Optical Gaging Products, Inc.

A QUALITY VISION INTERNATIONAL COMPANY

Measure-X™ Training Workbook

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Introduction

Welcome to the Measure-X training course.

This course is designed to provide you with basic skills to use the Measure-X software and run the video measuring machine to inspect different kinds of parts.

In this Introduction, you'll find the following information:

- What you need to know and do before attending this training
- What you can expect to learn during this training
- How this training is designed and organized
- How to use this workbook

Course Prerequisites

To ensure your success with this training, we recommend that you do the following **before** you come to class:

- Read Section 1, System Overview in the *Measure-X Reference Guide*, PN 700230. This guide is included with your system.
- Read Section 3, User Interface, and Section 4, Getting Started in the *Measure-X Fast Start Guide*, PN 790280. This guide is included with your system.

You should have a working knowledge of the following topics, which are **not** covered in this training:

- XYZ coordinate systems
- Reading blueprints (dimension drawings)
- Basics of geometric dimensioning and tolerancing (desirable)

Course Objectives

After completing this course, you will be able to:

- Turn on and operate the video measuring machine
- Select appropriate targets for manual alignments and measurements
- Select appropriate tools to analyze and measure features automatically
- Set up a part for measurements and define datums
- Inspect part features using the Measure and Construct functions
- View measurement results in the Model window
- Create, save and run an inspection routine
- Enter nominal and tolerance values from a dimension drawing
- Edit an inspection routine by changing, copying, inserting, and deleting steps
- Generate data output indicating in-tolerance and out-of-tolerance conditions
- Use the on-line Help to find desired information

Course Design and Organization

Optical Gaging Products, Inc. has designed this training to teach both concepts and procedures. Each major concept is presented in a separate session.

Each session starts with the “big picture” to introduce a concept, feature or function. The instructor then presents and explains the details in small, easy-to-absorb segments and “walks through” a typical procedure.

We believe that people generally learn best by doing. Each session includes exercises consisting of guided hands-on activities to measure a training part.

The course is organized to teach you the basics first, followed by tasks requiring increasing levels of knowledge. The information in each subsequent session builds on what was learned in the previous session.

Course Outline

The Measure-X training course contains the following sessions:

- **Session 1: System overview and user interface**
  - Machine power up and power down procedures
  - Hardware components, including lights, joystick, computer, stage, optics
  - Software user interface, including toolbox, windows, pull-down menus
- **Session 2: Using targets and tools**
  - Manual alignment targets
  - Automatic edge analysis tools such as Strong/Weak Edge, FeatureFinder
  - Focus tools for autofocus and Z axis measurements
- **Session 3: Part setup and datums**
  - Introduction to common Measure and Construct functions
  - Staging a part: how and when to stage a part
  - Setting up the part manually and defining datums automatically
- **Session 4: Creating, saving and running an inspection routine**
  - Nominal values and tolerances
  - Saving and running a routine
  - Printing specified measurements and print listing
- **Session 5: Model window**
  - Control the information displayed in the Model window
  - Display different views in the Model window
  - Use all the functions in the Model window toolbar
  - Understand how features are displayed in the Model window
- **Session 6: Editing and adding steps in a routine**
  - Change, insert, delete, copy steps
  - Define new datums
  - Interactively edit the routine
- **Session 7: Run options and measurement output**
  - Run options and overrides
  - Using a fixture and manual setup on a fixture
  - Statistics templates and output

- **Session 8: Other useful Measure-X functions**
  - Advanced weak edge parameters
  - Edge Trace and Centroid tools
  - Data extraction from measured reference features
  - Search function
  - System / Configuration menu options
  - Save an image to disk and create an overlay of a video image
  - True-position tolerances

Using This Workbook

This workbook is written to help you during this training and to use as a handy reference for your daily work. It contains the following information:

- Training sessions containing objectives, explanations and exercises
- Glossary of terms used in this course
- Listing of reference documentation and materials

Typographical Conventions Used in This Workbook

The table below describes the meanings of the typographical conventions used in this workbook.

Convention	Meaning
Slash: /	Selections from a menu or submenu, e.g., **Measure / Circle**
italic or **bold**	Emphasized words, e.g., Do **not** run this routine now.
Bold, initial caps	Commands, menu names or items, buttons, targets; also used for procedures to create a routine, e.g., Set the **Datum** for **X-Axis Alignment**.

Session 1

System Overview and User Interface

The purpose of this session is to provide you with an overview of the system and a general understanding of the user interface:

- Procedures to power up, stop and power down the machine
- Hardware user interface: joystick, computer, stage, lighting, and optics
- Software user interface: Measure-X functions, windows, pull-down menus, toolbox, and on-line Help

For more information about the user interface, see:

- Section 2 in the on-line Help, the *Measure-X Reference Guide*, and the *Measure-X Fast Start Guide*

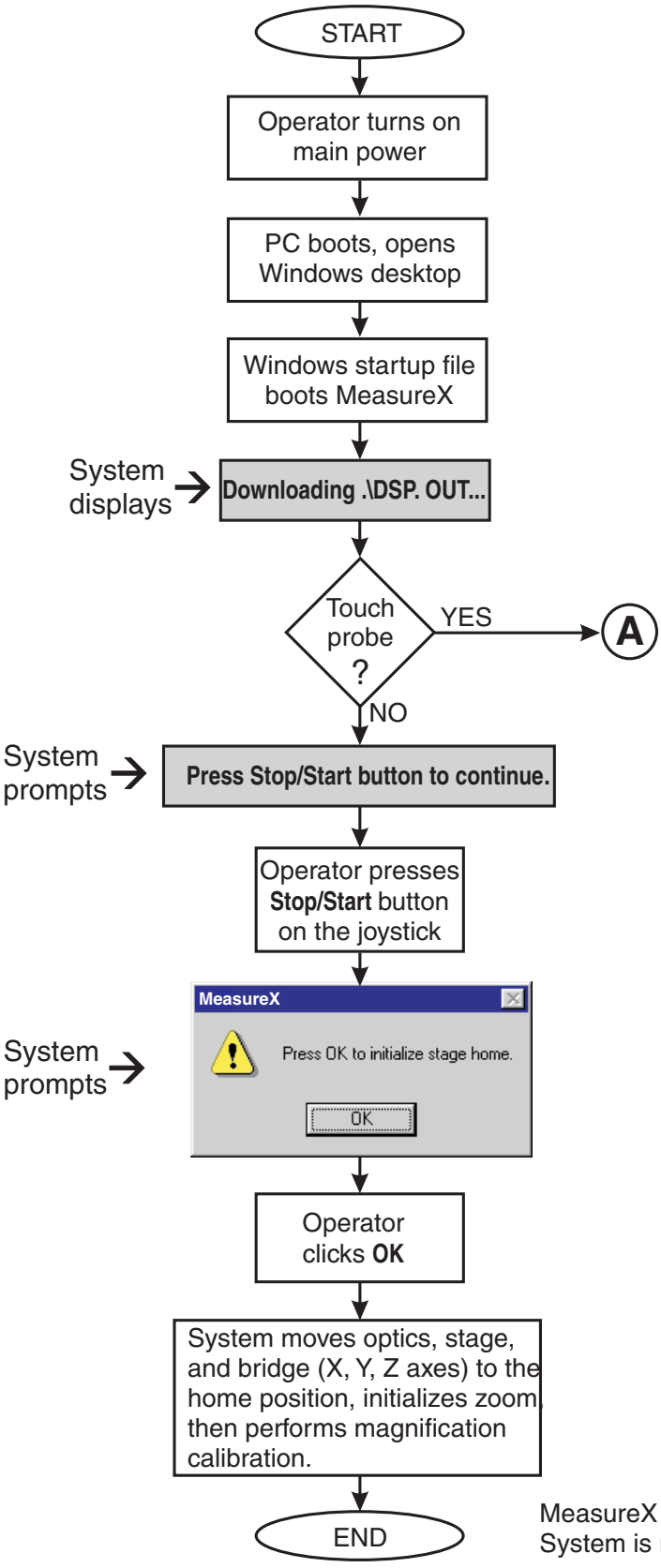
Session Objectives

After completing this session, you will be able to:

- Power up and power down the machine in proper sequence
- Set the proper lighting using the illumination knobs on the joystick and in the Illumination Control window
- Move the stage and optical assembly using the joystick
- Control the screen magnification using the joystick or zoom slider
- Select Measure-X functions with the mouse using the toolbox icons and pull-down menus
- View each Measure-X software component (functional area) on the computer screen and understand the purpose of each component
- View a live image of the part on the computer screen
- Zero out the X and Y axes in the Digital Readout (DRO) window
- Use the on-line Help to find specified topics

How to Power Up the System

Use the procedure below to power up the system.



MeasureX opens in the Image Window.
System is ready to use.

How to Stop the System

You can stop the system in the following ways:

- Press the **Stop/Start** button in the DRO window to stop the routine while it is running. The software completes the current step, stops the routine, and displays a confirmation prompt to end the routine. If you click on Cancel, the software resumes the run.
  - This is used most often when you specify a destination incorrectly in a routine. For example, if you forget to change the sign (+ or -) and the stage moves in a direction that is opposite to the desired destination, stop the stage and specify the destination correctly.
- Press the **Stop/Start** button on the joystick (or control panel) to:
  - Take the system out of E-stop mode when the yellow Stop LED is turned On (slow blinking) during the machine power up sequence.
  - Cut power to all motors, stop all the XYZ motion immediately, and interrupt the current measurement. The yellow Stop LED (visible through the optics cover) is turned On (steady glow). You cannot operate the XYZ, focus and zoom lens motors as long as the yellow Stop LED is On.
  - Take the system out of Stop mode and resume (start) operation of the system again. The yellow Stop LED is turned off.
- Press the red **E-Stop** button in front of the base to:
  - Cut power to all motors, cut the voltage to the surface and standard ring lights, stop all the XYZ motion immediately, and interrupt the current measurement. The yellow Stop LED (visible through the optics cover) is turned On (fast blinking). You cannot operate the XYZ, focus and zoom lens motors and you cannot operate the surface and standard ring lights as long as the yellow Stop LED is On. If it is necessary to view a feature, you may operate the SmartRing light or the Back light.
  - To take the system out of E-Stop mode and resume operation, twist the red button clockwise to pull it out and press the Stop/Start button on the joystick.

The stage, Z axis slide, focus, and zoom lens **cannot be moved** as long as the yellow indicator light on the Stop/Start button in the DRO window is On.

How to Exit from Measure-X and Power Down the System

You must exit from Measure-X **before** turning the system or computer off.

Action	Results/Comments
1. Click on the Save icon in the toolbox if you are working on a routine.	The routine should be saved if you added or changed steps in the routine.
2. Raise the camera above the parts on the stage and center the stage.	Although this is not required, it is recommended that the stage and optics be in a safe position before the system is powered down.
3. Click on the X in the upper-right corner of the screen or select **File / Exit** to exit from the Measure-X software, and click on **OK** in response to the confirmation prompt.	• The software displays a confirmation prompt. • All system files are closed and the Windows desktop is displayed.
4. Click on **Start** and point to **Shut Down...** in the displayed window. Then follow the shutdown instructions.	The system displays a message indicating that it is safe to turn the computer Off.
5. Turn the main power switch Off.	Remember to also turn off the monitor and any attached devices such as a printer.

Hardware User Interface

The hardware user interface consists of the hardware components such as mouse, joystick, computer components, and the machine itself. For detailed illustrations describing the functions of the hardware components, see the pages listed below in the *Measure-X Reference Guide*.

- Joystick: page 2-41
- Mouse: page 2-46
- Keyboard functions: page 2-47

Optical Configurations

SmartScope video measuring systems operated with Measure-X typically have the following optical configurations:

- Color camera
- AccuCentric self-calibrating 12:1 zoom lens with calibrated range of 32x - 280x (on-screen magnification)
- Optional 1.5x and 2x lens attachments

Optional Hardware

The following components are optional on SmartScope video measuring systems:

- Monitor and keyboard package (LCD monitor, keyboard, 3-button mouse)
- Color video printer
- Granite base workstation
- Off-axis touch probe and change rack
- DRS or through-the-lens (TTL) laser sensor

Software User Interface

Measure-X is a powerful software package that is used to measure parts accurately on SmartScope video measuring systems.

The software user interface consists of the Measure-X functions, windows, pull-down menus, toolbox, and on-line Help.

For detailed illustrations describing the functions of the software components, see the *Screen Layout* topic in the Measure-X on-line Help and the following topics in Section 2 in the *Measure-X Reference Guide*.

- Image window and controls: page 2-3
- Illumination (light) sources: page 2-10
- Model window and controls: page 2-18
- Routine listing controls: page 2-32
- Toolbox: page 2-35
- Measurement, DRO and tool/target settings windows: page 2-36

Software Options

The following software packages work in conjunction with Measure-X:

- SmartCAD converts CAD data into automated Measure-X routines
- MeasureFit compares the blueprint dimensions with the Measure-X measurement results for a detailed contour analysis
- QC-Calc™ SPC software

Screen Layout

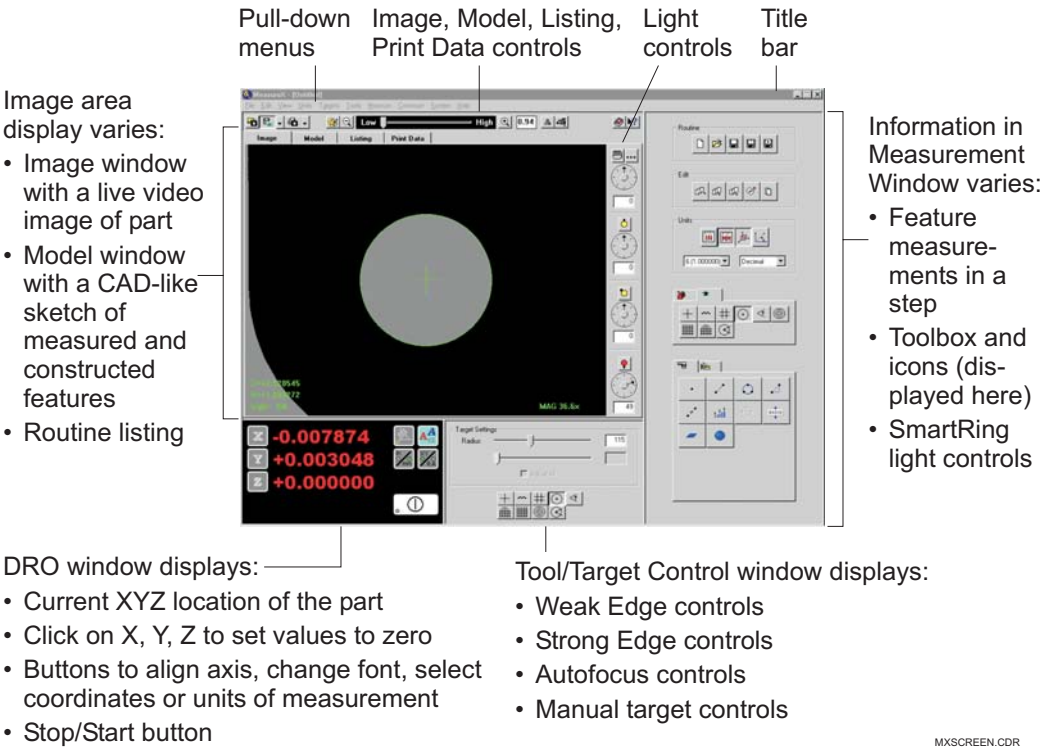
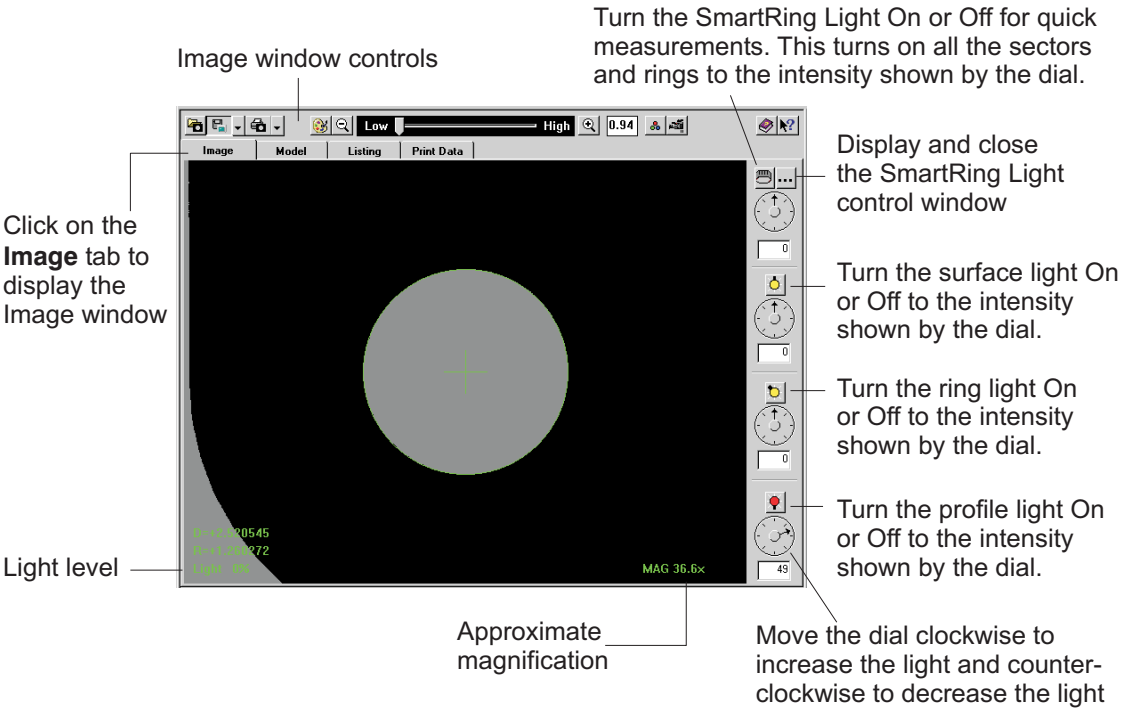


Image Window



Toolbox

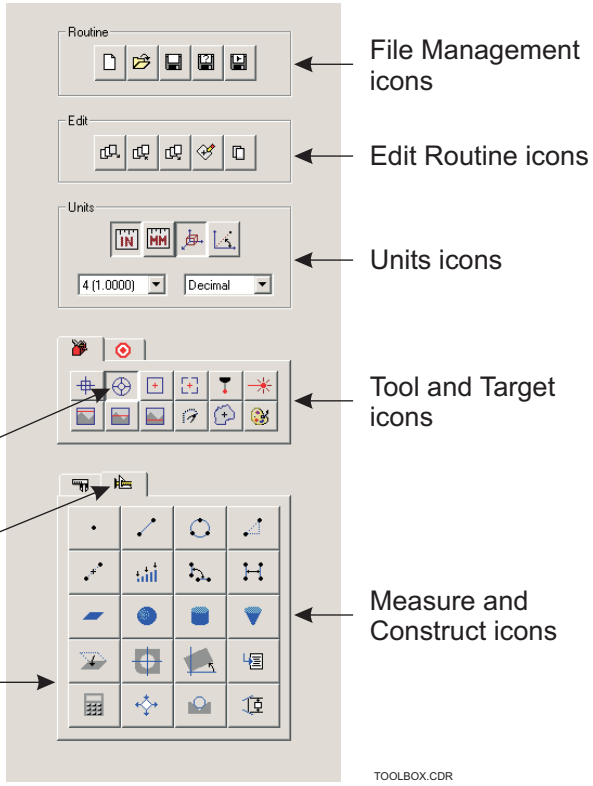
The toolbox shows icons in related functional groups that correspond to the functions in the File, Edit, Units, Tools, Targets, Measure, and Construct menus.

To display the function of an icon:

- Place the cursor over the icon (do not click)
- The icon name and function is displayed below the icon

To select a tab or icon:

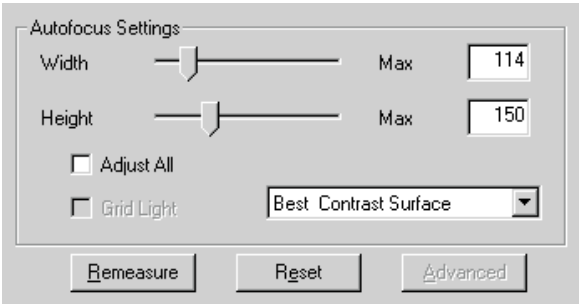
- Place the cursor on the tab or icon and click on it
- A selected icon has a "pushed-in" look
- The active tab is placed in the foreground
- Construct functions are displayed only when the Construct tab is selected



Tool and Target Settings Window

This window can display settings and controls for the following tools/targets:

- Edge analysis tools
- Focus tools (shown here)
- Centroid tool
- Laser sensor
- Manual targets



Each settings window is described in detail in Section 5 of the *Measure-X Reference Guide,* Using the Measurement Tools and Targets.

To display a different tool or target settings window, select the desired tool/target.

Review Practice Session

Perform the tasks below to become comfortable with using the hardware and software user interfaces to view an image of the OGP FastStart training part.

1. If the system is off, power the machine up as described on page 1-2.

2. Place the OGP FastStart training part near the middle of the stage or in a fixture.

3. Move the stage and the bridge/optics with the joystick so that the lower-left hole is under the optics.

4. Select the lowest magnification in one of the following ways:
   - Press and hold the button on top of the joystick knob and twist the knob counterclockwise.
   - Using the mouse, place the cursor over the Zoom slider in the Image window toolbar, press and hold down the left mouse button, and move the slider all the way to the left.

5. Turn the back light on so you can see the lower-left hole in the Image window.

   - Place the cursor on the **Back Light** dial in the Light Control window, press the left mouse button, and move the dial clockwise.
   - Place the cursor over the hole (lit area) and check if the light setting in the lower-left corner of the Image window is approximately 40% - 45%. If it is not, move the dial clockwise to increase the light or counterclockwise to decrease the light.

6. Twist the joystick knob clockwise and counterclockwise until an edge appears to be in focus. You may need to move the stage to display an edge.

7. Use the mouse to click on the **MM** icon in the toolbox to select Millimeters. Then select **Units / Inch** pull-down menu to return to inches.

8. Click on the **Targets** tab and the **Circle** icon in the toolbox to display the circle target in the Image window.

Hint

If you don't know which icon to press, place the cursor over the tab or icon, but do not click on it. This displays the icon function next to the icon.

9. Move the stage to center the hole image within the circle target. If you need to change the size of the target, place the cursor on the edge of the target, click and hold the left mouse button, and drag the edge to the desired size.

10. Zero the X and Y values in the DRO window: Place the cursor over the **X** button and click the left mouse button. Repeat this for the **Y** value.

11. Search for a topic in the on-line Help.

- Click on the **Help Book** icon.
- Click on the **Index** tab to display the topics in alphabetical order.
- Type **Image Window** in the search field or scroll down to that topic.
- Click on the **Display** button or double-click on the topic to display it. Then, if needed, use the scroll bar to view the entire topic.
- Click on the **X** button in the dialog box to exit from the on-line Help.

12. Display the What's This Help for the X button in the DRO window.

- Click on the **Question Mark** icon.
- Place the cursor over the **X button** and click the left mouse button.

13. Display the Dialog Box Help for the DRO window.
    - Place the cursor anywhere in the DRO window.
    - Press the **F1** key.

14. Power down the machine in proper sequence and then power it back up.

This completes the Review Practice Session.

Session 2

Manual Targets and Automatic Tools

The purpose of this session is to learn how to use various targets and tools to measure the size of part features.

- Manual alignment targets for manual measurements
- Automatic edge analysis tools to measure edges and create steps in a routine
- Focus tool to focus an edge or surface and measure the Z axis position

For more information about measurement tools and targets, see:

- Section 5 in the *Measure-X Reference Guide*
- Section 5 in the *Measure-X FastStart Guide*
- Tools and Targets topics in the Measure-X on-line Help

Session Objectives

After completing this session, you will be able to:

- Use the common manual alignment targets to align and measure features
- Change target and tool sizes and colors
- Use the Focus tools to focus on a surface and an edge
- Use the Strong Edge tool to measure a feature with strong edges
- Use the FeatureFinder tool to measure a feature and find multiple points automatically

Manual Alignment Targets

The manual alignment targets help you align geometric shapes and objects visually to the center of the screen. This enables you to measure both the feature size and location.

Four commonly-used manual targets include:

- **Crosshair target for aligning edges**

- **Box** target for square, rectangular or odd-shaped features

- **Circle** target for holes and features with rounded corners

- **Protractor** target for angles and intersections

For detailed descriptions on how to use the manual alignment targets, change their size, and change their color, see:

- *Measure-X Reference Guide*: pages 5-52 to 5-56

The manual alignment targets can also be used with the Measure function to perform simple measurements. For example, you can select three points with a Crosshair target to measure the diameter of a circle. See Section 8 in the *Measure-X Reference Guide* for a more detailed description.

Changing Target and Tool Colors

You can change the color of an edge analysis tool, focus tool, or a manual alignment target. This allows you to choose the optimum contrast between the part image and the tool or target

To change the color to any of the 16 basic colors or a custom color:

1. Select the desired tool or target.

2. Click on the **Color Palette** icon above the Image window.

3. Move the cursor to the desired color and click the left mouse button once.

4. If you wish to select a custom color, click on the **Custom** button and select the desired color.

The selected color will become the default color until you change it again.

Focus Tools

The Focus tools are used to measure the Z axis position and get an edge or surface in focus. When you click on the Tools tab and a Focus icon, the selected Focus tool appears as a box in the center of the Image window.

- **Basic Focus** tool appears as box with a closed border. When you use this target, the system performs an autofocus using general focus parameters.

- **Advanced Focus** tool has an open border with solid corners. The advanced autofocus is optimized for the image conditions at the instant of the measurement, such as magnification and lighting.

You can change the size of the Focus tools in two ways:

- Select any edge or corner and drag it to the desired size while holding the left mouse button.
- Use the scroll bar or click on the arrows in the Focus Box Type slider in the Focus tool settings window.

The Focus tools can also be used with the Measure Point function to measure the Z axis position and with the Measure Plane function to measure a plane or do height and depth measurements. The best illumination for these kinds of measurements is surface illumination.

For detailed descriptions on how to use the Focus tools, see:

- Focus Tools topic in the Measure-X on-line Help
- *Measure-X Reference Guide*: pages 5-21 to 5-33
- *Measure-X Fast Start Guide*: Section 5

Hint

Z-axis autofocus and repeatability improve at higher magnifications. For a zoom system, zoom to the highest magnification before you measure the Z axis position.

Automatic Edge Analysis Tools

The following automatic edge analysis tools are available to measure edges:

- **Strong Edge**
  - Used with high-contrast, smooth edges and back lighting.
  - Automatically moves the stage to find the edge at the point where you placed the cursor.
  - The point appears in the center of the image.


- **Weak Edge** (average, maximum and minimum)
  - Used with any kind of edge, especially low-contrast, ragged edges.
  - Also used to measure points along edges of features that are larger than the field of view.
  - Automatically finds and measures a point on an edge within the search area that you defined.

- **FeatureFinder**
  - Used with any kind of edge.
  - Automatically measures the selected geometric shape (line, arc or circle) after you specify the points or double-click on the edge.
  - Measures features in the field of view.
  - If the feature does not fit entirely in the field of view, you can measure multiple sections and use the Composite function (described in Session 4) to construct a composite circle or line from the measured points or features.

- **Edge Trace**
  - Used with high-contrast, smooth edges and backlighting.
  - Used to trace a line, arc, circle, or irregular contour.
  - The entire feature does not need to be in the field of view.

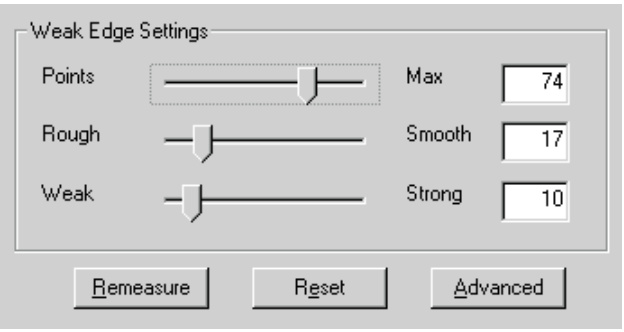
- **Centroid**
  - Used to measure the area and perimeter of an irregular contour. For example, it is useful for measuring leads, solder points and pins.
  - The feature or contour must fit entirely in the field of view.

For detailed descriptions on how to use the edge analysis tools, see:

- Tools and Targets topics in the Measure-X on-line Help
- *Measure-X Reference Guide*: pages 5-2 to 5-20
- *Measure-X Fast Start Guide*: Section 5

FeatureFinder Parameters

You can change any or all Weak Edge Point and FeatureFinder parameters (settings) using the sliders in the Weak Edge Settings window.



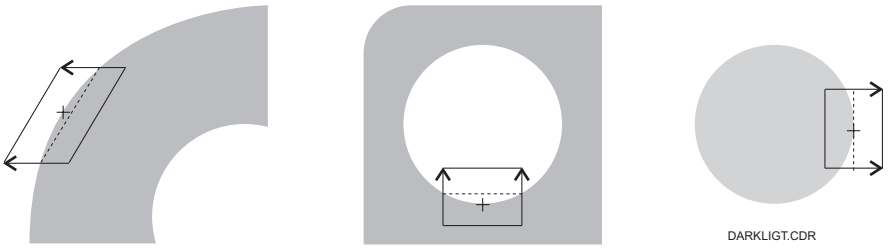
- **Number of points**. Increase the number of points for a better statistical sample. Decrease the number of points if the edge is very ragged.
- **Roughness of the edge**. This indicates the extent to which evaluated points are included in the edge analysis. Move the slider toward Smooth to statistically evaluate and remove points that do not belong in the analysis. Move the slider toward Rough to include more points in the analysis.
- **Strength of edge**. This indicates the contrast level which Measure-X will accept as a valid edge. Move the slider toward Strong if the edge shows high contrast. Move the slider toward Weak if the desired edge shows low contrast.

The advanced weak edge parameters are described in Session 8 of this workbook.

"Dark-to-Light" Rule for Weak Edge Analysis

Whenever you measure a feature with a weak edge tool (e.g., Weak Edge Point or FeatureFinder), the software performs the edge analysis going in a dark-to-light direction.

Weak edge analysis scans the search area going from dark to light (shown by the direction of the arrow)



Tool and Target Practice Exercises

You can complete any or all of the following exercises to get more practice with using the manual alignment targets, the focus tool, and the automatic edge analysis tools.

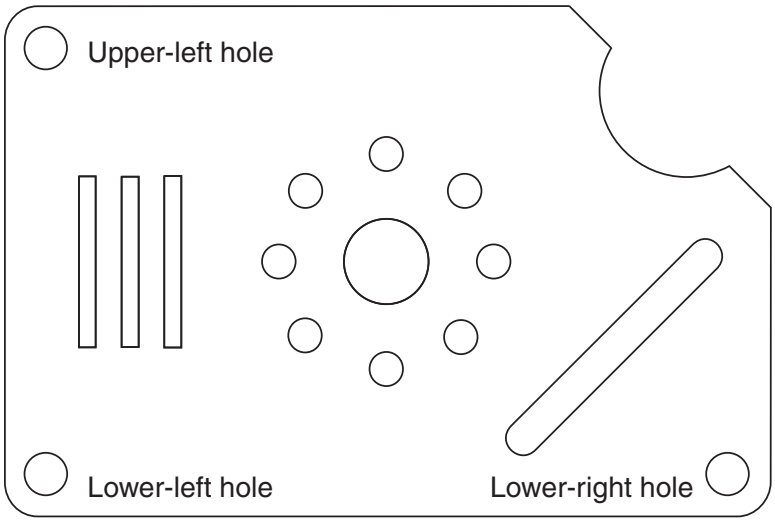
A. Using the Circle Target and Changing Target Colors

B. Using the Crosshair Target

C. Using the Focus Tools

D. Using Automatic Edge Tools to Measure Features

In these exercises you will use the different targets and tools to measure the diameters of the three holes shown below and compare the measurement results.



Exercise A: Using the Circle Target and Changing Target Colors

Follow the steps below to become comfortable with using the circle target and changing target colors. You will measure the diameter of the lower-left hole and the distance between the lower-left and lower-right holes.

Before you begin:

- Be sure that you have selected the appropriate back lighting and the lowest magnification
- Be sure that the lower-left hole of the training part appears on the screen and that the edge is in focus.
- Be sure that the units are Inches.

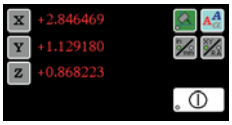
To use the circle manual alignment target and change its color:

1. Click on the **Targets** tab and the **Circle** icon to select the Circle target.

2. Move the lower-left hole of the training part to the center of the screen and align it with the Circle target.

3. Change the size of the target to match the lower-left hole. To do so, place the cursor on the edge of the target, click and hold the left mouse button, and drag it in or out, or use the spacing sliders in the Target Settings window.

4. Look at the diameter of the lower-left hole displayed in the lower-left corner of the screen and write it down here: _____. It should be approximately 0.100.



5. Zero out the **X** and **Y** axes in the Digital Readout (DRO) window.

6. Measure the distance between the lower-left and lower-right holes:
   - Move the lower-right hole to the center of the screen and align it with the Circle target.
   - Click on the **Axis Align** button in the DRO window.
   - Look at the X value, which is the distance. Write it down here: _____ It should be approximately 2.000.
   - Look at the diameter of the lower-right hole and write it down here: _____. It should be approximately 0.100.

7. Move the upper-left hole to the center of the screen and align it with the Circle target.
   - Look at the diameter and write it down here: _____. It should be approximately 0.100.

8. Change the color of the current target. To do so, click on the **Color** icon in the Image window toolbar to display the color dialog box and select the desired color. If you wish, you can also click on the Tools tab and then on the Color icon in the toolbox.

9. Move the lower-left hole back to the center of the screen.

This completes Exercise A.

Exercise B: Using the Crosshair Target to Measure Features

Follow the steps below to create a short routine by measuring features with the Crosshair target. You will measure the diameters of the lower-left, lower-right, and upper-left holes on the OGP FastStart training part.

To measure the holes with the Crosshair target:

1. Click on the **Targets** tab and the **Crosshair** icon to select the Crosshair target.

2. Move the lower-left hole to the center of the screen.

3. Click on the **Measure** tab and the **Circle** icon to display the Circle measurement window.

4. Measure four points around the circumference of the hole.
   - For each point, move the stage with the joystick to place the point at the center of the crosshairs and press **Enter** on the joystick to accept the point.
   - Click on **OK** after measuring the last point.

5. Repeat Steps 2 through 4 for the lower-right and upper-left holes.

6. Click on the **Run** icon and then on the **OK** button to run the routine.

7. Click on the **Listing** tab and then on the **Condensed** icon to view the measurements in the Size column. Each diameter should be approximately 0.100.

8. Write the answers below for Trial 1.

   Hole 1: _____ Hole 2: _____ Hole 3: _____

9. Repeat Steps 6 and 7 for a second trial.

10. Write the answers below for Trial 2.

    Hole 1: _____ Hole 2: _____ Hole 3: _____

11. Write the range between Trial 1 and Trial 2.

    Hole 1: _____ Hole 2: _____ Hole 3: _____

12. Move the lower-left hole back to the center of the screen.

This completes Exercise B.

Exercise C: Using the Focus Tool to Perform an Autofocus

Follow the steps below to practice using the Focus tool. You will perform an autofocus on an edge and on a surface, and include an autofocus in a measurement step.

1. Move the stage so that an edge of the lower-left hole appears in the center of the screen.

2. Zoom to the highest magnification using the zoom slider or the joystick.

3. Turn up the back light to approximately 45% (the light level is displayed in the lower-left corner of the Image window).

4. Twist the focus knob on the joystick until the edge of the hole is in best focus.

5. Zero out the Z axis in the DRO window.

6. Click on the **Tools** tab and select the **Basic Focus** tool.

7. Change the size of the tool to make it narrower by adjusting the Width slider in the Autofocus Settings window. If needed, move the edge so that it appears in the center of the Focus box.

8. Place the cursor anywhere in the Image window and click on the left mouse button.

   The system performs an autofocus and displays a green cross in the focus box.

9. Look at the Z value displayed in the DRO window and write it down here: _____ (it should be approximately 0.001). This indicates the difference between a visual focus and an autofocus with the Focus tool.

10. Click on the Back Light icon to turn off the back light and turn up the surface illumination to approximately 45% (the cursor must be in a lighted area).

11. Change the size of the Focus tool to make it a square. Hint: Use both the Width and Height sliders.

12. Move the stage so that a surface, e.g., near the right edge of the lower-left hole, is in the middle of the screen.

13. Place the cursor anywhere in the Image window and click on the left mouse button.

    The system performs an autofocus and displays a green cross in the focus box.

14. Click on the **Measure** tab and the **Point** icon in the toolbox.

15. Perform an autofocus on the surface and press **Enter** on the joystick.

16. The Z value displayed in the Measurement window indicates that the autofocus is now in a measurement step.

17. Click on **Cancel** when you're done.

18. Turn off the surface illumination, zoom to the lowest magnification, and turn on the back light.

This completes Exercise C.

Exercise D: Using Automatic Edge Tools to Measure Features

Follow the steps below to practice using automatic edge tools to measure different features. You will measure the diameters of the lower-left, lower-right and upper left holes with different tools and compare measurement results.

Before you begin, be sure that you have selected the appropriate back light and the lowest magnification.

1. Move the lower-left hole to the center of the screen, if it is not already there.

2. Select **Tools / Strong Edge** from the menu.

3. Click on the **Measure** tab and **Circle** icon in the toolbox.

4. Measure at least four points on the hole. Remember to press **Enter** on the joystick to accept each point.

5. Look at the diameter displayed in the Measurement window and write it down here: _____. It should be approximately 0.100. Click on **OK** when you're done.

6. Click on the **Average Weak Edge Point** icon in the toolbox.

7. Measure four points on the hole.

8. Click on the **Construct** tab and **Circle** icon in the toolbox.

9. Select the four points in the Model window.

10. Look at the diameter displayed in the Measurement window and write it down here: _____. Click on **OK** when you're done.

11. Click on the **FeatureFinder** icon in the toolbox.

12. Measure the lower-left hole and write down the diameter: _____. Click on **OK** when you're done. If you need help, look at the *How to Use FeatureFinder* topic in the on-line Help.

13. Move the lower-right hole to the center of the screen.

14. Repeat Steps 2 through 12 for the lower-right hole and write the diameters:

    Step 5: _____ Step 10: _____ Step 12: _____

15. Move the upper-left hole to the center of the screen and repeat Steps 2 through 12 for this hole and write the diameters:

    Step 5: _____ Step 10: _____ Step 12: _____

16. Click on the **Run** icon and then on the **OK** button in the displayed Run window. This runs the routine that you've just created.

17. Click on the **Listing** tab and then on the **Condensed** icon to view the measurements in the Size column.

18. Compare the diameters from Exercise A with the diameters in this exercise.
    - Note that under the same conditions, the measurements with the automatic edge tools and system optics are more accurate than measurements with the manual alignment targets, where the measurements were done visually.
    - Also note that FeatureFinder takes more points with fewer stage movements. This helps produce a more accurate and repeatable routine.

19. Click on the **Image** tab to display the Image window.

This completes Exercise D.

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Session 3

Part Setup and Datums

The purpose of this session is to learn how to:

- Stage the part to be measured
- Set up and align the part manually
- Define datums automatically at the beginning of an inspection routine

For more information about part setup and datums, see:

- Part Setup and Datum Functions topics in the Measure-X on-line Help
- Section 4 in the *Measure-X Reference Guide*
- Sections 6 and 7 in the *Measure-X Fast Start Guide*

For more information about the Measure and Construct functions, see:

- Measure Functions and Construct Functions topics in the Measure-X on-line Help
- Sections 8 and 9 in the *Measure-X Reference Guide*
- Sections 9 and 10 in the *Measure-X Fast Start Guide*

Session Objectives

After completing this session, you will be able to:

- Describe when a part needs to be set up and why
- Stage a part on the stage glass so that it can be inspected
- Manually establish the part origin and axis alignment using a part feature
- Use common Measure and Construct functions to define datums
- Automatically define a datum origin and axis alignment within a routine
- Save a routine
- Stage a part in a fixture

Manual Part Setup

Manual part setup consists of the following functions:

- Stage the part:
  - The stage should be cleared of any obstructions and the optics should be at a height that is above the part to be measured.
  - The part must be placed on the stage such that its features can be measured. If necessary, a fixture should be mounted to the stage and one or more parts can then be mounted in the fixture.
  - The part must be secured to the stage or in the fixture.
  - Appropriate illumination, magnification and focus are required to begin measurements.
- Manually set up the part, i.e., define the setup zero location (Zero X, Y and Z) and align the part (axis alignment):
  - The setup zero location tells the system where the part is located on the stage. The measurements are based on the setup zero location.
  - The Axis Alignment function tells the system how the part is rotated relative to the stage motion and it compensates for any misalignment between the part and the stage.

If you do not do the manual part setup or define a datum in the routine, the measurements are based on stage home. The stage home process sets the scale origin to zero. This is done each time you start Measure-X and initialize the stage.

- The XY origin is at the lower-left corner of the stage.
- The Z origin is approximately at the bottom of the Z axis travel.

When to Set Up a Part

You must do the manual part setup **anytime it is placed in a different location or orientation on the stage**. For example, it is necessary to set up a part:

- The first time you stage a part for measurement
- Every time if the part is not located in the same place as before
- Every time if additional samples of the same part are not located in the same place as the first part (for example, fixtures are not used or the fixtures are movable)

Useful Features for Setting Up a Part

When setting up a part, use features on the part or fixture that are easily seen in the Image window at low magnification and that are easy for operators to line up to. Useful features include:

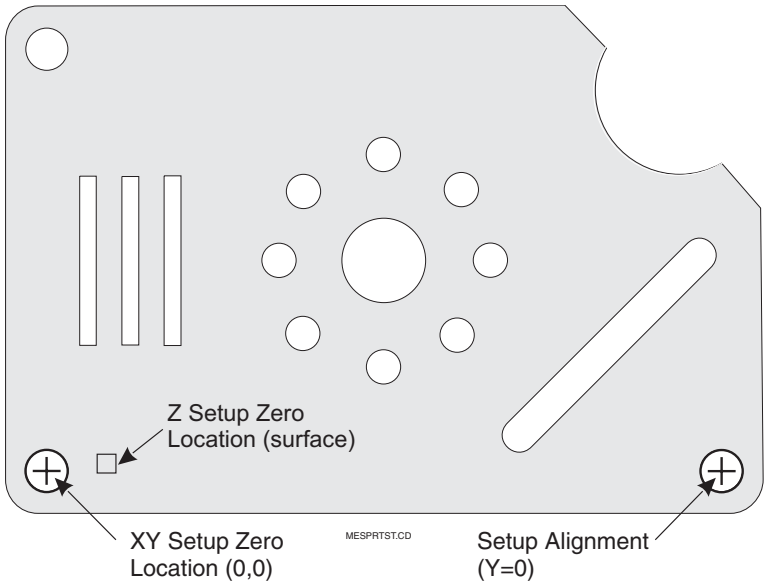
- Focus points for the Z axis
- Circles, corners and points for defining an XY origin and alignment point

Ways to Set Up a Part

You can set up a part in the following ways to create and run a part routine automatically.

- **Manual (visual) setup on part features**. This is described below.
- **Manual (visual) setup on a fixture**. This is described in Session 7.
- **Using stage home**. It is not necessary to set up a part if it is always located in the same place on a fixture that is permanently mounted to the stage.

Manual Setup on Part Features



With this method you can use manual alignment targets to locate features on the part itself for the part origin and axis alignment. For example, you can use the Focus tool to zero the Z axis and the Circle target to locate the lower-left and lower-right holes on the OGP FastStart training part.

This method is useful for quick part setups and when the part is not mounted in a fixture (i.e., it can be placed in different locations on the stage). If you use this method, you must do a manual setup each time you stage a part and load a measurement routine.

Before you begin to do the actual manual setup:

1. Secure the part to the stage. For example, you can use modeling clay to secure the OGP part to the stage glass.

2. Locate two features on the part that can be used for the XY origin and the axis alignment. For example, you can use the lower-left and lower-right holes on the OGP FastStart training part.

3. Identify the best manual alignment targets and edge tools to be used for the manual setup. For example, you can use the Focus tool to zero the Z axis and the Circle target for the lower-left hole and lower-right holes on the OGP FastStart training part.

To perform a manual setup using part features:

1. Manually define the Z setup zero location:
   - Display the surface of the part, e.g., near the lower-left hole. Use surface illumination and high magnification.
   - Select the Focus tool and perform an autofocus.
   - Click on the **Z** button in the DRO window to zero the Z setup zero location.

2. Manually define the XY setup zero location:
   - Display the feature used for the XY origin, e.g., lower-left hole, in the field of view. Remember to use the lowest magnification and adjust the lighting and focus.
   - Select the alignment target, e.g., circle, and adjust it as necessary.
   - Move the stage if necessary to align the feature with the target.
   - Click on the **X** and **Y** buttons in the DRO window to zero the XY setup zero location.

3. Manually define the axis alignment:
   - Display the feature used for the axis alignment, e.g., lower-right hole, in the field of view.
   - Use the same alignment target; select another target, only if it is necessary.
   - Move the stage if necessary to align the feature with the target.
   - Click on the **Axis Align** button in the DRO window to align the part.

Entering Part Setup Instructions

When you open an existing routine, it will run only if the manual part setup is done in the same exact way as when the routine was created. If you set up the part in a different way (e.g., use different features or locations), the routine will fail when you try to run it.

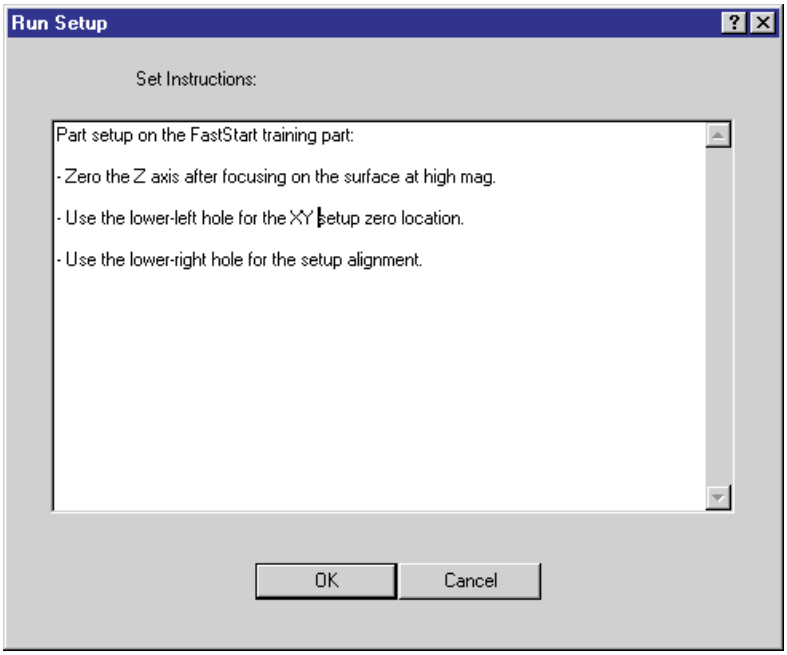
Setup instructions help you remember how the part was set up when you first created the routine and how it needs to be set up when you use the routine again. They are also useful for other people, e.g., operators, who run the routine.

It is strongly recommended that you **enter the part setup instructions after you do the manual part setup and create the datum steps**. For example, you can specify the location, orientation and alignment of the part, or explain how to begin measuring the part.

To enter the part setup instructions:

1. Select **Part Setup / Setup Instructions...** from the menu.

   A dialog box pops up where you can enter or view specific instructions for setting up the part.



2. Place the cursor in the dialog box and click the left mouse button once.

3. Type the desired text. If you reach the end of the line, characters will wrap to the next line.

4. If you wish to go to another line, press Enter and type the desired text.

5. Click on **OK** or Cancel to return to the Run window.
   - OK saves the instructions and any changes/additions you made.
   - Cancel saves only your original instructions; any additions or changes are not saved.

Defining Part Datums

A datum is a feature whose location is considered exact for the purpose of determining relationships to other features. Defining the datum ensures that the measurements done on a part correspond to the blueprint specifications.

You must do **both** the manual part setup and define the datums when you are creating a routine. All routines should have **datums at or near the beginning of the routine**.

Datums enable the same routine to be repeated for other identical parts. The only requirement is that you perform the manual setup on the part or fixture in the same way as it was done initially, before you run the routine.

Datum Features

Datums are constructed within a routine from previously-measured features. As with the part setup, useful features that can be used in the construction of datums include measured points and holes.

For example, on the dimension drawing of the OGP FastStart training part, the lower-left hole is the datum origin and lower-right hole is the datum axis alignment point.

The typical tools that are used to measure the datum features include Focus, FeatureFinder and Weak Edge Point.

You need to construct a datum origin and axis alignment **after** measuring each datum feature (see the sequence on the next page).

The **Construct** functions for **Datums** are:

- **Datum Origin** to establish an XY datum using a reference feature

- **Datum Skew Alignment** to align the specified axis and set the orientation of a part

- **Datum Level** to establish a Z axis datum using a reference plane

Typical Sequence for Defining Datums

The typical sequence for defining a Z and XY datum origin and an axis alignment is shown below:

1. Measure a point or plane on the surface of the part using the Focus tool. This becomes Step 1 of the routine.

2. Construct a Z datum level or origin step. This becomes Step 2 of the routine.

3. Measure the feature to be used as the XY datum origin. This becomes Step 3 of the routine.

4. Construct the XY datum origin. This becomes Step 4 of the routine.

5. Measure the feature to be used for the axis alignment. This becomes Step 5 of the routine.

6. Construct the axis alignment for the part. This becomes Step 6 of the routine.

Exercises

Complete the following exercises to become familiar with performing a manual part setup, measuring features to be used for datums, and automatically defining the datum origin and axis alignment.

1A. Manual setup of the OGP FastStart training part, including the Z setup zero location, the XY setup zero location, and axis alignment

1B. Automatic definition of the datum origin and axis alignment using measured features

1C. Repeating the manual setup after moving the part and running the routine

Part Setup and Datums Exercise (condensed version of Exercises 1A, 1B and 1C)

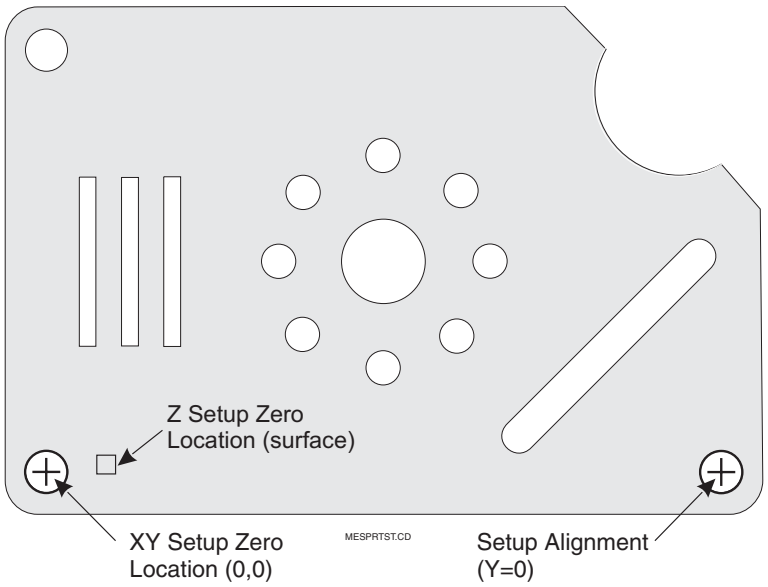
Challenge Exercise 1: Establish the part setup and datums on different features (use the large bolt hole for the axis alignment)

Challenge Exercise 2: Establish the part setup and datums on different features (use the corners for the datum origin and axis alignment)

Exercise 1A: Setting Up the OGP Training Part on the Stage Manually

In this exercise you will:

- Manually establish the Z setup zero location by performing an autofocus on a surface and zeroing the Z axis at the found focus point.
- Manually establish the XY setup zero location and axis alignment using the lower-left and lower-right holes.

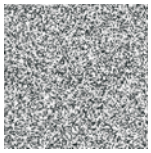


To set up the part manually, complete the steps below.

1. Zoom to the highest magnification if required.

2. Turn up the surface illumination to approximately 40%. Be sure that all other illumination sources are off.

3. Move the stage so that a surface, e.g., near the lower-left hole, is in the middle of the screen.



4. Turn up the surface illumination and, if needed, twist the focus knob on the joystick until the surface is in best focus.

5. Select the **Basic Focus** tool, change its size to look like a 1” square, and make sure that it is completely on the surface.

6. Click on the left mouse button to initiate the focus.

   The system performs an autofocus and displays a green cross in the focus box.

7. Click on the **Z** button in the DRO window to zero the Z axis.

8. Turn off the surface illumination and zoom to the lowest magnification.

9. Turn on the back light, move the stage so that the lower-left hole is in the middle of the screen, place the cursor in a lit area, and adjust the back light to approximately 40%.

10. Select the **Circle** target.

11. Line up the lower-left hole with the Circle target. Adjust the target if needed.

12. Press the **X** and **Y** buttons in the DRO window to zero the X and Y axes.

13. Move the stage along the X axis until the lower-right hole is in the middle of the screen.

14. Line up the hole with the Circle target.

15. Press the **Axis Align** button in the DRO window to align the part. The green LED on the button lights up. The Y field in the DRO window is reset to 0.

You have just completed the manual setup of the part. Now the system knows where the part is located on the stage.

Exercise 1B: Automatically Defining Datums in a Routine

In this exercise you will begin to automatically create a routine. You will:

- Define the Z datum origin by measuring autofocus points on a surface and including them in a Measure / Plane step, and then constructing the Z datum origin in a separate step.
- Define the part origin and axis alignment by measuring the lower-left and lower-right holes and then constructing the XY datum origin and axis alignment. In this exercise, you will measure the same features that were used in the manual part setup.
- Run the routine.

When you measure features and define datums, you are automatically creating steps at the beginning of the routine.

To measure the Z datum feature and automatically define the Z datum origin, complete the following steps.

1. Turn off the back light and turn up the surface illumination to approx. 40%.

2. Move the stage so that a surface, e.g., near the lower-left hole, is in the middle of the screen.

3. Zoom to the highest magnification and adjust the surface light as needed.

4. Turn up the surface illumination and, if needed, twist the focus knob on the joystick until the surface is in best focus.

5. Click on the **Basic Focus** icon, change the size of the displayed tool if needed, and make sure that it is completely over the surface.

6. Click on the **Measure** tab and **Plane** icon. Plane dimensions appear in the Measurement window.

7. Place the cursor in the Image window and click on the left mouse button to perform an autofocus on the surface.

8. Press **Enter** on the joystick to accept the focus point.

9. Repeat Steps 7 and 8 for three other focus points, spaced evenly around the entire part.

10. Click on **OK** in the Measurement window. The measurement is now in Step 1 of the routine.

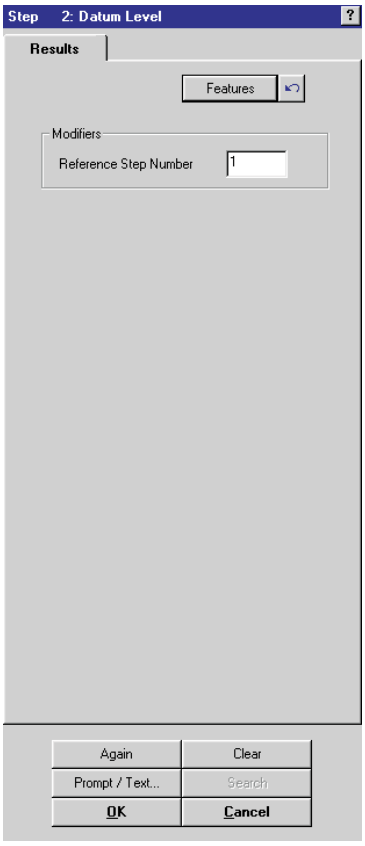
11. Click on the **Construct** tab and **Datum Level** icon. The system displays the Model window and Datum Level settings in the Measurement window.

12. Type **1** in the Reference Step Number field.

13. Click on **OK** in the Measurement window. The Z datum is now in Step 2 of the routine.

14. Click on the **Image** window tab to display the Image window.

15. Zoom to the lowest magnification and turn off the surface illumination.



To measure the XY datum features and automatically define the XY datum origin and axis alignment, complete the following steps.

1. Turn on the back light to approximately 40%.

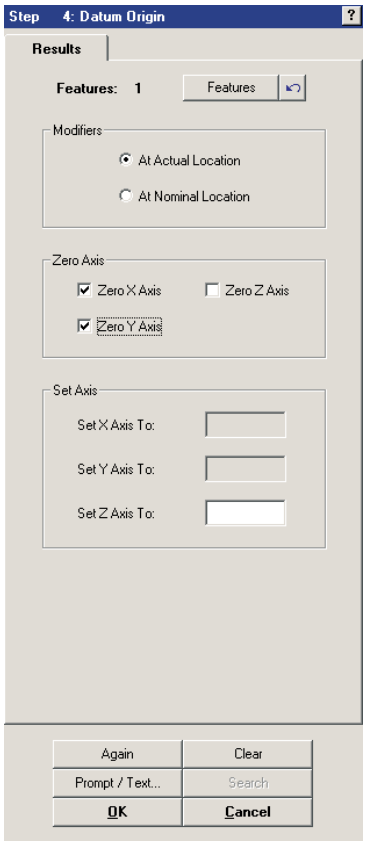
2. Move the stage so that the lower-left hole is in the middle of the screen.

3. If needed, twist the focus knob on the joystick until the hole is in best focus.

4. Click on the **FeatureFinder** icon and measure the lower-left hole.

5. Click on **OK** in the Measurement window. The measurement is now in Step 3 of the routine.

6. Click on the **Construct** tab and **Datum Origin** icon. The system displays the Model window and Origin settings in the Measurement window.



7. Click on the measured lower-left hole in the Model window. If the features do not appear in the Model window, click on the **Fit to Window** icon in the Model window toolbar.

8. Click on the check boxes next to **Zero X Axis** and **Zero Y Axis**.

9. Click on **OK** in the Measurement window. The XY datum origin is now in Step 4 of the routine. The intersection of the X and Y axes moves to the datum origin in the Model window.

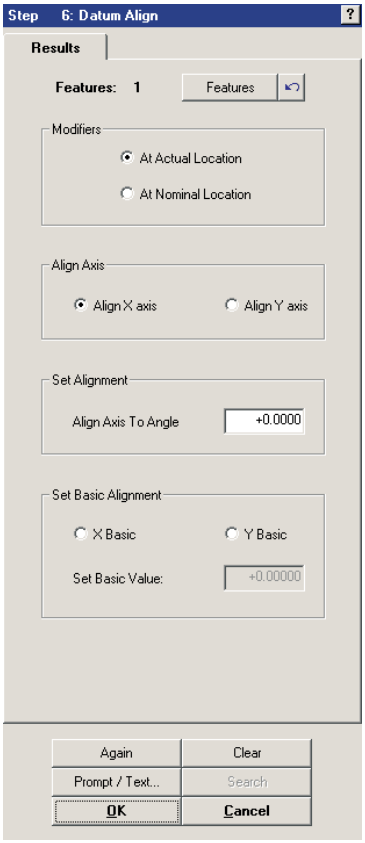
10. Click on the **Image** window tab to display the Image window.

11. Move the stage so that the lower-right hole is in the middle of the screen.

12. Measure the lower-right hole. (The FeatureFinder tool is still active.)

13. Click on **OK** in the Measurement window. The measurement is now in Step 5 of the routine.

14. Click on the **Datum Align** icon (the Construct mode is already active). The system displays the Model window and axis alignment settings in the Measurement window.



15. Click on the measured lower-right hole in the Model window. If the features do not appear in the Model window, click on the **Fit to Window** icon in the Model window toolbar.

16. Click on the radio button next to **Align X Axis**.

17. Click on **OK** in the Measurement window. The axis alignment is now in Step 6 of the routine. The X axis moves to the center of the lower-right hole in the Model window.

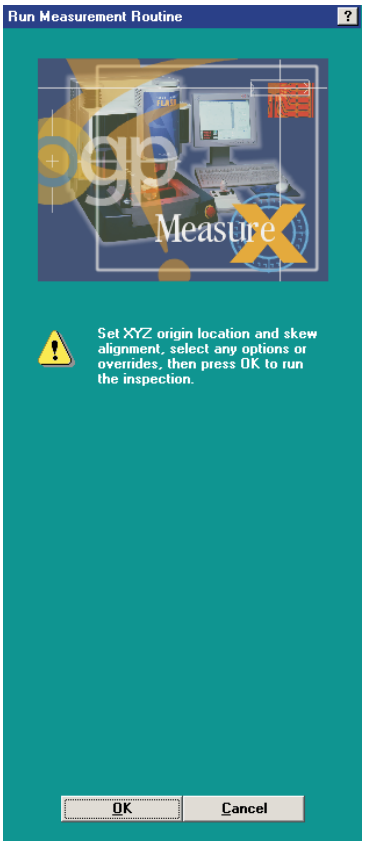
18. Click on the **Image** window tab to display the Image window.

19. Move the stage so that the upper-left hole is in the middle of the screen.

20. Measure the upper-left hole using FeatureFinder.

21. Click on **OK** in the Measurement window. The measurement is now in Step 7 of the routine.

22. Click on the **Run** icon to run the routine. The Measurement window displays a message to set the XYZ origin and align the axis along with run option and control buttons.



23. Click on **OK** to begin running the routine. The routine runs through all the steps.

24. When the run is completed, click on **OK** in the "Automatic Inspection Complete" dialog box.

25. Click on the **Save** icon to save the routine. A window pops up displaying the existing routine (MXI) files in the c:\ogp\routines folder.

26. Type **yourname1.mxi** in the File Name field to save this routine. The routine is saved in the Routines folder and also remains in memory so that it can be changed or run again.

Exercise 1C: Repeat the Manual Setup after Moving the Part (or else...)

In this exercise you will run the routine after moving the part. You must complete the manual setup procedure any time the part is moved in order for the routine to run. The following demonstrates what happens when you do not do a part setup after moving the part.

1. Move the OGP FastStart training part to another location on the stage and secure it.

2. Click on the **Run** icon to run the routine and click on **OK**. The system may be able to complete the first and/or second step but then it displays an "Unable to Complete Autofocus" or "Feature Calculation Failed" message because it cannot find the part setup zero location or measure the feature.

3. Respond to the prompts, e.g., Yes to the "Continue Run" prompt, and click on **OK** when a prompt is displayed to stop the run of the routine. Then the software displays a message "Automatic Inspection Complete" with OK and Run buttons.

4. Click on **Run** again but do **not** click on OK yet.

Hint

The reason for not clicking on OK yet is to allow you to perform a manual setup if the part is not in the same location as it was when the routine was created. When a routine is in memory, you can do a manual setup only when the routine is in run mode, i.e., the Run window is open.

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5. This time, perform the same manual setup as you did before: autofocus to establish Z=0 and establish the XY setup zero location and the X axis alignment on the lower-left and lower-right holes, respectively.

Hint

If you do not remember how to perform the manual setup, see Exercise 1A.

6. Click on **OK** to run the routine. The routine will run through all its steps because the system now knows where the part is located on the stage. You do not need to re-measure the steps or re-define the datums.

This completes Exercise 1 to define the Z origin, XY origin, axis alignment, and to run and save the routine.

Part Setup and Datums Exercise (Condensed)

This exercise is a condensed version of Exercises 1A, 1B and 1C. You can either do this exercise or complete Exercises 1A, 1B and 1C.

In this exercise you will:

- Manually establish the Z setup zero location, XY setup zero location, and axis alignment on the OGP FastStart training part.
- Begin to automatically create a routine by measuring the datum features and defining the Z datum origin, XY datum origin and axis alignment in the first six steps of the routine.

1. Perform a manual setup.
   - Use the Focus target to focus on the surface near the lower-left hole and establish Z=0.
   - Use the Circle target on the lower-left hole to establish the part origin (X and Y = 0) and on the lower-right hole to align the X axis.
2. Using surface illumination, measure a focus point at high magnification on the surface near the large hole (Step 1 of routine) and use this point to define the datum for Z=0 (Step 2 of routine).
3. Measure the lower-left hole (Step 3 of routine) and use this feature to define the datum origin for X and Y = 0 (Step 4 of routine).
4. Measure the lower-right hole (Step 5 of routine) and use this feature to define the axis alignment (Step 6 of routine).
5. Measure the upper-left hole (Step 7 of routine).
6. Run this routine (Steps 1 through 7 of routine).
7. Save this routine as **yourname1.mxi**.
8. Move the training part to another location on the stage and run the routine again. Remember that you need to perform a manual setup so the system knows the location of the part.

This completes the Condensed Part Setup and Datum Exercise.

Challenge Exercise 1: Establish the Part Setup and Datums on Different Features (Axis Alignment on Center of Bolt Hole)

Using the OGP FastStart training part, you will do the following in this exercise:

- Manually establish the Z setup zero location on the surface, the XY setup zero location on the lower-left hole, and the **X axis alignment through the center of the bolt hole**.
- Establish the XY datum origin on the lower-left hole and the X axis datum alignment through the center of the lower-right hole.

Establishing the X axis alignment through the center of the bolt hole will make the part features appear rotated in the Model window until you define the axis alignment in the routine (see Step 8 in this exercise). Although this is not the typical way to do the manual setup, this is done purposely to demonstrate the need to do the same setup each time you move the part and run the same routine. This also demonstrates the capability to manually align the part to one set of features and establish the datums on different features.

To establish the manual part setup on one set of features and create a routine with datums using different features, complete the steps below.

1. Click on the **New** icon to start creating a new routine.

2. Perform an autofocus on the surface (select the Focus tool, zoom to the highest magnification, use surface illumination) and press the **Z** button in the DRO window to zero the Z axis.

3. Turn up the back light to approximately 40%, zoom to the lowest magnification, and move the stage so that the lower-left hole is in the middle of the screen.

4. Select the **Circle** target and line up the lower-left hole with the target.

5 Press the **X** and **Y** buttons in the DRO window to zero the X and Y axes.

6. Move the stage until the large bolt hole is in the middle of the screen and line up the bolt hole with the Circle target.

7. Press the **Axis Align** button in the DRO window to align the part. You have just completed the manual setup.

8. Measure the datum features on the OGP FastStart training part and automatically define the Z, XY, and axis alignment datums. If you need help to do this, redo Exercise 1B.

9. **Run** the newly created routine. Do **not** save this routine.

Challenge Exercise 2: Establish the Part Setup and Datums on Different Features (Datums on Corners)

If there is time, you will do the following in this exercise:

- Manually establish the Z setup zero location on the surface, the XY setup zero location on the **lower-left hole**, and the X axis alignment on the **lower-right hole**.
- Establish the XY datum origin on the **lower-left corner** and the X axis datum alignment on the **lower-right corner**.

It does not matter which features are used for the manual part setup. What does matter is that the system knows where the part is located on the stage so that you can run the routine. This means that you can use one set of features for the manual setup and create and run the routine with the datums based on different features.

To establish the manual part setup on one set of features and create a routine with datums using different features, complete the steps below.

1. Click on the **New** icon to start creating a new routine.

2. Perform an autofocus on the surface (select the Focus tool, zoom to the highest magnification, use surface illumination) and press the **Z** button in the DRO window to zero the Z axis.

3. Turn up the back light to approximately 40%, zoom to the lowest magnification, and move the stage so that the lower-left corner is in the middle of the screen.

4. Select the **Circle** target and line up the lower-left hole with the target.

5 Press the **X** and **Y** buttons in the DRO window to zero the X and Y axes.

6. Move the stage until the lower-right hole is in the middle of the screen and line up the lower-right hole with the Circle target.

7. Press the **Axis Align** button in the DRO window to align the part. You have just completed the manual setup.

8. Move the stage until the lower-left corner is in the middle of the screen, measure the left and bottom edges, and construct the corner intersection.

9. Define the XY datum origin on the lower-left corner.

10. Repeat Steps 8 and 9 of this exercise to define the datum alignment on the lower-right corner.
11. **Run** the newly created routine. Do **not** save this routine.

Session 4

Creating, Saving and Running a Routine

The purpose of this session is to learn how to:

- Measure and construct features
- Include nominal values and tolerances in a step
- Save and run a routine

For more information about the Measure and Construct functions, see:

- Measure Functions and Construct Functions topics in the on-line Help
- Sections 8 and 9 in the *Measure-X Reference Guide*

For more information about nominal values and tolerances in a step, see:

- Nominal Values and Tolerances topic in the on-line Help
- Section 7 in the *Measure-X Reference Guide*
- Section 8 in the *Measure-X Fast Start Guide*

For more information about saving and running a routine, see:

- Save the Current Routine and Run Current Routine topics in the on-line Help
- Section 6 in the *Measure-X Reference Guide*
- Sections 8 and 11 in the *Measure-X Fast Start Guide*

Session Objectives

After completing this session, you will be able to:

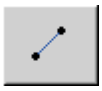
- Identify the common Measure and Construct functions
- Use common Measure functions to measure part features
- Construct features from measured features
- Include nominal values and tolerances in routine steps
- Select specific measurements for printing
- Enter specific instructions for setting up the part
- Enter specific information about the routine in the heading
- Save and run the current routine
- View the routine listing and print data on the screen

Common Measure Functions

The Measure functions enable you to measure the feature size, location and other geometric dimensions.

Four common **Measure** functions include:

- **Point, which is a single XYZ location.**
  - This is typically used to measure point locations and the Z location for constructing a datum.
  - The Locate Point function enables you to define a location without actually measuring the point; this can be used as a safe point.
  - A point appears as an asterisk in the Model window.



- **Line**, for measuring the straightness and angles of lines.
  - You must specify at least 2 points to measure a line.
  - You must specify at least 3 points for a straightness calculation.
  - The XYZ coordinates are of the line's **midpoint**.
  - A solid line appears in the Model window.

- **Circle**, for measuring diameters and radii of circles, arcs, holes, and rounded or curved edges.
  - You must specify at least 3 points to measure a circle or arc.
  - You must specify at least 4 points for a non-zero roundness calculation.
  - The XYZ coordinates are of the **center** of the circle.
  - Click on the desired radio button to display the **Diameter** or **Radius**.
  - Select Best-Fit, Minimum Contact or Maximum Contact from the drop-down list to display the applicable measurements.
  - A solid-line circle appears in the Model window.
  - If you measure a curved edge that goes into a line, do not specify a point that is very close to or on the line; this may cause inaccurate measurement results.

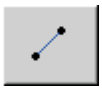
- **Plane**, for measuring the orientation and form of a plane.
  - Use the Focus tool to focus each point before entering it.
  - Spread the points as evenly as possible around the entire plane for the most accurate results.
  - You must specify at least 3 focus points for the plane and at least 4 focus points for a non-zero flatness.

Common Construct Functions

The Construct function enables you to build features in the Model window from previously-measured or -constructed features. A constructed feature does not necessarily have to be on the part itself. The **composite** function may be used for circles and lines that do not fit entirely in the field of view.

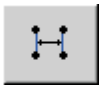
Common Construct functions include:

- **Point** enables you to define a point in space in the Model window.
  - You must either enter the nominal location or select a feature from the Model window. The point can be used for future constructions.

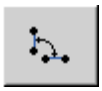


- **Line** enables you to measure the angle and midpoint location.
  - The angle is defined relative to the current coordinate system. Select **Angle2** from the drop-down list to display the supplementary angle.
  - The coordinates are of the **midpoint** of the line.
  - You must select at least three features for a straightness calculation.

- **Circle** enables you to measure diameter and center location.
  - You must select at least three features to construct a circle, and at least four features for a circularity calculation.
  - Click on the desired radio button to display the **Diameter** or **Radius.**
  - The coordinates are of the **center** of the circle.



- **Width** reports how far apart two features are and the location of the centerline, independent of the coordinate system.
  - Calculations are based on the perpendicular distance between the features.
  - You can construct widths between a point and a line, two lines, a point and a circle, or two circles, or an intersection and other features.
  - Select the Best-Fit, Minimum or Maximum widths from the drop-down list.



- **Intersection** is a point where two features meet.
  - You can construct intersections between two lines (one point), between a line and a circle (one or two points), or between two circles (one or two points). If the 1 of 2 and 2 of 2 radio buttons are active, this indicates that there are two intersection points.
  - Reports the angle between two lines and the coordinate of the intersection point, calculated counterclockwise from leg1 to leg2.

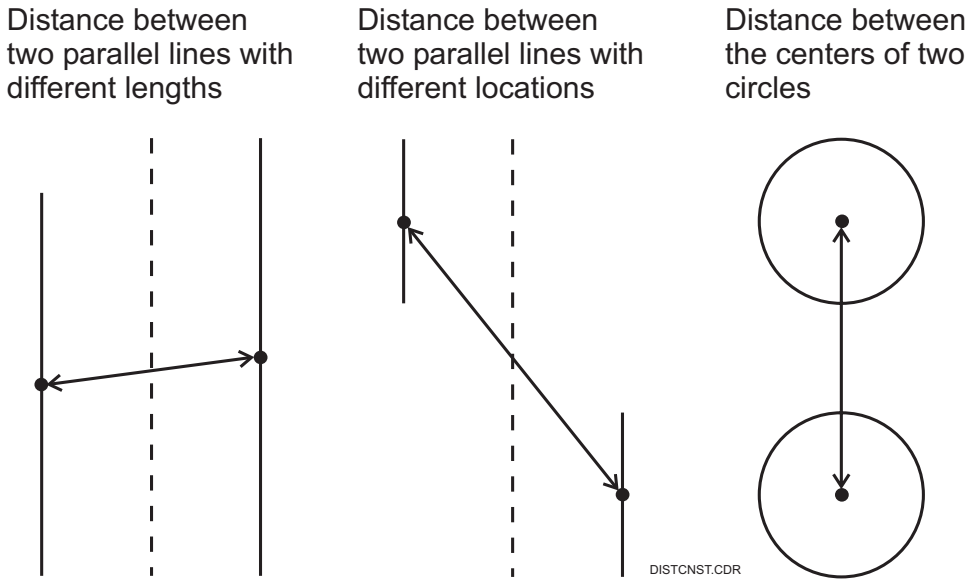
- **Distance** reports how far apart two features are, relative to the current coordinate system.
  - Reports the XYZ (RAZ) distance and the straight line distance, from one feature to another using their center locations.

Comparison of Distance and Width Functions

Both the Distance and Width functions can be used to find the size of a feature (i.e. overall length of part, size of slot) or the spacing between two features. However, while the functions seem to be similar, there are several differences, which are described below.

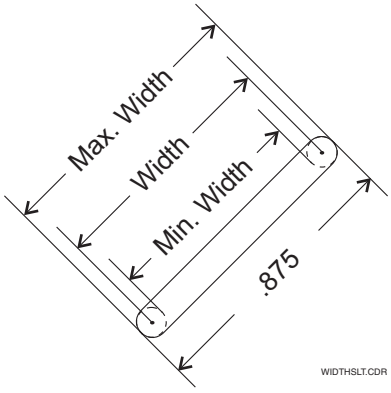
Distance

- Looks at the **center point** of the feature rather than the characteristics of the feature itself
- Reports XYZ and straight-line distance values relative to the current coordinate axis

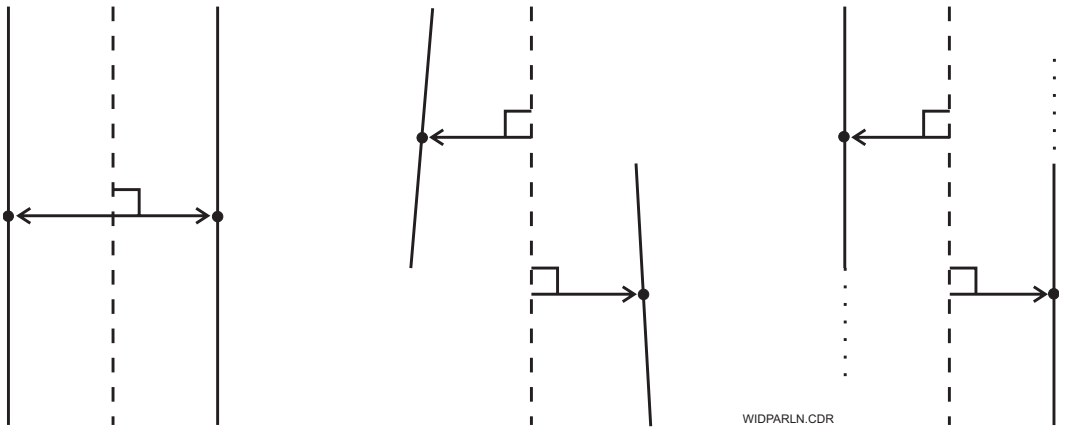


Width

- Looks at both the **center point** and the **size** of the feature
- Reports values relative to the selected features
- Allows the selection of the Best-Fit, Minimum or Maximum widths
- May be used with points, lines, circles within a 2D measurement

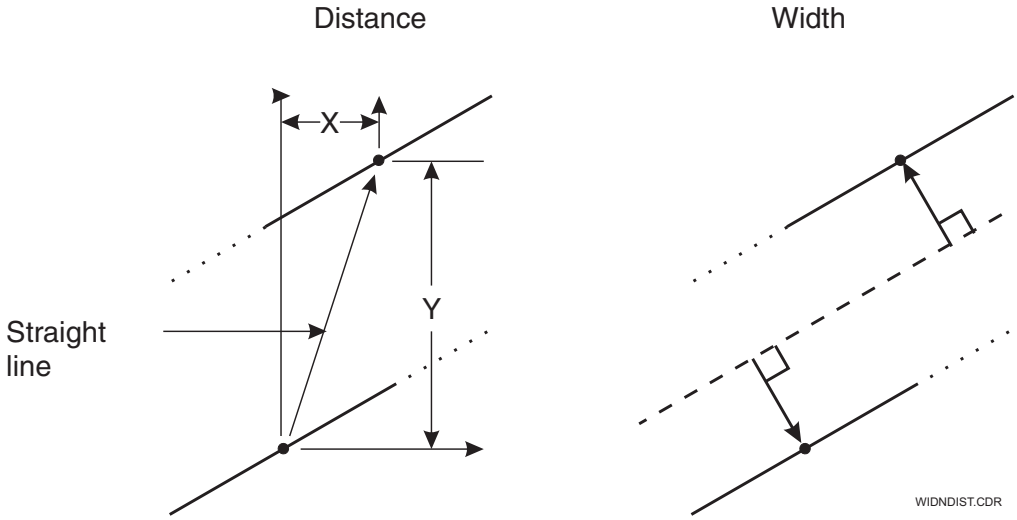


Width calculated as a perpendicular between two best-fit



Comparison Example

In the example shown here, you can use either function to determine dimensions between the same two parallel lines with different XY locations. The choice of which function to use is based on the dimensions that you wish to measure.



Including Nominal Values and Tolerances in a Step

Nominal values refer to the ideal dimensions of a feature. **Tolerances** are values that indicate how much the dimensions can vary. These dimensions are specified on the part's dimension drawing (blueprint).

The system uses the nominal values when it searches for a feature. It also displays the feature in the Model window at the nominal size and location.

How to Enter Nominal Values and Tolerances

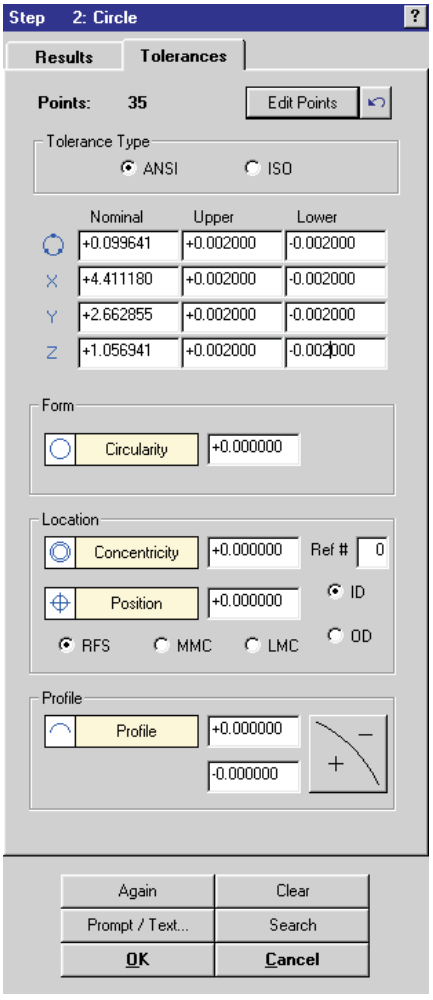
You need to enter the nominal values and tolerances that are on the blueprint for each dimension that you measure. For similar features, the system "carries forward" the *tolerance* information from one feature to the next (see next page). However, you need to enter the *nominal* values by overwriting the actual values.

You can enter nominal values and tolerances either before or after you measure a feature. OGP recommends that you measure the feature first and then enter the nominal values and tolerances.

When you do the measurement first, Measure-X copies the actual values into the nominal fields. This provides several benefits:

- It allows you to see the signs and enter the correct signs for the nominal values. For example, if the measurement results show an angle that is negative (e.g., -45º), you must also enter the nominal as a negative value.
- It decreases the amount of data entry because you only need to change some values rather than enter all of them.

To display the Nominal window and enter nominal values and tolerances, click on the **Tolerances** tab.



You can enter and change values in the Tolerances window in the following ways:

- Place the cursor in a field. While holding the left mouse button down, drag the cursor over the desired digits to highlight them. After releasing the button, type the new digits. This overwrites the highlighted digits.
- Place the cursor in a field. Enter new values at the cursor location. They are inserted in front of existing values. This is used most often for editing and changing existing values.
- Use the **Tab** key to move forward from one field to the next and **[Shift] + [Tab]** to move the cursor backward. When the tab key is used, the entire field changes color and the entire value in the field is replaced. This is used most often for first-time entry.

Tips

When entering nominal values and tolerances, keep the following in mind:

- You do not need to enter leading zeros (i.e., to the left of the decimal point) unless you are making changes.
- It is not necessary to enter the positive (+) sign for nominal values. However, a negative (-) sign is necessary for applicable location coordinates.
- You do not need to enter signs for ANSI tolerance values. When they appear on the printed report, the upper tolerance is + and the lower tolerance is -.

Understanding How Tolerances Are Carried Forward

When you enter the size, location and form tolerances for a feature, Measure-X "carries forward" the tolerances to the next measurement of the same feature. That is, the software automatically uses the same tolerances that were used in the last identical or similar type of feature.

For example, the OGP FastStart training part has three holes (circles) along its outer edges; the tolerances for these holes are the same. After you measure the first hole using the Circle function and enter the tolerances, Measure-X "remembers" the tolerances you entered. It carries them forward when you use the same Circle function to measure all the other holes. You do not need to enter any tolerances for the other holes.

The software also carries tolerances for similar types of features. Several examples are listed below.

- If you used Measure/Line, tolerances are carried forward for Construct/Line.
- If you used Measure/Circle, tolerances are carried forward for Construct/Circle.

How Deviations and Tolerance Ranges are Calculated

When you measure a feature, Measure-X calculates the deviations and tolerance ranges as follows:

1. It compares the actual measurements with the specified nominals by subtracting the nominal value from the actual value. The amount that the actual value exceeds (varies from) the nominal value is given as the **deviation**.

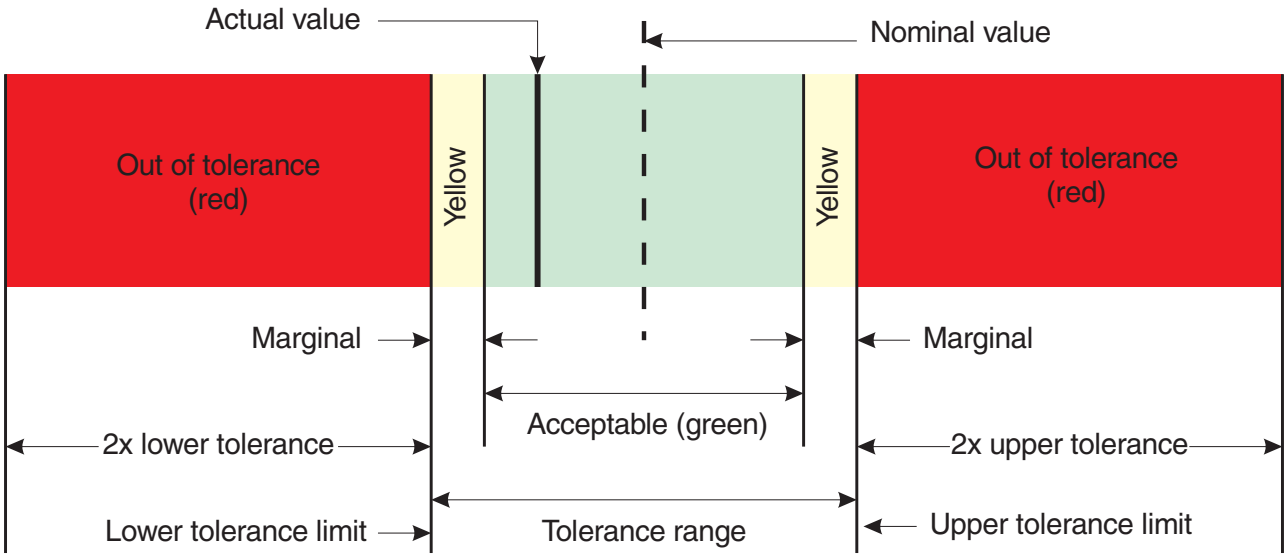
   Deviation = actual value - nominal value

2. It calculates the lower and upper tolerance limits and determines the range between the upper and lower tolerance limits.

   Lower tolerance limit = Nominal + lower tolerance

   Upper tolerance limit = Nominal + upper tolerance

   For example, if the nominal is 1.000 in., with an upper tolerance of + 0.005 in. and a lower tolerance of - 0.005 in., the range is from 1.005 in. (upper limit) to .995 in. (lower limit).



3. It checks if the actual value is within or outside the tolerance range.
   - If the actual value is between the upper and lower limits, it is in tolerance.
   - If the actual value is beyond the upper or lower tolerance limit, it is out of tolerance.

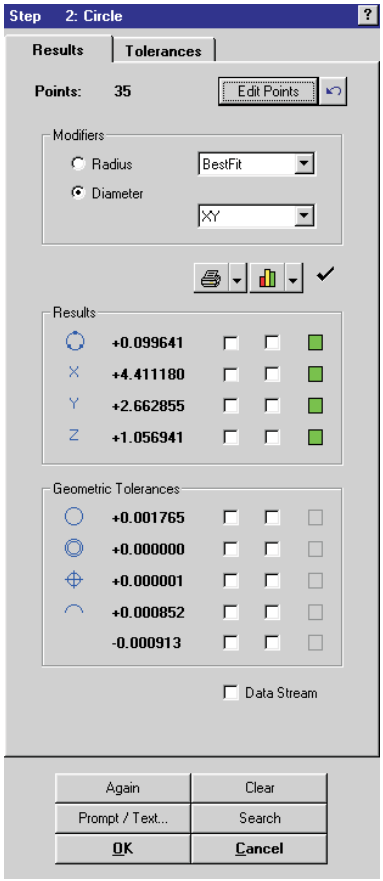
4. If the actual value is within the tolerance range, the software calculates the percentage of the tolerance used and displays the “quality” of the percentage.

   Tolerance percentage = deviation / upper or lower tolerance

How Toleranced Measurements Are Displayed on the Screen

All Measure and Construct results windows have pass/fail indicators. If the feature is toleranced, one of the following color indicators appears in the check mark column:

- **Red**, if the actual value exceeds the tolerance range (it is out of tolerance). The actual value falls outside the lower or upper tolerance limit.
- **Yellow**, if the tolerance percentage is between 75% and 100%. The actual value uses 75% or more of the tolerance range.
- **Green**, if the tolerance percentage is less than 75%. The actual value is within 75% of the tolerance range.



How to Output Measurement Results

Measurements results are displayed in the Measurement window after the minimum number of points have been specified. You can output the measurement results to four destinations, which are shown on the measurement output icons. However, only two destinations are displayed at the same time.

- Print data, which can be sent to the Print Data tab, printer, and/or print file
- Statistics file
- Print Output file
- Data Export file

This training session describes only the print data that is output to the printer or Print Data tab. See Section 11 in the *Measure-X Reference Guide* for more detailed information about sending measurement results to all the other destinations.

To output any of the measurement results (actual and nominal values, tolerances, and deviations):

1. If it is not already displayed, click on the **arrow** next to the measurement output icon and select the **Printer** icon from the drop-down list.

2. Click in the **check box** next to the desired measurement(s) under the printer icon to select the measurement(s) for output. A check mark appears in the box.

3. Click on **OK** to close the Measurement window.

Image | Model | Listing | Print Data

```
Routine Name                                                    Run #          Date & Time
fastart.mxi                                                       3      Tue Apr 25 11:20:54 2
FastStart
Feature          Unit    Nominal       Actual          Tolerances          Deviation     Excee
Step 1
Radius           mm   +001.250000   +001.259691   +0.005000   -0.005000   +000.009691  +000.00
X Location       mm   +000.000000   +000.007201   +0.005000   -0.005000   +000.007201  +000.00
Y Location       mm   +000.000000   +000.007031   +0.005000   -0.005000   +000.007031  +000.00
Z Location       mm   +000.000000   +000.000000                           +000.000000
Step 3
Radius           mm   +001.250000   +001.259442   +0.005000   -0.005000   +000.009442  +000.00
X Location       mm   +050.000000   +050.771411   +0.005000   -0.005000   +000.771411  +000.76
Y Location       mm   +000.000000   +000.002589   +0.005000   -0.005000   +000.002589      +++
Z Location       mm   +000.000000   +000.000000                           +000.000000
Circularity      mm                 +000.006468   +0.100000               +000.006468      +
Step 5
Radius           mm   +003.300000   +003.311944   +0.005000   -0.005000   +000.011944  +000.00
X Location       mm   +051.000000   +050.883292   +0.005000   -0.005000   -000.116708  -000.11
Y Location       mm   -000.100000   -000.083338   +0.005000   -0.005000   -000.016662  -000.01
Z Location       mm   +000.000000   +000.000000                           +000.000000
Circularity      mm                 +000.001518   +0.100000               +000.001518      +
Step 6
```

The selected measurements are output to the printer or to the Print Data tab, depending on the selected run override options (described in Session 7).

How Measurement Results Are Shown on the Print Data Tab or Printout

When measurement results are sent to the printer, Measure-X also sends the nominals, tolerances and deviation calculations to the printer.

If the actual value exceeds the tolerance range (it is out of tolerance), an amount is shown in the Exceeded column on the printout. The amount indicates how much the measured value has exceeded (gone beyond) the tolerance limit.

Amount in Exceeded Column = deviation - upper or lower tolerance

If the actual value is in tolerance, the deviation within the upper or lower tolerance is shown in the form of pluses and minuses in the Exceeded column on the printout. Each plus/minus represents 25 percent of the tolerance.

Sign	Meaning
(blank)	A deviation is not calculated because tolerances are not specified.
+	The deviation is between the nominal (0) and 25% of the upper tolerance.
+ +	The deviation is between 26% and 50% of the upper tolerance.
+ + +	The deviation is between 51% and 75% of the upper tolerance.
+ + + +	The deviation is between 76% and 100% of the upper tolerance.
-	The deviation is between the nominal (0) and 25% of the lower tolerance.
- -	The deviation is between 26% and 50% of the lower tolerance.
- - -	The deviation is between 51% and 75% of the lower tolerance.
- - - -	The deviation is between 76% and 100% of the lower tolerance.

The example below shows a sample printout and how the percentage is calculated and displayed. The printout shows two minuses in the Exceeded column for a diameter measurement. This indicates that the percent of the tolerance used (36.8%) is between 26 and 50 percent of the lower tolerance.

```
================================================================================
Feature   Unit    Nominal   Actual     Tolerances     Deviation     Exceeded
================================================================================

Step 6 - Datum -C- Hole
```

Calculation of the tolerance percentage: $\frac{\text{Deviation}}{\text{Tolerance}}$ $\frac{0.00184}{0.00500}$ = 36.8% (displayed as two minus signs)

How to View the Steps in a Routine Listing

A routine listing displays information about each step in the routine. It is useful to find specific steps and to identify the reference steps of a constructed measurement.

You can view and print a listing of all the steps in a routine or select which steps you wish to print. To view and/or print the steps in the routine, click on the **Listing** tab.

You can view and print the measurements in three formats:

- **Condensed**. For each step, this lists the feature, XYZ (or RAZ) location and size. If the measurements in a step are constructed from previous measurements, the step number(s) are listed in the Reference column.

- **Standard**. This lists the details of the measurements in each step. It includes the units of measurement, features measured, actual measurements, and nominal values and tolerances.

- **Expanded**. This lists the standard information with details about each point in the measurement. The details include location, zoom, lighting and target/tool used.

To print the routine listing and the name of the routine:

1. Specify the steps that you wish to print (default is all steps) and select the desired format (default is Standard).

2. Click on the **Print** icon in the toolbar.

The routine listing is sent to the printer.

Exercise 2: Measure and Construct Features and Include Nominals and Tolerances

In this exercise you will:

- Manually establish the Z setup zero location, XY setup zero location, and axis alignment on the OGP FastStart training part.
- Add steps to the routine you created earlier by measuring the outer edges of the OGP FastStart training part and constructing features where needed.
- Include nominal values and tolerances in the steps and select specific measurements for printing. **Refer to the print of the OGP FastStart training part for the nominal and tolerance dimensions**.

To measure the outer edges of the OGP FastStart training part, complete the steps below.

1. Open the routine **yourname1.mxi**.

2. Click on the **Run** icon but do **not** run the routine yet.

3. Perform a manual setup while the Run Routine window is open.
   - Focus on the surface near the lower-left hole and establish Z = 0.
   - Establish the XY setup zero location (X and Y = 0) on the lower-left hole.
   - Align the X axis on the lower-right hole.

4. Select **Part Setup / Setup Instructions...** and enter the manual part setup instructions.

5. Select **Part Setup / Header and Footer...** and enter the header "This routine measures the OGP FastStart training part."

6. Select **Part Setup / Run Overrides...** and click on the **Printer** tab. Then remove the check mark from the box next to **Printer and check the box next to Print Data Tab. Remember to click OK to close the window.**

7. Click on the **OK** button to run the routine to verify that the setup was done properly and that the initial steps were created properly.

8. Measure the upper-left hole and select the diameter for printing. Also include the nominal and tolerance dimensions for the diameter.

9. Measure the edges and arcs along the outside of the OGP FastStart training part, starting with the left edge.
   - Use **FeatureFinder** for the long straight edges and rounded corners.
   - Use **FeatureFinder** or **Average Weak Edge Point** for the segments of the large arc.
   - Include nominal and tolerance dimensions for the radius of each of the three small rounded corners called out in the blueprint. Notice that the tolerances are carried forward.
   - Select the radius size for printing in each arc step, except for the large arc, which will be done in Step 11 below.

10. View your measurements in the Model window.

11. Use **Construct / Circle** to construct the large arc from the measured points or arc segments.
   - Select the **Radius** for printing and specify the radius nominal and tolerance values.
   - Click the **Composite** check box. This uses the XYZ locations of the individual data points that make up (compose) each reference feature rather than the actual location of each reference feature (for example, the midpoint of a line or the center of a circle).

12. Use **Construct / Line** to construct the four outside edges.
   - Construct each edge in a separate step by selecting the measured line segments along that edge.
   - Click the **Composite** check box.
   - In each step, select the **Straightness** dimension for printing.

13. **Run** the routine. The dimensions that you selected for printing are sent to the Print Data tab.

14. **Save** the routine as **yourname2.mxi**.

15. Click on the **Listing** tab to view the routine listing. Look at the Condensed, Standard and Expanded views.

16. Click on the **Print Data** tab to view the “printed” measurements.

17. Open a **New** routine.

This completes Exercise 2.

Session 5

Model Window

The purpose of this session is to learn how to:

- Display different views in the Model window
- View the two sets of coordinate system axes
- Select and control the data that is displayed in the Model window
- Use the three mouse buttons in the Model window
- Interpret the features displayed in the Model window
- Interpret the colors of the features displayed in the Model window

For more information about the Model window, see:

- *Model Window* and *Model Window Toolbar* topics in the on-line Help
- Section 2 in the *Measure-X Reference Guide*

Session Objectives

After completing this session, you will be able to:

- Display different views in the Model window
- View the two sets of coordinate system axes
- Use the icons in the Model window toolbar to select and control the data that is displayed in the Model window
- Control the features displayed in the Model window using the three mouse buttons
- Identify the features displayed in the Model window
- Understand the colors of the features displayed in the Model window

Display the Model Window

To display the Model window, click on the **Model** tab or select **Model / Standard View** in the View menu, or click on the Model icon if the Surface window is displayed. The Model window is also displayed any time you use any of the Construct or Edit functions.

The Model window displays a CAD-like sketch of the measured and constructed features. A blue rectangle indicates the field of view.

The model is always drawn to reflect the current datum system. The current datum is shown by the intersection of three lines indicating the XYZ axes.

Views in the Model Window

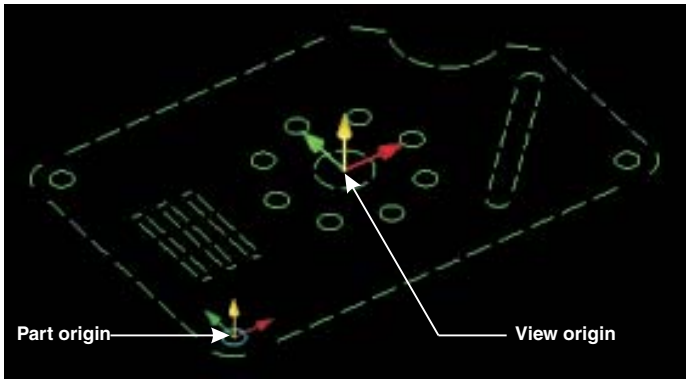
You can display different views in the Model window.

To display a specific view, select the view in the **View / Model** menu. You may also click on the view icons that are in the Model window toolbar (described later in this session).

The default is Top View. The other views that may be selected are: Isometric, Bottom, Left, Right, Front, and Back.

Coordinate System Axes

The Model window displays two sets of XYZ coordinate system axes.

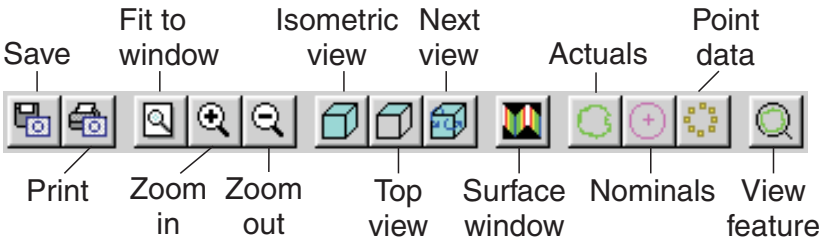


- **Part origin**, shown as smaller, thinner lines. This indicates the XYZ origin of the part being measured and is always displayed with the part image. If the image is moved or rotated, the part origin moves and rotates with the image.
- **View origin**, shown as larger, thicker lines. This is a set of XYZ reference axes that always remain in the center of the Model window.

- The view origin provides a constant visual reference for the location and orientation of the part in the Model window.
- Whenever you select Zoom In or Zoom Out, the zoom is done about the view origin.
- The view origin is displayed only when you click and hold one of the mouse buttons.

Model Window Toolbar

The Model window toolbar is displayed above the Model window. This window contains icons that represent the most common functions in the Model menu. If you do not know the icon's function, place the cursor over the icon. The system displays a tooltip for the icon.



The icons in the Model window toolbar have the following functions:

- The icons on the left **Save** the Model in an image file and **Print** the Model.
- The three **Zoom** icons on the left control the size of the model.
- The **Isometric View** and **Top View** icons enable you to display the appropriate views.
- The **Next View** icon toggles through six views in the following order: Top, Front, Right, Back, Left, and Bottom. When you click on the icon, the Icon Help indicates which view will be displayed next.
- The **Surface** icon displays the Surface window for the selected feature, if it was measured with a laser area scan.
- The **Actuals**, **Nominals** and **Points** icons control the display of the applicable data. See the topic *Graphical Representation of Displayed Data* in the on-line Help for more detailed information.
- The **View Feature** icon maximizes the feature currently being edited in the Model window. To view a feature, select the feature in the Model window and click on the View Feature icon.
    - The top view of the *feature* (not the entire part) is displayed in the Model window. The feature step is displayed in the Measurement window.
    - This function is useful when you wish to view the actual data and compare them to the nominal data.

Mouse Functions in the Model Window

The table below shows the mouse functions for a 3-button mouse, which is the default configuration.

Button	Function
Left	• Click to select features or icons • Hold the button down and - Drag the mouse up to zoom the entire model up - Drag the mouse down to zoom the entire model down • Zoom in on a specific area by holding the button and Shift key down and dragging the cursor diagonally to draw a box around the desired area
Middle	Pan (move) the entire model in any direction by holding the button down and moving the cursor in the desired direction
Right	Rotate the entire model around the view origin by holding the button down and moving the cursor: • Left/right to rotate the model around the Z axis • Up or down to rotate the model about the horizontal screen axis

Features in the Model Window

Features in the Model window are displayed in the following ways:

- Measured features are displayed as solid lines.
- Constructed features are displayed as dashed lines.
- Lines are drawn along the entered points.
- Circles are displayed in two ways:
  - As a full circle, if the diameter is output.
  - As an arc along the entered points, if the radius is output.
- An intersection between two lines displays a cross at the intersection location and joins the lines to create the corner formed by the intersection. When circles and lines are intersected, they are joined in a similar way.
- Contour features are displayed as a continuous line or curve with all the data points connected. The nominal contour location is displayed as an octagon.
- Spheres are displayed as five circles. One circle is near the top and one near the bottom, and the other three circles connect the top and bottom circles.
- Planes are displayed as a rectangle enclosing all of the plane's points.
- Cylinders and cones are displayed as two circles, one each at the top and bottom, connected by lines at the 0, 90, 180, and 270 degree points on the circles.
  - For cylinders, both circles are the same size.
  - For cones, one circle is smaller than the other.
- If the optional touch probe is enabled, the current location of the probe is shown with a solid red circle. This circle moves as you move the probe.
- All measured points are displayed differently based on the tool or target used to measure them.

Tool	Symbol	Tool/Target	Symbol
Strong edge		All manual targets	
Average weak edge		Constructed point	
Maximum weak edge		Touch probe point	
Minimum weak edge		Centroid	
Focus			

Colors of Model Window Attributes

The Model window has a black background. This enables the other colors to be displayed more vividly. However, if you print the Model, the system reverses the black and white colors to save printer ink.

Model Attribute	Color
Coordinate system axes	• X: red • Y: green • Z: yellow
Actual feature - in tolerance or not toleranced	Green
Actual feature - within the tolerance band specified in the YELLOW_PERCENT parameter in the Graphics section of the Configuration Editor	Yellow
Actual feature - out of tolerance	Red
Current feature	Light cyan
Features not measured yet	Dark cyan
Selected features	Light magenta
Reference features of selected features	Dark magenta
Nominal dimensions for all features (only if you entered nominal values for **all** feature and size dimensions in the Nominals window)	Light blue
Data points of a measured feature	White cross
DXF file features	Light gray
Touch probe attributes	Red: location of tip Green: point not entered yet Yellow: missed point

Exercise 3: Model Window

In this exercise you will:

- Manually set up the OGP FastStart training part, if necessary
- Use the functions in the Model window toolbar
- Use the mouse to become familiar with its functionality in the Model window

To measure three planes and view the measured features of the OGP FastStart training part in the Model window, complete the steps below.

1. Open the routine **yourname2.mxi**.

2 Perform a manual setup (if necessary). If you don't remember how to do this, see Exercise 1A.

3. **Run** the routine to verify that the setup was done properly and that the initial steps were created properly.

4. Click on the **Model** tab to display the Model window with the actual features (default).

5. Click on the **Fit to Window** icon in the Model window toolbar if the entire part is not displayed in the Model window.

6. Click on the **Points** icon to turn on the Points. Notice that all of the measured data points now appear as white plus (+) signs.

7. Turn off the Points icon, and turn on the **Nominal** icon. Notice that the features that contain nominal and tolerance information appear as dark blue.

8. Turn off the Nominal icon. Then toggle the **Actuals** icon off and back on.

9. Click on the **Isometric View** icon to look at a 3D view of the part and click on the **Next View** icon repeatedly to toggle through all of the 2D views. Note that all of these functions performed by the icons may also be accessed by clicking the **View / Model** submenu.

10. Click on the **Top View** icon.

11. Place the cursor in the Model window and:

    - Press and hold the **Left** mouse button to zoom in and out.
    - Hold the **Shift** key and zoom on a specific feature by placing the cursor to near the feature and then holding the button down and dragging the cursor diagonally around the feature.

12. Place the cursor in the Model window and hold the **Middle** mouse button to move the entire Model.

13. Click on the **Fit to Window** icon to redisplay all the features.

14. Place the cursor in the Model window and hold the **Right** mouse button to rotate the entire Model.

15. Click on the **Top View** icon.

16. Click on the **View Feature** icon. You may also need to click on the Fit to Window icon if the feature does not appear in the Model window.
    - Select the lower-left hole in the Model window.
    - The software displays a prompt for moving the stage. Click **OK**.
    - The software moves the stage and displays the selected feature in the Image window and the step in the Measurement window.

17. You do not need to save the routine because you did not add any new steps or make any changes to the routine.

This completes Exercise 3.

Session 6

Editing and Adding Steps in a Routine

The purpose of this session is to learn how to:

- Use the Edit functions to make changes in a routine
- Include nominal values and tolerances when editing steps
- Measure features based on a new datum

For more information about the Edit functions, see:

- Edit Functions topic in the Measure-X on-line Help
- Section 12 in the *Measure-X Reference Guide*
- Section 13 in the *Measure-X Fast Start Guide*

For more information about creating a bolt circle, see:

- Bolt Circle topic in the Measure-X on-line Help
- Section 9 in the on-line Help and the *Measure-X Reference Guide*
- Section 10 in the *Measure-X Fast Start Guide*

Session Objectives

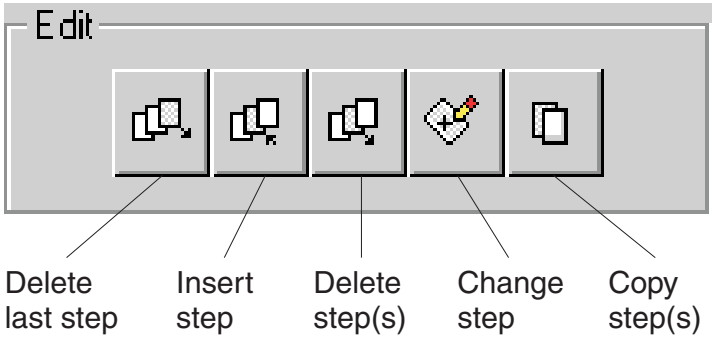
After completing this session, you will be able to:

- Add, change, insert, delete and copy steps in a routine
- Define a new datum in the routine
- Add measurements based on the new datum
- Construct a bolt circle

Using Edit Functions in a Routine

The Edit functions are used to edit and make changes to the current Measure-X routine.

Use the Edit icons in the toolbox or the Edit menu to access the Edit functions.



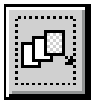
Tips

1. When you finish editing a routine in any way, it is strongly recommended that you run the routine to verify that the changes were made correctly.

2. The last step of the routine is displayed in all the Edit dialog boxes that appear in the Measurement window.

Delete the Last Step

This function deletes (removes) the last step that was entered in the routine.



When you select **Delete Last Step** in the Edit menu or click on the toolbox icon, the system displays a confirmation prompt and verifies the step number.

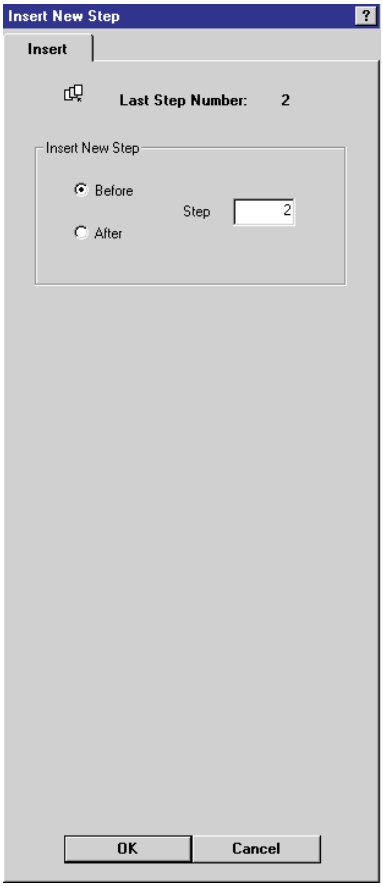
You can use this function more than once; each time you select it, the last step is removed.

Insert a Step

You can insert a step anywhere in the routine. The software **increments** the step numbers that follow.

To insert a step:

1. Click on the **Insert** toolbox icon. A prompt for the step number appears and the Model window is displayed.



2. Choose whether the step(s) should be inserted before or after (default) the current step.

3. Specify the step number in one of the following ways:
   - If you know the step number, type it in the **Step** field.
   - If you don't know the number, click on a feature in the model. That feature's step number appears in the field. Continue doing this until you find the feature **before** which you want to insert the new step. If multiple features appear in the same location, the software displays a menu where you can select the desired step.

4. Click on **OK**. The system will wait for you to measure or construct a feature.

5. Measure or construct the desired feature and click on **OK**. This inserts the feature in the selected step and ends the insert mode.

If you click on **Cancel**, only the measurement is removed; the insert mode is still active.

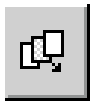
If you clicked on the Insert icon in the toolbox, it remains depressed to indicate that the insert mode is active.

If you wish to continue the insert mode and insert another feature, click on **Again** instead of OK. This displays the same type of measurement that was just done. Then measure or construct the next feature. You can continue to insert different types of features until you select OK.

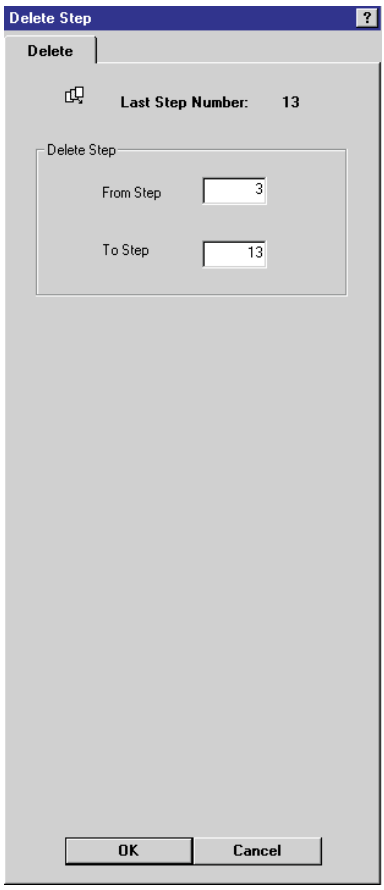
Delete a Step

You can delete one or more steps anywhere in the routine. The software **decrements** the step numbers that follow.

To delete a step:



1. Click on the **Delete** toolbox icon. A prompt for the step number(s) appears in the Measurement window and the **From Step** field becomes active. The model is also displayed.



2. Specify the beginning step number in the first field in one of the following ways:
   - Type the desired step number.
   - Click on the desired feature in the Model window. That feature's step number appears in the field. If you select the wrong feature, you can continue to select features until the desired step number appears. If multiple features appear in the same location, the software displays a menu where you can select the desired step.
3. If you want to delete only one step, leave the second field empty and go to Step 5.
4. If you wish to delete two or more steps or a range of steps, repeat Steps 2 and 3 for the ending step number in the **To Step** field.
5. Click on **OK**. The software displays a confirmation message showing the steps to be deleted.
6. Click on **OK** to delete the feature(s) or Cancel to quit the deletion.

Important

1. Be careful about deleting a feature that was used as part of a constructed measurement. If the deleted measurement is a component of a constructed feature, and the constructed feature becomes invalid, the software displays a message indicating the other constructed steps that may be deleted or modified.
2. Be very careful about deleting a step that contains a datum. This could make other measurements become invalid.

Edit (Change) a Step

You can change the measurement or construction in an existing step in different ways. For example, you can:

- Add, change or remove points or constructions that were used to build a feature
- Re-measure or change the feature using different tools, targets, units, magnification, or light settings
- Add, change or remove nominal values and tolerances for a feature
- Change the output choices and destinations in the Measurement window

To change a step:

1. Start in **one** of the following ways:
   - **Click on the feature** in the Model window. The system displays the measurement window for that feature; it also displays the video image if the feature was measured. Go to Step 4.
   - Click on the **Change** toolbox icon. A prompt for the step number appears and the Model window is displayed.

2. Specify the step number in the **Step** field in one of the following ways:
   - Type the desired step number in the field.
   - Click on a feature in the model. That feature's step number appears in the field.

3. Click on **OK**. The system displays the measurement window for that feature; it also displays the video image if the feature was measured.

4. Change the feature as desired, just as if you were creating the step.

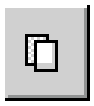
5. Click on **OK**.

If you wish to quit the change mode, click on Cancel.

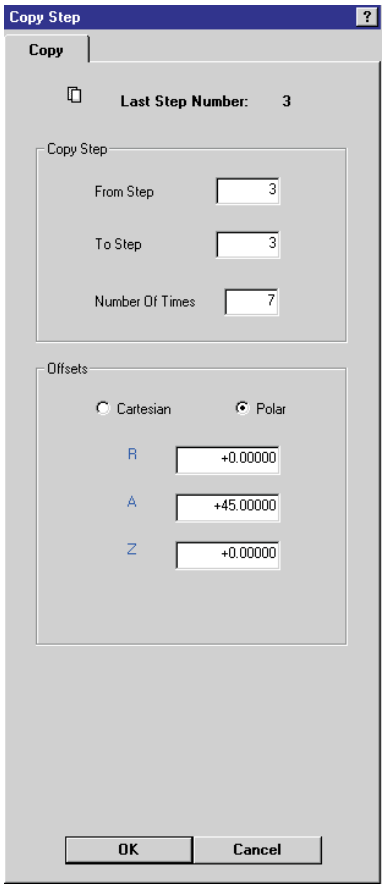
Copy a Step

If a part has many features with the same characteristics (geometry, size, tolerance, output, etc.), you can use Copy to quickly add the features to your routine. You can copy one or more steps at a time.

To enter the step numbers and copy the feature(s) one or more times:



1. Click on the **Copy** toolbox icon. Copy fields appear in the Measurement window and the model is displayed.



2. Specify the Start and Stop step numbers in **one** of the following ways:
   - Type the desired step numbers in the applicable fields.
   - Click on a feature in the Model. That feature's step number appears in the **From Step** field. Put the cursor in the **To Step** field and repeat this for the "To Step."

3. Put the cursor in the **Number of Times** field and type the number of times the feature is to be copied. They must be copied at least once.

4. Click on the desired radio button to select **Cartesian** (default) or **Polar** coordinates. For example, if you will specify an angular offset, click on Polar.

5. Enter an offset (XYZ or RAZ coordinate or angle). If you do not specify an offset, zeros are assumed. Offsets are added to data point locations of copied features and to nominal coordinates. All the offsets are relative to the **current** datum setup.

6. Click on **OK**.

The software displays a confirmation message showing the steps to be copied.

7. Click on **Yes** to copy the feature(s). The software displays the copied features in the model.

No additional measuring or output occurs when you finish the copying. The measuring occurs when you run the routine.

Note The coordinates of copied steps are always based on the current datum origin.

Defining a New Datum (Moving a Datum)

When you create a routine, you can move the datum origin to another location by defining another datum origin. All the measurements that follow will be based on the new datum.

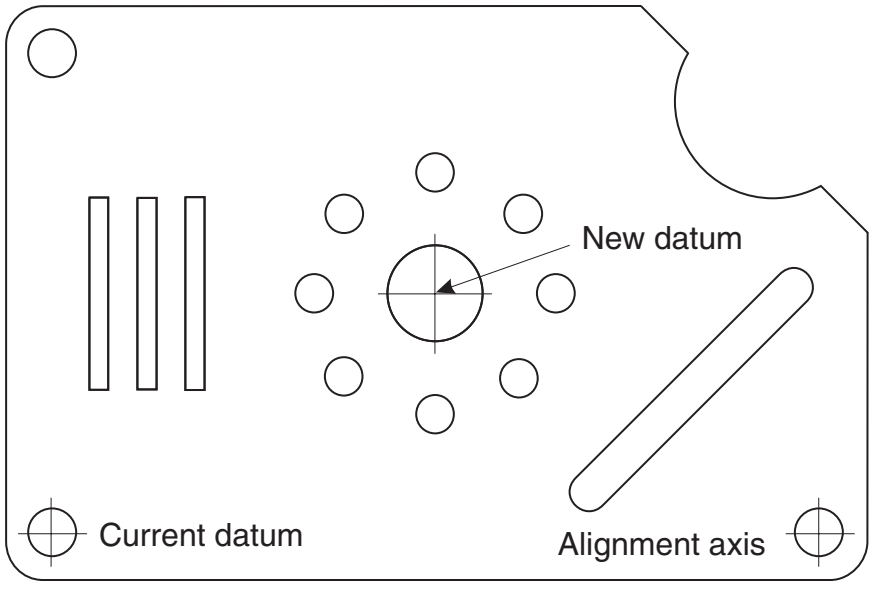
Use the following guidelines when you define a new datum.

- After you reset the datum origin, the coordinates of any features measured prior to the new origin are converted to the current coordinate system, which is based on the new datum origin. The **current** coordinates of these features are used in new calculations and constructions.
- If you plan to insert a new datum, add it at the end of the routine because any measurements that follow will be based on the new datum. If you insert the datum anywhere else, any existing measurements **may no longer be valid** because they were based on the previous datum.
- Datum definition is strongly recommended at the beginning of a routine.

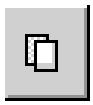
Example: Defining a New Datum to Create a Bolt Circle

The bolt circle consists of a large hole in the middle with eight smaller bolt holes that are equally spaced from each other and equidistant from the center of the large hole.

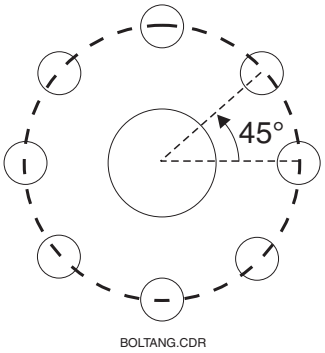
Since the locations of the smaller bolt holes are relative to the location of the large hole, it is much easier to create the bolt hole pattern when the holes are based on the distance and angle from the center of the large hole. To accomplish this, you need to define a new datum at the center of the large hole.



Using the Copy Function to Create a Bolt Circle



The **Copy** function is useful to measure features such as the holes that form the bolt hole pattern. For example, you can use this function to measure the eight smaller bolt holes that are equally spaced from each other and equidistant from the center of the large hole.



To create the bolt circle, you need to:

1. Measure the large hole.
2. Define a new datum based on the center of the large hole.
3. Measure one of the small holes near the large hole.
4. Copy the measurement of the small hole at an angular offset.
5. Construct the bolt circle in the Model window.

You will have the opportunity to define a new datum in Exercise 5.

Step Edit a Routine

The Step Edit option allows you to do interactive editing while running the routine. In step edit mode, the system steps through the routine in the way it was created. The routine pauses at every step or at each point in a step so that you can view the measurement results and make the necessary changes. You can:

- **Change** the current step, including individual points in a touch probe step
- **Insert** a feature after the current step
- **Delete** the current step

For example, to interactively change a step in step edit mode:

1. Select **Edit / Step Edit**. The software displays a Step Edit Run window with the starting and ending step numbers where you can specify the steps you wish to edit. The default is all the steps in the routine.
2. Specify the desired steps.
3. Make any desired change(s) in any of the ways described under Change Step.
4. Click **OK**. The software displays a Step Complete dialog box with Stop Run and Next Step buttons.
5. Click on Next Step to continue with step edit or on Stop Run to stop the run.

Exercise 4: Edit the Routine by Changing and Adding Steps

In this exercise you will:

- Open the routine that you created in the previous exercise.
- Change existing steps by adding nominal and tolerance values. **Refer to the print of the OGP FastStart training part for the nominal and tolerance dimensions**.
- Add steps to the routine by constructing distances, widths, and intersections.

To change and add steps in an existing routine, complete the steps below.

1. **Open** the inspection routine **yourname2.mxi**.
2. Use **Save As** to save this routine with the name **yourname3.mxi**.
3. Perform a manual setup in the same way as you originally set up the part.
4. **Run** the routine to make sure it runs without any problems.
5. **Change** the steps that measure the lower-left and lower-right holes, and add nominal values and tolerances for these steps.
6. **Save** the routine.
7. **Construct** the following **distances,** include the appropriate nominal and tolerance information and print the following dimensions:
   - A: Horizontal distance between the lower-left and lower-right holes.
   - B: Vertical distance between the lower-left and upper-left holes.
8. **Construct** the **intersection** between the top edge and the slanted edge.
9. **Construct** the following **widths**, include the appropriate nominal and tolerance information, print the following dimensions:
   - C: Between the lower-left hole and the left edge.
   - D: Between the lower-left hole and the bottom edge.
   - E: Between the top and bottom edges.
   - F: Between the left and right edges.
   - G: Between the intersection from Step 8 and the left edge.
10. **Save** the routine and then **run** it, viewing the measured results in the Print Data tab.
11. Open a **new** routine (this clears the routine in momory).

Exercise 5: Edit the Routine by Moving the Datum Origin and Copying Steps

In this exercise you will edit the routine that you created in the previous exercise and:

- Measure and construct the large hole in the center
- Construct a new XY datum origin
- Measure the bolt holes
- Reset the XY datum origin
- Measure the rectangular slots

Refer to the print of the OGP FastStart training part for the nominal and tolerance dimensions.

To construct a new datum origin and a bolt circle, complete the steps below.

1. **Open** the inspection routine **yourname3.mxi**.
2. Use **Save As** to save this routine with the name **yourname4.mxi**.
3. Perform a manual setup in the same way as you originally set up the part.
4. **Run** the routine to make sure it runs without any problems.
5. Measure the large hole in the center by measuring segments in separate steps.
6. **Construct** a **Circle** from the measured segments of the large hole.
   - Click the **Composite** check box and print it's minimum diameter and X and Y location.
   - Specify the nominal values for the diameter and XY location.
   - Specify **0.004** for the **Position** tolerance.
7. **Construct** an **XY Datum Origin** on the large center hole.
8. Measure the small hole just to the right of the large hole. Add the nominal value for the diameter and print the diameter.
9. **Copy** the circle from Step 8 above, seven times to create the rest of the bolt circle. Remember to:
   - Change the units to **Polar** coordinates.
   - Enter an **angle** offset of 45°.
   - Click on **OK**.
10. Reset the XY datum origin to the lower-left hole.

11. Measure the four edges of the **right** rectangular slot.

12. **Copy** the measurements of the rectangular slot edges to create the other two slots. Specify **2** times with an X offset of **- 0.125** inches.

13. **Construct** the following **widths** using the rectangular slots, include the appropriate nominal and tolerance information, print the following dimensions:

    - H: Between a bottom edge of a slot and the lower-left hole
    - I: Between the left edge of the left slot and the lower-left hole
    - J: Between the top and bottom edge of a slot
    - K: Between the left and right edge of a slot

14. **Run** the routine to make sure it runs without any problems and view the printed results in the **Print Data** tab.

15. **Save** the routine.

This completes Exercise 5.

Challenge Exercise 3: Edit the Routine by Measuring Additional Features

In this exercise you will edit the routine that you created in the previous exercise and insert and add steps to the routine by measuring the rounded slot and constructing widths.

Refer to the print of the OGP FastStart training part for the nominal and tolerance dimensions.

To measure and construct additional features, complete the steps below.

1. **Open** the inspection routine **yourname4.mxi** if it is not already in memory.

2. Perform a manual setup in the same way as you originally set up the part.

3. **Run** the routine to make sure it runs without any problems.

4. Insert the measurement of the rounded slot **before** the first rectangular slot.
   - Select the **Insert** mode and specify the first step of the right rectangular slot.
   - **Measure** the straight edges first. Remember to click on the **Again** button to keep the Insert mode active.
   - Click on **Insert** again, specify the last straight edge and click on **After.**
   - **Measure** the rounded corners; include the radius nominal and tolerances.

5. **Construct** the **width** between the rounded corners and specify a tolerance for the width. Hint: The **Maximum Width** of the slot is 0.875 inches.

6. **Construct** the following **distances**, include the appropriate nominals and tolerances, and print the dimensions below:
   - L and M: Horizontal (X) and vertical (Y) distances between the lower-left hole and the center of the slot
   - N and Q: Horizontal (X) and vertical (Y) distances between the lower-left hole and the center of the large hole
   - O and P: Horizontal (X) and vertical (Y) distances between the lower-left hole and the center of the large arc

7. **Construct** the bolt circle.

8. **Run** the routine to make sure it runs without any problems and view the printed results in the Print Data tab.

9. **Save** the routine.

Session 7

Run Options and Measurement Output

The purpose of this session is to learn how to:

- Run a routine with various run options and overrides
- Measure more than one part with the same routine
- Send measurement output to a printer and statistics file

For more information about the Run options, see:

- Run Options and Run Override Options topics in the Measure-X on-line Help
- Section 10 in the *Measure-X Reference Guide*
- Section 11 in the *Measure-X Fast Start Guide*

For more information about measurement output, see:

- Measurement Output Options and Destinations topic in the Measure-X on-line Help
- Section 11 in the on-line Help and the *Measure-X Reference Guide*
- Section 12 in the *Measure-X Fast Start Guide*

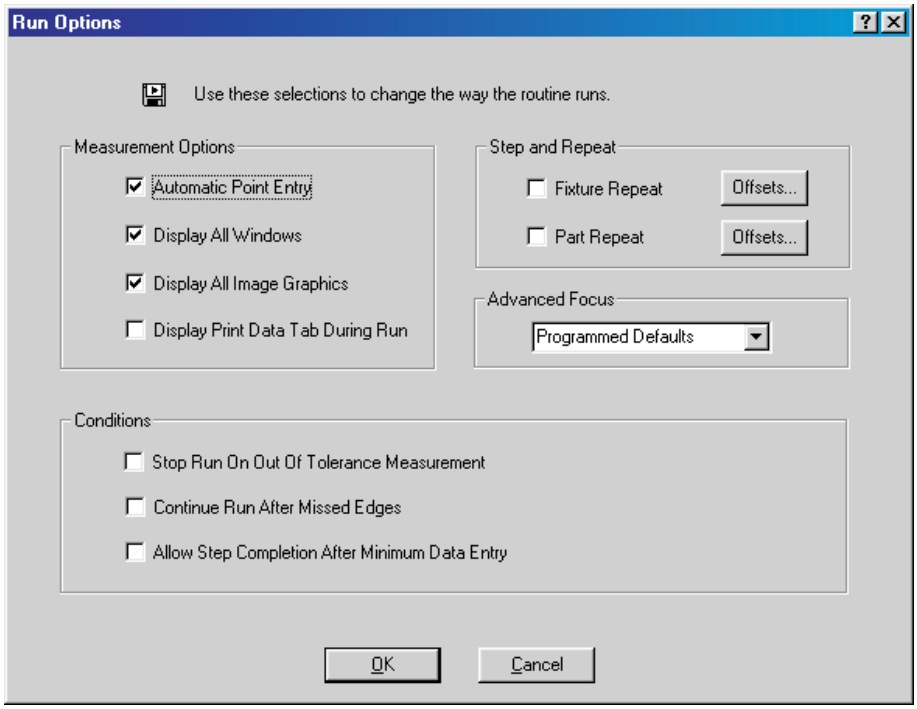
Session Objectives

After completing this session, you will be able to:

- Select specific routine run options
- Specify routine run overrides
- Use the same routine to measure two training parts
- Send selected measurements to the printer
- Specify the destination of the statistical data output
- Create a statistics template and view the statistical data output

Run Options

Select **Part Setup / Run Options...** to specify certain settings when you run the routine.



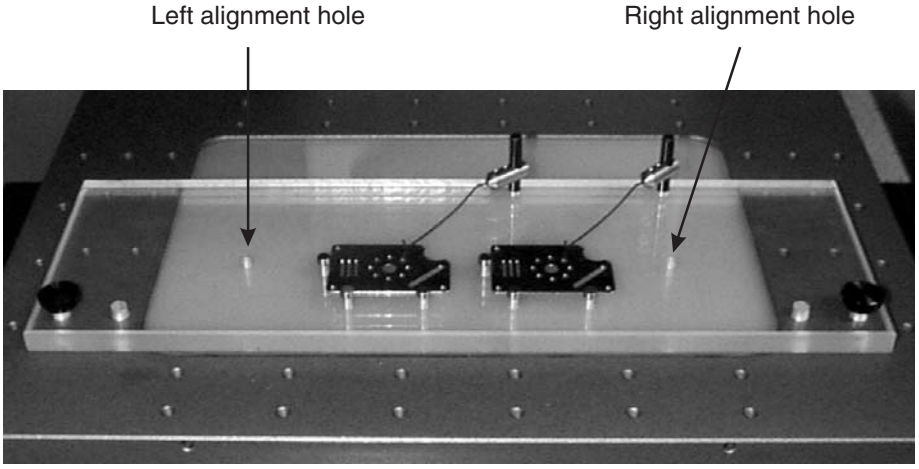
Each option has a box next to it. Click on the box to select and activate that option. Click on the box again to deactivate it. You can select as many options as you wish.

- **Automatic Point Entry.** This activates the automatic entry of Strong Edge and FeatureFinder points.
- **Display All Windows**. This allows you to display or not display the Measurement and Model windows during the routine run.
- **Display All Image Graphics**. This allows you to display or not display the tool graphics in the Image window during the routine run.
- **Display Print Data Tab During Run**. This displays the print data output in the Image window area during the run. If a measured feature fails, the software will display the Image window until the step is completed and then it will redisplay the print data output.
- **Advanced Focus**. This allows you to use the same run time method for all features that were measured with Advanced Focus. This option is not saved with the routine and it is reset when a new routine is created or a routine is opened.
- **Stop Run On Out of Tolerance Measurement**. If this option is checked, the system stops the run if a feature is out of tolerance.
- **Allow Step Completion After Minimum Data Entry**. This option is used for measurements done with Strong Edge. It allows you to end the measurement during the run after the software has processed the minimum number of points for the feature.
- **Continue Run after Missed Edges**. This option instructs the software not to display any message and wait for user input when the software encounters a missed strong edge, or a focus fails during the run of the routine. The software continues with the next point in the feature. For missed weak edge features or points, the system prompts the user to change the run to Step Edit.

With Step and Repeat, you can select either one of the following options:

- **Fixture Repeat**. This can be used to measure up to 24 additional parts that are mounted in a fixture (the parts do not need to be spaced evenly). The fixture may have empty cavities and uneven offsets. The offsets are from the original part.
- **Part Repeat**. This option contains two offset entries (X and Y) to measure equally spaced parts in a fixture. The offsets are from the original part. If the Confirm Next Part option is on, the routine stops after measuring a part. You can stop the run or continue to run to measure the next part.

Manual Setup on a Fixture



With this method you can use manual targets to locate features on the fixture rather than on the part itself. Using a fixture provides the following benefits:

- You can mount and measure more than one part in a multi-part fixture
- You can create one routine and **use the Part Repeat and Fixture Repeat run options** to measure multiple parts with only one manual setup.
- You don't need to stage and set up the part each time it is placed in the fixture.

A manual setup is required when the fixture is mounted or moved, if you have exited from Measure-X, or if you have reset the system.

To perform a manual setup on a fixture:

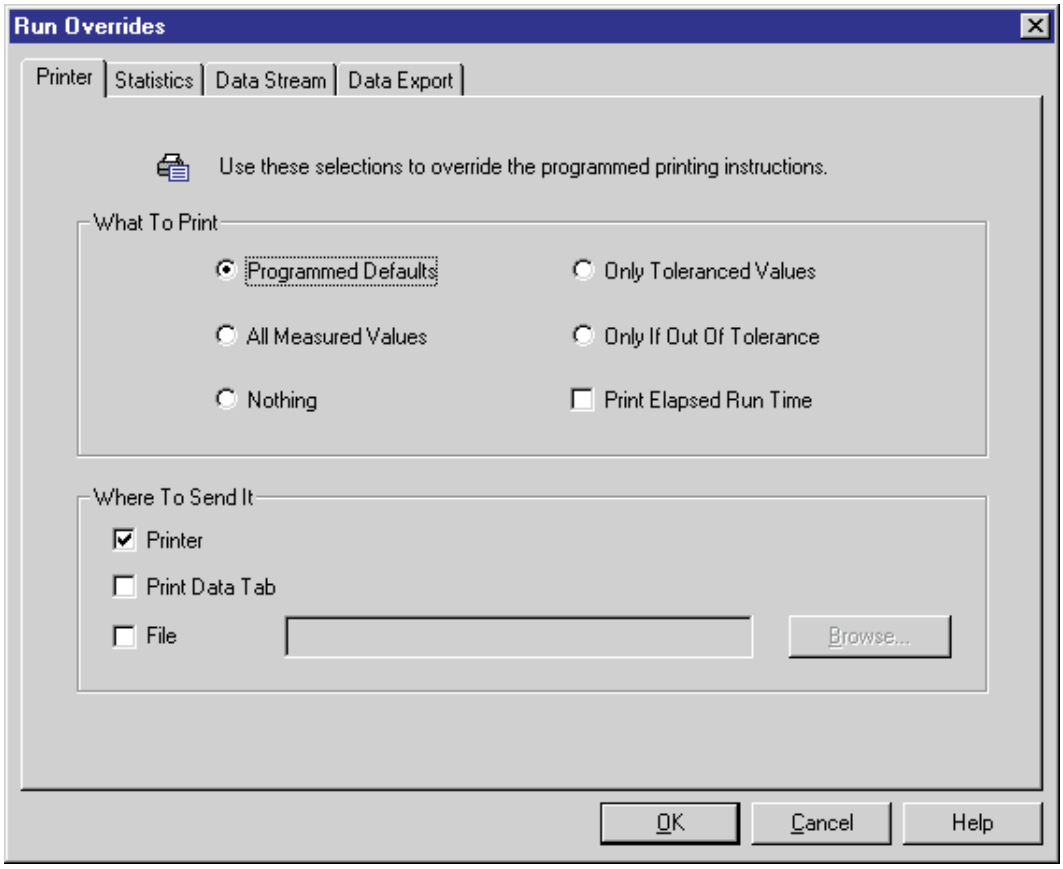
1. Secure the part(s) in the fixture and mount the fixture on the stage.
2. Locate two features on the fixture that can be used for the XY origin and the axis alignment. For example, you can use the two alignment holes on the OGP training fixture.
3. Identify the best manual alignment targets to be used for the manual setup, e.g., the Circle target for the alignment holes on the OGP training fixture.
4. Manually define the part XYZ origin on the left alignment hole and the axis alignment on the right alignment hole.

Run Override Options

Select **Part Setup / Run Overrides** to display a dialog box with tabs for different run override options. They override the current settings for the dimensions or measurements in the individual steps.

Click on the desired tab to display the overrides for that category:

- **Printer**. Overrides any Print settings for the dimensions or measurements in the individual steps.
- **Statistics**. Overrides any Statistics settings for the dimensions or measurements in the individual steps.
- **Data Stream**. Overrides any data stream settings for the dimensions or measurements in the individual steps.
- **Data Export**. Overrides any Data Export settings for the dimensions or measurements in the individual steps.



Example: Printer Override Options

You can select any of the following printer override options, as shown in the dialog box on the previous page. The selected values will be output to a printer **or** file, depending on whether **Print to File** is checked.

- **Programmed Defaults**. This uses the Print settings in the routine steps.
- **All**. All dimensions and measurements are sent to the printer, even if they are not selected in a step.
- **Nothing.** No dimensions or measurements are sent to the printer (or file), even if they are selected in a step.
- **Only Toleranced Values**. Only those dimensions and measurements that have nominals and tolerances are sent to the printer.
- **Only if Out of Tolerance**. Only those dimensions and measurements that are out of tolerance are sent to the printer.
- **Print Elapsed Run Time**. If this option is checked, the software prints the elapsed time for the run of the routine.

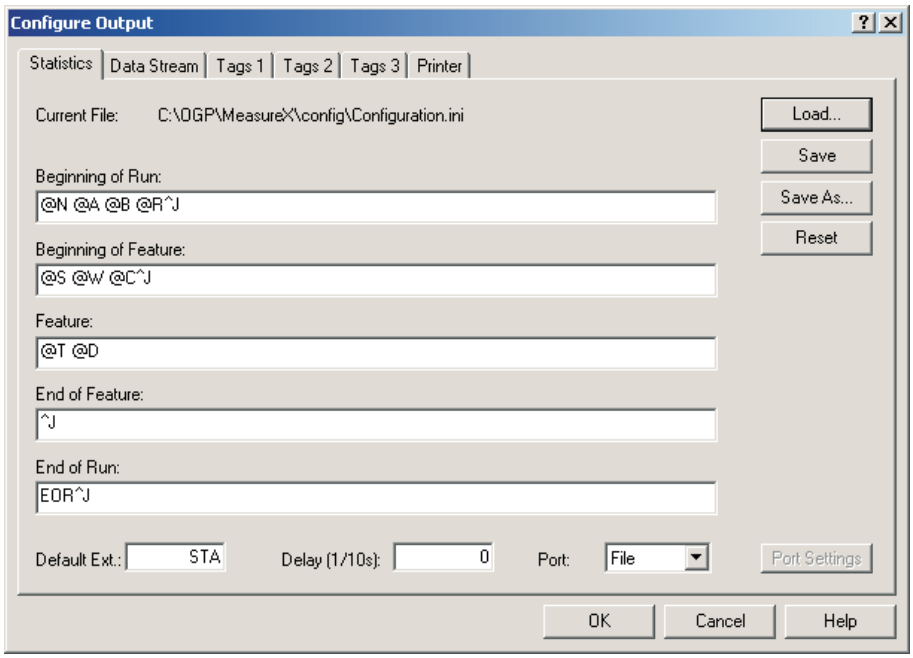
You can specify up to three destinations for the print data (when you select dimensions and click on the Printer icon in the step):

- **Printer** (this is the default setting).
  - When you are creating or editing a routine or the routine is in step edit mode, the checked dimensions are sent to the Print Data Output.
  - When you run the routine, the checked dimensions are sent directly to the printer and printed when the run is completed.
- **Print Data Tab**. The checked dimensions are sent to the Print Data Output, which is the displayed in the Image window area when you click on the Print Data tab.
- **Print to File**. This overrides the printer. Any values checked for Print are sent to a file rather than to the data printer.
  - When you check this box, you can type the name of a new or existing file. The default file type is PRT. If you click on the Browse button, the software displays the standard “Save As” dialog box where you can change the path and file name.
  - The software overwrites the data if you use the same file each time you run the routine.
  - The override is turned off whenever you select System / Reset, File / New, or File / Open.

The system checks to make sure that the data is sent to the file. If data cannot be sent, it displays a Retry confirmation message.

Configuration of Statistical Output

This option allows you to configure the format and destination of the statistics output. To display or change the statistics output configuration, select **System / Configuration / Output** and click on the **Statistics** tab.



The name of the file from which the configuration is loaded is shown at the top. This can be either:

- The default configuration, which is defined in the Statistics section of the CONFIGURATION.INI file. You can use the default configuration with any routine that you create. The software loads the defaults into temporary memory when you start creating a new routine.
- The configuration that you have defined and saved in a separate file. Each routine can have its own statistics output configuration file. Different routines can also share the same statistics configuration data file.

You can also configure the following:

- The **default file name extension** for the statistical data, which is TXT. If you wish to change it, highlight the extension and type the desired extension.
- **Delay**, which is used to pause the system **after** the statistics value has been transmitted to allow additional processing time. The value entered is in tenths of seconds. For example, to add a 30 second delay, enter 300.
- **Destination**, which can be a file or output device connected to a serial port.

The dialog box also displays:

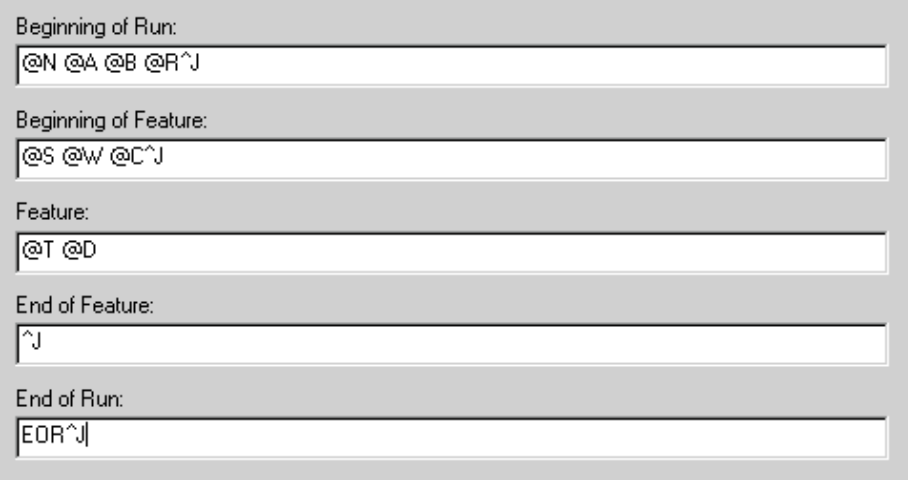
- Buttons to **load, save** and **reset** the statistics configuration templates.
- Buttons to access the **tags** windows where you can format the data so that you can read the results and the data is compatible with your data collector.

The **names** of both the template file (.CFG) and the statistics data file (.TXT) are stored as part of the Measure-X routine file when you save the routine.

Statistics Configuration Template

Measure-X outputs measurement results in ASCII form. Five templates control the form and content of the statistics and data stream output. Each template has a maximum length of 80 characters.

To display the templates, click on the **Statistics** tab in the **System / Configuration / Output** dialog box.



The templates format the statistics data as described below. The default templates are shown below each description. The meaning of each letter is described under the **Output Characters** topic in the *Measure-X Reference Guide*.

- The **Beginning of Run** template formats the header for the statistics report.
  - @N @A @B @R^J (output routine name, date, time, run number)
- The **Beginning of Feature** template indicates the data to appear at the beginning of the feature. The default is a blank template. An example is shown below.
  - @W @S^J (output the feature name)
- The **Output** template formats the output for each measured feature.
  - @T @D^J (output the tag and actual data)
- The **End of Feature** template indicates the end of a specific feature.
  - EOM^J
- The **End of Run** template indicates the end of a specific run.
  - EOT^J

The two characters, @ and ^, are used together with letters to specify action:

- @ followed by a letter is a command to output a specific piece of information
- ^ followed by a letter outputs a control character such as carriage return or line feed

Note See the **Output Characters** topic in the on-line Help for output character details.

Exercise 6: Run the Routine with Run Options and Overrides

In this exercise you will:

- Open the routine that you created in the previous exercise
- Run the routine with selected run options
- Run the routine with selected overrides

To run the routine with selected options and overrides, complete the steps below.

1. **Open** the inspection routine **yourname4.mxi**.
2. Use **Save As** to save this routine with the name **yourname5.mxi**.
3. Perform a manual setup in the same way as you originally set up the part.
4. **Run** the routine to make sure it runs without any problems.
5. Clear the **Print Data** window (use the "eraser" icon in the toolbar).
6. Select the **Only Toleranced Values** and **Print Elapsed Run Time** Printer Override options and **run** the routine.
7. View the measurement results in the **Print Data** window.
8. Run the routine with the **Display All Windows** and **Display All Image Graphics** options set to **Off**. Hint: See the Part Setup / Run Options window.
9. Run the routine with the **Stop Run on Out of Tolerance** option **On**.
10. Reset the **Run Options** to their defaults.
11. **Save** the routine.

This completes Exercise 6.

Exercise 7A: Measure Four OGP Training Parts with the Part Repeat Option

In this exercise, you will:

- Mount four OGP FastStart training parts in a fixture
- Perform a manual setup on the features of one of the parts
- Measure the parts using the Part Repeat run option

To measure four OGP FastStart training parts with the Part Repeat option, complete the steps below.

1. Mount the fixture on the stage where the bottom edge of the fixture is in the middle of the stage.

2. Secure all the OGP FastStart training parts in the fixture.

3. **Open** the inspection routine **yourname5.mxi**.

4. Click on the **Run** icon, but do not run the routine.

5. Perform a manual setup on the **part in the lower-left cavity** in the same way as you originally set up the part.

6. Run the routine to measure the part.

7. Select the **Part Repeat** run option.
   - Enter an X offset of 3 inches.
   - Enter 1 for the Number of Times.
   - Enter a Y offset of 2.5 inches.
   - Enter 1 for the Number of Times.
   - Select Repeat X Offset first.

8. **Run** the routine to measure the parts. Notice that you can measure other copies of the same part using the same routine. Also, in this case, you do not need to redo the part setup because the part setup was done on the first part and all parts are in a secured fixture.

9. Do **not** save this routine.

This completes Exercise 7A.

Exercise 7B: Measure Three OGP Training Parts with the Fixture Repeat Option

In this exercise, you will:

- Mount three OGP FastStart training parts in a fixture and leave one cavity open
- Perform a manual setup on the features of one of the parts
- Measure the parts using the Fixture Repeat run option

To measure three OGP FastStart training parts with the Fixture Repeat option, complete the steps below.

1. Make sure that the fixture is mounted on the stage securely.

2. Secure three OGP FastStart training parts in the fixture, leaving the upper-left cavity empty.

3. **Open** the inspection routine **yourname5.mxi**.

4. Click on the **Run** icon, but do not run the routine.

5. Perform a manual setup on the **part in the lower-left cavity** in the same way as you originally set up the part.

6. Run the routine to measure the part.

7. Select the **Fixture Repeat** run option.
   - For the first offset, enter an X offset of 3 inches.
   - For the second offset, enter an X offset of 3 inches and a Y offset of 2.5 inches.
   - For the third offset, enter a Y offset of 2.5 inches.
   - Click in the check boxes **only next to the first two offsets**; do **not** check the box next to the third offset.
   - Select **Confirm Next Part**.

8. **Run** the routine to measure the parts. Notice that you can measure other copies of the same part using the same routine. Also, in this case, you can skip cavities that do not contain any parts.

9. Do **not** save this routine.

This completes Exercise 7B.

Challenge Exercise 4: Measure Parts with an Existing Routine and a Different Part Setup

In this exercise, you will:

- Perform a manual setup on the features of the fixture
- Edit an existing routine so that it will run with a different part setup
- Measure multiple parts using the Fixture Repeat run option

To perform a setup on fixture features, edit the routine, and measure multiple parts with the Fixture Repeat option, complete the steps below.

1. Secure three OGP FastStart training parts in the fixture, leaving the **upper-right cavity empty**.

2. **Open** the inspection routine **yourname5.mxi**.

3. Select **Edit / Step Edit** and select all steps of the routine, but do **not** run the routine yet.

4. Perform a manual setup using **features on the fixture**.
   - Do the manual Z setup on the edge of the left alignment hole of the fixture at low magnification.
   - Do the XY setup zero location and the X axis alignment on the alignment holes of the fixture.

5. Enter the setup instructions.

6. Step edit through the **first six steps** of the routine.
   - In each measurement step (1, 3, 5) click on the **Delete Points** button so you can re-measure the feature at the new location. Notice that if you wish to use an existing routine when the part setup is done on different features, e.g., of the fixture, you must edit the datum steps in the routine.
   - After step editing through the first six steps, click on **Back to Run** in the confirmation prompt and run the routine to measure the first part.

7. Click on the **Run** icon and select the **Fixture Repeat** run option.
   - Click in the check boxes next to the **first** and **third** offsets and specify the respective offsets (see Step 7 in the previous exercise).
   - Select **Confirm Next Part**, if it is not already selected.

8. Run the routine to measure all the parts.

9. Do **not** save this routine.

Challenge Exercise 5: Send Measurement Output to a Statistics File

In this practice session you will:

- Specify the destination of the statistical data output
- Create a statistics template
- View the statistical data output in a Microsoft Excel spreadsheet.

To run the routine and output data to a statistical file, complete the steps below.

1. **Open** the inspection routine **yourname5.mxi**.

2. Click on the **Run** icon, but do not run the routine.

3. Perform a manual setup on the **part in the lower-left cavity** in the same way as you originally set up the part.

4. **Run** the routine to make sure that it runs without any problems.

5. **Change** the **three steps** that measure the lower-left, lower-right and upper-left holes to send the diameter to Stats in each step. Also specify the name of the statistics file as **fstart.txt**.

6. Select **System / Configuration / Output** and click on the **Statistics** tab to create a statistics template so that only the diameters are output.
   - Create a Feature template with **@W,@S,@T,@D,@E,@J^J** in the Feature field. This is the only field with data in it.
   - Save the template **as fstart.cfg**.

7. **Run** the routine.
   - Make sure that the Statistics Override setting is Programmed Defaults.
   - Check the box for **Keep Same File Name** and specify the folder and name of the statistics file: **fstart.txt.**

8. **Run** the routine a second time.

9. View the measurements sent to the stats file in an Excel spreadsheet.
   - Open a blank Excel spreadsheet and then open **fstart.txt**.
   - Select **Delimited** and **Comma** in response to the prompts.
   - View the data in the spreadsheet. Notice the output from both runs.
   - Close the spreadsheet and exit from Excel.

10. Do **not** save this routine.

Session 8

Other Useful Measure-X Functions

The purpose of this session is to learn about other useful Measure-X functions that may not be used every day.

Session Objectives

After completing this session, you will be able to:

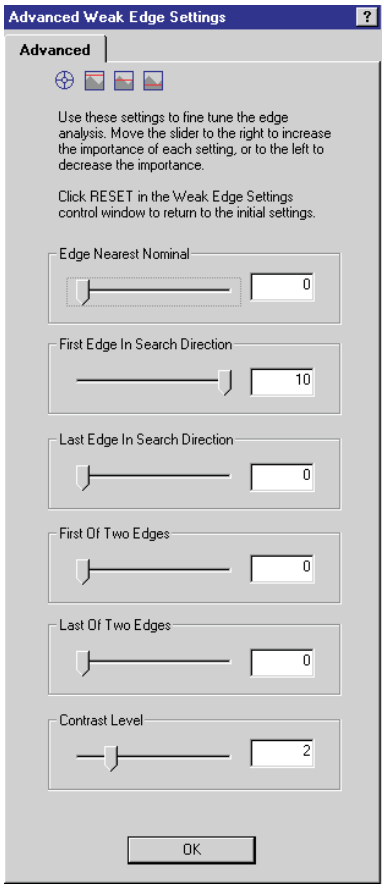
- Use advanced weak edge parameters with the weak edge analysis tools
- Evaluate focus measurements using basic focus diagnostics
- Evaluate weak edge measurements using basic weak edge diagnostics
- Change optics and sound settings in the System / Configuration menu
- Create an overlay of the video image
- Save a video image in a file and print the video image
- Print the model
- Measure a feature with the Edge Trace tool
- Extract data from a measured feature
- Measure a feature with the Centroid tool
- Use the Search function to find a measured feature
- Measure a feature and calculate a true position tolerance

Advanced Weak Edge Settings

The advanced weak edge settings indicate the relationship of an edge to neighboring edges. They are calculated when you first measure a point with FeatureFinder or Weak Edge Point.

To view and change the weighting factors, click on the **Advanced** button in the Weak Edge Settings window when a weak edge tool is displayed.

The sliders control the importance of the weighting factors in the edge analysis. A weighting factor is considered to be least important when you move the slider all the way to the left. The importance of the factor increases as you move the slider to the right.



The weak edge analysis uses the following advanced weak edge settings:

- **Edge Nearest Nominal** — Highly weights the edge that is closest to where you clicked and dragged the cursor or to the center of the search area. The measured edge is considered the nominal until you enter X, Y and Z nominal values.
- **First Edge in Search Direction** — Highly weights the edge that is found first in the search area, going in the direction of the arrow.
- **Last Edge in Search Direction** — Highly weights the edge that is found last in the search area, going in the direction of the arrow.
- **First of Two Edges** — Highly weights the first of two edges that are very close to each other.
- **Last of Two Edges** — Highly weights the last of two edges that are very close to each other.
- **Contrast** — Highly weights the edge that has a contrast value closest to the value that was calculated during the initial measurement.

Note The most commonly-used advanced weak edge setting is First Edge or Last Edge depending on the direction of the dark-to-light search.

Select **System / Diagnostics / Basic** to display diagnostic tools in the Measurement window.

Focus Diagnostics

To display focus diagnostic graphics, click in the **Focus** check box.

When you use a Focus tool:

- Points are plotted in a bell-shaped contrast curve in a box in the lower-right part of the Image window to indicate the contrast level. The top of the curve displays the calculated Z axis position with the maximum contrast (sharpness). If the curve is oddly shaped, this may indicate that the contrast is not sharp or that an autofocus calibration may be necessary.
- Measured and calculated focus results appear in the upper-left portion of the Image window.

Weak Edge Diagnostics

To display weak edge diagnostics, click in the **Weak Edge** check box.

When you measure an edge with FeatureFinder or a Weak Edge Point tool, the weak edge measurement displays two sets of weak edge points:

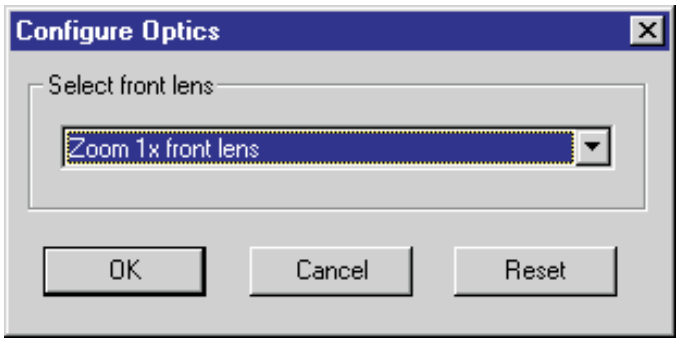
- The actual (selected) weak edge points, which are larger and have the same color as the tool
- All the other possible points that were used to calculate the actual weak edge, which are smaller and are shown with another color

You can then use the diagnostics, together with both the weak edge controls in the Weak Edge Settings window and the weighting factors, to measure the feature more accurately.

View and Change the Optics Settings

The base SmartScope Flare or Flash system is configured with no additional lens, i.e., only a 1x lens is built into the optics. The **Optics** option allows you to configure the lens attachment. This controls the magnification.

You must configure the additional lens **each time you attach or remove an add-on lens**. To do so, click on **System / Configuration / Optics** and select the lens attachment from the drop-down list.

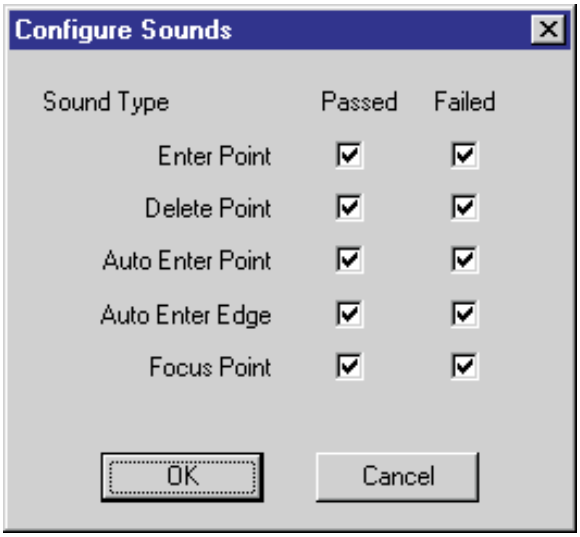


CAUTION The Reset button clears all the field of view and zoom lens calibration values for all lenses. If you click on Reset, **you must perform the zoom lens and field of view calibration for all lenses** before you can use the system.

Note The field of view calibration must be done anytime the optics configuration is changed.

View and Change the Sound Settings

Select **System / Configuration / Sound** to configure the audio signals that serve as a guide or warning during the measuring process.



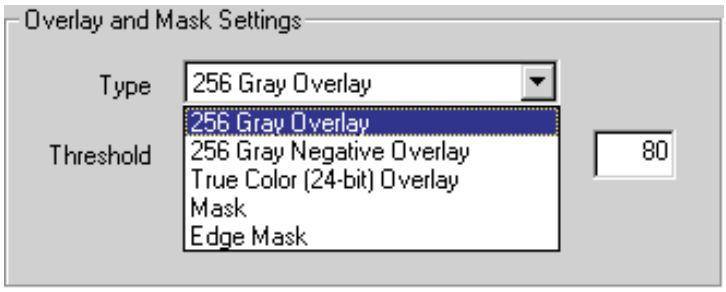
You can turn the sound On or Off for any listed action by clicking in the appropriate box to specify when the sound should occur.

- **Enter Point** is activated when you use a Measure function during the creation of a routine. You hear a high-tone beep when you press Enter to accept the point. You hear a low-tone beep if the entry of the point is not successful.
- **Delete Point** is activated when you remove a point from a measurement. You hear a low-tone beep when you remove a measured point successfully or when you try to remove a non-existent point.
- **Auto Enter Point** is activated when you use the Weak Edge tool while running a routine. You hear a high-tone beep each time a valid (pass) edge is encountered or a low-tone beep each time an invalid (fail) edge is encountered.
- **Auto Enter Edge** is activated if you used the Strong Edge tool while running a routine. You hear a high-tone beep each time a valid (pass) edge is encountered or a low-tone beep each time an invalid (fail) edge is encountered.
- **Focus** is activated when you use the Focus tool or you perform an Autofocus. You hear a high-tone beep for each pass condition or a low-tone beep for each fail condition. The same beep is used for either edge or surface focus.

Note Even if all the audio signals are Off, warning sounds are given if you use incorrect options or out of sequence operations, e.g., when you try to measure another feature before completing the current measurement.

Create an Overlay or Mask of the Video Image

An overlay or mask is a graphic representation of the live video image. When you create an overlay or mask, the video image is “frozen” and becomes a snapshot.



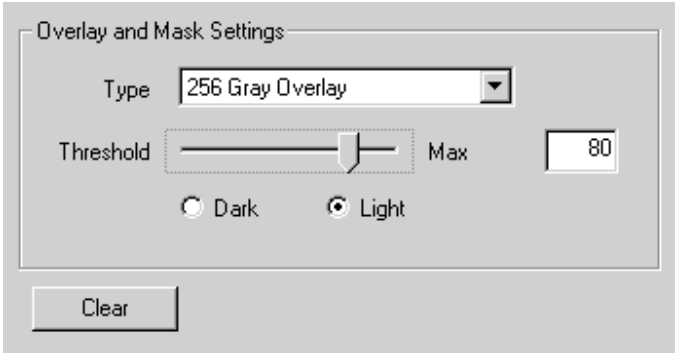
You can select the type of overlay or mask that you wish to create in the Overlay and Mask Settings window (select **View / Overlay and Masks**):

- **256 gray-scale overlay**. This creates an overlay using 256 shades of gray.
- **256 gray-scale negative overlay**. This inverts the gray-scale intensity of the overlay, e.g., it turns dark into light.
- **True color (24-bit) overlay**. This creates an overlay in 24-bit true color and displays it at the current screen display settings.
- **Target color overlay**. This creates an overlay using the current tool or target color.
- **Edge mask**. This displays the mask as an outline anywhere that a sharp contrast exists between light and dark. The edge mask uses the currently selected tool or target color.

After creating an overlay or mask, you can view the live image behind the overlay or mask for comparison purposes.

To create an overlay or mask of the video image:

1. Click the right mouse button in the tool settings window to display a list of windows that can be selected and use the left mouse button to select the Overlay and Mask Settings window.



2. Select the type of overlay or mask that you wish to use from the drop-down list.

3. Click on the desired radio button. These buttons are inactive for an edge mask.
   - If you select **Dark**, the overlay appears in the dark area.
   - If you select **Light**, the overlay appears in the light area.

4. Move the **Threshold** slider to set the light intensity threshold. The range is 0 to 100%. This slider is inactive for an edge mask.
   - If the Dark radio button is selected, any area that is darker than the threshold is digitized.
   - If the Light radio button is selected, any area that is brighter than the threshold is digitized.
   - The box next to the Threshold slider displays the percentage of the image that is dark or light. These percentages can also be used in the comparisons.

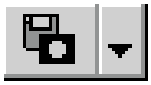
5. Place the cursor in the Image window and click the left mouse button to create the overlay or mask. An hourglass cursor is displayed until it is completed.

6. Move the stage (e.g., using the fine-adjust knob or right mouse button) to view the live image behind the overlay or mask and to make the desired comparisons.

If you do not see the live video image, adjust the Threshold slider, clear the overlay or edge mask, and repeat Steps 5 and 6.

7. Click on the **Clear** button to remove the current overlay or edge mask.

Save the Video Image



An image is typically saved as a reference for comparisons with other identical parts. For example, you can save an image of the master part or of a part with a known defect. You may also wish to archive images of measured parts for future use.

You can save the video image displayed in the Image window in the ways described below.

- **Live video image**. It can be saved in a bitmap (BMP), Tagged Image File (TIF), or 24-bit Targa (TGA) format. This is the default.
- **Live video image and any displayed tool or target**. It can be saved only in a bitmap (BMP) format.
- **Full screen**, including the image and any displayed tool or target. It can be saved only in a bitmap (BMP) format.

To save an image:

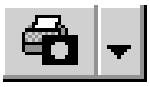
1. Click on the **arrow** next to the Save Image icon in the Image window controls and select the desired icon from the drop-down list. Each icon represents an option to save the video image.

2. Click on the selected **Save Image** icon to save the image in the selected format. A window pops up displaying the image files in the Routines folder or in the folder that was used last.

3. If you are saving a live video image, select the desired format.

4. Type a unique name for the image file. You can also change the folder if you wish. Then click on **OK** or press Enter. This freezes the video image and saves it in the designated file in the Routines folder or another folder that you may have specified.

Print the Video Image



This function allows you to print the image displayed on the screen to the printer that may be configured to the computer. The Windows print driver for the selected printer must be loaded before you can print the image.

You can print the video image in the ways described below.

- **Live video image** (this is the default)
- **Live video image and any displayed tool or target**
- **Full screen**, including the image and any displayed tool or target

The printed images are typically based on an 8 ½ x 11 format.

To print the screen or video image

1. Click on the **arrow** next to the Print Image icon in the Image window controls and select the desired icon from the drop-down list. Each icon represents a different print image option.

2. Click on the selected **Print Image** icon in the Image window controls. The image is immediately sent to the printer.

Print the Model

The printed images are typically based on an 8 ½ x 11 format.

To print the model, click on the **Print Model** icon in the Model window toolbar.

The software immediately sends the model to the currently selected printer, which can be local or on a network. If you have not selected a printer, the software displays the standard Print Setup window to select the printer.

Measure a Feature with the Edge Trace Tool

The edge trace tool enables you to measure many points on a line, arc, circle, Min/Max/Avg feature, or an irregular contour. When you use this tool, the software traces the edge from the specified start point to the specified end point using the dark-to-light rule or the direction that you specified.

The feature or contour does not have to fit entirely in the field of view; the stage will move automatically if required. Typically, the edge trace tool is used for the Measure Contour function and to measure circles and lines that are larger than the field of view because the measurement can occur in a single step.

To measure an edge with the **Edge Trace** tool, click on the icon in the toolbox.

You can trace an edge in the following ways:

- Specify the start point and activate the trace immediately. To do so, place the cursor on the desired edge and *double-click* the left mouse button quickly. The system traces the edge until it returns to the start point or reaches the maximum number of points.
- Specify a start point and an end point.
  - For the start point, place the cursor at the desired start point and click the left mouse button once. The software displays a dot with a box around it.
  - For the end point, place the cursor at the desired end point and click the left mouse button ***twice*** (or click on the **Trace** button) to activate the trace. You can either double-click the left mouse button or click the mouse button once and then place the cursor over the displayed dot and click the mouse button again.
  - If you wish to specify an end point that is not in the field of view, move the stage so that the desired end point location is displayed in the Image window.
- Specify the start point and end point as described above, and indicate the direction and size of the search area when the start point dot and box are displayed.
  - To change the size of the search area, place the cursor anywhere on the box, press and hold the left mouse button, and drag the box to the desired size. Then release the mouse button.
  - To indicate the direction, place the cursor over the start point dot, press and hold the left mouse button, and drag the rubber-band arrow in the direction that you wish the trace to go. Then release the mouse button.

For more information, see the *Edge Trace* topics in the on-line Help.

Extract Data from a Measured Feature

The data extraction function enables you to construct a feature from a subset of points taken from one or more measured reference features or composite features.

You can select one or more subsets in a reference feature in the Model window. You can select subsets from one feature or multiple features. Each subset is considered a "feature" and increments the Features counter in the constructed step.

Typically data is extracted from features that have many points. For example, it is common to construct lines and circles from contours that were measured with an Edge Trace or Laser Scan tool.

To extract data from one or more reference features, follow the steps below. It is assumed that you have measured a feature that has many points, e.g., Contour.

1. Select the feature that you wish to construct, e.g., Circle. The software displays the Model window.

2. Decide which features you wish to extract. This will affect how they are extracted. For example:
   - Use **Control-Clicks** (press and hold the Control key and click the mouse button at the same time) in pairs to extract data points in subsets.
   - Use one click on a feature to extract all the data points in that feature.
   - Make sure that you extract the subsets in the same order (direction) in which the points were specified, e.g., left to right, clockwise, counter-clockwise.

3. **Control-Click** on the **Start** point to begin creating a subset. The software highlights the entire feature in the Model window, automatically checks the **Composite** check box, and the cursor changes to a cross.

4. **Control-Click** on the **End** point to finish creating a subset. The software creates and draws the subset in the picked color, changes the cursor back to normal, and increments the Features counter in the step. The software also grays out the Composite check box when at least one subset is defined.

5. Repeat Steps 3 and 4 if you wish to select other features or subsets.

6. Click on **OK**. The constructed feature is displayed in the Model as dashed lines and the subsets are no longer highlighted.

When you click on a constructed step to edit it, all of its reference features and subsets are highlighted and the feature itself turns to a bright blue.

Note: If the extracted subset is not what was expected, reverse the order of the Start and End points.

Measure a Feature with the Centroid Tool

The Centroid tool enables you to measure the area and perimeter of an irregular contour. For example, this tool is useful for measuring leads, solder points and pins.

The feature or contour must fit entirely in the field of view. The centroid tool can be used with the Measure Centroid and Measure Circle functions.

To access the **Centroid** tool, click on the icon in the toolbox. The system displays the tool as a box with corner handles in the center of the Image window.

You can change the size of the tool to any desired rectangular size. The maximum size is the size of the field of view. To change the size, select any corner of the box and hold the left mouse button while "dragging" the corner to the desired size.

When you measure a feature with the centroid tool, the system measures the portion of the feature that lies within the boundaries of the centroid tool.

To measure a feature in the Image window with the centroid tool:

1. Select the desired Measure function, i.e., **Measure Circle** or **Measure Centroid**. If you do not select a Measure function before selecting the centroid tool, the software activates the Measure Centroid function automatically when you click in the Centroid box to start the measurement.

2. Select and adjust the desired parameters in the Centroid Settings window and/or the Advanced Centroid Settings.

3. Click inside or outside the centroid box in the Image window to start the measurement.

   - The system measures the foreground pixels using the selected parameters and displays the measured area within the centroid tool using the tool's color. The measurement results are displayed in the measurement step.

4. If the results are not what you expected, repeat Step 2 and click on the **Remeasure** button as often as needed.

   - You can click on the **Reset** button if you wish to reset all the check boxes and sliders to their default settings.

5. Click on **OK** in the measurement step.

A Centroid measurement appears as an octagon in the Model window.

Find Features with the Search Function

The Search function is used to measure features that have a direct location correlation with other features. When you use this function in a step, you can include a reference feature. The system automatically fills in the offset values between the two features (the software adds the deviation from the location of the reference feature to the current feature's location).

This function is available in every Measure step except Digital I/O. It is available on a per axis basis (i.e., multiple features are allowed as references). Any individual axis may be pursued at its original measured / nominal location, rather than relative to a reference feature.

To use the Search function, follow the steps below.

1. Measure the reference feature(s), i.e., the feature(s) that will be specified in the Search Settings window.

2. Click on the **Tolerances** tab and specify the nominal values for the desired location dimensions.

3. Measure the current feature in which the Search function will be enabled.

4. Click on the **Search** button in the current step to display the Search Settings.

5. Click in the check box of the desired X, Y, and or Z (or RAZ) coordinates. This enables the field for entering the reference step number.
   - The software automatically fills in the step number of the previous valid step and checks that the reference step number is valid.
   - Valid steps are measured or constructed features that have a location and Math steps.

6. If you wish to specify a different step, enter the step number or click on the feature in the Model window.
   - You cannot enter a step number greater than or equal to the current step.

7. Click on **OK** in the Search Settings window to accept the changes or keep the current settings.

8. Remeasure the current feature (if measured with a weak edge tool) or run the routine.

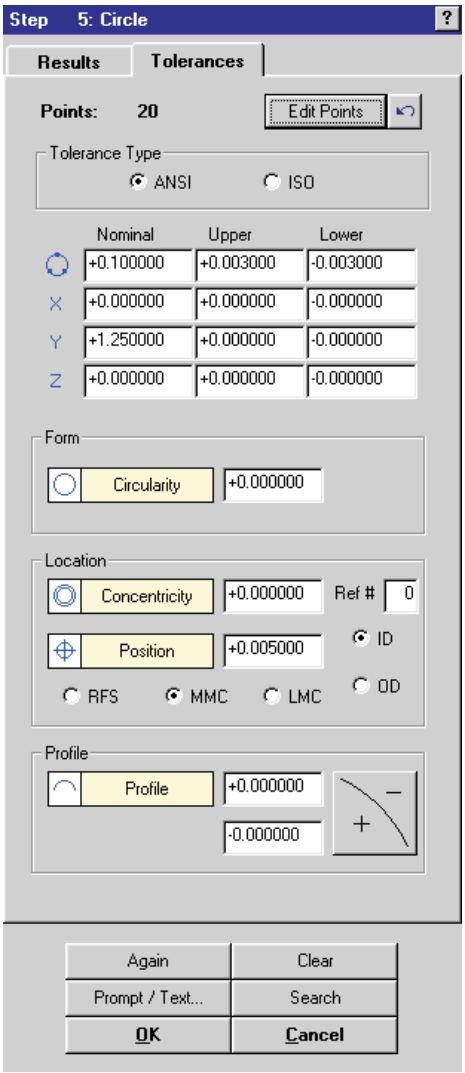
When you click on Remeasure or run the routine, the system measures the current feature using the deviations from the reference feature. If the reference feature fails when the routine is run, the software will try to measure the current feature at the nominal location and ignore the offset.

True Position Tolerances

A true position tolerance is a tolerance of location. It defines a zone within which the center point or axis of a feature is permitted to vary from the nominal location. True position tolerances are applied on the basis of the material condition.

If the blueprint shows a position tolerance, type the value in the True Position Tolerance field. No sign is necessary.

If you specify a position tolerance, click the left mouse button in the Tolerance Modifier field to select the material condition.



- **RFS** (Regardless of Feature Size). This is the default. If the blueprint shows a circled S or does not show a circled M or L in the feature control box, the tolerance should be applied RFS. Any deviation in the size of the feature will not change the position tolerance.
- **MMC** (Maximum Material Condition). Use MMC if there is a circled M in the feature control box on your dimension drawing or blueprint.
- **LMC** (Least Material Condition). Use LMC if there is a circled L in the feature control box on your dimension drawing or blueprint.

If you select MMC or LMC, you must also specify **ID** (inner dimension) or **OD** (outer dimension) in order to calculate the appropriate "bonus" tolerance. Bonus tolerances are determined by comparing the feature's actual measured size (up to its size limit) to the MMC or LMC size and adding the difference to the position tolerance as a "bonus." The default is ID. An example of the calculation is shown on the next page.

Note If the true position tolerance has a value other than zero, the X and Y nominal values, actual values, and deviations can be printed, even if the X and Y nominals are zeros.

True Position Tolerance Calculation

The following example shows how the elements of a true position tolerance are calculated. The calculation is based on the actual measurements and the nominal and tolerance values specified in the Nominals window shown on the previous page.

Calculated true position tolerance in the printout after the measurement is completed

```
================================================================================
=
Feature      Unit   Nominal     Actual      Tolerances      Deviation
Exceeded
================================================================================
=
 Step 5 - Upper-left hole measurement
Diameter      in  +00.10000  +00.09943  +0.00300  -0.00300  -00.00057    -
```

1

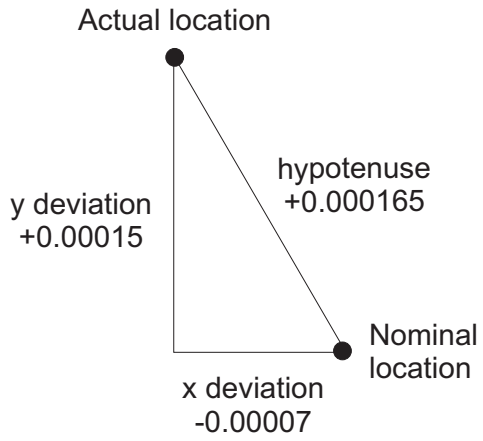
.10000	Nominal	
(+) - 0.00300	Lower Tolerance	
.09700	Maximum Material Condition	

2

.09943	Actual Size	
- 0.09700	At MMC	
.00243	Bonus	

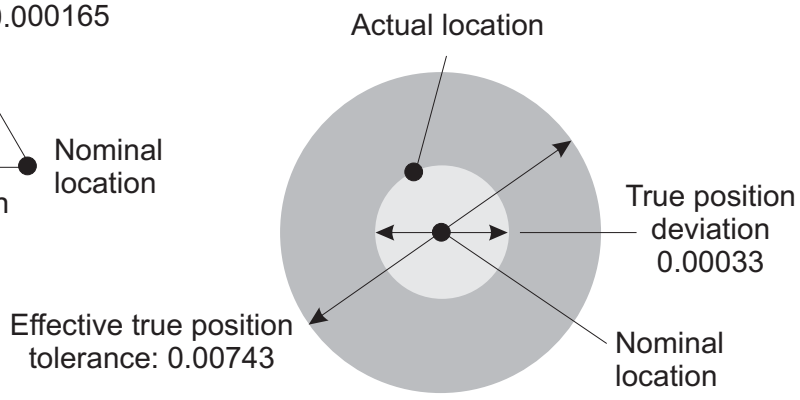
3

0.00500	Basic T.P. Tolerance
+ 0.00243	Bonus
0.00743	Effective T.P. Tolerance



4 Double the hypotenuse to get the actual true position deviation.

0.000165 x 2 = 0.00033



TPTOLCAL.CDR

Exercise 8: Use Weak Edge Diagnostics and the Advanced Weak Edge Parameters

In this practice session you will turn on the weak edge diagnostics and measure the left edge of the upper-left hole while changing advanced weak edge parameters.

1. Check that the training part is mounted securely.

2. Perform a manual setup on the part datum holes. Do the manual Z setup on the *surface* near the left alignment hole of the OGP FastStart training part.

3. Turn on the display of the weak edge diagnostics. Hint: Use **System / Diagnostics / Basic**.

4. Display the upper-left hole the Image window.

5. Turn on the back light **and** the ring light to approx. 45%.

6. Select the **Average Weak Edge Point** tool and measure a point on the left edge of the hole.

7. Stretch the boundaries of the tool so that the boundaries also include the left edge of the part.

8. Click on the **Advanced** button.

9. Move the **First Edge** slider to the right and all the other sliders to the left.

10. Click on **Remeasure**. Notice that the software measures the left edge of the part instead of the left edge of the hole; the system searches for an edge going dark to light in the direction of the arrow.

11. Move the **Last Edge** slider to the right and all the other sliders to the left.

12. Click on **Remeasure**. Notice that the software measures the last edge (going in the direction of the arrow) instead of the edge that was measured earlier.

13. Close the advanced weak edge parameters window.

14. Resize the Weak Edge tool and click on **Reset**.

15. Turn off the ring light.

16. Turn off the weak edge diagnostics.

This completes Exercise 8.

Exercise 9: Extract Multiple Features from One Measured Feature

In this exercise, you will:

- Measure the perimeter of the OGP FastStart training part with the Edge Trace tool
- Extract multiple lines and arcs and construct widths

To measure the perimeter and extract data, complete the steps below.

1. Perform a manual setup on the part datum holes.

2. Start a **New** routine and display an outer edge of the part.

3. Select the **Edge Trace** tool, measure the perimeter of the part, and close the step. If you are not sure how to do this, see the *How to Use the Edge Trace Tool* topic in the on-line Help.

4. Click on the **Construct** and **Circle** icons and extract the arc in the lower-left corner. Also include the nominal and tolerance values for the radius. If you are not sure how to do this, see the *How to Extract Data* topic in the on-line Help.

5. Set the constructed arc as the XY **datum origin**.

6. Repeat Step 4 for the arc in the lower-right corner and use it to set the **datum alignment** to the X axis.

7. Click on the **Construct** and **Line** icons and extract the edge on the right side.

8. Repeat Steps 4 and 7 as needed to construct all the other arcs and edges.

9. Construct the **Widths** between the top and bottom edges and the left and right edges. Also include the nominal and tolerance values.

10. Click on the **Print Listing** tab, select the **Expanded** mode, and view the data extraction points at the end of each constructed (non-datum) step.

11. **Run** the routine.

12. Do **not** save this routine.

This completes Exercise 9.

Exercise 10: Measure Variable Features with the Centroid Tool and Search Function

In this exercise, you will:

- Measure a bolt hole on the OGP FastStart training part with FeatureFinder, move the hole in the field of view to simulate part variability, and re-measure it
- Measure the same hole with the Centroid tool, use the Search function to find the hole even after it is moved in the field of view, and run the routine

To measure the bolt hole, complete the steps below.

1. Perform a manual setup on the part datum holes only if the part was moved.

2. Start a **New** routine and display one of the eight bolt holes in the center of the Image window.

3. Measure the hole with **FeatureFinder**.

4. Move the part with your hand so that the entire hole is in the upper right corner of the Image window.

   - **Note**: This undoes your manual setup; this is done only to mimic and illustrate part variability. Do not do this when you measure your own parts.

5. **Run** the routine. The software displays an error message because it cannot find the hole.

6. Move the part again so that the same hole that you measured in Step 3 is in its original location and is displayed in the center of the Image window.

7.. Perform a manual setup on the part datum holes again.

8. Start a **New** routine again.

9. Select the **Centroid** tool.

   - Change the size of the tool so that the search area fits the entire field of view.
   - Click on the **Advanced** button and select **Touch Boundary** and **Light** illumination in the Advanced window.
   - Place the cursor in the Image window and click the mouse button to measure the hole.
   - If you need more information, see the *How to Use the Centroid Tool* topic in the on-line Help.

10. Click on **Again** to display the Centroid step again. Do **not** move the stage.

11. Repeat Step 9 to measure the feature again. This will enable the software to capture the data more easily when you run the routine.

12. Click on the **Search** button, select the X and Y dimensions of Step 1 of the routine, and click **OK** to close the Search window.

13. Click on **OK** to close the Centroid step.

14. Measure the same hole again with **FeatureFinder**. Do **not** move the stage.

15. Click on the **Search** button, select the X and Y dimensions of Step 2 of the routine, and click **OK** to close the Search window.

16. Click on **OK** to close the Circle step.

17. **Run** the routine.

18. Repeat Step 4 of this exercise.

19. **Run** the routine.

    - This time the software does not display an error message because it can find the hole using the Search function.
    - The Search function will work as long as the hole is within the search area of the Centroid tool in the field of view.

This completes Exercise 10.

Challenge Exercise 6: Measure and Calculate a True Position Tolerance

In this exercise, you will measure the upper-left hole and include the required nominal values and a true position tolerance value. **Refer to the print of the OGP FastStart training part for the nominal and tolerance dimensions.**

To measure and calculate a true position tolerance, complete the steps below.

1. Check that the training part is mounted in the fixture securely.

2. If not done already, perform a manual setup on the part datum holes. Do the manual Z setup on the surface near the left alignment hole.

3. Measure the datum features and define the datum origin and datum alignment.

4. Measure the upper-left hole.

5. Specify the nominal and tolerance values for the hole size and location, and the true position tolerance at MMC.

6. Select the size, XY location, and position tolerance dimensions for printing.

7. Run the routine to measure the step and view the measured results in the Print Data window.

Glossary

This glossary defines terms that appear in the Measure-X Training Workbook. The terms encompass the following categories:

- **User interface**. This includes terms related to the computer, hardware and software.
- **Metrology**. This includes measurement concepts and terms, geometries, dimensions and tolerances.
- **Optics**. This includes terms related to imaging, projection and illumination.
- **Acronyms**, such as DRO, FOV, LMC, and RFS.

The glossary information on the following pages is listed in two columns:

- **Term**. This lists the term and any specific OGP equipment or software with which it is associated.
- **Usage**. This contains a definition or description of the term. Words indicated with a bold typeface are also listed in the Term column.

Term	Usage
Accuracy	Degree to which a measurement conforms to an exact standard. Usually expressed in **micron**s.
Actual	A measured value.
Active memory	A temporary storage area for the current **routine** that is being created or that was loaded from the disk. Anything in active memory is lost when you start a new routine or exit from Measure-X.
AccuCentric	Patented OGP zoom lens that performs an automatic self-calibration when the magnification is changed.
Alignment, axis	When positioning a part during **part setup**, this function electronically aligns the part to a designated **axis** or reference point. This tells the system how the part is rotated relative to the stage motion, and compensates for any misalignment between the part and the stage.
Angle 1, 2 ,3, 4	Angles between constructed intersecting lines. Reported counterclockwise going from the first line to the second.
ASCII	American Standard Code for Information Interchange. Typically used to describe plain text.
Axes of travel	Stage motion in the X and Y axes and movement of the optical assembly in the Z axis
Axis	One of the reference lines of a coordinate system. • X axis is horizontal in the plane of projection. • Y axis is vertical in the plane of projection and perpendicular to X. • Z axis is the optical axis, which is perpendicular to the plane of projection and the X and Y axes.
Back light	Light projected from below or behind the part creates a contour or profile “shadow” image of the part. This type of illumination is used most frequently. It is typically used to outline edges and through-feature measurements. Also called profile illumination.
Backoff distance	• The distance that Z moves (up or down) from the nominal location before performing an autofocus. The distance is increased if the autofocus operation fails. • The distance that the touch probe moves away from the contact point after contact.
Blueprint	See **Dimension drawing**.

Term	Usage
Calibration	The process of determining the **deviation** from a standard and making the necessary adjustments or applying correction factors so that a measuring machine meets the standard.
Cartesian coordinates	Rectangular 2D or 3D coordinate system where X, Y and Z define the location of a point as the distance and direction from the origin and where the axes intersect.
Circle	A function used to measure rounded or curved edges. At least three points are required for a circle measurement.
Coaxial light	See **Surface light**.
Comment	Descriptive text for a feature, step or **routine**. It can also be a report **heading** or **setup instructions**.
Construct(ion)	• A mode of programming using previously-measured or constructed features. • A measurement or feature that is built from two or more previously measured or constructed features.
Contrast	The apparent difference in brightness between light and dark areas of an image.
Control (Settings) window	The area on the screen where the user can control tool and target parameters such as size, number of points, edge processing, etc. See also **Toolbar**.
Datum	An exact point, axis (line) or plane used as an origin for measuring the features of a part and establishing their location. Typically a part's datum features are measured first and defined as coordinate origin and **axis alignment** features, from which all other features are referenced.
Dark-to-light	Process by which the system searches for an edge in a dark-to-light direction to avoid erroneous edges that may be caused by improper illumination or dust particles. See also **Edge detection**.
Deviation	The amount by which a measured (actual) value differs from the **nominal** value.
Dialog box	A window that displays messages or further instructions, and allows you to select items or enter information such as values or commands.
Diameter	Length of a straight line passing through the center of an object and ending at the object's surfaces or perimeter. Indicates the size of a circle.
Dimension	A numerical value, expressed in appropriate units of measure, that defines the size and/or geometric characteristic of a part or feature.
Dimension drawing	An engineering drawing that shows the dimensions and **tolerances** of each part feature that can be measured.

Term	Usage
Distance	Degree or amount of separation between two points, lines, surfaces or objects measured along the shortest path joining them.
DRO	Digital Readout, which typically displays the current **XYZ** location.
Edge analysis and detection	Process used to search for an edge. Typically the system searches for an edge in a **dark-to-light** direction to avoid erroneous edges that may be caused by improper illumination or dust particles. The following kinds of factors affect edge detection: illumination, contrast, roughness, search area, search direction, weak edge weighting factors, number of points, percent of the feature, etc.
E-stop	Emergency-**stop button** on the side of the machine or on the control panel.
Feature	A physical portion of a part, such as surface, hole, edge, or slot.
Fixture	A device that holds one or more parts in a desired position so that they can be measured. A fixture is typically mounted at a fixed location on the stage or worktable.
Flatness	The condition of a surface having all elements in one plane. A flatness measurement is the deviation from the plane.
Focus	Movement of the optics along the Z-axis relative to an object to obtain the sharpest possible (highest **contrast**) image.
FOV	Field of View. This is the size of the image area as seen in the Image window. The FOV varies with **magnification**.
Geometric tolerance	The category of tolerance information used to control form, profile, orientation, location, and runout.
Header	User-specified descriptive text that appears at the beginning of a routine **listing**.
Icon	Graphic representation of a function. It can be a label for a button or key, or it can be a software object.
Illumination	The application of light to a subject. See **back light**, **surface light**, **ring light**, **SmartRing light**.
Image window	The area on the computer screen that displays the **video image**. Depending on which menu selections you make, the **model**, pop-up **dialog boxes**, and prompts and messages may be displayed over the video image.
Intersection	A constructed point where two **features** meet.
LED	Light-Emitting Diode. A source of illumination or a display device.
Light-on-right	See **Dark-to-Light**.

Term	Usage
Line	A function that measures a straight path. At least two points are required for a line measurement.
Listing	A sequential record of the **steps** in a **routine**. It shows all the pertinent information for each measurement of a **feature**, e.g., actual values, nominals, tolerances, light settings, magnification, and text. A listing can be displayed on the screen, stored in a file, or sent to a printer.
LMC	Least Material Condition, in which a feature of size contains the least amount of material within the stated limits of size – for example, maximum hole diameter, minimum pin diameter.
Mag(nification)	• Optical: Ratio of the actual size of an object to the image of the object. It is based on the magnification lens that is used, any adapter tube, and the position of the **zoom** lens. • Screen: Ratio of the actual object size to the image size on the computer monitor. The magnification varies with the monitor size. For example, the on-screen mag is increased with a larger monitor.
Menu	A list of related functions or options under one keyword. For example, the Edit menu lists options for editing the steps of a routine, such as Insert, Copy, Change, and Delete.
Microinch	One millionth of an inch. Shown as 0.000001 inch. ≈.0254µm.
Micron (µ), µm	One millionth of a meter (10^{-6}); micrometer. Used to indicate measurement **accuracy**. Shown as 0.001 mm (.000039 inch).
Midpoint	A function that reports a 3-D **distance** and a point that is equally distant from the two end points. At least two points are required.
mm	millimeter (one thousandth of a meter).
MMC	Maximum Material Condition, in which a feature of size contains the maximum amount of material within the stated limits of size – for example, minimum hole diameter, maximum pin diameter.
Model	CAD-like sketch of the part based on measured or constructed features.
Mouse	Device used to move the cursor that is displayed on the computer screen. The buttons have different functions such as selecting an item and changing the spacing of a target.
Nominal	Basic dimension of a feature as specified on the **dimension drawing**.
Origin	An exact point (Zero XYZ/RAZ) used to tell the system where the part is located on the **stage** and to measure the features of a part. See also **Part setup** and **Datum**.

Term	Usage
Out of tolerance	Condition where the measured value exceeds the **tolerance** limits.
Override	A method to change parameters temporarily. Example: display only out-of-tolerance measurements for the current run of the routine.
Part setup	Method used to indicate where a part is located on the **stage** and how it is aligned so that system can measure the part and its features. Part setup consists of the following functions: • Staging: positioning the part on the stage or in a fixture, mounting it securely and making sure it is illuminated properly and in focus • Defining the part **origin** (Zero X, Y and Z) • **Axis** (or Skew) **alignment**
Plane	A 2-D surface that has no curvature and is perfectly flat. It is of such nature that a straight line joining any two of its points lies wholly in the surface. The plane function enables you to measure the angle, profile and flatness of a surface. Height and depth measurements are based on **focus** points.
Point	• A single location that is measured or constructed on the part. • Subset of a feature measurement. For example, a measured circle may consist of nine points, which can be changed or removed.
Polar coordinates	2-D or 3-D polar **coordinate system** where R(adius), A(ngle) and Z define the location of a point using circles rather than a grid.
Positional tolerance	A zone within which the center, axis, or center plane of a feature of size is permitted to vary from the **true position**. Positional tolerancing is applied on an **MMC**, **RFS** or **LMC** basis.
Profile light	See **Back light**.
Program	See **Routine**.
Radius	Length of a straight line from the center of an object to the edge.
RAZ	Used for **Polar coordinates** (Radius, Angle, Z)
Reference plane	A function that levels a plane so that all the measured **focus** points on the plane are set to a Z axis value of 0. This is typically done in the first **step** of a **routine**.
Reset	Changes the origin back to the **stage home** location and removes a routine from memory.
Resolution	The number of significant digits to the right of the decimal point. Inches are displayed with two to five significant digits; millimeters and angular units are displayed with one to four significant digits.

Term	Usage
Revision (software)	A number indicating an update to a **version** of the software. The number is typically incremented when the software is corrected or an enhancement is added.
RFS	Regardless of Feature Size. Indicates that a geometric **tolerance** or datum reference applies at any increment of size of the feature within its size tolerance.
Ring light	Circular bundles of optical fibers that project a cone of light onto a surface. The light creates a three-dimensional image that highlights heights, depths and surface imperfections. Also called oblique light. See also **Quad light** and **SmartRing Light**.
Routine	A sequence of measurements saved as **steps**. You can run the same routine for identical parts. You can also edit a routine and make changes to it. Also called inspection routine or program.
Run setup	Actions that the user can perform just before running a routine. Typically include re-doing the **part setup**, specifying run options, etc.
Scroll bar, Slider	A horizontal or vertical bar with a scroll box and arrows at each end. Use the cursor to click on either arrow or slide the scroll box in the desired direction to change a parameter.
Setup instructions	User-specified instructions that explain how to do the **part setup**. After they are entered by the user, they are included as part of the routine **listing**.
Skew alignment	• See **Alignment, axis**.
SmartRing Light	A source of **illumination** on OGP video systems that lets you control the **ring light** more precisely by varying the intensities and angles of incidence at which the light is projected.
Software	Computer programs that the user can manipulate to perform various functions such as measuring features and parts automatically.
Stage	Surface on which the object to be measured is placed. Uses vertical projection.
Stage Home	Machine origin: XYZ (RAZ) zero location. • The machine's Z origin is approximately at the bottom of the Z axis travel. • The machine's XY origin is located at the lower left corner of the stage.
Step	A unit in an inspection routine that contains the measurement results for one feature of a part. A step may contain several discrete measurements, e.g., location, size and number of points.
Stop button	• Button on the joystick or control panel, or red **E-stop** button that can be pushed to stop the movement of the stage and cut power to all motors. Typically used to prevent the accidental collision of the optics with an object on the stage. • Software button at the bottom of the screen used to stop the run of a routine.

Term	Usage
Surface light	Light projected down through the lens directly onto the surface of the part. This provides better contrast on a surface. Typical applications include the illumination of blind holes and standoff surfaces. This illumination is also best for a Z axis autofocus on a surface. Also called coaxial, auxiliary and front light.
Targets	Graphical tools used in video systems • Alignment: used to manually align geometric shapes and objects, e.g., circle. • Image processing: used to automatically find and enter points more accurately and quickly, e.g., FeatureFinder or Strong Edge. • Focus: used to automatically focus an edge or surface and to measure the Z axis position of the part.
Template	A pre-set format that controls the form and content of output. The user may use or change an existing template, or create a new template.
Tenth	Slang term used to refer to ten thousandths of an inch (.0001 inches).
Thousandth	Refers to 1 one thousandth of an inch (.001 inches); also known as a “mil.”
Tolerance	The total amount by which a specific **dimension** is permitted to vary. It is the difference between the minimum and maximum limits.
Toolbar	The area on the screen where the user can control the data in the displayed window such as save/print, view, zoom, etc. See also **Control window**.
True position	The theoretically exact location of a **feature** established by basic dimensions.
Version	• Software: General level of a release, indicated by a single digit. The version is normally changed when there are significant enhancements in the software, e.g., from Measure-X Version 1 to Measure-X Version 10. • Subassemblies (PC boards): a subassembly which is similar to the original, but must have a different part number because the bill of materials is different. Typically the versions are in the same series of part number, e.g., 036541, 036543, 036544.
Video image	Actual, live image of a part that appears on the computer screen.
Width	Measurement taken at right angles to the length. A width can be measured or constructed between lines, a point and a line, a point and a circle, a line and a circle, and two circles.
XYZ	Used for **Cartesian coordinates**. Do not put any commas or spaces between the letters. See also **axis**.
Zoom	Used to control the size of an image by magnifying or reducing it.

Reference Information

OGP provides the following documentation related to Measure-X and the SmartScope Flash/Flare video machines:

- *Measure-X FastStart Guide* (PN 790280). This guide provides basic instructions on how to get started with using Measure-X.
- *Measure-X Reference Guide* (PN 790230). This manual contains detailed instructions about using the system. It provides in-depth descriptions of the user interface and Measure-X software tools.
- Standard training part (PN 790012) for testing and self training. It is used in all the examples in the reference guides.

Measure-X On-Line Help

The Measure-X on-line Help topics describe the software functions, explain how to use the software, and provide information for specific dialog boxes and fields.

You can access the on-line Help in the following ways:

- Select **Help Topics** in the Help menu or click on the **Help** book above the Illumination Control window. Then you can click on the **Contents** tab to view topics as you would in a manual or on the **Index** tab to view and search for index entries. Follow the instructions to view a book and its topics or find a specific topic. Also see the *How to Use Help* and *Hints on Using Help* topics in the **Measure-X Software** on-line book.
- Click on the question mark (**?**), which represents the context-sensitive What's This Help. Then place it over the desired field in a window or dialog box and click the left mouse button to view the pop-up text.
- Click on a **Help** button in a dialog box, if a button is displayed.
- Press the **F1** key for help on the currently-displayed dialog box or window.

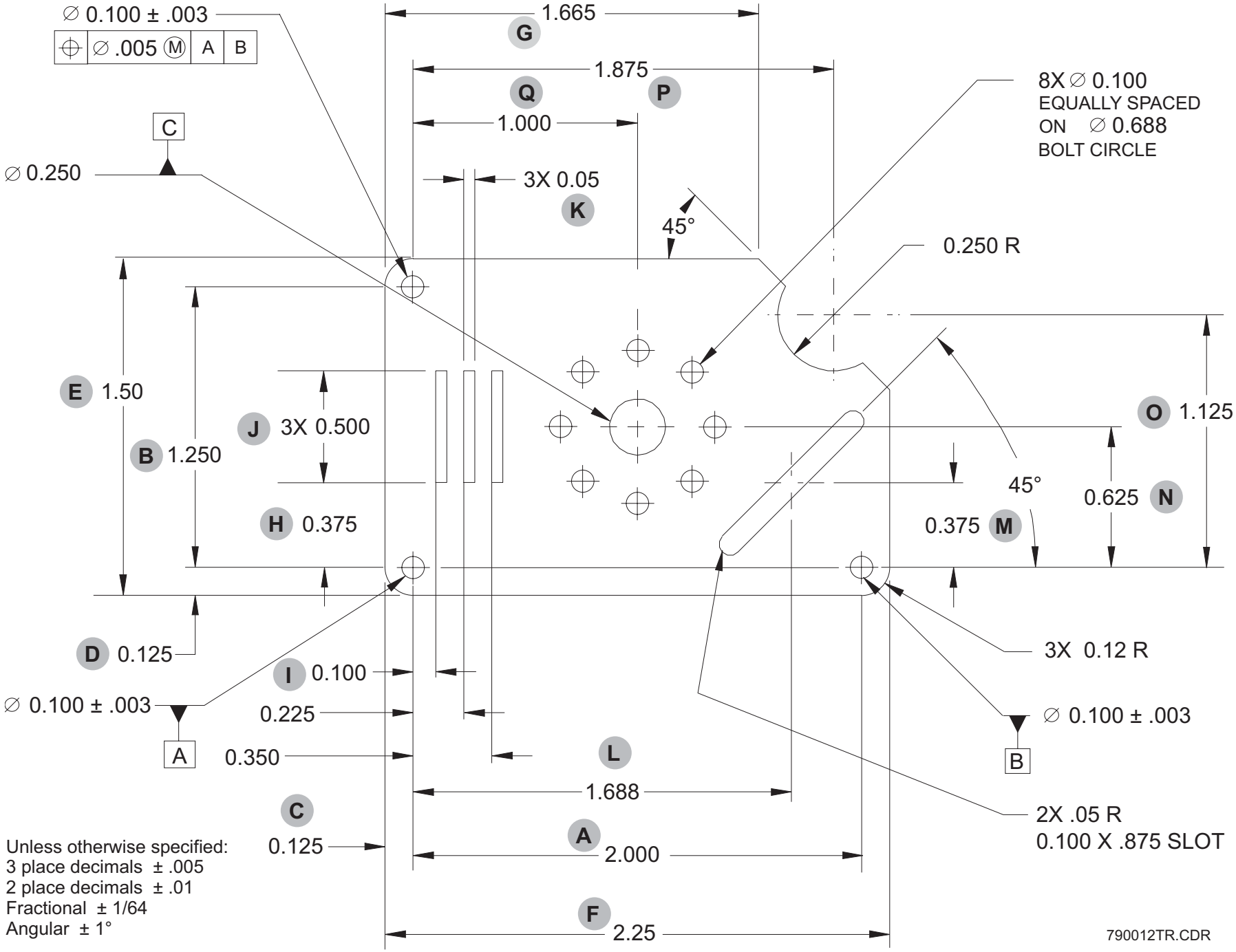
If You Need Assistance

If you need additional assistance, contact your local authorized OGP representative first. If he or she cannot solve your problem, you may contact us —

- By phone at 585-544-0400
- By Fax at (585) 544-8092 (Sales) or (585) 544-0131 (Service)
- By e-mail at *sales@ogpnet.com* or *service@ogpnet.com*
- On the Internet at http://www/ogpnet.com

Software Revision

To view the revision of the Measure-X software, click on **About** in the **Help** menu.


∅ 0.100 ± .003
⌖ ∅ .005 Ⓜ A B
1.665
G
1.875
Q
P
1.000
8X ∅ 0.100
EQUALLY SPACED
ON ∅ 0.688
BOLT CIRCLE
C
∅ 0.250
3X 0.05
K
45°
0.250 R
E 1.50
B 1.250
J 3X 0.500
H 0.375
O 1.125
45°
0.625 N
0.375 M
D 0.125
I 0.100
0.225
0.350
L
1.688
C
0.125
A
2.000
F
2.25
∅ 0.100 ± .003
A
3X 0.12 R
∅ 0.100 ± .003
B
2X .05 R
0.100 X .875 SLOT
Unless otherwise specified:
3 place decimals ± .005
2 place decimals ± .01
Fractional ± 1/64
Angular ± 1°
790012TR.CDR

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