zoom control buttons.
- **Probe Menu:** Provides access to the Video Probe buttons.
- **Markup Menu:** Provides access to the Live Video markup and archive tools.
- **Measure Point Button/Menu:** Measures Point feature and provides access to the Point Menu.
- **Measure Line Button/Menu:** Measures Line feature and provides access to the Line Menu.
- **Measure Circle Button/Menu:** Measures Circle feature and provides access to the Circle Menu.
- **Measure Distance Button/Menu:** Measures Distance feature and provides access to the Distance Menu.
- **Measure Angle Button/Menu:** Measures Angle feature and provides access to the Angle Menu.
- **Measure Datum Button/Menu:** Measures Datum feature and provides access to the Datum Menu.

M2 User Interface and Button Detail

The M2 System Menu



Print: executes print command for the current view.

Settings: provides access to the setup screens buttons.

Play Part: initiates run of the current, or loaded, part.

Open Part: allows loading of previously saved part.

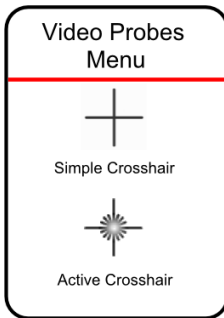
New Part: clears loaded part or current feature/program list.

Save Part: saves file of current feature program state.

Log Out: returns system to login screen, logging off user.

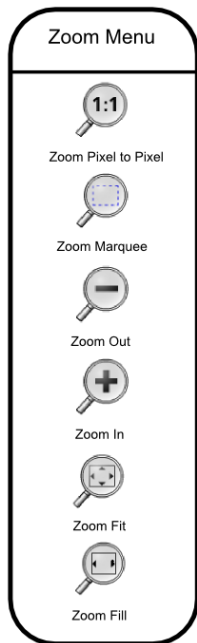
Exit: exits the current software session.

Command/Control Buttons



Simple Crosshair: displays the simple crosshair probe in the Live Video view port.

Active Crosshair: displays the active crosshair probe in the Live Video view port.



Zoom Pixel to Pixel: sets the current video zoom level to 1 camera pixel to 1 screen pixel.

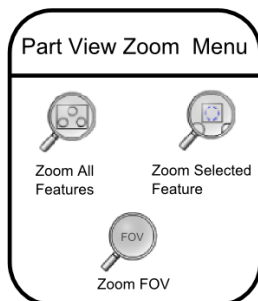
Zoom Marquee: sets the current video zoom to the specified marquee region.

Zoom Out (-): steps the video zoom level "out" incrementally.

Zoom In (+): steps the video zoom level "in" incrementally.

Zoom Fit: sets the current video zoom level to fit the video view port horizontally.

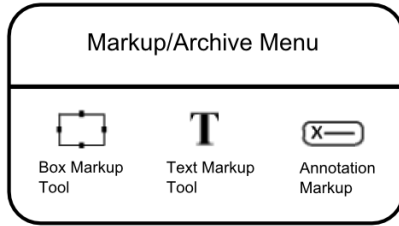
Zoom Fill: sets the current video zoom level to fit the Video viewport horizontally and vertically.



Zoom All Features: sets the current Part View zoom level to fit the current features in the feature list.

Zoom Selected Feature: sets the current Part View zoom level to the specified marquee region.

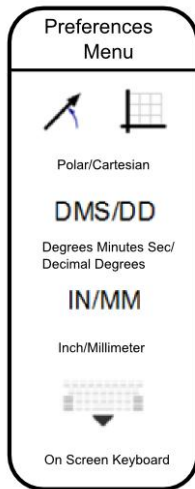
Zoom FOV: sets the current Part View zoom level to the current video field of view region.



Box Markup: selects the box draw tool for Live Video markup.

Text Markup: selects the add text tool for Live Video markup.

Annotation Tool: toggles the annotation “sticky” mode on or off.

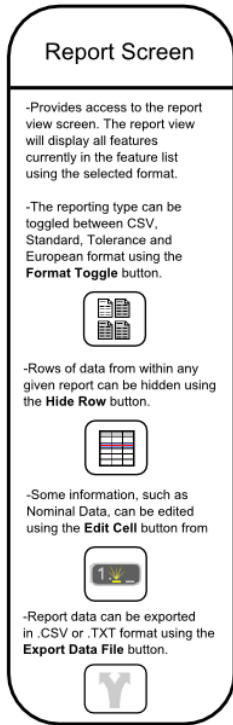


Polar/Cartesian: sets the current coordinate system display type to Polar or Cartesian.

IN/MM: sets the displayed linear unit type to inch or millimeter.

DMS/DD: sets the displayed angular unit type to Degrees/Minutes/Seconds or Decimal Degrees.

On-Screen Keyboard: displays the On-Screen keyboard.

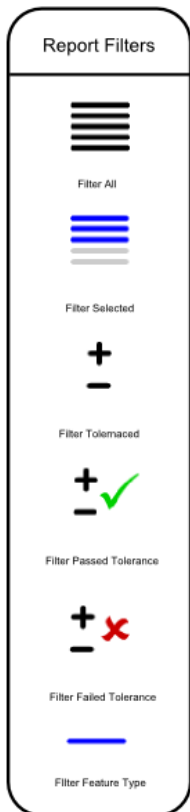


Format Toggle: displays the data report formats available for selection; Standard, Tolerance, CSV, and European.

Hide Row: hides the currently selected report view data row. Report exports and printouts will reflect these hidden rows.

Edit Cell: enabled editing of applicable report view data cells.

Export Data: displays buttons for data export in .CSV or .TXT format.



Filter All: applies the “displays all features” filter to the currently selected data report format.

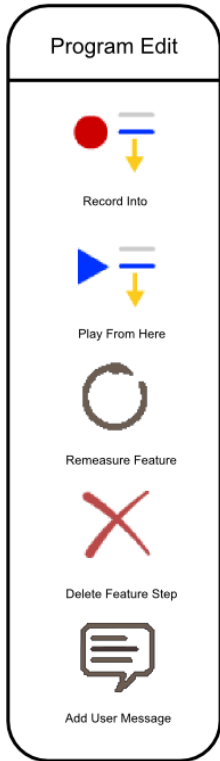
Filter Selected: applies the “filter by selected feature” filter to the currently selected data report format.

Filter Toleranced: applies the “filter by tolerance features” filter to the currently selected data report format.

Filter Passed Tolerance: applies the “filter by passed toleranced features” filter to the currently selected data report format.

Filter Failed Tolerance: applies the “filter by failed toleranced features” filter to the currently selected data report format.

Filter Selected: applies the “filter by selected feature” filter to the currently selected data report format.



Record Into: executes a “Record Into” routine on the currently selected program edit step. The “Record Into” step will be recorded after the selected step.

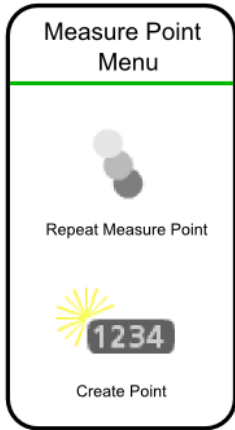
Play From Here: executes a “Program Playback” from the currently selected program edit step.

Re-measure Feature: prepares the software to re-measure a previously measured feature while in Program Edit Mode.

Delete Feature Step: deletes the currently selected program step.

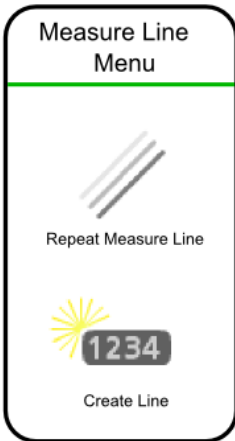
Add User Message: displays a text entry screen for adding user messages to programs.

Measure/Construct Buttons:



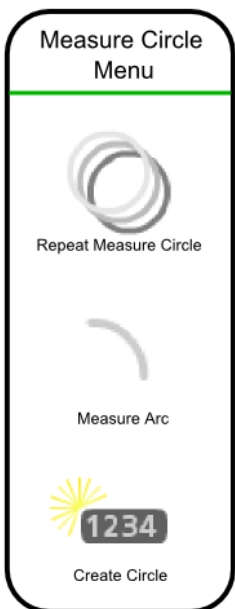
Repeat Point: enables the multi-measure capability for point features.

Create Point: displays the Create Point feature screen.



Repeat Line: enables the multi-measure capability for line features.

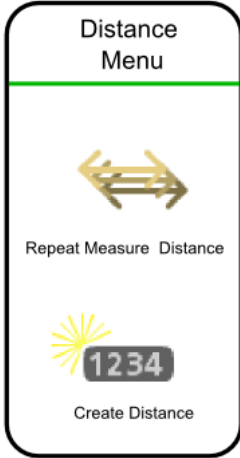
Create Line: displays the Create Point feature screen.



Repeat Circle: enables the multi-circle capability for line features.

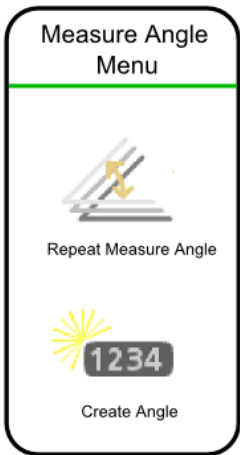
Measure Arc: initiates a discrete Arc feature measurement.

Create Circle: displays the Create Circle feature screen.



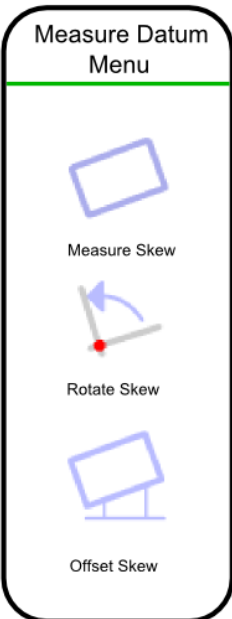
Repeat Distance: enables the multi-distance capability for Distance features.

Create Distance: displays the create Distance feature screen.



Repeat Angle: enables the multi-angle capability for angle features.

Create Angle: displays the create Angle feature screen.

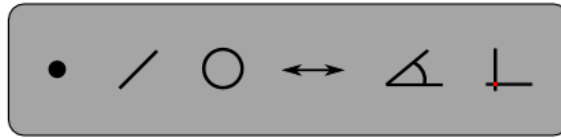


Measure Skew: enables the multi-angle capability for angle features.

Rotate Skew: displays the Rotate Skew Angle screen.

Offset Skew: displays the Offset Skew screen.

Section 2: Feature Measurement and Construction



Concepts:

- Feature measurements in the M2 software can always be performed using either a Simple Crosshair probe or the Active Crosshair probe. The Simple Crosshair required that the feature edge be aligned to a screen crosshair using an operator's visual judgment. The Active Crosshair probe can capture edge positions automatically using Video Edge Detection (VED).
- Explicit feature measurements are always performed by choosing the desired feature and probing at least the minimum required points on the feature's edge.
- Feature constructions are performed by selecting the desired feature construction type, then selecting the parent features to be used for the feature construction. When the feature measurement is complete, the desired construction will be added to the feature list and part view.
- The M2 software supports measuring, constructing and creating: Lines, Circles, Angles, Points, and Distances. When a feature measurement is complete, it is added to the Feature List and Part View.
- Detailed feature information, including coefficients and a data cloud of the points probed, is always available for measured features.
- Applicable tolerances types can always be applied to measured features.

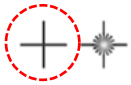
“Measure Circle” Example

The M2 Software supports measuring **Circle** features and can be accomplished using the following procedure:

- Select the Measure Circle button from the Measure Toolbar.



- Using the “Enter” button or by pressing in the yellow measure port, probe at least 3 points on the feature’s edge using a Crosshair Video probe.



- Press “Done” to complete the Circle Measurement. The Circle is added to the Feature List and Part View.

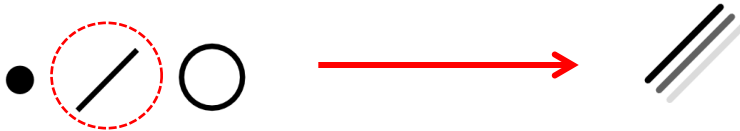
All supported feature types can be measured explicitly using the same procedure described above.

“Measure Repeat” Example

The M2 software supports measuring features in “Repeat Mode” using the following procedure:

- When measuring in “Repeat Mode”, the Measure Feature button does not need to be pressed between each feature measurement. The system prepares the next feature measurement automatically at the completion of the previous feature. This mode is designed for measuring a large quantity of “like features” sequentially. “Repeat Mode” is available for all feature types using the same procedure.

- Press the measure feature button for the desired feature type, next select the repeat button for that feature.



- You can now select any video probe you would like and begin probing the first feature. When finished press “Done”.

- You will notice that the system is now ready for another line measurement. This will continue until “Repeat mode” is exited. Press the “Done” button to exit “Repeat Mode”.

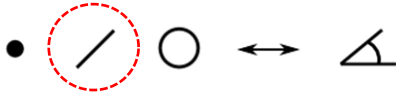
Points requirements for probed and constructed features:

- **Point Features** require one (1) or more points. When more than one (1) point is probed or used in a construction, the average point is the result.
- **Line Features** require two (2) or more points. When more than two (2) points are probed, a data fit type is applied to the feature's data cloud.
- **Circle and Arc Features** require three (3) or more points. When more than three (3) points are probed, a data fit type is applied to the feature's data cloud.
- **Angle Features** require four (4) or more points. The first (2) points must be probed on one leg of the angle, followed by two (2) additional points on the second leg. More points can be added after the initial (4) in any location of the angle's legs.

“Construct Line” Example

The M2 Software supports Tangent Line Constructions and can be performed using the following procedure:

- Select the measure line button from the measure toolbar.



- Select the two circles from the feature list or part view that are to be parents of the tangent line construction.
- Press “Done” to complete the Tangent Line construction. The feature will be added to the feature list and part view. **All supported feature constructions can be performed using this same procedural method.**

Supported Constructions

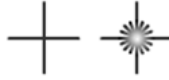
The list below contains all of the possible feature construction types on a feature-by-feature basis. The “feature types” from the list below represent the measure feature types that should be chosen from the M2 to achieve the desired “construction sub-type” listed to the right. The features chosen as parent feature will determine which construction subtype is produced.

| <u>Feature Type</u> | <u>Construction Sub-type</u> | <u>Feature Type</u> | <u>Construction Sub-type</u> |
|---------------------|------------------------------|---------------------|------------------------------|
| Point | Average Point | Line | Average Line |
| | Duplicate Point | | Duplicate Line |
| | Center Point | | Perpendicular Line |
| | End Point | | Mid Line |
| | Mid Point | | Center Line |
| | Intersect Point | | Tangent Line |
| | Tangent Point | | Parallel Line |
| | Perpendicular Point | | |

| <u>Feature Type</u> | <u>Construction Sub-type</u> | <u>Feature Type</u> | <u>Construction Sub-type</u> |
|---------------------|------------------------------|----------------------|------------------------------|
| Distance | Duplicate Distance | Circle or Arc | Duplicate Circle/Arc |
| | Center Distance | | Average Circle |
| | Nearest Distance | | Bolt Center |
| | Farthest Distance | | |
| | Length Distance | | |

| <u>Feature Type</u> | <u>Construction Sub-type</u> |
|---------------------------|------------------------------|
| Angle | Duplicate Angle |
| | Line Angle |
| | Included Angle |
| | -180deg <i>minus</i> Angle |
| | 180deg <i>plus</i> Angle |
| 360deg <i>minus</i> Angle | |

Section 3: Probing and the Video Probes



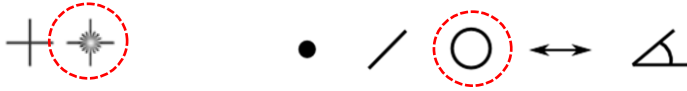
Concepts:

- In the M2 software, features are measured by probing points on the edge of a feature within the Live Video window. Points are probed as part of an explicit feature measurement using one of the M2 probes.
- There are two main probes available in the M2 software, a Crosshair probe and a Multi-point probes.
- Crosshair probes are used to measure a single point at a time. The simple Crosshair probe requires that the operator's eye be used to line up the crosshair with the feature edge. The active crosshair will detect the feature edge automatically, increasing both the speed and accuracy of the probe.
- The Active Crosshair probe can be used in either **Positioning** mode, or in **Vtouch Probe** mode. In positioning mode the feature is positioned under the center circle of the active crosshair probe by positioning the stage. A small green "Candidate Point" will appear within the circle at the center of the crosshair when a valid edge has been detected. Pressing the enter key will enter the point within a feature measurement.
- The Vtouch Probe mode is invoked by selecting the Active Crosshair probe from the probe menu, and then pressing or clicking on a features edge. The tool graphic on screen will move to the target location momentarily, entering a point, and then snap back to the center screen position.

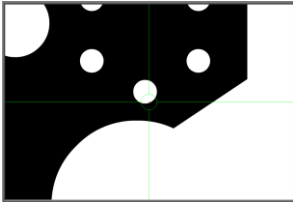
“Active Crosshair” Example

The M2 Software supports measuring features with an “Active Crosshair” using the following procedure:

- Select the “Active Crosshair” video probe from the probe menu. Press any “measure feature” button from the toolbar.



- Position the center region of the “Active Crosshair” probe on an edge within the live video window.



- Press “Enter” to fire the video probe. Press “Done” to complete the measurement.

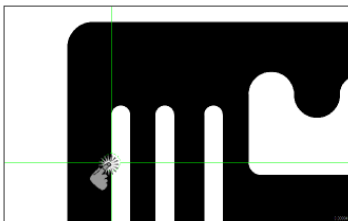
“Using the Vtouch Probe” Example

The M2 software supports measuring features with the VTouch probe using the following procedure:

- Select the “Active Crosshair” video probe from the probe menu. Press any Measure Feature button from the toolbar



- Press or click on the edge of the feature to be measured. As you click on an edge within the Live Video window, the active crosshair tool will momentarily move to the probed point position. Continue probing in the fashion until the desired number of probed points is reached.



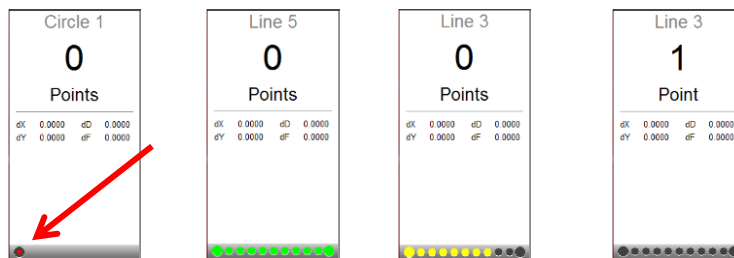
- Press “Done” to complete the feature measurement.

“Auto Point Entry” Example

The M2 software contains an “Auto Point Entry” feature that provides a fast and easy way to probe features, using a count-down timer.

- Select a crosshair probe from the probe menu. Select the desired feature to measure.
- A small red dot will appear in the horizontal divider bar between the Part View and DRO viewports. This red dot is the activation button for the “Auto Point Entry” timer. Press the dot to enable the timer.
- Position the stage on the edge you would like to begin probing on. As you move, the dots will turn green indicating the timer is armed.
- Once you stop moving the stage, the timer graphic will count down and a point will be automatically “fired” at the current crosshair position.
- You can now move on to the next point to be fired.

Note: When using the count-down timer, you may accidentally enter an incorrect point. To remove an entered point, simply press the “Undo” button and proceed with probing.

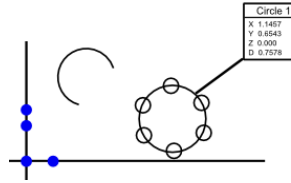


Program Playback

- During program playback, the part program remembers the approximate gradient of each edge that was recorded as part of a feature measurement within that part program.
- In playback, the system simply looks at the recorded position to find an edge. The found edge only needs to be similar to the recorded edge to be a valid point for acquisition in playback.
- Thus, playback is simply a collection of stage positions and their associated candidate points based upon the recorded edges of measured features. In most cases, the video probe used to initially measure a feature is inconsequential to the manner in which points are collected in playback.
- Each “programmed” stage position, after a valid registration has been completed, is advanced with a screen press or “Enter” key press. For measurements performed with the VTtouch probe, all valid candidate points that fall within a given stage positions’ field of view will be collected automatically, completing feature measurements as it goes.

Section 4: Feature List and Part View

| |
|--------|
| Line 1 |
| Line 2 |
| Arc 3 |
| Line 4 |
| Line 5 |
| Line 6 |



Concepts:

- The Feature List and Part View are the primary means of viewing and manipulating features that have been measured, constructed, or created in the M2 software.
- Selecting features in the feature list allows for feature construction, access to feature detail views, as well as provides a means of deleting features.
- The Part View is a graphical display of features measured, constructed, or created in the M2 software. The Part View can also contain additional graphic elements such as a reference frame indicator, and grid lines.
- The Part View supports feature selection for constructions using the same simple method as the Feature List. Feature selection from the Part View also provides a means for changing and deleting features.
- A simple set of tools are provided for zooming and panning around the Part View. For touch screen enabled systems, pinch-zooming and two finger panning is also supported.

“Feature Selection Tool” Example

The M2 software manages feature selection using the Multi-Selection toolbar:



- Features in the Feature List can be selected and de-selected either individually or in groups. The Multiple Selection tool is used to choose which selection mode is active.
- The single bar selector allows for individual feature selection and de-selection when pressed.
- The double bar selector allows for multiple features to be selected, one feature at a time.
- The large single bar selector allows for group feature selection defined as a range. In addition, this provides a quick means to “select all” features.

“Delete Feature(s)” Example

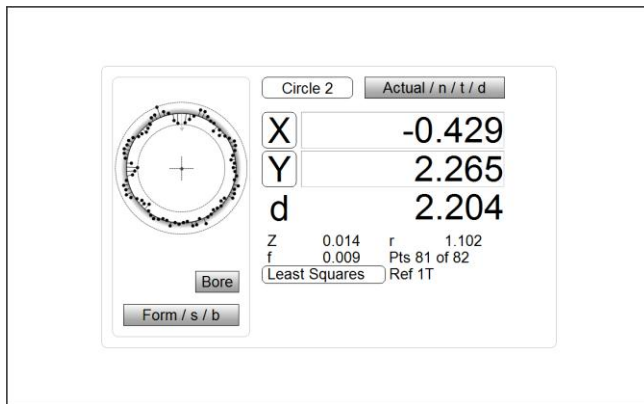
Feature deletion in the M2 software

- Features can be deleted by selecting them in the Feature List and then pressing the Delete button. The Delete key on a keyboard may also be used.
- Features can be deleted either individually or in groups.
- To delete all the features in the Feature List you can press and hold the Delete button, located in the main toolbar.
- Features that have been deleted can be restored by pressing the Undo button.

“Feature Detail View” Example

Accessing the Feature Detail screens

- To access expanded Feature Detail, select the desired feature from the Feature List, and press the DRO/Feature Detail viewport on either the left or right side of the screen.
- The expanded Feature Detail View will now fill the large viewport of the M2 application.
- The Feature Detail screen contains the feature graphic, showing the probed points, as well as fit and tolerance zones.
- The Feature Detail screen also provides access to tolerancing and datuming functions. These topics as well as an explanation of the actuals, nominals, tolerance, and deviation screens are covered in Sections 6 and 7.



“Part View Zoom/Pan” Example

Panning and Zooming the Part View

As features are measured, constructed and created, they will populate the Part View. Depending on the zoom level, features may fall outside the viewable area of the Part View. Panning allows you to “grab” the Part View and move it in any direction.

- With two-fingers spaced about an inch apart, press within the Part View, hold down, and move your fingers. The Part View will pan according to the direction of your finger swipe. When using a mouse, the right mouse button is used to pan.
- Features that are outside the limits of the Part View can also be brought into viewable range by using one of the several available zoom commands found in the Part View Zoom Menu. Touch screen systems with multi-touch support can also make use of “pinch-zooming” within the Part View.

“Annotate Feature in Live Video” Example

- Measure several features on a part and set the live video to the large viewport.
- Select the Pencil icon toolbar button from the lower left-hand corner of the M2 screen.



- A menu of items will appear on the right-hand side of the Live Video window starting with Auto. From this menu, you can select the coefficients that you want displayed within the Annotation Box. For this example select, X, Y and D.
- Press or click and hold on a measured feature in the live video window near where you would like to place an Annotation Box and drag away from the feature.
- An Annotation Box will appear with an arrow line attached to the circle. Move the annotation box to the desired location and release your finger or the mouse button.

“Auto” will draw a single representative coefficient for the selected feature.

“Name” will include the feature name in the Annotation Box.

“Nominal” and “Deviation” will include tolerance information for a feature that has been toleranced.

“Box Markup in Live Video” Example

- Measure several features on a part and set the live video to the large viewport.
- Select the Pencil button from the lower left hand corner of the M2 screen.



- A menu of items will appear on the right hand side of the live video window. Select the Box Markup button from the displayed menu.



- Click or press, and drag on the screen to create a box graphic. Release the mouse or release your finger, to complete the box markup graphic.
- Once the box annotation is complete, it can be resized using the circular handles at the boxes corners, or can be moved by clicking or pressing in the box region and dragging it to the desired location.
- To change the color of the box markup, select the box, and then choose the desired color from the color selector displayed below the box.

“Text Markup” Example

- Set the Part View to occupy the main M2 viewport.
- Select the “Pencil” icon toolbar button from the lower left hand corner of the M2 screen.

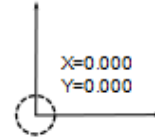


- A menu of items will appear on the right hand side of the Part View. Select the Text Markup button from the displayed menu.

T

- Click or press, and drag onto the screen to create a text markup graphic. Release the mouse, or lift your finger, to position the text markup graphic.
- Type the desired text into the text markup box using either a connected keyboard or the on-screen keyboard.
- Once the text annotation is complete, it can be resized using the circular handles at the box’s corners, or can be moved by clicking or pressing in the box and dragging it to the desired location.
- To change the color of the text markup, select the text box, and then choose the desired color from the color selector displayed below the text box. Set the font size using the font increase or decrease buttons also located below the text box.

Section 5: Part Alignment and Datuming



Concepts:

- Datuming in the M2 software can be accomplished using any of a variety of alignment operations. These operations may be used individually or in combination, and will be based upon the capability of the measuring machine, as well as the particular alignment requirements of the application.
- Datum operations can be performed in the form of explicit datum feature measurements, by modifying the individual coefficient values of previously measured features, or by constructing datum features from existing features.
- The M2 software supports a two part alignment system. Skew correction for a part, as an alignment step, corrects for x-axis alignment error. Establishing an origin, or datum, point sets a coordinate system zero position. Used together, a complete two part alignment can be achieved.
- When measuring a datum dependent part, it is advisable to go through the process of establishing a datum or part alignment first, followed by measuring the features associated with that datum.
- "Offset Skew" allows for setting a skew line position in a location that is not directly measured by the system. This skew position is identified by offset values from other measured or constructed features.
- "Rotate Skew" allows for the presetting of the current skew orientation to a specified angular value.

“Part Skew” Example

The M2 software supports skew or secondary alignment and can be explicitly measured using the following procedure:

- Select a Probe from the probe menu.
- Press the “Datum” toolbar button to access the datum submenu.



- Press the “Measure Skew” button to initiate the explicit skew measurement or skew construction.



- Probe at least (2) points on the line to apply skew to, or select the features from the feature list or part view that you would like to construct the skew line from.
- Press Done to complete the skew measurement.

Note: Previously measured or constructed features can also be used to apply skew by manually zeroing the theta angle coefficient and the X or Y axis coefficient. Pressing the label buttons to the left of these coefficients, in either the feature detail screen or the mini-DRO view port, sets the corresponding value to zero.

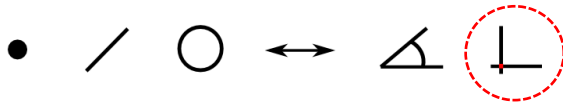
“Part Datum” Example

The M2 software supports setting a Datum (Origin) point and can be performed using the following procedure:

Note: Setting a datum position is typically performed on a previously constructed or measured feature. Datum points can be explicitly measured as well using the “Measure Datum” button.

“Datum Construction” Method

■ Press the “Datum” toolbar button to initiate the datum procedure. The system is now prepared to set an existing feature to the datum, or to explicitly measure a datum position.



■ Select the feature that you would like to set as the Datum Zero position.

■ Press “Done” to apply the datum to the selected feature.

Or...to measure explicitly:

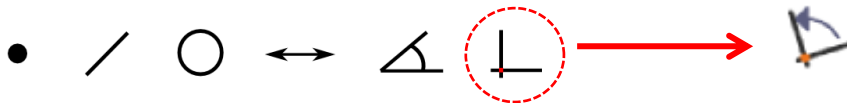
■ After pressing the measure datum button, probe a point and press Done.

Note: Previously measured or constructed features can also be used to apply a datum by manually zeroing the X and Y coefficients of the feature. Pressing the label buttons to the left of these coefficients, in either the feature detail screen or the mini-DRO view port, sets the corresponding value to zero.

“Rotate Coordinate System” Example

The M2 software supports “Rotating” of the coordinate system. The rotation will be added to the feature list to indicate the manipulation of the coordinate system.

- Press the “Datum” toolbar button to access the datum submenu.
- Press the “Rotate” button to access the “Rotate Coordinate System” screen.



- Enter the desired angular rotation value into angle field.

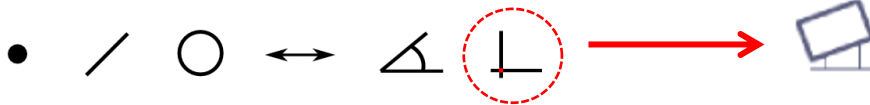
| | |
|---|---------------------------------------|
| A | <input type="text" value="45°00'00"/> |
|---|---------------------------------------|

- Press “Done” to complete coordinate system rotation.

“Offset Alignment” Example

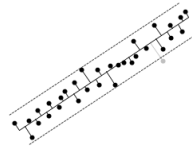
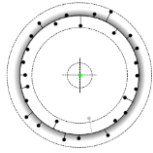
The M2 software supports establishing an “Offset Alignment” from previously measured features.

- Press the “Datum” toolbar button to access the datum submenu.
- Press the “Offset Alignment” button to access the “Offset Alignment” screen.



- Using the Axis Selector, select the axis that you would like the offset applied in.
- Enter the desired offset values to be applied to feature #1 and #2 and press “Done”.
- The system will exit to standard Measure mode, displaying the measure prompt.
- Measure or select the features that you would like to be the basis for the offset alignment values entered in the previous step.
- Press “Done” to complete the offset alignment. The new alignment feature will be added to your Feature List and the Part View.

Section 6: Applying Tolerances



Concepts:

- The Tolerance functionality in the M2 software allows you to apply blueprint nominal information to the measured and constructed features of a part.
- Each feature type has a set of tolerance conditions that can be applied to that feature. Typically, tolerance conditions are applied to features after valid datum operations have been performed and a part coordinate system has been established.
- The feature detail view and the report view can both be used to apply tolerance types to features, enter tolerance values, and execute other tolerance related operations.
- Once a tolerance is applied, you can see on screen, or in a report, the actual, nominal, and variance data for a given feature.
- Tolerance conditions can be applied to a single part inspection routine or included within a part program for repetitive part measurement.
- Tolerances can be applied in the standard feature to feature fashion, or by using a more traditional “place tolerancing” system. Engineering drawings may indicate that all features reported to 2 significant digits will get one tolerance value, where all features reported to 3 digits will get another. The M2 software allows for the entry and application of universal tolerance values according to these feature resolution groupings.
- Notification that a feature has failed tolerance is indicated in the Feature List, the Part View, the Feature Detail View, and the Report View by way of red color signaling.

“X/Y Position Tolerance” Example

The M2 software supports applying an XY positional tolerance to a circle feature and can be accomplished by using the following procedure:

- Select the circle feature in the feature list you intend to apply the tolerance to.
- Access the feature detail screen for the circle by pressing in the feature detail viewport.
- Toggle the feature detail screen from “Actuals” view to “Nominals” view using the screen selection button located above the feature coefficients.

Actual / n / t / d

- Set the nominal position values in X and Y for your circle feature.

X

Y

- Select the X or Y positional tolerance button from the toolbar and then enter the desired tolerance values in the appropriate fields.



- Switch the detail view screen from “Tolerance” to “Deviation” using the view selector button to observe the results of the applied tolerance.

“Auto-Round Nominals” Example

The M2 software supports “Auto-Rounding” of nominal values and can be accomplished according to the following example:

The following software feature can often save time when repetitively entering nominal feature data. The key principal is that when you first measure a part that needs tolerances applied, it is common for the measured values to be close to the blue print nominal values. Using “Auto-Round Nominals”, the nominals for each coefficient can be quickly rounded up or down to match the likely nominal values, based upon the actual measured values.

- Align and establish a datum for the part being measured part.
- Measure the first feature that requires a tolerance from the print. In our example we will use a “Circle”.
- Select the detailed feature view for this circle. The actual values of the circle you just measured are now displayed.
- Press the “Actuals/n/t/d” button, to display the nominal entry screen.
- To enter the nominal information, select the numeric field to the right of the X button, the values will now turn blue and a numerical keypad will appear. You can either use the keypad to manually enter the nominal value, or “Auto Rounding” can be used, as described below.
- As an example, the measured value of the circle is 0.4997”, the nominal value from the print is 0.5000”. In this case, to round up to .5000” to match the print, simply press the “4” digit. This will round the X nominal value to .5000”.

Note: The digit selected will cause rounding, either up or down, based on the value in the place to the right. For example, if the value is .3727 and you select and press the ‘2’, your new value will be .3730.

- To make adjustments up or down to any digit, select the digit, and while holding down, slide your finger or the mouse pointer downward off of the digit. This will select the digit place to be incremented or decremented from.
- Slide your finger or mouse pointer to your left to increase the value, or to the right to decrease the value.

“Place-Tolerancing” Example

The M2 software supports “Place-Tolerance” style tolerance entry and can be configured using this procedure:

This time saving convention relies upon using tolerance information found in the “detail block” of a blue print. This blueprint element indicates the tolerance values to be used, based on the number of digits reported for the actual value of a feature. The following is an example of how this may appear:

| | |
|------|------------|
| .X | +/- 0.1” |
| .XX | +/- 0.01” |
| .XXX | +/- 0.001” |

The above graphic indicates that if a diameter coefficient has a nominal value of 1.50, the tolerance that should be applied is +/- .01.

Note: In order to take advantage of “place tolerancing” the option must be enabled. Set the item “Enable tolerance places” to “Yes” in the Measure Setup screen of the settings section of the M2 software. “Tolerance place data on new part” can also be set to “Yes” within this setup screen in order to apply the same place tolerance chart to all newly created parts. This method of tolerancing is supported for both metric and English values.

- Align and datum you part. Measure the first feature to be toleranced. For our example we will use a circle.
- Once you have measured the circle, select the detailed feature view. You will see the actual values of the circle. Select the Nominal/n/t/d/a button once. You will now see the nominal data entry page. Enter the nominal values for the X.Y and D coefficients either by using the keypad or the “Auto-rounding” feature.
- Once this is done, look at the you blue print and see how many digits to the of the decimal pint were used to specify the dimension and then look at the tolerance block and look for the corresponding number of “X’s” and the value associated with it.
- For example, if the nominal value for the X position was 1.500 and the Y value was 2.000 and the Diameter was 1.000, then look for the value associated with XXX. For this example we will use .001 for XXX tolerancing.
- Press the third digit to the right of the decimal point for the X,Y and D values. You will now see all digits to the right of this place position go gray.
- From the nominal entry screen, you will see an icon “X.X, X.XX, X. XXX” in the bottom toolbar. Press this button and the place tolerance set up screen will appear. In this screen, you can enter the values from the tolerance block of you blue print that corresponds to the various “X.X” value. Only fill in the place fields that correspond to the print you are working from.

| | - Tol | + Tol |
|----------|----------|----------|
| X.X | 0.000000 | 0.000000 |
| X.XX | 0.020000 | 0.020000 |
| X.XXX | 0.000000 | 0.000000 |
| X.XXXX | 0.000000 | 0.000000 |
| X.XXXXX | | |
| X.XXXXXX | | |



















Supported Tolerances

The following list contains all of the supported tolerance types on a feature by feature basis. The “feature type” from list below represents the feature type that supports the tolerance listed to the right.

| <u>Feature Type</u> | <u>Tolerance Type</u> | <u>Feature Type</u> | <u>Tolerance Type</u> |
|---------------------|-----------------------|---------------------|-----------------------|
| Point | True Position (RFS) | Line | X/Y Positional |
| | X/Y/Z Positional | | Angle (Theta) |
| | | | Parallelism |
| | | | Angularity |
| | | | Perpendicularity |
| | Straightness | | |
| <hr/> | | | |
| Circle | True Position | Distance | X/Y/Z Positional |
| | (RFS/MMC/LMC) | | Length |
| | X/Y Positional | | |
| | Diameter | | |
| | Concentricity | | |
| | Runout | | |
| Roundness | | | |
| <hr/> | | | |
| Arc | True Position(RFS) | Angle | Angle(Theta) |
| | X/Y Positional | | |
| | Diameter/Radius | | |
| <hr/> | | | |

Tolerance Symbols

The following tolerance symbols indicate the associated tolerance type as well as the correct corresponding tolerance entry button within the M2 software.

| | | | |
|---|---|---|-----------------------------------|
|  |  |  | X/Y/Z Positional Tolerance |
|  |  | | Diameter/Radius Size Tolerance |
|  | | | Theta "Angle" Tolerance |
|  |  | | Length/Width Size Tolerance |
|  | | | Form Tolerance |
|  | | | Parallelism Orientation Tolerance |
|  | | | Angularity Tolerance |
|  | | | True Position Tolerance |
|  | | | Straightness Tolerance |
|  | | | Perpendicularity Tolerance |
|  | | | Roundness Tolerance |
|  | | | Concentricity Tolerance |
|  | | | Runout Tolerance |
|  | | | "Place Tolerancing" Entry Chart |

Section 7: Reporting

| Feature | Position | Size | Tolerance |
|---------|----------|----------|-----------|
| Hole 1 | X | 0.1070 | A 07.206 |
| | Y | -0.1025 | |
| Hole 2 | X | -0.3605 | A 114.502 |
| | Y | 0.4948 | |
| Hole 3 | X | -0.3000 | |
| | Y | 0.0000 | |
| | Z | 0.0000 | |
| Cham 4 | X | 1.5054 D | 0.0082 |
| | Y | 0.7481 | |
| Cham 5 | X | 1.1008 D | 0.0084 |
| | Y | 0.6319 | |
| Cham 6 | X | 1.9091 D | 0.0091 |
| | Y | 0.7481 | |
| Cham 7 | X | 1.5002 D | 0.0082 |
| | Y | 0.9000 | |
| Cham 8 | X | 1.1007 D | 0.0085 |
| | Y | 1.0000 | |
| Cham 9 | X | 1.2163 D | 0.2519 |
| | Y | 0.8009 | |
| Hole 10 | X | 0.9004 R | 0.0117 |
| | Y | 0.3657 | |

Concepts:

- After feature or part measurements, any of four (4) standard report formats can be viewed within the Report View screen. By default, any features within the Feature List will be populated within each of these four (4) report formats.
- The report styles range from simple, including only feature numbers and actual values, to complex, including graphical representations of the results and tolerance data.
- Individual data cells within the report views can be edited to make changes to feature names, feature numbers, and tolerance values. Editing mode can be enabled or disabled using the “Edit Report” button.
- Individual rows of feature data can be hidden from any report format to create fully customized reports for print or export.
- Flexibility for report contents and formatting allows for full customization of the data format, header information, and header and footer graphics. Part view graphics, time and date stamps, and operator information can all be included for any report type.
- Reports can be viewed, printed, or exported at the conclusion of a single part measurement, or they can be included in a part program to support repetitive and/or automated measurement and reporting.
- Reports can be printed as hard copies to standard Windows compatible printers, or exported as data files in popular file formats.

“Select Report Template” Example

The M2 software supports (4) report format templates. These templates can be toggled using the following procedure.

- Populate your Feature List with measured, constructed, or created features.
- Access the report view screen using the “Report View” button found in the top right toolbar.



- Select from the available report templates using the “Report Type” menu button found in the bottom toolbar.



- The name of the currently selected report template will be shown at the top left of the report screen.

“Edit Report Cells” Example

The M2 software supports editing of report cells in report view using the following procedure:

- Populate your Feature List with measured, constructed, or created features.
- Access the report view screen using the “Report View” button found in the top right toolbar.



- Enable report editing mode by pressing the “Edit Report” button. Data fields that can be edited will be shaded light green. To close edit mode, press the “Edit Report” button again.



- While in edit mode changes can be made to feature names, feature numbers, and tolerance data. Nominal and tolerance limit values can be edited or changed from within this mode.

“Hide Report Data” Example

The M2 software supports hiding and displaying of specific report data rows and can be accomplished using the following procedure:

- Populate your Feature List with measured, constructed, or created features.
- Access the report view screen using the “Report View” button found in the top right toolbar.



- Select the individual or group of data rows that you would like to hide for a given report template.
- Press the “Hide Data” button from the bottom toolbar to hide these rows from display. The hidden rows will be excluded from printed reports, and file exports.



- Rows of hidden data for a given feature can be restored by pressing the “Hide Data” button with the feature selected.

“Print Report Template” Example

The M2 software supports printing the selected report view to a Windows compatible printer using the following procedure:

- Display the desired report template in Report View and configure the report to look like the desired printed report.

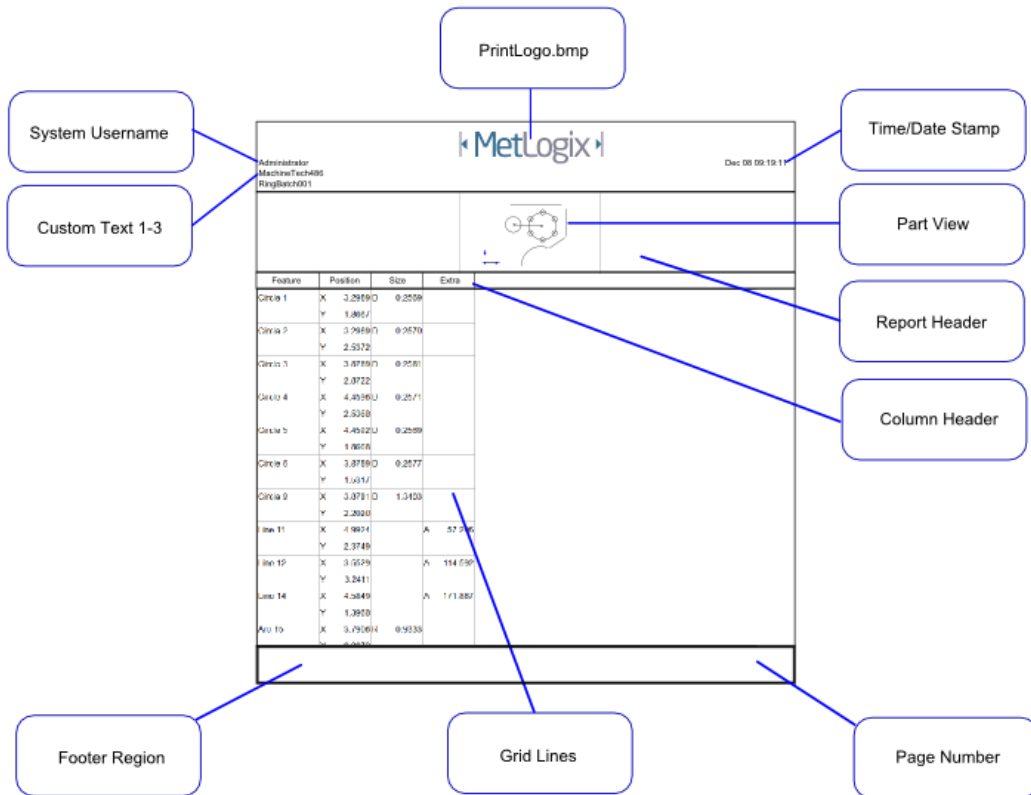


- While in Report View, press the “Print Report” button found in the M2 System Menu and confirm print settings from the displayed Windows Print dialog box.



“Customize Report Template” Example

The M2 software supports customizing reports with custom header information, part view graphics, grid lines, column headers, page numbers, etc.. The following diagram and list of “Print Options” can be used to configure the report contents to meet specific reporting requirements:



The options listed below can be configured either globally from within the “Printouts” setup screen, or at the point of each print execution.

Note: To configure the software to prompt for “Printout” settings at each Print command, configure the “Printout” settings item called “Prompt for Print Settings” to “Yes”.

“Printout” settings items:

- **Print Report Header** Set this field to “Yes” to include the report header in your report printout. Additional items, listed below, will affect what items are included in the report header. Set this item to “No” to omit the report header from printed reports.
- **Print Column Header** Set this field to “Yes” to include column headers in report printouts. The column header labels the contents of a report column by category. Some examples are X, Y, Deviation, etc...Set this field to “No” to omit the column header from printed reports.
- **Print Grid Lines** Set this field to “Yes” to include grid lines on printed reports. Set this field to “No” to have the grid lines removed from printed reports.
- **Print “PrintLogo.bmp” in Header.** Set this field to “Left”, “Center”, or “Right” to include a custom bitmap image in the desired location of the report header. Set this field to “No” to omit the custom bitmap from the report header. Place the desired custom bitmap image, with the file name “PrintLogo.bmp”, into the root location of your M2 software.
- **Print User Name in Header** Set this field to “Left”, “Center”, or “Right” to include the currently “logged-in” user name in the desired location of the report header. Set this field to “No” to omit the username from the report header.
- **Print Date/Time in Header** Set this field to “Left”, “Center”, or “Right” to include the system date and time in the desired location of the report header. Set this field to “No” to omit the date and time from the report header.
- **Print Part View with Data** Set this field to “Top”, “Bottom”, or “Watermark” to include an image of the current part view in the desired location of the printed report. Setting the field to “Watermark” will print an alpha blended part view image underneath the report data. Set this field to “No” to omit the part view image from printed reports.
- **Print Page Number in Footer** Set this item to “Yes” to include a page number in the report footer. Set this item to “No” to omit page numbers from report printouts.
- **Printed Part View Height** Set this item to the desired size of the part view to be included with the printed report. This item can be set to 25%, 50%, 75%, or 100% of the native size of the part view image.
- **Print Custom Text in Header** Enter custom alpha-numeric information into these fields to be displayed in the report header. Custom text entered into these fields will always be aligned left and bottom in the report header. Leaving these fields blank will omit custom text from the printed report.

Section 8: Data Export

Concepts:

- Measurement data in the M2 software can be exported to a data file on your computer from the Report View screen. Data can be exported in standard ASCII “.txt” format, or in .csv format for import to a spreadsheet or SPC application.
- The exported data file will be formatted according to the selected report template at the time the export is executed. The exported file will also reflect any other modifications made to the report view, including the hiding or modification of data cell contents.
- The destination of exported data files can be configured from within the “File Locations” setup screen. Data can be exported to a folder location, a fixed drive location, or a network location.
- Data file exports can have custom file names applied, and can be configured to append an existing file, overwrite an existing file, or be added as a new file with an “auto-number” applied.
- Data Export steps that are part of a saved part program can be edited to change the report format type of the exported data file.

“Export Data File” Example

The M2 software supports exporting of measurement data in either .txt or .csv format and can be accomplished using the following procedure:

- Display the desired report template in report view and configure the report formatting according to the file export style desired.



- Press the “Export Data” toolbar button, found in the bottom toolbar, and choose the desired export format.



- The exported data file will be written to the designated target location, and a message will appear indicating successful export of the data file.
- To select a specific target location for the file export, set the export location in the “File Location” setup screen.

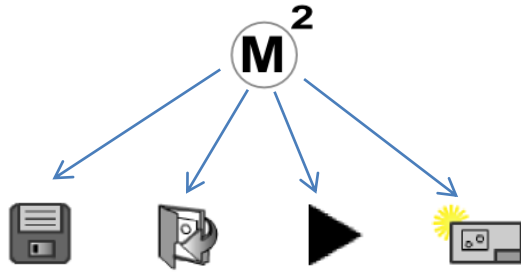
The export options can be configured as a global setting from within the “Export Setup” screen, or on an export by export basis by enabling the “settings export prompt” from within the “Export” setup screen.

Note: To configure the software to prompt for “Export” settings at each File Export command, configure the “Export” settings item called “Prompt for Export Settings” to “Yes”.

“Export” settings items:

- **File Name** Configure the desired base filename for file exports in the “File name” field of the “Export” setup screen.
- **Include column headers** Set this field to “Yes” to include column headers in file export. The column header labels the contents of a report column by category. Set this field to “No” to omit the column header from printed reports.
- **Target file type** Set this field to “Append” to append exported data to the existing target file, set to “Overwrite” to overwrite the target file with a new file on each data export, and set to “Auto Number” to create a new file on each export that increments, starting with the Auto number file name identified below.
- **Auto number file name** Set this field to the desired file export “auto-number”. The file number will automatically increment when the target file type is set to “Auto Number”.

Section 9: Part Programs, Editing, and Playback



Concepts:

- In the M2 software, groups of measured, constructed, and created features can be saved to a part program file. Part program files, when loaded, will prepare the M2 software to repeat a sequence of feature measurement steps. When a part program file is loaded, all existing feature list contents are cleared, making room for the newly loaded part features.
- The M2 software can be in any of three operating modes: interactive mode, playback mode or edit mode.
- "Interactive" mode is the default "free measure" mode of the M2 software and is typically used for either part program creation, or for performing "on the fly" or non- programmatic measurements. "Playback" mode is for running a previously saved or recently created part measurement routine. "Edit" mode is used for modifying the steps of a previously saved or recently created part program.
- In "edit" mode, program steps can be modified, deleted, and/or added to an existing part program. Functions such as, re-measuring features, appending measurement steps, and changing system parameters, can all be modified within the M2's "edit" program mode.
- Once a part has been loaded, a part run can be executed to begin a program playback routine, or to enter the programs "edit" mode. The M2 software will provide a visual indication of the current part program step and what the next step in the measurement routine is.
- At the completion of program playback, a program options panel will be displayed. The display panel provides you with a convenient mechanism for replaying the part program, starting a new part, or evaluating or editing the currently loaded program.
- Additional feature and system characteristics will also be saved as part of an M2 part program. Details such as applied tolerances and data output or printing parameters can all be saved as part of an M2 part program file.
- Part program files in the M2 software will always be saved using the extension ".mlxpart".

Program Playback

Groups of measured and constructed features, as well as other software operations, can be “played back” as part of a sequence of program steps. When a saved part is newly opened, the Feature List will populate with shaded (grey) feature items. This grey color indicates that the features are “un-measured”, or not yet played back.

The feature data for a newly opened part will reflect the last recorded actual values prior to the part program being saved. As the program playback proceeds, measured features will display in white (pass or no tol) or red (fail tol) and reflect newly acquired measurement data.

The Blue Pin will indicate the current step in the program playback routine. A program status bar will also be displayed at the bottom of the feature list. The status will either be “playing” or “paused/inspecting”. This playback state can be toggled by pressing or clicking on this status indicator.

“Using Program Playback Mode” Example

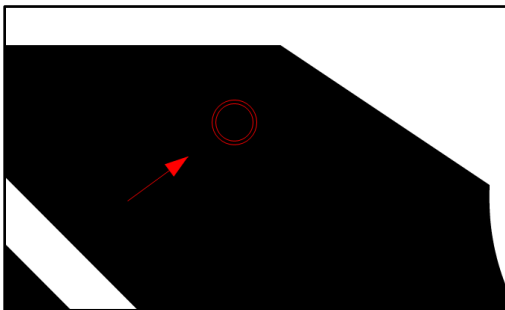
The M2 Software supports playing back part programs using the following procedure:

- Press the play button in the M2 System Menu to execute program playback.

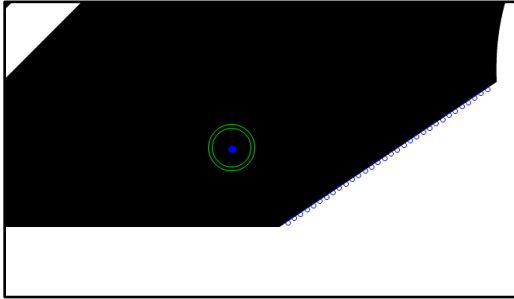


In the event the program is newly created (not from a previously saved file) a default program file name will automatically be assigned and the program file saved.

- Probe the first feature in the playback sequence according to the screen instruction and Blue Pin Position in the “run” list. After 2 positional features have been measured the program playback guidance will begin.
- Move the measuring stage, following the play back arrow direction, toward the playback target circle.



- Once inside the target circle, the circle will turn green permitting playback step execution. Press within the Live Video window, or press “Enter” to advance playback.



- For playback stage positions containing more than one measured feature within the field of view, each feature will be automatically measured in the sequence they were originally measured.
- When the program playback is complete, the status indicator at the bottom of the Feature List will display “Finished” and the program options screen will appear. The part program can then; be Replayed, cleared for New Part creation, display measurement results, or edited(with adequate privileges).



- For features with tolerances applied, the feature name in the “run” list, the part view graphic, and the corresponding detail view field, will display in either red (fail) or white(pass).
- Other software functions may also execute during playback. Data exports, report printouts, and user messages are some examples.

Program Editing

All newly created part programs can be edited.

Program Editing may or may not be available for a given saved part program. A programs author may select the availability of program edit controls using the “Allow program editing” setting in the program properties edit step.

Note: It is always recommended that a program author generates an “edit copy” of any program file. Because the “Allow programming editing” setting is permanent and not reversibile by a regular user, this copy will be needed if further edit changes are required after “locking” the program.

Changes made to an existing program will be reflected in subsequent program runs for the current program file session. If the file is reloaded these changes will only be reflected if the program file was saved.

“Using Program Edit Mode” Example

The M2 software supports editing of current, or previously saved part programs using the following procedure:

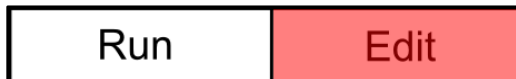
- To edit existing program files, open the program file prior to proceeding.



- Press the “program play” button from the M2 menu.



- Press the “Edit” tab found at the top of the feature/program list.



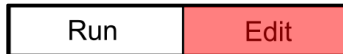
The “Edit” tab will always be visible for either newly created or “unlocked” programs.

- The program steps will be listed within the “Edit” view. Select a program step to make changes to recorded feature detail, tolerance values, light levels, and data export and printing commands.
- Use the feature detail screens to make changes to tolerance and feature data for a selected program step. Use the “on-screen” controls to make changes to light level steps, data export and print steps, and magnification steps.
- If desired, save the program file using the “Save” button from the M2 System Menu.

“Appending Program Steps” Example

The M2 software supports appending, or “recording-in”, program steps and can be accomplished using the following procedure:

- Select the program edit view.



- Select the program step where you would like your newly created program operations to be added. These newly added program operations will be inserted after the selected program step.
- Press the “Record Into” button from the bottom toolbar.



- A blue “Edit Pin” will be positioned between the currently selected program step and the following step, indicating the current “record into” position.

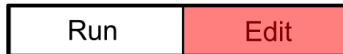
Note: When editing a program that has already been “played back”, the context generation will occur automatically, filling in context dependent program steps automatically from the previously acquired program data. For programs that have not yet been “played back” the software will prompt the operator to manually measure all context dependent features prior to completing the context generation.

- Once the “record into” edit command has been initiated, the operator may measure or construct new features or insert data output or print command steps according to the standard software procedures for these functions.
- These newly added program steps will be added to the current program edit list.
- To save the newly added program steps to the currently loaded part program, press the “save” button found in the M2 System Menu.

“Re-Measuring Feature Steps” Example

The M2 software supports re-measuring feature steps in “edit” mode and can be accomplished using the following procedure:

- Select the program edit view.



- Select the program feature step of the feature that you would like to re-measure.
- Press the “re-measure feature” edit command from the bottom toolbar.



- The software will prompt the operator to re-measure the selected feature. Proceed with re-measuring the selected feature and press “done” when finished.
- The newly measured feature data will replace the existing measured feature within the program.

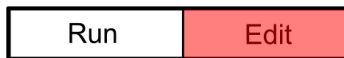
Note: The “re-measure” edit command is commonly used to record new environment variables, along with the feature measurement, for a given step within a program. The newly created feature program step will contain all program variable information that exists at the time the “re-measure” is executed. Information such as point spacing and light levels will be changed to reflect the context of the newly measured feature.

- To save the newly created feature program steps to the currently loaded part program, press the “save” button found in the M2 System Menu.

“Deleting Program Steps” Example

The M2 software supports deleting program steps and can be accomplished using the following procedure:

- Select the program edit view.



- Select the program step that you would like to delete.
- Press the “delete program step” edit command found in the bottom toolbar.



- The selected program step will be deleted.
- Newly deleted program steps will be deleted for current part playback session. Save the program using the “save” button found in the M2 System Menu to permanently apply these “delete” changes to the part program.

“Play from Selected Step” Example

The M2 software supports playing a part program back from a specified program step, and can be accomplished using the following procedure:

-When “Play from Selected Step” is used, the software will determine requirements for generating feature context. If context dependent features have already been measured, the system will advance immediately to the selected “play from step”. If it is determined that additional context information is required, the operator will be prompted to measure the feature(s) required to do so.

- With a program loaded, select the program edit view.



- Select the program step that you would like to “play from”.
- Press the “play from selected step” button found in the bottom toolbar.



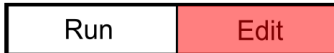
- Context dependent steps will be executed automatically, or prompted for manually and playback will begin from the selected step. Program playback will proceed from this step per normal playback behavior.

“Adding a User Message” Example

The M2 software supports adding and editing custom “user messages” for program playback, and can be accomplished using the following procedure:

-Note: “User messages” are added and edited in program edit mode. Part program edit mode can only be accessed after the play program button has been pressed.

- Select the program edit view.



- Select the program step where you would like the user message displayed in program playback. The message will be displayed after this selected step.
- Press the “User Message” edit command found in the bottom toolbar.



- The “user message” window will appear. Enter the desired user message text into the space provided.
- Press the “Done” button to complete the user message. The user message will be displayed as part of the program playback sequence.

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