SIEMENS EDA

Calibre® DefectReview™ User's Manual

Software Version 2021.2

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Getting Started With Calibre DefectReview

Calibre© DefectReview™, part of the Calibre tool suite, provides efficient analysis, classification, and trend analysis of defects identified by mask inspection systems. The software includes features for easy and fast defect navigation, visual display, defect selection and filtering, defect classification, clustering, sophisticated CD analysis, analysis over multiple inspections, and repeatability and trend analysis.

These features, along with the automatic generation of reports, charts, graphs, image mosaics and Pareto charts (charts with both bars and line graph), significantly improve the productivity of mask inspection operators. The software supports several types of defect analysis (including Die-to-Die and Die-to-Database), making it applicable at both mask shops and wafer fabs. Features such as automatic grid detection, comparisons of the actual versus expected Detection Line, and Repeatability Analysis on test masks allow Calibre DefectReview to be used also for calibrating mask inspection systems to check their defect detection capabilities.

Calibre DefectReview's open architecture can be extended to support multiple mask inspection tools from different vendors. A unique plug-in interface to Calibre DefectReview enables you to use your own proprietary defect analysis and image processing algorithms as well. Based on the Nirmaan Post Layout Software Development Toolkit Platform, Calibre DefectReview combines mask inspection and design automation processes by supporting the correlation of defect data on reticles with design layout data in any major industry-standard layout and mask data format.

Calibre DefectReview Installation and Licensing

The Calibre DefectReview mask inspection analyzer can be installed on different supported hosts.

Calibre DefectReview is supported for Microsoft® Windows® and Linux®[1] and each host has its own installation procedure.

Installing Calibre DefectReview on Windows Hosts

You can install Calibre DefectReview on Microsoft® Windows® hosts.

Prerequisites

- You must have the following system requirements:
    - Microsoft Windows 10 (64-bit).
    - 2-GHz Intel Core 2 Dual-Core or equivalent processor.
    - At least 1 GB RAM. The capacity varies with the amount of RAM present on the system. For instance:
        - On a machine with 2 GB RAM, a maximum of 20 K defects can be loaded into Calibre DefectReview.
        - On a machine with 3 GB RAM, a maximum of 40 K defects can be loaded into Calibre DefectReview.
- You have the Calibre DefectReview installation executable.
- You have a valid Calibre DefectReview license.
- Any previously-installed version of Calibre DefectReview should be uninstalled.

Procedure

1. On your Windows PC, double-click the Calibre DefectReview install executable icon to start installation. A message box appears asking to confirm the installation. Click **Yes** to invoke the Setup Wizard, then follow the prompts given during the installation process.

1. Linux® is a registered trademark of Linus Torvalds in the U.S. and other countries.

Note the following during installation:

- If you have a previously installed Calibre DefectReview, then another message box appears indicating that you need to uninstall the existing version before you can begin the installation process. Click **Yes** to uninstall the product and continue with the installation process.
- Review the License Agreement when it appears, then select the “I accept the agreement” radio button and click **Next**.
- By default, the Setup Wizard installs not only Calibre DefectReview, but also Mathworks MATLAB Compiler Runtime (7.6, 7.9), Microsoft Visual C++ Runtime, and the Siemens EDA Licensing utility, all of which are required to run Calibre DefectReview (unless they are already present on your system). Other tools may appear in the installation list based on your product package (such as Calibre MDPAutoClassify).
- You will have an opportunity to review the settings prior to installation. After you have reviewed the settings, click **Install** to install the product. The setup starts the installation.
- If a previous installation of Calibre DefectReview is present on your system, then towards the end of the installation, a message box appears, asking if you want to import your user configuration to the new installation.

  If you click **Yes**, the user configuration settings from the previously-installed Calibre DefectReview is imported into the new installation, including the following:

  - Username and password
  - Docking arrangement (panes that can be docked inside the Calibre DefectReview GUI layout)
  - Defect List column size and visibility
  - Image Measurement Unit (IMU) display arrangement
  - Report settings
  - Recently-opened files
  - dllInfo section of the *dat-ini.xml* file, if it was not otherwise supplied during setup

If you click **No**, the new version of Calibre DefectReview uses a default user configuration instead.

2. When installation completes, the Setup Wizard indicates that the process has completed. Click **Finish** to close the Setup Wizard.
3. The install program adjusts the PATH variable. For example, if the MATLAB Compiler v7.9 Runtime is installed in *C:\Program Files (x86)\MATLAB\MATLAB Compiler*

Runtime, the installer adds *C:\Program Files (x86)\MATLAB\MATLAB Compiler Runtime\v79\runtime\win32* to the PATH variable. Check if this directory has been added to your PATH variable. Perform the following steps to view your current environment variables:

- In Windows 10:

    i. In the Start Search text entry field, type ‘env’, then select **Edit the system environment variables**. The System Properties dialog box appears.

    ii. In the **Advanced** tab of the System Properties dialog box, click the **Environment Variables** button.

4. To uninstall Calibre DefectReview, to **Start** > **All Programs** > **DefectAnalysisTool** > **Uninstall NxDAT**. A message box prompts you to confirm uninstallation. Click on **Yes** to uninstall.

Calibre DefectReview Licensing on Windows Hosts

There are two methods of licensing: floating and node-locked. Floating licenses are a pool of shared licenses available from a licensing server. With node-locked licensing, licenses are assigned to specific machines.

Configuring the License File

Prior to installing any node-locked or floating license (.lic) file, you must first enter the PC host names in the license file.

Procedure

1. Open the Siemens EDA license file using any text editor.
2. Check the MAC address provided in the *license.lic* file as shown in the following figure:

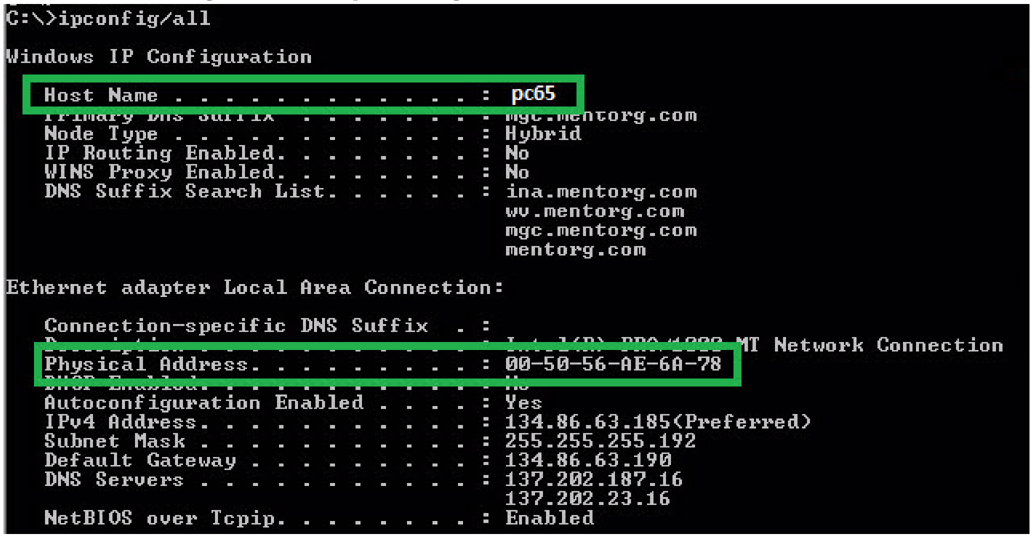
Figure 1-1. MAC Address Information

3. Open a command window in the PC corresponding to the MAC address.
4. Enter the following command:

```
ipconfig/all
```

5. Get the PC’s host name for the specified MAC address as shown in the following figure:

Figure 1-2. ipconfig/all Command Information



6. In the license file, replace the text “put_server_name_here” with the host name of the PC. For the above case, it will be pc65 as shown in the following figure:

Figure 1-3. Replace Host Name

7. Save the license file.

8. If there are multiple instances of “put_server_name_here” text in your license file, repeat steps 2 through 7.

Floating Licensing

With the floating licensing scheme, a pool of shared licenses are available from a licensing server.

Invoking the Floating License Manager

Calibre DefectReview supports a floating license manager on Windows hosts.

Prerequisites

- A valid Calibre DefectReview license file. The <*license file*>*.lic* file should be copied to a directory accessible to the server.
- The license file is configured as described in "Configuring the License File" on page 32.

Procedure

1. On your Windows PC, open a command window.
2. Run the following command:

```
<install_path>\LMGRD.EXE -c <license_file>.lic -l license.log -z
```

   where *install_path* is the path to where the licensing executables have been installed (by default, it is *C:\MentorGraphics\Licensing*) and *license_file* is the name of the license file.

3. Check the *license.log* file. The log file indicates that license manager daemon has started. The license manager daemon must be restarted every time the machine is turned on. Your system administrator can add the licensing command to your Windows startup so that the floating license always runs even when PC is restarted.

Setting Up a Floating License

Once the license manager for floating licenses is invoked, the machines that are on the same network as the server machine can use it by setting the LM_LICENSE_FILE environment variable.

Procedure

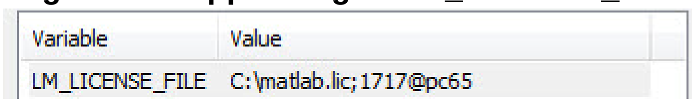
1. From your Windows PC, invoke the Environment Variables dialog box.
   - In Windows 10:
     i. In the Start Search text entry field, type 'env', then select **Edit the system environment variables**. The System Properties dialog box appears.

   ii. In the **Advanced** tab of the System Properties dialog box, click the **Environment Variables** button.

2. If LM_LICENSE FILE does not exist, click **New** and set the value to *<port_number>@<host_name>* (for example, 1717@pc65).

   If LM_LICENSE_FILE exists, then append the Calibre DefectReview license path using a semicolon. For example, if LM_LICENSE_FILE is already set to the path *C:\matlab.lic*, then the Calibre DefectReview license path can be appended as shown in the following figure:

Figure 1-4. Appending to LM_LICENSE_FILE



Variable	Value
LM_LICENSE_FILE	C:\matlab.lic;1717@pc65

Node-Locked Licensing

In this scenario, Calibre DefectReview can run in stand-alone mode, which means that your machine need not be on the network. Here, a license file is given to each host.

Setting up LM_LICENSE_FILE for a Node-Locked License

On each machine to receive a node-locked license, you must add the LM_LICENSE_FILE environment variable and point it to the host name on which the license server is running

Procedure

1. From your Windows PC, invoke the Environment Variables dialog box.

   a. In the Start Search text entry field, type “env”, then select **Edit the system environment variables**. The System Properties dialog box appears.

   b. In the **Advanced** tab of the System Properties dialog box, click the **Environment Variables** button.

2. Add the user variable LM_LICENSE_FILE and set its value *to the path of the license file (*for example, *C:\License\Site_112233.txt*).

Node-Locked Counted Licensing

In this scenario, there is a pool of node-locked licenses. This requires that the license server be installed.

Setting Up the Server for Node-Locked Licenses

When setting up for a group of node-locked licenses, you must first set up a license server.

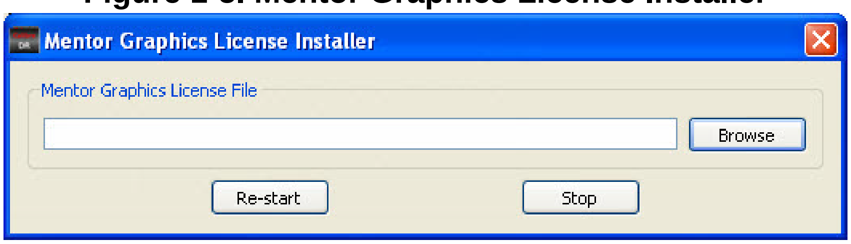
Prerequisites

- A valid Calibre DefectReview license file. The *<license file>.lic* file should be copied to a directory accessible to the server.
- The license file is configured as described in "Configuring the License File" on page 32.

Procedure

1. Select **Start** > **All Programs** > **DefectAnalysisTool** > **Mentor Graphics License Installer**. The dialog box shown in the following figure appears:

Figure 1-5. Mentor Graphics License Installer



2. In the dialog box, enter the pathname to the Siemens EDA license file (for example, *C:\License\NxDAT.lic*) or click the **Browse** button to search for the license file.
3. Click **Re-start** to start the license server. If the pathname and license file are valid, a message is issued stating that the licensing server has started successfully.

Setting Up LM_LICENSE_FILE for a Node-Locked Counted License

On each machine to receive a node-locked license, you must add the LM_LICENSE_FILE environment variable and point it to the host name of on which the license server is running.

Procedure

1. From your Windows PC, invoke the Environment Variables dialog box.

a. In the Start Search text entry field, type “env”, then select **Edit the system environment variables**. The System Properties dialog box appears.

b. In the **Advanced** tab of the System Properties dialog box, click the **Environment Variables** button.

2. Add the user variable LM_LICENSE_FILE and set its value to the *<port_number>@<host_name>* (for example, *1717@pc*).

Setting Up an Idle Time for Releasing a License

You can specify an idle time after which Calibre DefectReview releases its license. This is also known as a timeout.

The timeout is set in the GeneralInfo/timeOut node in the *dat-ini.xml* file.

Figure 1-6. timeOut Node

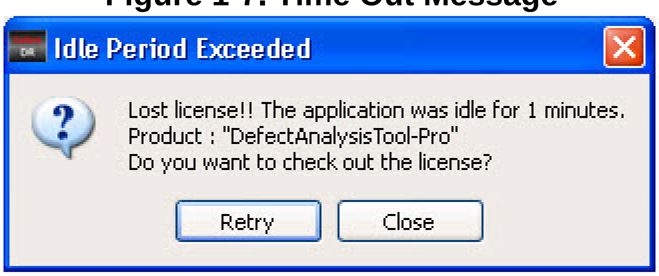
```
<GeneralInfo>
  <notifyFileModified>0</notifyFileModified>
  <refreshRetries>5</refreshRetries>
  <memoryUtilizationControl enable="yes">
  <!-- Time out based on idle time, Unit: Minute, <= 0 : No time out -->
  <timeOut> 1</timeOut>
  <!-- Unit of measure -->
  <UnitOfMeasure>
  <logRefreshInfo enable="false" cleanLog="false"/>
</GeneralInfo>
```

Procedure

1. In a text editor, open the *dat-ini.xml* file.

2. In the *dat-ini.xml* file, set the value of the timeOut node to a positive number and save the file. For example if you set it to 1, after 1 minute of inactivity, Calibre DefectReview times out and displays a dialog box (shown in the following figure). Before this message is displayed, the license for Calibre DefectReview is released.

Figure 1-7. Time Out Message



If the Layout Server is running, then the process terminates and all states corresponding to layout image generation are reset.

Note
If the value of the timeOut node is negative, then timeout does not occur.

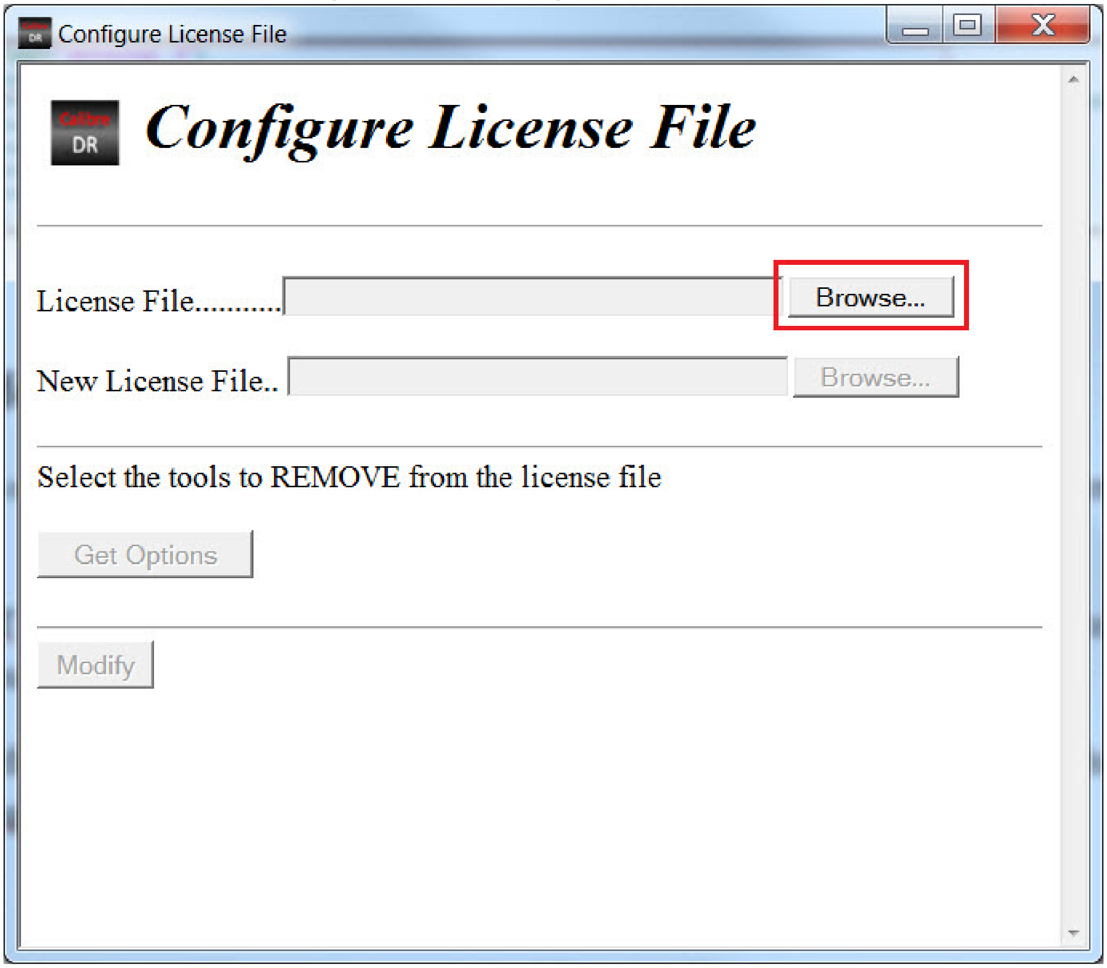
Customizing the License File

You can customize the license file on Windows hosts to restrict usage of certain Calibre DefectReview sub-tools by removing corresponding license features from the license file.

Procedure

1. Double-click *<install_path>/DefectAnalysisTool/bin/configure-license-file.hta*. This invokes the Configure License File dialog box.

Figure 1-8. Configure License File



2. Click the **Browse** button next to the License File field to locate your original license file. Once the license file is selected, a second Browse button is enabled next to the New License File field

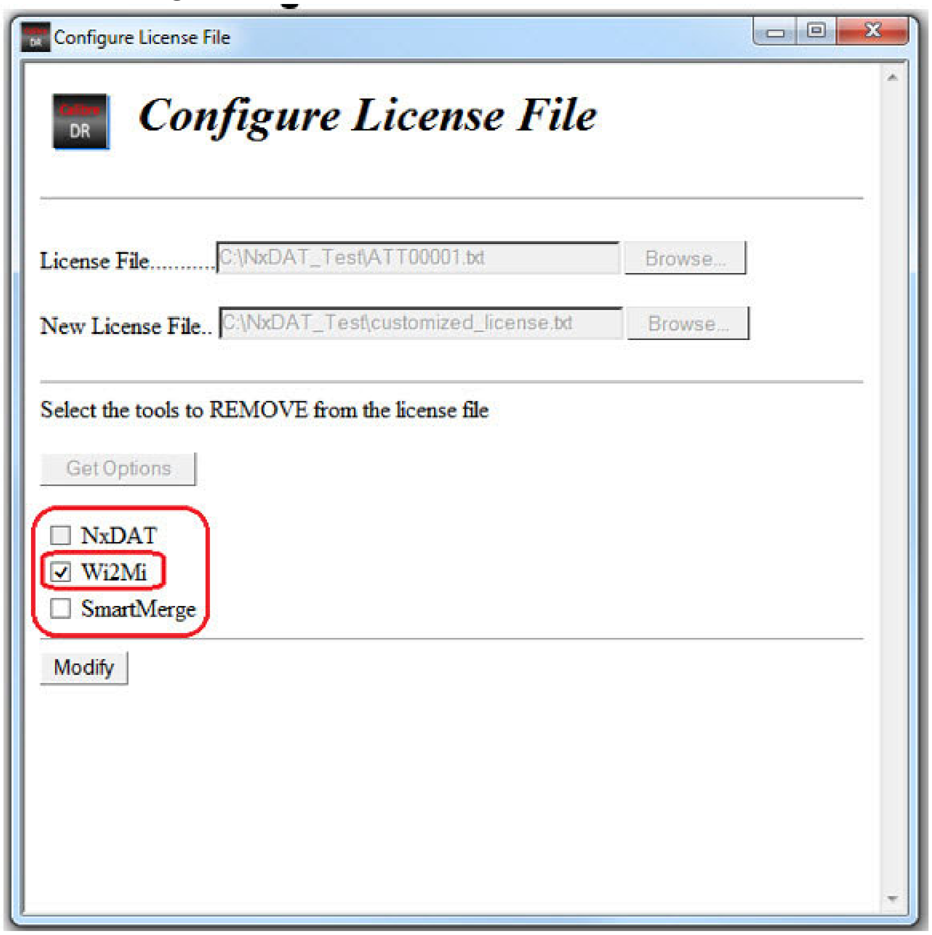
3. Create an empty text file to save as the new customized license. For example, you can create a file named *customize_license.txt* for the new license.

4. Click the **Browse** button next to the New License File field to locate the new custom license file. Once the file is selected, the **Get Options** button is enabled.

5. Click the **Get Options** button to validate the original license file and check for available sub-tools. If the original license file is corrupted or invalid, then Calibre DefectReview displays an “Invalid License File” error message.

6. After validation, Calibre DefectReview displays a list of sub-tools you can opt to activate or deactivate for the new license file.

Figure 1-9. Sub-tools Listed in License File



Select the sub-tools that you want to remove from the license file and click the **Modify** button. This populates the new license file with the tools that were not checked.

7. After the license file is created, Calibre DefectReview displays a dialog box indicating that the customization was successful. There is no option to remove the license for Calibre DefectReview.

Installing and Licensing Calibre DefectReview on Linux Hosts

The installation for Calibre DefectReview includes Calibre self-extracting software (*_mib.exe* file). This bundle installs the MGC_HOME tree and the docs directory into your current directory by default. Therefore, if you have downloaded the compressed executable files to, for example, *$HOME/my_downloads*, but want to install the tree under */user/mgc*, you must cd to */user/mgc*.

The complete Calibre installation and licensing procedures for Linux hosts are covered in the *Calibre Administrator's Guide*.

In a command window, set the environment variable NXDAT_MGC_HOME to the installed Calibre DefectReview location and LM_LICENSE_FILE to your license file installation location as shown:

```
setenv NXDAT_MGC_HOME <path_to_Calibre_DefectReview_install>
setenv LM_LICENSE_FILE <path_to_license_file>
```

An optional script called *post-install* is also available to perform the following tasks:

- Create a desktop shortcut icon on the Linux®desktop.
- Migrate your old password file to the new installation location.

Use of this script is optional and depends on your requirements. The script is located at *<installation-directory>/bin/post-install*.

Note

You must provide your old NXDAT_MGC_HOME location if you want to migrate your old password file for your new installation.

Invoking Calibre DefectReview on Windows Hosts

To begin using Calibre DefectReview on Microsoft® Windows® hosts, invoke the Calibre DefectReview executable and then log in.

Prerequisites

- Calibre DefectReview is installed.
- A valid Calibre DefectReview license is present.

Procedure

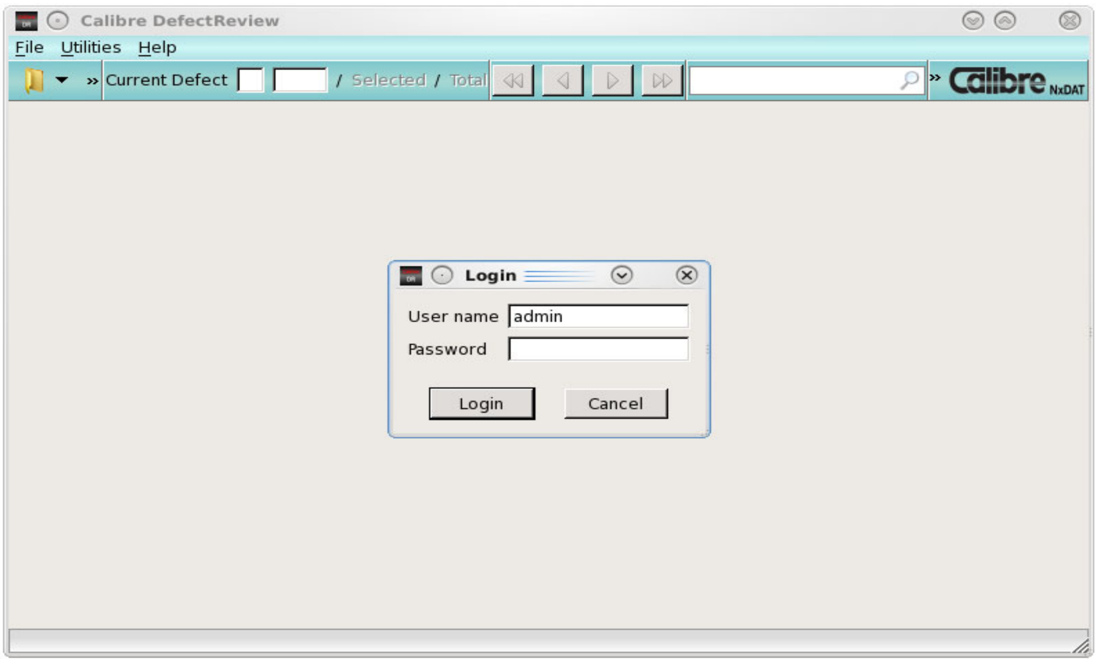
1. Select **Start > All Programs > DefectAnalysisTool > Defect Analysis Tool**.

Alternatively, double-click the shortcut icon on the desktop.

Figure 1-10. Shortcut Icon

The Calibre DefectReview launcher appears as shown in Figure 1-11.

Figure 1-11. Calibre DefectReview Launcher Screen



2. Log in to the tool by entering a user name and password on the login screen. When logging in for the first time, use the default user name and password. The following are the default settings:

   - **User Name** — admin
   - **Default Password** — welcome
   - **User Type** — privileged

     There are three user levels: privileged, normal and restricted. These are further described in the section “User Permissions Overview”.

     Note

     When you log in for the first time or if the End User License Agreement (EULA) was not accepted before, a License Agreement dialog appears, and you must click “**I accept the agreement**” in order to begin using Calibre DefectReview.

   The user name and password are case-sensitive. They may contain spaces and special characters, such as @. There is no character limit.

Invoking Calibre DefectReview on Linux Hosts

To begin using Calibre DefectReview on Linux hosts, invoke the Calibre DefectReview executable and then log in.

Prerequisites

- A valid Calibre DefectReview license.
- The Calibre DefectReview product installed as described in the *Calibre Administrator's Guide*.

Procedure

1. In a command window, set the environment variable NXDAT_MGC_HOME to your Calibre DefectReview installation directory and LM_LICENSE_FILE to your license file installation location.

   ```
   setenv NXDAT_MGC_HOME <path_to_Calibre_DefectReview_install>
   setenv LM_LICENSE_FILE <path_to_license_file>
   ```

2. To invoke Calibre DefectReview, in the same command window:

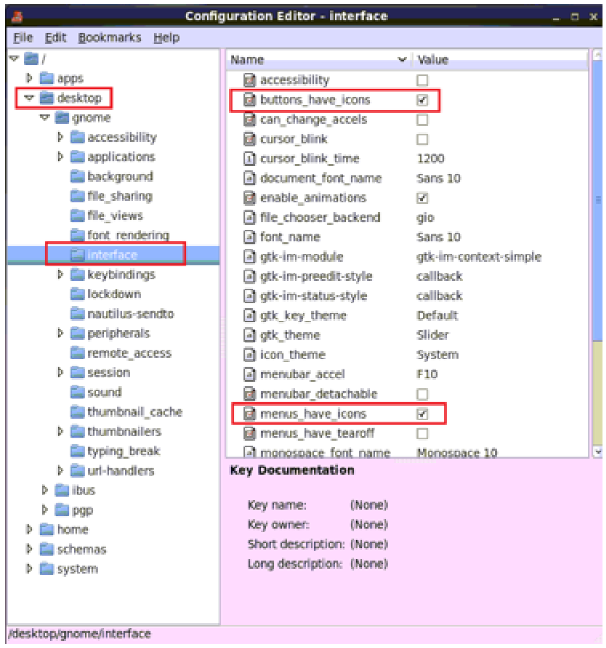
   ```
   $NXDAT_MGC_HOME/bin/nxdat
   ```

   All log files are created in *$HOME/.calibrenx_workspace/*. If icons are not visible in Calibre DefectReview menus, run the following command:

   ```
   gconftool-2 --type boolean --set /desktop/gnome/interface/
   menus_have_icons true
   ```

   Alternatively, you can use the Linux configuration editor (on your Linux desktop, select **Applications** > **Configuration Editor**).

Figure 1-12. Linux Configuration Editor



Select **desktop** > **interface**, then check **buttons_have_icons** and **menus_have_icons**.

Importing Settings on Linux

Calibre DefectReview allows you to import your user configurations from a previous version.

Procedure

1. When you invoke a new version Calibre DefectReview, you are asked if you want to import user configurations from a previous version. For example, you have been using the 2018.4 version of Calibre DefectReview and you have customizations in your configuration files. When you update to the 2019.1 version of Calibre DefectReview, all your customizations are applied to your new configuration files. A message similar to the following appears in a dialog box:

```
Import user configurations from NxDAT version "2018.4_xx.xx" to
"2019.1_xx.xx"?
```

2. In the dialog box, you are prompted to click either **Yes** or **No**. To import your settings, click **Yes**. All changes in your old configuration file are updated in the new file (in the *dat-ini.xml* and *dat-ini-wafer.xml* files). Click **No** to use the latest configuration file without importing previous modifications. Once the update is complete, the following message appears:

```
Updated Configuration Files
Tool will launch automatically after 5 seconds.
```

3. Either click **OK** or wait until Calibre DefectReview appears automatically.

Note

Importing user settings do not work if you downgrade (for example going from 2019.1 to 2018.4).

Introduction to the Calibre DefectReview Configuration File

After you login to Calibre DefectReview for the first time, a configuration file called *dat-ini.xml* is created in your HOME directory. The location of this file is *$HOME/.calibrenx_workspace/*.

For the wafer tool, the configuration file is called *dat-ini-wafer*.*xml*. This file is created in *$HOME/.calibrenx_workspace/* when you launch the wafer tool.

Edit the configuration file to manually configure settings for Calibre DefectReview. The specific settings and their syntax are described along with their relevant tasks and features throughout this document.

Note

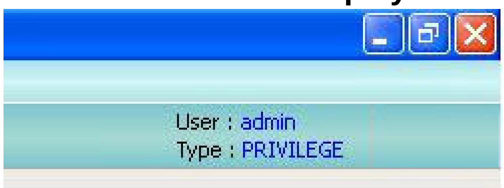
Exercise caution before modifying any values in the configuration file as it contains mandatory and critical parameters to run the tool.

User Permissions Overview

There are three user permission levels, also referred to as user types, that control the availability of features in Calibre DefectReview: privileged, normal, and restricted.

Once you log in, the user name and the user type are displayed in the toolbar as shown in Figure 1-13.

Figure 1-13. User Information Displayed in the Toolbar



Privileged Users

Of the three types, privileged users have the greatest access to Calibre DefectReview features. In particular, privileged users can delete defects from the inspection file.

Defects can be deleted using the following methods:

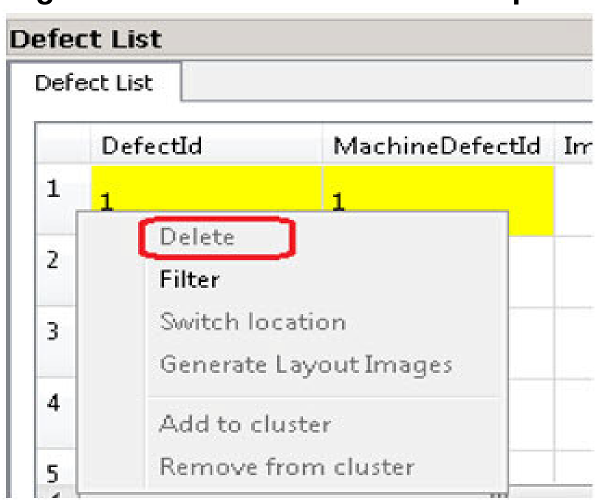
- Using **Delete** from the right-click menu displayed when selecting a specific defect (or defect group) in the following windows and locations:
  - Defect Map
  - Defect List
  - Repeatability Analysis charts
- Pressing the **Delete** key to delete defects selected in the Defect List table. Refer to "Defect Operations in the Defect Map Window" on page 144 for further details on deleting defects.

Normal Users

The restrictions for normal users are as follows:

- Normal users cannot delete defects from the inspection file. If you log in as in as a normal user, the **Delete** option in the right-click popup menu that appears when selecting a defect is unavailable (see Figure 1-14).

Figure 1-14. Unavailable Delete Option



If a normal user presses the **Delete** key to delete defects selected in the Defect List table, a "Normal users do not have permission to delete defects" warning message is issued.

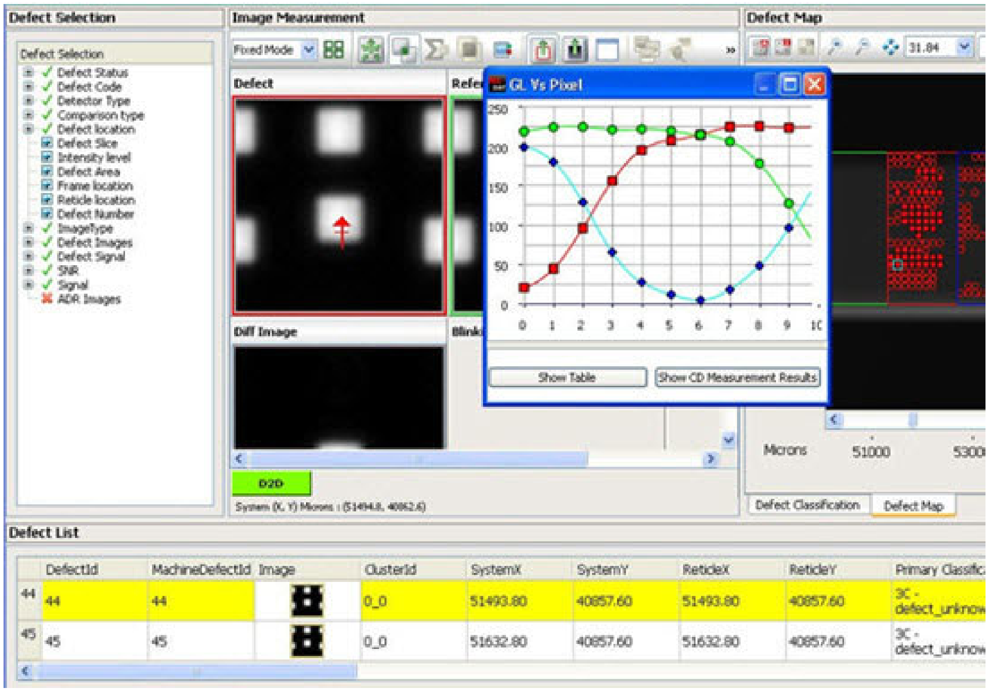
Restricted Users

In addition to all limits enforced for normal users, restricted users have the following additional limitations:

- Restricted users cannot modify the Calibre DefectReview layout.

  Restricted users cannot move or close most parts of the Calibre DefectReview layout except for the Cross Section window. Double-clicking on any docked pane will not undock it. However, the Cross Section dialog box can be docked or undocked in order to view the CD analysis results (as shown in Figure 1-15).

Figure 1-15. Undocked Cross Section Window for Restricted User

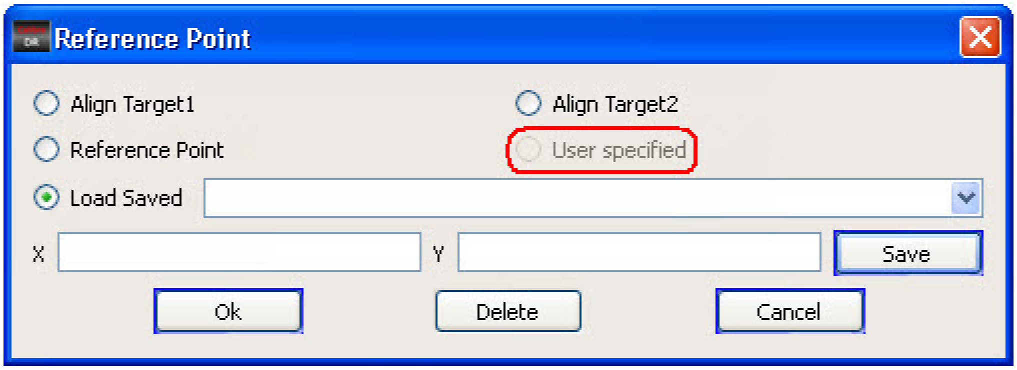


- The following menus in the main Calibre DefectReview menu bar are unavailable for restricted users (see Figure 1-16):
  - **View**
  - **Dock Layout**
  - **Layout**
  - **Plugins**

Figure 1-16. Menus Unavailable for Restricted Users

  - The **Read Write Plugins** menu item in the **Utilities** menu is also unavailable.
- A restricted user cannot define new reference points, and defined reference points also cannot be modified. The User specified radio button is unavailable in the Reference Point dialog box (see Figure 1-17). Refer to the section “Translate” on page 410 for details on opening the Reference Point dialog box.

Figure 1-17. Unavailable User Specified Option



- Restricted users cannot classify multiple defects at once. Restricted users cannot classify multiple defects using the Defect List, Defect Map, or Repeatability Analysis list.

  If a restricted user attempts to classify multiple defects in any of these modules, a “RESTRICTED users do not have permission to classify multiple defects” warning message is issued.

Related Topics

User Management

Configuration of Utilities and Settings Menus

You can configure menu items under the **Utilities** and **Settings** menus for normal and restricted user types in Calibre DefectReview’s *dat-ini.xml* file. This is set using the UserFeatureControl entry in the datInfo node of the *dat-ini.xml* file.

An example of the UserFeatureControl node from a *dat-in.xml* file is shown in Figure 1-18, listing the state of **Utilities** (under UtilitiesFeatureList) and **Settings** (under SettingsFeatureList) menu items for a normal user type.

You can activateor deactivate menu items by specifying ENABLED or DISABLED for each menu entry in the UserFeatureControl node. By default, all menu items are enabled. Menu items that are unavailable for normal users are disabled for restricted users as well.

To configure menu items for a restricted user, add a similar child node to the *dat-ini.xml* file with the User type set to RESTRICTED.

Figure 1-18. UserFeatureControl Node Example

```xml
<UserFeatureControl>
 <User type="NORMAL">
  <UtilitiesFeatureList>
   <Feature name="Calibration Parameter Editor">ENABLED</Feature>
   <Feature name="Read Write Plugins">ENABLED</Feature>
   <Feature name="Manage users">ENABLED</Feature>
   <Feature name="Start Recording">ENABLED</Feature>
   <Feature name="Stop Recording">ENABLED</Feature>
   <Feature name="Run Recorded Script">ENABLED</Feature>
   <Feature name="Save Defect List">ENABLED</Feature>
   <Feature name="Save Correlation List">ENABLED</Feature>
   <Feature name="Save Dock Layout">ENABLED</Feature>
   <Feature name="Load Dock Layout">ENABLED</Feature>
   <Feature name="Auto Cluster">ENABLED</Feature>
   <Feature name="Auto Grid Detection">ENABLED</Feature>
   <Feature name="Mosaic">ENABLED</Feature>
   <Feature name="Reset Classification">ENABLED</Feature>
   <Feature name="Switch Location">ENABLED</Feature>
   <Feature name="Load Image File">ENABLED</Feature>
   <Feature name="Unfilter All Filtered">ENABLED</Feature>
   <Feature name="Save With Delete Tiff">ENABLED</Feature>
   <Feature name="Merge Defect Files">ENABLED</Feature>
   <Feature name="Export">ENABLED</Feature>
   <Feature name="Translate">ENABLED</Feature>
   <Feature name="Alignment Info">ENABLED</Feature>
  </UtilitiesFeatureList>
  <SettingsFeatureList>
   <Feature name="Set Binary Image Properties">ENABLED</Feature>
   <Feature name="Set CD Measurement Properties">ENABLED</Feature>
   <Feature name="Set Contact Measurement Properties">ENABLED</Feature>
   <Feature name="Set Image Interpolation Properties">ENABLED</Feature>
   <Feature name="Set Image Window Properties">ENABLED</Feature>
   <Feature name="Set Image Registration Properties">ENABLED</Feature>
   <Feature name="Set Reference Point">ENABLED</Feature>
   <Feature name="Set Record Script">ENABLED</Feature>
  </SettingsFeatureList>
  <DefectMapFeatureList>
   <Feature name="RubberBand Selection">ENABLED</Feature>
   <Feature name="All Defects">ENABLED</Feature>
   <Feature name="Isolated Defects Only">ENABLED</Feature>
   <Feature name="Clustered Defects Only">ENABLED</Feature>
   <Feature name="Zoom In">ENABLED</Feature>
   <Feature name="Zoom Out">ENABLED</Feature>
   <Feature name="Fit To Window">ENABLED</Feature>
   <Feature name="Zoom Factor">ENABLED</Feature>
   <Feature name="Overlay Die Cycle">ENABLED</Feature>
   <Feature name="Overlay Reticle Image">ENABLED</Feature>
   <Feature name="Show Origin">ENABLED</Feature>
   <Feature name="Show Classification Label">ENABLED</Feature>
   <Feature name="Ruler">ENABLED</Feature>
   <Feature name="Go To XY">ENABLED</Feature>
   <Feature name="Show Capture Rate">ENABLED</Feature>
   <Feature name="Show Comparison Type">ENABLED</Feature>
   <Feature name="Demarcate Inspection">ENABLED</Feature>
   <Feature name="Classify">ENABLED</Feature>
   <Feature name="Display Grid">ENABLED</Feature>
   <Feature name="Hide Grid">ENABLED</Feature>
   <Feature name="Reverse Grid Labels">DISABLED</Feature>
   <Feature name="Reverse Periodiocity Labels">ENABLED</Feature>
   <Feature name="Add Grid Line">ENABLED</Feature>
   <Feature name="Delete Grid Line">ENABLED</Feature>
  </DefectMapFeatureList>
 </User>
```

Some items have permanent restrictions associated with the user type, such as the ability to delete. These are covered in "User Management Restrictions" on page 53. These permanent restrictions cannot be overridden by the *dat-ini.xml* file.

For example, as the **Read Write Plugins** menu item in the **Utilities** menu is unavailable for the restricted user, the corresponding feature is not listed under the UserFeaturesList node for a restricted user type.

User Management

After logging in as a privileged account, there are a number of operations that allow you to manage user access to Calibre DefectReview features.

Adding a New User

You can add a new user to Calibre DefectReview through the **Utilities** menu.

Prerequisites

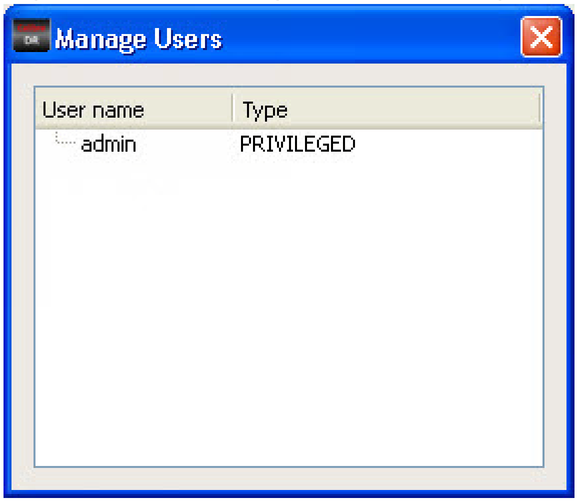
- To add a new user for AOI Linux hosts, your system administrator must have write permission in the location where $NXDAT_MGC_HOME is set. The password file is stored in the following location:

```
$NXDAT_MGC_HOME/pkgs/nxdat.aoi/pvt/NxDAT.password
```

Procedure

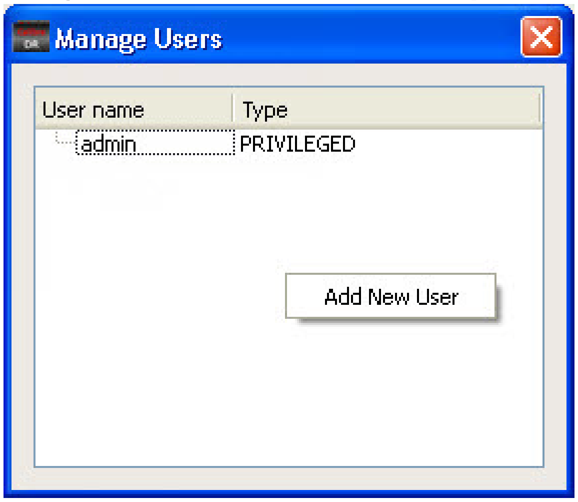
1. In the Calibre DefectReview menu bar, select **Utilities** > **Manage Users**. The Manage Users dialog box appears (see Figure 1-19).

Figure 1-19. Manage Users Dialog Box



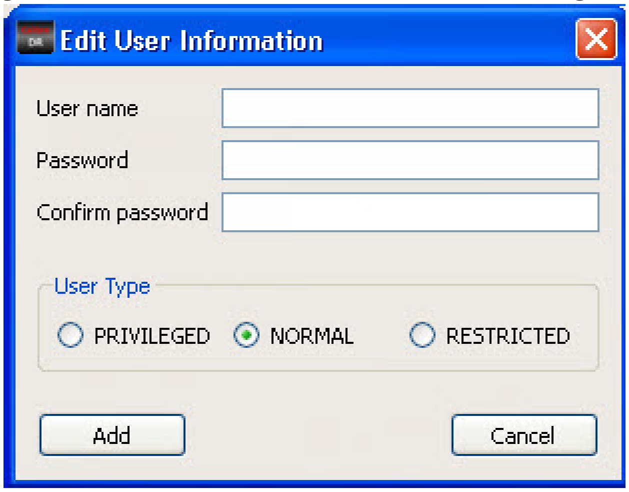
2. Right-click on the blank space of the dialog box. A popup menu appears with the **Add New User** item (see Figure 1-20).

Figure 1-20. Add New User Option



3. Click **Add New User**. The Edit User Information dialog box appears (see Figure 1-21).

Figure 1-21. End User Information Dialog Box



4. In the Edit User Information dialog box, enter the following information:
   - **User name** — Enter a non-empty string.
   - **Password** — Enter a password for the new user.
   - **Confirm password** — Re-enter the same user password.
   - **User Type** — Choose PRIVILEGED, NORMAL, or RESTRICTED.
5. Click **Add** to add the user or **Cancel** to cancel the entry.

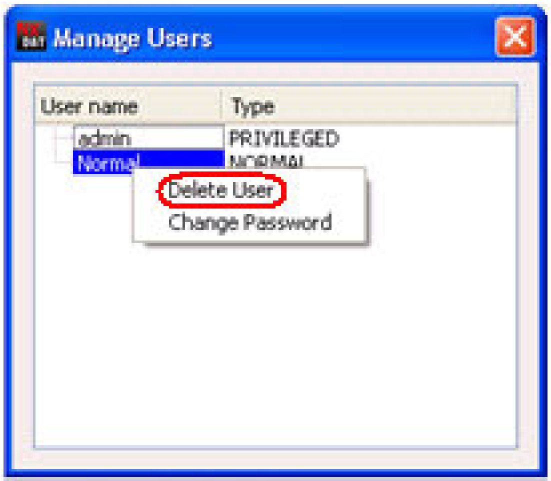
Deleting a User

You can delete an existing user account from Calibre DefectReview.

Procedure

1. In the Calibre DefectReview menu bar, select **Utilities** > **Manage Users**. The Manage Users dialog box appears with a list of users.
2. Right-click the user to be deleted. A popup menu appears with a **Delete User** item (see Figure 1-22).

Figure 1-22. Delete User Menu Item



3. Click **Delete User**. A message appears, prompting you to confirm the deletion.
4. Click **Yes** to delete the user. Once the account is deleted, the user is not able to access Calibre DefectReview upon the next log in or when importing or adding a file in the active session.

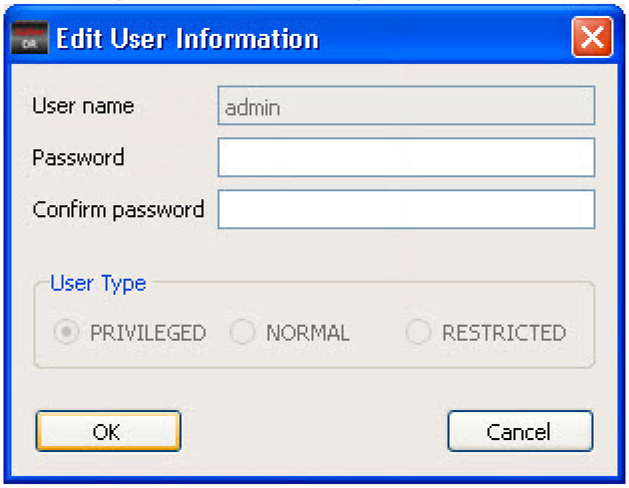
Changing a User Password

You can change a Calibre DefectReview user password in the **Utilities** menu.

Procedure

1. In the Calibre DefectReview menu bar, select **Utilities** > **Manage Users**. The Manage Users dialog box appears with a list of users.
2. Right-click on a user. A popup menu appears with **Change Password**.
3. Click **Change Password**. The Edit User Information dialog box appears as shown in the Figure 1-23.
4. In the Edit User Information dialog box, enter the new password twice, then click **OK**.

Figure 1-23. Change Password



User Management Restrictions

There are three user types: privileged, normal, and restricted. There are additional restrictions that apply when performing user management tasks.

General Restrictions

The following restrictions apply to all user types:

- If an incorrect user name or password is entered during log in, a “Sorry invalid user name or password” message is issued.
- You cannot change the password of another user. If you attempt to change another user’s password, a “You do not have permission to change another user’s password” message is issued.
- You cannot create a new user account with an existing user name. If you attempt to do so, a “User ‘*username*’ already exists” message is issued.

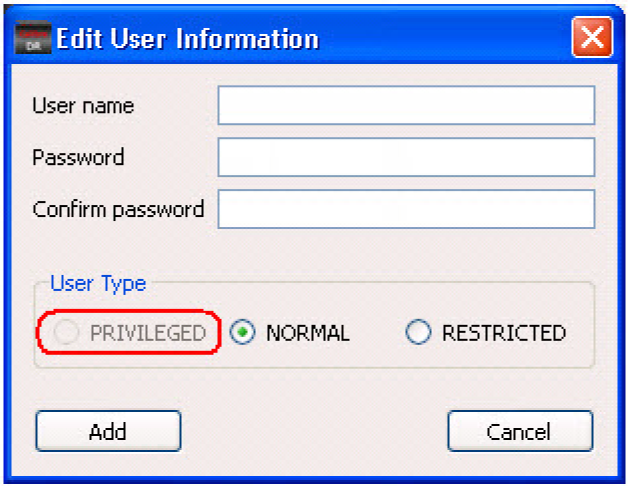
Restrictions for Normal and Restricted Users

There are restrictions related to user management that apply to normal and restricted users.

For normal users:

- Normal users cannot create or delete privileged users.
- The radio button PRIVILEGED User Type in the Edit User Information dialog box is unavailable, preventing a normal user from defining new privileged users. Normal users can create new normal and restricted user accounts as shown in the Figure 1-24.

Figure 1-24. Edit User Information for Normal Users



- Normal users are not allowed to delete privileged users. However, a normal user is allowed to delete other normal and restricted users. If a normal user selects the option **Delete User** (Figure 1-22) for any privileged user, then a "NORMAL users do not have permission to delete PRIVILEGED user" error message is issued.

For restricted users:

- Restricted users cannot define any new users or delete any existing users.

  If a restricted user attempts to delete an existing user, a "RESTRICTED users do not have permission to delete any user" error message is issued.

- The **Add User** menu item is dimmed for restricted users (shown in Figure 1-25).

Figure 1-25. Add New User Unavailable for Restricted Users

Inspection File Operations

Calibre DefectReview uses an inspection file as the primary means of collecting and tracking defect information.

Opening Inspection Files

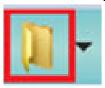
You can open inspection files from the **File** menu of Calibre DefectReview.

Procedure

1. In the Calibre DefectReview main window, display the Open Inspection(s) dialog box in one of two ways:

   - Select **File** > **Open Inspection(s)**.
   - Click the Open Inspection(s) icon in the tool bar (see Figure 1-26).

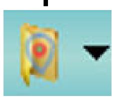
   Figure 1-26. Open Inspection(s) Icon

   To open an inspection report in place of one that is currently open, use one of two ways:

   - Select **File** > **Open Inspection(s) Inplace**.
   - Click the Open Inspection(s) In Place icon in the tool bar (see Figure 1-26).

   Figure 1-27. Open Inspection(s) In Place Icon

   This keeps the current GUI configuration intact and opens the Open Inspection(s) dialog box to select inspection files.

2. In the Open Defect Inspection(s) dialog box:

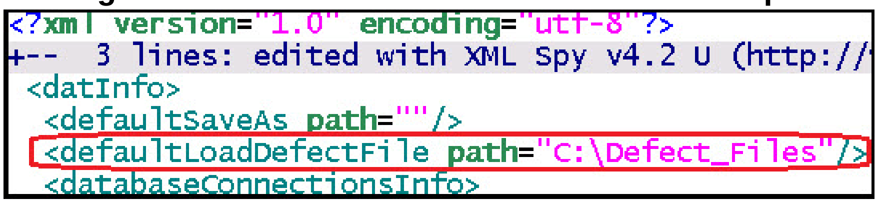
   - To select a single file, click the filename.

- To select multiple files:
    - Click on one file, then press the Ctrl key and click on other desired files.
    - To open all files in a given folder, click on one file and then use Ctrl-a to select all the files.
    - You can also use the Shift key and select a range of files.

3. Click **Open**.

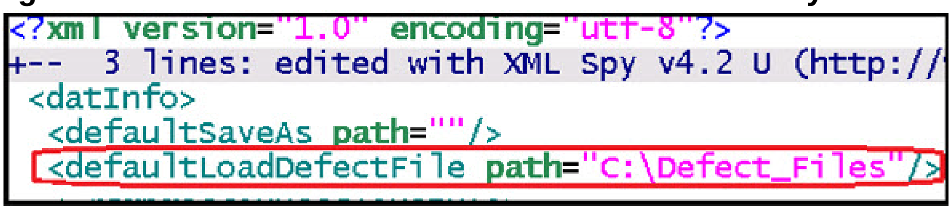
4. You can also specify a default path for opening a inspection file in the defaultLoadDefectFile entry for the *dat-ini.xml* file as shown in Figure 1-28.

Figure 1-28. defaultLoadDefectFile Path Example



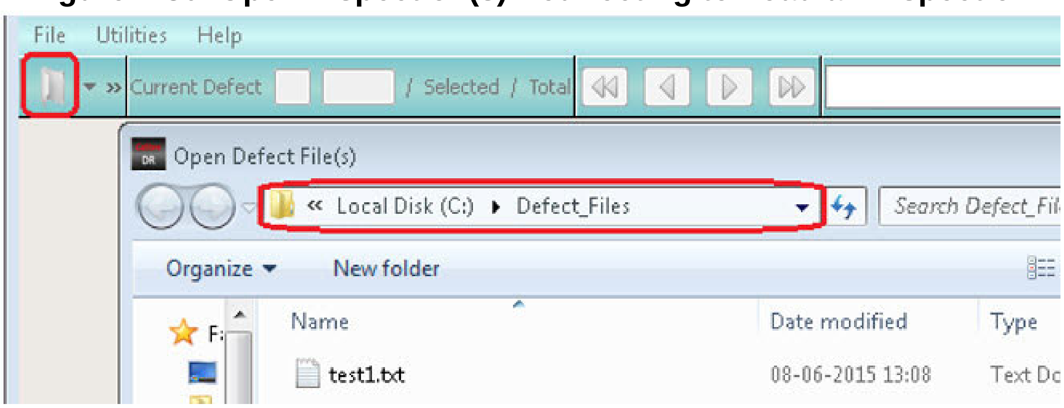
By default, the path is empty. To enable it, specify a valid path as shown.

Figure 1-29. defaultLoadDefectFile With Valid Directory Location



5. Once a default path has been specified, the Open Inspection(s) dialog box redirects to that directory for loading an inspection file.

Figure 1-30. Open Inspection(s) Redirecting to Load an Inspection



Note

Calibre DefectReview supports mask inspection report files but wafer files are not supported. To open a wafer inspection report file, use Wi2Mi. Refer to "Using Wi2Mi" on page 529 for details.

Opening Recently-Opened Files

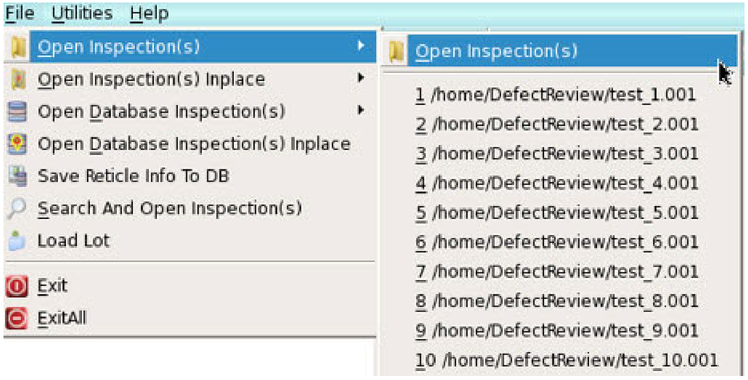
You can also open recently opened files from the **File** menu.

Procedure

1. To open a recently opened file, you can do either of the following:

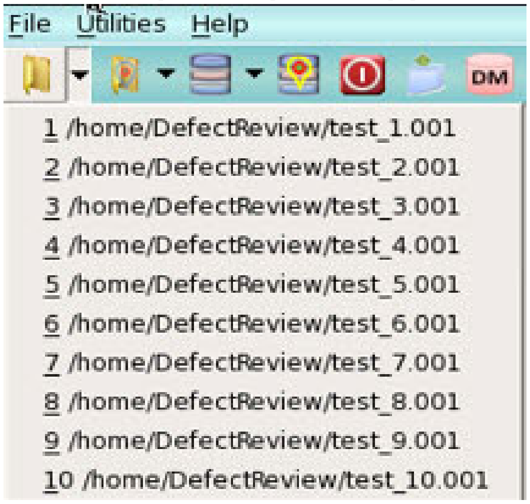
    - In the Calibre DefectReview menu bar, select **File** > **Open Inspection(s)**. A sub-menu with recently opened files appears.

    Figure 1-31. Open Inspection(s) With File List

    - Click the **Open Inspection(s)** dropdown icon in the toolbar. A recently opened file list appears.

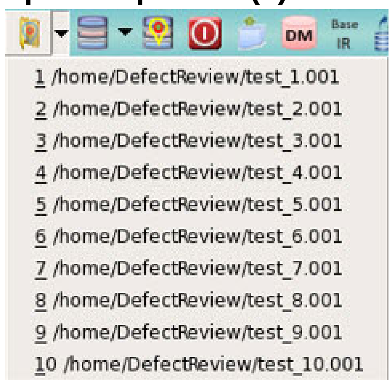
    Figure 1-32. Open Inspection(s) Sub-menu

To open another recently-opened inspection report that replaces the currently open report (while keeping the current GUI window arrangement unchanged):

- In the Calibre DefectReview menu bar, select **File** > **Open Inspection(s) Inplace**. A sub-menu with recently opened files appears.
- Click the **Open Inspection(s) Inplace** dropdown icon in the toolbar. A recently opened file list appears.

Figure 1-33. Open Inspection(s) In Place Sub-menu



2. Select the desired file from the available list.

Note

Recently opened files of each user are displayed in each user's recent file list.

Inspection File Search

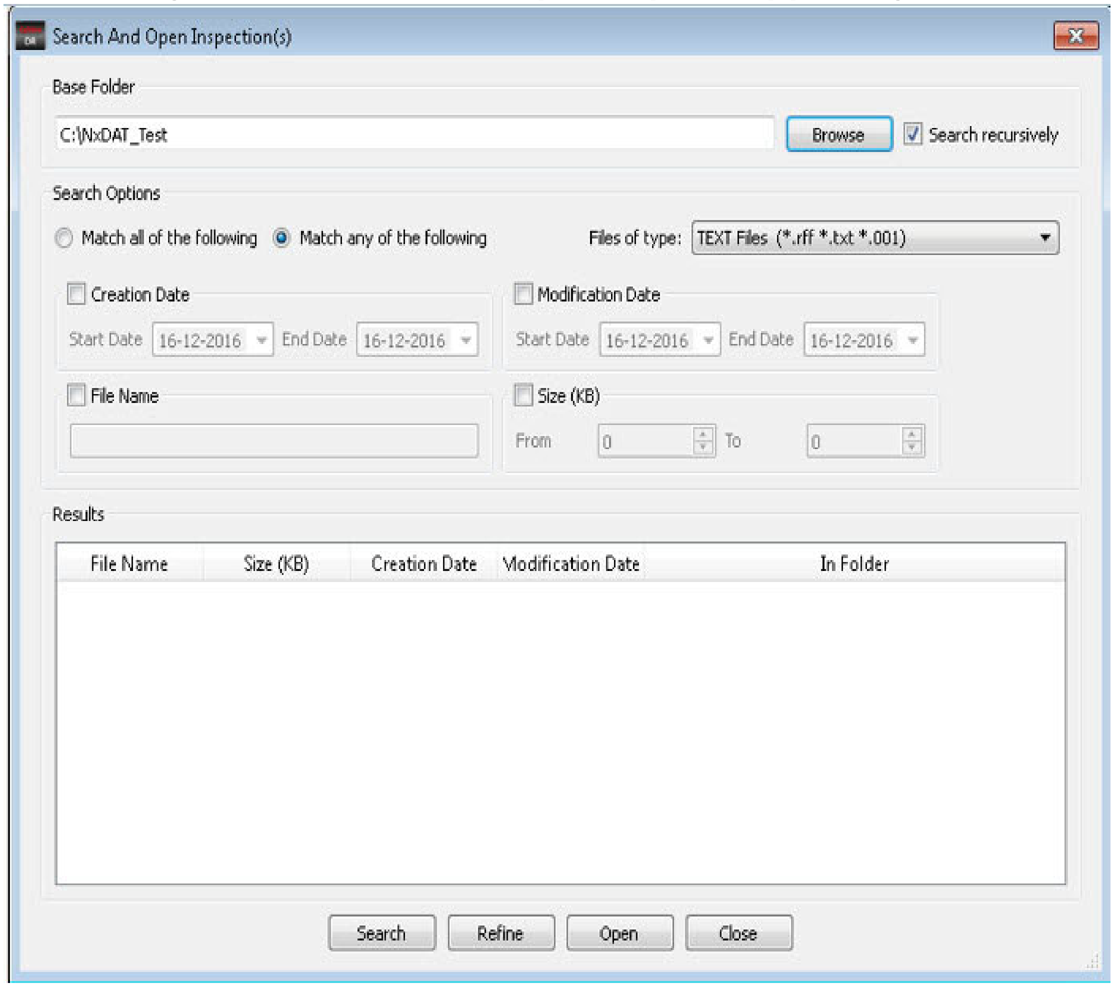
There are a number of methods available to search for and open inspection files using Calibre DefectReview.

Setting Up Search Parameters

Use the Search and Open Inspection(s) dialog box to set up parameters for your search for inspection files.

Figure 1-34 shows the Search And Open Inspection(s) dialog box. The dialog box has a base folder area, a search options area with advanced search options, and a results area to display the results of the search operation.

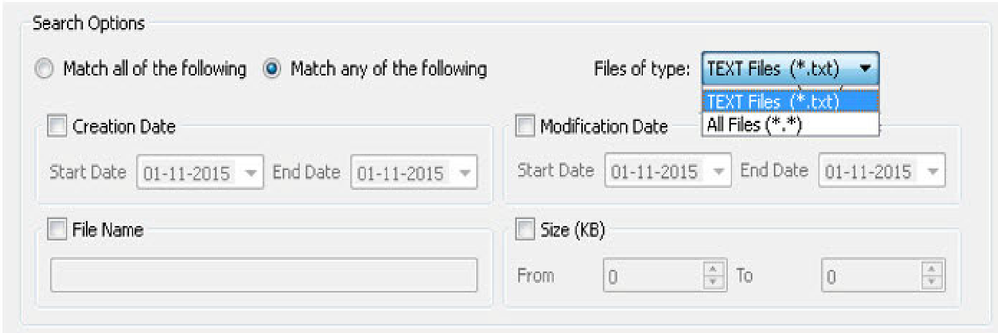
Figure 1-34. Search And Open Inspection(s) Dialog Box



Procedure

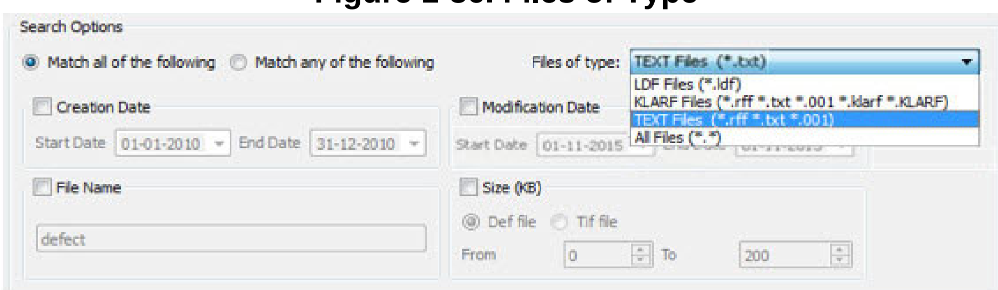
1. In the Calibre DefectReview menu bar, select **File** > **Search And Open Inspection(s)**.
2. Set the base folder by clicking the **Browse** button. A Select Base Folder dialog box appears.
3. Select the base folder. The search operation is performed inside the base folder.
4. Select the “Search recursively” check box.
5. Figure 1-35 shows the Search Options of the Search And Open Inspection(s) dialog box.

Figure 1-35. Search Options



- To search files matching or satisfying all the search options or criteria, select the **Match all of the following** option. This type of search operation resembles an AND operation of all the selected search options.
- To search files satisfying any of the search options or criteria, select the **Match any of the following** option. This type of search operation resembles an OR operation of all the selected search options.
- To search for a specific type of file, select the type of file to be searched from “Files of type” list box, as shown in Figure 1-36. The types are configured through the *dat-ini.xml* file.

Figure 1-36. Files of Type



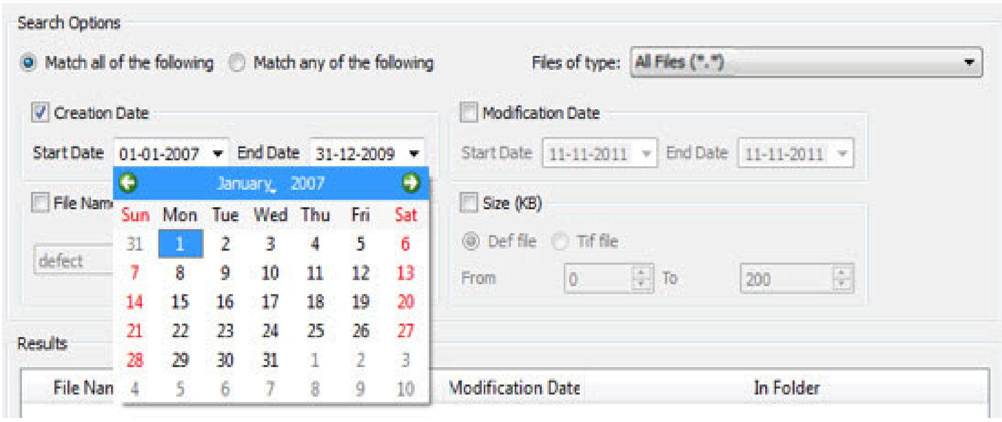
Searching Based on Creation Date

You can set the search utility to search based on the file creation date.

Procedure

1. In the Search and Open Inspection(s) dialog box, select the Creation Date check box.
2. To set the start and end dates, for each entry, click the down arrow and a calendar appears. Select the desired dates as shown in Figure 1-37.

Figure 1-37. Creation Date Option



3. Note the following:
    - The system creation date (returned by operating system) is used to search the results.
    - By default, the End Date is the current date. If the End Date is not entered, all files with creation dates between the starting date and the current date are selected.

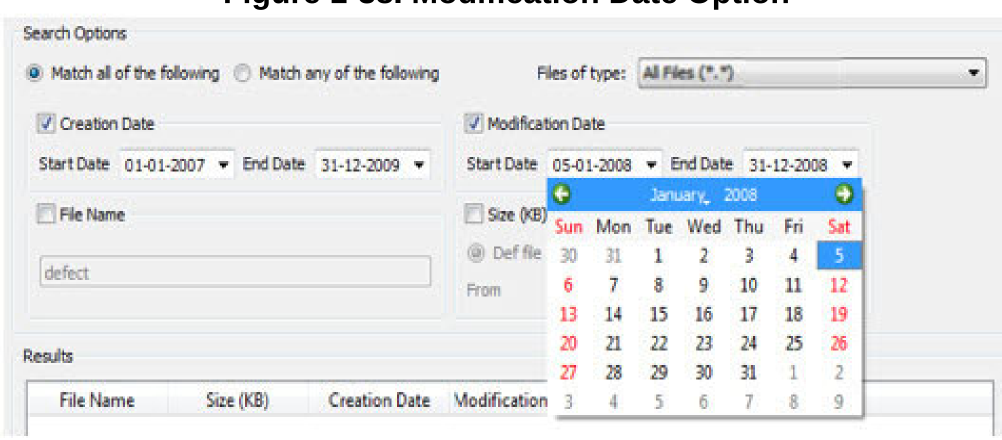
Searching Based on Modification Date

You can set the search utility to search based on modification date.

Procedure

1. In the Search and Open Inspection(s) dialog box, select the Modification Date check box.
2. To set the start and end dates, for each entry, click the down arrow and a calendar appears. Select the desired dates as shown in Figure 1-38.

Figure 1-38. Modification Date Option



3. Note the following:

    - The system modification date (returned by operating system) is used to search the results.

    - By default, the ending date is the current date. If the ending date is not entered, all files with last modification dates between the starting date and the current date are selected.

Searching Based on Size

You can set the search utility to search based a range of file sizes in kilobytes (KBs).

Procedure

1. In the Search and Open Inspection(s) dialog box, select the Size check box.

2. Enter the lower size limit in the From field.

3. Enter the upper size limit in to To field.

4. Note the following:

    - The system file size is used to search the results.

    - If the lower size limit is not entered, the lower limit defaults to 0 KB.

    - The “Def file” and “Tif file” options are available only if “XML files (*.txt)” is selected in the “Files of type” dropdown list.

    - To search files based on size of the TIF file, select the “Tif file” option. By default, the size option works on the size of the inspection files.

Starting the Search Operation

After setting all desired search criteria in the Search And Open Inspection(s) dialog box, you can begin searching for your inspection file.

Procedure

1. In the Search And Open Inspection(s) dialog box, click the **Search** button. The matching results are listed in the Results area.

    The search operation searches inside the base folder to find the matching results. The results are updated continuously in the Results area as a match is found.

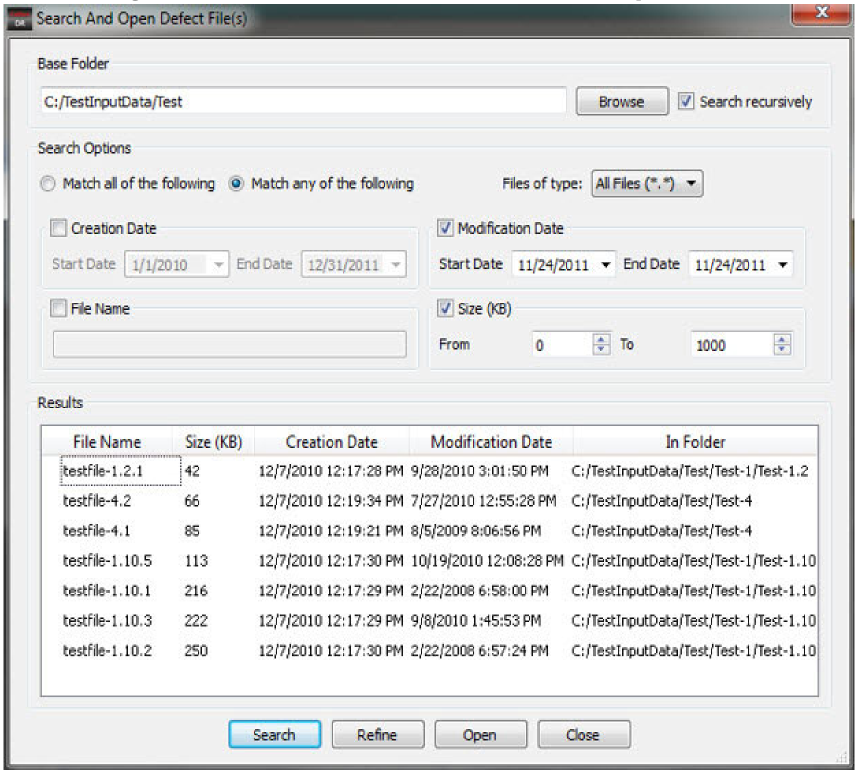
2. To stop the search operation before its completion, click on the **Stop Search** button, which replaces the **Search** button while search operations are underway.

3. Entries in the Results area can be sorted by column. To sort results, click the header of the column.

Results

Figure 1-39 shows the results obtained after a search operation.

Figure 1-39. Results After Search Operation



Refining the Search Results

You can further refine your results using Search Options.

Procedure

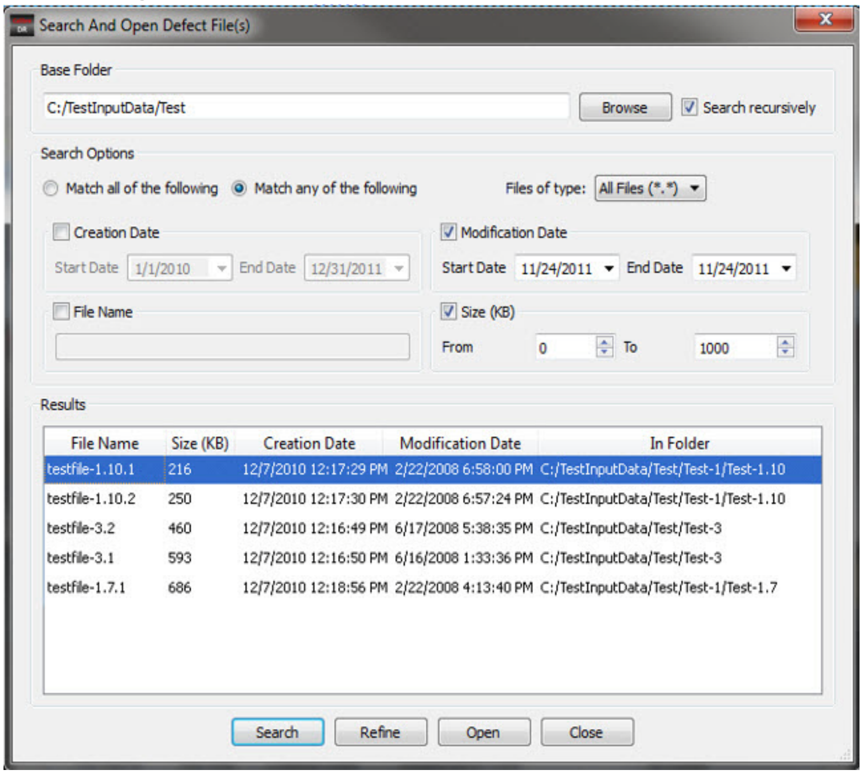
1. Add or modify the search options in the Search Options field.
2. Click the **Refine** button.

   Note

   The Refine operation searches within the existing results in the Results area to find the matching results for the modified search options. The results are updated continuously in the Results area if and when a match is found.

3. Figure 1-40 shows the matching results after refining the search results shown in Figure 1-39.

Figure 1-40. Results After Refine Operation



Saving Inspection File Search Results

You can save your inspection file search results in Calibre DefectReview.

Prerequisites

- An open spreadsheet application.

Procedure

1. Select entries in the Results area of the Search and Open Inspection(s) dialog box. You can use your mouse to drag over an area to select multiple entries.
2. Copy the selected entries by pressing Ctrl-c.
3. Paste the selection into an open spreadsheet by pressing Ctrl-v.

Support for Different Inspection Report Formats

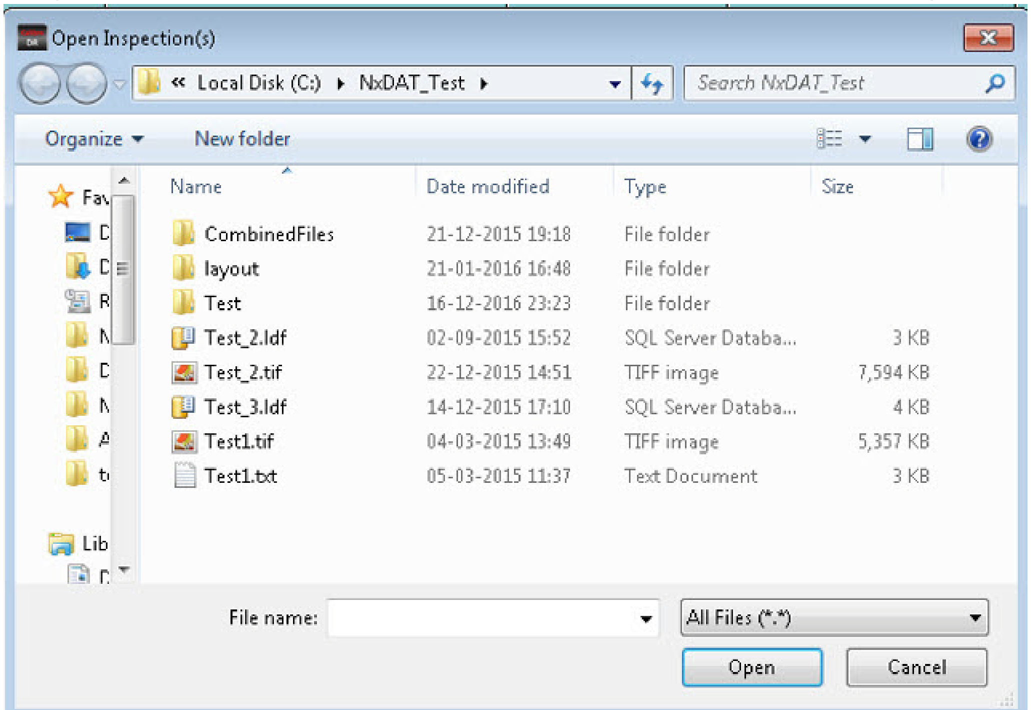
Calibre DefectReview supports alternative inspection reports that you can load into the tool.

The currently supported formats are:

- KLA-Tencor's Klarf v1.2
- Lasertec's X700 and X800 Inspection Report
- NuFlare's XML Inspection Report
- Lasertec's LDF

To select different types of inspection files, select **All Files (*.*)** from the Open Inspection(s) dialog box.

Figure 1-41. All Files Option in the Open Inspection(s) Dialog Box



Klarf Inspection Report

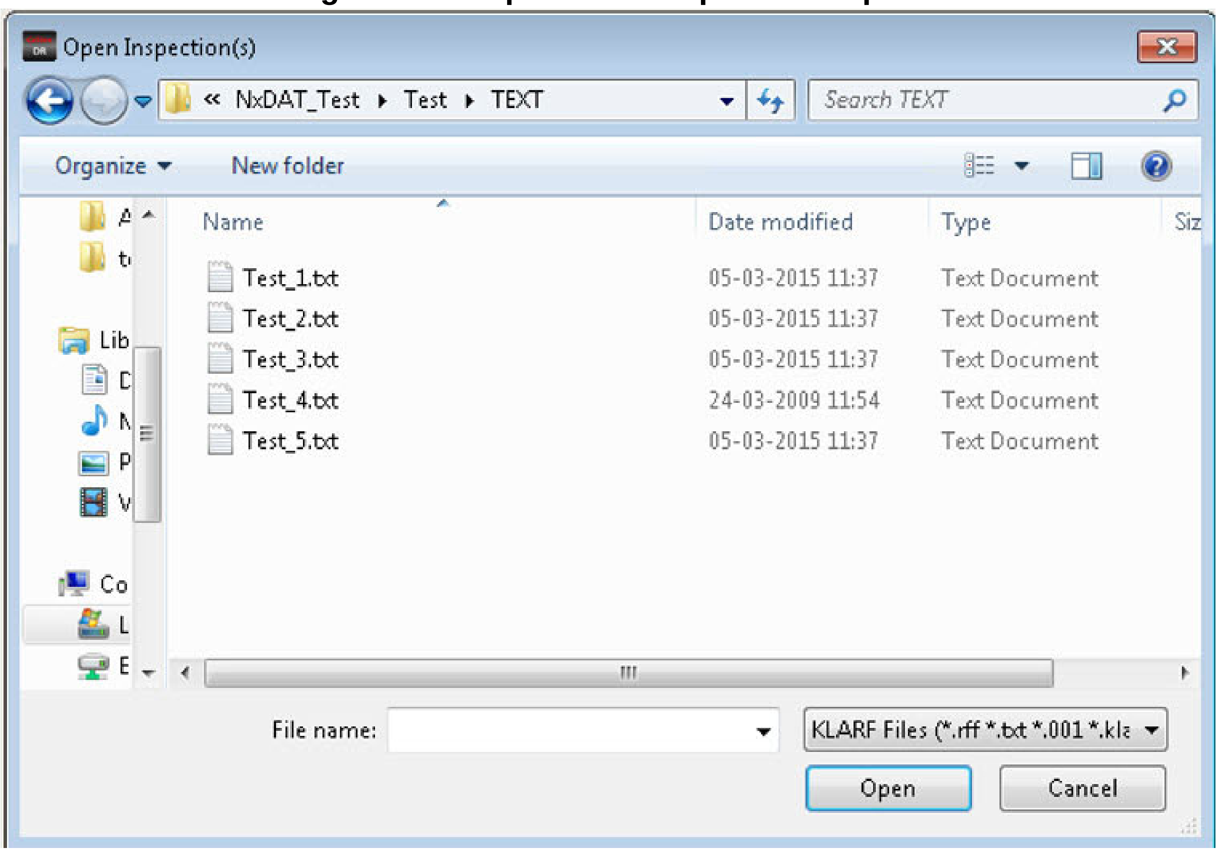
KLA-Tencor inspection report format

Calibre DefectReview supports loading of KLA-Tencor’s Klarf v1.2 inspection report files.

Format

The reader’s functionality is configurable through the node <klarfConfigParams> in the *dat-ini.xml* file. The following figure shows a inspection file opening window with options to read different extensions of Klarf v1.2 format (for example, “.rff”, “.001”, “.txt”, “.klarf” and “.KLARF”).

Figure 1-42. Open Klarf Inspection Report



Parameters

- ext

  Defines the file extensions possible for Klarf inspection report (.rff, .txt, .001, .klarf, and so on). The following figure shows the node and a sample set of values (Klarf file formats).

Figure 1-43. ext Node (Klarf)

```
<ext>rff,txt,001,klarf,KLARF</ext>
```

- InspectionMachines

  Defines the defect and reference tags for transmitted and reflected images to be used for displaying Klarf defect images in Calibre DefectReview. For transmitted images, you must define defect_tag and reference_tag. For reflected images, you must define reflected_defect_tag and reflected_reference_tag. The following figure shows the relevant nodes in the *dat-ini.xml* file.

Figure 1-44. InspectionMachines Node

```
<klarfConfigParams>
 <ext>rff,txt,001,klarf,KLARF</ext>
 <InspectionMachines>
  <Machine name="SLF27-12" mode_number="1" defect_tag="17" reference_tag="18" reflected_defect_tag="" reflected_reference_tag="" />
  <Machine name="TeraScan" mode_number="1" defect_tag="23" reference_tag="27" reflected_defect_tag="" reflected_reference_tag="" />
  <Machine name="6XX" mode_number="1" defect_tag="23" reference_tag="27" reflected_defect_tag="24" reflected_reference_tag="28" />
  <Machine name="6XX" mode_number="2" defect_tag="17" reference_tag="27" reflected_defect_tag="18" reflected_reference_tag="28" />
  <Machine name="UV-200" mode_number="1" defect_tag="30" reference_tag="31" reflected_defect_tag="" reflected_reference_tag="" />
 </InspectionMachines>
```

- UseAlignPtInImport

  Activates or deactivates shifting of defect coordinates by using AlignmentPoints present in a Klarf file.

Figure 1-45. UseAlgnPtInImport Node

```
<UseAlignPtInImport enabled="true">
```

- AlignmentPoint

  If the value of the previous sub-node, UseAlignPtInImport, is set to “true”, and this child node specifies the index of the alignment point by which shifting of defect coordinates is to be done.

Figure 1-46. AlignmentPoint Node

```
<AlignmentPoint index="1" add="yes"/>
```

- AlignmentPointIndex

  Specifies the index of the alignment point against which mask defects are to be aligned.

Figure 1-47. AlignmentPointIndex Node

```
<AlignmentPointIndex value="3"/>
```

- UseXYRELasXY

  Determines whether to consider XREL and YREL values as absolute values instead of relative to Die.

Figure 1-48. UseXYRELasXY Node

```
<UseXYRELasXY enabled="true"/>
```

- classificationTable

  Defines primary classification tables for Klarf inspection files.

- SecondaryClassifications

  Defines multi-tier classification tables for Klarf inspection files.

- KlarfExtensionSupport

  You can add the following columns to the Klarf inspection report by setting KlarfExtensionSupport to true:

  - Aligned X — Reported when you run Calibre DefectClassify (**Utilities** > **Image to Layout Alignment**). Refer to the *Calibre DefectClassify User's Manual* for details.
  - Aligned Y — Reported when you run Calibre DefectClassify (**Utilities** > **Image to Layout Alignment**).
  - PatMatchID — Reported by pattern based defects grouping (see "Performing Pattern Based Defects Grouping" on page 585), representing the pattern classification ID generated by the utility.

  Figure 1-49. KlarfExtensionSupport Node

  ```
  <KlarfExtensionSupport enable="false">
  </KlarfExtensionSupport>
  ```

  If enable is set to true, additional columns are added to the Klarf inspection report.

  Note
  The Cluster Centroid X and Cluster Centroid Y values are also saved.

Klarf Inspection Report Modification Recording

Calibre DefectReview records all changes done in a Klarf file when the inspection file is saved.

Recordings are performed if any of the following occurs:

- The ClassLookUp table changes (due to loading of two Klarf files with a conflicting ClassLookUp table or due to differences in the classification table in the *dat-ini.xml* and inspection file).
- You classify and thus change the classification number.
- You delete a defect.

Once you save the inspection report, the MentorSoftwareChanges keyword is added with all changes. Different types of comments are added based on the user operation:

- During conflicting ClassLookUp:

  MentorSoftwareChanges "ClassLookUp changed from (<*old_classLookUp_table*> to <*new_ClassLookUp_table*>) and each defect's classification index has been remapped"

- During classification:

  MentorSoftwareChanges “Changed defect <*defect_no*>’s classification from <*old_class_number*> to <*new_class_number*>”

- During Deletion of a defect:

  MentorSoftwareChanges “Deleted defect <*defect_no*> (<*all_attributes_of_deleted_defect*>)”

Once you click **Save**, Calibre adds MentorSoftwareChanges. This file is modified by Calibre DefectReview <*version*> comment in addition to all of the previously-defined comments. However, during **Save As** and **Export**, Calibre only adds the following comment: “This file is generated by Calibre DefectReview <*version*>”. All the other comments are deleted.

LRF Inspection Report

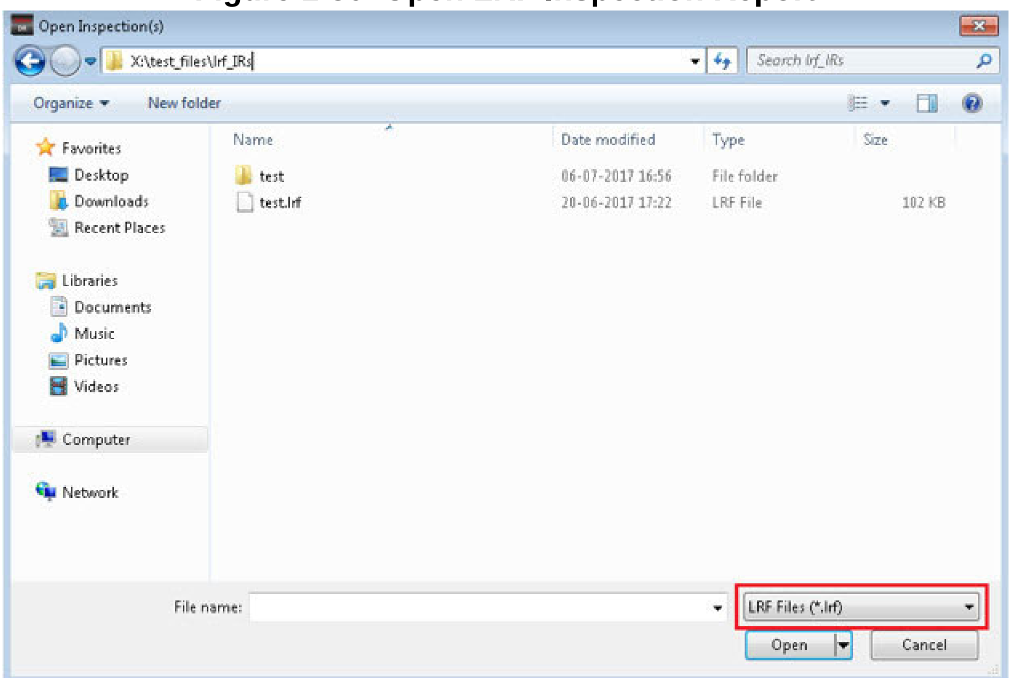
Lasertec inspection report format

Calibre DefectReview supports loading of Lasertec inspection reports. It currently supports X700 and X800 file formats. The LRF inspection report supports the TransRef Mode for improved analysis.

Format

The reader's functionality is configurable through the node lrfConfigParams in the *dat-ini.xml* file. The following figure shows an inspection file window with options to open LRF X700 or X800 file formats.

Figure 1-50. Open LRF Inspection Report



Note

Class names that do not follow the <ClassCode>_<ClassName> format for LRF files are considered invalid and are ignored. They do not appear in the GUI.

Parameters

- ext

  Defines the file extensions possible for an LRF inspection report. The following figure shows the node and a sample set of values (.lrf file formats).

Figure 1-51. ext Node (lrf)

```
<ext>lrf</ext>
```

- lrfX700Images

  Defines the relative folder location from where the images should be picked for lrf X700 inspection reports. It has the following sub-sections:

  - lrfTransImgDir — Defines the transmitted image folder location relative to the inspection report.
  - lrfRelfImgDir — Defines the reflected image folder location relative to the inspection report.
  - lrfReticleImgName — Defines the reticle image name. This reticle image is shown in the Defect Map. It is a relative location to the inspection report.

Figure 1-52. lrfX700Images Node

```
<lrfX700Images>
 <lrfTransImgDir>Images/InstantReviewT</lrfTransImgDir>
 <lrfRelfImgDir>Images/InstantReviewR</lrfRelfImgDir>
 <lrfReticleImgName>LastMacroView4.png</lrfReticleImgName>
</lrfX700Images>
```

- lrfX800Images

  Defines the relative folder location from where the images should be picked for lrf X800 inspection reports. It has the following sub-sections:

  - lrfTransImgDir — Defines the transmitted image folder location relative to the inspection report.
  - lrfRelfImgDir — Defines the reflected image folder location relative to the inspection report.
  - lrfReticleImgName — Defines the reticle image name. This reticle image is shown in the Defect Map. It is a relative location to the inspection report.

Figure 1-53. lrfX800Images Node

```
<lrfX800Images>
 <lrfTransImgDir>Images/InstantReviewT</lrfTransImgDir>
 <lrfRelfImgDir>Images/InstantReviewRt</lrfRelfImgDir>
 <lrfReticleImgName>MacroView4_T.png</lrfReticleImgName>
</lrfX800Images>
```

- classificationTable

  Defines primary classification tables for LRF inspection reports.

- SecondaryClassifications

  Defines multi-tier classification tables for LRF inspection reports.

Note

Automatic image alignment is supported. See “Automatic Alignment of Defect and Reference Images” on page 77 for further information.

NuFlare XML Inspection Report

NuFlare XML inspection report format

Calibre DefectReview supports loading of NuFlare’s XML inspection report files.

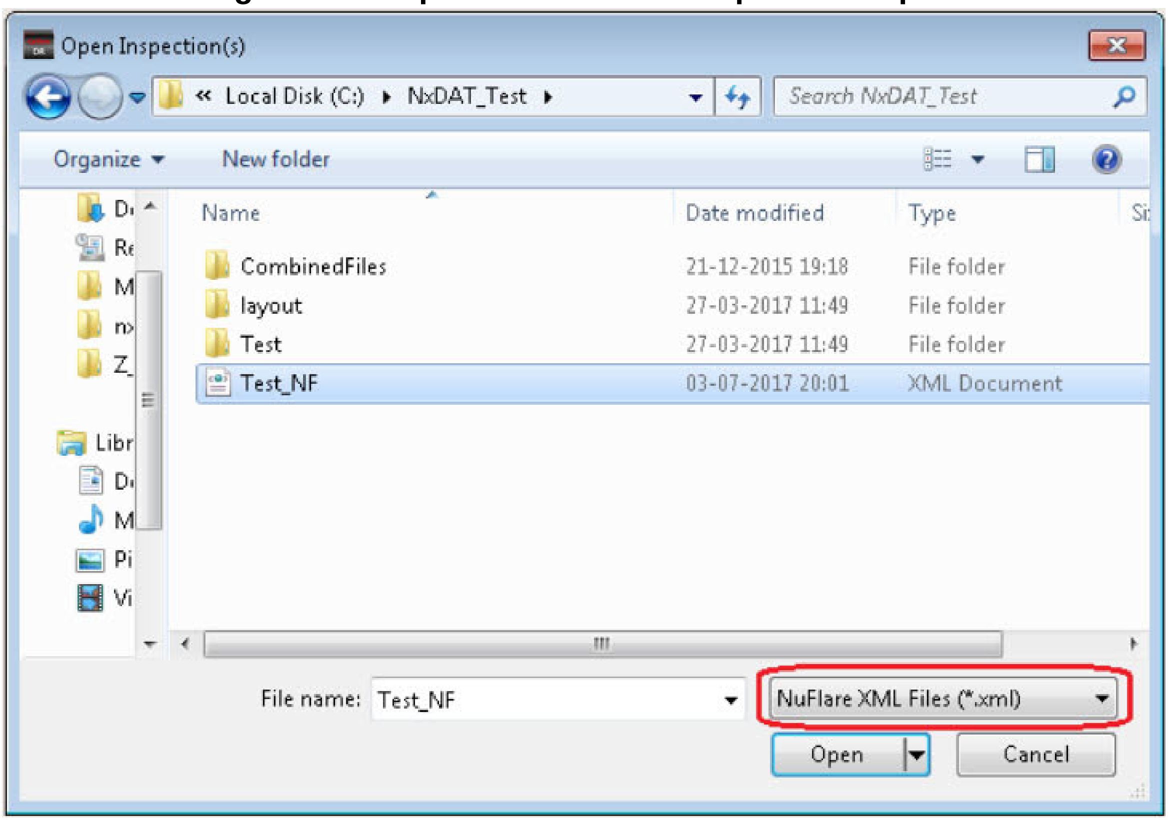
Format

The reader’s functionality is configurable through the node nuFlareXmlConfigParams in the *dat-ini.xml* file.

Note

Automatic image alignment is supported. See “Automatic Alignment of Defect and Reference Images” on page 77 for further information.

Figure 1-54. Open NuFlare XML Inspection Report



Parameters

- ext

  Allows you to configure possible file extensions for the NuFlare XML inspection report (for example, .xml).

Figure 1-55. ext Node (NuFlare XML)

```
<ext>xml</ext>
```

- classificationTable

  Defines primary classification tables for NuFlare XML inspection files.

- SecondaryClassifications

  Defines multi-tier classification tables for NuFlare XML inspection files.

> **Note**
> Currently, saving NuFlare XML to a database and loading from a database is not supported in Calibre DefectReview.

LDF Inspection Report

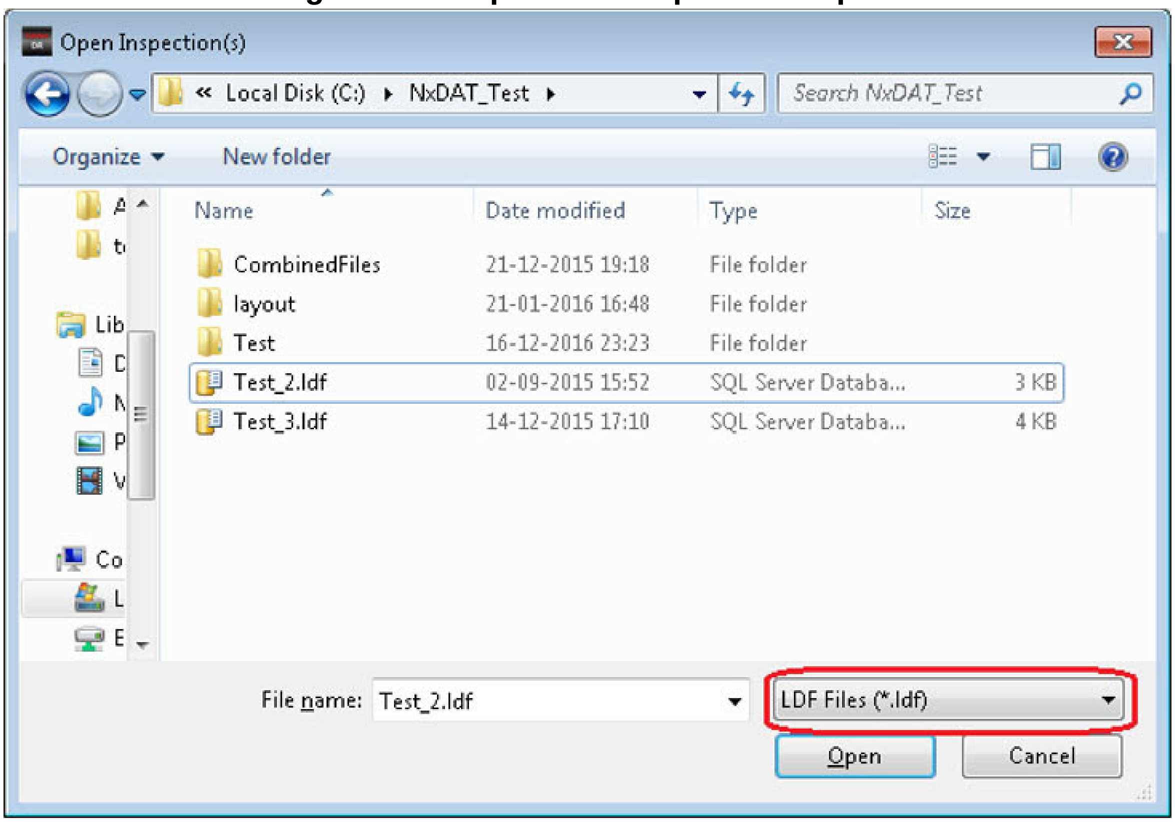
Lasertec LDF inspection report format

Calibre DefectReview supports loading of Lasertec's LDF inspection report files.

Format

The reader's functionality is configurable through the node ldfConfigParams in the *dat-ini.xml* file.

Figure 1-56. Open LDF Inspection Report



Parameters

- ext

  Allows you to configure possible file extensions for the LDF inspection report (for example, .ldf).

  Figure 1-57. ext Node (LDF)

  ```
  <ext>ldf</ext>
  ```

- peripheryArea

  Allows you to configure the size (in micrometers) of the peripheral area of the mask.

Figure 1-58. peripheryArea Node

```
<peripheryArea>152400</peripheryArea>
```

- activeArea

  Allows you to configure the active area (in micrometers).

Figure 1-59. activeArea Node

```
<activeArea>142000</activeArea>
```

- pixelSize

  Specifies the size of a defect image pixel in microns.

Figure 1-60. pixelSize Node

```
<pixelSize>0.125</pixelSize>
```

- ldfConversionFactor

  Specifies the conversion factor to convert measurement unit s from the LDF file format into micrometers as expected by Calibre DefectReview.

Figure 1-61. ldfConversionFactor Node

```
<ldfConversionFactor>1000</ldfConversionFactor>
```

- ldfRefImgName

  Enables you to configure the folder name where the reflected defect images are stored.

Figure 1-62. ldfRefImgName Node

```
<ldfReflImgName>Image</ldfReflImgName>
```

- ldfTransImgName

  Enables you to configure the folder name where transmitted defect images are stored.

Figure 1-63. ldfTransImgName Node

```
<ldfTransImgName>Transmission</ldfTransImgName>
```

- classificationTable

  Defines primary classification tables for LDF inspection files.

- SecondaryClassifications

  Defines mult-itier classification tables for LDF inspection files.

Auxiliary Files and Folders for Supported Inspection Reports

Auxiliary files contain extra review information created by Calibre DefectReview. All supported formats create an auxiliary file when the inspection report is saved. They are also created during a Save As operation.

During a Save or Save As operation, an auxiliary file is created in the inspection report folder itself. This filename is appended with an additional "a". For example, if a Klarf inspection report *test.rff* is opened and saved in Calibre DefectReview, an auxiliary file *test.rffa* is created along with the original inspection report (*test.rff*). Similarly, after performing a Save or Save As of an LRF file *demo.lrf*, an auxiliary file *demo.lrfa* is created.

This file contains extra review information such as Calibre DefectClassify results (if it completed), multi-tier classification performed by the user, and external image information, if any. For further information on Calibre DefectClassify, refer to *Calibre DefectClassify User's Manual*.

Note

The wafer-based Klarf inspection report creates an extra folder to store bin files. The folder name is the same as the inspection report name. For example, if the inspection report is *test.rff*, then Calibre DefectReview creates a folder *test* to store bin files. The bin files are required to draw the contour in IMU images. Refer to the *Calibre DefectClassify User's Manual* for details.

Automatic Alignment of Defect and Reference Images

By default, many types of inspection reports (such as LRF and Nuflare) can have issues when aligning images, which can make the process of finding differences between the defect and reference images cumbersome. To overcome this, Calibre DefectReview performs automatic alignment of defect and reference images during the load time of the inspection report, as well as zooming in and centering the defect location. Calibre DefectReview also maintains a cache of these registered images to speed up the load time for subsequent sessions.

Note

Currently, this functionality is supported for lrfX700, lrfX800, and NuFlare XML formats only.

To register defect and reference images, Calibre DefectReview takes different approaches based on the inspection file types.

lrfX700 Format

Calibre DefectReview reads the file *MatchingShiftResult.csv* that accompanies the inspection file. This file contains required shift values needed to align defect and reference images. If the image registration process is successful, the tool creates two cache folders named *InstantReviewR_REG* (for Reflected images) and *InstantReviewT_REG* (for transmitted images). By default, the **Save To DB** operation also saves the cache.

If write permission is not available, the cache is created inside the system temp folder.

IrfX800 Format

Calibre DefectReview registers defect and reference images using its own algorithms and creates a cache folder named *InstantReviewR_REG* (for Reflected images) and *InstantReviewT_REG* (for transmitted images). By default, the **Save To DB** operation also saves the cache.

If write permission is not available, the cache is created inside the system temp folder.

NuFlare Format

Calibre DefectReview reads the shift values from the inspection report and aligns the images during loading. In this case, the cache is always created in the system temp folder.

Note

A cache created inside system temp folder is not saved in the database. All operations on images (in the IMU) take these registered images.

Reticle Information File (RIF)

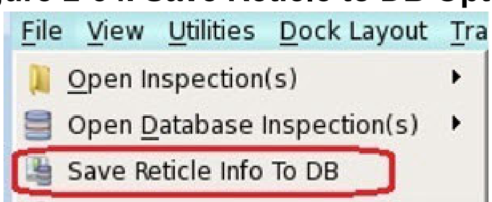
Reticle information file format

A reticle information file (RIF) contains supplemental information about a reticle and inspections that are not captured in an inspection report or auxiliary files (including mask unique ID, mask type, blank mask ID, layout or job deck file name, reticle resist tone, CD image coordinates, wafer scanner parameters).

This information may be available in your internal database and captured in a reticle information file. Calibre DefectReview can load a RIF with this information and save to its defect database. This supplemental information can then be output by defect management queries and be used as input to Calibre DefectClassify.

You can save reticle information by selecting **File** > **Save Reticle Info to DB**. When the Reticle Info File dialog box appears, select a reticle info file with a *.rif* extension and click **Open**. Calibre DefectReview saves the reticle info file to a database as configured in the *dat-ini.xml* file and displays a success message. Upon encountering any error, it displays the appropriate error message.

Figure 1-64. Save Reticle to DB Option



Reticle information is overwritten in the database if it already exists. Each unique file instance is maintained by a mask unique ID for any reticle related information and by inspection unique ID for inspection information. For example, if a RIF file is stored again with a different blank mask unique ID but the same mask unique ID, then the existing blank mask unique ID is overwritten as the mask already exists in the database. However, if a RIF is saved with a new inspection, then the inspection information is added to the database. If an inspection already exists into database, then the inspection information is overwritten.

An error is issued when an existing inspection is saved with a different mask unique ID using an RIF file.

Format

The format of the reticle information file is XML and the following figure illustrates the main nodes.

Figure 1-65. Reticle Information File Example

```
<?xml version='1.0' encoding='utf-8'?>
<ReticleInfoList MaskUniqueId="2202253.003">
    <ReticleInfo>...
    <JobdeckInfo>...
    <InspectionInfoList>
        <InspectionInfo ...
        <InspectionInfo ...
    </InspectionInfoList>
    <ScannerInfo>...
    <TargetCdInfoList>
        <TargetCdInfo ...
        <TargetCdInfo ...
    </TargetCdInfoList>
</ReticleInfoList>
```

The nodes are described in detail in the Parameters section.

Parameters

- ReticleInfoList

  This is the root node in a RIF file and it contains the following attribute:

  - MaskUniqueId — Specifies a unique identifier for a mask. Any string value with maximum length of 255 can be assigned to it.

  The ReticlInfoList node contains the following children nodes: ReticleInfo, JobdeckInfo, InspectionInfoList, ScannerInfo, and TargetCdInfoList.

- ReticleInfo

  Contains nodes to store information on the reticle. Its children nodes are described in the following table.

Table 1-1. ReticleInfo Nodes

Node Name	Description and Accepted Values	Value Type and Restriction(s)
MaskBarcode	Specifies the mask barcode. Can be any string.	String with maximum length of 20
BlankMaskId	Required if the mask had a different ID before it was patterned. Can be any string or be empty.	String with maximum length of 20
MaskType	Specifies one of the following mask types: BIN, ATTPSM, ALTPSM, HIT, OMOG, EUV.	Not applicable

Table 1-1. ReticleInfo Nodes (cont.)

Node Name	Description and Accepted Values	Value Type and Restriction(s)
MinClearFeature	Specifies the minimum clear feature. It can be empty.	Decimal value
MinDarkFeature	Specifies the minimum dark feature. It can be empty.	Decimal value
TargetMosiTransmittance	Specifies the target MoSi transmittance. Its value is between 0 and 1.	Decimal value
ReticleResistTone	Specifies the resist tone: N or P.	Not applicable
TargetDevice	This is target device code describing the chip that the mask is intended for in the wafer fabrication process. Can be any string or be empty.	String with maximum length of 20
TargetWaferLayer	Describes the layer that the mask is intended for in the wafer fabrication process. Can be any string or be empty.	String with maximum length of 20
ClearPatternDensity	Specifies the percentage density of clear patterns in the job deck. It can be empty.	Decimal value
TechNode	Specifies the technology node that the mask is targeted for. Can be any string or be empty.	String with maximum length of 20
BlankQuality	Specifies the blank quality code supplied by the mask vendor. Can be any string or be empty.	String with maximum length of 20
BlankPhaseFilm	Specifies the blank phase film code. Can be any string or be empty.	String with maximum length of 20
BlankChromeFilm	Specifies the blank chrome film code. Can be any string or be empty.	String with maximum length of 20

Table 1-1. ReticleInfo Nodes (cont.)

Node Name	Description and Accepted Values	Value Type and Restriction(s)
BlankResistType	Specifies the blank resist type code. Can be any string or be empty.	String with maximum length of 20
BlankResistThickness	Specifies the thickness of the resist coat on the blank. It can be empty.	Integer
BlankVendorLotId	Specifies the resist lot number. Can be any string or be empty.	String with maximum length of 20
ResistBatchId	Specifies the resist batch number. Can be any string or be empty.	String with maximum length of 20
FirstWriteTool	Specifies the ID of the tool used for first mask write. Can be any string or be empty.	String with maximum length of 20
SecondWriteTool	Specifies the ID of the tool used for second mask write. Can be any string or be empty.	String with maximum length of 20
ResistDevelopTool	Specifies the ID of the tool used for developing the resist. Can be any string or be empty.	String with maximum length of 20
FirstWriteChromeEtchTool	Specifies the ID of the chrome etch tool used for the first mask write. Can be any string or be empty.	String with maximum length of 20
FirstWriteChromeEtchTime	Specifies the duration of chrome etch for the first mask write. It can be empty.	Integer
MosiEtchTool	Specifies the ID of the MoSi etch tool. Can be any string or be empty.	String with maximum length of 20
MosiEtchTime	Specifies the duration of the MoSi etch. It can be empty.	Integer
MosiOverEtchTime	Specifies the duration of extra MoSi etch past the end point. It can be empty.	Integer

Table 1-1. ReticleInfo Nodes (cont.)

Node Name	Description and Accepted Values	Value Type and Restriction(s)
SecondWriteChromeEtchTool	Specifies the ID of the chrome etch tool used for the second mask write. Can be any string or be empty.	String with maximum length of 20
SecondWriteChromeEtchTime	Specifies the duration of chrome etch for the second mask write. It can be empty.	Integer
CleanTool1	Specifies the ID of the clean tool. Can be any string or be empty.	String with maximum length of 20
CleanTool2	Specifies theID of the clean tool. Can be any string. It can be empty.	String with maximum length of 20
CleanTool3	Specifies the ID of the clean tool. Can be any string or be empty.	String with maximum length of 20

- JobdeckInfo

  Contains nodes to store information on the job deck file used to write patterns on the reticle. Its children nodes are described in the following table.

Table 1-2. JobdeckInfo Nodes

Node Name	Description and Acceptable Values	Value Type and Restriction
JobdeckFilename	Specifies the job deck file name. The job deck path is specified in the *adc-ini.xml* file.	String with maximum length of 255
JobdeckType	Specifies the job deck type: MEBESJOB, OASIS®[1], GDS. The default value is MEBESJOB.	Not applicable
JobdeckMagnification	Specifies the job deck magnification. The default value is 1.	Decimal value
JobdeckRotation	Specifies the job deck rotation in degrees: 0, 90, 180, 270. The default value is 0.	Decimal value

Table 1-2. JobdeckInfo Nodes (cont.)

Node Name	Description and Acceptable Values	Value Type and Restriction
JobdeckReflection	Specifies the job deck reflection: X_MIRROR, Y_MIRROR, NO_MIRROR. Default value is NO_MIRROR.	Not applicable
JobdeckXTranslation	Specifies the job deck X translation in nm. The default value is 0.	Decimal value
JobdeckYTranslation	Specifies the job deck Y translation in nm. The default value is 0.	Decimal value
JobdeckXOrigin	Specifies the job deck X origin in nm. The default value is 0.	Decimal value
JobdeckYOrigin	Specifies the job deck Y origin in nm. The default value is 0.	Decimal value

1. OASIS® is a registered trademark of Thomas Grebinski and licensed for use to SEMI®, San Jose. SEMI® is a registered trademark of Semiconductor Equipment and Materials International.

- InspectionInfoList

  Contains one or multiple InspectionInfo nodes to store information on the various inspections performed on the reticle. The following attribute is associated with the InspectionInfo node:

  - InspectionUniqueId — Specifies the unique identifier for an inspection and any string value can be assigned to it.

  The children nodes of InspectionInfo node described in the following table.

Table 1-3. InspectionInfoList Nodes

Node Name	Description and Acceptable Values	Value Type and Restriction
InspectionFilename	Specifies the inspection file name. Can be any string. The value of InspectionFilename should be the same as the InspectionUniqueId (case insensitive).	String of any length

Table 1-3. InspectionInfoList Nodes (cont.)

Node Name	Description and Acceptable Values	Value Type and Restriction
TargetCdImageFilename	Specifies the target CD image file name. The target CD image path is specified in the *adc-ini.xml* file. Can be any string.	String with maximum length of 255
TargetCdStructure	Each TargetCdStructure corresponds to a CdStructure in the TargetCdInfo node.	String with maximum length of 20
TargetCdTiffIndex	Identifies a list of comma-separated indices in a TIFF image file upon which the image's printability threshold is calculated by Calibre DefectClassify. If the non-TIFF file is provided, the value is -1.	String with maximum length of 20
PlateOrientation	Specifies the orientation of the reticle in the inspection machine. It can be 0, 90, 180, or 270. The default value is 0.	Not applicable

Table 1-3. InspectionInfoList Nodes (cont.)

Node Name	Description and Acceptable Values	Value Type and Restriction
InspectionStep	Specifies the step of inspection. It can be one of the following: BLANK_INCOMING, BLANK_AFTER_CLEAN, BLANK_AFTER_RESIST_COAT, BLANK_AFTER_CONDUCTIVE_COAT, BLANK_AFTER_WRITE, BLANK_AFTER_ACCLIMATIZATION, PATTERN_AFTER_FIRST_WRITE, PATTERN_AFTER_SECOND_WRITE, PATTERN_AFTER_REPAIR, POST_PELLICLE, REPELL_INCOMING, REPELL_OUTGOING InspectionStep is also used to identify whether an inspection is blank or pattern. The InspectionStep value with a prefix BLANK is considered as a blank inspection.	Not applicable
InspectionTool	Specifies the ID of the inspection tool used for this inspection. It can be empty.	String with maximum length of 50
InspectionMode	Specifies the mode of inspection. It can be one of the following: DIE_TO_DIE_AERIAL, DIE_TO_DIE_REFLECTED, DIE_TO_MODEL, DIE_TO_DIE_HIRES, STARLIGHT, SINGLE_DIE_CTM, DIE_TO_DIE_WITH_STARLIGHT, INTENCD, DIE_TO_DIE_AERIAL_WITH_CTM. It can be empty.	Not applicable

Table 1-3. InspectionInfoList Nodes (cont.)

Node Name	Description and Acceptable Values	Value Type and Restriction
InspectionModelFilename	Specifies the inspection model file name. Inspection model path is specified in the *adc-ini.xml* file. If the model file specified does not already exist, it should be created with the name specified in InspectionModelFilename.	String with maximum length of 255
InspectionWavelength	Specifies the inspection wave length. It is provided in nm. It can be empty.	Decimal value
InspectionNa	Specifies the inspection numerical aperture (NA). It is divided by 1000 before use in Calibre opticsgen. It can be empty.	Decimal value
InspectionIllumPrimitive	Specifies the inspection illumination primitive. It can be one of the following: DIPOLE, ANNULAR, STANDARD, QUASAR, CROSS-QUAD, HEXAPOLE, MULTIPOLE. It can be empty.	Not applicable
InspectionIllumAxis	Specifies the inspection illumination axis. Can be X or Y or empty.	Not applicable
InspectionIllumAngle	Specifies the source opening angle. It can be empty.	Decimal value
InspectionIllumRotation	Specifies the source rotation angle with respect to the X-axis. It can be empty.	Decimal value
InspectionSourceMap	Specifies the source map file name. The source map path is specified in the *adc-ini.xml* file. It can be empty.	String with maximum length of 255
InspectionOuterSigma	Specifies the radius of the outer circle of the source in microns. It can be empty.	Decimal value

Table 1-3. InspectionInfoList Nodes (cont.)

Node Name	Description and Acceptable Values	Value Type and Restriction
InspectionInnerSigma	Specifies the radius of the inner circle of the source in microns. It is required only for DIPOLE, ANNULAR, QUASAR, or CROSS_QUAD primitives. It can be empty.	Decimal value
InspectionPolarization	Specifies the inspection polarization. It can be UNPOLARIZED, LINEARX, LINEARY, LINEAR, S/TE, P/TM, or SPLIT_XY. It can be empty.	Not applicable
InspectionMinGl	Specifies the inspection minimum GL. It can be between 0 and 255 and the default value is 1.	Decimal value
InspectionMaxGl	Specifies the inspection maximum GL. It can be between 0 and 255, and the default value is 200.	Decimal value
InspectionPrintability Warning	This node is used by Calibre DefectClassify to determine the Warning and Fail Printability Classifications. The default value is specified by printabilityWarning in the *adc-ini.xml* file. It can be empty.	Decimal value
MdppcPrintabilityThr eshold	This node is populated by DefectClassify after the printability threshold is calculated. It can be empty.	Decimal value

Note

If an inspection is a Blank Inspection, then all fields except InspectionFilename are treated as optional. The InspectionStep field determines whether an inspection is a Blank Inspection or not. If the inspection is not a Blank Inspection, use the method described in the previous table to determine which field is optional or mandatory.

- ScannerInfo

  Contains nodes to store information on the scanner used to fabricate chips on a wafer using the reticle. Its children nodes are described in the following table.

Table 1-4. ScannerInfo Nodes

Node Name	Description and Acceptable Values	Value Type and Restriction
ScannerModelFilename	Specifies the scanner model file name. The path is specified in the *adc-ini.xml* file. It can be any string.	String with maximum length of 255
ScannerWavelength	Specifies the scanner wave length and is provided in nm.	Decimal value
ScannerNa	Specifies the scanner NA. It is divided by 1000 before use in Calibre opticsgen.	Decimal value
ScannerIllumPrimitive	Specifies the scanner illumination primitive. It can be DIPOLE, ANNULAR, STANDARD, QUASAR, CROSS-QUAD, HEXAPOLE or MULTIPOLE.	Not applicable
ScannerIllumAxis	Specifies the scanner illumination axis. It can be X, Y, or empty.	Not applicable
ScannerIllumAngle	Specifies the source opening angle. It can be empty.	Decimal value
ScannerIllumRotation	Specifies the source rotation angle with respect to the X axis. It can be empty.	Decimal value
ScannerSourceMap	Specifies the scanner source map containing the name of the scanner source map file. It can be empty.	String with maximum length of 255
ScannerOuterSigma	Specifies the radius of the outer circle of the source in microns. It can be empty	Decimal value

Table 1-4. ScannerInfo Nodes (cont.)

Node Name	Description and Acceptable Values	Value Type and Restriction
ScannerInnerSigma	Specifies the radius of the inner circle of the source in microns. This is required for DIPOLE, ANNULAR, QUASAR, and CROSS_QUAD primitives.	Decimal value.
ScannerPolarization	Specifies the scanner polarization. It can be UNPOLARIZED, LINEARX, LINEARY, LINEAR, S/TE, P/TM, or SPLIT_XY.	Not applicable
ScannerMaskBias	Specifies the scanner mask bias.	Decimal value

- TargetCdInfoList

  Contains one or multiple TargetCdInfo nodes to store information on the various target CD patterns in the reticle for printability calculation by Calibre DefectClassify. The following attribute is associated with the TargetCdInfo node:

  - CdStructure — Specifies the unique identifier for a target CD pattern. Any string value with maximum length of 20 can be assigned to it.

  The children nodes of TargetCdInfo node are described in the following table.

Table 1-5. TargetCdInfoList Nodes

Node Name	Description and Acceptable Values	Value Type and Restriction
CdAngle	Specifies the CD angle. It can be X for horizontal and Y for vertical cut line.	Not applicable
CdLocX	Specifies the X location of the cut-line in reticle coordinates in nm.	Decimal value
CdLocY	Specifies the Y location of the cut-line in reticle coordinates in nm.	Decimal value
CdPolarity	Specifies the CD polarity. It can be CLEAR or DARK.	Not applicable
CdMaskBias	Specifies the CD mask bias.	Decimal value

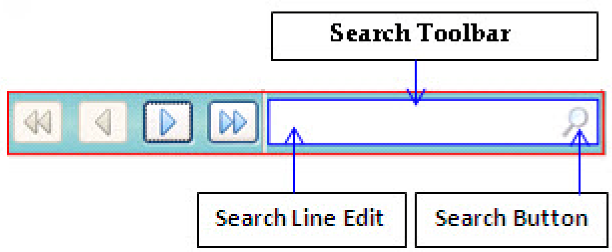
Table 1-5. TargetCdInfoList Nodes (cont.)

Node Name	Description and Acceptable Values	Value Type and Restriction
CdMaskTarget	Specifies the target CD at mask level (4x) in nms.	Decimal value
CdWaferTarget	Specifies the target CD at wafer level in nms. It can be empty.	Decimal value

Using the Search Toolbar for Inspection File Searches

Inspection files can be searched and opened from the Calibre DefectReview window by entering a search string in the Search toolbar.

Figure 1-66. Search Toolbar in Calibre DefectReview



Procedure

1. Enter a search string in the Search Line Edit field.
2. Press Return or click the **Search** button (the magnifying glass icon).

Results

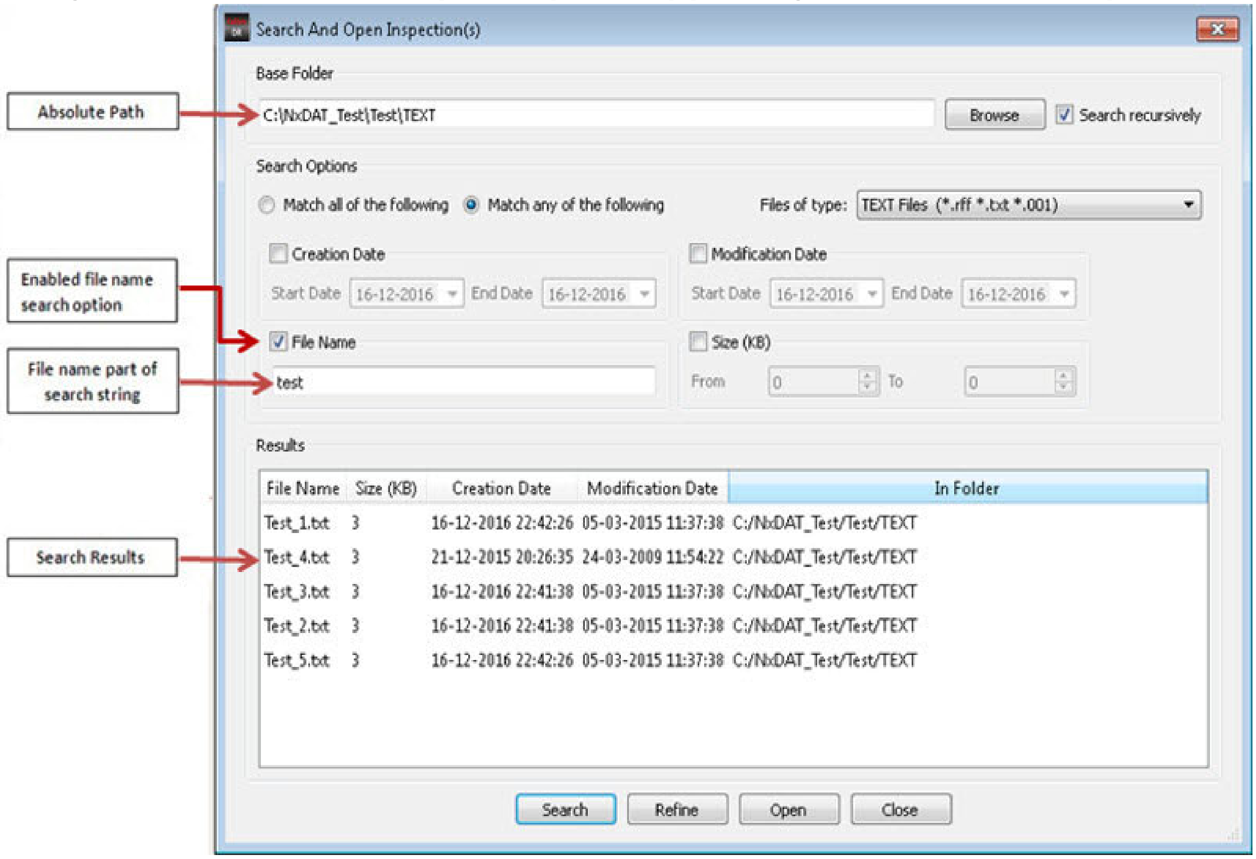
If the search string is a valid file path, then the file is opened in Calibre DefectReview. For example:

```
C:\TestInputData\Test\Test-2\testfile-2.1.txt
```

In this case, *testfile-2.1.txt* is filename and *C:\TestInputData\Test\Test-2* is an absolute path.

If the search string provided is not a valid filename with an absolute path as a prefix, then the Search And Open Inspection(s) dialog appears, as shown in Figure 1-67.

Figure 1-67. Search And Open Inspection(s) Dialog Box With Search Options



For example:

```
C:\TestInputData\Test\Test-2\test
```

In this case, *test* is a string (not a valid filename) and *C:\TestInputData\Test\Test-2* is an absolute path. In this scenario, the search starts inside *C:\TestInputData\Test\Test-2* (the base folder) and all files containing *test* as a substring are displayed in the Results area, as shown in Figure 1-67.

The Search And Open Inspection(s) dialog box parameters are filled in as follows:

- **Base Folder** — Contains the absolute path of search string entered in search toolbar.
- **File Name** — This option is active.
- **File Name Text Entry Field** — Contains the filename part of the search string entered in the search toolbar.

  The rest of the values use the default.

If the search string provided does not contain an absolute path as a prefix, as shown in Figure 1-68, then the Search And Open Inspection(s) dialog box appears, as shown in Figure 1-69.

Figure 1-68. Search String Without an Absolute Path

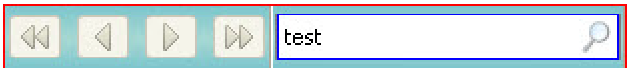
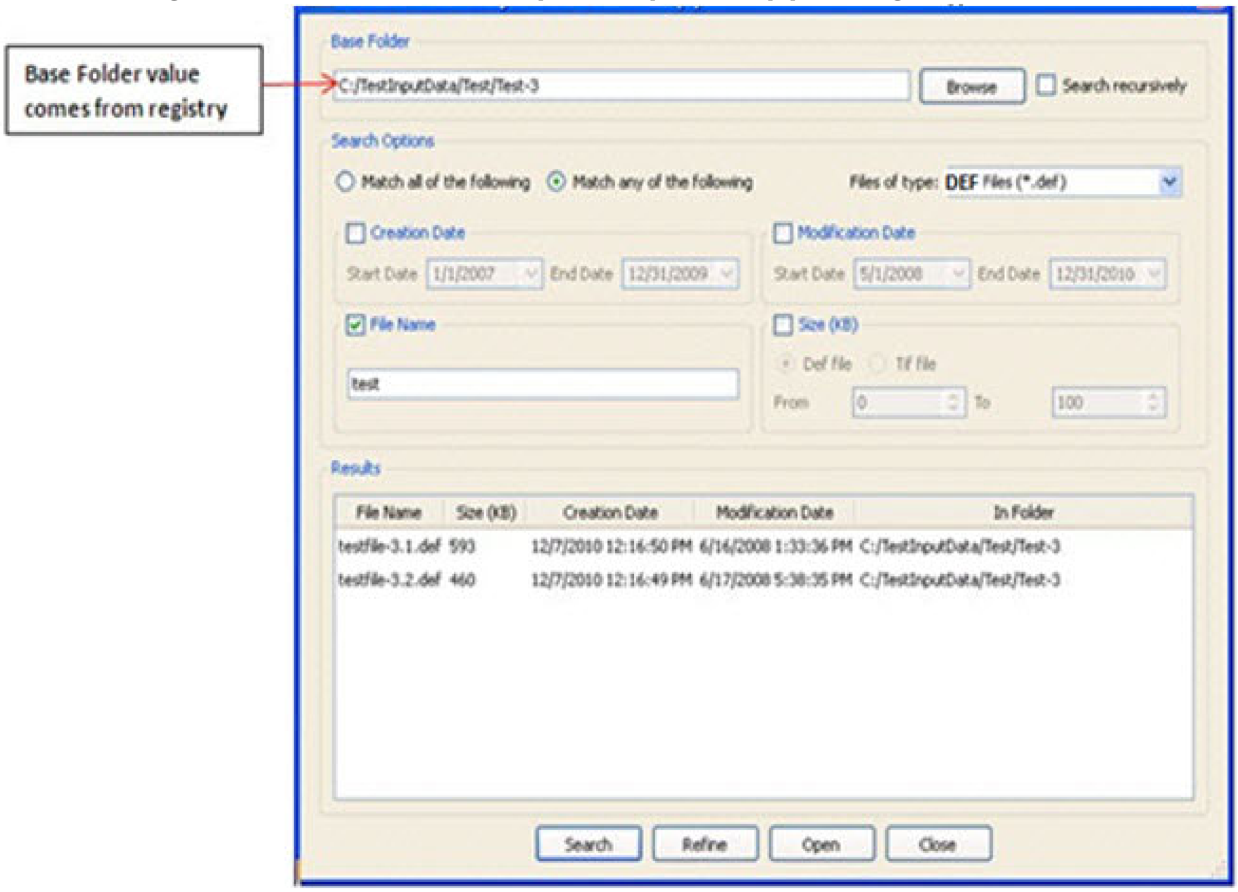


Figure 1-69. Search And Open Inspection(s) Dialog Box Results



To open a new inspection file, follow the procedure in “Opening Inspection Files” on page 55. The selected files are opened in a new Calibre DefectReview session.

Opening Inspection File(s) from a Database

You can open inspection files stored in the database from the File menu of Calibre DefectReview.

Prerequisites

- For database prerequisites, refer to“Defect Database” on page 419 .

Procedure

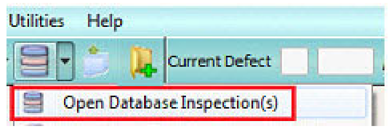
1. In the Calibre DefectReview main window, display the Select Inspection(s) dialog box by performing either of the following:

    - Select **File** > **Open Database Inspection(s)** > **Open Database Inspection(s)**.

Figure 1-70. Open Database Inspection(s) Menu Option

- Click the Open Database Inspection(s) icon in the tool bar as shown in the following figure.

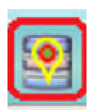
Figure 1-71. Open Database Inspection(s) Icon



Additionally, you can open a database inspection file in place (where the newly-opened file replaces the currently open file while preserving the GUI window layout) using one of the following methods:

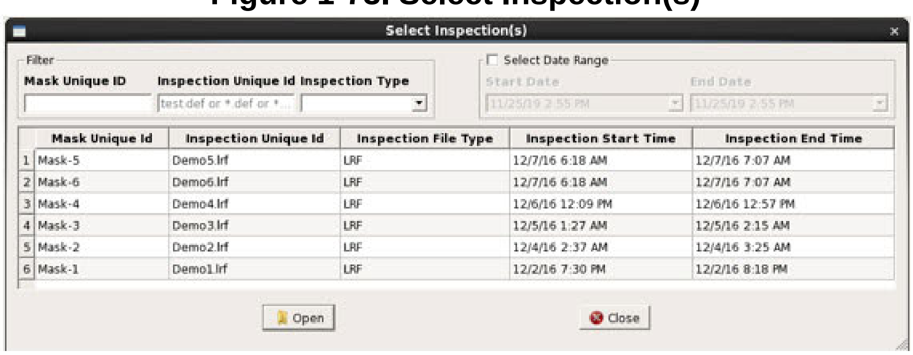
- Select **File** > **Open Database Inspection(s)** > **Open Database Inspection(s) Inplace**.
- Click the Open Database Inspection(s) In Place icon in the toolbar.

Figure 1-72. Open Database Inspection(s) In Place Icon



2. The Select Inspection(s) dialog box appears. The inspections stored in the database are displayed in the result table. The results are sorted based on the descending order of Inspection Start Time.

Figure 1-73. Select Inspection(s)



3. In the Select Inspection(s) dialog box:
   - To select a single file, click the filename.

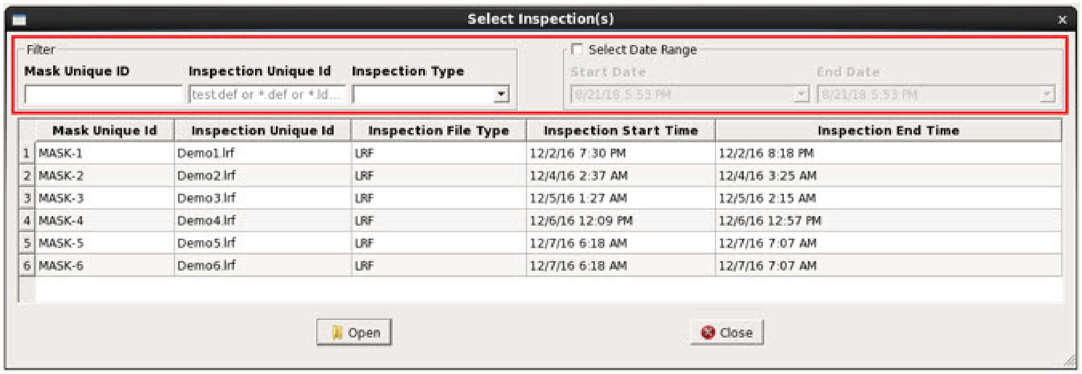
- To select multiple files:
    - Click on one file, then press the Ctrl key and click on other desired files.
    - To open all files in a given folder, click on one file and then use Ctrl-a to select all the files.
    - You can also use the Shift key and select a range of files.

4. Click **Open**.

Results

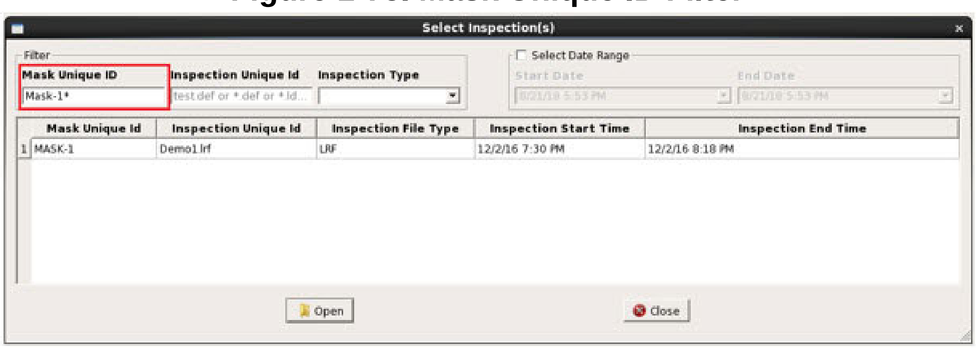
The results in the Select Inspection(s) can be narrowed down by applying various filter options available in the dialog box as show in the following figure.

Figure 1-74. Filters in Select Inspection(s)



- **Mask Unique Id** — To filter the results based on mask unique ID, provide substring of mask unique ID in the Mask Unique Id input box as shown in following figure and press Enter. Inspections with a mask unique ID starting with Mask-1 are displayed in the table. To remove the filter, remove the string from the Mask Unique Id input box and press Enter.

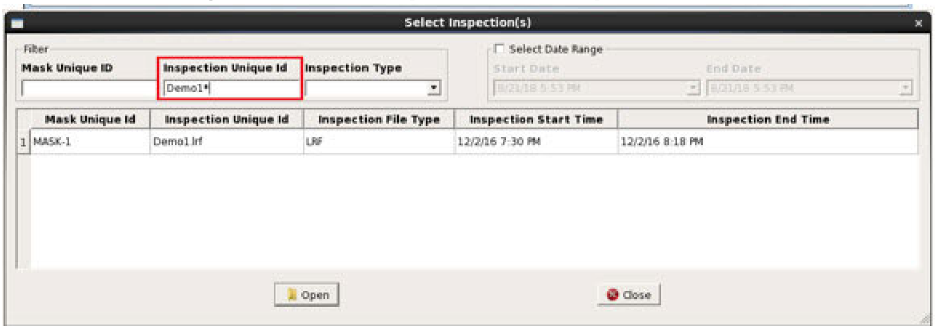
Figure 1-75. Mask Unique ID Filter



- **Inspection Unique Id** — To filter the results based on an inspection unique ID, provide the substring of the unique ID in the Inspection Unique Id input box as shown in the following figure and press Enter. Inspections with an inspection unique ID starting with

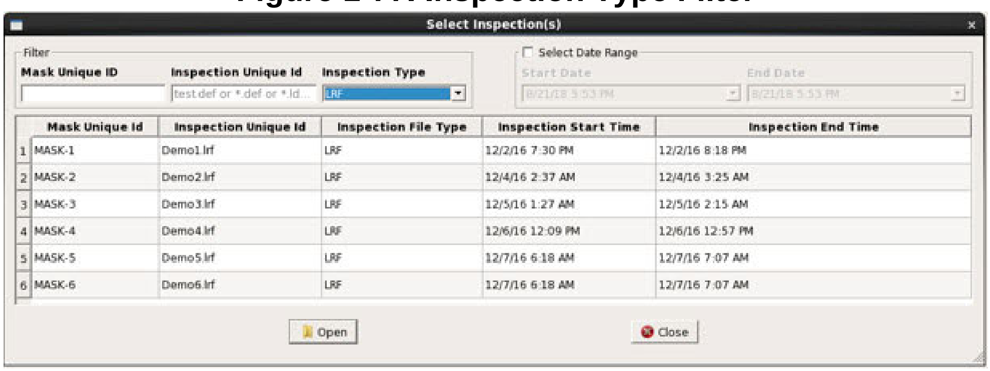
Demo-1 are displayed in the table. To remove the filter, remove the string from Inspection Unique Id input box and press Enter.

Figure 1-76. Inspection Unique ID Filter



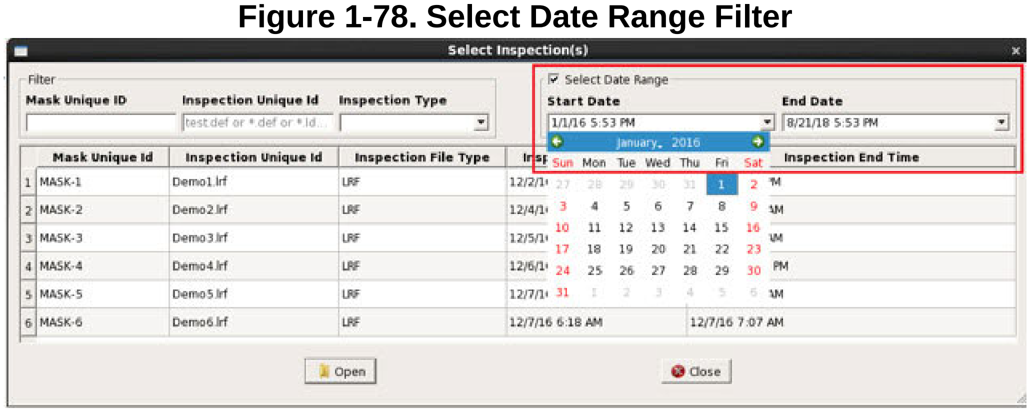
- **Inspection Type** — To filter the results based on inspection type, select the type of file from the drop-down box as shown in the following figure. Inspections with a selected type (in this example, LDF) are displayed in the table. To remove the filter, select the empty row from drop-down box

Figure 1-77. Inspection Type Filter



- **Select Date Range** — To filter the results based on inspection start time, check **Select Date Range** and specify the date time range as shown in the following figure. Inspections with a start time in between the given range are displayed in the table. To remove the filter, uncheck **Select Date Range**.

Figure 1-78. Select Date Range Filter



Save an Inspection File

You can use two different methods to save a inspection file.

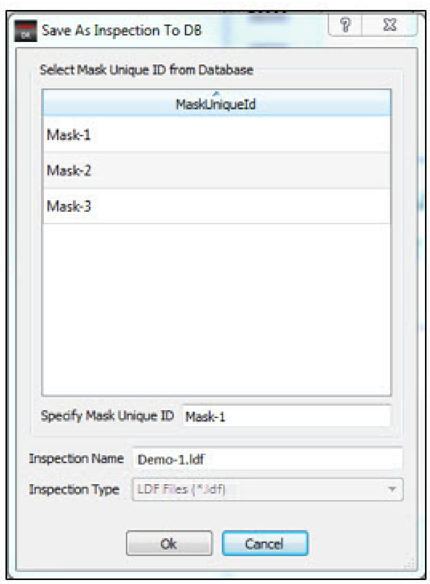
- **Save** — Click **File** > **Save**. This saves the current inspection file.
- **Save As** — Click **File** > **Save As**. This saves the inspection file in the current working folder with a filename you specify. You can configure the *dat-ini.xml* file to change the default folder or path for the **Save As** option. This option works differently between the single and All folders.
- **Save to DB** — Click **File** > **Save to DB**. This saves the current inspection file to the database.

Save As in a Single Folder

The **Save As** option in a single folder saves the inspection file in the current working folder. You can configure the *dat-ini.xml* file to change the default folder or path for the **Save As** option. Refer to "Changing the Default Save Location of an Inspection File" on page 100 for further information.

When an inspection file is opened from the database, the Save As option displays the following dialog box. You can change the mask unique ID or inspection name (or both) before saving.

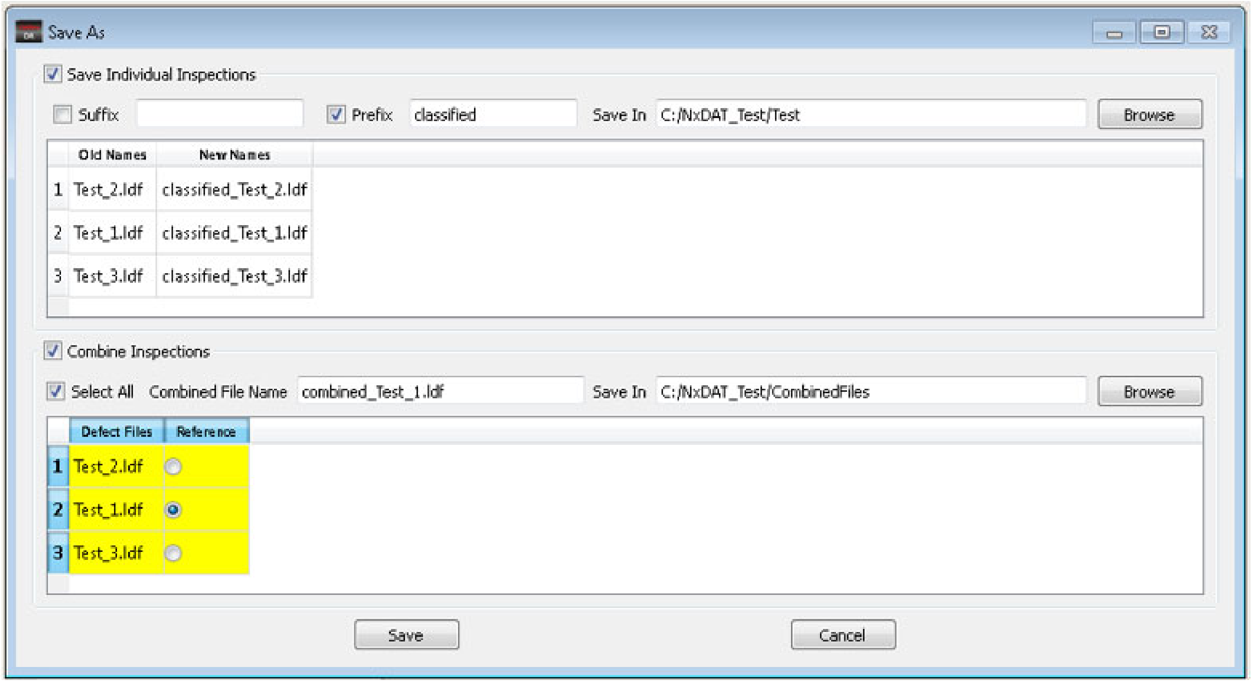
Figure 1-79. Save As Inspection



Save As in the All Folder

In the All folder, **Save As** works on all of the inspection files currently loaded. While in the All folder, if you click **Save As** (either under the **File** menu or in toolbar), the Save As dialog box appears. The dialog box contains two options: Save Individual Inspections and Combine Inspections.

Figure 1-80. Save As Dialog Box (All Folder)



- **Save Individual Inspections** — This option helps you to save each of the opened inspections from the All folder with new names. The new names are generated by adding prefix and suffix to each inspection file name (old names). Click **Browse** to select the Save In directory where the new files are saved.
- **Combine Inspections** — This option helps you to generate a inspection file by combining multiple inspection files. It combines all undeleted defects from each file and writes them into a defect list of the combined file. The process takes header information for the combined file from the selected Reference file. In the table, you can select which inspection files are to be combined and a Reference for the header information. Click the **Select All** check box to select all files in the table. You can also configure the Combined File Name by editing it and configure the Save In directory by clicking the **Browse** button.

  If you want to combine all real defects, then first filter out all false alarm defects using Defect Selection. Delete those filtered out defects using **Utilities** > **Delete Unselected** and then use **Combine Inspections** to save all real defects in single file for review.

  Note the following:

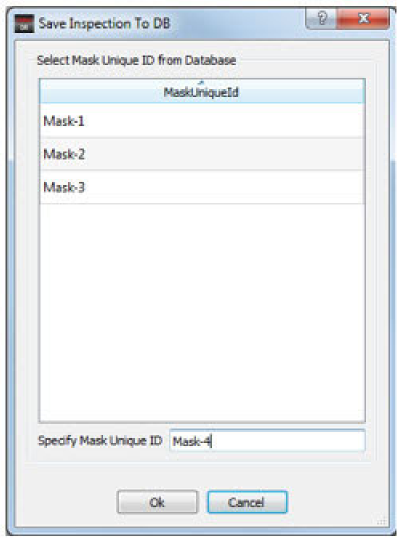
  - This is a Pro Add-Ons feature and you need a separate license to use it.
  - The selection of **Combined Inspections** and Save In directory is remembered across session.
  - The default Reference inspection file is selected based on the selected reference in Repeatability Analysis.

- Currently, this feature is only supported for LDF inspection files. That is, if all of the opened inspection files are LDF files, the Combine Inspections option appears.
- In absence of appropriate license or if any of the inspection files is not a LDF file, only the **Save Individual Inspections** feature is displayed.

Save to DB

This displays a Save Inspection To DB dialog box as shown in the following figure.

Figure 1-81. Save Inspection To DB



Select a MaskUniqueId from the list or specify a new mask unique ID in the Specify Mask Unique ID field. Click **Ok** to save the current inspection to the database. While saving an inspection to the database, the inspection is aligned with respect to a reference inspection and correlated with the defects available in a database from the same mask. The first inserted inspection for a mask unique ID becomes the reference for all subsequent inspections with the same mask unique ID used for alignment.

Note

Save To DB is deactivated in the All folder.

Refer to"Automating Inspection Report Alignment" on page 412 for details on the search radii used to align various inspection report formats.

The following points also apply to the Save to DB operation:

- While searching for a reference inspection for alignment, inspections from all related masks from the same physical reticle such as blank and link masks (searched recursively) are considered. The first inserted inspection from all the linked masks available in the database is considered as the reference for auto alignment during a Save

To DB operation. Refer to “Reticle Information File (RIF)” on page 79 for details on the blank and link mask unique IDs.

The following illustrates an example: you have a physical reticle with a mask unique ID M1, and that is linked with a blank mask unique ID M2 and a link mask unique ID M3, which is again linked with a mask unique IDs M4 and M5. When storing an inspection with the mask unique ID M1, the first inserted inspection (from M1, M2, M3, M4, and M5) is used as the reference inspection for alignment.

- The Mask Unique ID list displayed in the Save Inspection To DB window contains a union of IDs consisting of mask unique IDs and their related blank and link mask unique IDs.
- An existing inspection is overwritten if the same inspection is saved to the database again with same mask unique ID. An inspection’s unique instance is maintained based on the inspection unique ID. The inspection name is treated as the inspection unique ID while saving to the database.
- An error is issued during a Save To DB operation if the inspection already exists in the database with a different mask unique ID. The inspection cannot be part of multiple reticles.

The defect images are stored in the image server location supplied through the DbImagesBaseDir node in the *dat-ini.xml* file (as shown in Figure 1-82). A directory path */<inspection type>/<mask unique>/<inspection file name>/* is created under the base directory to store inspection and defect images.

Figure 1-82. Database Image Server Base Directory

```
<DbSettings>
 <!-- DbType: MySQL, MSSQL -->
 <DbType>MySQL</DbType>
 <ServerNameOrDSN>dbserver.domain.com</ServerNameOrDSN>
 <PortNumber>3306</PortNumber>
 <DbName>MgcDefectManagementDB</DbName>
 <!-- DbImagesBaseDir: A mandatory base dir path where defect images should be stored. The dummy value need to be
      replaced with valid directory by the user -->
 <DbImagesBaseDir>/home/dummydir</DbImagesBaseDir>
 <DbSearchRadius>1.0</DbSearchRadius>
 <!-- DbConnTimOutInSeconds: An optional time-out time to connect to database. DB connection throws error after time
      specified if not able to connect to database. If not set in dat-ini.xml file, then
      default value of 2 seconds is used. -->
 <DbConnTimeOutInSeconds>2</DbConnTimeOutInSeconds>
</DbSettings>
```

Changing the Default Save Location of an Inspection File

You can change the default save location for your inspection file.

Prerequisites

- Calibre DefectReview must not be running.

Procedure

1. Open the *dat-ini.xml* file with a text editor.

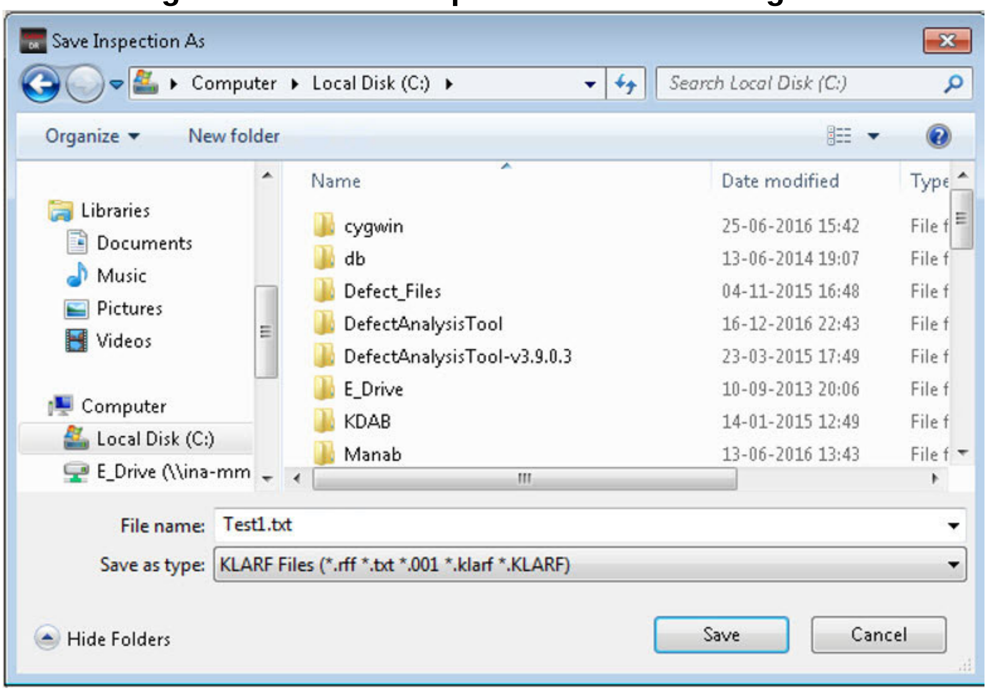
2. Set the “path” entry in the defaultSaveAs node. For example:

```
<datInfo>
   <defaultSaveAs path="C:/" />
```

   In this example, the path is set to “C:/”.

3. Save the *dat-ini.xml* file.
4. Invoke Calibre DefectReview.
5. Edit the inspection file as needed.
6. Click **File > Save As**. A dialog box appears where you can see that the default folder or path has been changed as per the configuration of *dat-ini.xml* file.

Figure 1-83. Save Inspection File As Dialog Box



7. Enter the filename and click **Save**. An inspection file is saved in the path or folder as per the configuration specified in the *dat-ini.xml* file.
8. Note the following:
   - If you click **Refresh** after the completion of inspection, then **Save** and **Save As** are available and you can save an inspection file.
   - You can use **Save** and **Save As** icons in the toolbar as well.
   - The “Save in” directory is same as the inspection file directory if either of the following conditions occur:
     - The path specified in the defaultSaveAs node is empty.

- o The path specified in the defaultSaveAs node is not a valid directory.

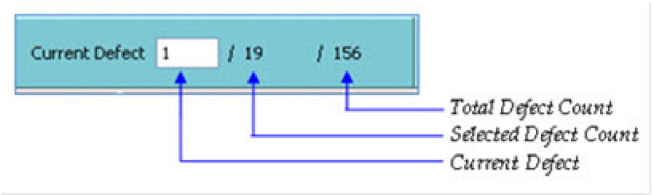
Current Defect Display and Navigation

The toolbar of Calibre DefectReview displays the current defect information.

At any point of analysis, the current defect bar displays the following:

- The ID of the current defect.
- The selected defect count or the number of defects that are currently selected through Defect Selection.
- The total defect count or the total number of defects in the loaded inspection file.

Figure 1-84. Current Defect Bar



To view the tool tip for each label, hold the mouse pointer over it.

The current defect bar also provides navigation. To view any defect, enter the ID of the defect you want to navigate to in the Current Defect entry field. You can also use the defect navigation buttons or keyboard shortcuts to navigate to different defects.

Figure 1-85. Defect Navigation Buttons

To use shortcut keys, you can use one of the following methods:

- Select the **Current Defect** input box, then use the Up Arrow key to navigate to the previous defect, and the Down Arrow key to go to the next defect.
- Use Ctrl + Up Arrow on the keyboard to go to the previous defect, and Ctrl + Down Arrow to go to the next defect.

Syntax Conventions

Commands documented in this manual utilize particular syntax conventions.

Table 1-6. Syntax Conventions

Convention	Description
Bold	A bold font indicates a required item.
Italic	An italic font indicates a user-supplied argument.
Monospace	A monospace font indicates a shell command, line of code, or URL. A bold monospace font identifies text to be entered by the user.
Underline	An underlined item indicates either the default argument or the default value of an argument.
UPPercase	For certain case-insensitive commands, uppercase indicates the minimum keyword characters. In most cases, you may omit the lowercase letters and abbreviate the keyword.
[ ]	Brackets enclose optional arguments. Do not include the brackets when entering the command unless they are quoted.
{ }	Braces enclose arguments to show grouping. Do not include the braces when entering the command unless they are quoted.
‘ ’	Single quotes enclose metacharacters that are to be entered literally.
| or ||	Vertical bars indicate a choice between items. Do not include the bars when entering the command.
…	An ellipsis follows an argument or group of arguments that may appear more than once. Do not include the ellipsis when entering the command.
Example: **DEVice** {*element_name* [‘(’*model_name*‘)’]} ***device_layer*** {***pin_layer*** [‘(’*pin_name*‘)’] …} [‘<’*auxiliary_layer*‘>’ …] [‘(’*swap_list*‘)’ …] [BY NET | BY SHAPE]	

Chapter 2
Calibre DefectReview User Interface Overview

The Calibre DefectReview main window contains a number of functional regions for defect analysis and classification.

Calibre DefectReview Main Window Layout

The Calibre DefectReview interface is organized into several key functional regions.

Figure 2-1 shows the layout of Calibre DefectReview.

Figure 2-1. Calibre DefectReview Main Window

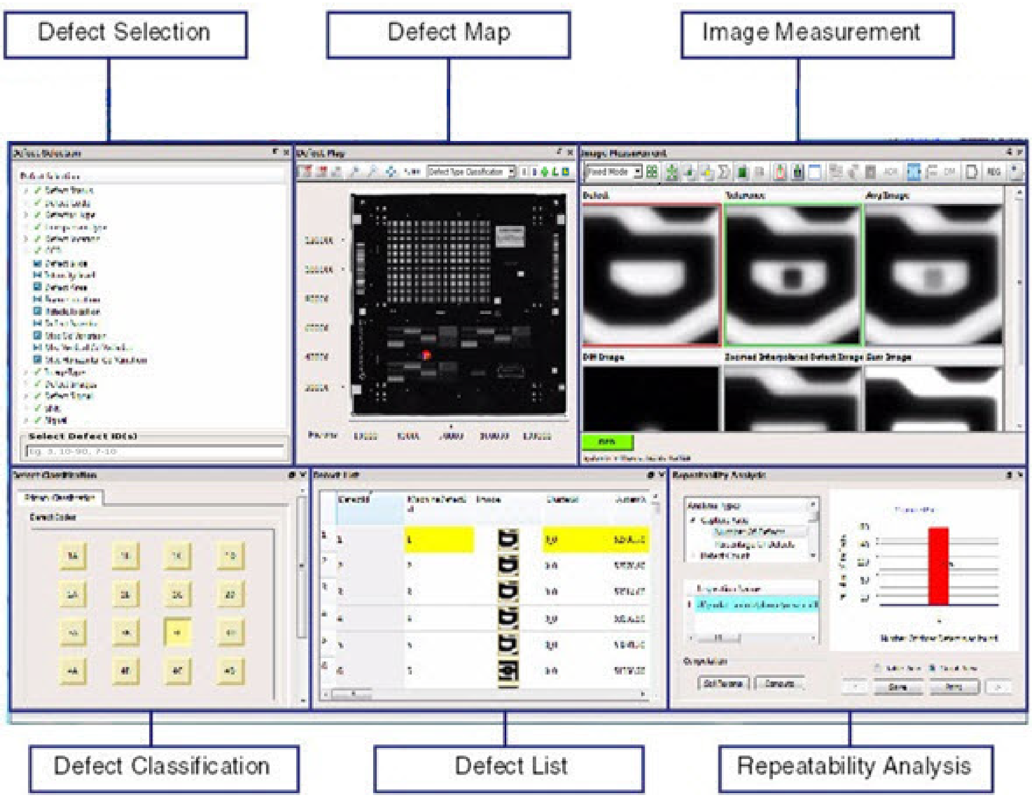


Table 2-1 describes each functional area of the Calibre DefectReview main window.

Table 2-1. Calibre DefectReview Layout Descriptions

Region	Description
Defect Map (1)	Provides a graphical view of the defects as well as a convenient spatial way to navigate defects. Refer to "Defect Map" on page 115 for details.
Defect List (2)	Provides a table view of the defect properties. The Defect List enables you to navigate defects based upon their sorted properties. Refer to "Defect List" on page 157 for details.
Defect Selection (3)	Provides options to select a subset of defects present in the input inspection file. Refer to "Defect Selection" on page 187 for details.
Defect Classification (4)	Provides an interface for classifying defects. Refer to "Defect Classification" on page 207 for details.
Image Measurement (5)	Displays defects and provides utilities for analyzing images associated with a defect. Refer to "Image Measurement" on page 265 for details.
Repeatability Analysis (6)	Provides an interface to analyze multiple inspections together and perform repeatability analysis on these inspections. Refer to "Repeatability Analysis" on page 225 for details.

When multiple inspection files are loaded into Calibre DefectReview, the main window appears. However, for a single file, a single tab or folder is opened instead. Refer to "Understanding Folders" on page 113 for more information on folders. For multiple files, multiple folders are opened.

Refer to "Multiple Inspection Operations" on page 109 for details on analyzing the results of multiple inspections.

Refer to "Calibre DefectReview GUI Quick Reference" on page 603 for a summary of all the menu and toolbar options in the main Calibre DefectReview window.

Calibre DefectReview Layout Modification

All windows in the main display of Calibre DefectReview are "dockable." Dockable windows allow you to modify the GUI layout by arranging the windows based on your desired configuration.

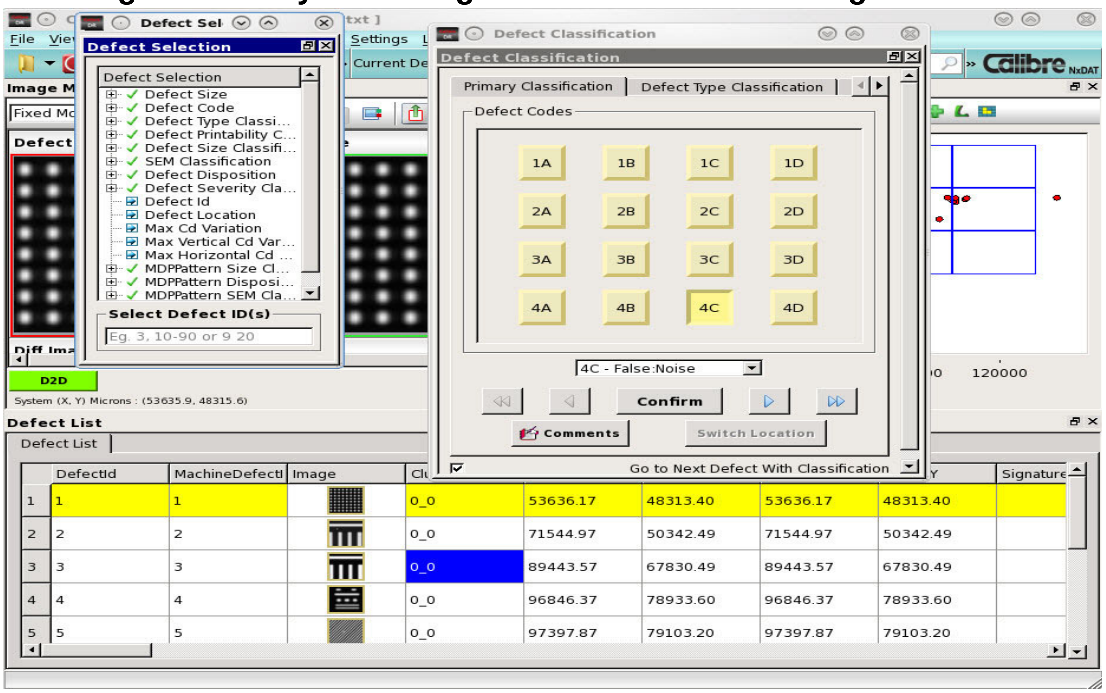
For example, you can:

- Resize windows.
- Dock and undock windows.

You can double-click the title bar of a window to undock it and have it as a floating window. Multiple windows can be undocked and floating.

To restore any window back its previous position, double-click the title bar of that window. Figure 2-2 shows the Calibre DefectReview GUI with two floating windows, Defect Map and Defect Selection.

Figure 2-2. Layout Configuration With Two Floating Windows

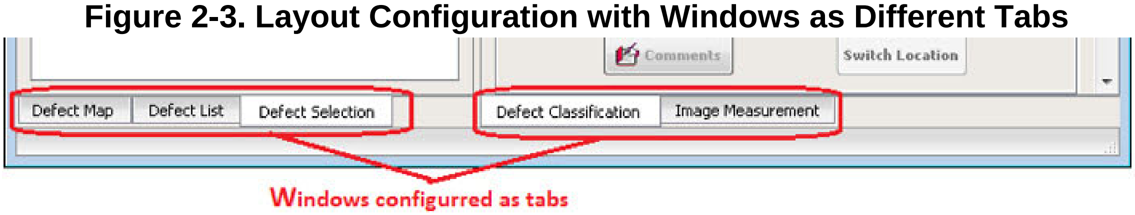


- Arrange floating windows on top of each other.

  Click and drag a floating window to move the window. The regions of the main window where a window can be moved are a light blue color. If windows are docked on top of each others, tabs appear at the bottom.

  Figure 2-3 shows a layout configuration with windows arranged as different tabs.

Figure 2-3. Layout Configuration with Windows as Different Tabs



- Control display of features in the Calibre DefectReview main window.

  For example, if you are doing a Repeatability Analysis, you can close the IMU display by disabling the corresponding option in the **View** menu.

  You can also hide the display of columns in the Defect List. To hide specific columns, right-click the Defect List column header and select **Hide** from the popup menu. For details on configuring the Defect List window, refer to "Using Operations on All Attributes" on page 170.

Once the layout is set, save the layout configuration by selecting **Dock Layout > Save**. For details, refer to "Saving and Loading a Dock Layout" on page 385.

Chapter 3
Multiple Inspection Operations

There are a number of operations in Calibre DefectReview that enable you to work with multiple inspection files.

Adding Inspection Files

You can use Calibre DefectReview to open multiple inspection files.

Prerequisites

- A inspection file must already be loaded into Calibre DefectReview.

Procedure

1. Select one of the following:

    - In the Calibre DefectReview menu bar, select **File > Add Inspection(s)**.

    - Click the **Add Inspection(s)** icon in the Calibre DefectReview toolbar (see Figure 3-1).

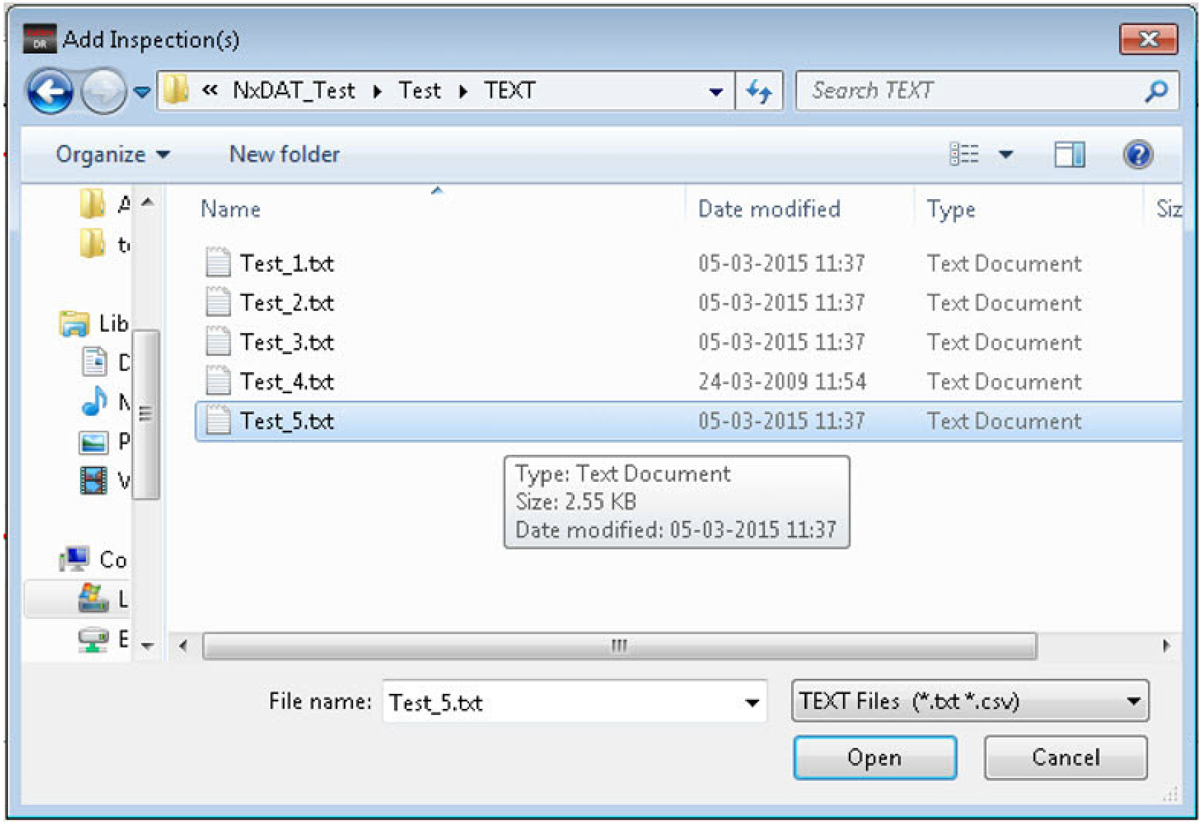
Figure 3-1. Add Inspection(s) Icon

2. An Open Inspection(s) dialog box appears as shown in the Figure 3-2. Select the desired files and click **Open**.

3. You can load different types of inspection files in Calibre DefectReview (for example, text files and CSV files) at the same time.

4. As the different types of inspection files may have conflicting classification codes in the All folder, Calibre DefectReview deactivates the Defect Selection and Classification options in the All folder. In the All Folder, the classification option is also deactivated for the Defect Map and Repeatability Analysis windows.

Figure 3-2. Open Inspection(s) Dialog Box



Loading Recently Opened Inspection Files

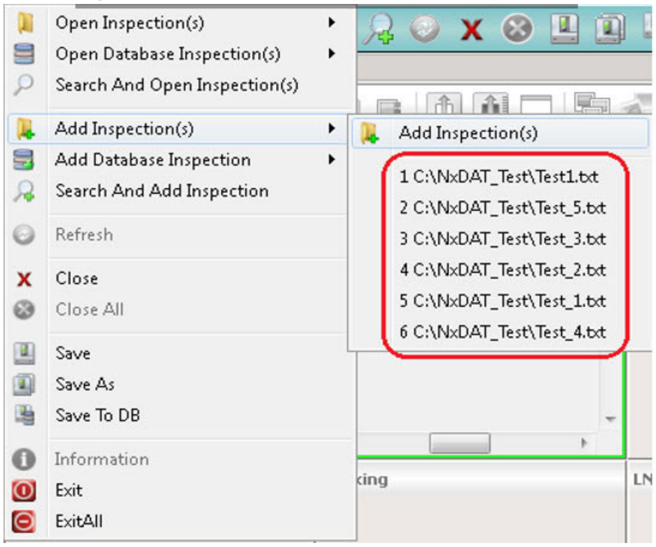
You can access recently opened inspection files from the Calibre DefectReview window.

Procedure

1. Select one of the following:

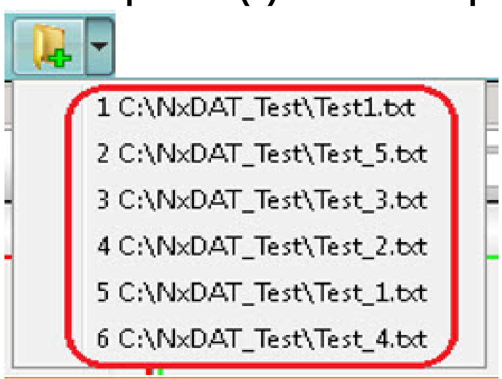
    - In the Calibre DefectReview menu bar, select **File** > **Add Inspection(s)**. A sub-menu with a list of recently opened files appears as shown in the Figure 3-3.

Figure 3-3. Add Inspection(s) Menu



- Click the arrow next to the **Add Inspection(s)** icon in the toolbar. A list of recently opened files appears as shown in Figure 3-4.

Figure 3-4. Add Inspection(s) Toolbar Dropdown Menu



2. Select the desired file or files from the available list.

Note

Recently-opened files for each user are displayed in the recent file list.

Adding Inspection File(s) From a Database

You can use Calibre DefectReview to open multiple inspection files from the database.

Prerequisites

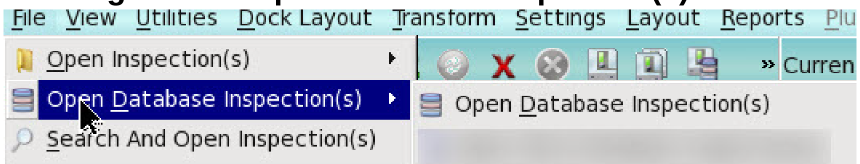
- An inspection file must already be loaded into Calibre DefectReview
- For database prerequisites, refer to “Defect Database” on page 419

Procedure

1. In the Calibre DefectReview main window, display the Select Inspection(s) dialog box by performing either of the following:

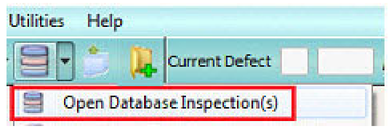
    - Select **File** > **Open Database Inspection(s)** > **Open Database Inspection(s)**.

        Figure 3-5. Open Database Inspection(s) Menu

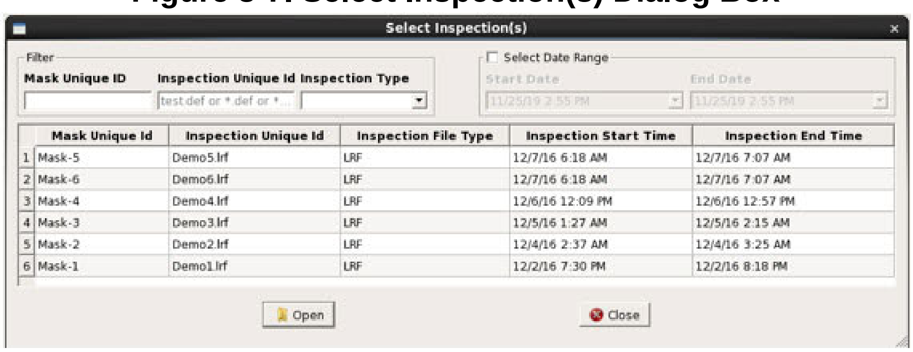
    - Click the Open Database Inspection(s) icon in the tool bar as shown in the following figure.

        Figure 3-6. Open Database Inspection(s) Toolbar Icon

2. A Select Inspection(s) dialog box appears. The inspections stored in the database are displayed in the result table.

    Figure 3-7. Select Inspection(s) Dialog Box

3. In the Select Inspection(s) dialog box:

    - To select a single file, click the filename.
    - To select multiple files:
        - Click on one file, then press the Ctrl key and click on other desired files.
        - To open all files in a given folder, click on one file and then use Ctrl-a to select all the files.
        - You can also use the Shift key and select a range of files.

4. Click **Open**.

Results

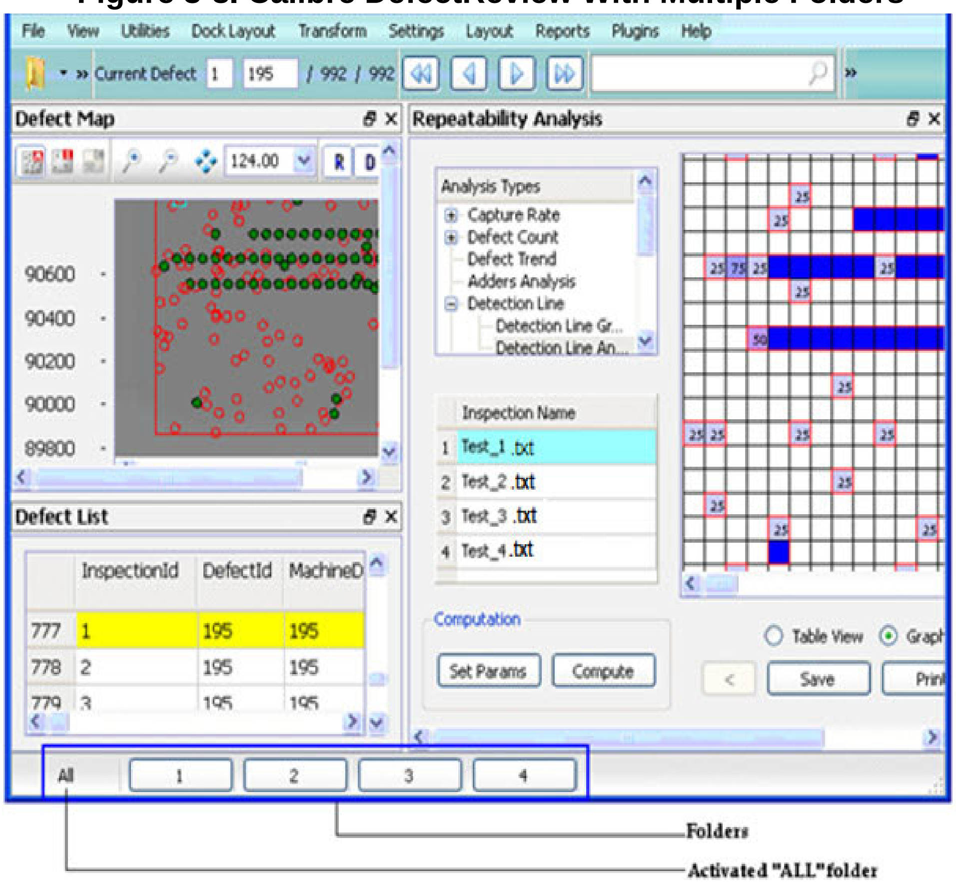
You can filter the results as described in the Results section of "Opening Inspection File(s) from a Database" on page 93

Understanding Folders

When opening multiple inspection files, Calibre DefectReview loads each inspection file in folders, which are accessed with numbered buttons. The buttons are also referred to as folders.

The data for each inspection or inspection file is loaded in a different folder called a Single Inspection (SI) folder. In addition to creating these SI folders, a folder called "All" is created. This folder contains defect data for all inspections. Figure 3-8 shows an example Calibre DefectReview session with four inspections loaded. The numbered button bar at the bottom-left of the Calibre DefectReview window shows the folders. The SI folders are displayed as buttons labeled with the inspection ID number. The "All" folder is displayed as it is the currently active folder.

Figure 3-8. Calibre DefectReview With Multiple Folders



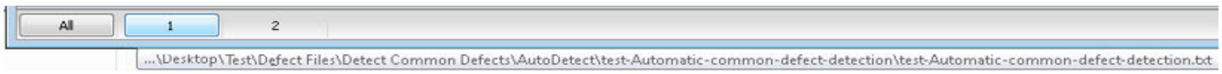
You can analyze multiple inspections together using Repeatability Analysis in the "All" folder. Refer to Chapter 8, "Repeatability Analysis", for details.

You can switch between the folders by clicking any of the buttons on the Folders button bar.

Figure 3-9. Example Folders Button Bar

If you hover your mouse pointer over a folder button, a tooltip appears with the filename and path displayed. If the filename (including the path) is longer than150 characters, the extra characters in the pathname are truncated (see Figure 3-10).

Figure 3-10. Tooltip Displaying Filename and Path



Note

Once a specific folder is selected, all menu and tool bar options are applicable only to that folder.

Chapter 4
Defect Map

This chapter describes the operations that can be performed using the Defect Map window in Calibre DefectReview.

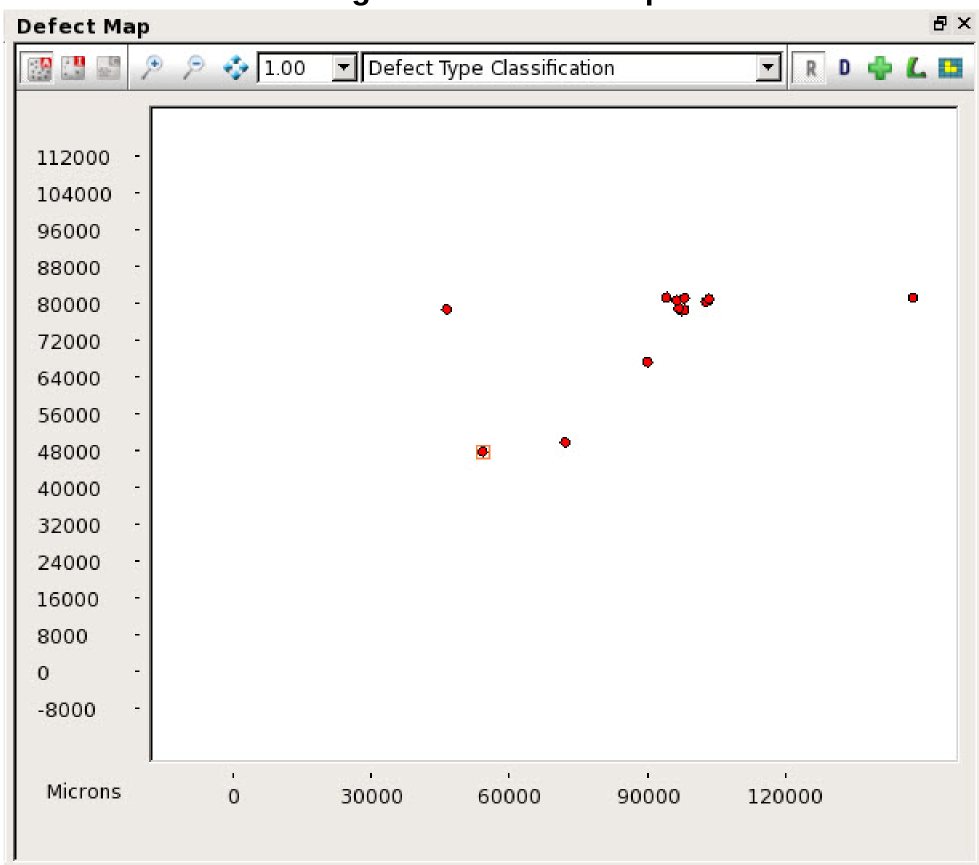
The Defect Map Window

To access: **View > Defect Map**

The Defect Map window provides a graphical view of all the defects detected from an inspection. It also provides the option to navigate and edit defects.

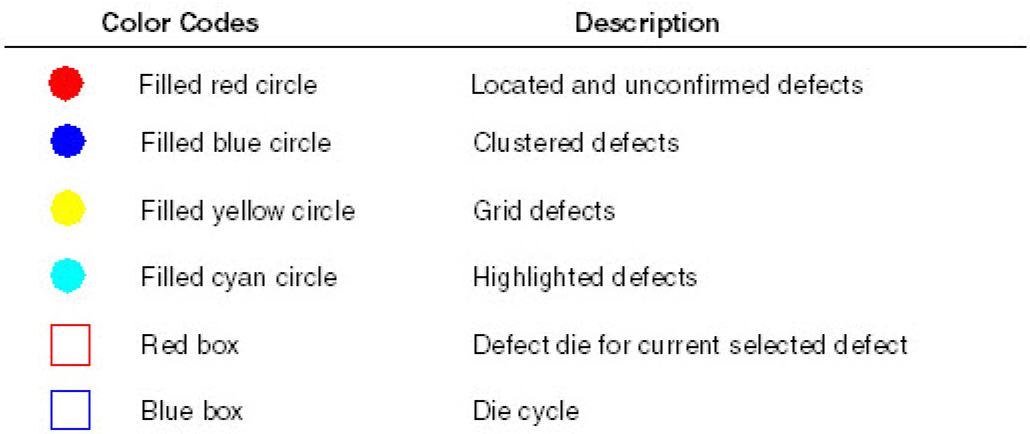
Description

Figure 4-1. Defect Map



Every defect in the Defect Map window is shown as a circle with specific color codes based on the type of defect. The currently selected defect is always enclosed with a colored box indicating the die type. Figure 4-2 illustrates the color codes used in the Defect Map window.

Figure 4-2. Defect Color Codes



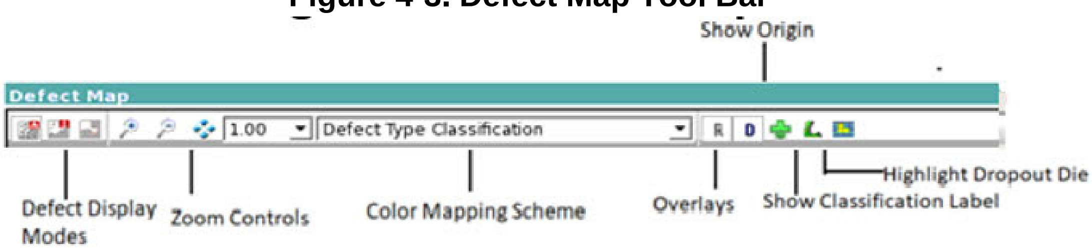
Note

If you are viewing inspections in different colors using the Demarcate Inspections option, then the color code conventions given in Figure 4-2 do not hold true. Refer to "Demarcating Multiple Inspections" on page 136 for information.

You can modify the dimensions of the circle depicting the defects by changing it through **Utilities > Calibration Parameter Editor**. Refer to "Calibration Parameter Modification" on page 367 for details on the Calibration Parameter Editor utility.

At the top of the Defect Map window is the icon bar. The icon bar contains the main controls for the display of defects. The tool bar is illustrated in Figure 4-3 and described in Table 4-1.

Figure 4-3. Defect Map Tool Bar



Objects

Table 4-1. Defect Map Window Toolbar

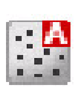
Control	Description
Defect Display Modes	Control the display of defects. If defects are not clustered, then the clustered defects icon is deactivated.
	All defects are shown.

Table 4-1. Defect Map Window Toolbar (cont.)

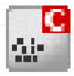
Control	Description
	Only isolated defects are shown.
	Only clustered defects are shown.
Zoom Controls	View any desired section or part of the Defect Map using the zoom controls. See "Additional Zoom Controls" on page 120 for information on additional zoom controls that are not on the tool bar.
	Zoom in.
	Zoom out.
	Fit to window. The default zoom factor is 1.00.
	Set zoom factor. The current zoom factor is always displayed. You enter an exact value in this field or select from existing zoom factors in the drop-down list. The minimum zoom value that can be entered is 1.00.
	Set the color mapping scheme based on one of the following classification types: • **Defect Type Classification** — The colors mapped to the mask defect are based on the value set by defectColor for the corresponding defectType (manual classification). This behavior is defined in the Defect Type Classification table in the *dat-ini.xml* file. • **Auto Defect Type Classification** — The colors mapped to the mask defect are based on the value set by defectColor for the corresponding defectType specified using Auto Classification. This behavior is defined in the Defect Type Classification table in the *dat-ini.xml* file.
Overlays	Overlay the die cycle on the Defect Map. See "Using Overlays" on page 120 for further details.
	Display die cycles.
Show Origin 	Toggle display of the origin on the Defect Map. See "Show Origin" on page 121 for further details.

Table 4-1. Defect Map Window Toolbar (cont.)

Control	Description
Show Classification Label 	Toggle the display of defect information, including the defect ID, classification code, and Primary Classification comments (if present) for all defects present in the Defect Map window. See “Show Classification Label” on page 122 for further details.

Related Topics

Defect Map Operations

Defect Map Operations

The Defect Map window supports a number of operations that enable you to visually analyze the results of an inspection.

Additional Zoom Controls

Aside from the zoom controls available in the toolbar, there are additional methods to adjust your view in the Defect Map window.

Center Around

Click the left mouse button in the display area to make any position appear at the center of the Defect Map. By default, the Center Around mode is enabled.

Rubber Band Zoom

Use the mouse to zoom in or zoom out of specific regions of the Defect Map. By default, the "rubber band" zoom is enabled:

- To zoom in using "rubber band" mode, click the top left or right corner of the selected area to zoom in on, then drag a box around the area.
- To zoom out, click the bottom right or left corner of the zoom area and then drag a box around the area.

Using Overlays

You can overlay the die cycle or the reticle image (or both) on the Defect Map.

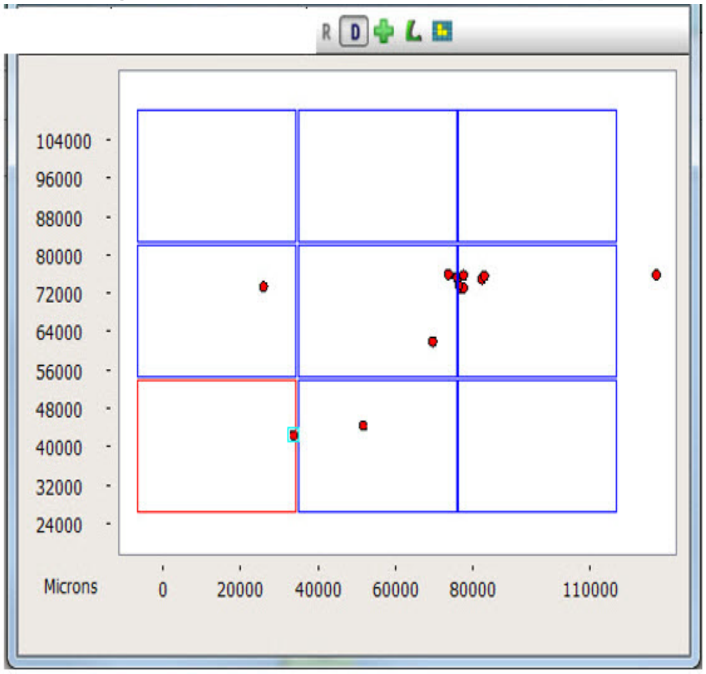
Procedure

1. To overlay a die cycle, click the **Overlay Die Cycle** button (the "D" iconTable 4-1). The same button can be toggled to remove the overlay. The die cycle is shown as blue colored rectangles on the Defect Map.
2. You can distinguish the defect die for any defect by left-clicking on any defect.

Results

The defect die is shown in red. Refer to Figure 4-2 for details.

Figure 4-4. Die Cycle in Defect Map

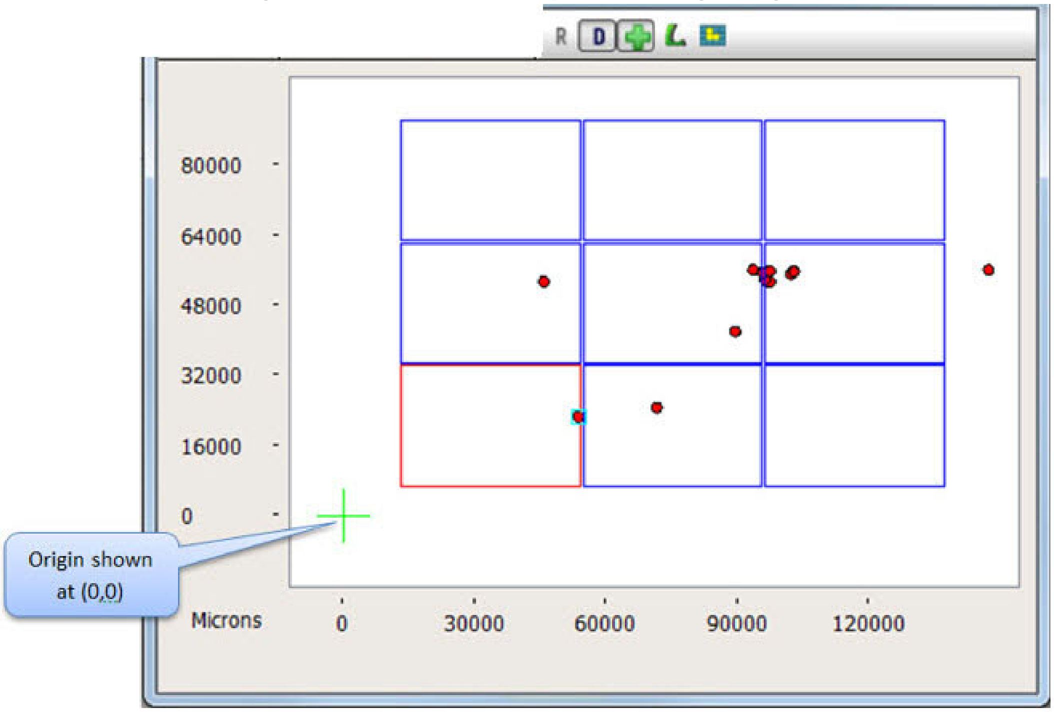


Show Origin

Show Origin (the green plus icon) toggles the display of the origin on the Defect Map window.

When you click **Show Origin**, the origin is shown at the (0,0) location on the Defect Map window (see Figure 4-5).

Figure 4-5. Defect Map Showing Origin

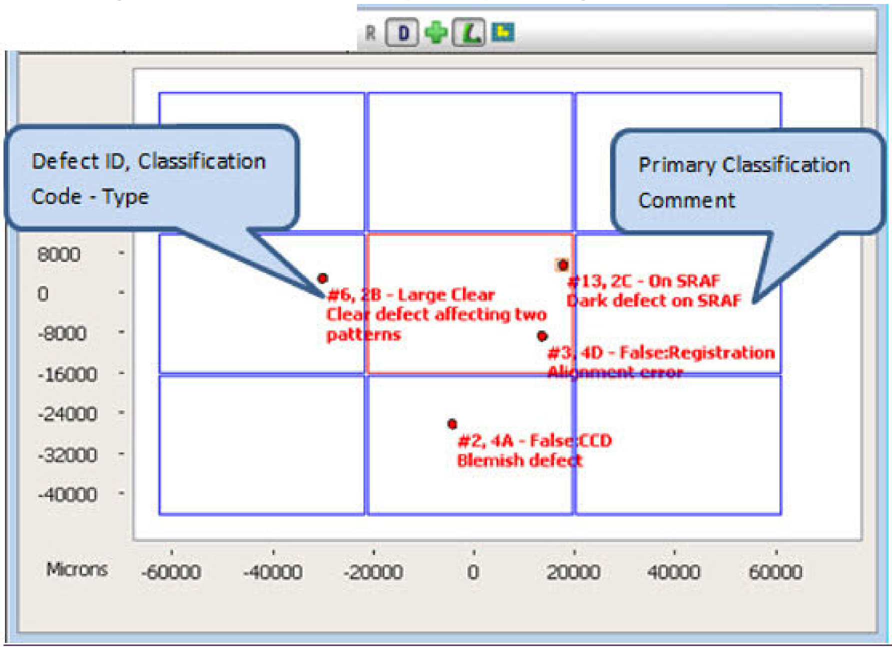


Show Classification Label

Show Classification Label (the green L icon) controls the display of defect information. The defect information includes the defect ID, classification code, and Primary Classification comments (if present) for all defects in the Defect Map window.

Figure 4-6 illustrates an example.

Figure 4-6. Defect Map Displaying Defect Labels

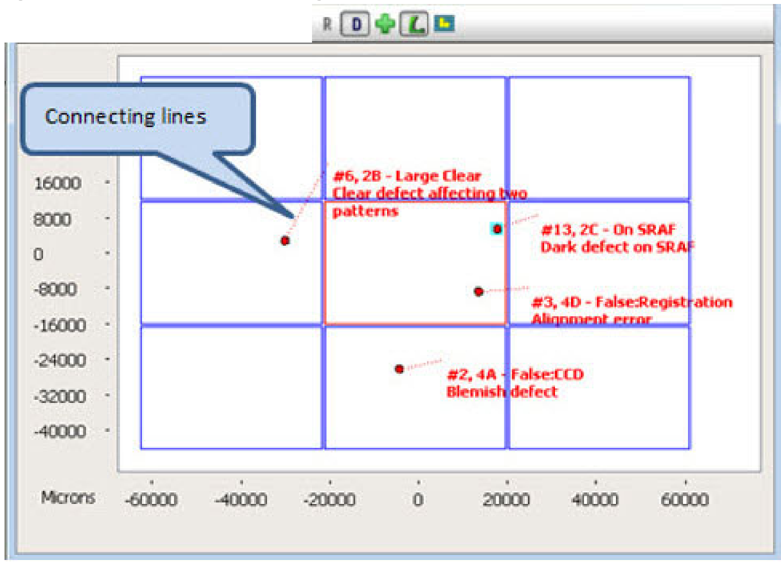


You can also view defect and other object information with tool tips. Refer to "Tool Tip on Map" on page 151 for further information.

Primary classification comments can be added using the Defect Classification window. For more details on adding or editing the primary classification comment, refer to "Editing Defect Comments" on page 215.

You can reposition labels by dragging them to new positions. If a label is repositioned, a line connecting the defect and label is displayed (see Figure 4-7). The connecting line is displayed to make it easier to locate the corresponding label for a defect.

Figure 4-7. Connecting Line From a Defect to Its Label



Defect Map Label Configuration

You can configure information displayed in the labels using the defectMapLabel node present under the node defectMapInfo in the *dat-ini.xml* file. The defectMapLabel node is shown in Figure 4-8.

The defectMapLabel node contains two attributes: displayComment and displayType. The possible values for these attributes are true and false.

- Setting the value of displayComment and displayType to true displays the Primary Classification comment and defect type as part of the information in the label.
- Setting the value of displayComment and displayType to false hides the Primary Classification comment and defect type in the label.

Figure 4-8. defectMapLabel Node in the dat-ini.xml File

```
<defectMapInfo>
 <defectSize>6</defectSize>
 <defectMapLabel displayComment="true" displayType="false">
  <maxLabels>50</maxLabels>
 </defectMapLabel>
```

You can set the maximum number of defects displayed along with the classification information using the maxDefectLabels entry under the defectMapInfo node in the *dat-ini.xml* file. The maxDefectLabels node is shown in Figure 4-9.

Figure 4-9. maxDefectsLabel Node in dat-ini.xml file

```
<defectMapInfo>
 <defectSize>6</defectSize>
 <defectMapLabel displayComment="true" displayType="false">
  <maxLabels>50</maxLabels>
 </defectMapLabel>
</defectMapInfo>
```

If the number of defects exceeds the limit specified in the node, when you display labels, the following error message is issued:

```
Classification labels cannot be displayed. Number of defects exceeds the
limit of <num> defects. Please filter defects and try again.
```

Unit of Measurement Configuration

You can configure the units used to display the coordinates as either microns or millimeters using the *dat-ini.xml* file.

By default, the unit of measurement is set to microns and the conversion factor is set to 1 as shown in Figure 4-10.

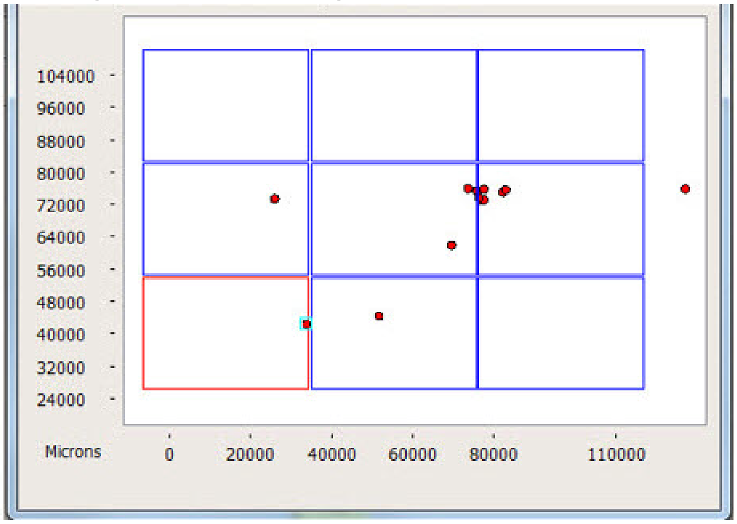
Figure 4-10. Unit of Measurement Specification in the dat-ini.xml file

```
<GeneralInfo>
 <!-- Unit of measure -->
 <UnitOfMeasure>
  <Name>Microns</Name>
  <!-- Unit of measure conversion factor from microns -->
  <ConversionFactor>1</ConversionFactor>
 </UnitOfMeasure>
  .
  .
  .
</GeneralInfo>
```

You can configure the string used to display the units by setting the appropriate value in the Name node and setting the corresponding multiplication factor in the ConversionFactor node to convert the units from microns (see Figure 4-11).

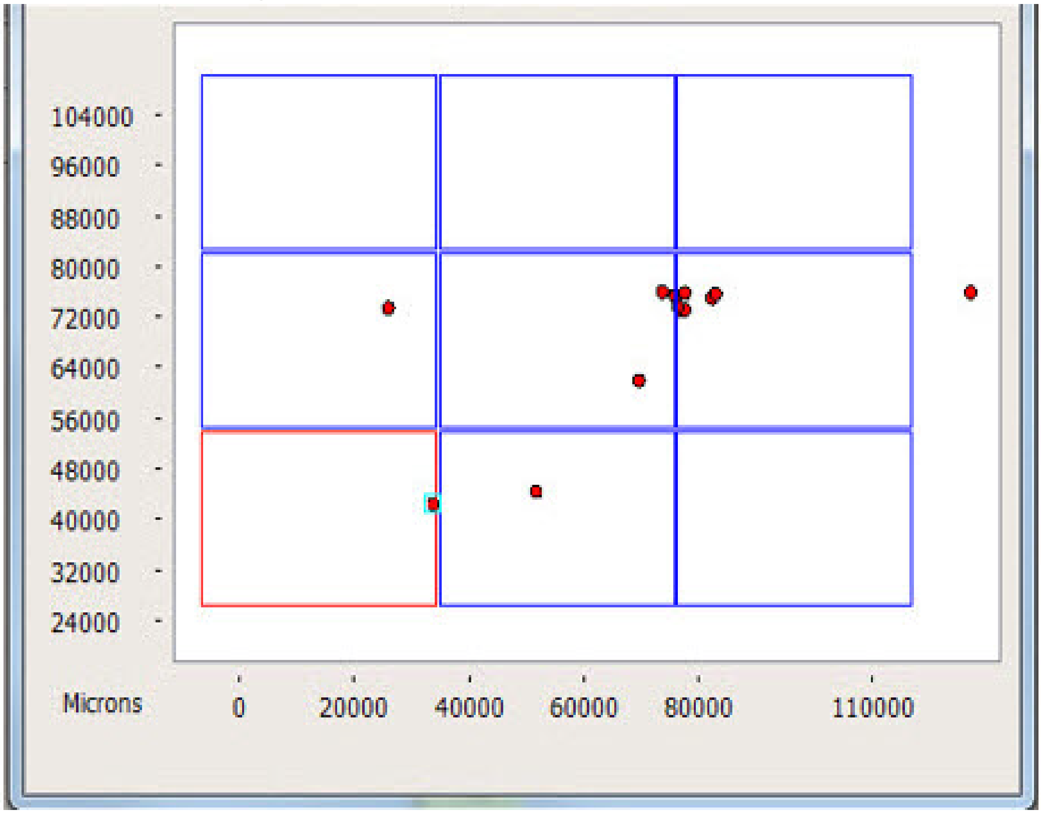
For example, in order to set the unit of measurement to millimeters, the conversion factor should be set to 0.001 and the name to “Millimeter”.

Figure 4-11. Configuration to Millimeters



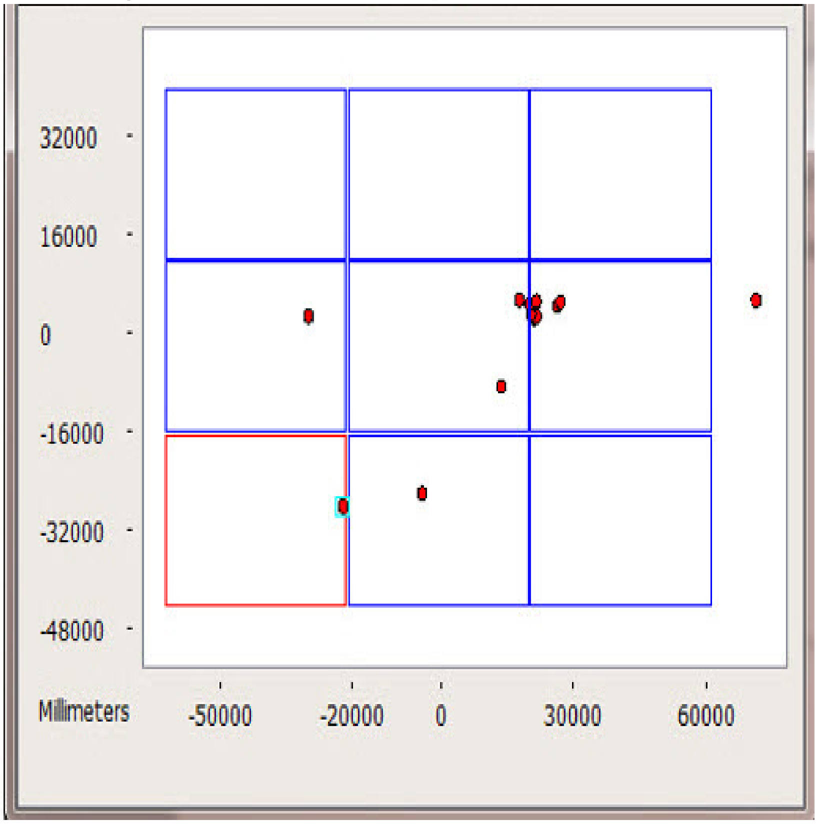
The Defect Map window with the unit of measurement set to microns is shown in Figure 4-12.

Figure 4-12. Defect Map Set to Microns



The Defect Map window with the unit of measurement set to millimeters is shown in Figure 4-13.

Figure 4-13. Defect Map Set to Millimeters



Rubber Band Selection Mode

Calibre DefectReview supports a selection mode known as “rubber band” selection.

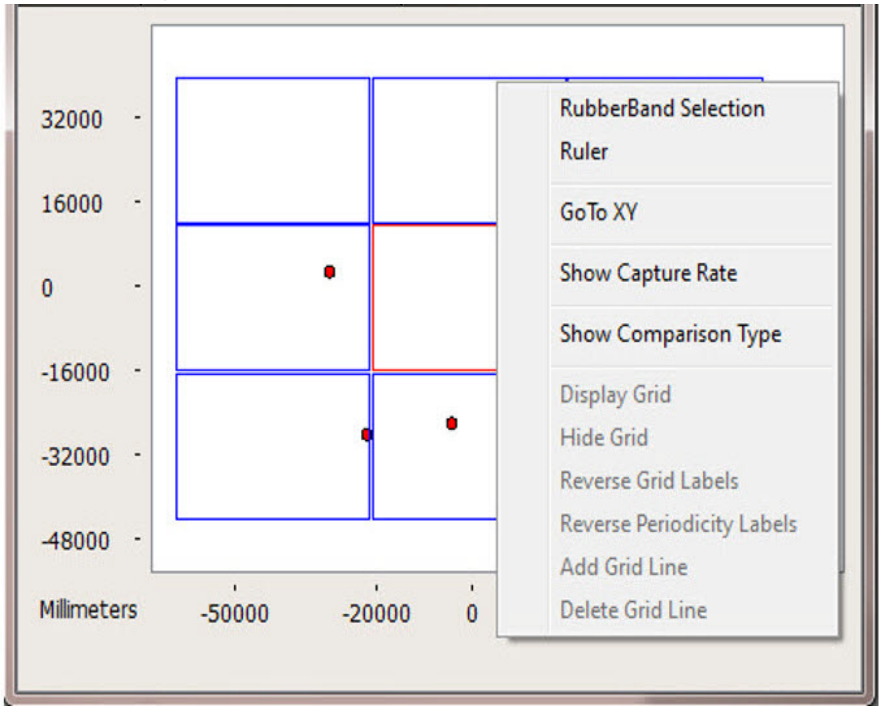
Using Rubber Band Selection Mode

In Calibre DefectReview, you can select defects by dragging a box around them using your mouse.

Procedure

1. Right click on the any empty area of the Defect Map. A popup menu appears (see Figure 4-14).

Figure 4-14. RubberBand Mode Selection



2. Click **RubberBand Selection**. A check mark indicates the mode is enabled.

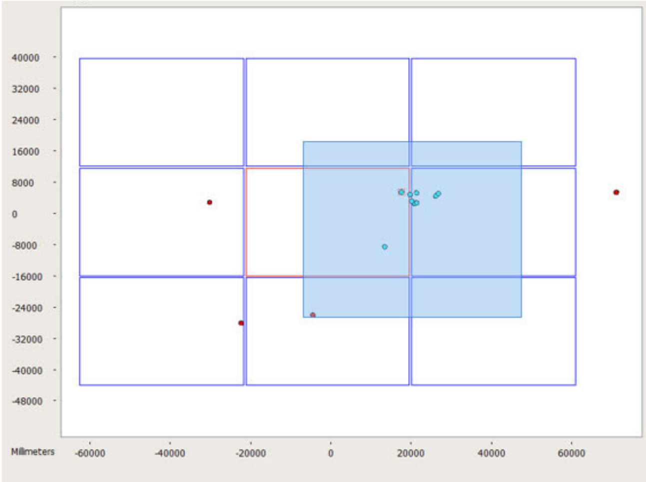
Note
When **RubberBand Selection** is enabled, you can only move defects to the center position of the Defect Map. If you click on any object other than defects, the Defect Map does not change.

3. To select defects:

    a. Click the top-left or bottom-right corner of the desired area.

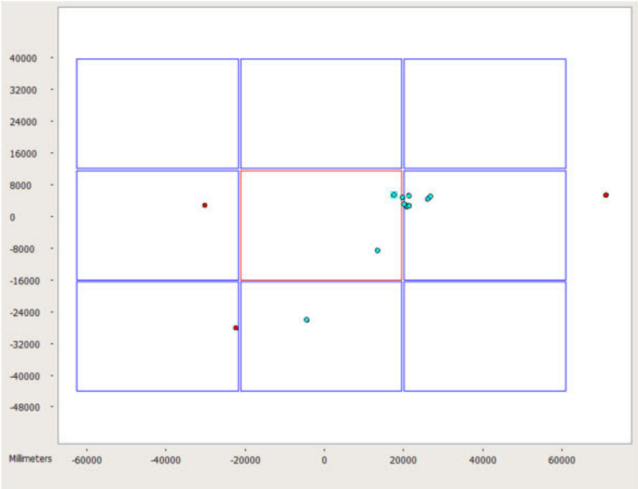
    b. Drag diagonally across the selected area and release.

Figure 4-15. Area Selection of Defects



The selected defects are highlighted in cyan as shown in Figure 4-16.

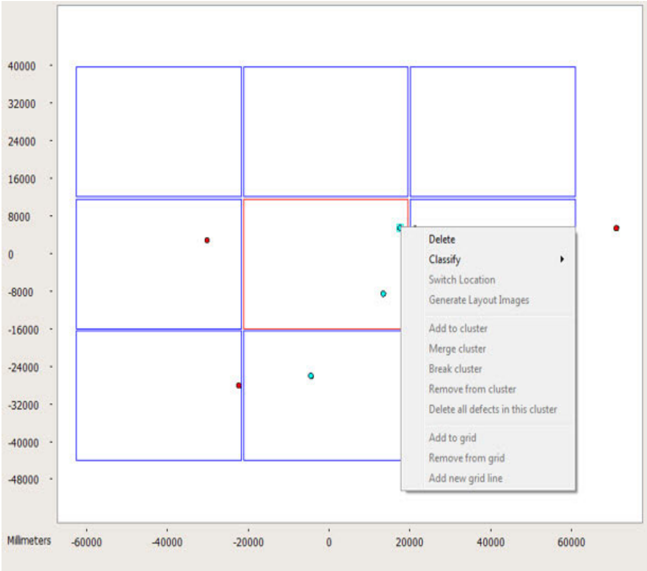
Figure 4-16. Highlighting of Selected Defects



Results

You can now perform various operations on the selected defects by right-clicking on any of the highlighted defects (see Figure 4-17). Refer to the section "Defect List Operations" on page 163 for details.

Figure 4-17. Operations Menu for Defects



Disabling Rubber Band Selection Mode

The **RubberBand Selection** menu item can be deactivated for normal and restricted user types only.

Procedure

1. Using a text editor, open the *dat-ini.xml* file and locate the DefectMapFeatureList entry (shown in Figure 4-18). This node is present under the UserFeatureControl/User node.

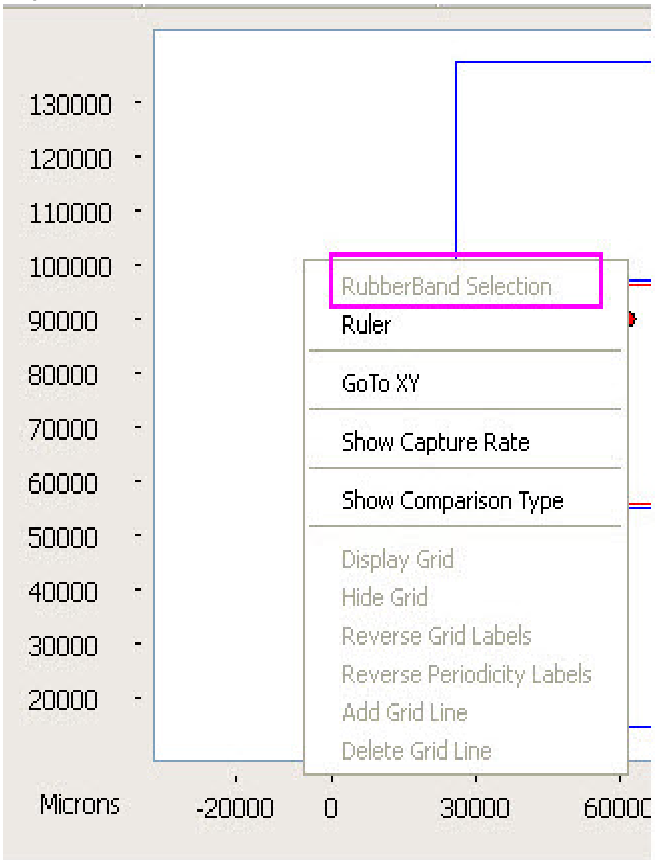
Figure 4-18. DefectMapFeatureList Node

```
<UserFeatureControl>
 <User type="NORMAL">
-- 31 lines: <UtilitiesFeatureList>--------------------------------
-- 12 lines: <SettingsFeatureList>---------------------------------
-- 27 lines: <DefectMapFeatureList>--------------------------------
 </User>
 <User type="RESTRICTED">
-- 28 lines: <UtilitiesFeatureList>--------------------------------
-- 12 lines: <SettingsFeatureList>---------------------------------
  <DefectMapFeatureList>
   <Feature name="RubberBand Selection">DISABLED</Feature>
   <Feature name="All Defects">ENABLED</Feature>
   <Feature name="Isolated Defects Only">ENABLED</Feature>
   <Feature name="Clustered Defects Only">ENABLED</Feature>
   <Feature name="Zoom In">ENABLED</Feature>
   <Feature name="Zoom Out">ENABLED</Feature>
   <Feature name="Fit To Window">ENABLED</Feature>
   <Feature name="Zoom Factor">ENABLED</Feature>
   <Feature name="Overlay Die Cycle">ENABLED</Feature>
   <Feature name="Overlay Die Cycle">ENABLED</Feature>
   <Feature name="Overlay Reticle Image">ENABLED</Feature>
   <Feature name="Show Origin">ENABLED</Feature>
   <Feature name="Show Classification Label">ENABLED</Feature>
   <Feature name="Ruler">ENABLED</Feature>
   <Feature name="Go To XY">ENABLED</Feature>
   <Feature name="Show Capture Rate">ENABLED</Feature>
   <Feature name="Show Comparison Type">ENABLED</Feature>
   <Feature name="Demarcate Inspection">ENABLED</Feature>
   <Feature name="Classify">ENABLED</Feature>
   <Feature name="Display Grid">ENABLED</Feature>
   <Feature name="Hide Grid">ENABLED</Feature>
   <Feature name="Reverse Grid Labels">DISABLED</Feature>
   <Feature name="Reverse Periodiocity Labels">ENABLED</Feature>
   <Feature name="Add Grid Line">ENABLED</Feature>
   <Feature name="Delete Grid Line">ENABLED</Feature>
  </DefectMapFeatureList>
 </User>
</UserFeatureControl>
```

2. Enter ENABLED or DISABLED for the RubberBand Selection entry for the different user types.

   In the example shown in Figure 4-19, the value of RubberBand Selection is DISABLED for a restricted user. This means that the **RubberBand Selection** menu item in the Defect Map window is unavailable for all restricted users. (The option is dimmed in the menu.)

Figure 4-19. RubberBand Selection Dimmed



Note the following:

- If a feature is deactivated for normal users then, it is also deactivated for restricted users.
- All Defect Map features are enabled for privileged users.

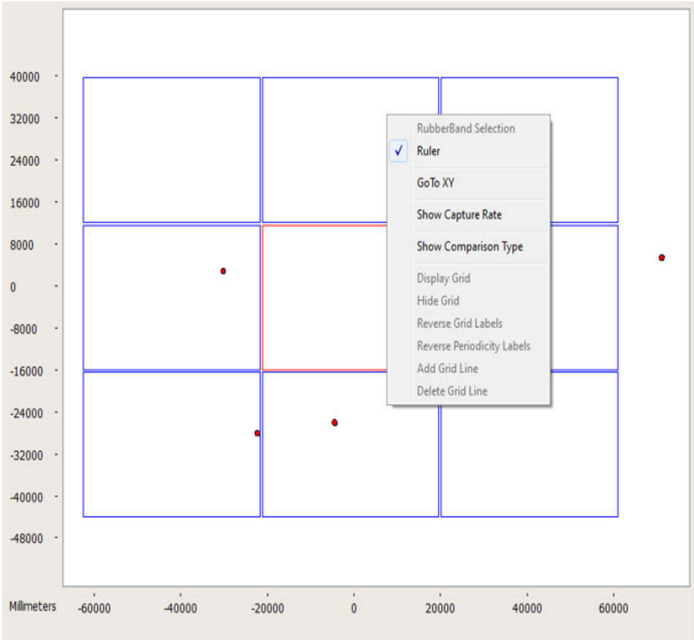
Using Rulers

Distances between defects can be measured using the Ruler feature in the Defect Map window.

Procedure

1. Right-click in any empty area of the Defect Map display area to invoke the popup menu.
2. Select **Ruler**. Once enabled, a check mark appears next to it.

Figure 4-20. Ruler Option Enabled



Note

If the Ruler mode is enabled, Center Around mode is deactivated.

3. To measure the distance between two points in the Defect Map window:

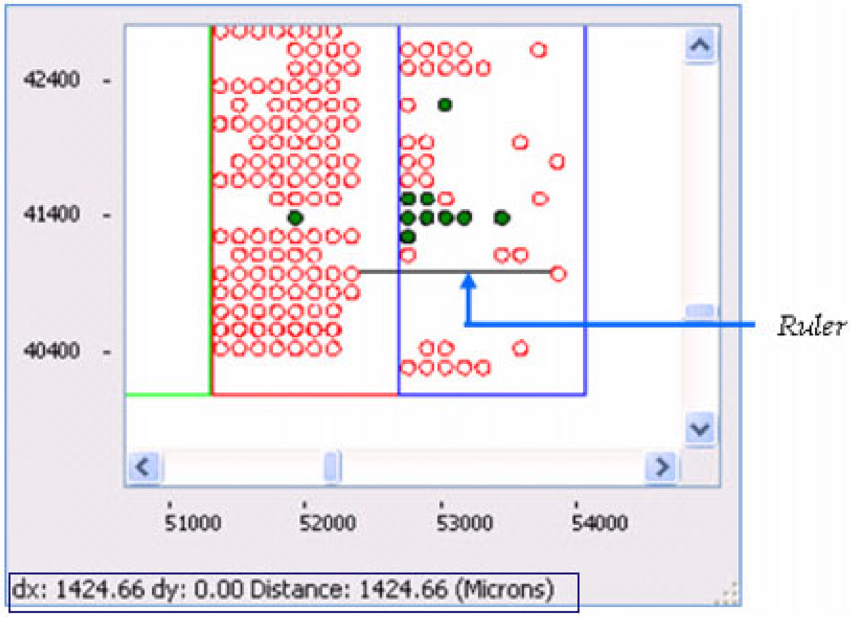
   a. Click and hold a point in the Defect Map window to indicate where you want to start measurement.

   b. Drag a line to the end point.

Results

The measured distance between start point and end point is displayed in the status bar of the Defect Map. Figure 4-21 illustrates an example ruler measurement.

Figure 4-21. Ruler Measurement Example



In Figure 4-21, the measurement is displayed as:

```
dx:1424.66 dy:0.00 Distance: 1424.66 (Microns)
```

The distance is displayed in units specified in the *dat-ini.xml* file.

Demarcating Repeats

You can use the Demarcate Repeats feature in the Defect Map window to distinguish defects with different repeat counts across inspections from same mask. By default, this feature is enabled.

Prerequisites

- The inspection must be opened from the database. When using the All folder, all inspections must be opened from the database.
- Define the color code for a defect repeat count in the *dat-ini.xml* under DefectRepeatColorCodes within the DatabaseInspection node.

Figure 4-22. Defect Repeat Color Codes

```
<DefectRepeatColorCodes>
 <Range color="#00FF00" min="1" max="4"/>
 <Range color="#FFFF00" min="5" max="9"/>
 <Range color="#8B0000" min="10"/>
</DefectRepeatColorCodes>
```

As shown in the previous figure, if a defect repeats from 1-4 in a mask, the defect is displayed in green. If a defect repeats between 5 and 9 times, the defect is displayed in yellow. If a defect repeats for 10 or more times, then it is displayed in dark red, which represents a severe defect due to high repetition.

Values and ranges must be set correctly:

- Valid values for the min and max attributes are a positive non-zero integer value.
- If an invalid value is supplied for min, then min is set to 1.
- If an invalid value is specified for max, then max is set as an unsigned integer maximum value.
- If min is set higher than max in the *dat-ini.xml* file, then their values are exchanged.
- You can specify a hash value with color as shown in the previous figure or the color name can be specified as in the following example:

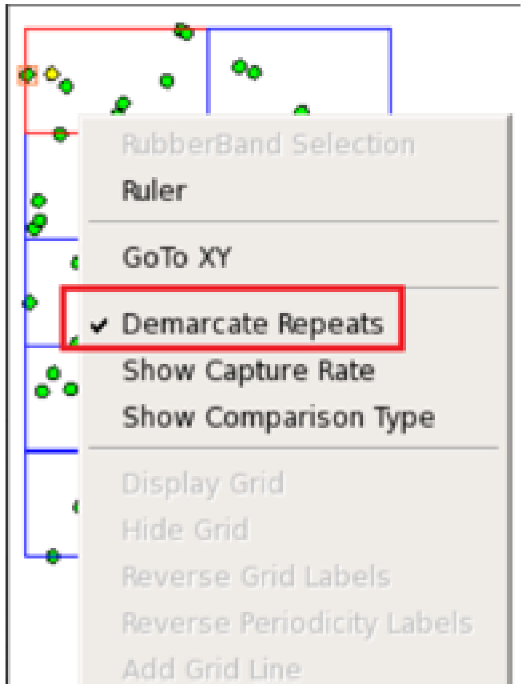
  ```
  <Range min="1" max="4" color="green"/>*
  ```

- If you have overlapping Range (min, max) values across multiple Range nodes, the first matching range (based on the Range node order) is considered to color the defect.
- If an invalid value is supplied for a color, then the color is set to red by default.
- Red is already the default color and should not be explicitly specified in the *dat-ini.xml* file for any defect repeat count. However, no check is provided in the code if you specify red, as the behavior is considered undefined.

Procedure

1. Right-click in an empty area of the Defect Map to invoke a popup menu.
2. Select **Demarcate Repeats**, if it is not already selected. Defects are then displayed in a color based on the number of repetitions across inspections from the same mask and the color code set in the *dat-ini.xml* file.

Figure 4-23. Demarcate Repeats



Demarcating Multiple Inspections

You can use a demarcation feature in the Defect Map window to distinguish between defects from different inspections.

Prerequisites

The Multiple Inspections (All) folder must be open. The Demarcate Inspections feature is enabled only in the Multiple Inspections (All) folder.

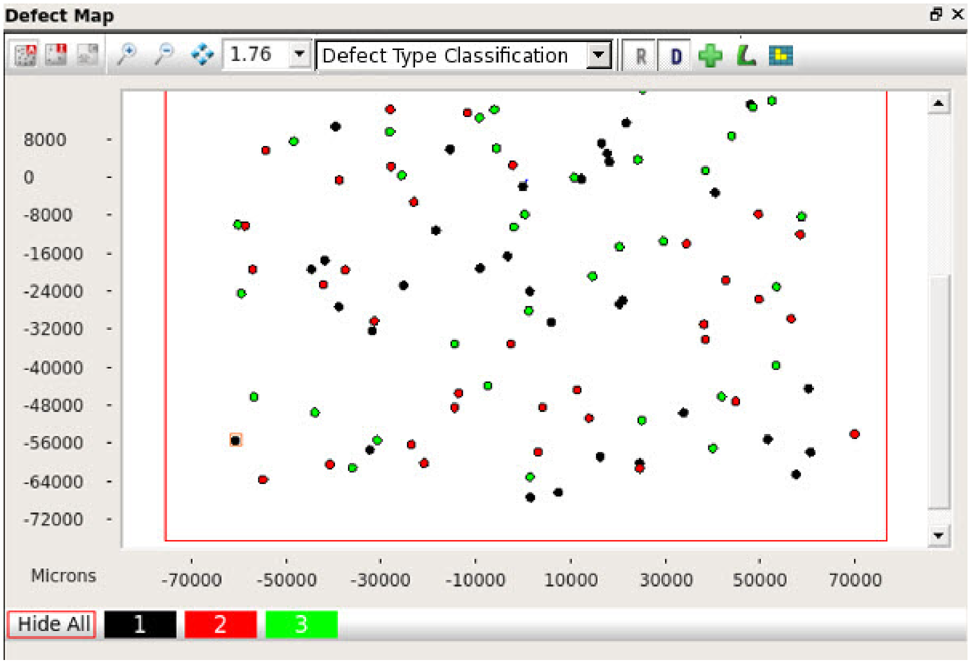
Procedure

1. Right-click in an empty area of the Defect Map to invoke a popup menu.
2. Select the **Demarcate Inspections** menu item.

Results

For example, if you load three inspection files and select **Demarcate Inspections**, the inspections are shown in red, black, and green. The corresponding color legend is shown in the tool bar. Hovering over the color legend shows the name of the inspection file. (See Figure 4-24.)

Figure 4-24. Defects From Different Inspection Runs



Double-clicking on each demarcate label turns off that particular inspection. Once an inspection is turned off, all the defects of that inspection are filtered out from all the modules in Calibre DefectReview. When the inspection is filtered out in this manner, the corresponding label is grayed out. Double-clicking on a grayed out label un-hides all the defects of the inspection in the Defect Map and all other modules of Calibre DefectReview.

To hide all inspections at a time, double-click **Hide All**. To show all the hidden inspections, double-click **Show All**.

Showing Capture Rate

Show Capture Rate mode allows you to find the number of inspections in which the defects have been captured for a particular defect location.

Prerequisites

A folder must be open.

Procedure

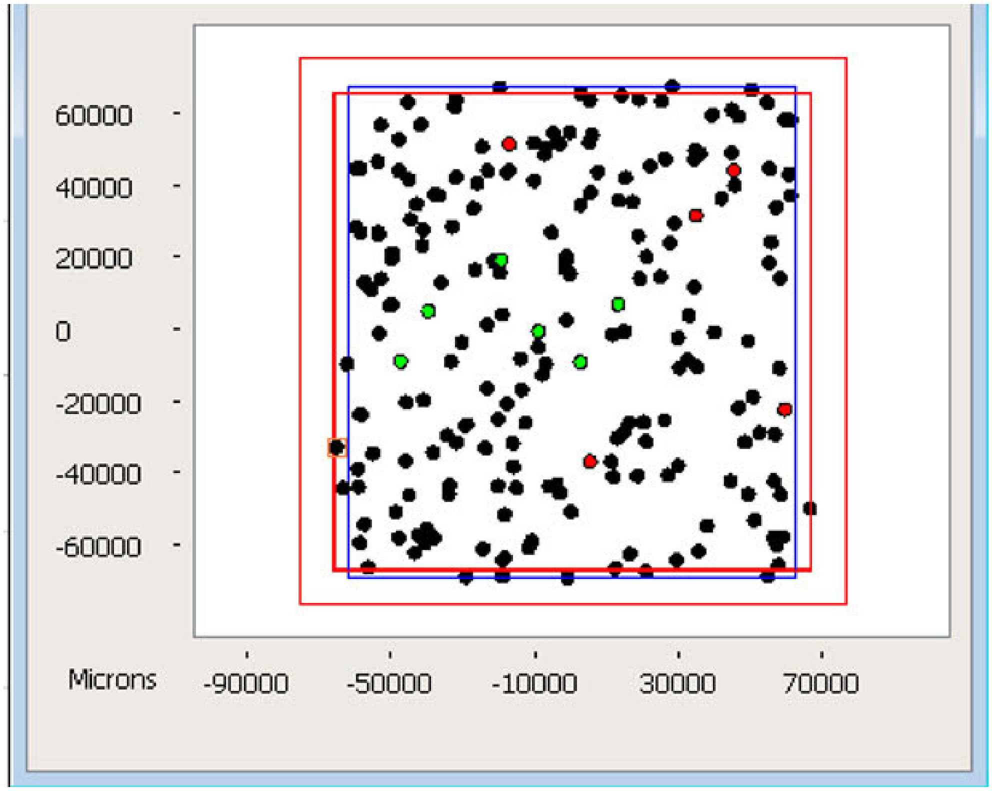
1. Right-click in an empty area of the Defect Map to invoke a popup menu.
2. Select **Show Capture Rate**. A check mark indicates the option is enabled.

Results

The defects in the Defect Map are displayed as shown in Figure 4-25. The defect colors temporarily change to reflect what is shown in the Capture Rate Color Legend dialog box.

When the Capture Rate Color Legend dialog box is closed, the defects return to their original colors.

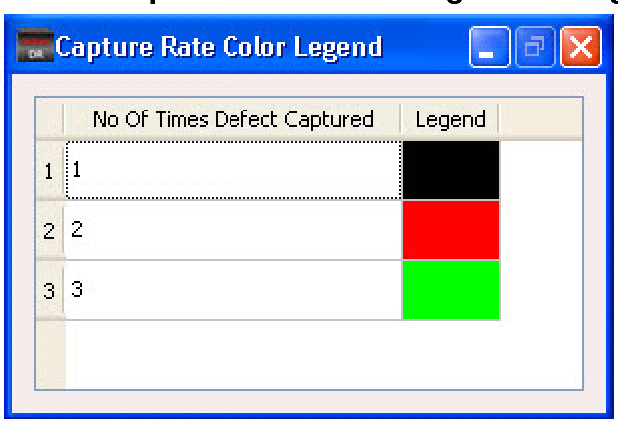
Figure 4-25. Defect Map With Show Capture Rate



Examples

In the following example, there are three inspection files and **Show Capture Rate** is selected. A Capture Rate Color Legend dialog box appears as shown in Figure 4-26.

Figure 4-26. Capture Rate Color Legend Dialog Box



As shown in Figure 4-26:

- Defects captured in only one inspection file are highlighted in black.

- Defects captured in two inspection files are highlighted in red.
- Defects captured in all the three inspection files are highlighted in green.

Highlighting Based on Comparison Type

You can use the highlighting feature in the Defect Map window to distinguish between defects detected in different comparison types.

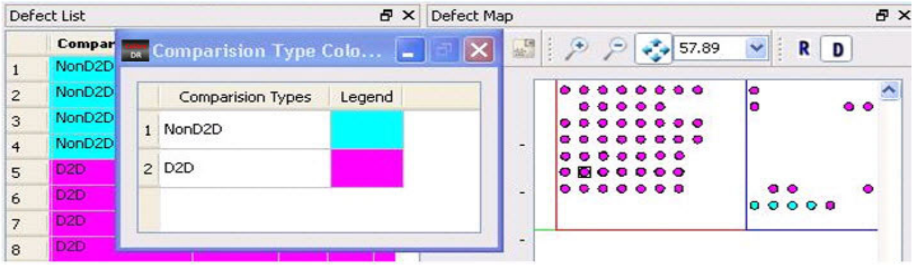
Procedure

1. Right-click on any empty area of the Defect Map to invoke a popup menu.
2. Select **Show Comparison Type**. A check mark indicates the feature is enabled.

Examples

In this example, an inspection is loaded with two comparison types: D2D and NonD2D. **Show Comparison Type** is then selected. All defects with the D2D and NonD2D defects are highlighted in different colors (see Figure 4-27).

Figure 4-27. Highlighting Comparison Types



Using Grid Display Operations

You can use Calibre DefectReview to detect the grid on any inspection and perform a number of grid display- specific operations on the Defect Map.

Prerequisites

- A Single Inspection (SI) folder must be open.

Procedure

1. From the Calibre DefectReview menu bar, select **Utilities** > **Auto Grid Detection** > **X-direction** or**Y-Direction** to detect and display the grid used for the inspection in either X- or Y-direction, respectively. Refer to"Auto Grid Detection" on page 374 for details.

2. Once the grid is detected, you can perform a number of grid display operations on the Defect Map. Right-click in the Defect Map window and select an item from the popup menu. These items are available only if a grid is detected.

Table 4-2. Grid Display Operations Menu Items

Menu Item	Description
Display Grid	View the grid. By default, once a grid is detected, it is displayed. When the grid is displayed, **Display Grid** is unavailable. The grid lines include the periodicity lines as well. Grid lines are shown as solid black lines. Periodicity lines are shown as dotted black lines and are perpendicular to the grid lines. If the grid is hidden, then this option is enabled.
Hide Grid	Hide grid lines.
Reverse Grid Labels	Reverse the orientation of the grid labels.
Reverse Periodicity Labels	Reverse the orientation of the periodicity labels.
Add Grid Line	Add a grid line in the Defect Map where your mouse pointer is.
Delete Grid Line	Remove a particular grid line.

Certain operations are expanded as follows:

- For the **Reverse Grid Labels** operation:

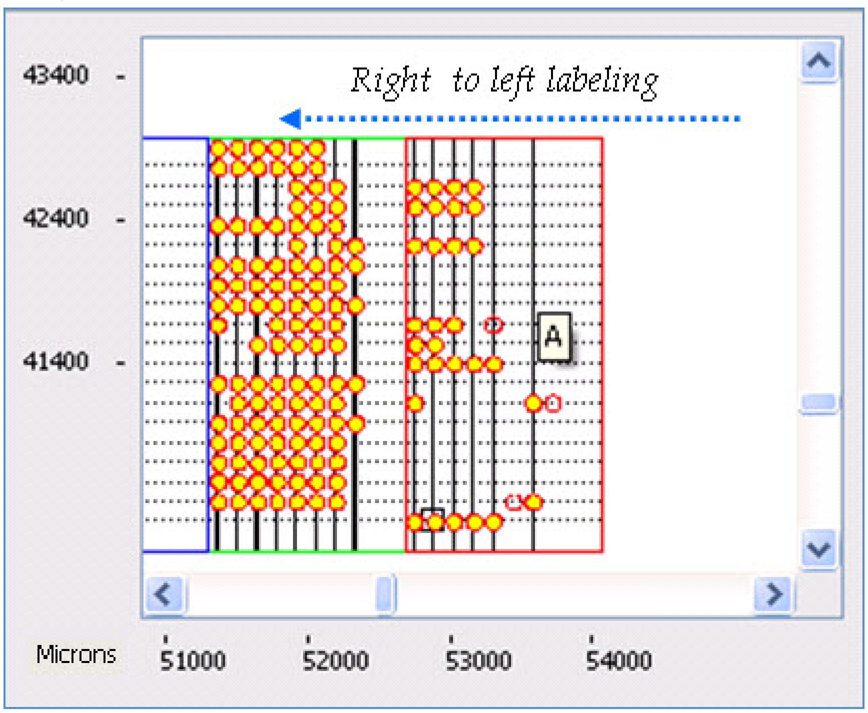
    i. Right-click in the Defect Map window to invoke the popup menu.

    ii. Select **Reverse Grid Labels**. The grid labeling follows the ordering of A-Z, AA-AZ, BA-BZ, and so on.

    For grid detection in the Y direction, if the initial grid labels are from left to right as shown in Figure 4-28, then after reversing, the grid labels are from right to left as shown in Figure 4-29.

Figure 4-28. Initial Grid Labels From Left to Right for Y-Direction

Figure 4-29. Grid Labels After Reversal for Y-Direction



- For the **Reverse Periodicity Labels** operation:

  i. Right-click in the Defect Map window to invoke the popup menu.

ii. Select **Reverse Periodicity Labels**.

For grid detection in the Y-direction, if the initial periodicity labels are numbered from top to bottom as shown in Figure 4-30, then after reversing, the periodicity labels are numbered from bottom to top as shown in Figure 4-31.

Figure 4-30. Initial Periodicity Labels

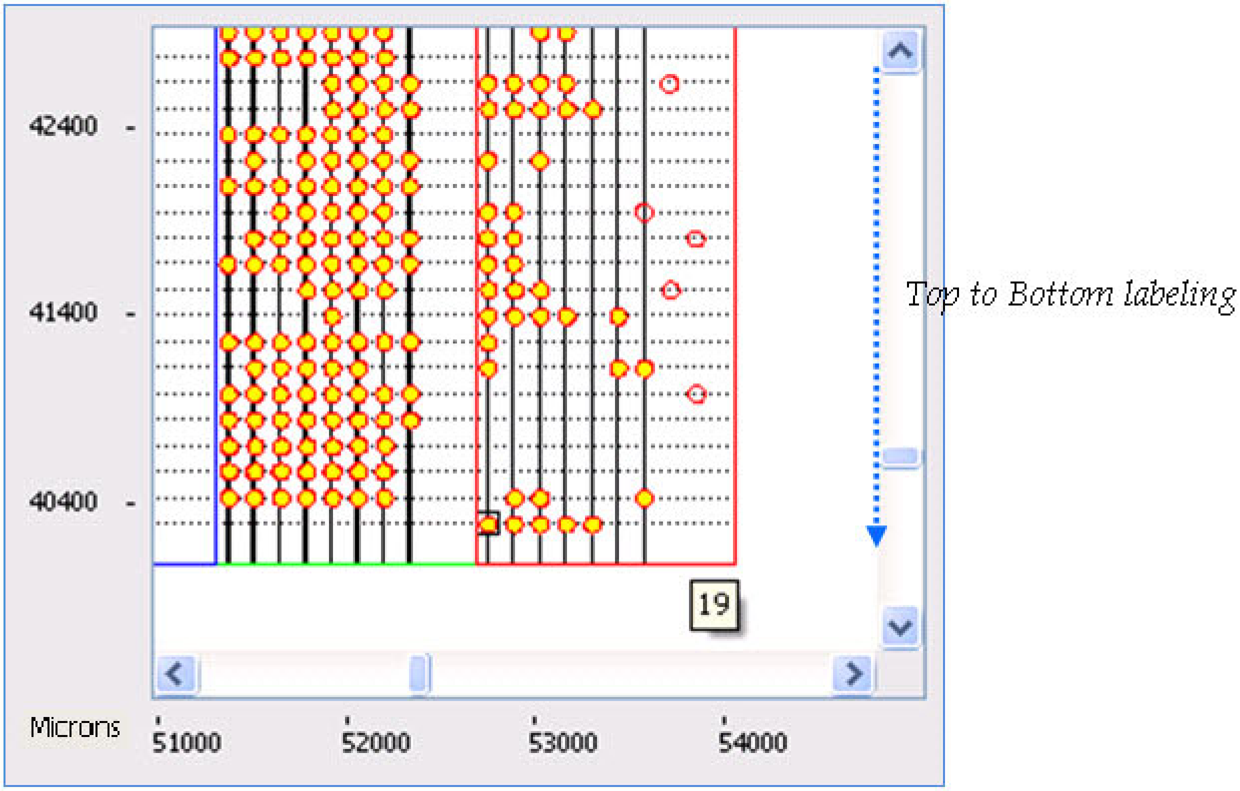
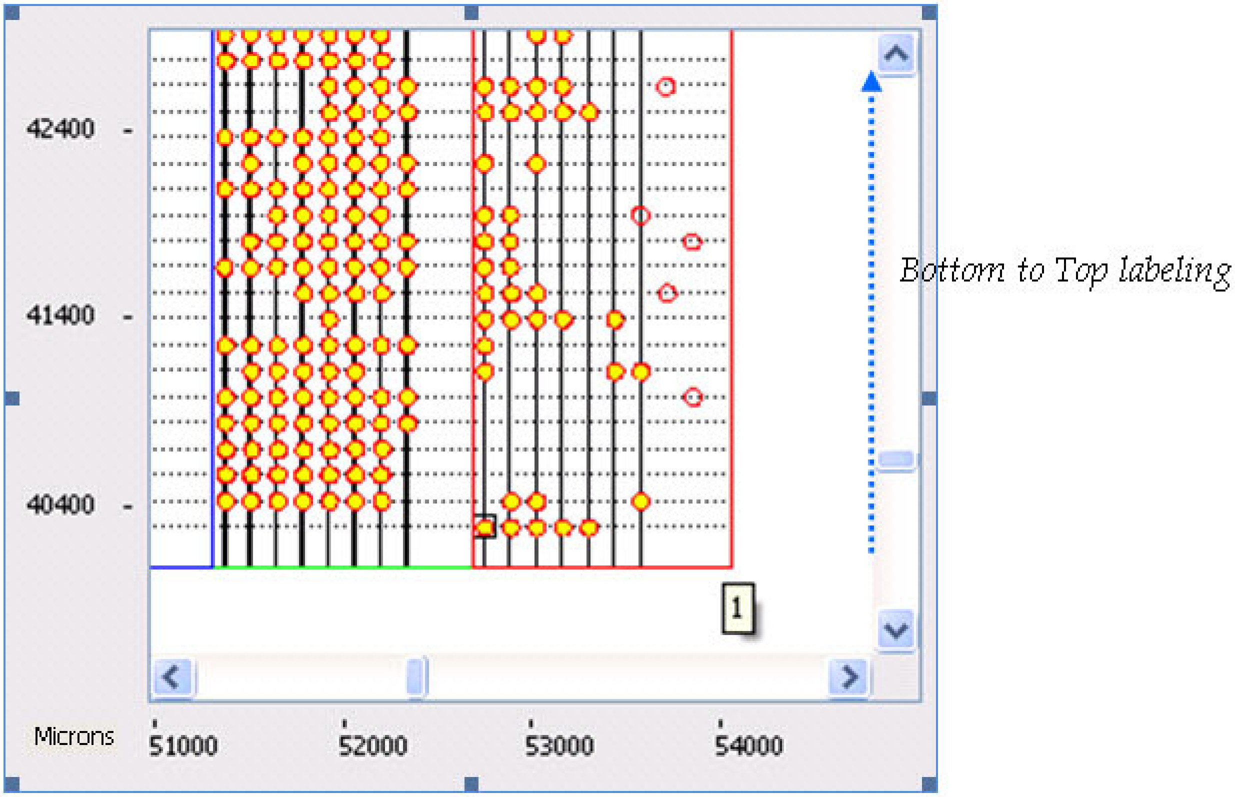


Figure 4-31. Periodicity Labels After Reversal



- For the **Add Grid Line** operation:
  i. Right-click in the Defect Map window to invoke the popup menu.
  ii. Select **Add Grid Line** to add a grid line in the Defect Map.
- For the **Delete Grid Line** operation:
  i. Right-click in the Defect Map window to invoke the popup menu.
  ii. Select **Delete Grid Line**. A dialog box appears as shown in Figure 4-32.

Figure 4-32. Delete Grid Line Dialog Box

- In the Delete Grid Line dialog box, select the grid name in the dialog box, then click **Delete** to remove the selected grid line.

Defect Operations in the Defect Map Window

A number of defect-specific operations appear when you right-click on a specific defect in the Defect Map window.

Using General Defect Operations

This section describes many of the general operations that can be performed on any defect (isolated or clustered) in the Defect Map window.

Procedure

1. In the Defect Map window, right-click a defect to invoke a popup menu.
2. Select an item from the popup menu. There are a number of defect-specific operations available.

Table 4-3. General Defect Operations Menu Items

Menu Item	Description
Delete	Delete a defect or a set of defects selected with rubber band mode (see "Using Rubber Band Selection Mode" on page 128). When you delete a defect, a message box appears prompting you to confirm the deletion. For example, if you select defect ID 147 of inspection 1 for deletion, then the following message is issued: `DefectId(s) 1_147 will be removed permanently from the list`
Classify	Classify a defect or set of defects as specific classification types. You can classify a defect as a specific type. To classify a set of defects, first select them using **RubberBand Selection**.
Track Defects	Launch Defect Progress Tracking using the defect's attribute such as Cd Var, Size, Area, Reflectance, Reflectance Residue, Transmittance, or Transmittance Residue.
Generate Layout Images	Generate layout images for a defect or set of defects. Once layout images are generated, images can be viewed in the Image Measurement Unit window. The image names are prefixed with the word "Layout". You can generate layout images only if the layout data for the reticle has been set up. The details for setting up layout data are described in "Layout Import" on page 389.

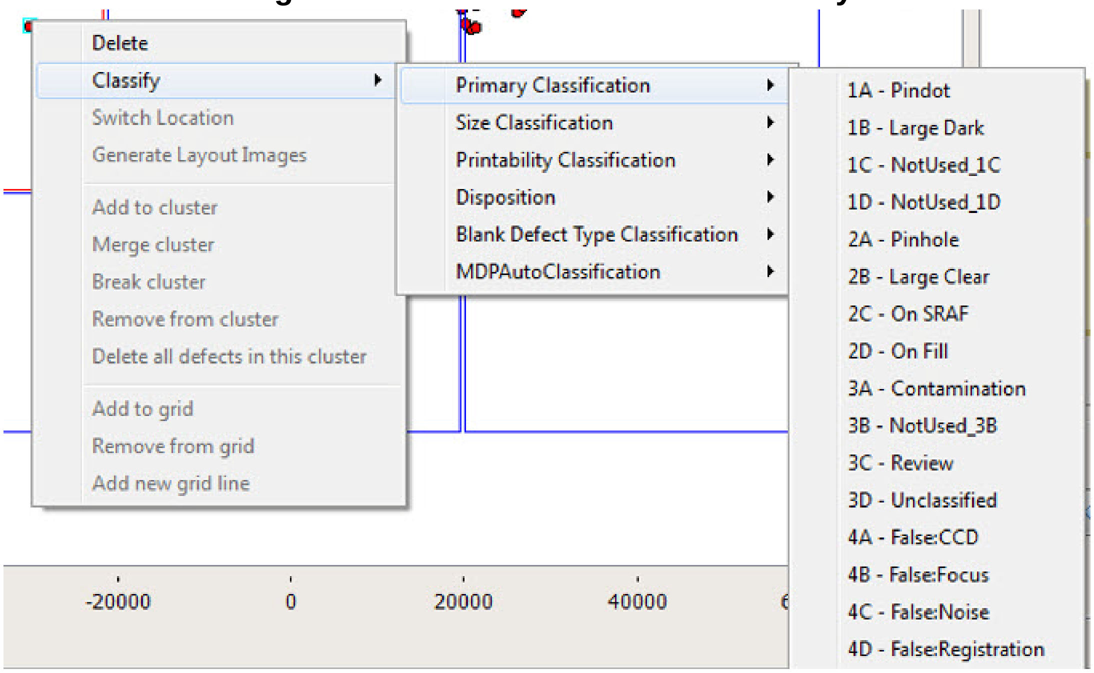
Certain operations are expanded as follows:

- For the **Classify** operation:

    i. Click **Classify**. A cascading menu with all defect types and corresponding defect codes appears as shown in Figure 4-33.

    ii. Click the desired classification type.

Figure 4-33. Extended Menu for Classify



- For the Track Defects operation:

    i. To track defects across inspections from a mask, right-click on a defect in the Defect Map to invoke the popup menu.

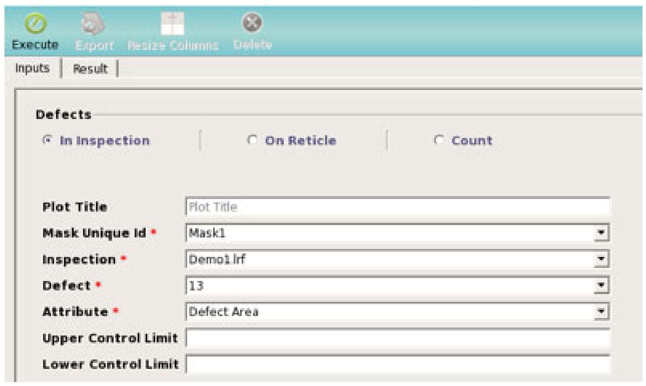
    ii. Select **Track Defects**.

    iii. Select an **Attribute**: Cd Var, Defect Area, Defect Size, Reflectance, Reflectance Residue, Transmittance, or Transmittance Residue.

Figure 4-34. Track Defects Selection

The Defect Progress Tracking dialog appears.

Figure 4-35. Defect Progress Tracking in an Inspection



iv. Specify an Upper or Lower Control Limit or both (if any) and click **Execute**.

For details on Defect Progress Tracking (DPT), please refer "Defect Progress Tracking (DPT)" on page 445.

Using Cluster-Specific Operations

Defects can be grouped in clusters using **Utilities > Auto Cluster** in the Calibre DefectReview menu bar. There are a number of operations available in the Defect Map window.

Prerequisites

- You must have grouped defects into clusters using one of the options available from **Utilities > Auto Cluster**. Refer to "Auto Clustering" on page 371 for details.

Procedure

1. In the Defect Map window, right-click a clustered defect to invoke a popup menu.

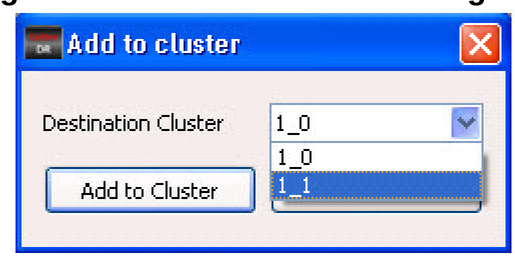
2. Select an item from the popup menu. There are a number of cluster-specific operations available.

Table 4-4. Cluster Specific Menu Items

Menu Item	Description
Add to Cluster	Add an isolated defect to an existing cluster.
Merge Cluster	Merge one or more clusters into another cluster.
Break Cluster	Break a cluster of defects into individual isolated defects.
Remove From Cluster	Remove a selected defect from a cluster.
Delete All Defects in This Cluster	Remove all defects from a selected cluster.

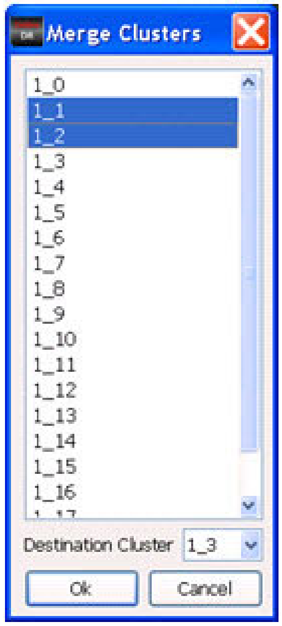
- For the **Add to Cluster** operation:
    - i. Right-click an isolated defect to invoke the popup menu.
    - ii. Select **Add to cluster**. A dialog box appears with a list of the existing cluster names as shown in Figure 4-36.

Figure 4-36. Add to Cluster Dialog Box



    - iii. Choose the destination cluster from the pulldown list.
    - iv. Click **Add to Cluster**. The isolated defect changes and uses the same color as the cluster it was added to.
- For the **Merge Cluster** operation:
    - i. Right-click a defect in a cluster to invoke the popup menu.
    - ii. Select **Merge cluster**. A dialog box appears as shown in Figure 4-37.

Figure 4-37. Merge Clusters Dialog Box



iii. Select the clusters to be merged from the list. Multiple clusters can also be selected by holding down the Ctrl key and clicking the additional clusters.

iv. Select the Destination Cluster from the drop-down list.

v. Click **OK**. The selected clusters are merged with the destination cluster. All defects are now grouped under the destination cluster ID.

For example, if you select clusters 1_1 and 1_2 from the list and select 1_3 as the destination cluster, then all defects of 1_1 and 1_2 become part of cluster 1_3.

- For the **Delete All Defects in This Cluster** operation:

  i. Right-click any defect in a cluster to invoke the popup menu.

  ii. Select **Delete all defects in this cluster**. A message appears prompting you to confirm:

```
This will remove cluster defects permanently from the list
```

  iii. Click **OK** to confirm the deletion.

Adding or Removing Defects on the Grid

You can add or remove defects from the grid displayed in the Defect Map window.

Prerequisites

- The grid must be detected. From the Calibre DefectReview menu bar, select **Utilities** > **Auto Grid Detection** > **X-direction** or **Y-Direction** to detect and display the grid used for the inspection in either X- or Y-direction, respectively. Refer to "Auto Grid Detection" on page 374 for details.

Procedure

1. In the Defect Map window, right-click a defect to invoke the popup menu.
2. Select an item from the popup menu.

Table 4-5. Menu Items for Adding or Removing Defects on the Grid

Menu Item	Description
Add to Grid	Add defects to the grid. If the defect is successfully added, then the color code of the defect changes to yellow. If the defect is not successfully added, then the following message is issued: `The defect <defect_num> cannot be part of a grid`
Remove From Grid	Remove a defect from any grid. The color code of the defect changes to a non-grid defect.
Add New Grid Line	Add a new grid line on any defect. A new line is displayed on the Defect Map window and the color code of the associated defect changes to the grid defect color.

View Information

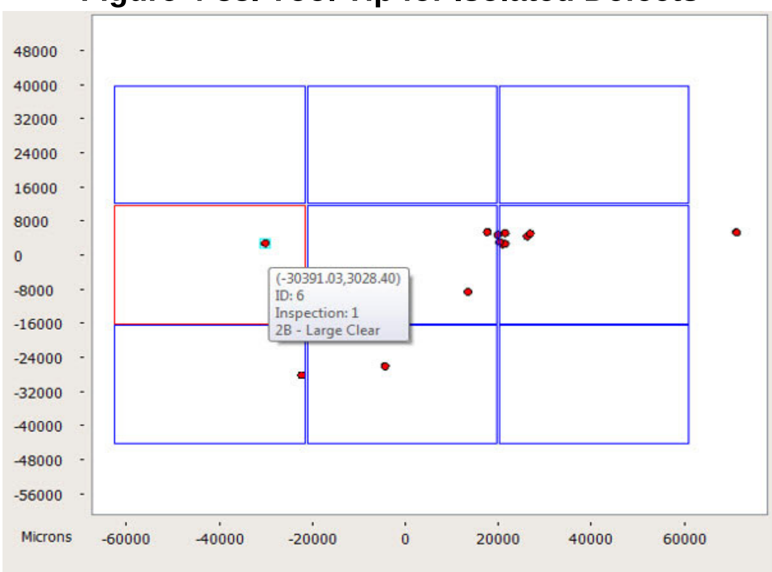
Information about a defect can be viewed using a tool tip. This section describes the different types of tool tips available in the Defect Map window. To view information on multiple defects simultaneously, click the **Show Classification Labels** button.

Tool Tip on Defect

In the Defect Map window, you can view the tool tip on any defect by placing the cursor on that defect. An arrow is shown with the tool tip initially.

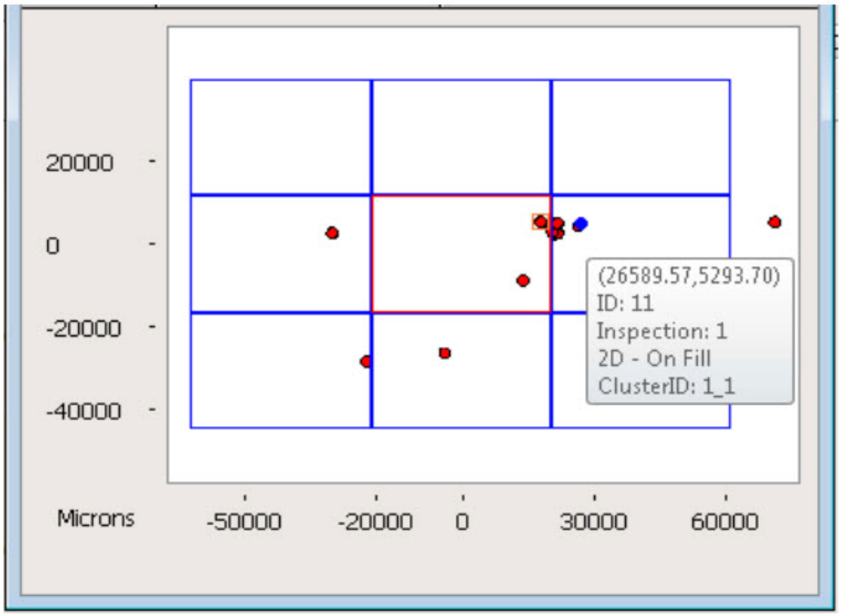
- For isolated defects, the tool tip displays information about the system coordinates (Sys) of the defect in units configured in the *dat-ini.xml* file (for more details on configuration of units refer to section “Unit of Measurement Configuration” on page 125), the defect number (ID), the inspection number, and the classification type. Figure 4-38 shows an example of an isolated defect.

Figure 4-38. Tool Tip for Isolated Defects



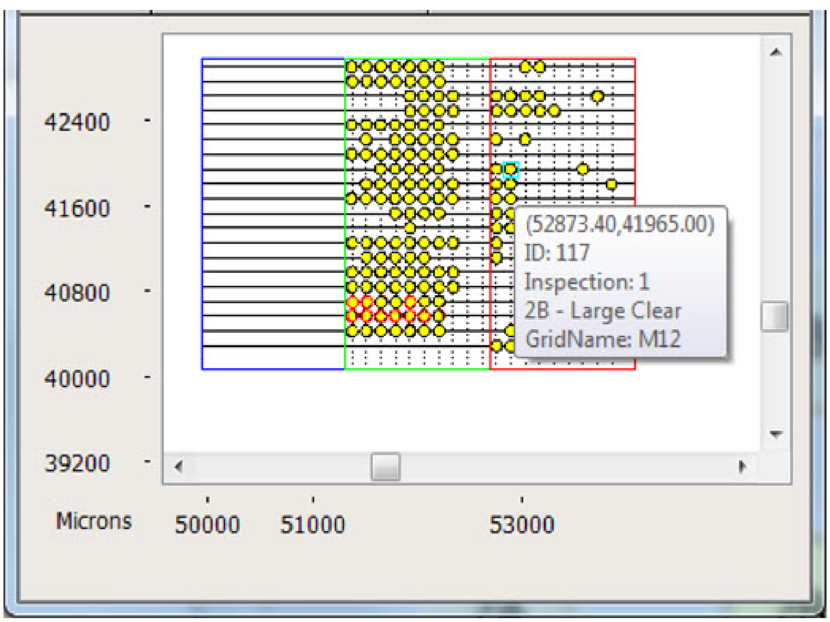
- For clustered defects, the tool tip includes the isolated defect information and also has the Cluster ID information. The entry for the cluster ID attribute is assigned as the InspectionID_ClusterNo node. For example, 1_1 indicates cluster 1 of inspection 1 and the defect 11 is part of the cluster 1_1. Figure 4-39 shows an example for a clustered defect.

Figure 4-39. Tool Tip for Clustered Defects



- For grid defects, the tool tip also has the grid information. For example, M12 indicates that the defect is on grid line M at periodicity interval 12. Figure 4-40 shows an example tool tip for a grid defect.

Figure 4-40. Tool Tip for Grid Defects

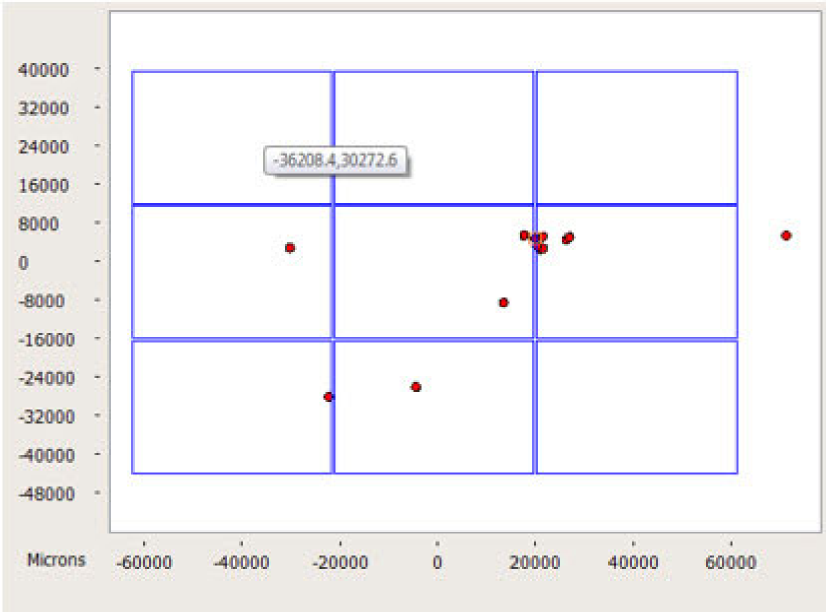


Tool Tip on Map

You can view the X and Y coordinates at any point in the Defect Map window.

The value of the coordinates is displayed in the units configured in the *dat-ini.xml* file. For more details on configuration of units, see "Unit of Measurement Configuration" on page 125.

Figure 4-41. Tool Tip to Show Coordinate Information



Navigate to a Defect

You can navigate to a defect by using **GoTo XY** or by left-clicking a defect. This section describes both methods.

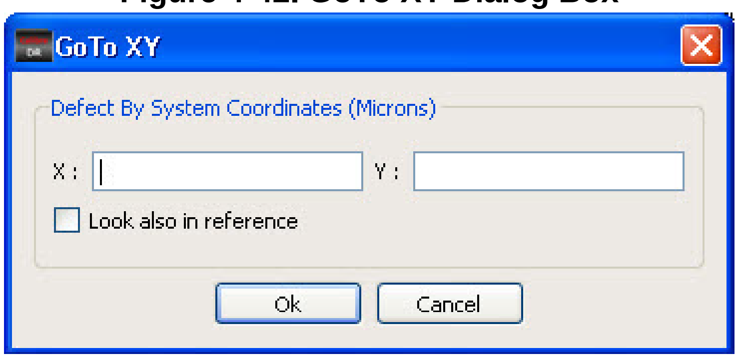
Using GoTo XY

Use the GoToXY dialog box to navigate to a defect using its system coordinates.

Procedure

1. Right-click in an empty area in the Defect Map window to invoke the popup menu.
2. Select **GoTo XY**. The GoTo XY dialog box appears (see Figure 4-42).

Figure 4-42. GoTo XY Dialog Box



3. In the GoTo XY dialog box, enter the values of X and Y in the same units as shown on the axes of the defect map. To search for a defect in the reference cell, select **Look also in reference**.
4. Click **OK**.

Results

The defect closest to the coordinates becomes the current defect. It is highlighted in the Defect Map and the Defect List. If no defect is found within the search radius, a message is issued indicating that the defect was not found.

Examples

To find a defect with the system coordinates (51620, 41960), enter the values 51620 for the X field and 41960 for the Y field in the GoTo XY dialog box. If there are no defects at the specified system coordinates and no defect lies within the search radius (5 by default) of the specified coordinates, a message pops up:

```
The defect with X:51620.00 and Y:41960.00 coords was not found
```

Suppose the nearest defect has the system coordinates (51629, 41965). If you change the search radius to 11.00, the defect is found and that changes to the current defect. You can modify the GoTo XY search radius in the Calibration Parameter Editor. Refer to "Calibration Parameter Modification" on page 367 for details.

Left-Click on Defect

You can navigate to any defect by clicking on that defect.

The current defect is updated and all information about the current defect is also updated in other units such as the Image Measurement Unit and the Defect List.

Color Configurability for Comparison Types

Colors assigned to defects of different comparison types can be configured through the *dat-ini.xml* file.

The ComparisonTypeColorInfo node in the *dat-ini.xml* file specifies the color information for comparison types. This information is used in the **Show comparison type** option on the Defect Map, highlighting the defects of different comparison types in different colors.

The following is an example:

```
<ComparisonTypeColorInfo>
      <D2D     color="magenta" />
      <D2DRef  color="red"/>
      <D2M     color="green" />
      <NonD2D  color="cyan" />
</ComparisonTypeColorInfo>
```

Allowed values for the color attribute are white, red, green, blue, cyan, magenta, yellow and light gray.

Defect Map Limitations

There are a number of factors to keep in mind when using the Defect Map window.

- You cannot zoom the Defect Map view lower than a factor of 1.00, which is the default zoom factor for **Fit to View**.
- The RubberBand Selection mode and Ruler mode cannot be activated simultaneously. One mode is deactivated if the other is enabled.
- If you are in RubberBand Selection mode or Ruler mode, you cannot zoom in or zoom out using the mouse. However, you can zoom in or zoom out using the Zoom buttons or Zoom factor control.

- If you are viewing inspections in different colors using the Demarcate Inspections feature, then the color code conventions given in Figure 4-2 on page 117 do not hold true.
- The Demarcate Inspections feature is available only in the Multiple Inspections (All) folder.
- Grid operations are enabled only in Single Inspection (SI) folders. Refer to section "Understanding Folders" on page 113 for folder concept details.

Chapter 5
Defect List

The Defect List window provides a table view of all defects found during an inspection. It also provides controls to navigate and edit your defects from the inspection.

The Defect List Window

To access: **View > Defect List**

The Defect List window contains a number of attributes pertaining to defects generated from inspections. Each defect appears as a single row with each attribute in a column. A few attributes are hidden by default.

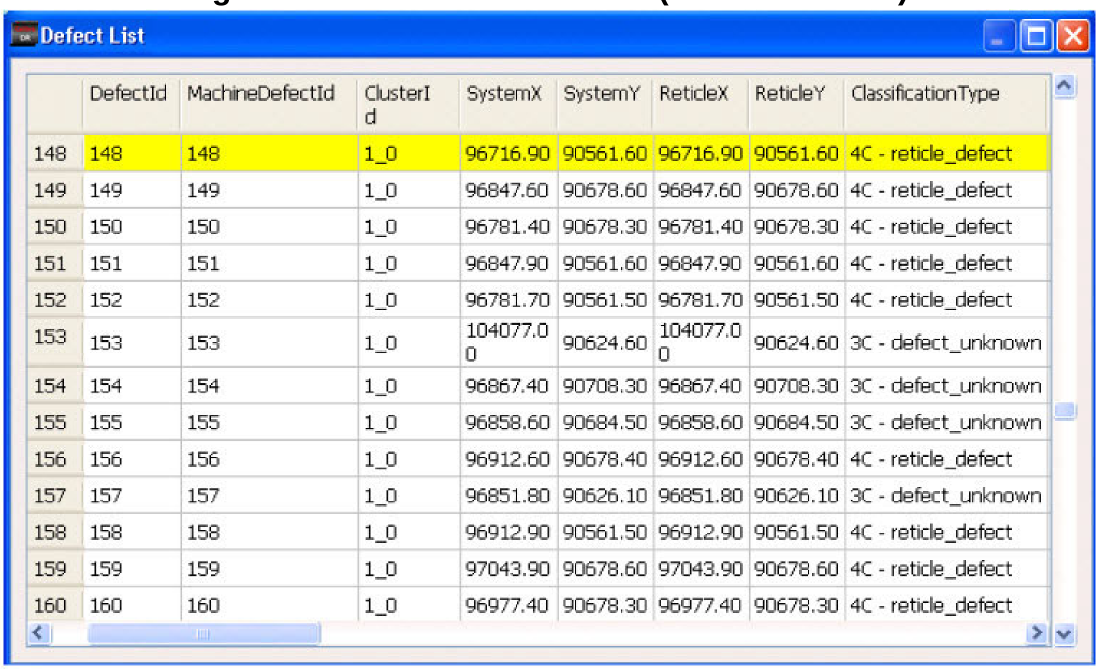
Description

The Defect List window can contain the following:

- **Defect List** — Displays the list of defects and their attributes.

  The current defect is always highlighted in the **Defect List** tab in yellow in as shown in Figure 5-1.

Figure 5-1. Defect List Window (Defect List Tab)

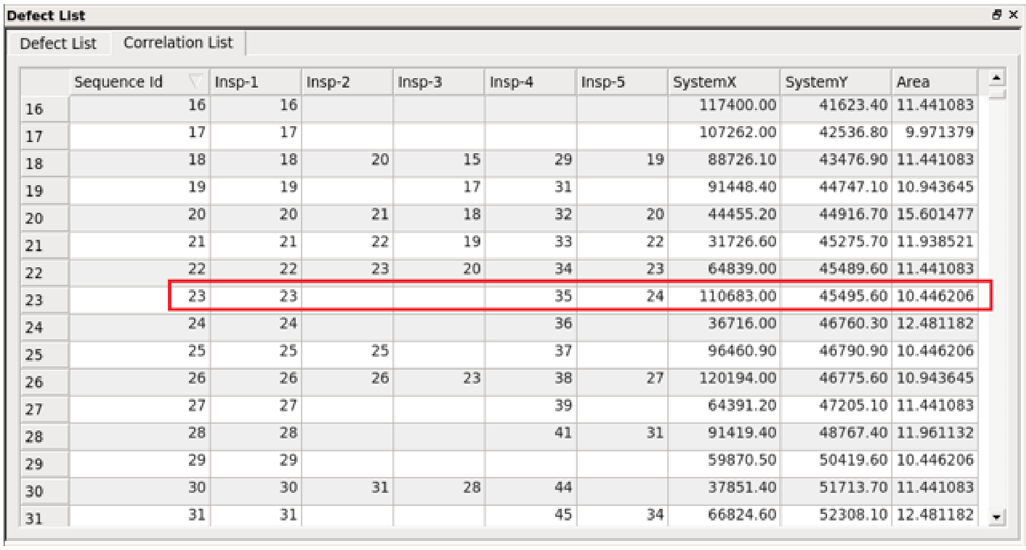


Defect List

	DefectId	MachineDefectId	ClusterId	SystemX	SystemY	ReticleX	ReticleY	ClassificationType
148	148	148	1_0	96716.90	90561.60	96716.90	90561.60	4C - reticle_defect
149	149	149	1_0	96847.60	90678.60	96847.60	90678.60	4C - reticle_defect
150	150	150	1_0	96781.40	90678.30	96781.40	90678.30	4C - reticle_defect
151	151	151	1_0	96847.90	90561.60	96847.90	90561.60	4C - reticle_defect
152	152	152	1_0	96781.70	90561.50	96781.70	90561.50	4C - reticle_defect
153	153	153	1_0	104077.00	90624.60	104077.00	90624.60	3C - defect_unknown
154	154	154	1_0	96867.40	90708.30	96867.40	90708.30	3C - defect_unknown
155	155	155	1_0	96858.60	90684.50	96858.60	90684.50	3C - defect_unknown
156	156	156	1_0	96912.60	90678.40	96912.60	90678.40	4C - reticle_defect
157	157	157	1_0	96851.80	90626.10	96851.80	90626.10	3C - defect_unknown
158	158	158	1_0	96912.90	90561.50	96912.90	90561.50	4C - reticle_defect
159	159	159	1_0	97043.90	90678.60	97043.90	90678.60	4C - reticle_defect
160	160	160	1_0	96977.40	90678.30	96977.40	90678.30	4C - reticle_defect

- **Correlation List** — This appears only if you have a Pro license. The Correlation List Illustrates common defects from different inspections within specified search radius. The **Correlation List** tab is displayed only in the All folder. For example, as highlighted with red rectangle in the following figure, defects with DefectId 23 of inspection-1, 14 of inspection-2, 3522 of inspection-4 and 110 24 of inspection-5 are common defects and identified as Sequence Id 23.

Figure 5-2. Defect Correlation List

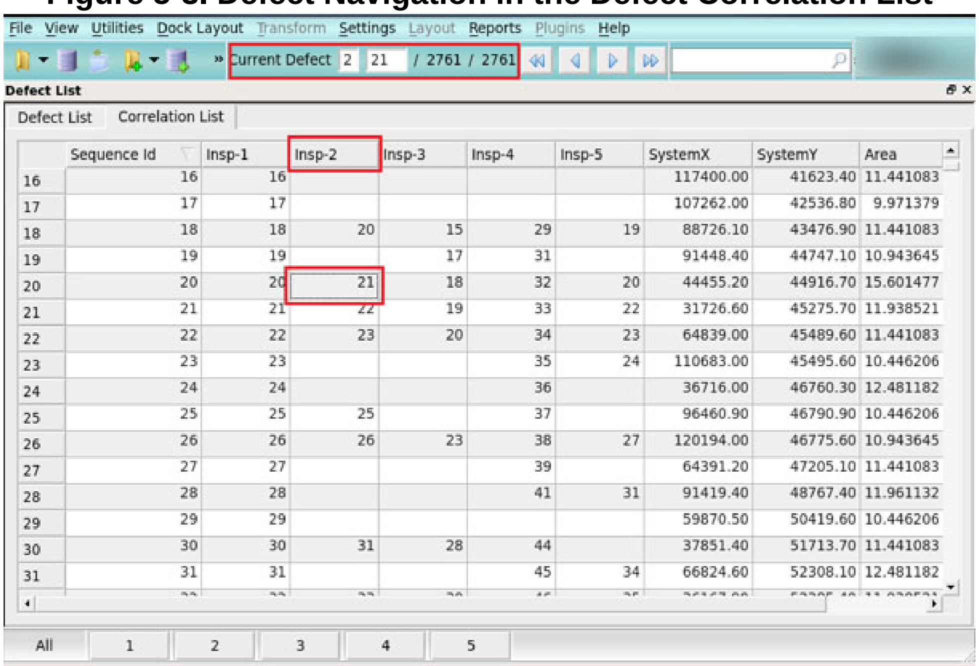


	Sequence Id	Insp-1	Insp-2	Insp-3	Insp-4	Insp-5	SystemX	SystemY	Area
16	16	16					117400.00	41623.40	11.441083
17	17	17					107262.00	42536.80	9.971379
18	18	18	20	15	29	19	88726.10	43476.90	11.441083
19	19	19		17	31		91448.40	44747.10	10.943645
20	20	20	21	18	32	20	44455.20	44916.70	15.601477
21	21	21	22	19	33	22	31726.60	45275.70	11.938521
22	22	22	23	20	34	23	64839.00	45489.60	11.441083
23	23	23			35	24	110683.00	45495.60	10.446206
24	24	24			36		36716.00	46760.30	12.481182
25	25	25	25		37		96460.90	46790.90	10.446206
26	26	26	26	23	38	27	120194.00	46775.60	10.943645
27	27	27			39		64391.20	47205.10	11.441083
28	28	28			41	31	91419.40	48767.40	11.961132
29	29	29					59870.50	50419.60	10.446206
30	30	30	31	28	44		37851.40	51713.70	11.441083
31	31	31			45	34	66824.60	52308.10	12.481182

For all common defects, the correlation list displays single defect properties based on defect area. For example, the previous three defects are common; however the correlation list displays other defect properties (like SystemX, SystemY, classifications) from defect no 23 of inspection-1 as this defect has a greater area than others.

To navigate to an inspection's defect, click the cell containing the DefectId under that inspection column in the Defect Correlation List, as illustrated in the following figure (DefectId 2114 of inspection-2).

Figure 5-3. Defect Navigation in the Defect Correlation List



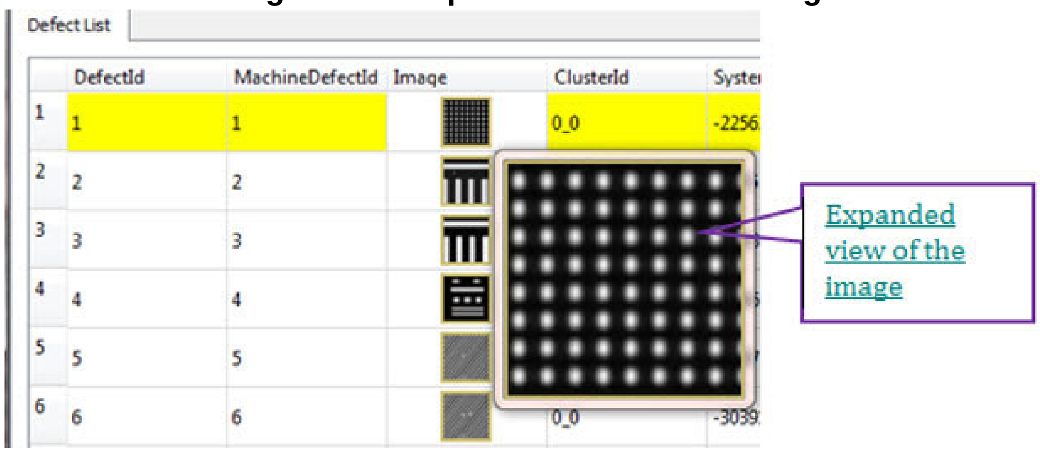
	Sequence Id	Insp-1	Insp-2	Insp-3	Insp-4	Insp-5	SystemX	SystemY	Area
16	16	16					117400.00	41623.40	11.441083
17	17	17					107262.00	42536.80	9.971379
18	18	18	20	15	29	19	88726.10	43476.90	11.441083
19	19	19		17	31		91448.40	44747.10	10.943645
20	20	20	21	18	32	20	44455.20	44916.70	15.601477
21	21	21	22	19	33	22	31726.60	45275.70	11.938521
22	22	22	23	20	34	23	64839.00	45489.60	11.441083
23	23	23			35	24	110683.00	45495.60	10.446206
24	24	24			36		36716.00	46760.30	12.481182
25	25	25	25		37		96460.90	46790.90	10.446206
26	26	26	26	23	38	27	120194.00	46775.60	10.943645
27	27	27			39		64391.20	47205.10	11.441083
28	28	28			41	31	91419.40	48767.40	11.961132
29	29	29					59870.50	50419.60	10.446206
30	30	30	31	28	44		37851.40	51713.70	11.441083
31	31	31			45	34	66824.60	52308.10	12.481182

Thumbnail Image

The Image attribute in the defect list displays an image of the corresponding defect image.

When the mouse pointer is hovered over the thumbnail image, an expanded view of the corresponding image is displayed as shown in Figure 5-4.

Figure 5-4. Expanded View of the Image



PrimaryClassificationComments

Defect Comments display user comments related to Primary Classification.

Note that if the inspection file is saved, then the comments are saved in the file.

Note
The columns can be re-arranged by dragging and dropping them in the Defect List window.

Objects

Table 5-1. Defect List Fields

Field	Description	Hidden by Default?
Defect List Tab		
InspectionID	Specifies the inspection number to which the defect belongs. By default, when the defect list is for a single inspection filder (SI), this column is not visible.	Yes (in a single folder)
DefectID	Specifies an integer ID for a defect assigned by Calibre DefectReview. It is unique within an inspection.	No
MachineDefectID	Specifies a unique ID reported by the inspection system.	No

Table 5-1. Defect List Fields (cont.)

Field	Description	Hidden by Default?
Image	Displays a thumbnail image of the corresponding defect image. If you hover your mouse over the thumbnail image, an expanded view of the corresponding image is displayed. Refer to "Thumbnail Image" on page 160 for further information.	No
ClusterID	The cluster number to which the defect belongs. The entry for the ClusterID attribute is assigned as *InspectionID_ClusterNo* when automatic clustering is done.	No
Cluster Centroid X Cluster Centroid Y	The centroid (the center of a cluster) is calculated as the average of all defects belonging to the same cluster. All defects in the same cluster display the same X and Y coordinate values. The tool also displays the defect's system X and Y coordinates if it does not belong to a cluster. These values can be saved in a Klarf inspection report by enabling additional columns for Klarf (as described in "Klarf Inspection Report" on page 67.	No
SystemX SystemY	Displays system coordinates (these are initially equal to the reticle coordinates). If you apply any transformation on an inspection, then these coordinates change accordingly. Refer to "Applying Transform Operations" on page 407 for details on applying transformations. The units of system coordinates depend upon the configuration of the unit of measurement in the *dat-ini.xml* file. For details on configuring the units of measurement, refer to "Unit of Measurement Configuration" on page 125.	No
ClassificationType	Specifies the classification type of the defect. It is shown as *Defect Code - Defect Type*. If the defect code and defect type are same, it is shown as *Defect Type*.	No
PrimaryClassificationComments	Specifies user comments related to Primary Classification. If inspection file is saved, then the comments is saved. Refer to "PrimaryClassificationComments" on page 160for further information.	No

Table 5-1. Defect List Fields (cont.)

Field	Description	Hidden by Default?
Status	Specifies the status of the defect. The status can be Unlocated, Located, or Confirmed. If the status is Confirmed, then it is shown in green text.	No
Area	Specifies the area of the defect in units configured in the *dat-ini.xml* file. For details on configuring the units of measurement, refer to section "Unit of Measurement Configuration" on page 125.	No
DefectSize	Specifies the classification of defects based on defect area.	No
GridDefect	Indicates whether the defect falls in a grid or not. Values are either Yes (in the grid) or No (not in the grid).	No
Adders	Identifies if the defect is a common, adder, or missing defect based on Adders Analysis with respect to a reference inspection.	No
DefectTrend	Specifies the trend of the defect (growing, shrinking, no change, or not applicable (NA)) with respect to a reference inspection.	No
CaptureRate	Specifies the number of inspections in which the defect has been captured for a particular defect location.	No
CaptureRateTag	Specifies the unique ID for each group of captured defects based on the capture rate and defect location.	No
MustCatchX MustCatchY	Specifies the coordinates of the corresponding Must-Catch location, when a Must Catch file is used for Detection Line Analysis.	No
Correlation List Tab		
Sequence ID	Specifies the sequence ID number.	No
Insp-N	Specifies the inspection number.	No
SystemX SystemY	Specifies the system X and Y coordinates.	No
Area	Specifies the area of the defect.	No

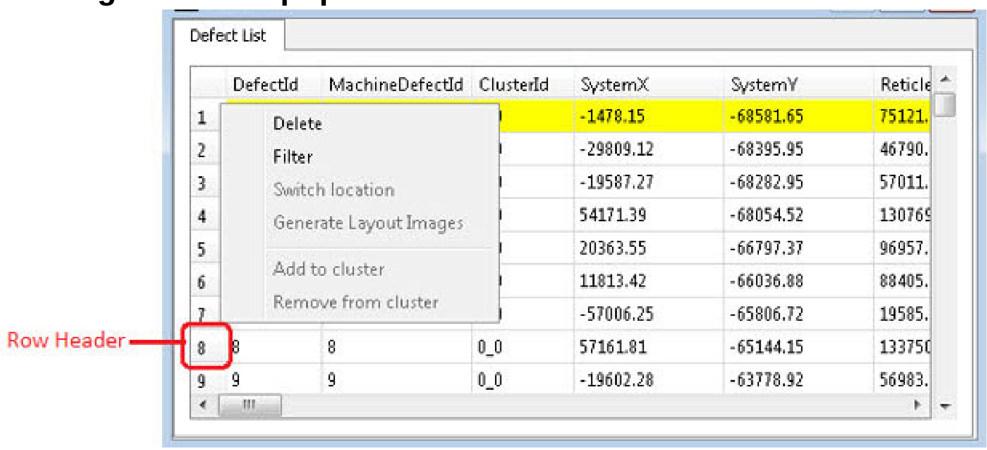
Related Topics

Defect List Column Configuration

Defect List Operations

You can perform a number of different operations on defects in the Defect List window. The available operations can be accessed from a popup menu that appears when you right-click any row heading.

Figure 5-5. Popup Menu on the Defect List Row Header



Selecting Defects

You can select one or more defects to perform operations on.

Procedure

1. Use one of the following methods to select defects:

    - Select a single defect. Click on the row header. This selects the defect.
    - View the supported right-click menu. Right-click on any row header. This invokes a popup menu.
    - Select multiple defects and invoke the menu:

        i. Select the first defect with a left-click.

        ii. Press the Ctrl or Shift key and click to select the other defects.

        With the Ctrl key, you can select defects from any non-adjacent row.

        With the Shift key, you can select a set of defects from adjacent rows. Once you click on one defect and then, after pressing Shift key, click on another defect, all defects between these two defects are selected. The selected defects are highlighted in cyan as shown in Figure 5-6. If the CDD is also part of the highlighted defects, then the CDD alternates between cyan and yellow.

Figure 5-6. Multiple Defects Highlighted

	InspectionId	DefectId	MachineDefectIc	Image	ClusterId	SystemX	SystemY	ReticleX	ReticleY
246	1	246	249		0_0	101428.10	32305.47	101428.10	32305.47
247	1	247	250		0_0	33606.31	32624.80	33606.31	32624.80
248	1	248	251		0_0	54179.01	32651.50	54179.01	32651.50
249	1	249	252		0_0	24097.47	32810.37	24097.47	32810.37
250	1	250	253		0_0	62529.75	33030.70	62529.75	33030.70
251	1	251	254		0_0	68680.63	33778.02	68680.63	33778.02
252	1	252	255		0_0	100900.53	33779.18	100900.53	33779.18
253	1	253	256		0_0	50572.56	34471.34	50572.56	34471.34
254	1	254	257		0_0	50579.62	34548.44	50579.62	34548.44
255	1	255	258		0_0	51241.72	35785.07	51241.72	35785.07
256	1	256	259		0_0	54003.01	35784.48	54003.01	35784.48
257	1	257	260		0_0	54016.26	35785.25	54016.26	35785.25

Note

You can also select defects from other locations such as the Defect Map, Repeatability Analysis, and so on. Those selected defect areas also highlighted in cyan in the Defect List.

2. Right-click the row header of any of the selected defects to view the supported operations menu.

Using General Operations in the Defect List

There are a number of general operations that can be performed from a popup menu in the Defect List.

Procedure

1. In the **Defect List** tab, select a defect and invoke a popup menu as described in “Selecting Defects” on page 163.

2. In the popup menu, select one of the operations listed in Table 5-2.

Table 5-2. Defect List Defect Menu Items

Menu Item	Description
Delete	Deletes the selected defect. A dialog box appears asking you to confirm the deletion.

Table 5-2. Defect List Defect Menu Items (cont.)

Menu Item	Description
Generate Layout Images	Generates layout images for a defect or set of defects. However, layout data for the reticle must be set up prior to image generation. The details for setting up layout data are described in "Layout Import" on page 389. Once layout images are generated, you can view the images in Image Measurement Units. The names of all the images are prefixed with the word "Layout".
Track Defect Track Defect in Normal Mode Track Defect in Fast Mode	Launches defect progress tracking for defect attributes such as CD Var, Size, Area, Reflectance, Reflectance Residue, Transmittance, or Transmittance Residue. See "Tracking Defects" on page 165 for further information.

Tracking Defects

In the Defect List window, you can track defects across inspections from a mask, in the Defect List window.

Procedure

To track a defect across inspections from a mask, in the Defect List window, right-click on a defect row header and select one of the following from the popup menu:

- Select **Track Defect** to track the defect from Normal and Fast mode inspection reports. An inspection report is inspected either in Normal or Fast mode.
- Select **Track Defect in Normal Mode** to track the defects only from Normal mode inspection reports.
- Select **Track Defect in Fast Mode** to track the defects only from Fast Mode inspection reports.

Results

The Defect Management window is launched and Defect Progress Tracking results are generated for all the supported attributes such as Cd Var, Defect Area, Defect Size, Reflectance, Reflectance Residue, Transmittance or Transmittance Residue. For further information on Defect Progress Tracking, see "Defect Progress Tracking (DPT)" on page 445.

To generate the charts, values of Lower and Upper Control Limits are selected from the *dat-ini.xml*.

Figure 5-7. Lower and Upper Control Limits for Each Attribute

```xml
<!-- Threshold details-->
<Thresholds>
  <DefectAttributes>
  <CDVar>
   <UpperControlLimit>0.05</UpperControlLimit>
   <LowerControlLimit>0</LowerControlLimit>
  </CDVar>
 <!-- Unit of DefectArea is Square Microns such as 0.05 square microns -->
  <DefectArea>
   <UpperControlLimit>0.05</UpperControlLimit>
   <LowerControlLimit>0</LowerControlLimit>
  </DefectArea>
  <Size>
   <UpperControlLimit>0.05</UpperControlLimit>
   <LowerControlLimit>0</LowerControlLimit>
  </Size>
 <!-- Unit of TransmittedResidue is GL such as 10 GL -->
  <TransmittedResidue>
   <UpperControlLimit>10</UpperControlLimit>
   <LowerControlLimit>0</LowerControlLimit>
  </TransmittedResidue>
 <!-- Unit of ReflectedResidue is GL such as 10 GL -->
  <ReflectedResidue>
   <UpperControlLimit>10</UpperControlLimit>
   <LowerControlLimit>0</LowerControlLimit>
  </ReflectedResidue>
 <!-- Unit of MaxTransmittance is % such as 10% -->
  <MaxTransmittance>
   <UpperControlLimit>10</UpperControlLimit>
   <LowerControlLimit>0</LowerControlLimit>
  </MaxTransmittance>
  <MaxReflectance>
   <UpperControlLimit>10</UpperControlLimit>
   <LowerControlLimit>0</LowerControlLimit>
  </MaxReflectance>
  <TransmittedFlux>
   <UpperControlLimit>10</UpperControlLimit>
   <LowerControlLimit>0</LowerControlLimit>
  </TransmittedFlux>
  <ReflectedFlux>
   <UpperControlLimit>10</UpperControlLimit>
   <LowerControlLimit>0</LowerControlLimit>
  </ReflectedFlux>
 </DefectAttributes>
</Thresholds>
```

Note

All the inspections are displayed on the x-axis regardless of whether Normal or Fast mode is selected. However, charts will contain values only from inspection reports belonging to the selected mode. If you select **Track Defect in Normal Mode** but the loaded inspection is using Fast mode, then defects from Normal mode are also tracked as the defect tracking occurs across inspections.

Using Cluster-Specific Operations in the Defect List

There are a number of cluster-specific operations that can be performed on defects in the Defect List.

Procedure

1. In the **Defect List** tab, right-click in the row header to invoke the cluster-specific operations menu.

2. In the popup menu, select one of the operations listed in Table 5-2.

Table 5-3. Defect List General Operations

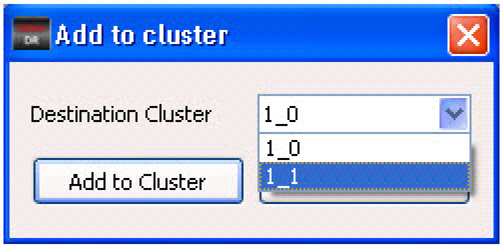
Menu Item	Description
Add to Cluster	Adds an isolated defect to an existing cluster.
Remove from Cluster	Removes a defect from a cluster. The defect becomes an isolated defect.

Certain operations are expanded as follows:

- To add a cluster:

  i. Click **Add to Cluster**. A pop up appears with a list of the existing cluster names.

Figure 5-8. Add to Cluster Dialog Box (Defect List)



  ii. Choose the destination cluster from the dropdown list.

  iii. Click **Add to Cluster**.

Attribute Operations in the Defect List

Various operations can be performed on attributes using the Defect List.

Sorting Based on Attributes

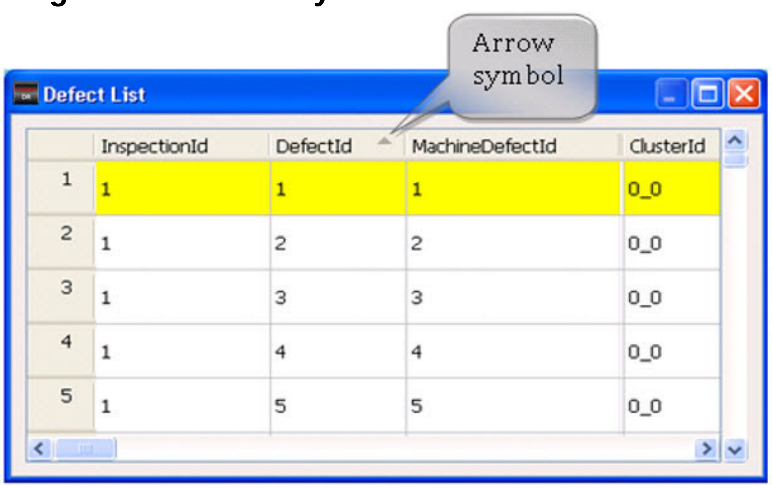
You can sort the Defect List based on any of the listed attributes.

Procedure

1. Click the column header for the attribute. An arrow symbol appears on the left corner of the column header cell when sorting is applied (see Figure 5-9).

2. Once the Defect List is sorted, navigation between the defects (to the next or previous defects) is done in the sorted order of the Defect List.

Figure 5-9. Arrow Symbol in the Column Header



Sorting on the Image Column

Defect report files may sometimes contain a set of defects having, or not having, associated images. The Defect List window enables you to sort and group these defects based on the presence or lack of associated images.

Procedure

In the Defect List window, click the image column header. The Defect List table is sorted so that all defects associated with an image are grouped together.

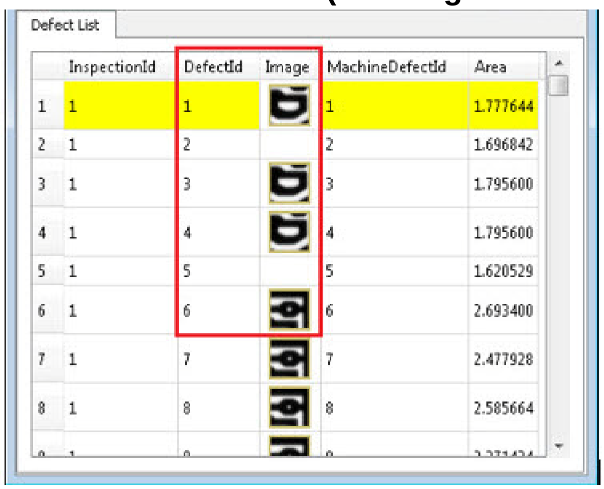
Note

Sorting on the Image column is deactivated if an inspection file has images for all of its defects. Sorting is also deactivated if the inspection file does not contain images.

Results

For example, the following figure shows an unsorted list of defects. Most of the defects have associated images except for defects 2 and 5.

Figure 5-10. Unsorted Defect List (No Images for Defect 2 and 5)

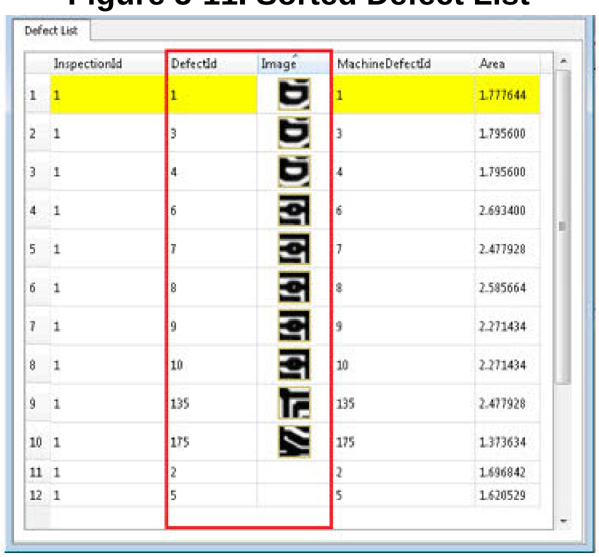


Defect List

	InspectionId	DefectId	Image	MachineDefectId	Area
1	1	1		1	1.777644
2	1	2		2	1.696842
3	1	3		3	1.795600
4	1	4		4	1.795600
5	1	5		5	1.620529
6	1	6		6	2.693400
7	1	7		7	2.477928
8	1	8		8	2.585664

After clicking on the Image column, defects 2 and 5 are grouped together and all the other image-associated defects are grouped together.

Figure 5-11. Sorted Defect List



Defect List

	InspectionId	DefectId	Image	MachineDefectId	Area
1	1	1		1	1.777644
2	1	3		3	1.795600
3	1	4		4	1.795600
4	1	6		6	2.693400
5	1	7		7	2.477928
6	1	8		8	2.585664
7	1	9		9	2.271434
8	1	10		10	2.271434
9	1	135		135	2.477928
10	1	175		175	1.373634
11	1	2		2	1.696842
12	1	5		5	1.620529

Two Column Sorting

In the Defect List, certain pairs of columns can be sorted simultaneously. In this case, the first column is considered as the primary column for sorting purposes. Once the first column is sorted, sorting is applied to the second column automatically.

There are two pairs of columns that use two column sorting: Primary Classification and Defect Progress Classification, and Auto Defect Type Classification and Auto Defect Progress Classification.

For example, for the columns Primary Classification and Defect Progress Classification, the Primary Classification column is considered primary and is sorted based on its STRING value. However, if the values are the same for more than one defect, the Defect Progress Classification column undergoes additional sorting.

Figure 5-12. Two Column Sorting

	Primary Classification	Defect Progress Classification
1	1B - 1B_OnEdge_Dark	REP - Repeater
2	2B - 2B_OnOpa._Open	NeedReview
3	2B - 2B_OnOpa._Open	New
4	2B - 2B_OnOpa._Open	REP - Repeater
5	2B - 2B_OnOpa._Open	REP - Repeater
6	2D - 2D_Repair_Mark	NeedReview
7	2D - 2D_Repair_Mark	New
8	2D - 2D_Repair_Mark	REP - Repeater
9	2D - 2D_Repair_Mark	REP - Repeater
10	4D - 4D_WhiteSpot	New
11	4D - 4D_WhiteSpot	New
12	4D - 4D_WhiteSpot	New
13	4D - 4D_WhiteSpot	New
14	4F - 4F_False	New

Note

Some columns are secondary classification columns and may not always contain values.

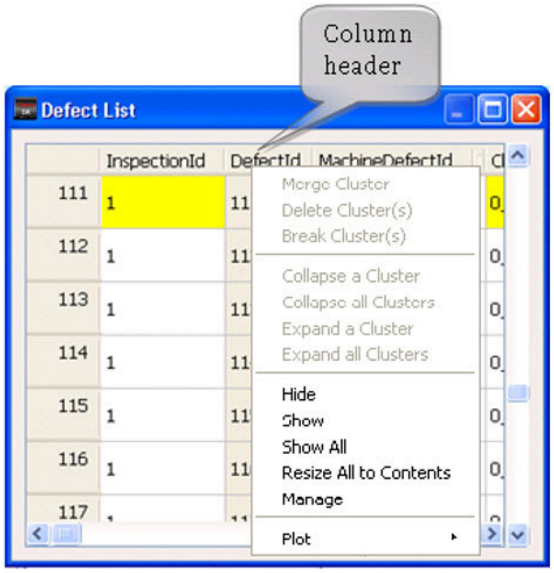
Using Operations on All Attributes

To perform operations on the defect attributes, right-click on any column header in the Defect List to access a popup menu.

Procedure

1. Right-click on any column header in the Defect List to access a popup menu. The attribute-based operations options are shown in Figure 5-13.

Figure 5-13. Attribute Options in the Defect List Column Header



2. In the popup menu, select one of the menu items listed in Table 5-2.

Table 5-4. Attribute-Based Defect List Operations

Menu Item	Description
Hide	Hides a column from display in the list. To hide a single column: 1. Select a column. 2. Right-click, then select **Hide** in the popup menu. To hide multiple columns: 1. Select the first column. 2. Press the Ctrl or Shift key and select the other columns. 3. Right click, then select **Hide** in the popup menu.
Show	Display a hidden column or set of hidden columns between two columns. 1. Select the first column. 2. Press the Ctrl or Shift key and select the other columns. 3. Click **Show** in the popup menu.
Show All	Display all defect attributes.
Manage	Hide or unhide columns in the Defect List.
Plot	Plot a graph between values in two columns of the Defect List.

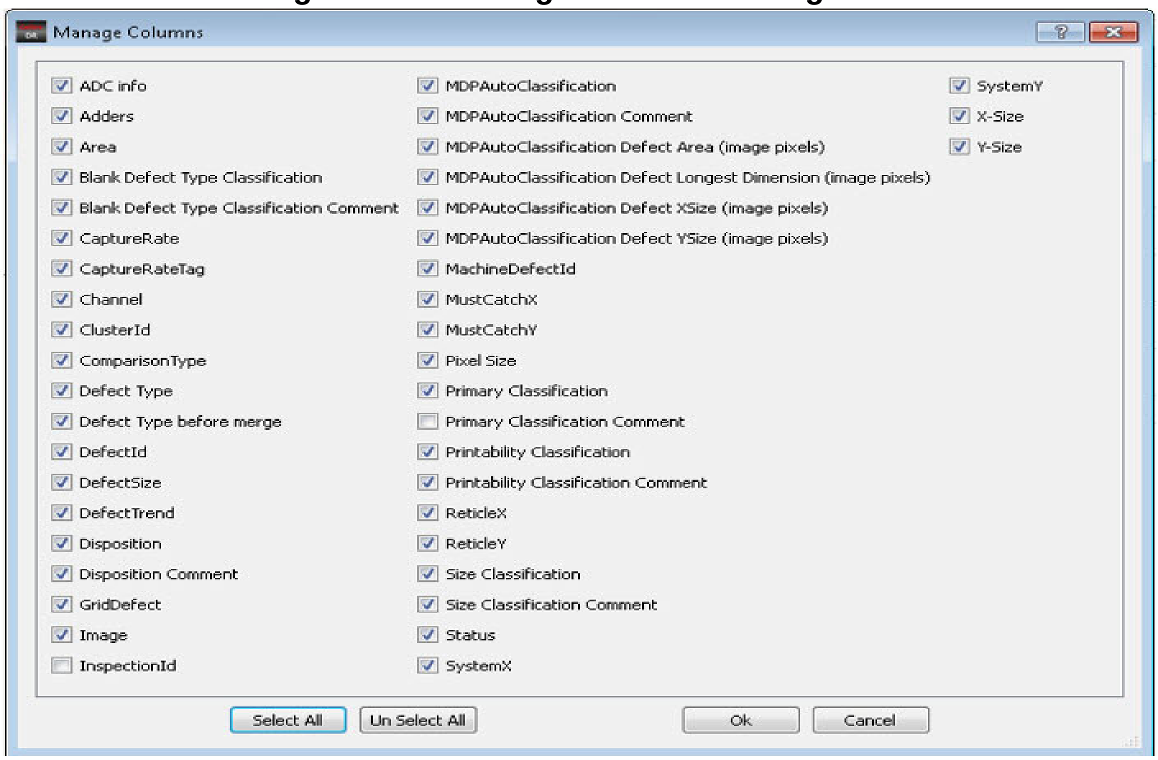
Several of these operations are expanded as follows:

- For the **Manage** operation:

    i. Select a defect list column and right-click the column header.

    ii. Select **Manage** in the popup menu. A dialog box appears with all the currently-enabled Defect List column names as shown in Figure 5-14.

Figure 5-14. Manage Columns Dialog Box



    iii. You can select or unselect column names by clicking on check boxes. By default, the Manage Columns dialog box populates all column names from the *dat-ini.xml* file and selects them. Once customization is done, you view only the selected column names in the Defect List (the other columns are hidden).

Note

To save customized Defect List columns across Calibre DefectReview sessions, save the dock layout (see "Saving and Loading a Dock Layout" on page 385).

- For the **Plot** operation:

    i. Select a defect list column and right-click the column header. The x-axis values are read from this column.

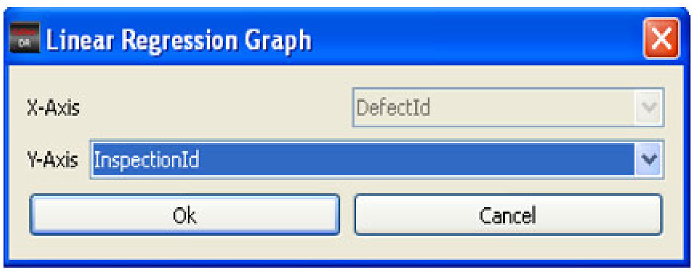
ii. Select **Plot** in the popup menu. A sub-menu (see Figure 5-15) appears.

Figure 5-15. Plot Option

iii. The sub-menu displays the list of columns recently used for plotting graphs. Select the y-axis column if it is present in the list.

If the Y-Axis column is not present on the recently used column list, click **Other**. A dialog box as shown in Figure 5-16 appears. Select the Defect List column for y-axis values from the dropdown list.

Figure 5-16. Y-Axis Selection Dialog Box



For details about operations on the Linear Regression Graph, refer to "Linear Regression Graph" on page 174

Note

A graph can only be plotted between two Defect List columns that have numerical defect attributes.

Linear Regression Graph

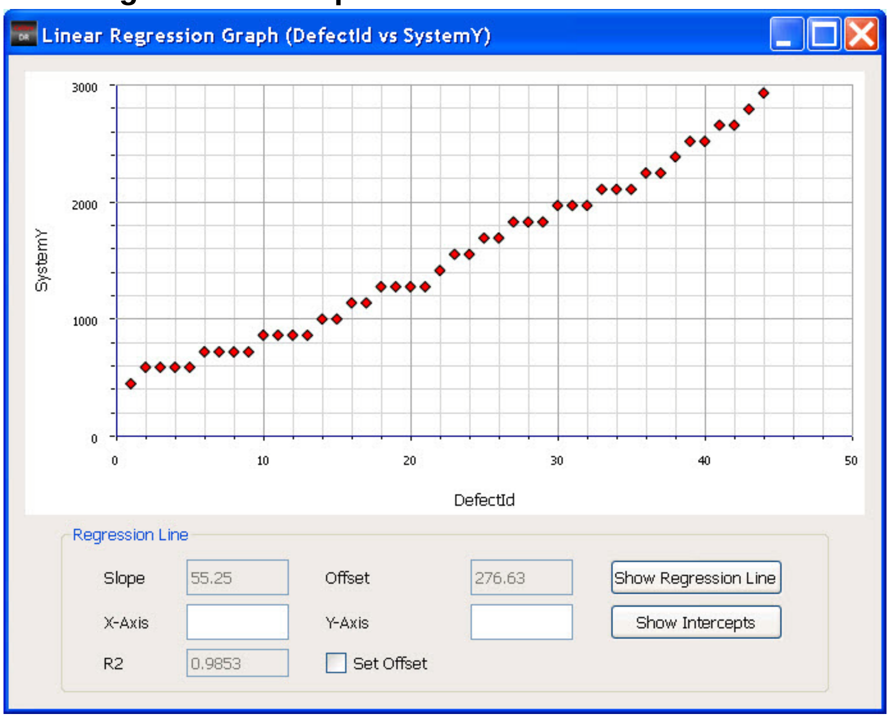
To Access: In the Defect List window, perform a plot as described in "Using Operations on All Attributes" on page 170.

The Linear Regression Graph between the values of two Defect List columns provides options to compute and view the regression line on the plotted graph.

Description

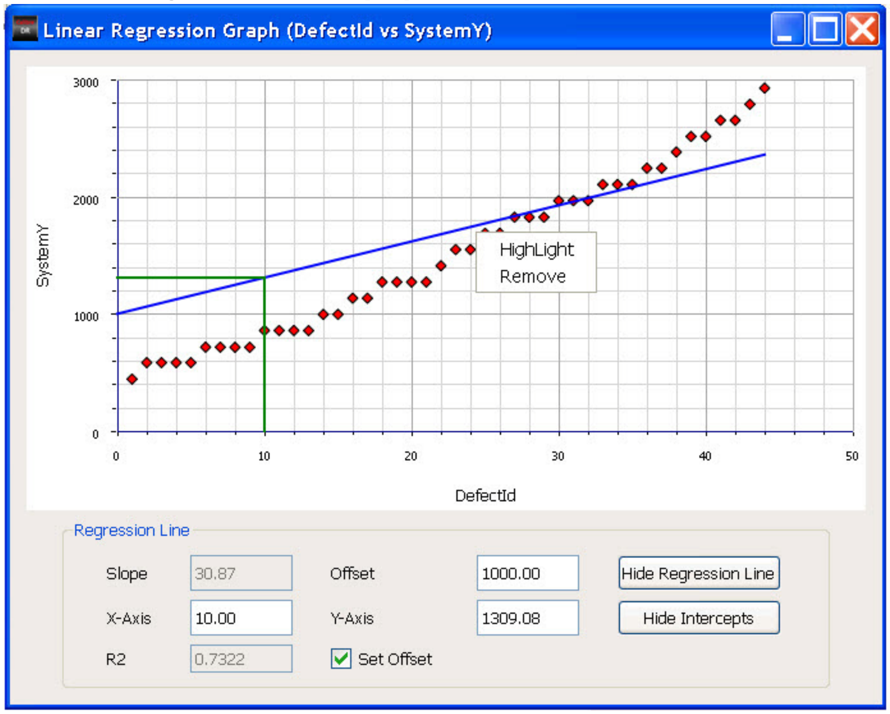
The following figure shows a sample graph plotted with values of the DefectId and SystemY columns.

Figure 5-17. Graph Plot of Defect List Columns



To perform operations on a specific defect, right click on the defect data point on the graph. A popup menu appears as shown in Figure 5-18.

Figure 5-18. Popup Menu for a Data Point



Objects

Table 5-5. Regression Line Graph Controls

Attribute	Description
Show Regression Line	Computes the regression line and displays it on the graph.
Slope	Displays the slope of the linear regression line.
Offset	Displays the Y-intercept of the linear regression line.
X-Axis	Displays the Y-intercept on the regression line for a selected X-intercept
Y-Axis	Displays the X-intercept on the regression line for a selected Y-intercept.
Show Intercepts	Displays the selected X- and Y-intercepts on the regression line.
R2	Represents the coefficient of determination. The value of R2 is always between 0 and 1.0. It is used to describe how well a regression line fits a set of data and how well a prediction can be made using the data set. R2 values near 1.0 indicate that a regression line fits the data well, while R2 values closer to 0 indicate a regression line does not fit the data.
Set Offset	Modifies the offset value. See "Set Offset" on page 177 for further information

Table 5-5. Regression Line Graph Controls (cont.)

Attribute	Description
Highlight	Highlights a defect in the Defect List.
Remove	Removes a data point from the data on which the Linear Regression Line is computed. The graph is replotted and the regression line is recomputed.

Certain attributes are expanded in the Usage Notes.

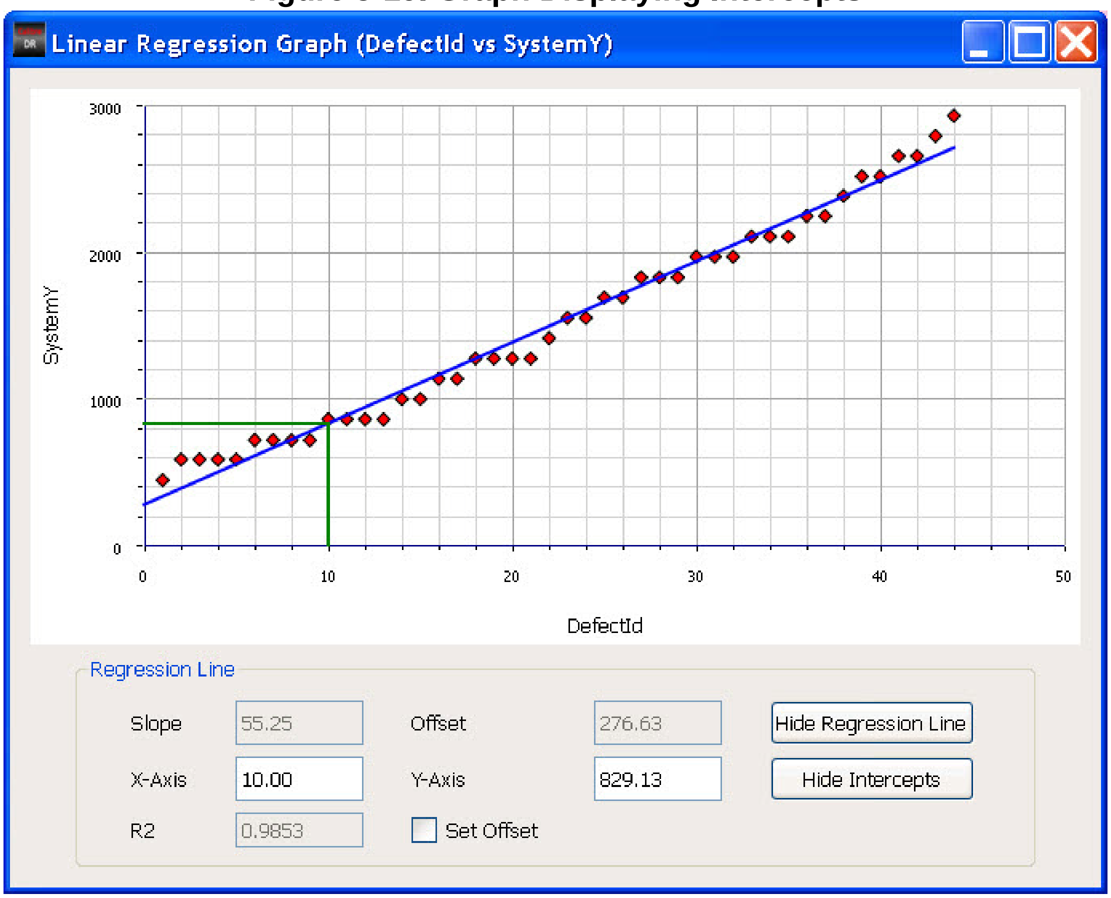
Usage Notes

Show Intercepts

The Show Intercepts field displays the selected X- and Y-intercepts on the regression line.

Figure 5-19 illustrates a linear regression line and the intercepts on the graph plotted between values of the DefectId and System Y columns.

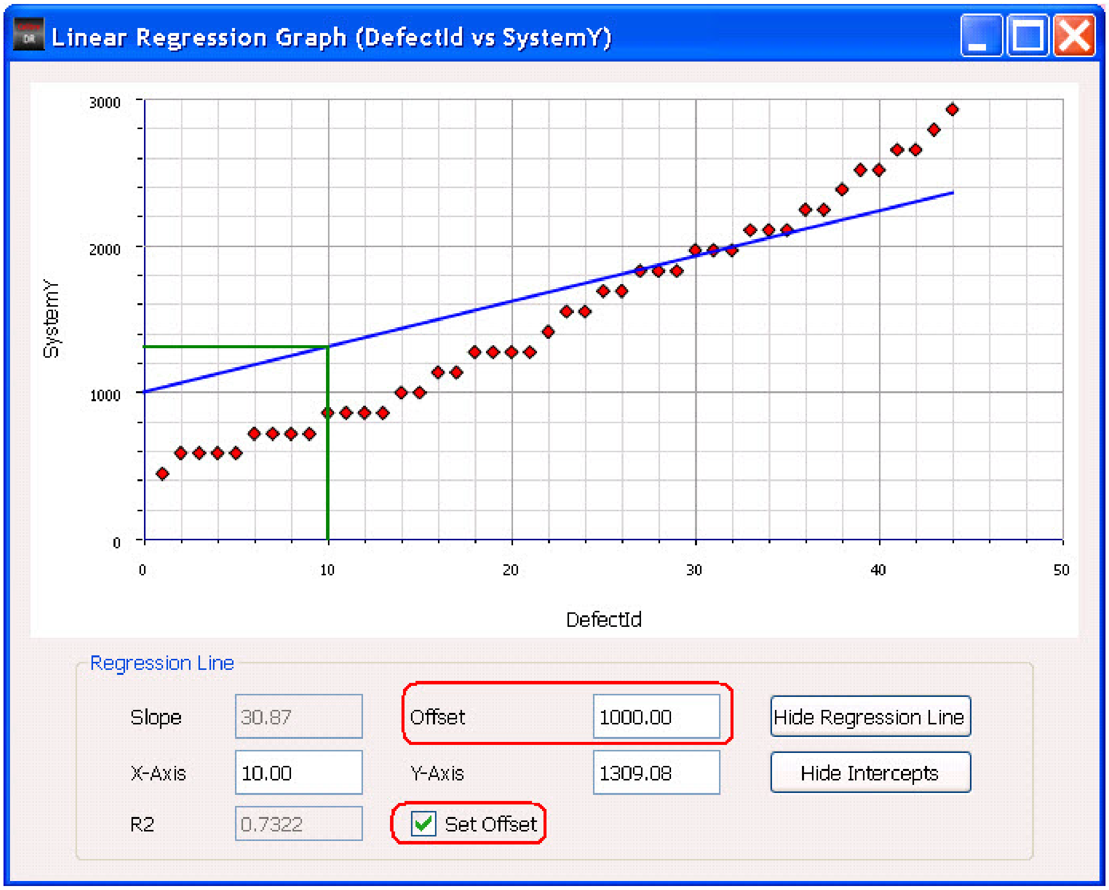
Figure 5-19. Graph Displaying Intercepts



Set Offset

The Set Offset field modifies the offset value. To modify the offset value, click the **Set Offset** option, set the offset value, and press Enter. The regression line then passes through the offset value as shown in Figure 5-20

Figure 5-20. Graph of Regression Line Passing Through an Offset

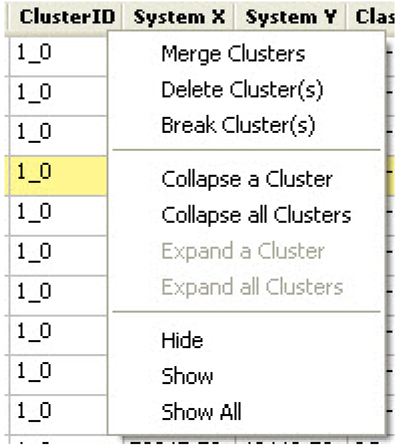


Operations Specific to Cluster ID

A number of additional operations can be performed on the ClusterId attribute. These options can be accessed from the popup menu that appears when you right-click the ClusterId attribute.

Figure 5-21 illustrates the popup menu items.

Figure 5-21. Popup Menu for Cluster ID Attribute



Note

Cluster IDs start from 1. If the ClusterID attribute for a defect is 1_0, then the defect does not belong to any cluster.

Procedure

1. In the Defect List window, right-click the ClusterId column to invoke a popup menu.
2. In the popup menu, select one of the operations listed in Table 5-2.

Table 5-6. Cluster ID-Based Defect List Operations

Menu Item	Description
Merge Clusters	Merge one or more clusters into another cluster.
Delete Cluster(s)	Deletes all defects from one or more clusters.
Break Cluster(s)	Breaks a cluster or set of clusters. .
Collapse a Cluster	Collapse all defects shown in a cluster. The Defect List shows all the defects in a cluster. The user can view only one defect of a cluster.
Collapse all Clusters	Display only one defect for each cluster in the Defect List.
Expand a Cluster	Once a cluster is collapsed, you can expand it. After collapsing a cluster, only one defect is shown for that cluster.
Expand all Clusters	Expands all the collapsed clusters. The defects for all clusters are shown in the Defect List.

Certain operations are expanded as follows:

- For the **Merge Cluster** operation:

  i. Select **Merge Clusters**. The Merge Clusters dialog box appears as shown in Figure 4-37.

ii. In the Merge Clusters dialog box, select the clusters to be merged from the list. Multiple clusters can also be selected using the Ctrl key.

iii. Select the Destination Cluster from the dropdown list.

iv. Click **OK**.

For example, if you select clusters 1_1 and 1_2 from the list and select 1_3 as the destination cluster, then all defects of 1_1 and 1_2 become part of cluster 1_3.

- For the **Delete Cluster** operation:

i. Click **Delete Cluster(s)**. The Delete Cluster(s) dialog box appears as shown in Figure 5-22.

Figure 5-22. Delete Clusters Dialog Box

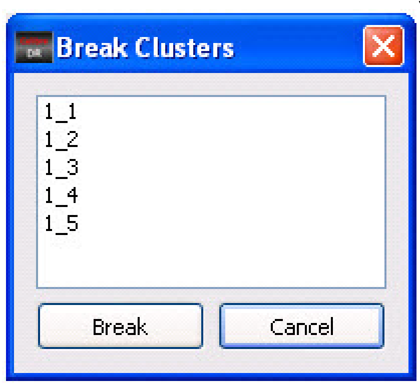
ii. Select the clusters to be deleted. You can choose multiple clusters using the Ctrl key.

iii. Click **Delete**. The defects in the selected cluster IDs are deleted permanently from the defect database.

- For the **Break Cluster** operation:

i. Click **Break Cluster(s)**. The Break Clusters dialog appears as shown in Figure 5-23.

Figure 5-23. Break Clusters Dialog Box



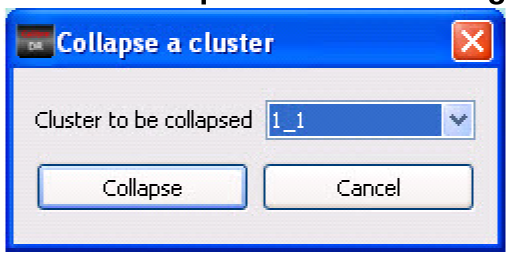
ii. Select a cluster from the list.

iii. Click **Break**. All the defects belonging to the selected cluster become isolated defects.

- For the **Collapse a Cluster** operation:

i. Click **Collapse a Cluster**. The Collapse a cluster dialog box appears as shown in Figure 5-24.

Figure 5-24. Collapse a Cluster Dialog Box



ii. Select a cluster from the **Cluster to be collapsed** dropdown list.

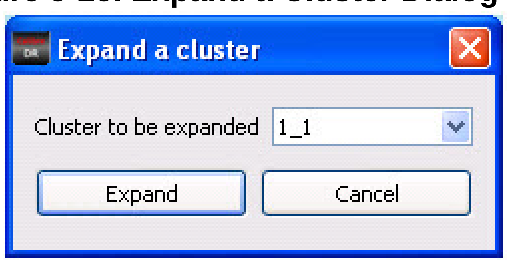
iii. Click **Collapse**.

For example, if there are five defects in a selected cluster 1_1, then only the first displayed defect of the Defect List is shown for cluster 1_1.

- For the **Expand a Cluster** operation:

i. To display the hidden defects of a collapsed cluster, click **Expand a Cluster**. A dialog box appears as shown in Figure 5-25.

Figure 5-25. Expand a Cluster Dialog Box



ii. Select the cluster to be expanded from the drop-down list.

iii. Click **Expand**.

Using Operations in the Correlation List

There are a number of operations that can be performed from a popup menu in the Defect Correlation List.

Procedure

1. In the **Correlation List** tab, right-click in a correlation column.
2. In the popup menu, select one of the operations listed in Table 5-2.

Table 5-7. Correlation List Operations

Menu Item	Description
Hide	Hides the selected column. You can select multiple columns to hide using Shift-select, then selecting **Hide**.
Show	Shows a hidden column. You can select multiple columns to show using Shift-select, then selecting **Show**.
Show All	Show all defect attributes.
Manage	Customizes Correlation List columns. A dialog box appears with all the currently-enabled Correlation List column names. The Manage option in the correlation list shows a subset of Defect List columns that are relevant.

Navigate to a Defect in the Defect List

You can navigate to any defect by clicking on any row header or by double-clicking any cell. It becomes the current defect and all information about the current defect is also updated in other windows, such as Image Measurement Unit, Defect Map, and so on.

Copying and Pasting Content

You can copy and paste content from the Defect List window to spreadsheet programs.

Procedure

1. Select the contents from the Defect List by holding the left button of the mouse and dragging a box around the items to copy.
2. Press Ctrl-c to copy.
3. Paste the result into an open spreadsheet using Ctrl- v. The contents are copied into the spreadsheet.

Defect List Column Configuration

You can configure Defect List columns using the *dat-ini.xml* file.

The Defect List column attributes are present under the nodes DefectListInfo/ColumnInfo as shown in the Figure 5-26.

Figure 5-26. Configuring Defect List Attributes

```
<column name="InspectionId">
 <visible>yes</visible>
 <displayName>Insp ID</displayName>
 <miShow>yes</miShow>
 <siShow>yes</siShow>
 <specdeftype>yes</specdeftype>
 <valuetype>number</valuetype>
 <multiValue>0</multiValue>
</column>
```

Table 5-8 lists the Defect List attributes. Note that many of the attributes have the option to hide columns. However, at any time, you can view all columns of the Defect List using **Show All** in the right-click popup menu. For more details, refer to “Using Operations on All Attributes” on page 170.

Table 5-8. Defect List Attributes in the dat-ini.xml File

Attribute	Description
column name	Specifies the Defect List column name. The column name is predefined. Do not change it.
visible	If visible is set to yes, this column is displayed in Defect List. If set to no, the column is hidden.
displayName	Specifies the column header text to be displayed in the Defect List. For example, to change the PrimaryClassification column header text to "1st Tier Classification", the value of the displayName node for the PrimaryClassification column name should be set to"1st Tier Classification" (shown in Figure 5-27, following this table). You can also change the Primary Classification table name in the Defect Classification window. For details, refer to "Primary Classification Table Name Configuration" on page 211.
miShow	If set to yes, the column is visible when the defect list is for multiple inspections (All folder). If set to no, the column is hidden.
siShow	If set to yes, the column is visible when the defect list is for a single inspection. If set to no, the column is hidden.
valuetype	Controls how the column is sorted. Set to one of the following values: • **string** — Use string sorting. • **number** — Use numerical sorting.

Figure 5-27 shows an example of changing the PrimaryClassification column header name to "1st Tier Classification" using the displayName node in the *dat-ini.xml* file.

Figure 5-27. Setting the displayName

```
<column name="ClassificationType">
  <visible>yes</visible>
  <displayName>1st Tier Classification</displayName>
  <miShow>yes</miShow>
  <siShow>yes</siShow>
  <specdeftype>yes</specdeftype>
  <valuetype>string</valuetype>
  <multiValue>0</multiValue>
</column>
```

Multitier Classification Column Configuration

Whenever you add a secondary classification table in Defect Classification, a corresponding secondary classification column must be displayed in the Defect List. To display the corresponding secondary classification column, you must configure the *dat-ini.xml* file.

For example, a secondary classification table named “Disposition” is added for Defect Classification. To display the corresponding classification and classification comment in the Defect List, add the columns to the *dat-ini.xml* file as shown in the Figure 5-28, under the node DefectListInfo. For details on configuring multitier classification tables, refer to “Multitier Classification Table Configuration” on page 213.

Figure 5-28. Configuration to Display Multitier Classifications

```
<column name="Multitier">
 <index>1</index>
 <visible>yes</visible>
 <displayName>Disposition</displayName>
 <miShow>yes</miShow>
 <siShow>yes</siShow>
 <valuetype>string</valuetype>
 <multiValue>0</multiValue>
</column>
<column name="MultitierComment">
 <index>1</index>
 <visible>yes</visible>
 <displayName>DispositionComment</displayName>
 <miShow>yes</miShow>
 <siShow>yes</siShow>
 <valuetype>string</valuetype>
 <multiValue>0</multiValue>
</column>
```

Once the *dat-ini.xml* file is configured, the corresponding classification and comments can be viewed in the Defect List.

Note

You can configure multiple secondary classification columns by using a different index. The Index will be 1 for the first secondary classification column, 2 for the second secondary classification column, and so on.

Track Classification History

Use the Classification History column to track all classification changes for a defect. Whenever you classify any defect, the Classification History column records all classification changes in a predefined order.

For details on configuring Classification History, refer to “Classification History or Code Sequence Tracking” on page 221.

Visibility Configuration in the Defect List

The Defect List can be configured by changing the visibility status of each column in the *dat-ini.xml* file.

The node DefectListInfo specifies the visibility status of all the available attributes in the Defect List. To configure the Defect List, set the value of the visible attribute to yes or no.

```
<DefectListInfo>
   <ColumnInfo>
      <column visible="yes" name="MachineDefectId" />
      <column visible="no" name="ClusterId" />
      <column visible="yes" name="SystemX" />
      <column visible="yes" name="SystemY" />
                ...
                ...
   </ColumnInfo>
</DefectListInfo>
```

Chapter 6
Defect Selection

Defect Selection displays the defect attributes based on what you select for analysis.

The Defect Selection Window

To access: **View > Defect Selection**

The Defect Selection window allows you to select a subset of defects from the input defect data.

Description

The Defect Selection window contains two main tabs:

- **Filter Tree** — Enables you to select defects from a tree structure.
- **Classification Filter Table** — Groups defects into multiple bins based on defect classifications.

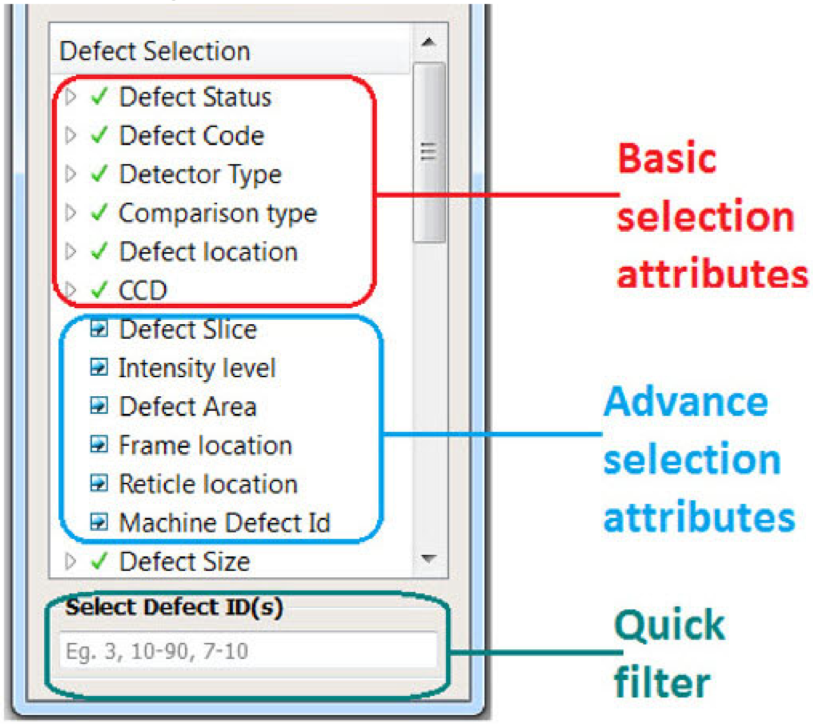
Filter Tree

The **Filter Tree** tab contains the following selection categories:

- **Basic Selection** — Attributes that have known or predefined values. For example, Defect Size may only have values of XSmall, Small, Medium, Large, and Xlarge.
- **Advanced Selection** — Attributes such as Defect ID and so on, for which values can be a series of ranges or rectangles.
- **Quick Filter** — This is for defect IDs only. It is used to quickly select defects based on defect IDs.

The basic selection attributes are displayed as parent nodes in the tree and the values are displayed as child nodes. The advanced selection attributes are shown as nodes with no children.

Figure 6-1. Defect Selection Window



Different icons indicate the type of selection criteria and their status (activated or deactivated).

Figure 6-2. Defect Selection Icons

Icon	Description
	Basic selection attribute is in a selected or enabled state.
	Basic selection attribute is in an unselected or disabled state.
	Basic selection attribute is in an active state. Some child values are in an enabled state and some are in a disabled state.
	Indicates an advanced selection attribute.
	Advanced selection attribute is in an active state. Some values have been selected under this attribute.

Once the selection is done, only those defects that match the selected attributes or values are considered for analysis by the tool.

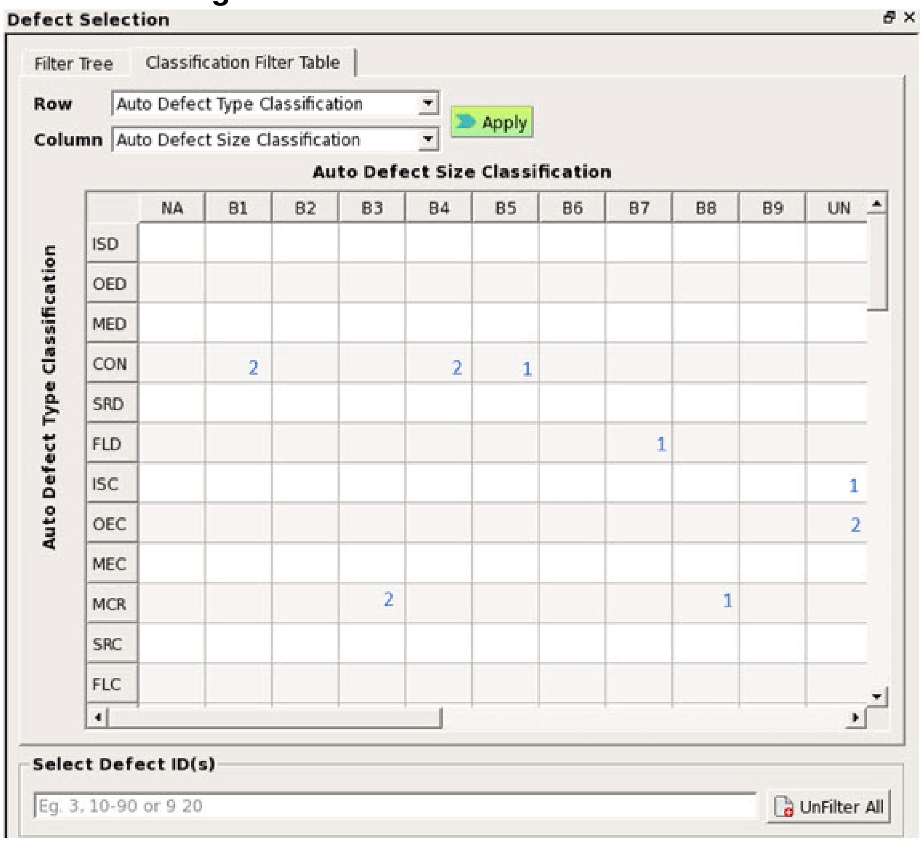
Note

In the All folder, the Defect Selection window is not visible if you load different types of inspection files (for example, text files and xml files) at the same time.

Classification Filter Table

The Classification Filter Table can be used to group defects into multiple bins based on defect classifications. After grouping the defects, you can filter for defects belonging to a particular group by clicking on the group's cell in filter table.

Figure 6-3. Classification Filter Table



Refer to "Using the Classification Filter Table" on page 203 for information on how to use the Classification Filter Table.

Objects

Table 6-1. Defect Selectors List

Selector	Type	Description
Defect Size	Basic	Selects defects based on defect size. For details, refer to "Automatic Defect Classification Using Defect Size" on page 216.
Defect Code	Basic	Selects defects based on defect codes.

Table 6-1. Defect Selectors List (cont.)

Selector	Type	Description
Size Classification	Basic	Selects defects based on the Size Classification table.
Printability Classification	Basic	Selects defects based on the Printability table.
Defect ID	Advanced	Selects defects based on the ranges of defect IDs.
Defect Location	Advanced	Selects the defects based on the values of the system coordinates.
CD Measurement (Max Cd Variation, Max Vertical Cd Variation, Max Horizontal Cd Variation)	Advanced	Selects defects based on CD measurements. This is only available when loading a Klarf file.

Applying Basic Selection

The basic selection attributes include Defect Size, Defect Code, and so on, for which the values are known or defined.

Procedure

1. Click any basic selection attribute to change its status. Enabled status is marked with a green check mark, deactivated is marked with a red X icon.

   For example, if you want to exclude all XSmall defects from analysis, click on the enabled XSmall attribute value under the Defect Size attribute to deactivate it. If the located attribute has a green check mark (enabled), click the attribute to deactivate it.

2. Click any parent basic selection attribute to activate or deactivate all the values of the attribute.

   For example, if you click the Defect Size attribute, all the attribute values (XSmall, Small, Medium, Large and XLarge) attain the same state as that of Defect Size.

Applying Advanced Selection

The advanced selection attributes include Defect Location and so on, for which values can be entered as a series of ranges or rectangles.

Procedure

1. Double-click on any advanced selection attribute. Advanced selection attributes are indicated by a blue arrow icon. The Advanced Selection dialog box appears.
2. In the Advanced Selection dialog box, you can specify attribute ranges (see Figure 6-4) or the coordinates of rectangles (see Figure 6-5).
    - Specify ranges in the **From** and **To** fields.
    - Specify rectangles as X-bl (bottom left x-coordinate), Y-bl (bottom left y-coordinate), X-tr (top right x-coordinate) and Y-tr (top right y-coordinate) as shown in Figure 6-5.

Figure 6-4. Using Advanced Selection to Enter Ranges

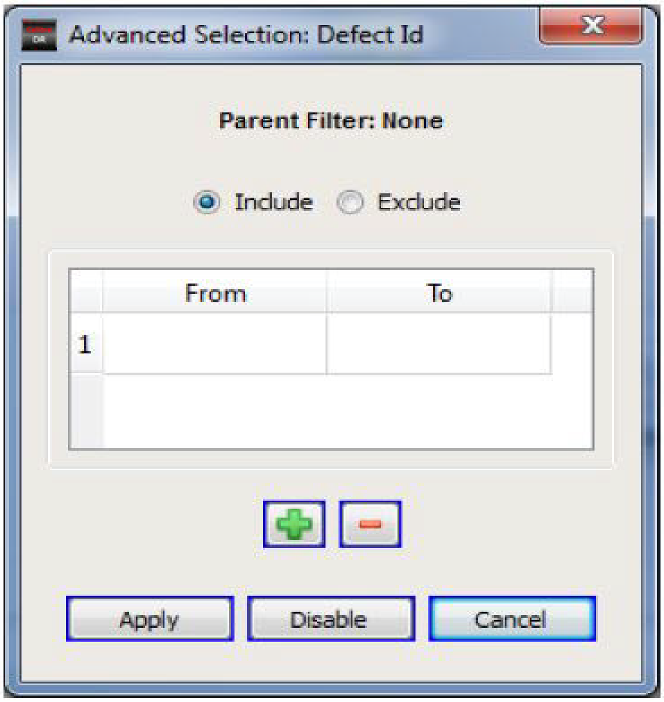
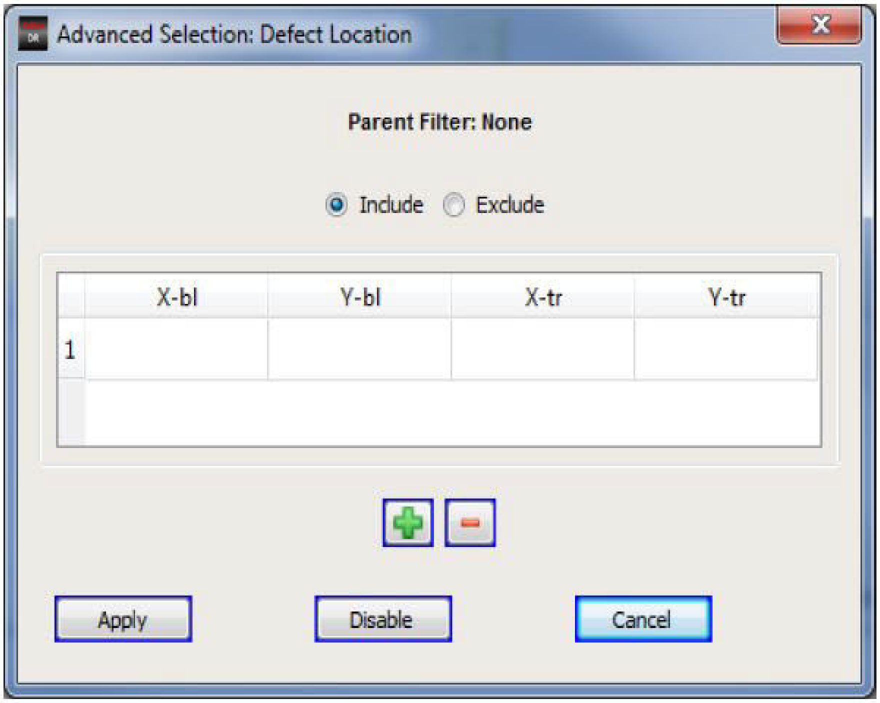


Figure 6-5. Using Advanced Selection to Enter Rectangles



3. To enter values:
   - Type the values in the table cells. You can use the Tab key to navigate to the cells.
   - To add a new row for values, click the green plus button. A new row is added.

     If you enter any range in which the From value is larger than To value, when you click **Apply**, an error message is generated:

     ```
     Invalid range in row: 1
     ```

     If you enter conflicting rectangle coordinates and click **Apply**, then an error message is generated.

     ```
     Invalid rectangle in row: 1
     ```

4. To remove values:

   a. Select the row to be deleted by clicking on the row header or any cell of the row.

   b. Click the red minus button.

5. To include the selection in analysis, select the **Include** option. For example, if you have entered the range 1 to 10 in the defect number entry, only the defects numbered 1 to 10 are considered for analysis.

6. To exclude the values entered in analysis, click the **Exclude** radio button. For example, if you enter the range 1 to 10 in the defect number entry, defects numbered 1 to 10 are not considered for analysis.

7. To apply the values, click the **Apply** button. To deactivate the selection based on the entered values for a particular advanced selection attribute, click the **Disable** button.

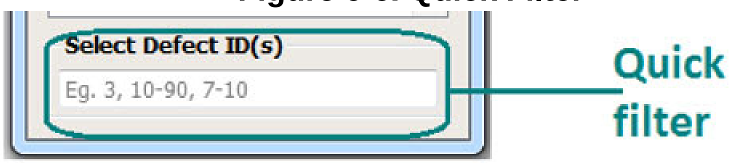
Applying a Quick Filter

The quick filter attributes includes only Defect ID(s). It is used to quickly select defects based upon defect IDs.

Procedure

1. Click the text box below Select Defect ID(s) and specify your defects, separated by commas. You can also specify multiple ranges in this field. For example, if you want to look at defects from 10 to 20 and then 25 to 30, you specify 10-20, 25-30.

Figure 6-6. Quick Filter



2. To turn off all filters, you use the keyboard shortcut Alt-u-u or specify **Utilities** >**Unfilter All Filtered**.

Expression-Based or User-Defined Selectors

Expression-based selectors are used to create customized or user-defined selectors.

Using Expression-Based or User-Defined Selectors

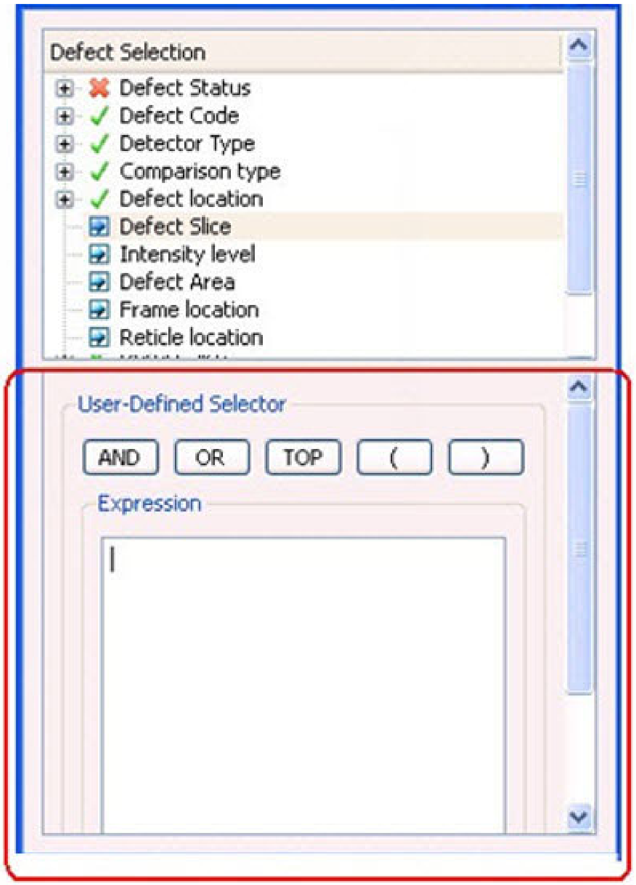
You can create expression-based or user-defined selectors through the Calibre DefectReview GUI.

Procedure

1. To create an expression-based selector, right-click in the **Filter Tree** tab of the Defect Selection window. A menu appears.
2. Click **Create User Selector**. The User-Defined Selector pane is displayed in the Defect Selection window as shown in Figure 6-7.

   The User-Defined Selector pane contains the buttons **AND**, **OR**, **TOP**, **(,)**, and the display area. Other buttons such as **Save**, **Close**, **Save & Close** and **Help** are provided at the bottom of the pane.

Figure 6-7. Defect Selectors With Expression-Based Selectors



User-Defined Selector Creation Rules

There are a number of rules to apply when creating user-defined selectors.

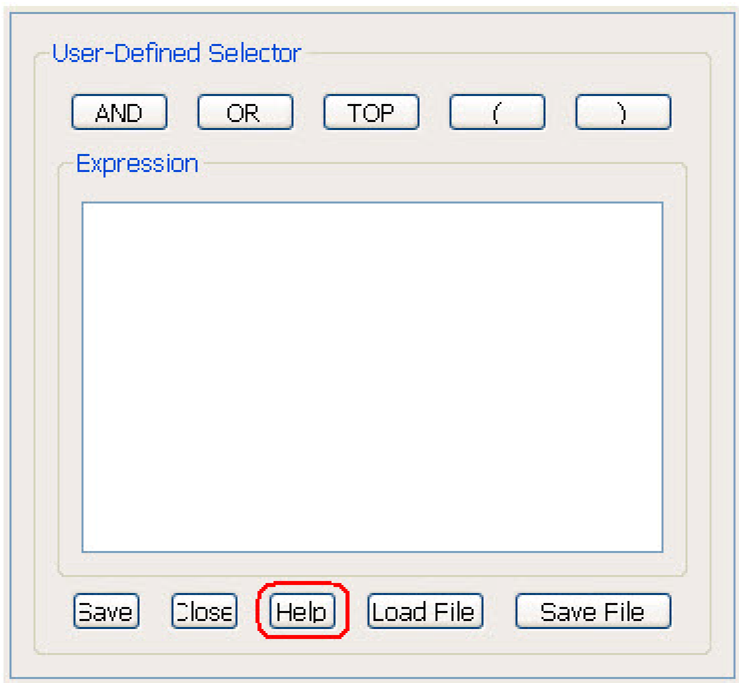
Invoking Help for Rule Overview

The **Help** button in the User-Defined Selector pane is available to provide a quick overview about the rules.

Procedure

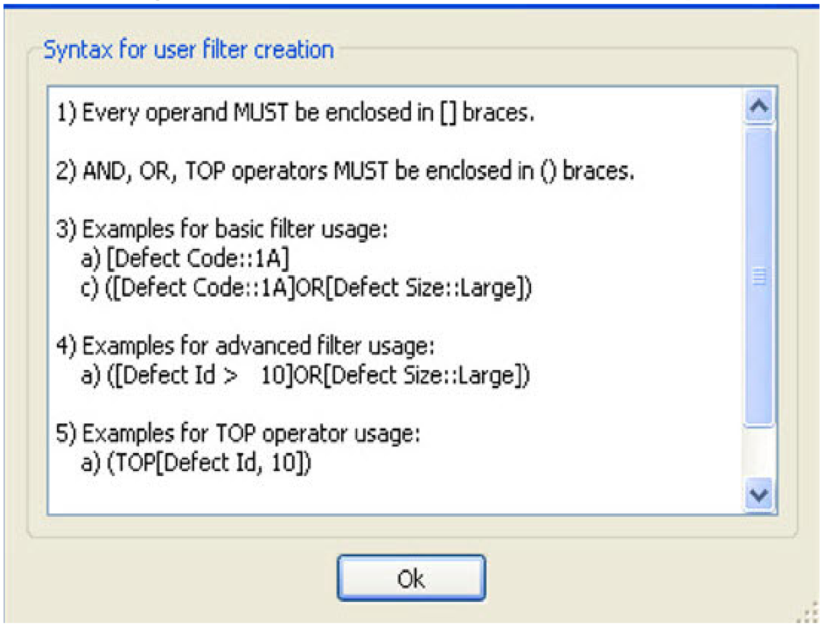
1. Click **Help** in the User-Defined Selector pane. The **Help** button is shown in Figure 6-8.

Figure 6-8. Help Button in User-Defined Selector Pane



2. When the **Help** button is clicked, a window pops up as shown in Figure 6-9.

Figure 6-9. User-Defined Selector Help



Supported Operators and Operands for User-Defined Selectors

User-defined selectors can combine supported operators and operands following some grammar rules. Operands are the selectors of Calibre DefectReview.

Examples of basic operands are Defect Code::1A, Defect Status::located, and so on. An example of an advanced filter operand is Defect ID. All operands must be enclosed in square braces (**[ ]**).

The types of operators for user-defined selectors are:

- Boolean Operators
- Binary Relational Operators
- Unary Operators

Boolean Operators

Boolean operators are the operators used between two operands. The AND and OR operations should be used on two operands.

For example:

```
([DefectStatus::located] AND [Defect Code::3C])
```

This filter is used to select from the defects that are located and with defect code 3C.

Binary Relational Operators

Binary relational operators are operators that test the operand against a value.

For example:

```
([Defect Code::3C] AND [Defect Size::xSmall])
```

This filter is used to select from the defects that have defect code 3C and a defect size equal to extra small.

A space should be used between the selector type and the relational operators.

Unary Operators

A unary operator is used on a single operand.

For example:

```
(Top [Defect Id 100])
```

This is used to select from the one hundred defects that have the largest Defect Id. The TOP operator filter extracts *N* defects (100 in this example) in descending order.

Operator Syntax

Boolean and unary operators should be enclosed in parenthesis (**()**). The syntax to write a user defined selector is:

- ([*operand*] *operator* [*operand*]) (for binary and logical operators)

  For example:

  ```
  ([Defect Code::1A] AND [Defect Size::Small])
  ```

- (*operator* [*operand*, *N*]) (for unary operators)

  For example:

  ```
  (TOP [Defect Id 100])
  ```

- (*expr operator expr*)

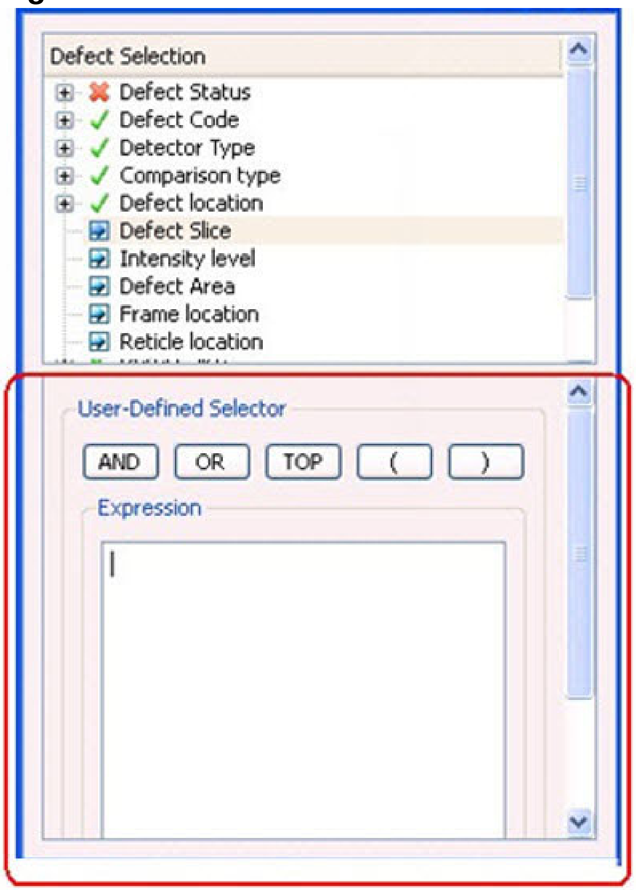
  For example:

  ```
  (([Defect Code::1A] OR [Defect Code::3C]) OR ([Defect Code::4B] AND
  [Defect Size::Small]))
  ```

Creating a User-Defined Selector

Use the User-Defined Selector pane to create a new selector, defining the operators and the operands to be used.

Figure 6-10. User-Defined Selectors Pane



Procedure

1. Click on the operand (entries in the Defect Selection list) or the operators (for example, AND). The syntax is displayed in the Expression pane.

   Alternatively, the inputs can be entered in the Expression pane using the keyboard.

2. Once the expression is entered in the Expression pane, click the **Save** button.

   If there is no error in the expression typed, then a dialog box appears prompting you to enter a selector name as shown in Figure 6-11. The expression is saved with the name and is added to the selectors list.

Figure 6-11. User Defined Filter dialog box

If there is any error in the expression, then an error is issued:

```
Invalid expression
```

Examples

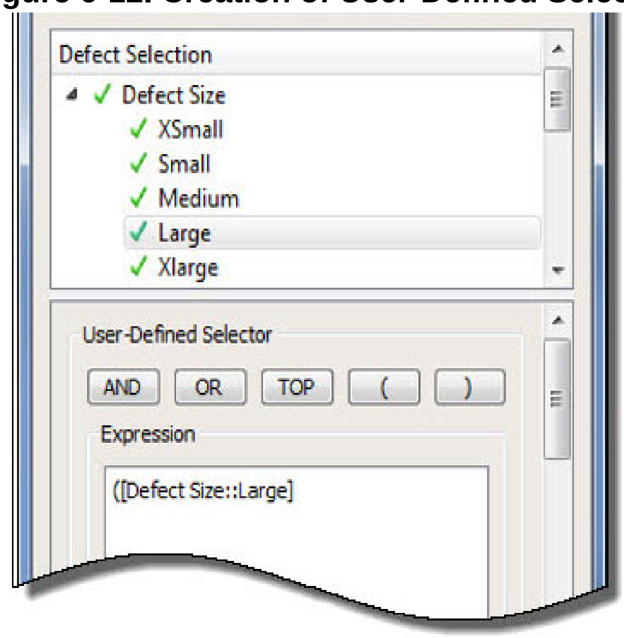
In this example, a user-defined selector is created in Calibre DefectReview. The new selector should be capable of filtering the defects which are located and which have defect code 3C. The steps are as follows:

1. Right-click in the Defect Selection window and select **Create User Selector**. The User-Defined Selector pane appears in the Defect Selection window.
2. You can type the expression directly in the Expression area, or you can create one using the following method:

    a. Click the **(**button.

    b. Expand the Defect Status entry in the selector list and click on "located". The code ([Defect Status::located] appears in the Expression area as shown in Figure 6-12.

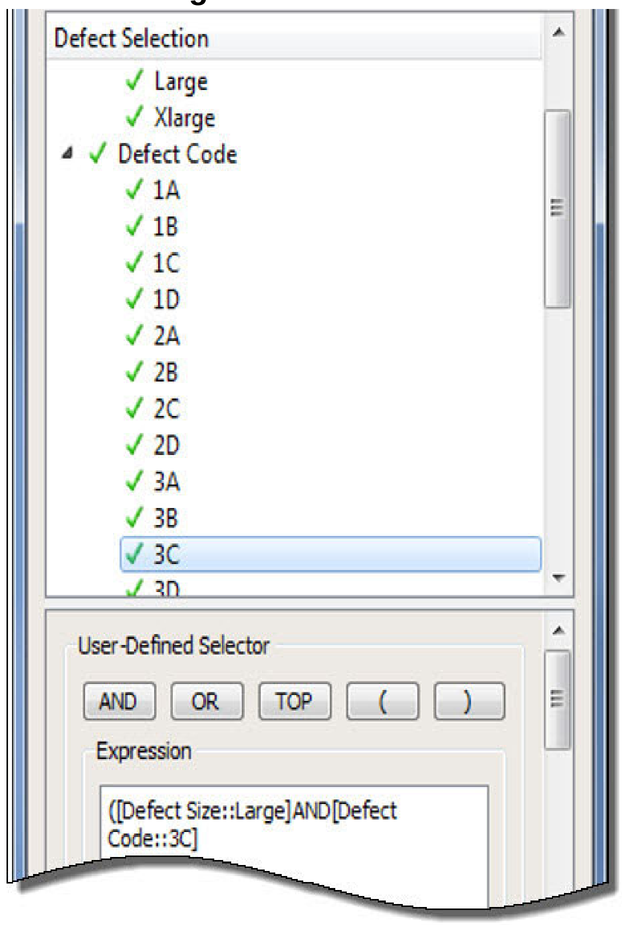
Figure 6-12. Creation of User-Defined Selector



c. Click **AND**. The selector is updated in the Expression pane.

d. Expand the Defect Code entry and select “3C”. The expression shows as ([Defect Status::located] AND [Defect Code::3C] as shown in Figure 6-13.

Figure 6-13. Adding AND to the User-Defined Selector

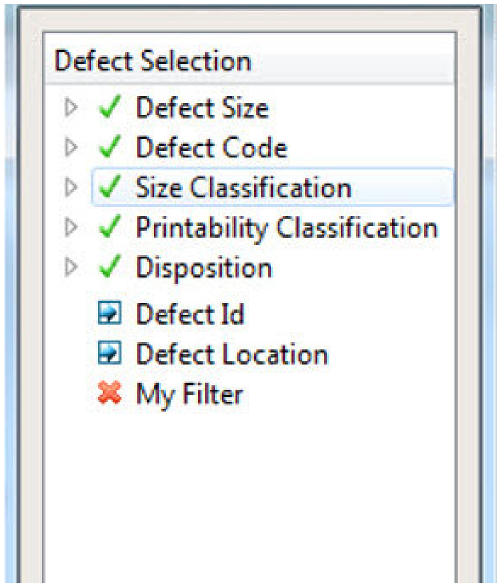


e. Click the **)** button to complete the expression.

f. Click **Save** and enter “My Filter” as the filter name. The new selector is added in the selectors list as shown in Figure 6-14.

g. Initially, the filter “My Filter” is not applied, shown by the red X. To apply the selector, click “My Filter”.

Figure 6-14. User-Defined Selector in the Selectors List

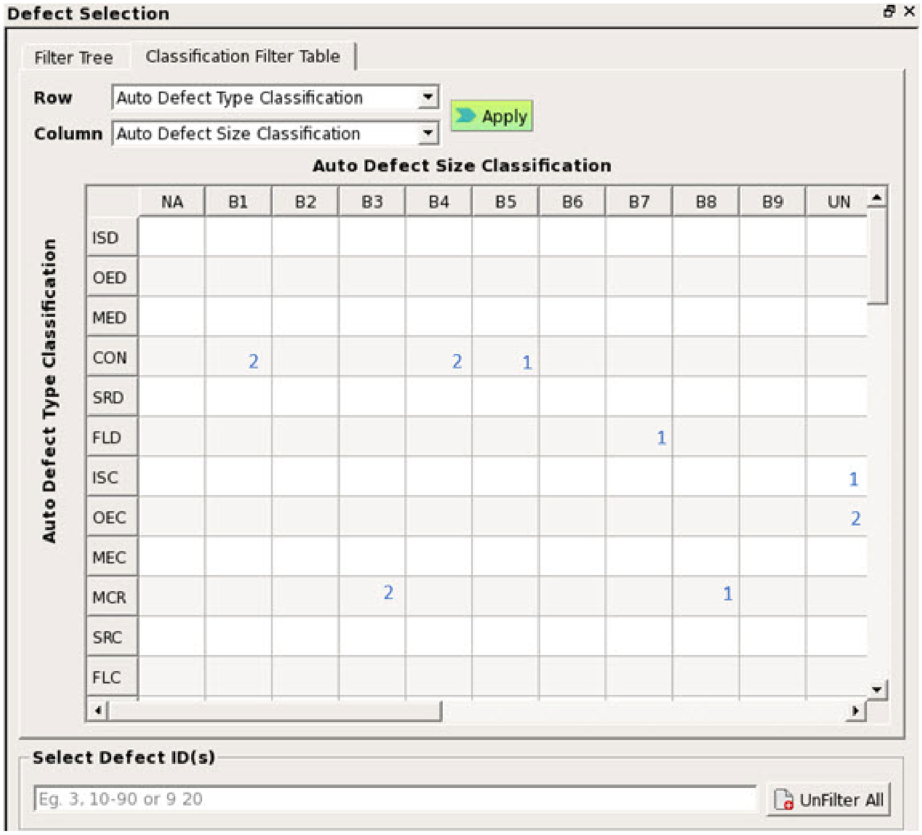


Using the Classification Filter Table

Use the Classification Filter Table in the Defect Selection window to group defects into multiple bins based on defect classifications.

After grouping the defects, you can filter for defects belonging to a particular group by clicking on the group's cell in filter table.

Figure 6-15. Classification Filter Table Tab



Procedure

1. To use the Defect Classification Table, specify classification groups from the **Row** and **Column** pull-down menus.

   The following are the supported classification groups for defects that can be selected for either **Row** or **Column**:

   - Primary Classification
   - Defect Type Classification
   - Defect Printability Classification
   - Defect Size Classification
   - SEM Classification
   - Defect Disposition
   - Defect Severity Classification
   - Defect Progress Classification
   - Defect Source Classification

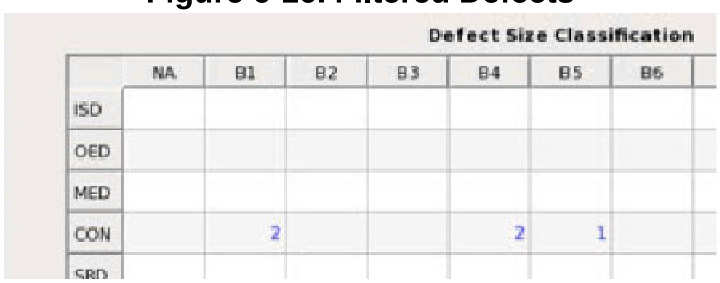
- Auto Defect Type Classification
- Auto Defect Printability Classification
- Auto Defect Size Classification
- Auto Defect SEM Classification
- Auto Defect Disposition
- Auto Defect Severity Classification
- Auto Defect Progress Classification

For example, to filter defects with the Defect Type Classification code CON and the Defect Size Classification code B1. Select **Defect Type Classification** in the **Row** pull-down menu and **Defect Size Classification** from the **Column** pull-down.

2. Click **Apply** to group the defects and populate the filter table. In this example, the classification codes for Defect Type Classification and Defect Size Classification are selected from the *dat-ini.xml* file.

3. Locate the filtered defects in the Defect Size Classification Table. In this example, locate the cell with the specified Defect Type Classification code CON and Auto Defect Size Classification code B1. Click the cell to filter-in those defects.

Figure 6-16. Filtered Defects



There are two defects in this group displayed in the Defects List for this example.

4. To remove the applied filter, you can click the **Unfilter All** button.

Note

If you click any cell in the Classification Filter Table, all previously-applied filters are cleared and the new filter is applied.

Chapter 7
Defect Classification

The Defect Classification window allows you to classify a defect or a set of defects.

The Defect Classification Window

To access: **View > Defect Classification**

The Defect Classification window contains controls to classify defects generated from a mask inspection.

Note

Refer to "Classifying a Defect" on page 210for further information.

Description

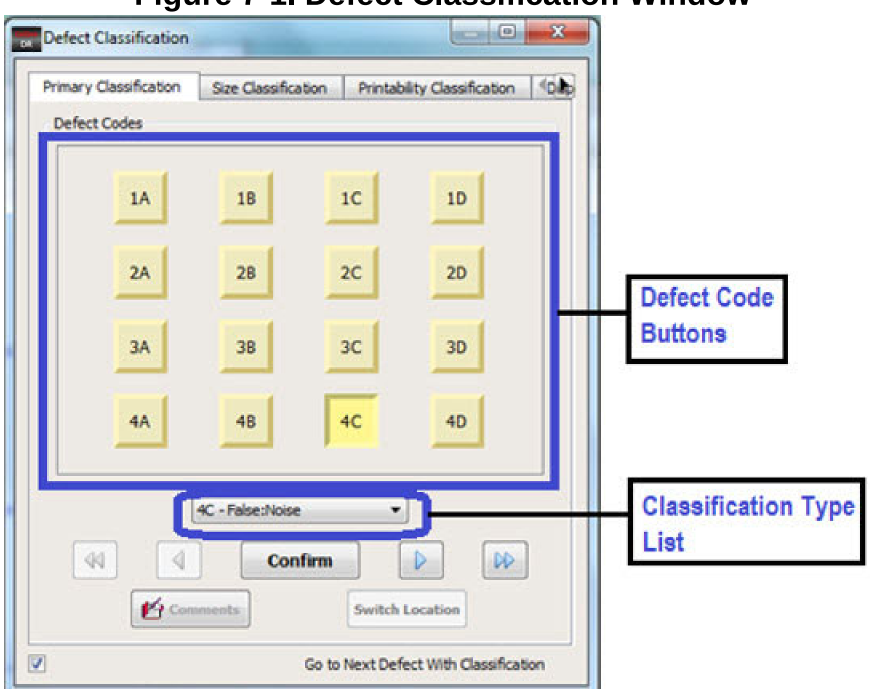
A defect that is currently selected in the Defect List or Defect Map is highlighted in the Defect Codes area as a pressed button.

You can navigate to different defects by any of the following methods:

- Click a defect in the Defect List or Defect Map. You can classify, add or edit comments, perform switch operations, and confirm classification of a single or multiple defects from this window. Refer to section "Selecting Defects" on page 163 for details on selecting defects from the Defect List window. For details on selecting defects from the Defect Map window, refer to "Using Rubber Band Selection Mode" on page 128.
- To navigate to different defects, use the arrow navigation buttons near the bottom of the Defect Classification window.

The classification type of the current defect is highlighted in the Classification Type list as shown in Figure 7-1.

Figure 7-1. Defect Classification Window



Note
Once the classification of a defect is classified or confirmed, the tool automatically navigates to the next defect based on defect ID. In the All folder, the Defect Classification window is deactivated if you load different types of inspection files (for example, text files and XML files) at the same time.

Objects

Table 7-1. Defect Classification Window Elements

Objects	Description
Defect code buttons	Specifies the codes of the Classification Types. Click on an individual button to change the Classification of the defect.
Classification type list	Specifies the classification type for the selected defect ID. A list of all possible classification types appears in a menu. • Inspection files generated by mask inspection machines. • Primary classification tables defined in the *dat-ini.xml* file. See "Primary Classification Table Name Configuration" on page 211. • Secondary, multi-tier classification tables defined in the *dat-ini.xml* file. See "Multitier Classification Table Configuration" on page 213.
Navigation buttons	Navigates to the first, previous, next, or last defect in the inspection. 
Confirm	Confirms the classification of a single defect or set of defects after selecting the defects from the Defect List or Defect Map. See "Classification Confirmation" on page 215.
Comments	Invokes a Defect Comments dialog box to add comments for the selected defect. See "Editing Defect Comments" on page 215

Defect Classification Operations

There are a number of operations related to classifying defects that are supported in the Defect Classification window.

Classifying a Defect

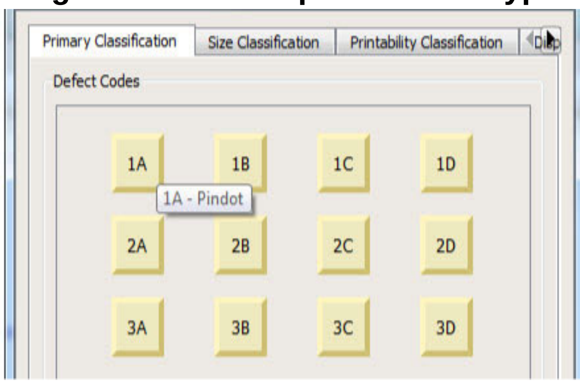
Use the Defect Classification window to classify a defect.

Procedure

1. To classify the current defect using a defect code button, click the button with the desired defect code. You can view the defect type mapping for the defect code on the tool tip of the defect code button as shown in Figure 7-2.

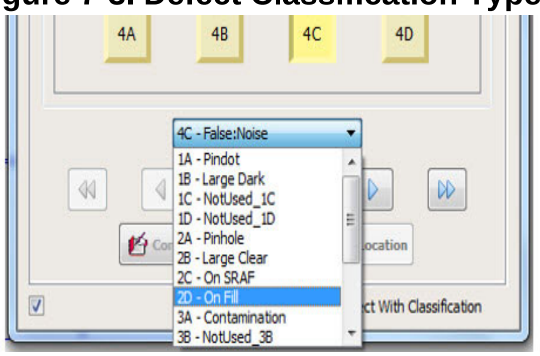
   To view the tool tip, move the mouse pointer over a button.

Figure 7-2. Tool Tip for Defect Type



2. To classify the current defect, select the classification type from the Defect Classification List. The dropdown list displays a list of all possible classification types.

Figure 7-3. Defect Classification Types



3. You can classify subsequent defects with the previous classification.

- Classify the first defect using the defect code button or Defect Classification List.
- Press the Space Bar key for other defects.

Primary Classification Table Name Configuration

You can specify the name displayed for the Primary Classification table in the *dat-ini.xml* file, using the tableName attribute in the classificationTable node.

Figure 7-4. tableName Attribute

```
<classificationTable tableName="Primary Classification"
        classCodeUnion="false" higherPriorityToDatIni="false">
        <classificationData defectName="Pindot"
                defectType="Pindot" defectCode="1A"/>
        <classificationData defectName="Large Dark"
                defectType= "Large Dark" defectCode="1B"/>
        <classificationData defectName="NotUsed_1C"
                defectType="NotUsed_1C" defectCode="1C"/>
        <classificationData defectName= "NotUsed_1D"
                defectType= "NotUsed_1D" defectCode="1D"/>
```

The tableName attribute represents the Primary Classification table name.

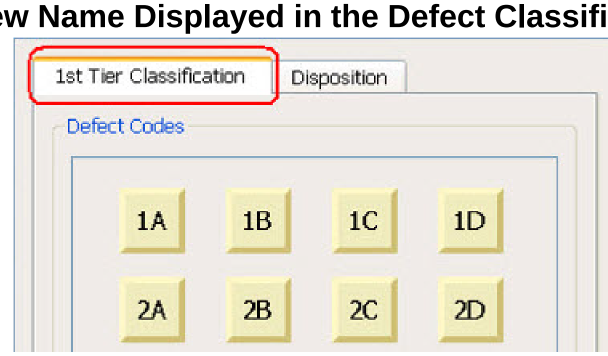
For example, the Primary Classification table name needs to be changed to “1st Tier Classification”. Enter the string “1st Tier Classification” as the tableName value in the *dat-ini.xml* file.

Figure 7-5. tableName Set to New Name

```
<classificationTable tableName="1st Tier Classification"
        classCodeUnion="false" higherPriorityToDatIni="false">
        <classificationData defectName="Pindot"
                defectType="Pindot" defectCode="1A"/>
        <classificationData defectName="Large Dark"
                defectType="Large Dark" defectCode="1B"/>
        <classificationData defectName="NotUsed_1C"
                defectType="NotUsed_1C" defectCode="1C"/>
        <classificationData defectName= "NotUsed_1D"
```

The new name is displayed in the Defect Classification window as shown in Figure 7-6.

Figure 7-6. New Name Displayed in the Defect Classification Window



Note

If you change the Primary Classification table name in Defect Classification window through the *dat-ini.xml* file, the name also changes in the Repeatability Analysis window and in the **Classify** right-click menu in the Defect Map.

Understanding Multitier Classification

Multitier classification provides the flexibility to add more than one classification type per defect.

Multitier Classification Table Configuration

To use multitier classification, add a node named “SecondaryClassifications” under the datInfo node in the *dat-ini.xml* file. Within the SecondaryClassifications node, add classificationTable nodes as needed.

For example, a new classification type needs to be added under the “Disposition” table name. To do this, add defect codes and defect types related to “Disposition” in the *dat-ini.xml* file under the datInfo node, as shown in Figure 7-7.

Figure 7-7. Secondary Classification Table Information in the dat-ini.xml File

```
<SecondaryClassifications>
  <classificationTable tableName="Disposition" classCodeUnion="false" higherPriorityToDatIni="true">
    <classificationData defectName="Continue On"   defectType="Continue On"  defectCode="A"/>
    <classificationData defectName="type1"   defectType="type1"  defectCode="B"/>
    <classificationData defectName="type2"   defectType="type2"  defectCode="C"/>
    <classificationData defectName="type3"   defectType="type3"  defectCode="D"/>
    <classificationData defectName="type4"   defectType="type4"  defectCode="E"/>
    <classificationData defectName="Scope"   defectType="Scope"  defectCode="F"/>
    <classificationData defectName="Re-inspect"   defectType="Re-inspect"  defectCode="G"/>
    <classificationData defectName="Clean"   defectType="Clean"  defectCode="H"/>
    <classificationData defectName="Rework"   defectType="Rework"  defectCode="I"/>
    <classificationData defectName="Pull Pell"   defectType="Pull Pell"  defectCode="J"/>
    <classificationData defectName="Notify"   defectType="Notify"  defectCode="K"/>
  </classificationTable>
<SecondaryClassifications>
```

The figure shows a classificationTable named “Disposition” has been added under the SecondaryClassifications node in the *dat-ini.xml* file. All the classification types related to “Disposition” are listed under this classificationTable.

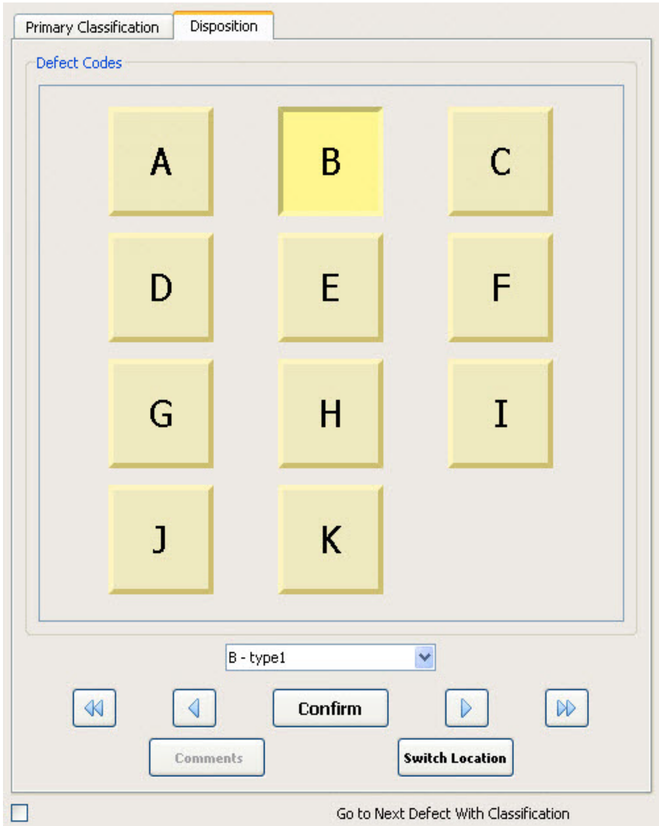
For each classification type, the defect name, defect type, and the defect code should be specified. In Figure 7-7, a type called “Continue On” is added, where the defectName and defectType are specified as “Continue On”, and the defect code for this type is specified as “A”. Similarly, other classification types can be added in the *dat-ini.xml* file.

In case you want to add more classification tables, a new “classificationTable” node should be inserted under the “SecondaryClassifications” node with the desired classification types.

Classification Using the Defect Classification Window

The Defect Classification window displays all secondary classification tables inserted in the *dat-ini.xml* file as tabs.

Figure 7-8. Defect Classification Window With Multitier Classification



The primary classification codes present in the inspection file are shown under the first tab (**PrimaryClassification** tab). The rest of the SecondaryClassification tables are displayed under the respective names present in the *dat-ini.xml* file.

You can click on the classification code button in any of the tabs to classify a defect. Refer to "Classifying a Defect" on page 210 for further information.

If the "Go to Next Defect With Classification" option is enabled, then Calibre DefectReview advances to the next defect when any defect is classified. If this option is not enabled, you will need to use the defect navigation buttons to advance to the next defect after classification.

Note

The "Go to Next Defect With Classification" option is present if at least one secondary classification table entry exists in the *dat-ini.xml* file.

Defect Classification in the Defect Map Window

You can also classify a defect in the Defect Map window using a right-click menu.

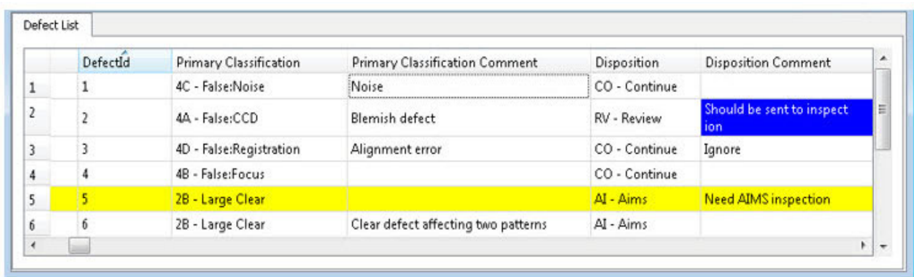
Refer to the **Classify** option description in "Using General Defect Operations" on page 144 for information.

Display of Classification Types and Comments in a Defect List

For each defect, by default, the secondary classifications are shown in the Defect List window. The secondary classifications are blank if they are not set for the defect. Each of the secondary classification tables is listed in a separate column in the Defect List window. Comments are also added as separate columns for each of the classification types.

The columns that display comments are hidden by default. They can be enabled with the **Show All** option, available from a right-click menu in the Defect List table header.

Figure 7-9. Classification Data in the Defect List Window



Classification Confirmation

To confirm the existing classification of a single defect or set of defects after selecting the defects from the Defect List or Defect Map, click the **Confirm** button in the Defect Classification window.

The status column in the Defect List changes to "Confirmed" for those defects.

Editing Defect Comments

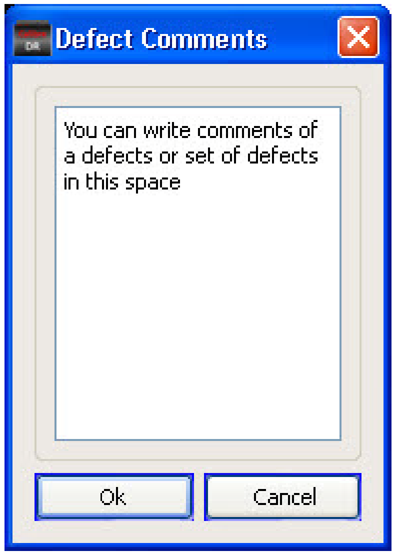
You can edit comments of a single defect or set of defects after selecting the defects from the Defect List or the Defect Map.

Procedure

1. In the Defect Classification window, click the **Comments** button. The presence of comments is indicated by green colored text in the **Comments** button. If there are no comments, the text is grey. The Defect Comments dialog box appears.

2. In the Defect Comments dialog box, enter comments in the space provided, then click **OK**.

Figure 7-10. Defect Comments Dialog Box



Automatic Defect Classification Using Defect Size

Defects can be classified based on size. In this case, the Area parameter present in the inspection file is used to determine the size of the defect.

The DefectSizeClassification entry under the ClassificationInfo node in the *dat-ini.xml* file can be configured for automatic classification.

Figure 7-11. DefectSizeClassification Node

```
<DefectSizeClassification>
 <area range="[0,12)" type="Small"/>
 <area range="[12, 47)" type="Medium"/>
 <area range="[48,65)" type="Large"/>
 <area range="[66,10000]" type="Xlarge"/>
</DefectSizeClassification>
```

You must specify the area range and corresponding type in the attributes.

The starting area range in the DefectSizeClassification node begins with either a left parenthesis (**(**) or bracket (**[**). The end area range ends with a right parenthesis (**)**) or bracket (**]**). These values must be separated by commas.

Using a parenthesis or bracket has different implications in the syntax, as described in Table 7-2.

Table 7-2. Parenthesis and Bracket Behavior in DefectSizeClassification

Symbol	Description
(	The starting area value is not included in the area range.
[	The starting area value is included in the area range.
)	The end area value is not included in the area range.
]	The end area value is included in the area range.

The DefectSizeClassification node can be used to specify ranges for each of the following default classification types:

- Small
- Medium
- Large
- Xlarge

You can modify these types or add new classification types.

The corresponding Defect List column named “DefectSize” is present under the DefectListInfo node in the *dat-ini.xml* file.

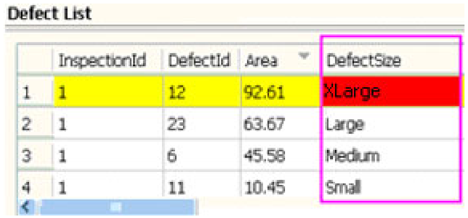
Figure 7-12. DefectSize Node

```
<column name="DefectSize" >
 <visible>yes</visible>
 <miShow>yes</miShow>
 <siShow>yes</siShow>
 <specdeftype>yes</specdeftype>
 <valuetype>string</valuetype>
 <multiValue>0</multiValue>
</column>
```

The Defect Size Classification features can be enabled by setting the value of “visible” to “yes” in the DefectSize node. If the value of “visible” is set to “no”, then the Defect Size Classification feature is unavailable.

The Defect List table with the DefectSize column enabled is shown in Figure 7-13.

Figure 7-13. Defect List With DefectSize Column

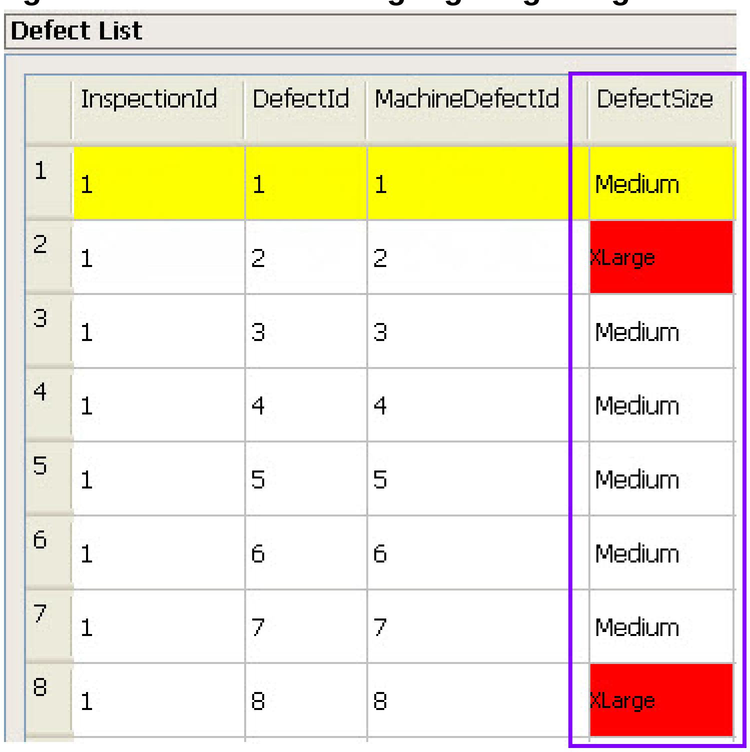


Defect List

	InspectionId	DefectId	Area	DefectSize
1	1	12	92.61	XLarge
2	1	23	63.67	Large
3	1	6	45.58	Medium
4	1	11	10.45	Small

If the classification of the defect is the largest defect size classification specified in the DefectSizeClassification node of the *dat-ini.xml* file, then the corresponding defect's DefectSize cell is highlighted with a red background in the Defect List window as shown in Figure 7-14.

Figure 7-14. Defect List Highlighting Xlarge Defects



Defect List

	InspectionId	DefectId	MachineDefectId	DefectSize
1	1	1	1	Medium
2	1	2	2	XLarge
3	1	3	3	Medium
4	1	4	4	Medium
5	1	5	5	Medium
6	1	6	6	Medium
7	1	7	7	Medium
8	1	8	8	XLarge

Note the following:

- If the range values are discontinuous or not undefined, then the DefectSize column indicates this with "unknown" as illustrated in Figure 7-15.

Figure 7-15. Unknown DefectSize

	DefectId	MachineDefectId	ClusterId	SystemX	DefectSize
1	1	1	0_0	51331.00	unknown
2	2	2	0_0	69229.60	unknown
3	3	3	0_0	75986.00	unknown

- The area units are the square of the unit of measurement. For more details about the unit of measurement, refer to "Unit of Measurement Configuration" on page 125.

Classification Table Configuration

You can add defect codes through the *dat-ini.xml* file using the classCodeUnion and higherPriorityToDatIni attributes.

These attributes are present under the classificationTable node of Primary and Secondary Classification sections as shown in Figure 7-16 and Figure 7-17. With these attributes, you can display defect codes from either the inspection file, *dat-ini.xml* file, or from a merging of codes from both files.

Figure 7-16. classCodeUnion and higherPriorityToDatIni in Primary Classification

```
<!-- Primary Classification Table -->
<classificationTable classCodeUnion="false" higherPriorityToDatIni="false">
```

Figure 7-17. classCodeUnion and higherPriorityToDatIni in Secondary Classification

```
<SecondaryClassifications>
        <classificationTable tableName="Auto Defect Classification"
         classCodeUnion="false" higherPriorityToDatIni="true">
```

If the classCodeUnion attribute is set to "true", then defect codes from both the inspection file and the *dat-ini.xml* file are displayed. If the higherPriorityToDatIni attribute is set to "true", then priority is given to the *dat-ini.xml* file instead of the inspection file. (If higherPriorityToDatIni is not true, priority is given to the inspection file.)

Four possible combinations of classCodeUnion and higherPriorityToDatIni are possible:

- classCodeUnion = "false" and higherPriorityToDatIni = "false".

In this case, higher priority is given to the inspection file. All defect codes from the inspection file are displayed. If defect codes are not available in the inspection file, codes are taken from the *dat-ini.xml* file.

- classCodeUnion = “false” and higherPriorityToDatIn i = “true”.

  In this case, higher priority is given to the *dat-ini.xml* file. Defect codes from the *dat-ini.xml* file are displayed.

- classCodeUnion = “true” and higherPriorityToDatIni = “false”.

  In this case, defect codes from both the inspection file and *dat-ini.xml* file are displayed. If there is a conflict between defectCode attribute values, priority is given to the inspection file, and the corresponding defectName and defectType values are taken from the inspection file.

- classCodeUnion = ”true” and higherPriorityToDatIni = “true”.

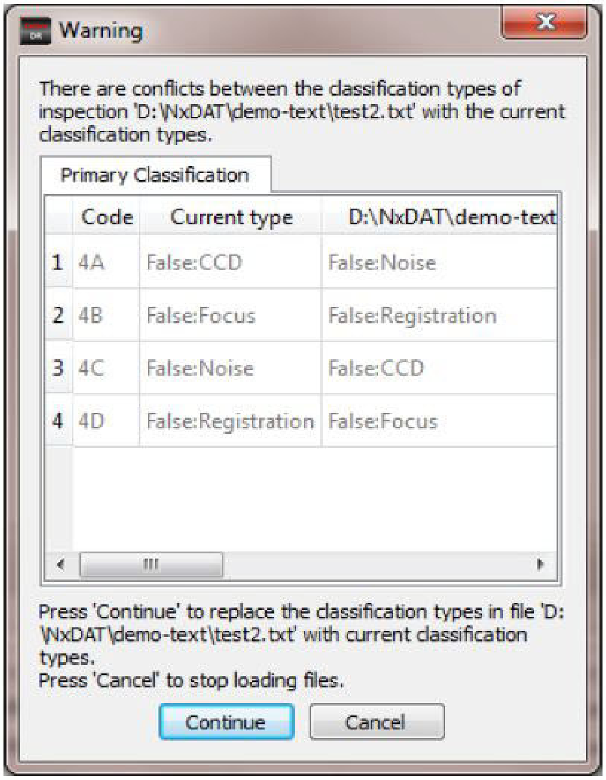
  In this case, defect codes from both the inspection file and *dat-ini.xml* file are displayed. If there is a conflict between defectCode attribute values, priority is given to the *dat-ini.xml* file, and the corresponding defectName and defectType values are taken from the *dat-ini.xml* file.

Conflict Resolution in Classification

If you open multiple files (using **File > Open** or **Add Inspection**), if there is any conflict with a defect type for the same defect code in a classification table (primary and secondary), then Calibre DefectReview prompts you to either resolve the conflict or cancel the loading of the conflicting inspection file.

In this case, a Warning dialog box appears, listing the conflicts for all classification tables as shown in Figure 7-18.

Figure 7-18. Conflict Warning Window for Classification



Calibre DefectReview provides suggestions for all the primary and secondary classification tables that have conflicts with each table name in a separate tab. For example, in Figure 7-18, the Warning dialog box shows a suggestion to resolve conflicts in the "Primary Classification" and "Printability Classification" tables.

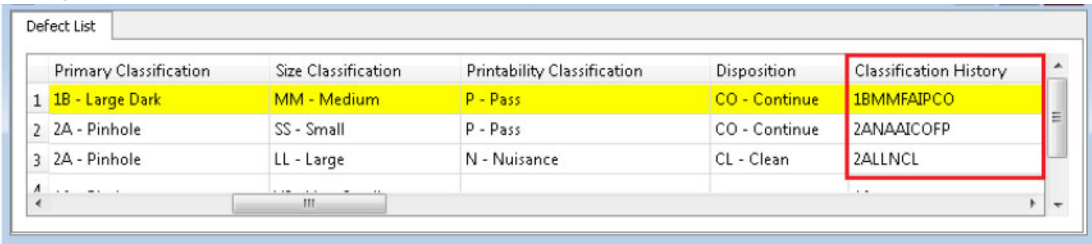
For each classification table with a conflict, the "Current type" and the type present in the inspection file being loaded is displayed. If you click **Continue**, then the current type is applied to all defects in file being loaded. If you click **Cancel**, the file is not loaded.

Classification History or Code Sequence Tracking

You can track all classifications of each defect. Once you classify a defect, it will be tracked and will be shown as part of classification history in the Defect List.

The Classification History column is highlighted in the following figure.

Figure 7-19. Classification History Column in the Defect List Window



To enable this feature, in the *dat-ini.xml* file, search for the ClassificationHistory node under the “DefectManagement” node, then set enable = “true” as shown in the following figure.

Figure 7-20. ClassificationHistory Node

```
<ClassificationHistory enable="true" storeHistory="true">
 <classificationTables>
  <table name="Primary Classification" appendCode="no"/>
  <table name="Defect Type Classification" appendCode="no"/>
  <table name="Defect Printability Classification" appendCode="yes"/>
  <table name="Defect Size Classification" appendCode="no"/>
  <table name="SEM Classification" appendCode="no"/>
  <table name="Defect Disposition" appendCode="yes"/>
  <table name="Defect Severity Classification" appendCode="no"/>
  <table name="Defect Progress Classification" appendCode="no"/>
 </classificationTables>
</ClassificationHistory>
```

Note the following:

- Define all Multi-tier classification tables under the SecondaryClassifications node in the *dat-ini.xml* file
- Configure the table names and order under the *<DefectManagement/ ClassificationHistory/classificationTables>* node to track the classification history
- If you want the classification code of a table to be appended in a code sequence, set appendCode = “yes”.
- In the *dat-ini.xml* file, “Primary Classification” is in first place and “Disposition” is in the last, which defines the order of codes of first four positions in the generated code sequence.

During classification of a defect, from the Defect Classification, Defect Map, and the Repeatability Analysis windows, the Classification History column is updated according to the order and rules defined in the *dat-ini.xml* file. Saving an inspection file saves the Classification History for each defect.

Defect Reclassification

By default, an inspection machine reports a particular classification code during inspection. This is the first level of reporting of a defect with some classification. However, the report may not be correct or be empty. This typically requires an additional review. If the classification is found to be incorrect, it is reclassified according to the severity of the defect. To track classification changes for these operations, Calibre DefectReview supports defect reclassification.

After opening an inspection file, a Defects Re-Classification column in the Defect List indicates whether defects in the inspection were reclassified. Initially, each defect is set to N (No), but changes to Y (Yes) once you reclassify a defect.

This is controlled through the *dat-ini.xml* file. To set up defect reclassification (if not already set), you must define a secondary classification table, as shown in the following figure:

Figure 7-21. Defect Reclassification Table

```
 <classificationTable tableName="Defect Re-classification">
  <classificationData defectCode="Y" defectType="Yes" defectName="Yes"/>
  <classificationData defectCode="N" defectType="No" defectName="No"/>
 </classificationTable>
</SecondaryClassifications>
```

The tableName of this secondary table in this example should be “Defect Re-classification” and contain the entries as shown in Figure 7-21. The entry with defectCode=“Y” (Yes) means that the defect has been reclassified by the user.

As the Defect List displays the reclassification indicator, it should also be present in *dat-ini.xml*. You must add the following node in the *dat-ini.xml* file (if not present):

Figure 7-22. Defect Reclassification Multi-Tier Column

```
<column name="Multitier">
 <index>9</index>
 <valueType>string</valueType>
 <multiValue>0</multiValue>
 <visible>yes</visible>
 <displayName>Defect Re-classification</displayName>
 <miShow>yes</miShow>
 <siShow>yes</siShow>
</column>
```

Once this configuration is complete, you can open Calibre DefectReview with an inspection file. For the first time, the Defect Re-classification column contains “N-No” indicators. Once manual classification is performed, the values change to “Y-Yes”.

The following behavior applies to defect reclassification:

- Performing any manual classification changes the defect reclassification value from N to Y.
- If a defect is already set to Y, performing further manual classifications does not alter the setting.
- If previous classification values are empty and manual classification has been performed, there are no changes to the Defect Re-classification field.

- Classification History or Code Sequence Tracking is supported for this feature.
- You can save defect reclassification values along with inspection files.
- Custom Query is supported by defect reclassification (see “Custom Query Interface” on page 460 for information).

Chapter 8
Repeatability Analysis

A mask is used multiple times for several IC (integrated circuit) fabrications with same circuit. During its lifetime, a mask is inspected for defects at regular interval. The Repeatability Analysis capability in Calibre DefectReview provides analysis results among successive inspection reports, such as information about added defects or changes in defect size.

The Repeatability Analysis Window

To access: **View > Repeatability Analysis**

You can select different analyses to perform on one or more inspection files in the Repeatability Analysis window.

Description

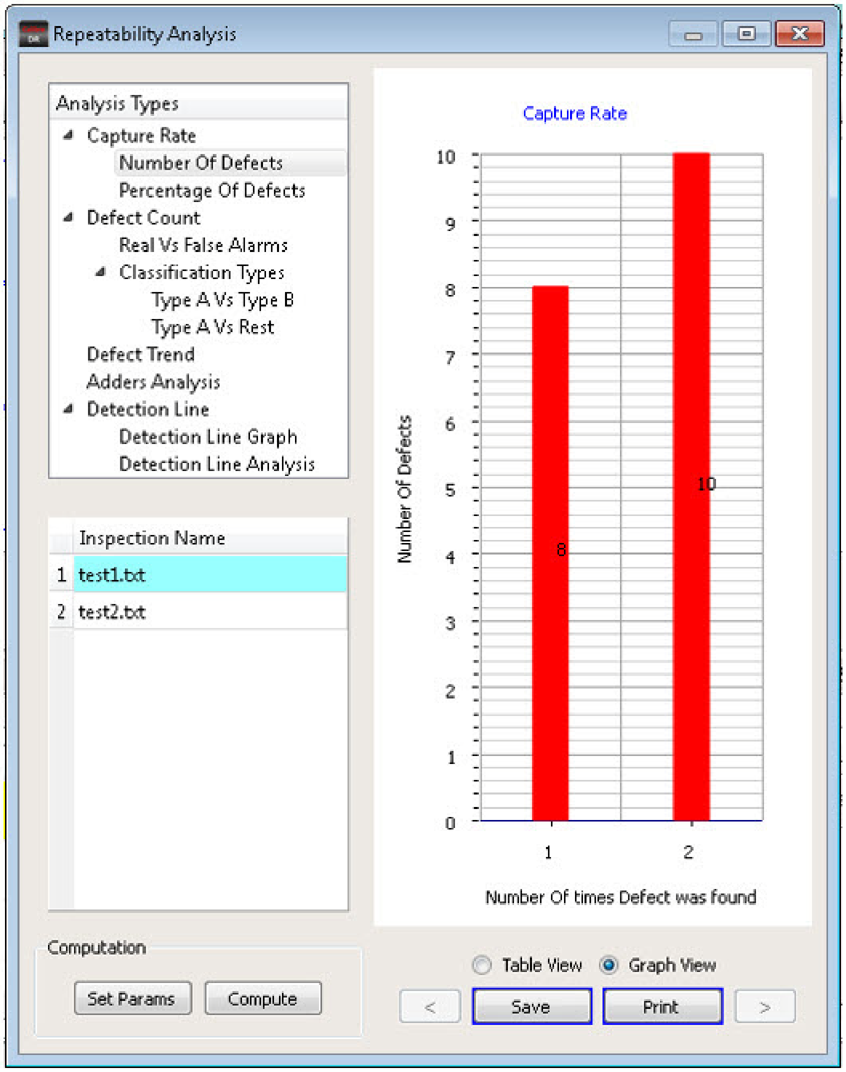
Repeatability Analysis is typically done in the All folder when multiple inspections are opened.

Note

When multiple inspections are loaded, Repeatability Analysis is not enabled in the single inspection folders. It is enabled only when the All folder is selected. However, if only a single file is loaded, then Repeatability Analysis is enabled.

There are a number of functional areas in the Repeatability Analysis window, illustrated in Figure 8-1.

Figure 8-1. Repeatability Analysis Window

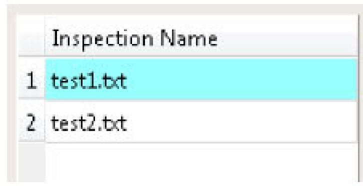


Objects

Table 8-1. Repeatability Analysis Window Fields

Field	Description
Analysis Types	Select different analysis types to perform on an inspection. The various analysis types are displayed as a tree in the Repeatability Analysis window. See “Repeatability Analysis Types” on page 229 for a complete list of types.

Table 8-1. Repeatability Analysis Window Fields (cont.)

Field	Description
Inspection Names	Specify the inspection file(s) and ID number for analysis. When you open multiple inspections, the inspections are referred to by a number or ID instead of the name. The inspection IDs start from 1. The mapping between the ID and the name is given in the mapping list in this area. **Figure 8-2. Mapping Between Inspection IDs and Inspection Names**  **Note:** The reference inspection is highlighted in cyan.
Computation	Set parameters for the analysis, then compute. • **Set Params** — Opens the Parameters dialog box to edit analysis default values. See "Repeatability Analysis Parameters" on page 232 for information. • **Compute** — Computes the data and presents results in the Results area. Computation is automatically performed when the Repeatability Analysis window is invoked. Clicking the **Compute** button is only required for certain circumstances. See "Analysis Results Computation" on page 237 for information.
Results Viewing Area	View results in one of the following forms: • **View Table** — View results as a table. • **View Graph** — View results as a graph. See "Analysis Results Viewing" on page 239 for further information. To view the graphical results of all the inspections for a given analysis, click on the navigation buttons (the arrow buttons) at the bottom of the Results Viewing Area. The navigation buttons are deactivated for table view. The analysis results for all inspections are given in a single table. You can also save table results to a CSV file as well as save and print graphs. See "Save and Print Results" on page 263 for further information.

Repeatability Analysis Types

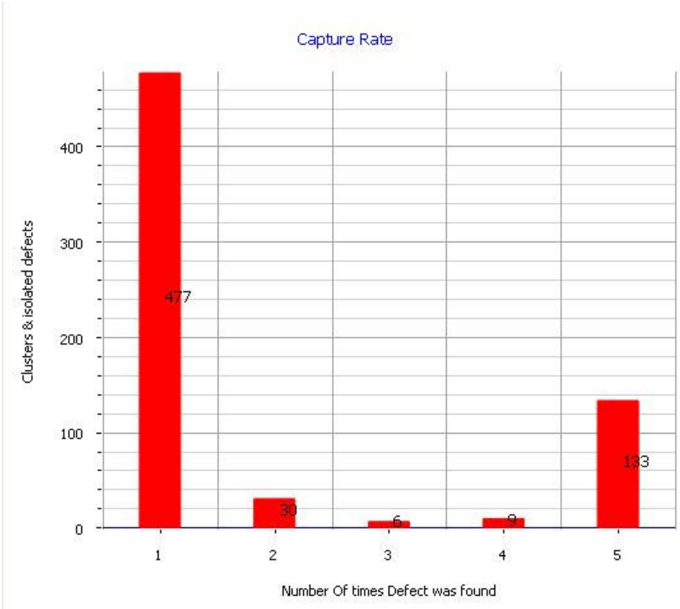
There are a number of different types of analyses that can be performed on an inspection. These types can be selected from the Analysis Types area in the Repeatability Analysis window. When you perform an analysis, the results appear in the Results Viewing Area.

The analysis types which can be performed as part of Repeatability Analysis include the following:

- **Capture Rate** — Collects data on the capture rate of defects in each inspection. This includes the following:
    - **Number Of Defects** — Specifies the number of times a defect is detected across all inspections.

      Figure 8-3 shows an example capture rate plotted on a graph for 5 defect (inspection) files. In this example, 133 defects were found in 5 inspections, 9 defects were found in 4 inspections and so on.

Figure 8-3. Capture Rate Graph



The graph displays the number of clusters and isolated defects that are found in the inspections. If clustering is done, then a cluster is considered as a single defect and is reported accordingly in the graph. If clustering is not done, then only isolated defects are reported. Refer to “Auto Clustering” on page 371 for more details about clustering.

When analyzing the Capture Rate, you can use a method called “blob overlapping” to check which defects from different inspection files overlap each other. There are two methods of blob overlapping supported, StaticBlob and DynamicBlob.

- StaticBlob uses the RA Search Radius (specified in the Calibration Parameter Editor) to check which defects from different inspection files overlap (in other words, which defects are located within the search radius).
- DynamicBlob uses the defect window, the dilation_factor (specified in the *dat-ini.xml* file), and the RA Search Radius for the overlap check of defects.

You can select either the StaticBlob or DynamicBlob overlapping method by configuring the *dat-ini.xml* file as shown in Figure 8-4.

Figure 8-4. Blob Overlapping Method

```
<raInfo>
 <dilation_factor value="0.0" />
 <!-- possible method DynamicBlob,  StaticBlob -->
 <BlobOverlappingMethod method="StaticBlob" />
```

- **Percentage Of Defects** — Specifies the percentage of real versus false alarm defects in each inspection.

- **Defect Count** — Provides a numerical count of defects found in the inspections. This includes the following counts:
    - **Real Vs False Alarms** — Generates a graph of total real defects versus false alarms defects across all inspections.
- **Classification Types** — Provides an analysis of the classification types of defects from the inspections. The total defect count across inspections are compiled in terms of the following:
    - **Type A Vs Type B** — Specifies the total defect count across inspections in terms of the number of defects classified as Type A Vs Type B (for example, defects classified as 1C versus defects classified as 2C).
    - **Type A Vs Rest** — Specifies the total defect count across inspections in terms of the number of defects classified as Type A Vs Rest of the classification types.
- **Defect Trend** — Specifies the number of growing, shrinking, and no-change defects in one inspection with respect to a reference inspection. A defect trend is computed only for defects common to the inspection and the reference inspection. If clustering is done, then a cluster is considered as a single defect and is reported accordingly in the chart. If clustering is not done, then only isolated defects are reported. Refer to “Auto Clustering” on page 371 more details about clustering.
- **Adders Analysis** — Specifies the number of missing, common, and adder defects in one inspection with respect to a reference inspection. If clustering is done, then a cluster is considered as a single defect and is reported accordingly in the chart. If clustering is not done, then only isolated defects are reported. Refer to “Auto Clustering” on page 371 for more details about clustering.

Note

If only a single file is opened in Calibre DefectReview, then Defect Trend and Adders Analysis cannot be performed and are deactivated.

- **Detection Line** — Performs a detection line analysis with the following information:
  - **Detection Line Graph** — The detection line graph shows the bar graph analysis of Must-Catch locations versus inspection defects. For more details on a detection line graph, refer to "Generating a Detection Line Graph" on page 258.
  - **Detection Line Analysis** — The detection line analysis is performed to show the defect detection capability of the mask inspection system on test masks. For more details on Detection Line Analysis, refer to "Detection Lines" on page 242.

Repeatability Analysis Parameters

There are a number of operations relating to setting parameters for Repeatability Analysis supported in Calibre DefectReview.

Setting and Modifying Analysis Parameters

You can set or modify particular parameters for each analysis to be performed on an inspection file. This is done primarily through the Parameters dialog box, accessed by clicking the **Set Params** button in the Computation area of the Repeatability Analysis window.

Prerequisites

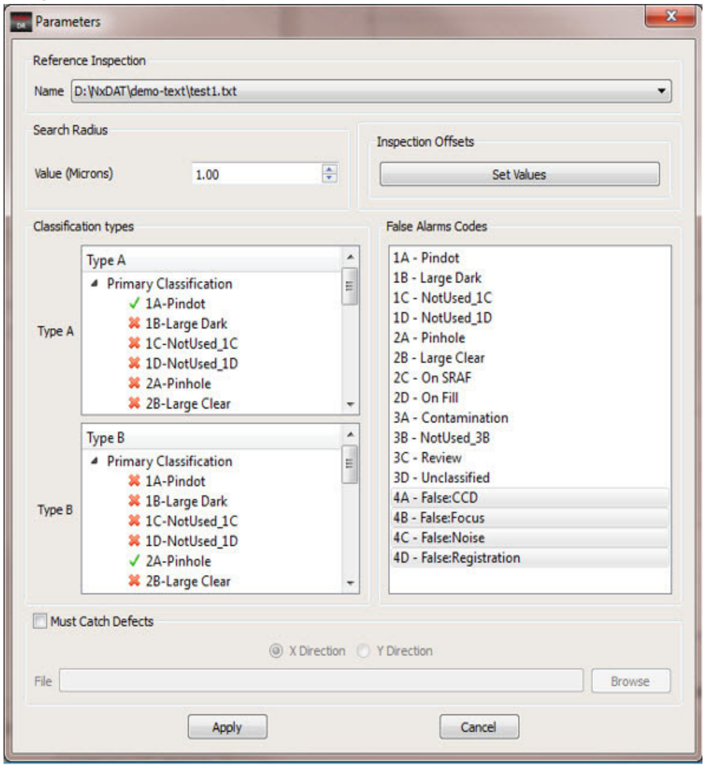
- An inspection file must be loaded into Calibre DefectReview

Procedure

1. In the Computation area of the Repeatability Analysis window, click **Set Params**. The Parameters dialog box appears as shown in Figure 8-5.

   The parameters shown in the dialog box have default values taken from the calibration file. You can modify the default values in the calibration file editor. Refer "Calibration Parameter Modification" on page 367 details.

Figure 8-5. Repeatability Analysis Parameters



2. You can override the default values by modifying them the Parameters dialog box. Table 8-2 lists the different overrides that can be performed in the Parameters dialog box.

Table 8-2. Default Value Overrides in the Parameters Dialog Box

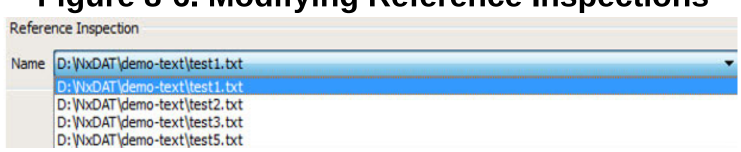
Override	Description
Reference Inspection	By default, the first inspection is set as the reference inspection. To select a different reference inspection, choose from the combo box in the Reference Inspection pane. **Figure 8-6. Modifying Reference Inspections** 

Table 8-2. Default Value Overrides in the Parameters Dialog Box (cont.)

<table>
<tr><th>Override</th><th>Description</th></tr>
<tr><td>Search Radius</td><td>The search radius parameter is used for the following analysis types:
Capture Rate
Defect Trend
Adder Analysis
Detection Line
The search radius parameter is used to determine whether a defect of the reference inspection is located in other inspections within the specified radius.

To modify the search radius, type or select the value in the Value (Microns) field in Search Radius pane. The value is in units configured in the dat-ini.xml file. For more details on configuring units, refer to “Unit of Measurement Configuration” on page 125.</td></tr>
<tr><td>False Alarm Codes</td><td>The False Alarm codes are required for defect count analysis result of Real Vs False Alarms.

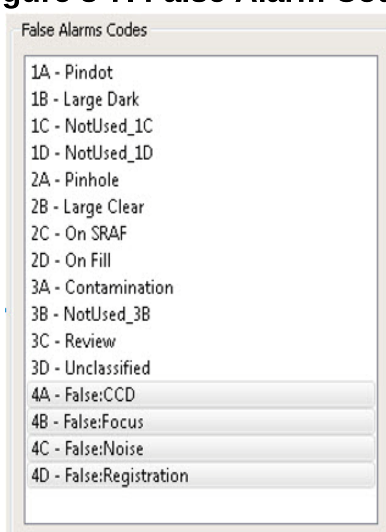
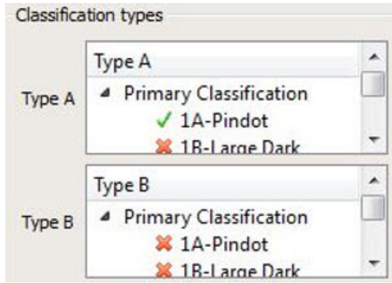
The False Alarm codes are listed in the False Alarm Codes pane. To specify multiple False Alarm codes:
Left click on one classification code
Press the Ctrl key or Shift key with a mouse left click to select the other classification codes.
Press the Ctrl key to select codes from any non-adjacent row.
Press the Shift key to select a set of defects from adjacent rows (click the beginning defect, press Shift and then click the ending defect to select all defects in the adjacent rows).
Figure 8-7. False Alarm Codes

</td></tr>
</table>

Table 8-2. Default Value Overrides in the Parameters Dialog Box (cont.)

Override	Description
Classification Types	Classification types are used to plot the results of a defect count based on classification types. To modify the classification types, select from the Type A and Type B combo boxes. **Figure 8-8. Classification Types** 
Must Catch Defect File	To plot the detection line graph, grid detection should be computed. You can either use the grid detected by the tool using auto grid detection or use the grid obtained by Must Catch Defects file. Refer to "Specifying a Must Catch Defects File" on page 235 for information.
Inspection Offsets	Before computing the Repeatability Analysis results, you can compute the shift in all inspections with respect to the reference inspection. Click the Set Values button in the Inspection Offsets pane to invoke a dialog box. Refer to "Shifting Inspections" on page 236 for information.

3. Click **Apply** to override the default settings.

Specifying a Must Catch Defects File

To plot the detection line graph, you must either use auto grid detection or the grid obtained through a Must Catch Defects file.

The Must Catch Defects file is a CSV file. The file contains three columns; the first column denotes X coordinates, the second specifies Y coordinates, and the third column denotes whether the defect at that location is a Must Catch (1) or not (0). The third column is optional and, by default, all the locations are considered as Must Catch (1).

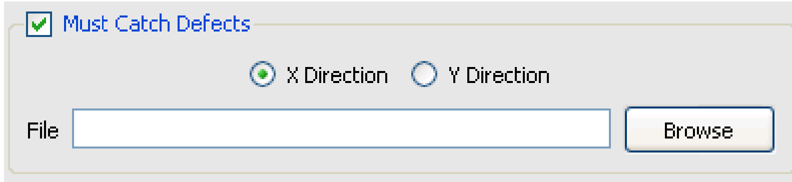
The following is an example Must Catch Defects file:

```
X                   Y              isRealDefect
92355.90            90000.1           0
92120.65            90000
```

Procedure

1. Click the check box of the Must Catch Defects pane to enable the Must Catch Defects file mode.

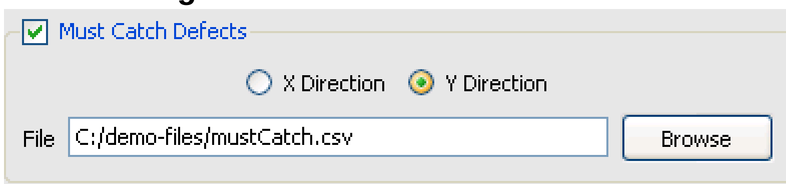
Figure 8-9. Must Catch Defect file



2. To select the direction of the grid, click either the **X Direction** or **Y Direction**.

3. Click **Browse**, select the Must Catch Defects file, and then click **Open**. The file path is displayed in the File pane.

Figure 8-10. Must Catch File Path



Note

"Must Catch Defects", "X Direction" or "Direction", and "File" in the Parameters dialog box are remembered across all Calibre DefectReview sessions.

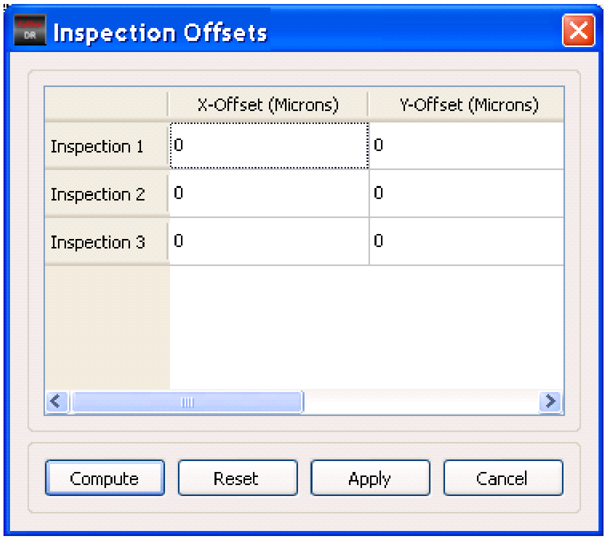
Shifting Inspections

Before computing the Repeatability Analysis results, you can compute the shift in all inspections with respect to the reference inspection.

Procedure

1. Click the **Set Values** button in the Inspection Offsets pane. The Inspection Offsets dialog box appears.

Figure 8-11. Inspection Offsets



2. Click **Compute** to compute the offsets automatically.
3. After the computation is performed, you can edit the values by double-clicking in each of the cells
4. Click **Apply**.

Note

The **Reset** button resets all the values to their defaults (the values displayed before the any changes were made).

5. The automatic offset computation algorithm uses two parameters, step and length. These two parameters can be configured in the *dat-ini.xml* file. To change these parameters edit the following fields:

```
<offsetInfo>
<steps>0.25</steps>
<length>3</length>
<offsetInfo>
```

Analysis Results Computation

When the Calibre DefectReview tool is invoked, a computation for Repeatability Analysis is automatically performed by default.

Re-computation is required under the following circumstances:

- You modify the default parameters in the Parameters dialog box and click **Apply** button.
- If any operation performed in Calibre DefectReview changes the defect database. For example, deletion of defects, classification of defects, and so on.

If a computation is required for new results, the color of the **Compute** button changes to green. If you hover your mouse pointer over the button, the tool tip displays the message “Defect database or parameters have changed. Re-compute Repeatability Analysis.”

To compute the new analysis results, click the **Compute** button.

When all the must catch defects are not within the search radius of the grid defects, then a warning message is issued in a dialog box:

```
Only <num> out of <total_num> must catch defects are used in the detection
line graph.
```

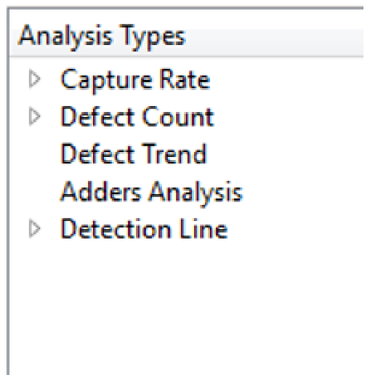
This warning dialog box displays the number of must catch defects caught within the search radius of the grid defects.

Analysis Results Viewing

The Results Viewing Area of the Repeatability Analysis window allows you to view analysis results (based on your selection in the Analysis Types pane) either as a graph or a table.

The various analysis types whose results can be viewed in the Repeatability Analysis window are displayed as a tree. To select an analysis, click on the corresponding tree item. If the analysis type has further sub-analysis types, click the required sub-type.

Figure 8-12. Repeatability Analysis Results



Results are displayed only for the child items. For example, Defect Count results are only displayed on clicking on **Defect Count** > **Classification Types** > **Type A Vs Type B**.

You can navigate through the results by clicking on the arrow buttons on the Repeatability Analysis window. The navigation buttons are deactivated for table view. The analysis results for all inspections are given in a single table.

Viewing the Results in Graphs

You can view analysis results as a graph in the Results Viewing Area.

Procedure

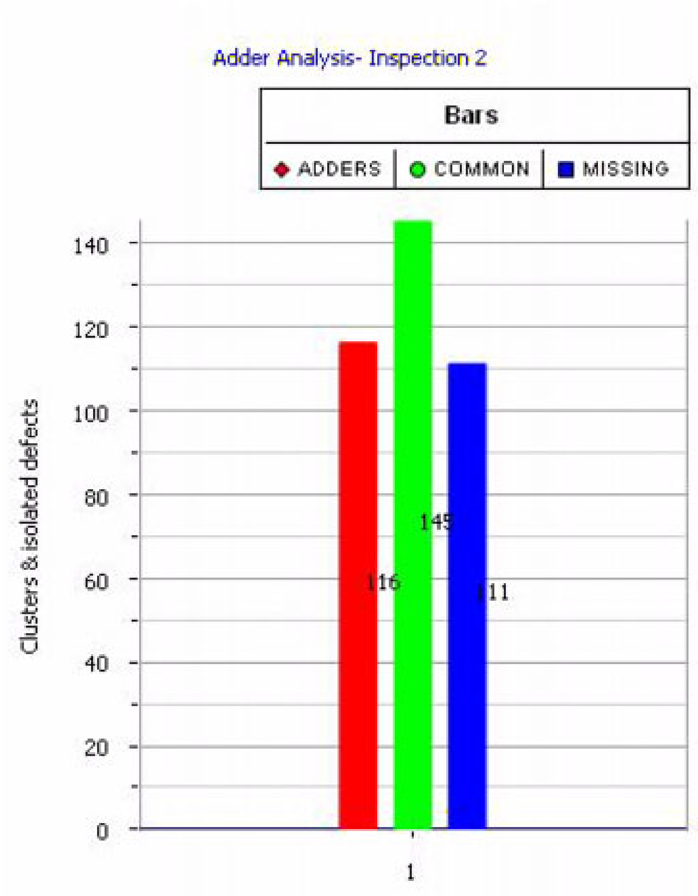
1. Select an analysis type from the Analysis Types pane.
2. Click the **Graph View** radio button in the Results Viewing Area to display the results as a graph.

Figure 8-13. Graph View

Results

A sample result in graph view for an Adders Analysis for one inspection is shown in Figure 8-14. The data value for each histogram is displayed on top of it.

Figure 8-14. Results for Adders Analysis for an Inspection



Viewing the Results in Tables

You can view analysis results as a table in the Results Viewing Area.

Procedure

1. Select an analysis type from the Analysis Types pane.
2. Click the **Table View** radio button in the Results Viewing Area to display the results as a graph.

Figure 8-15. Table View

Results

A sample result in table view for **Defect Count > Real Vs False Alarms** on 4 inspections is shown in Figure 8-16.

Figure 8-16. Results for Defect Count (Real Vs False Alarms) in Table View

	Real	False Alarm
Inspection 1	16	156
Inspection 2	26	149
Inspection 3	11	145
Inspection 4	14	96

Detection Lines

Detection line analysis helps verify the detection capability of a mask inspection system on test masks. Each square (a grid point in the test mask) in the mosaic graph shows the capture rate of a given defect of a particular size. The row in the mosaic represents different defect types and the column represents defect sizes.

Generating a Detection Line Plot

You can generate a detection line plot from the Repeatability Analysis window.

Prerequisites

You have done one of the following:

- Have a Must Catch Defects File specified in the Parameters dialog box
- Run **Utilities > Auto Grid Detection > X-direction** or **Y-direction**. If auto grid detection is not carried out prior to computation, then a warning message is displayed when you click on the detection line analysis item:

  ```
  Results not computed for detection line analysis. Run auto grid
  detection on reference inspection and re-compute.
  ```

If either of these conditions are specified, then you can re-compute to generate detection line results. If both the conditions are satisfied, then a grid defined by the Must Catch Defects file is used for detection line plotting.

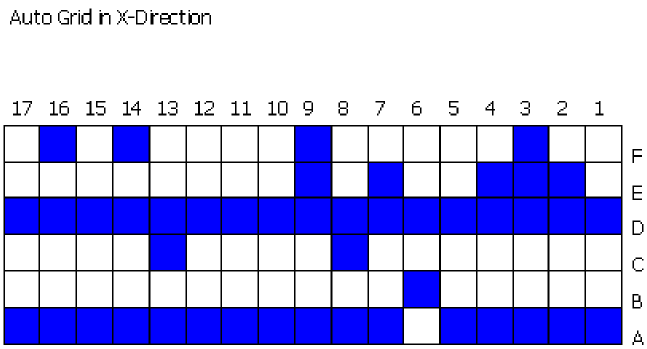
Procedure

1. If either of the detection line conditions are satisfied, click **Compute** to generate the detection line results.
2. To view the results, click the Detection Line analysis type in the Analysis Types area.

Results

If computation is completed and you select the detection line plot, then a graph similar to Figure 8-17 appears.

Figure 8-17. Sample Detection Line Plot



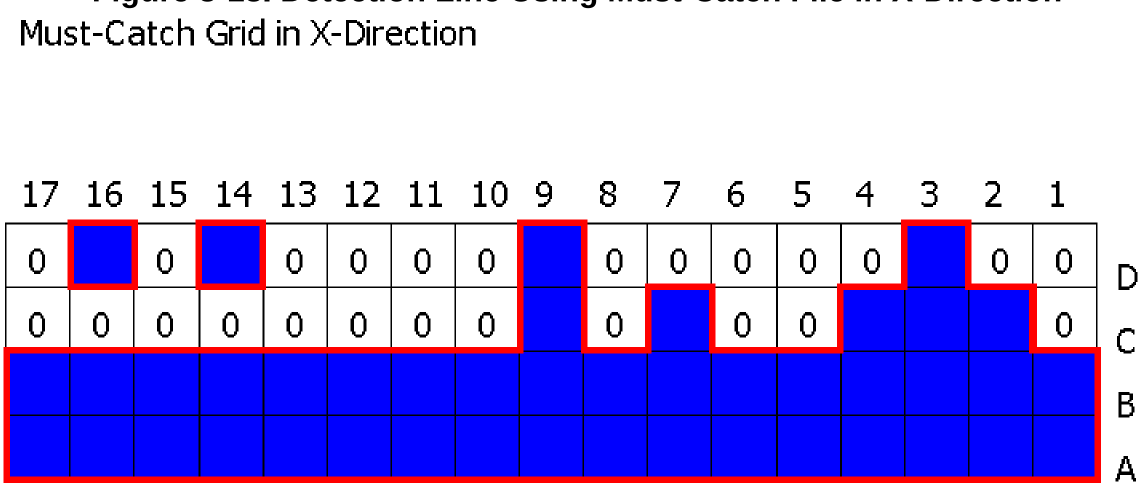
The labels in the plot indicate the following:

- For X direction, the row labels represent defect types (A, B, C and so on) and the column labels represent defect sizes (1, 2, 3 and so on). Above the graph, direction text is displayed.
- For the Y direction, the row labels represent defect sizes and column labels represent defect types.

The capture rate is displayed as a label for each grid defect within the cube represented by a grid defect. If the capture rate is 100%, then it is shown in dark blue color and labeling is not done. The color transparency of other cubes (where the capture rate is other than 100%), reflects the capture rate value (100% dark blue, 50% light blue, 20 % lighter blue, and so on).

If the detection line is computed using a Must Catch Defects file in the X-direction, then “Must-Catch Grid in X-Direction” is displayed above the graph as shown in Figure 8-18.

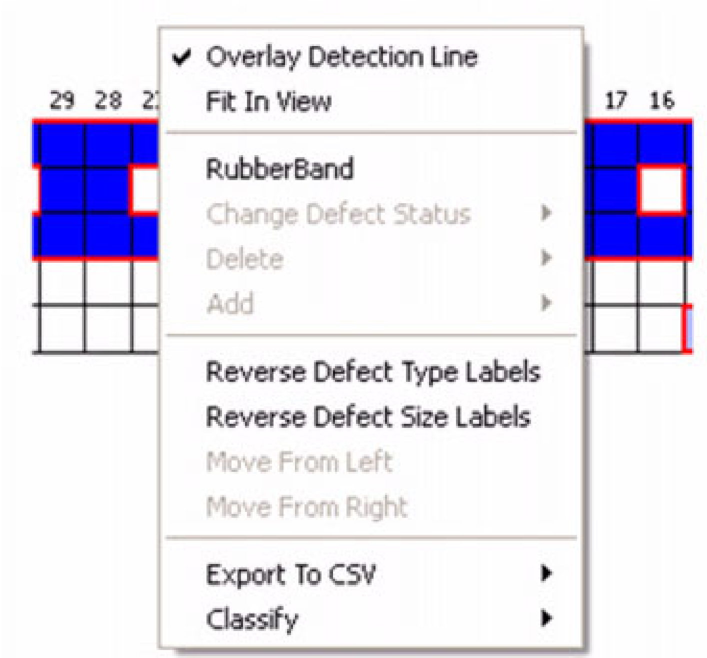
Figure 8-18. Detection Line Using Must-Catch File in X-Direction



Note

If you right-click outside the Detection Line plot, options such as Change Defect Status, Delete, Add, Move From Left/Right in X-Direction and Move From Top/Bottom in Y-Direction are deactivated as shown in Figure 8-19.

Figure 8-19. Deactivated Options Outside the Detection Line Matrix



Overlaying the Line of Detection

Overlaying a detection line helps in distinguishing Real defects from Non-Real defects shown in the grid. Non-Real defects are not enclosed by the overlaid detection line.

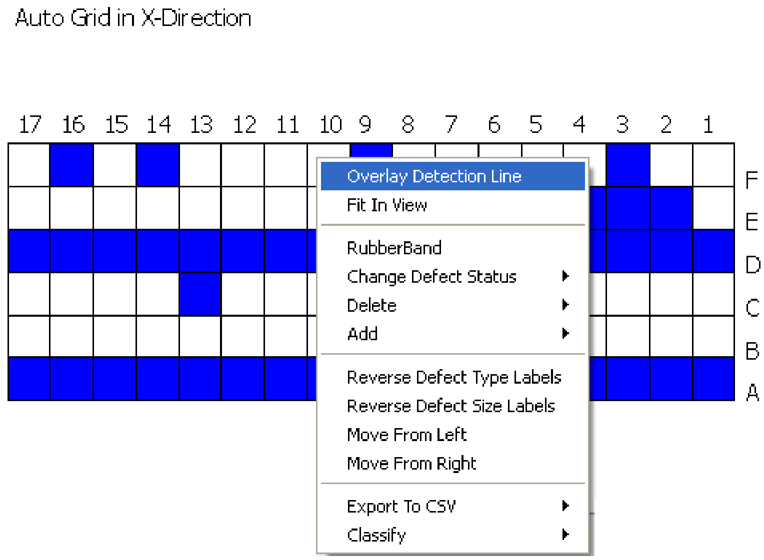
Prerequisites

- A detection line graph should be generated as described in "Generating a Detection Line Plot" on page 242.

Procedure

1. Right-click in the detection line graph. A menu appears.

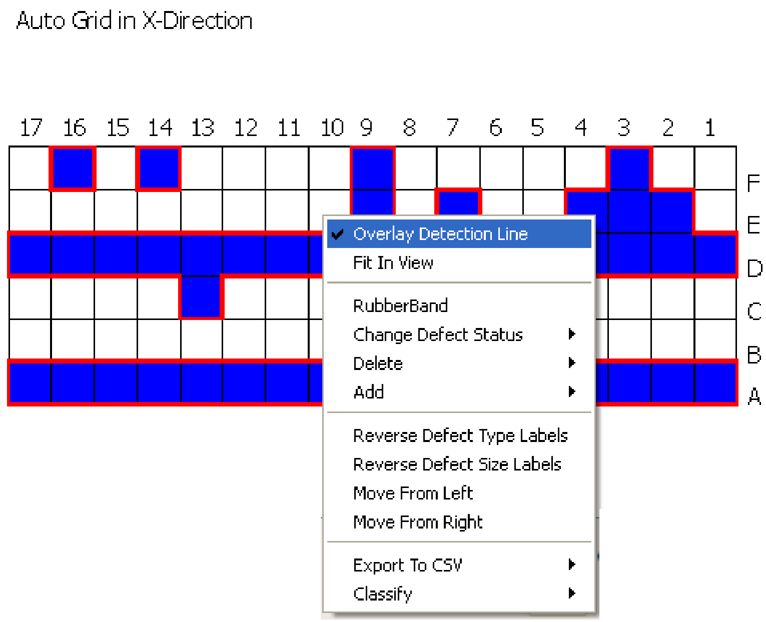
Figure 8-20. Right-Click Menu Items for Detection Line Graph



2. Click **Overlay Detection Line**. The line of detection is computed from the grid detected on the reference inspection or from the must catch defects file.

3. The detection line is overlaid in red. The option is shown as checked in the menu as shown in Figure 8-21.

Figure 8-21. Overlay Detection Line



4. To hide the overlay, click the checked **Overlay Detection Line**.

Reversing Labels

You can reverse the order of defect type labels or defect size labels on detection line graph.

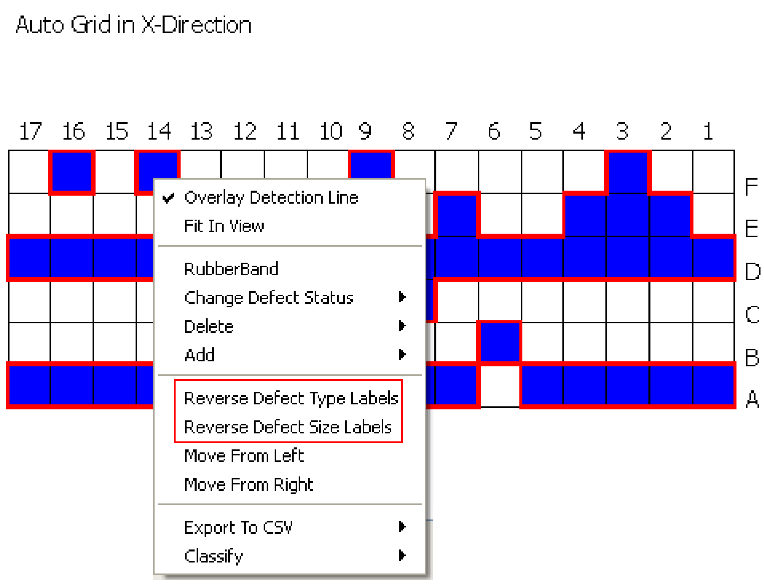
Prerequisites

- A detection line graph should be generated as described in "Generating a Detection Line Plot" on page 242.

Procedure

1. Right-click in the detection line graph. A menu appears.

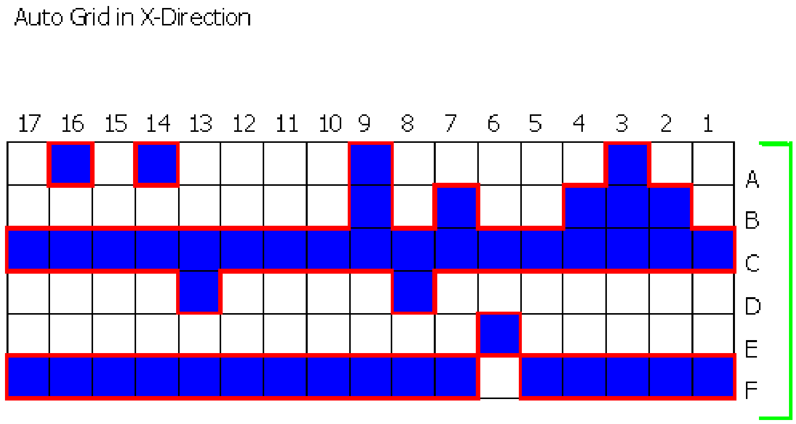
Figure 8-22. Reverse Labels



2. Click one of the following options:

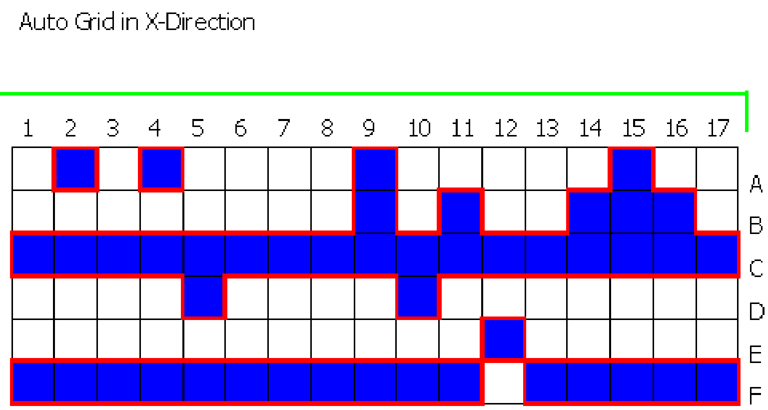
    - **Reverse Defect Type Labels** — the defect type labels are reversed as shown in the following figure:

Figure 8-23. Reverse Defect Type Labels



    - **Reverse Defect Size Labels** — the defect size labels are reversed as shown in the following figure:

Figure 8-24. Reverse Defect Size Labels



Moving the Detection Line

You can move the detection line in the right or left direction as well as top to bottom.

Prerequisites

- A detection line graph should be generated as described in "Generating a Detection Line Plot" on page 242.

Procedure

1. To move the detection line from left to right:

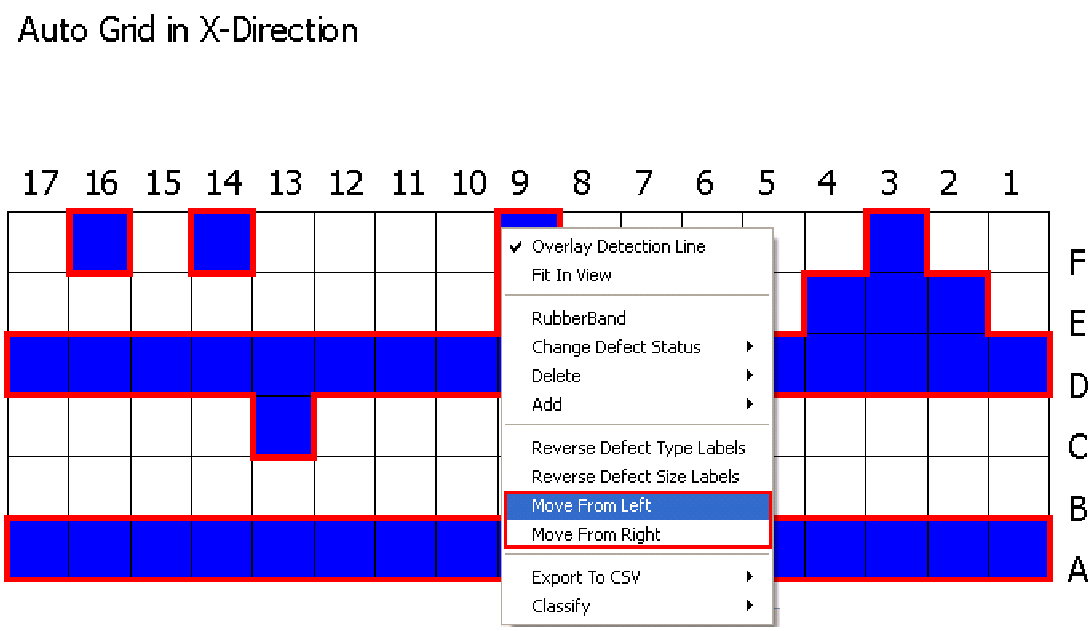
    a. Detect the grid in the X-direction and right-click on the detection line graph. A menu appears.

    b. To move detection line from left-most position, select **Move From Left** from the menu.

    a. To move detection line from right-most position, select **Move From Right** from the menu.

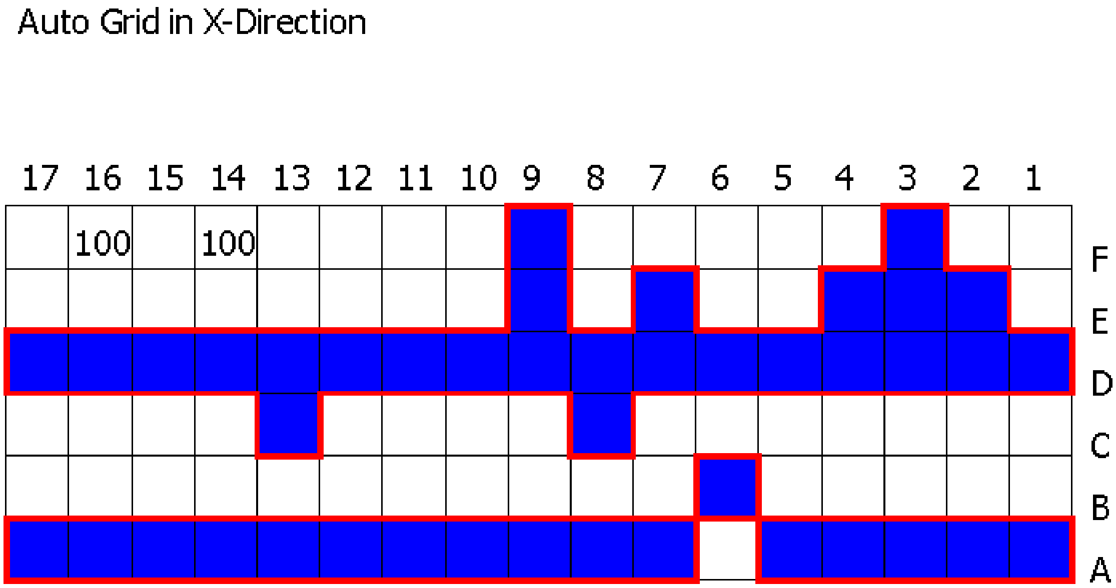
    Figure 8-25 shows an example of **Move From Left** on a detection line graph.

Figure 8-25. Move Detection Line Horizontally



After moving the detection line from the left to the current mouse pointer position, a detection line is displayed as shown in Figure 8-26.

Figure 8-26. Results After Moving Detection Line from Left



b. If the left detection line crosses the right detection line, then a message box is displayed:

```
Left Detection Line crosses Right.
Do you wish to continue changing status?
```

a. If you click **OK** in the message box, the status of the real defects on the left of the selected defect changes to non-real defects. If you click **Cancel**, there will be no change.

2. To move the detection line from top to bottom:

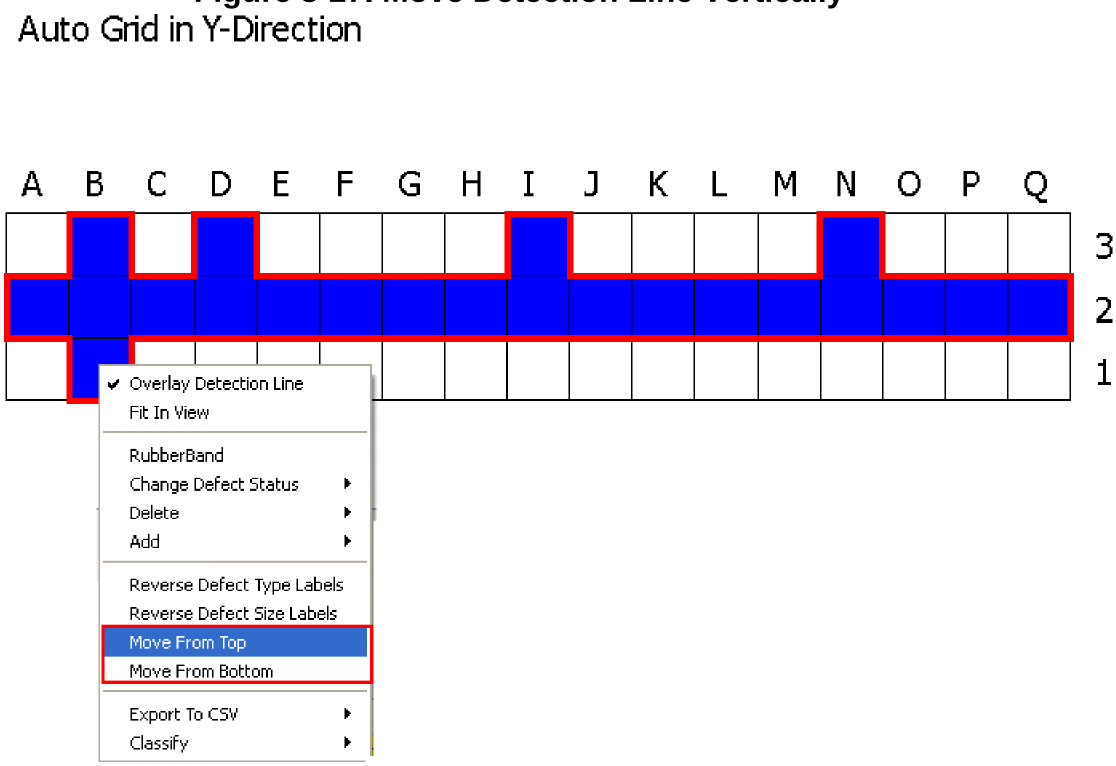
   a. Detect the grid in the Y-direction and right-click on the detection line graph. A menu appears.

   a. To move detection line from the top position, select **Move From Top** from the menu.

   a. To move detection line from bottom position, select **Move From Bottom** from the menu.

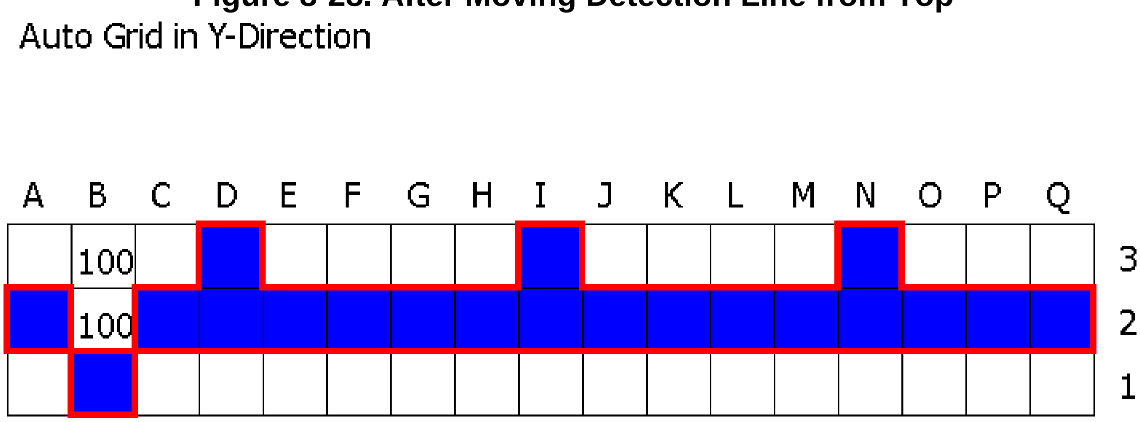
   Figure 8-27 shows an example of **Move From Top** on a detection line graph.

Figure 8-27. Move Detection Line Vertically



After moving the detection line from the top to the current mouse pointer position, a detection line is displayed as shown in Figure 8-28.

Figure 8-28. After Moving Detection Line from Top



a. If the top detection line crosses the bottom detection line, then a message box is displayed:

```
Top Detection Line crosses Bottom.
Do you wish to continue changing status?
```

a. If you click **OK** in the message box, the status of the real defects above the selected defect changes to non-real defects. If the you click **Cancel**, there will be no change.

Exporting a Grid

You can export a detection line grid to a CSV file.

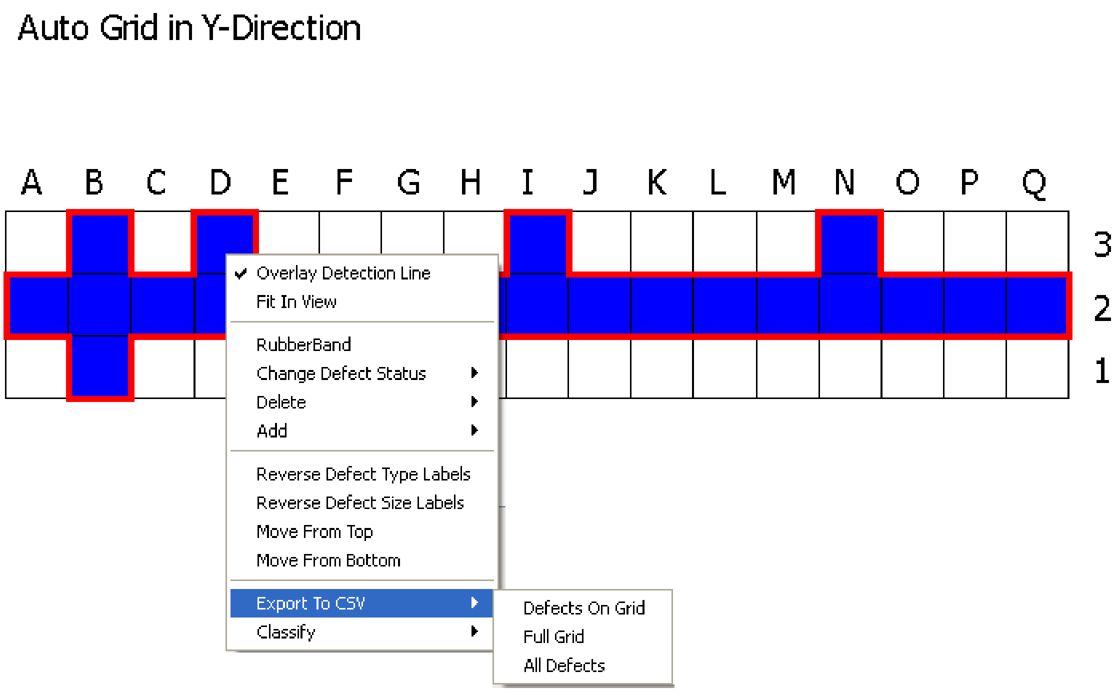
Prerequisites

- A detection line graph should be generated as described in “Generating a Detection Line Plot” on page 242.

Procedure

1. Right-click on the detection line graph. A menu appears.
2. Select **Export to CSV** from the menu. There are three different sub-options available:

Figure 8-29. Export Grid as CSV File



- **Defects on Grid** — Exports only the grid locations where defects are present. In the example shown in Figure 8-29, all the locations colored in blue on the grid are exported.
- **Full Grid** — Exports only real and non-real defects into a CSV file. This will not export deleted cells to a CSV file.
- **All Defects** — Exports all defects currently open in the Calibre DefectReview session to a CSV file.

Displaying RubberBand Selection

RubberBand mode allows selection of defects using mouse and performing editing operations on the selected defects or locations. You can highlight which defects are selected using RubberBand mode.

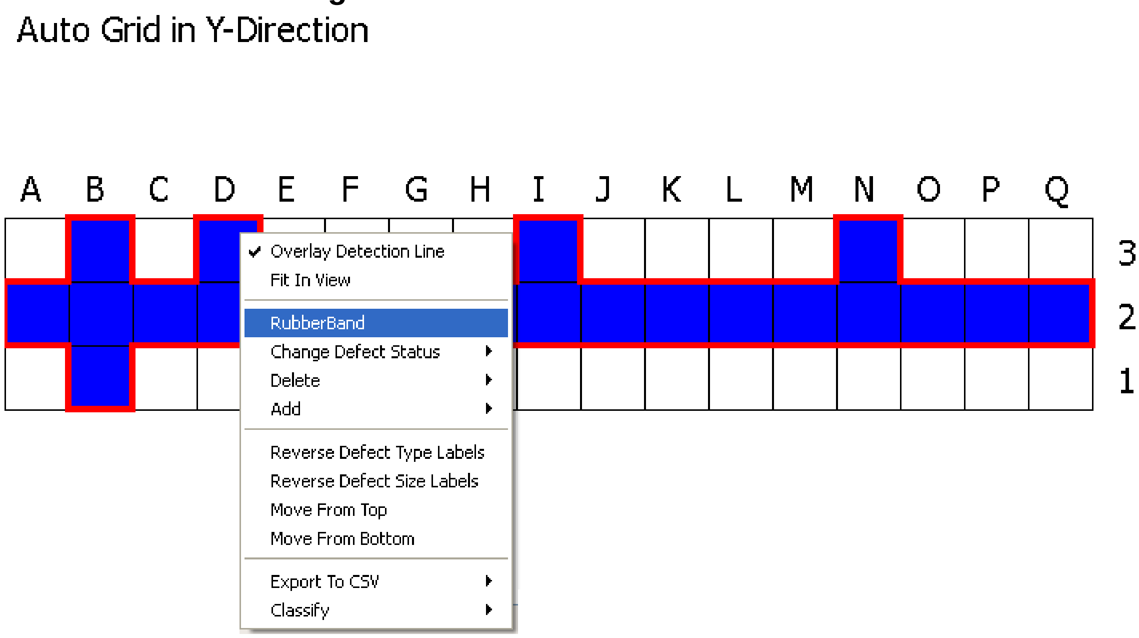
Prerequisites

- A detection line graph must be generated as described in "Generating a Detection Line Plot" on page 242.

Procedure

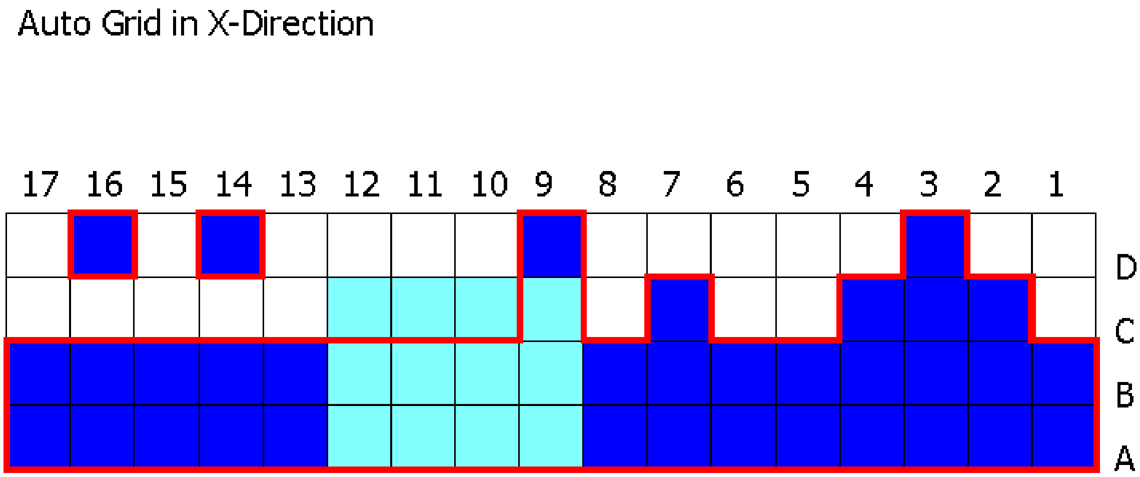
1. Right-click on the detection line graph. A menu appears.
2. Select **RubberBand** from the menu.

Figure 8-30. RubberBand Selection



3. Defects or locations selected using RubberBand appears highlighted as shown in the Figure 8-31.

Figure 8-31. Defects Selected Using RubberBand



Note

Defects can have highlighting removed by unchecking the RubberBand Selection menu item.

Deleting a Defect from the Grid

You can delete defects from the grid by selecting Delete from the right-click menu in a detection line graph.

Prerequisites

- A detection line graph should be generated as described in “Generating a Detection Line Plot” on page 242.

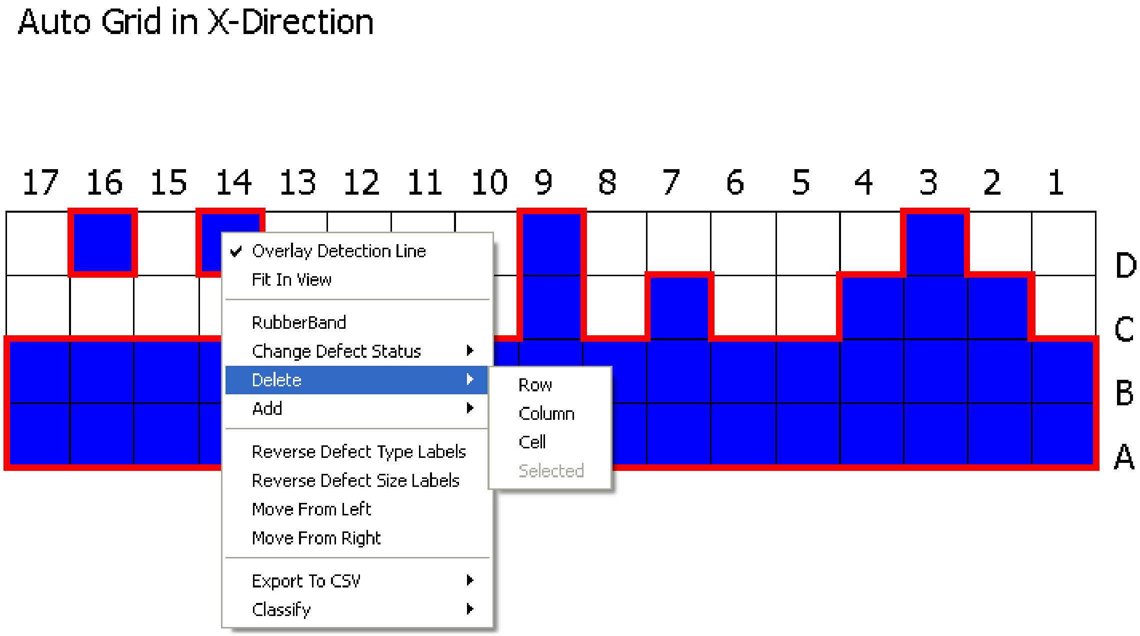
Procedure

1. Right-click on the detection line graph. A menu appears.
2. Select **Delete** from the menu. There are four different sub-options available: Row, Column, Cell, and Selected. The Selected option deletes selected defects from grid point.

Note

If the RubberBand mode is enabled, then the Selected option is enabled and Row, Column, Cell options are deactivated.

Figure 8-32. Delete Options



3. If the **Must Catch Defects** option is not specified in the Parameters dialog box (refer to "Specifying a Must Catch Defects File" on page 235 for details), the defects are also deleted from grid points in the Defect Map.

4. If the **Must Catch Defects** option is specified, grid detection is automatically performed after the deletion.

Changing Defect Status

You can change the defect status from a detection line graph.

Prerequisites

- A detection line graph should be generated as described in "Generating a Detection Line Plot" on page 242.

Procedure

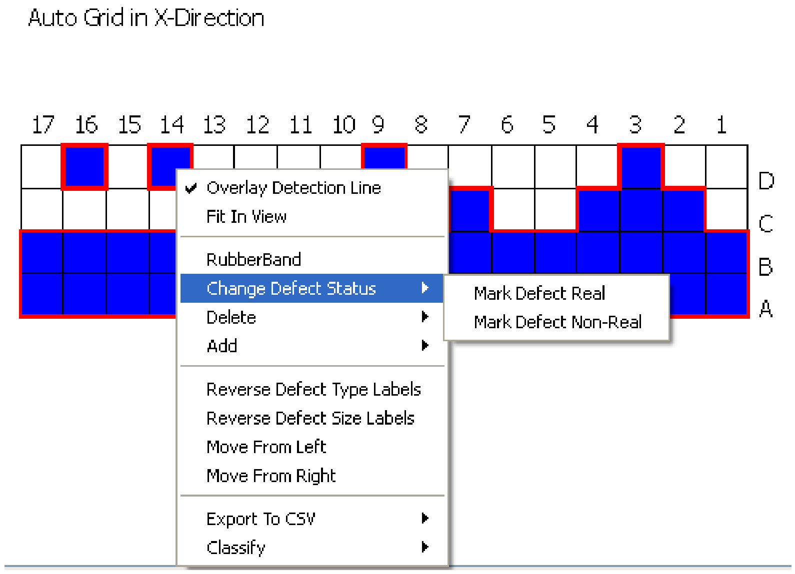
1. Right-click on the detection line graph. A menu appears.

2. Select **Change Defect Status** from the menu. This option is available only if the **Must Catch Defects** option is also checked in the Parameters dialog box (refer to section "Specifying a Must Catch Defects File" on page 235 for details). There are two different sub-options available:

   - **Mark Defect Real** — Marks status as a real defect.

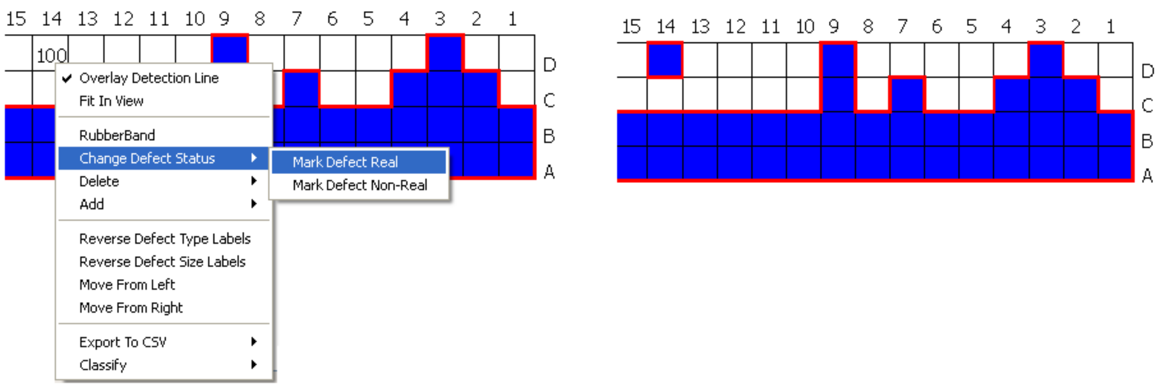
   - **Mark Defect Non-Real** — Marks status as a non-real defect.

Figure 8-33. Change Defect Status



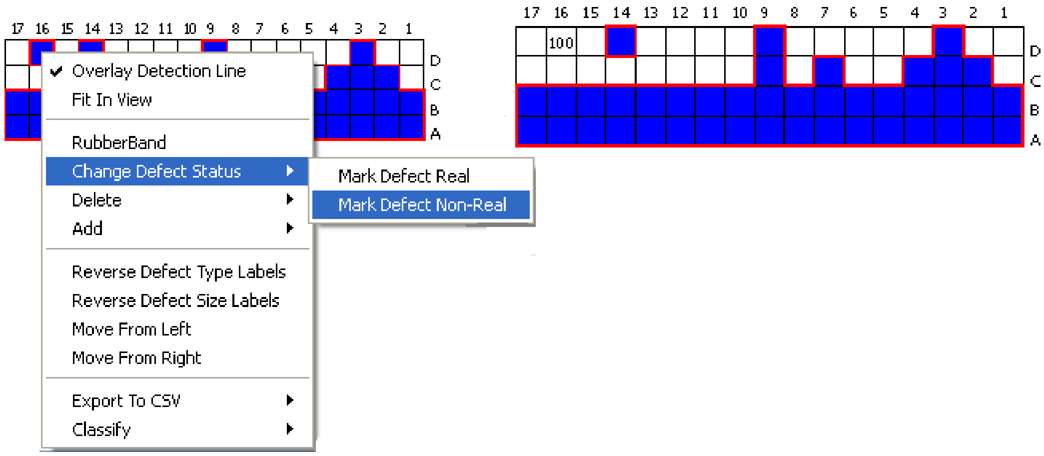
3. Figure 8-34 shows an example of changing a defect's status from non-real to real.

Figure 8-34. Defect Status Changed from Non-Real to Real



4. Figure 8-34 shows an example of changing a defect's status from real to non-real.

Figure 8-35. Defect Status Changed from Real to Non-Real



Note

If RubberBand mode is active, the Defect Status of selected defects can be changed from Real to Non-Real as well as from Real to Non-Real.

Using Zoom on a Detection Line Graph

Use the mouse to zoom in or zoom out to specific regions of the detection line graph.

Prerequisites

- A detection line graph should be generated as described in “Generating a Detection Line Plot” on page 242.

Procedure

1. Perform one of the following zoom operations:

   Zoom In: Left-click on the top-left or right corner of the desired area of zoom.

   a. Drag the mouse to select the area of zoom.

   b. Release the mouse at the bottom right or left corner of desired area of zoom.

   Zoom Out: Left-click on the bottom-right or left corner of the desired area of zoom.

   a. Drag the mouse to select the area of zoom.

   b. Release the mouse at the top left or right corner of desired area of zoom

2. Once you apply the zoom, to fit the entire graph in your viewer, select **Fit In View** in the right-click menu of the detection line graph.

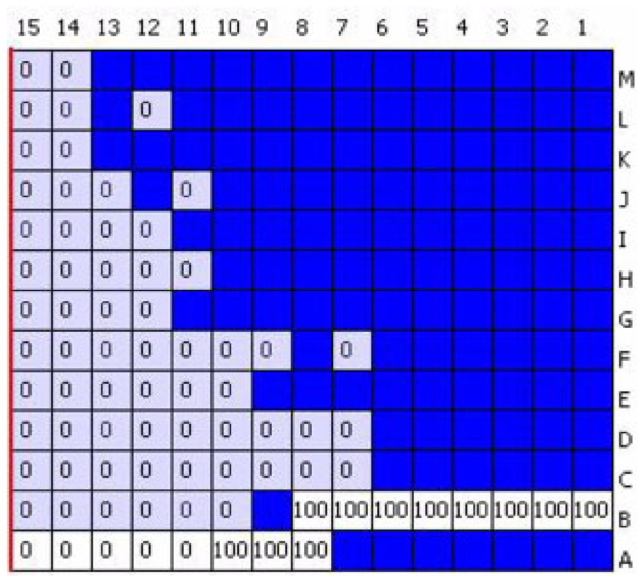
Must Catch Defects File and Capture Rate

You can use a Must Catch Defects file to find the capture rate.

Refer to “Specifying a Must Catch Defects File” on page 235 for details on specifying a Must Catch Defects file.

When a Must Catch Defects file is specified, a complete grid is computed using the must catch defect locations.

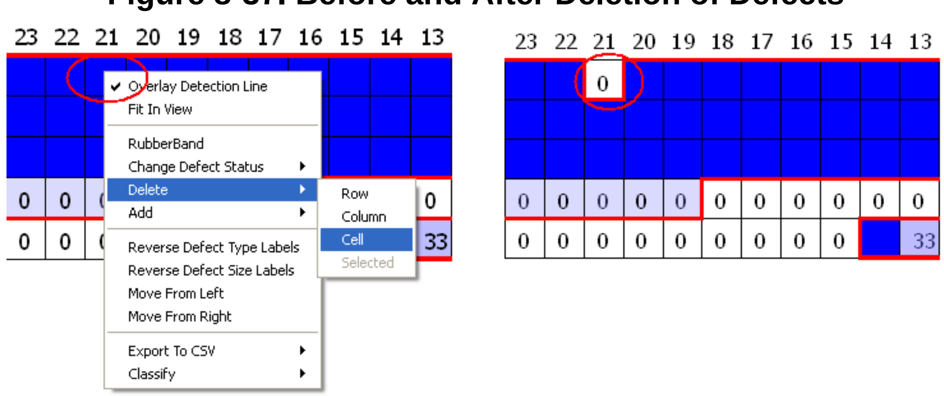
Figure 8-36. Detection Line Using a Must Catch Defects File



In the bottom two rows of this example graph, the cells with white background are the dummy grid cells added for forming a complete grid using the Must Catch Defects file.

Locations in the Must Catch file can be deleted using the **Delete** option in the right click menu of the detection line graph. You can delete a row, a column, or a cell. The defects after deletion are shown with a zero capture rate as illustrated in Figure 8-37.

Figure 8-37. Before and After Deletion of Defects



Generating a Detection Line Graph

For a detection line graph, the analysis uses the Must Catch file as reference inspection and the results are shown in a bar chart with four bars.

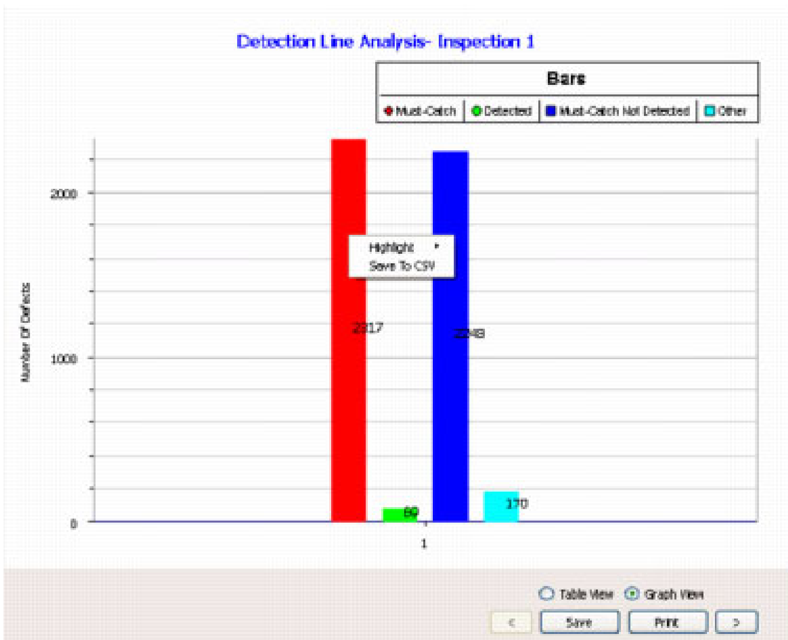
Prerequisites

- A Must Catch Defects file must be specified in the Parameters dialog box. Refer to "Specifying a Must Catch Defects File" on page 235 for details.

Procedure

1. Select **Detection Line** > **Detection Line Graph** in the Analysis Types area. A bar chart is generated as shown in Figure 8-38.

Figure 8-38. Detection Line Bar Chart



The graph bars represent the following in order of appearance:

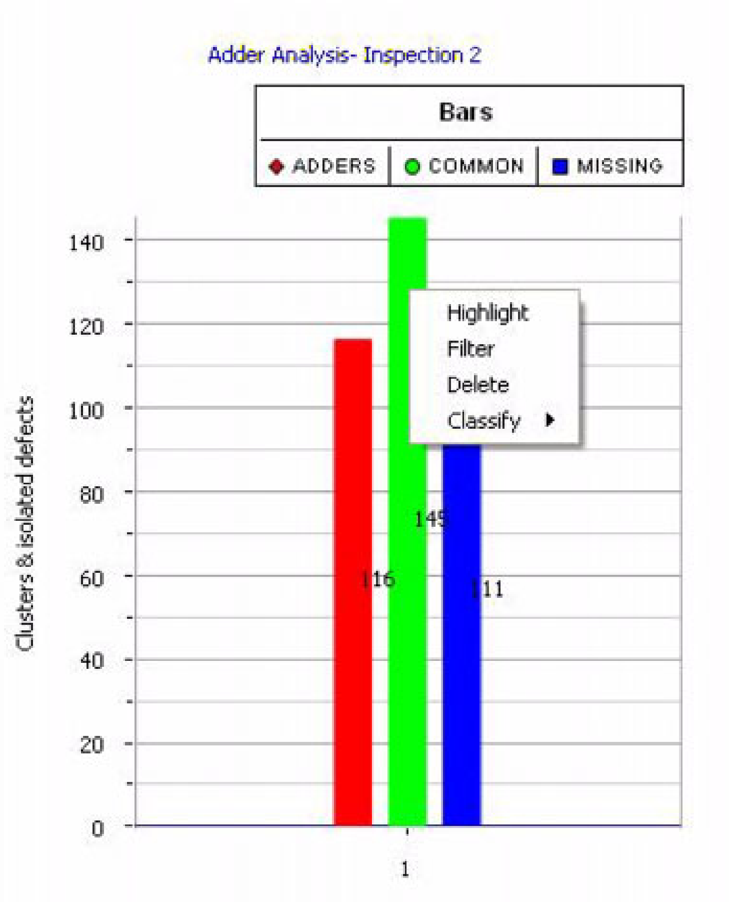
- **Must-Catch** — Represents all defect locations that are present in the Must Catch Defects file.
- **Detected** — Represents the detected defects in the current inspection with respect to the Must Catch Defects file.
- **Must-Catch Not Detected** — Represents the must Catch defect locations that are not detected in current inspection.
- **Other** — Represents other defects in the current inspection that are not in the grid.

2. The detection line graph is computed for all open inspections and can be navigated to using the arrow buttons at the bottom of the Results Viewing Area.

3. You can different perform operations from a right-click menu on the detection line graph, depending on the type of defect.

   The results are displayed as bar charts. You can apply various operations on the defects represented in a given bar of bar charts. To apply the operations, right click on any bar and select from the menu that appears.

Figure 8-39. Example Operations on Bar Charts



   The options that appear in the menu depend on the defect type.

   For Must-Catch and Must-Catch Not Detected defects:

Table 8-3. Options for Must-Catch and Must-Catch Not Detected

Option	Description
Highlight	Highlights the defects falling in a bar. In the Defect Map, the defects are highlighted in cyan color, and in the Defect List, they are highlighted in yellow color. The user can highlight defects of multiple bars at the same time
Save to CSV	Save Must-Catch Defect locations to a CSV file.

For Detected and Other defects:

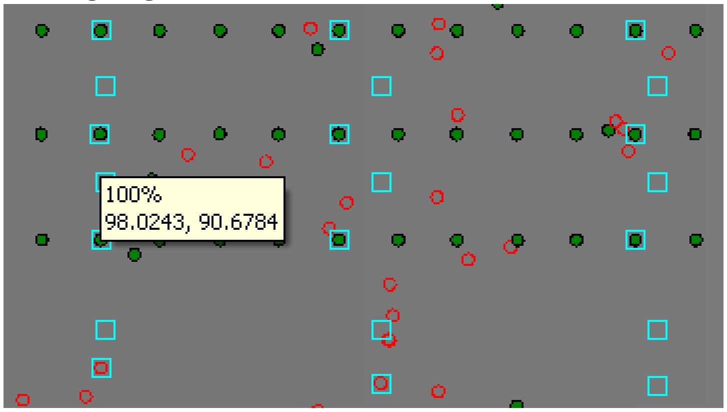
Table 8-4. Options for Detected and Other

Option	Description
Highlight	Highlights the defects falling in a bar. In the Defect Map, the defects are highlighted in cyan, and in the Defect List, they are highlighted in yellow. You can highlight defects for multiple bars at the same time. To undo the highlight: 1. Re-click the Highlight option. 2. Click on any defect in Defect Map. 3. Click on any defect in Defect List.
Filter	Filters defects on the bar. Once the option is clicked, the selected defects are filtered out.
Delete	Deletes Must-Catch defects.Whenever you delete Must-Catch defects from Defect Map, the **Compute** button changes to green, indicating that you must re-compute. You can delete any number of Must-Catch defects at a time and changes can be seen once the Repeatability Analysis is computed.
Classify	Applies a classification to defects from an extended sub-menu. **Note:** In the All folder, this option is deactivated if you load different types of inspection files (for example, text files and CSV files) at the same time.

Results

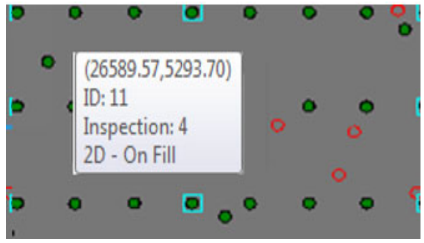
Must-Catch and Must-Catch Not Detected are highlighted as squares in the selected color and have the capture rate and coordinates displayed in a tool tip in the Defect Map.

Figure 8-40. Highlighted Must-Catch and Must-Catch Not Detected



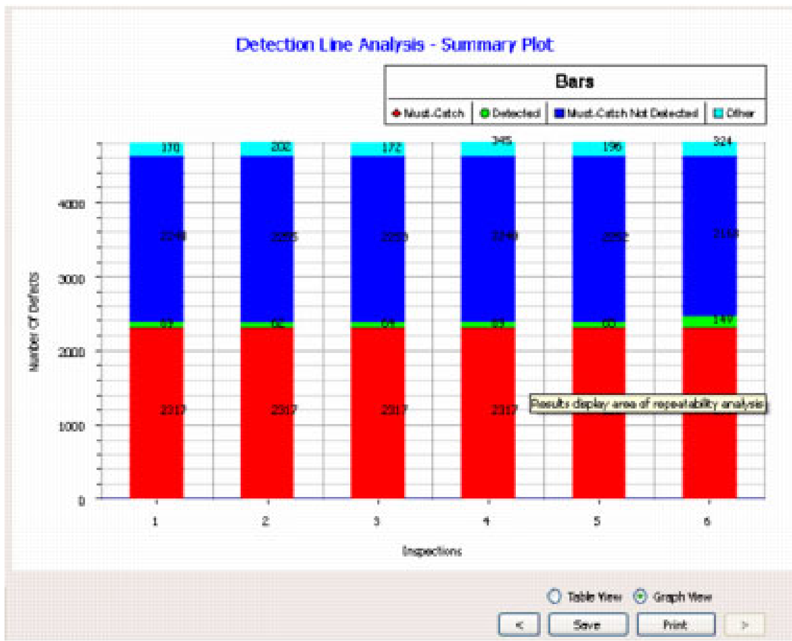
Detected and Other defects are highlighted using circles in the selected color in the Defect Map.

Figure 8-41. Highlighted Detected and Other



You can view a Summary Plot for all the inspections using the next navigate button (the right arrow button at the bottom of the graph. A summary plot is shown in Figure 8-42.

Figure 8-42. Detection Line Graph Summary Plot

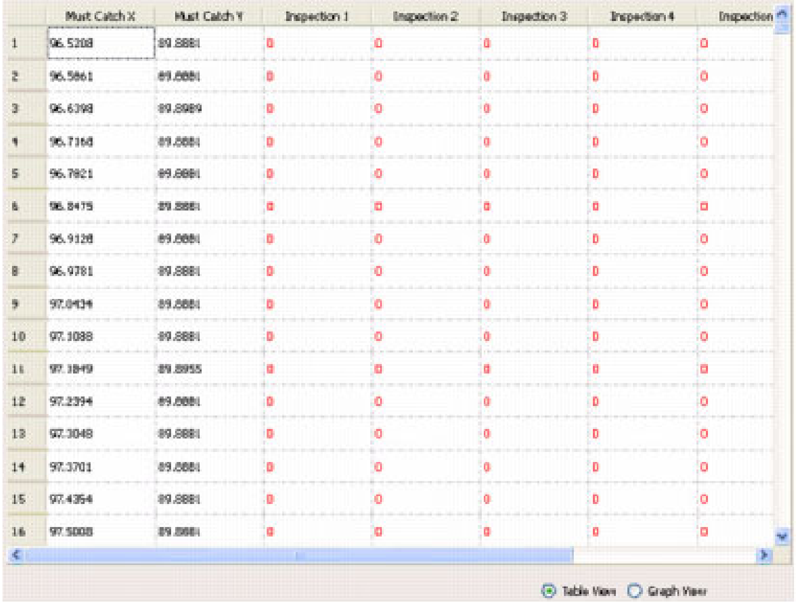


The Summary Plot summarizes the Must-Catch Defects versus Inspection Defects for all the open inspections.

- The first bar displays the number of Must Catch, Detected, Must Catch Not Detected and Other defects for the first inspection.
- The second bar displays the number of Must Catch, Detected, Must Catch Not Detected and Other defects for the second inspection and so on.

You can display a table view of the Detection Line Graph. The table view provides detailed information about Must-Catch locations as shown in Figure 8-43.

Figure 8-43. Table View of Detection Line Bar Graph



	Must Catch X	Must Catch Y	Inspection 1	Inspection 2	Inspection 3	Inspection 4	Inspection
1	96.5208	89.8881	0	0	0	0	0
2	96.5861	89.8881	0	0	0	0	0
3	96.6398	89.8989	0	0	0	0	0
4	96.7168	89.8881	0	0	0	0	0
5	96.7821	89.8881	0	0	0	0	0
6	96.8475	89.8881	0	0	0	0	0
7	96.9128	89.8881	0	0	0	0	0
8	96.9781	89.8881	0	0	0	0	0
9	97.0434	89.8881	0	0	0	0	0
10	97.1088	89.8881	0	0	0	0	0
11	97.1849	89.8955	0	0	0	0	0
12	97.2394	89.8881	0	0	0	0	0
13	97.3048	89.8881	0	0	0	0	0
14	97.3701	89.8881	0	0	0	0	0
15	97.4354	89.8881	0	0	0	0	0
16	97.5008	89.8881	0	0	0	0	0

In this table, the columns labelled “Must Catch X” and “Must Catch Y” indicate X and Y locations in the Must Catch Defects file. In the inspections column, a value of 1 in blue color indicates that the location is captured in a particular inspection and a value of 0 in red color indicates that the location is not captured.

You can save the results by selecting the Save or Save All options from the right-click menu. For more details, refer to “Saving Tables” on page 263.

Save and Print Results

You can save and print the table(s) and graph of an analysis result in the Repeatability Analysis window.

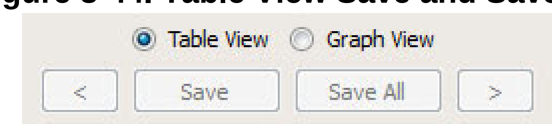
Saving Tables

You can save the table(s) of a single analysis or all analysis results into a CSV file.

Procedure

1. Select the analysis type in the Analysis Types area that you want to save results.
2. Click **Table View**.
3. Click **Save** (to save a single analysis table) or **Save All** (to save all analysis tables). A File dialog box appears.

Figure 8-44. Table View Save and Save All



4. Enter the name of the file and click **Save**.

Results

The following is an example file in CSV format for a sample defect trend analysis.

Table 8-5. CSV Output Example

Id	Inspection name		
1	test_4.txt		
2	test_1.txt		
3	test_2.txt		
4	test_3.txt		
Defect Trend			
	GROWING	SHRINKING	NO CHANGE
Inspection 2	7	6	153
Inspection 3	22	77	29

Table 8-5. CSV Output Example (cont.)

Inspection 4	19	47	18

Note

The results contain the inspection ID and name mapping in addition to data values.

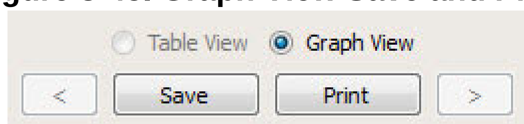
Saving and Printing Graphs

You can save or print the graph of an analysis result into an image file in PNG format.

Procedure

1. **Saving a Graph:** Click the **Graph View** button.

Figure 8-45. Graph View Save and Print



2. Click **Save**. A File dialog box appears.
3. Enter the name of the file and click **Save**.
4. **Printing a Graph:** Click the **Graph View** button.
5. Click **Print** to print a graph.

Automatic Loading of Reference Inspections

You can automatically load reference inspections by configuring data in the *dat-ini.xml* file.

To load the reference inspection automatically or not, set the autoLoad attribute to yes or no in the *dat-ini.xml* file as shown in the following example:

```
<ReferenceDirPath path="C:\inspections\reference" autoLoad="no" />
```

The Reference directory path can be set using the ReferenceDirPath node in the *dat-ini.xml* file. The value of the path attribute is treated as the dedicated folder for reference inspection files. When autoLoad is yes, the reference inspection file is automatically loaded when a new inspection file of the same mask is opened. Calibre DefectReview searches for a file with the prefix **.barcode_MASKNAME*.txt* in the reference folder path for the respective reference inspection file.

Chapter 9
Image Measurement

The Image Measurement Unit (IMU) window displays defect images and provides tools to perform image processing operations on these images.

The Image Measurement Unit Window

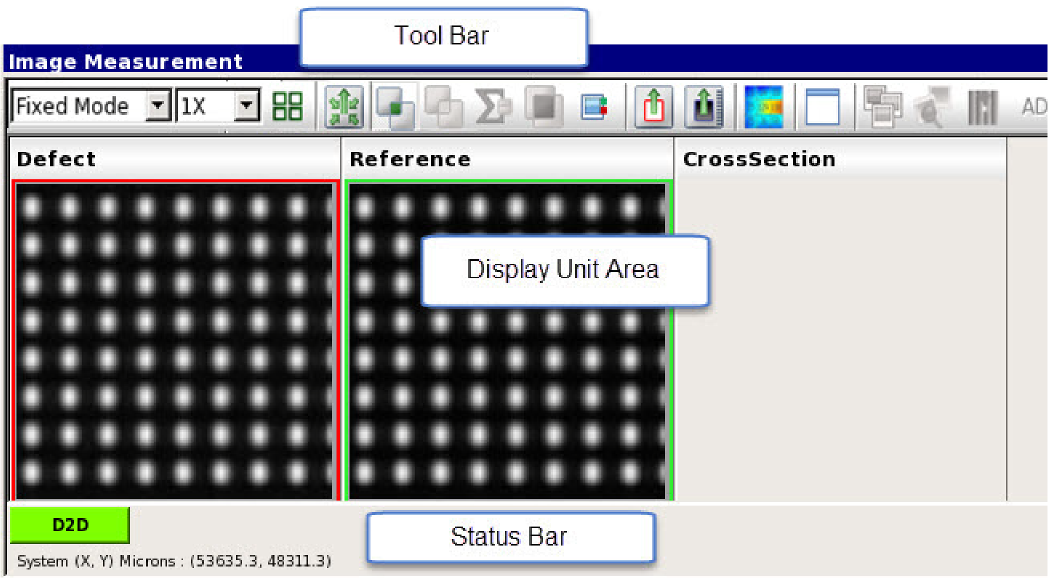
To access: **View > Image Measurement**

The Image Measurement Unit (IMU) window consists of display units, where each display unit displays an image or the Cross Section Analysis results. In addition to the display unit area, the IMU window has a tool bar and status bar area.

Description

There are a number of functional areas in the Image Measurement Unit window, illustrated in Figure 9-1.

Figure 9-1. Image Measurement Unit Window



- Display Unit Area

  The display unit area is where the images and the cross-section results are displayed.

- Status Bar

  The status bar displays information such as defect system coordinates, ruler measurement results, and so on. More specifically:

  - **X, Y** — System coordinates of the start point (the point where the mouse was pressed).
  - **dx, dy** — The distance between the start point and the endpoint in x and y direction.
  - **Length (1x)** — The distance between the start point and the end point @1x (length on wafer). Length (1x) is displayed in nanometers.
  - **Length (4x)** — The distance between the start point and the end point @4x (length on mask).

Note

All information (except Length (1x)) displayed in the status bar are in units defined in the *dat-ini.xml* file. For more details on the configuration of units, refer to "Unit of Measurement Configuration" on page 125.

- Tool Bar

  The tool bar contains icons that access all tools related to the IMU windowTable 9-1. There are two different modes available, depending on the setting of the mode menu on the left side of the button bar: Fixed Mode and Free Mode (see "Image Measurement Modes" on page 274).

- Modality Buttons (in the Status Bar)

  Modality buttons are located at the bottom of the window. Modality indicates one of the following settings:

  - D2D
  - D2DRef
  - TransRef
  - NonD2D and Other Modalities

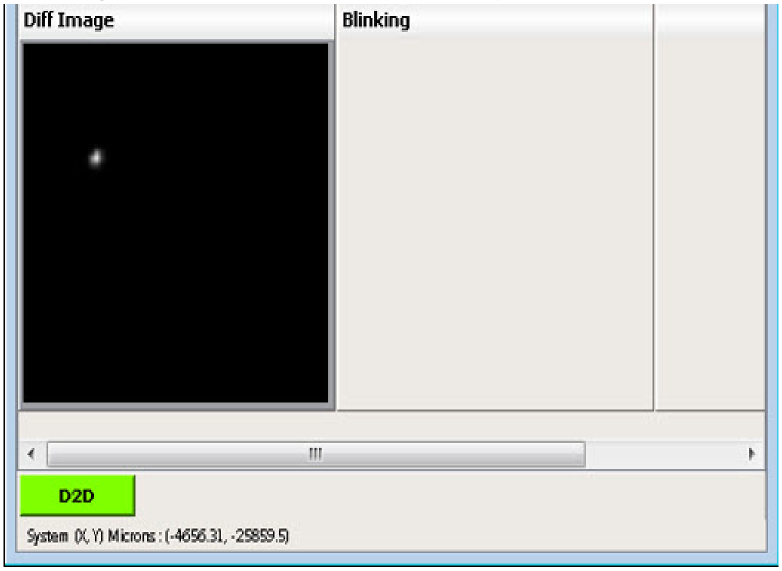
  The number of buttons varies depending on the number of modalities a defect has. The user can switch between the modalities by clicking on these buttons. The current modality button is highlighted in green. If you switch between modalities, then the Defect, Reference and Functional images are updated accordingly. You can configure and save the layout of the IMU window for each modality of the defect.

  For example, the layout for D2D can be different when compared with the layout for D2DRef. Each of these layouts can be saved separately. Figure 9-2 shows a defect with D2D modality.

  Note

  For LRF inspection reports, in the presence of transmitted and reflected defect and reference images, the TransRef modality is displayed in addition to D2D and D2DRef. TransRef assists in simultaneous views of transmitted and reflected images. See "TransRef Modality" on page 269 for more information.

Figure 9-2. Defect With Multiple Modalities



- Context-Sensitive Right-Click Menus

  There are a number of context-sensitive menus that appear depending on where you right-click on the IMU window. These include:

  - From any display unit header to select an image to display (see "Specifying the Image or Cross Section Display" on page 279).
  - Inside the image display unit to perform most IMU operations (see "Performing Operations in the Image Display Units" on page 291.
  - On a Cross Section bar in a display unit to rotate the cross section bar (see "Rotating a Cross Section Bar" on page 310).

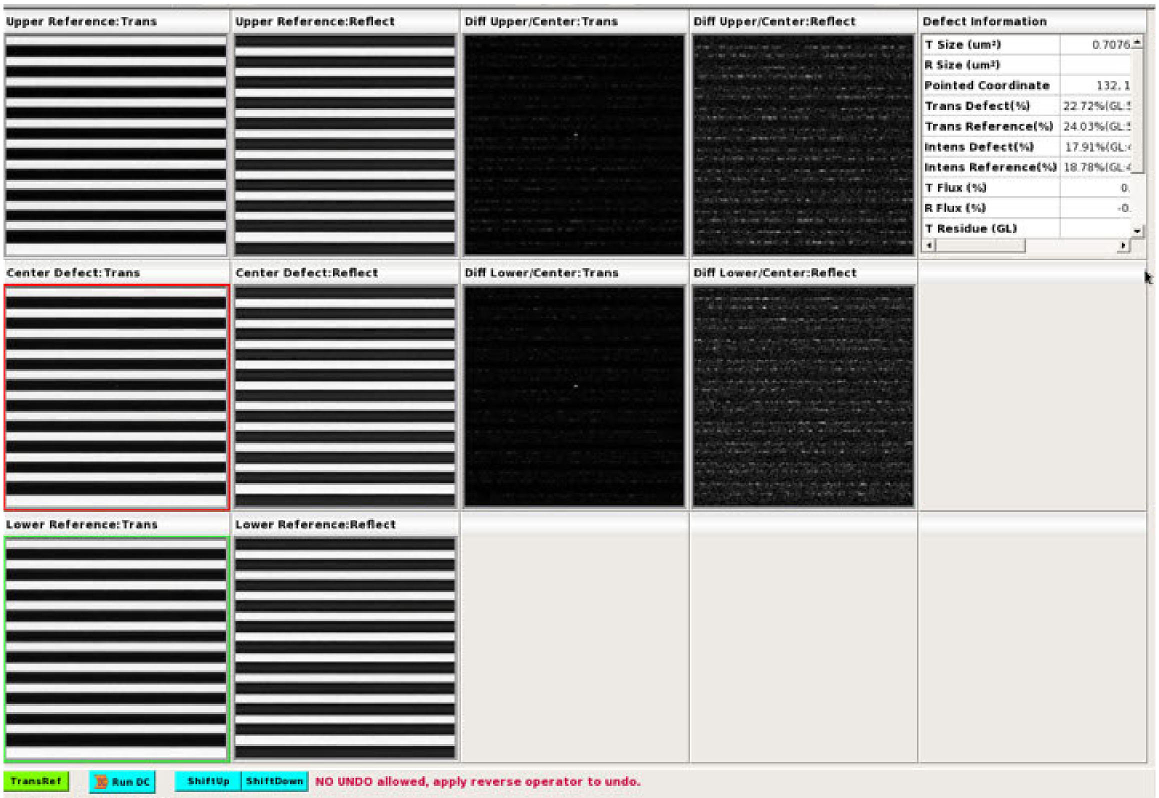
TransRef Modality

TransRef modality is an alternative display mode for the IMU window that enables additional displays of defect and reference images for improved analysis. It is particularly useful if a defect has two reference images (for example, an upper and lower reference image). In this mode, you can display the upper, center, and lower defect reference images simultaneously. This modality also displays images for Transmitted and Reflected inspections, as well as diff images, and enables additional controls for the display of flux areas.

Note

TransRef mode is currently supported only for LRF inspections.

Figure 9-3. IMU in TransRef Modality



To change image names in TransRef mode, refer to “Configuring Image Type Names in the Grid Display” on page 278.

Additionally, when the inspection tool cannot place the defect in the defect die image correctly, you can correct the placement of the defect from reference die to the correct defect die using the **ShiftUp** and **ShiftDown** buttons in TransRef modality. Refer to “Manually Swapping Dies” on page 297 for further information.

Objects

Table 9-1. Image Measurement Unit Window Toolbar

Control	Description	Fixed Mode or Free Mode?
Image Measurement Modes 	Selects mode of operation: Fixed Mode or Free Mode. See “Image Measurement Modes” on page 274 for further information.	Both
Zoom and Center Around the Defect 	Zooms images to the level specified. See “Zooming and Centering Around the Defect” on page 295 for further details.	Both

Table 9-1. Image Measurement Unit Window Toolbar (cont.)

Control	Description	Fixed Mode or Free Mode?
EDIT	Configures the layout of the display units. Refer to "Configuring the Image Grid Display" on page 276 for further information.	Both
Create Functional Image	Creates customized functional images.	Both
Display Absolute Difference Image	Displays Absolute Difference image. The Absolute Difference Image is created between the defect image and reference image and displayed in Diff Image display area of the IMU.	Both
Display Signed Difference Image	Displays the Signed Difference Image. Signed difference images show the absolute difference between defect and reference that to identify the polarity (dark or clear) of the defect.	Both
Display Sum Image	Displays Sum images. The Sum Image is created between the defect image and reference image and displayed in the Sum Image display area of the IMU. The Sum Image is displayed by default, if the inspection type is NonD2D. Viewing the sum image is similar to viewing the Absolute Difference Image.	Both
Display Average Image	Displays Average image. The Average Image is created between the defect image and reference image and displayed in the Avg Image display area of the IMU.	Both
Display Blinking Image	Displays Blink Images. A Blink Image is an image that toggles between the defect image and reference image with some time interval. The Blink Image is created between the defect image and reference image and displayed in the Blinking image display area of the IMU. Viewing the Blink Image is similar to viewing an Absolute Difference image.	Both
Display Cross Section Bar	Displays the Cross Section Bar and performs Cross Section Analysis. Refer to "Cross Section Analysis" on page 307 for more information.	Fixed

Table 9-1. Image Measurement Unit Window Toolbar (cont.)

Control	Description	Fixed Mode or Free Mode?
Display Cross Section Enabler	Displays the cross-section enabler. Refer to "Cross Section Analysis" on page 307 for more information.	Fixed
Overlay GL Matrix on Image	Overlays grey level values onto an image in the Image Measurement window. Refer to "Overlaying a Gray Level Matrix" on page 304 for information.	Fixed
Display Flux Area	Displays the flux area regions on the images displayed in Image Measurement. This assists in calculating the flux area ratio between two images. Refer to "Measuring Flux Area" on page 339 for further information. **Note:** This button is only visible in TransRef comparison mode	Fixed
Select Images for Flux Area	Displays the Flux Area Image Selection dialog box. Refer to "Selecting Images for Flux Area" on page 342 for further information. **Note:** This button is only visible in TransRef comparison mode	Fixed
Display Defect Information	Displays defect properties in a Defect Information table. Refer to "Using the Defect Information Table" on page 288 for further information. **Note:** This button is only visible in TransRef comparison mode	Fixed
Display Defect Window	Displays the defect window. The defect window shows the location of the defect on the images displayed in Image Measurement. The defect window is specified in the input inspection files. Refer to "Image Types" on page 281 for further information.	Both

Table 9-1. Image Measurement Unit Window Toolbar (cont.)

Control	Description	Fixed Mode or Free Mode?
Display Auxiliary Images	Displays external, plug-in, or layout images. Auxiliary Images are any image other than defect, reference, and functional images. By default, the IMU window displays the defect, reference, and absolute difference images. However, there could be images specified for a defect in the input inspection file. For example, external tiff images, layout images, and plug-in images are some example auxiliary images. Note that the auxiliary image icon is deactivated if there are no auxiliary images associated with a defect.	Both
Zoomed Images	Displays zoomed images of defect and reference images in the IMU window. These images are used to better identify defects.	Both
Ruler	Measures the distance between two specified points on the image. Refer to "Using the Ruler" on page 301 for more information.	Both
Display Measurement	Displays CD measurement information such as CDVar, LOC, and CDType. Refer to "Displaying Measurement Values" on page 302 for more information.	Both
Display Defect Contour	Displays the contour around the defective region on the images. "Displaying Defect Contours" on page 343 for more information. For LRF formats, the display also includes defect parts information. See "Displaying Defect Parts Location" on page 346 for more information.	Both
Display Contact Measurement Bar	Contact Measurement measures the area of contact present on the images. Refer to "Contact Measurement" on page 332 for more information.	Fixed

Table 9-1. Image Measurement Unit Window Toolbar (cont.)

Control	Description	Fixed Mode or Free Mode?
Contact Report 	Generates a report from the output of the Contact Measurement operation. In Fixed Mode, this button only appears if the Display Contact Measurement Bar button is enabled. In Free Mode, this button only appears if you have selected **Display Contact** from a right-click menu in a display unit. Refer to "Contact Measurement Report" on page 336 for more information.	Fixed
DI-SIGN DI-ABS 	Toggles the sign of Defect Information values. If values are displayed as signed values, click the **DI-ABS** toggle button to display them as absolute values. If values are displayed as absolute values, click **DI-SIGN** to display them as signed values. Toggling this button also impacts the sign of attribute values displayed in the Defect Progress Tracking window launched from **Defect List** > **Track Defect**.	Both

Image Measurement Modes

Image Measurement works in two modes, Fixed Mode and Free Mode. These modes can be selected from a dropdown list on the left side of the Image Measurement Unit window toolbar.

Fixed Mode

In Fixed Mode, any action applied on an image is applied to all images displayed in the IMU window.

Figure 9-4. Fixed Mode Toolbar

If the image view (refer to "Performing Operations in the Image Display Units" on page 291 for more details on image views) is changed on one image, then the image view is changed on all the images present in the Image Measurement.

The following menu items in Free Mode (accessed from a right-click menu in the display unit) behave differently in Fixed Mode:

- Cross Section

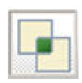
  If Cross Section is enabled in Fixed Mode, then cross section analysis (refer to "Cross Section Analysis" on page 307) is performed on the defect image, reference image, and the functional images. Any changes on the cross section bar such as a resize, rotate, and move are applied to all cross section bars on all images.

- Display Contact

  If Display Contact is enabled, then contact measurement analysis (refer to "Contact Measurement" on page 332) is performed on the defect and reference images. Any changes on the contact measurement box such as a resize and move are applied to all contact measurement boxes on all images.

Fixed Mode also impacts what appears on context-sensitive right-click menus that appear when you click on an image. See "Performing Operations in the Image Display Units" on page 291 for details.

In TransRef comparison mode, the following additional buttons are displayed in the toolbar of Fixed Mode:

- Display Reflected Absolute Difference Image 
- Display Reflected Absolute Signed Image 
- Display Flux Area 
- Select Images for Flux Area 
- Display Defect Information 

Free Mode

In Free Mode, actions are applied only to single image. If the image view is changed on any image, then the view is changed only on the selected image.

Figure 9-5. Free Mode Toolbar

The following buttons are not available in the toolbar when set to Free Mode:

- Display Cross Section Bar

- Display Cross Section Enabler
- Display Flux Area
- Select Images for Flux Area
- Display Contact Measurement Bar

The following options are still available from a popup menu that appears if you right-click in the image display unit. However, they will behave differently than in Fixed Mode.

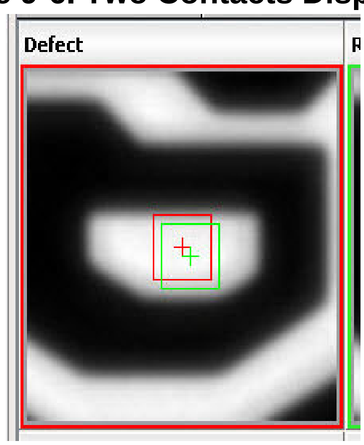
- Cross Section

  If Cross Section is enabled in Free Mode, then two cross section bars are displayed on the image on which the Cross Section is enabled (note that they can be displayed on top of each other during the initial view). These cross section bars can be moved independently on the image. If either of the cross section bars are resized, then the other cross section bar is also resized accordingly.

- Display Contact

  If Display Contact is enabled in Free Mode, then two contact measurement boxes are displayed on the image. These contact measurement boxes can be moved independently on the image.

Figure 9-6. Two Contacts Displayed



Free Mode also impacts what appears on context-sensitive right-click menus that appear when you click on an image. See “Performing Operations in the Image Display Units” on page 291 for details.

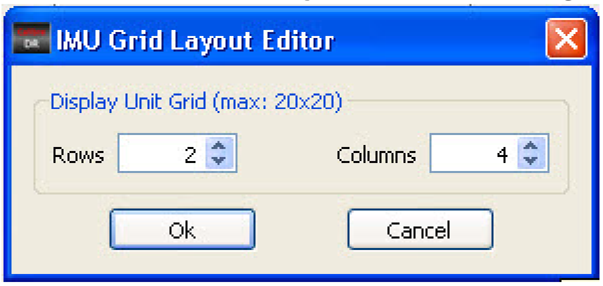
Configuring the Image Grid Display

Individual display units are shown in a grid in the IMU window. The number of rows and columns displayed in the IMU window can be reconfigured through the EDIT button located in the IMU window toolbar.

Procedure

1. In the IMU window toolbar, click the EDIT button (the green four-square icon). This invokes the IMU Grid Layout dialog box.

Figure 9-7. IMU Grid Layout Editor Dialog Box



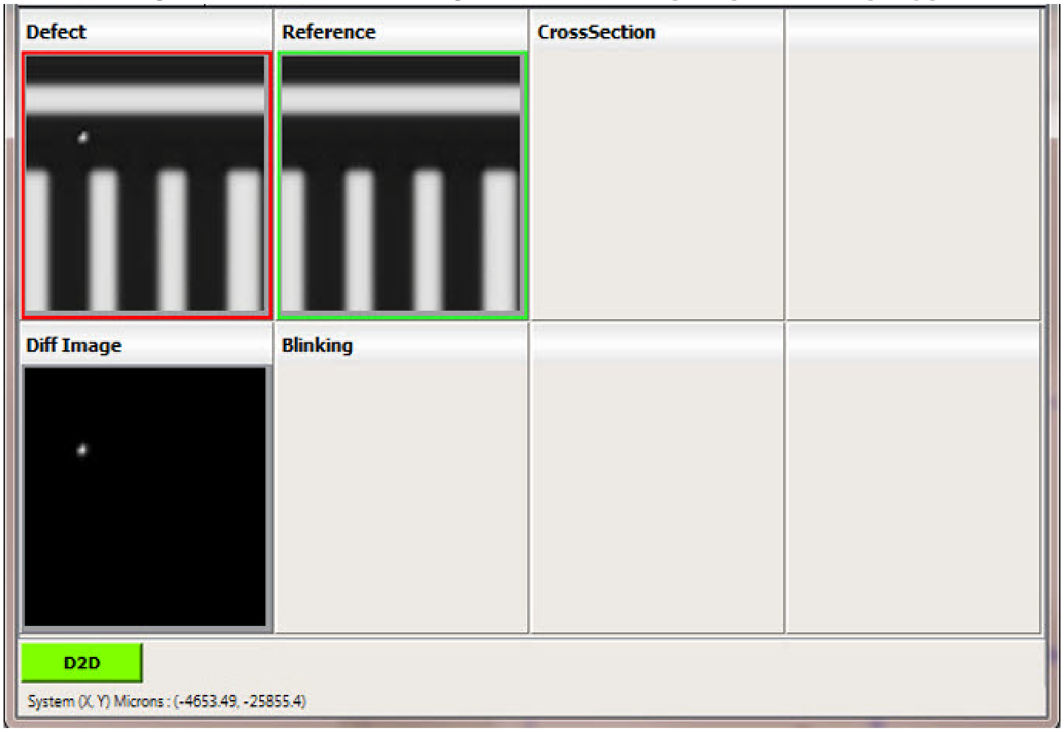
2. In the IMU Grid Layout dialog box, select the number of rows and columns you wish to apply to the layout of the IMU.

3. Click **OK**. The layout of the IMU window changes based on the number of rows and columns you specified.

Examples

If you selected the number of rows as 2 and the number of columns as 4 (as shown in Figure 9-7), then the layout is redrawn in the IMU window as shown in Figure 9-8.

Figure 9-8. Grid Configuration Example (2 x 4 Display)



Note

The gray level (GL) values are displayed as tool tip when the mouse pointer is hovered over the image as shown in the Figure 9-9. For more details on GL values, refer to the section “Viewing a Gray Level Matrix” on page 303.

Figure 9-9. Tool Tip on Image

Configuring Image Type Names in the Grid Display

You can configure image type names in the image grid display. Once you have changed the name, all modalities are updated to display the new name.

Procedure

1. Open *dat-ini.xml* in a text editor and search for the node ImageTypeFilter.

Figure 9-10. ImageTypeFilter Node

```
<!-- Image Type Filter Values-->
<!-- Purpose of the below node is to change the image display name in IMU -->
<!-- User can change only the displayValue from the below list. -->
<ImageTypeFilter>
 <item displayValue="Defect">defect_image</item>
 <item displayValue="Reference">reference_image</item>
 <item displayValue="Reflected Defect">reflected_defect_image</item>
 <item displayValue="Reflected Reference">reflected_reference_image</item>
</ImageTypeFilter>
```

2. In the ImageTypeFilter node, change the displayValue to your new image type name.

Note

You cannot modify the node name (for example, defect_image in the previous figure).

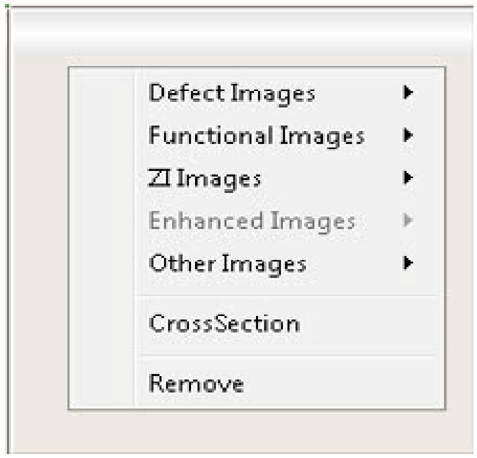
Specifying the Image or Cross Section Display

You can specify the type of the image or cross section results to be displayed in any display unit through a menu available from the header of the individual display units.

Procedure

1. Right-click on the header of any display unit and a menu appears.

Figure 9-11. Display Unit Right-Click Display Unit Header Menu



2. Select an operation to perform from the right-click menu.

Table 9-2. Display Unit Header Menu Operations

Option	Description
Defect Images	Lists available defect or reference to display. The defect and reference images include: • Defect • Reference • Reflected Defect • Reflected Reference See "Defect and Reference Images" on page 281 for further information on defect and reference images.
Functional Images	Lists available functional images to display. These include: • Diff Image • Avg Image • Sum Image • Blinking • Custom See "Functional Images" on page 282 for further information

Table 9-2. Display Unit Header Menu Operations (cont.)

Option	Description
ZI Images	Lists available zoomed-in images to display. These include: • Interpolated Defect Image • Interpolated Reference Image • Zoomed Interpolated Defect Image • Zoomed Interpolated Reference Image • Defect Threshold Image • Reference Threshold Image • Defect Edge Image • Reference Edge Image See "ZI Images" on page 284 for further information
Other Images	Lists any external images. See "Other Images" on page 286 for further information.
Cross Section	Displays a CrossSection window graph. See "CrossSection Graph" on page 287 for further information
Remove	Removes the selected item from the display unit. If the item is removed, then the display unit is shown as empty.

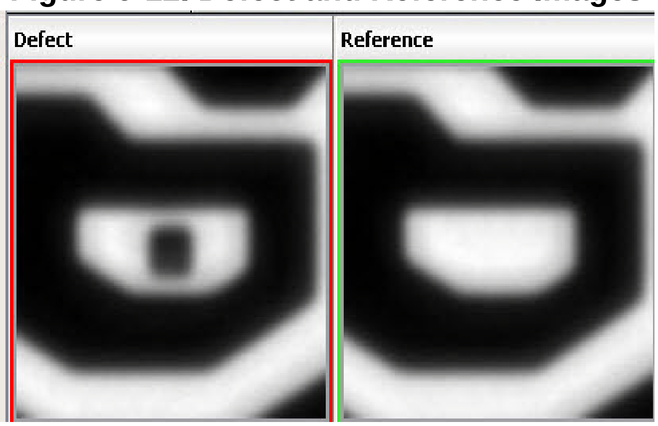
Image Types

A number of different types of images can be shown in a display unit in the IMU window.

Defect and Reference Images

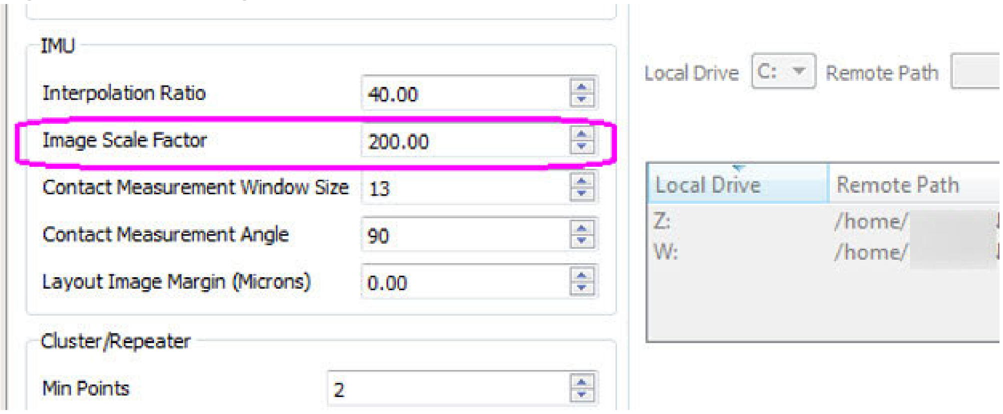
By default, the defect image and reference image of the current defect is displayed in the IMU window. Defect or reference images can be selected from the **Defect Images** option in the right-click display unit header menu. The layout of the IMU window updates with the image that is selected for the display unit.

Figure 9-12. Defect and Reference Images



You can increase the size of the images by increasing the image scale factor in **Utilities > Calibration Parameter Editor** (see Figure 9-13).

Figure 9-13. Image Scale Factor in the Calibration Parameter Editor



Refer to "Calibration Parameter Modification" on page 367for more details on editing the calibration file.

Some inspection machines capture the alignment offset of the transmitted or reflected defect image from the reference image and store the offset in an inspection report. Calibre DefectReview reads these offset values, shifts the defect image by the offset values, pads the shifted region with the pixel GL values from the reference image, and displays the defect and reference images. If required, the Defect window is also shifted to display on defect images.

Note

Currently, Calibre DefectReview supports the alignment of transmitted and reflected defect images for NuFlare XML inspection reports (IR) based on (Tr_OffsetX, Tr_OffsetY) and (Rfl_OffsetX, Rfl_OffsetY) values specified in the IR. It also shifts the Defect window location based on Def_Box and (Tr_OffsetX, Tr_OffsetY) values.

Functional Images

Functional images are the output of different operations between images displayed in Calibre DefectReview. These images help in highlighting defects.

You can display functional images in the IMU window by right-clicking the header display and select **Functional Images**. Functional images include an Absolute Difference (Diff), Sum, Average (Avg), Blinking, Sign Diff, and Custom. Any number of Functional images can be added or removed from the IMU window. Each of the different types of images can also be displayed through the **Display Absolute Difference Image**, **Display Sum Image**, **Display Average Image**, **Display Signed Difference**, **Display Reflected Signed Difference**, and **Display Blinking Image** buttons in the IMU window toolbar.

By default, the Diff Image is always enabled in the display unit for D2D, D2DRef, TransRef, and D2M type defects. Sum Image is enabled for NonD2D inspections. Refer to "Creating Custom Functional Images" on page 295 for more details.

To place the a functional image in any display unit, right click on the corresponding display unit and select the type of image to show in the display unit. Once the image is selected, the functional image is selected in the display unit.

If no display unit is configured to display a functional image, then the corresponding images cannot be seen in the IMU. The icons to display the Functional images are deactivated till the layout is configured.

For example, if the layout of the IMU window displays only defect, reference, and difference images, then the icons of the Sum, Average, and Blinking images are not enabled. These will be enabled only after selecting these options in any of the display units. If you view the Average image in any of the display units, only then is Average Image icon in the IMU window toolbar enabled. You can click on the Display Average Image icon in the toolbar to show or hide the Avg Images.

Functional Image Name Changes

You can change the name of the functional image in the grid display by setting the FunctionalImageFilter node in the *dat-ini.xml* file. In the FunctionalImageFilter node, change the displayValue setting to a new image name.

Figure 9-14. FunctionalImageFilter Node

```
<!-- Purpose of the below node is to change the image display name in IMU -->
<!-- User can change only the displayValue from the below list. -->
<FunctionalImageFilter>
 <item displayValue="Diff_First">Diff Image</item>
 <item displayValue="Diff_Second">Diff Image_2</item>
</FunctionalImageFilter>
```

Note

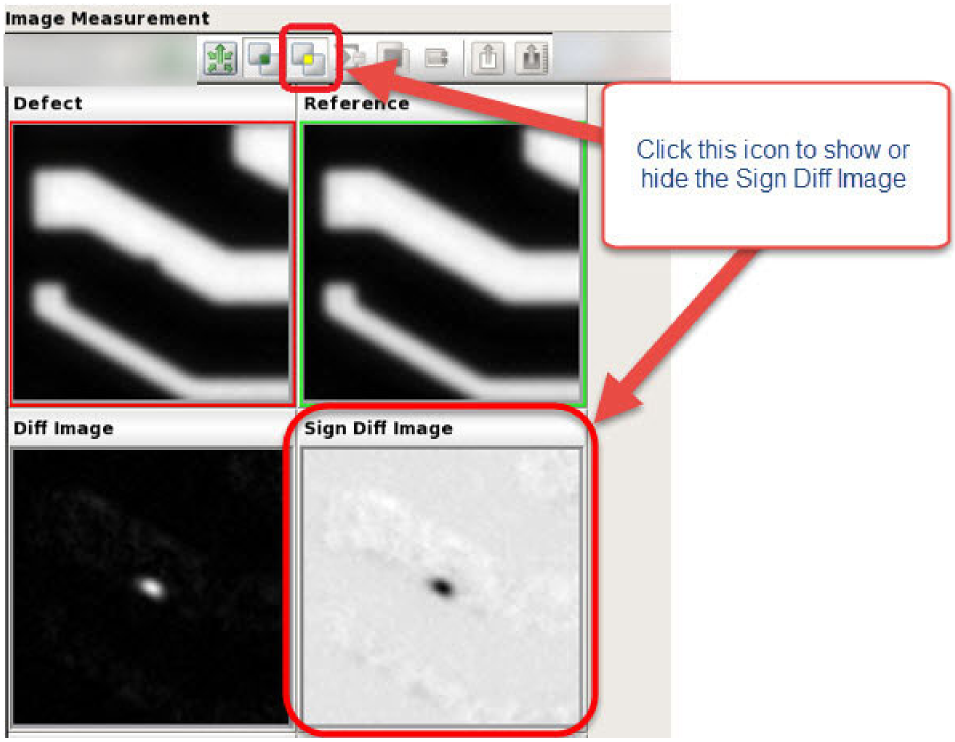
The node name cannot be modified (such as “Diff Image” shown in the previous figure).

Signed Difference Images

A signed difference image displays the absolute difference between defect and reference which helps the user to easily identify the polarity (dark or clear) of the defect.

As illustrated the following figure, the Diff image alone cannot identify the polarity of the defect (it is dark). The Sign Diff Image pane shows that the defect is dark.

Figure 9-15. Signed Difference Image



The signed difference image is computed as follows:

SD=(D-R) + (255/2)

where SD is the signed difference image, D is the defect image intensities, and R is the reference image intensities.

Note

If any pixel of SD is less than 0, then the value is set to 0. If any pixel value is greater than 255, then value is set to 255.

ZI Images

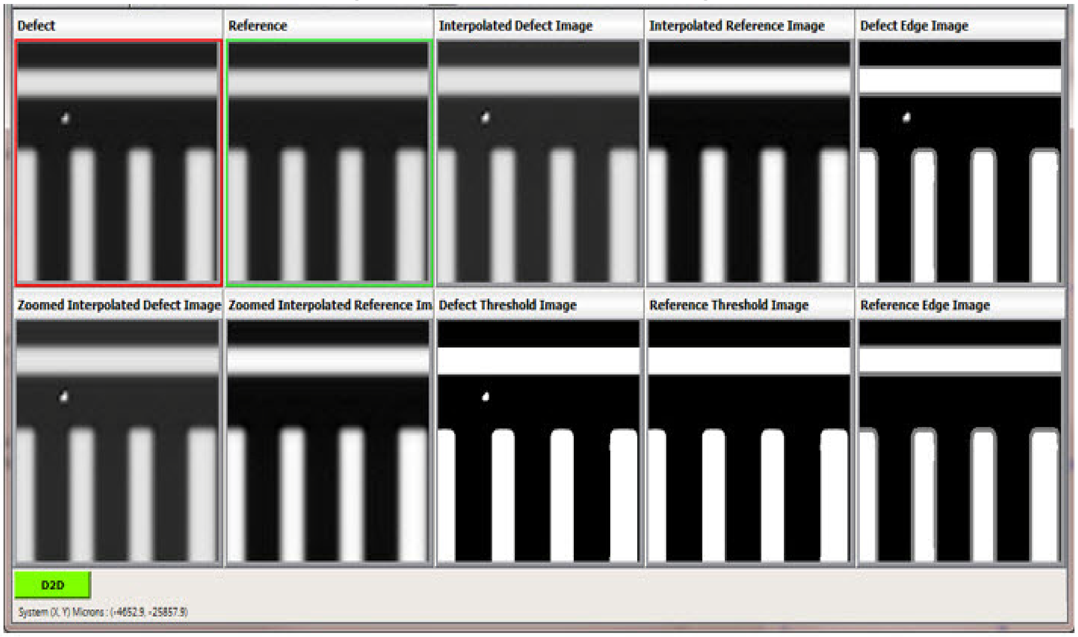
The Zoomed Images (ZI) display adds more images to the defect and reference images in the IMU window. These images are used to better identify defects. Zoomed Images can be selected in the **ZI Images** option in the right-click display unit header menu.-

There are a number of different Zoomed Image types. The following zoomed images can be displayed in the IMU window:

Table 9-3. Zoomed Image Types

Image	Description
Interpolated Defect Image	The defect image is interpolated and displayed. Refer to "Setting Image Interpolation Properties" on page 351 to specify the interpolation ratio to be used while displaying the images.
Interpolated Reference Image	The reference image is interpolated and displayed. Refer to "Setting Image Interpolation Properties" on page 351 to specify the interpolation ratio to be used while displaying the images.
Zoomed Interpolated Defect Image	The defect region of the defect image is interpolated and displayed. You can configure the defect region. Refer to "Setting Image Window Properties" on page 351 for more details to specify the defect window region.
Zoomed Interpolated Reference Image	The defect region of the reference image is interpolated and displayed. You can configure the defect region to be displayed. Refer to "Setting Image Window Properties" on page 351 for information on how to specify the defect window region on a reference image.
Defect Threshold Image	The threshold image of the zoomed interpolated defect image is displayed. One level gray level thresholding is used to compute the threshold image.
Reference Threshold Image	The threshold image of the zoomed interpolated reference image is displayed. One level gray level thresholding is used to compute the threshold image.
Defect Edge Image	The threshold image of the zoomed interpolated defect image is displayed. Two level gray level thresholding is used to compute the threshold image.
Reference Edge Image	The threshold image of the zoomed interpolated reference image is displayed. Two level gray level thresholding is used to compute the threshold image.

Figure 9-16. Zoomed Images

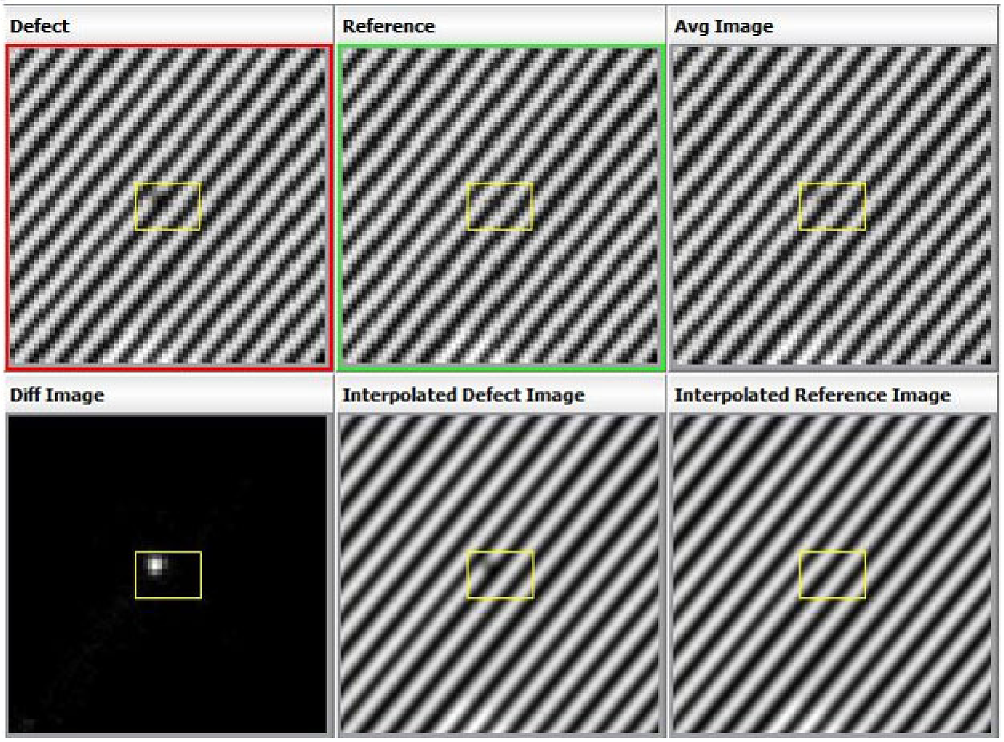


Other Images

If any auxiliary images such as external images, plug-in images, or layout images are added to a defect in Calibre DefectReview, these images can be selected using the **Other Images** option from the right-click header menu of the display unit.

The **Other Images** menu is empty if there are no external, plug-in, or layout images present in a defect. The Auxiliary Images icon is enabled in the toolbar of the IMU if at least one of the auxiliary images is configured in the layout of the IMU window.

Figure 9-17. Defect Window on Images

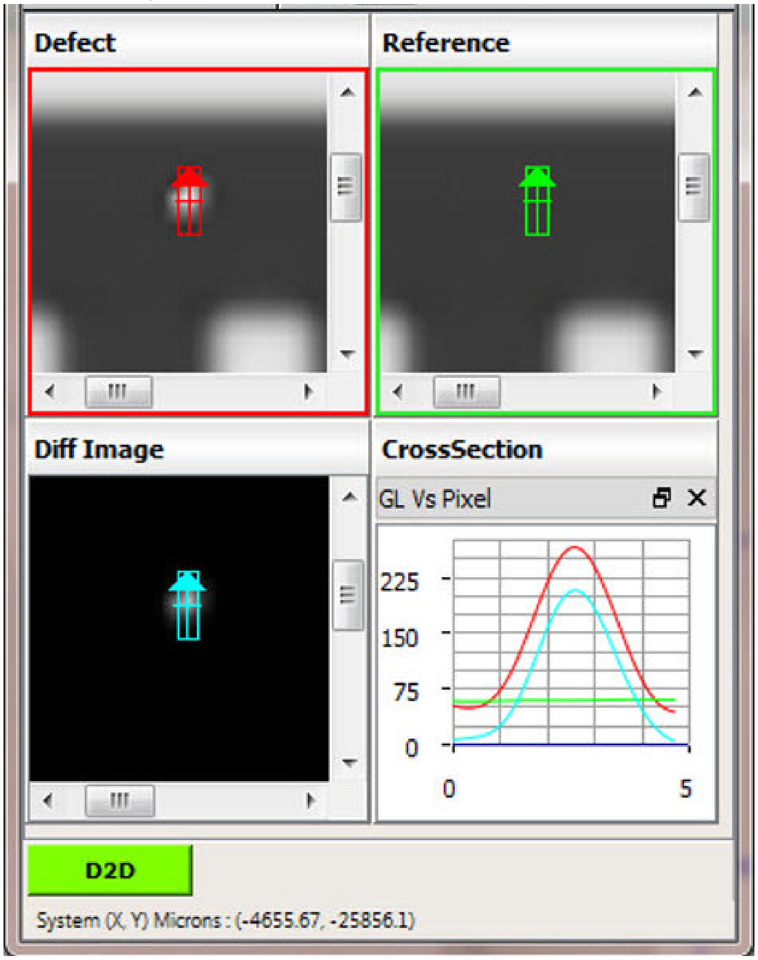


CrossSection Graph

Cross section analysis results can be configured to be displayed in any of the display units. To see the cross section results, select a display unit and then select the **CrossSection** option from the right click menu in the header of display unit .

Once the CrossSection option is selected, the cross section results are displayed and the Display Cross Section Bar and Cross Section Enabler buttons are enabled in the IMU window toolbar. Refer to "Cross Section Analysis" on page 307 for more details about cross section analysis.

Figure 9-18. Cross Section Results



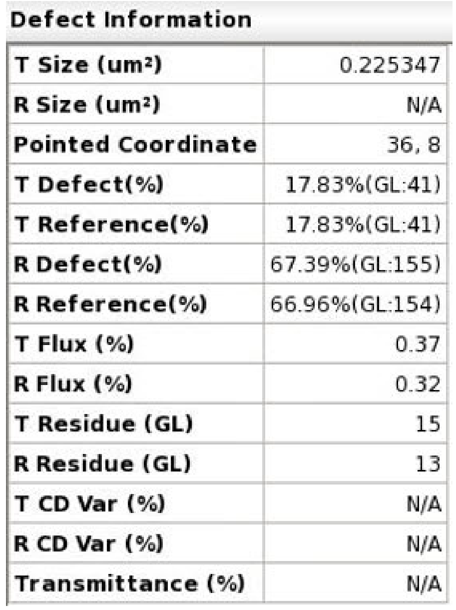
Using the Defect Information Table

The Defect Information table contains a description of defect properties and can be configured to be displayed in any display unit.

Procedure

To invoke the Defect Information table, select a display unit and then right-click on the header and select **Defect Information**. The following table appears.

Figure 9-19. Defect Information Table



Defect Information

T Size (um²)	0.225347
R Size (um²)	N/A
Pointed Coordinate	36, 8
T Defect(%)	17.83%(GL:41)
T Reference(%)	17.83%(GL:41)
R Defect(%)	67.39%(GL:155)
R Reference(%)	66.96%(GL:154)
T Flux (%)	0.37
R Flux (%)	0.32
T Residue (GL)	15
R Residue (GL)	13
T CD Var (%)	N/A
R CD Var (%)	N/A
Transmittance (%)	N/A

If the value for any attribute is not available, it is displayed as N/A. The sign (signed or absolute) of values can be toggled using the **DI-SIGN** and **DI-ABS** toggle button in the IMU toolbar. The Defect Information table reports the properties in the following table.

Table 9-4. Defect Information Table Properties

Defect Property	Description
T Size (um^2)	Specifies the transmitted defect size.
R Size (um^2)	Specifies the reflected defect size.
Pointed Coordinate	Displays the coordinate location on the image where the mouse was last clicked.
T Defect (%)	Displays the transmittance value of the defect and the unsigned 8-bit gray scale value. This is calculated manually when you click on the image.
T Reference (%)	Displays the transmittance value of the reference and the unsigned 8-bit gray scale value. This is calculated manually when you click on the image.
R Defect (%)	Displays the intensity value of the defect and the unsigned 8-bit gray scale value. This is calculated manually when you click on the image.
R Reference (%)	Displays the intensity value of the reference and the unsigned 8-bit gray scale value. This is calculated manually when you click on the image.

Table 9-4. Defect Information Table Properties (cont.)

Defect Property	Description
T Flux (%)	Specifies the transmitted flux ratio. Refer to "Measuring Flux Area" on page 339 for further information.
R Flux (%)	Specifies the reflected flux ratio.
T Residue (GL)	Specifies the maximum signed GL value between transmitted defect and reference images.
R Residue (GL)	Specifies the maximum signed GL value between reflected defect and reference images.
T CD Var (%)	Specifies the CD variation in transmitted defect image.
R CD Var (%)	Specifies the CD variation in reflected defect image.
T Flux (%)	Specifies the transmitted flux ratio. Refer to "Measuring Flux Area" on page 339 for further information.
R Flux (%)	Specifies the transmitted flux ratio.
Transmittance (%)	Specifies the transmittance (in percentage) of a defect reported by Calibre DefectClassify. The Transmittance value of a defect blob is calculated as a ratio of the minimum GL of a defect blob to the maximum GL value assigned to a pixel in a large clear region by the inspection machine. The Transmittance (%) is supported for TransRef modality only and the values are calculated as follows: LRF X700: 1C, 2C: (Darkest GL of defect ÷ ShadingResult.TMode.QzPix) × 100 2A, 1G: (Brightest GL of defect ÷ ShadingResult.TMode.QzPix) × 100 LRF X800: 1C, 2C: (Darkest GL of defect ÷ (ShadingResult.Result.TransBright / 4)) × 100 2A, 1G: (Brightest GL of defect ÷ (ShadingResult.Result.TransBright / 4)) × 100

Saving and Loading IMU Window Layout Settings

The layout that is configured for each of the display units in the IMU can be saved.

Procedure

1. To save the layout, select **Dock Layout** > **Save** in the menu bar of the Calibre DefectReview window.
2. To reload the layout, select **Dock Layout** > **Load** in the menu bar of the Calibre DefectReview window.
3. For more details on saving and loading the layout of Calibre DefectReview refer to "Dock Layout" on page 385.

Performing Operations in the Image Display Units

Most of the primary operations you can perform in the IMU window can be accessed from a right-click menu in any image display unit.

Procedure

1. Right click on any image displayed in the display unit window to invoke a right-click menu.
2. Select an operation from the following table:

Table 9-5. Right-Click Menu Items in Image

Option		Description
Image View Options		Specifies a viewing mode to display defect images.
	Original	Displays the actual image of the defect. The image is the same as present in the defect image file.
	Stretched	Displays the enhanced view of the image to make it brighter and clearer. The original image is enhanced and displayed.
	Colored	Displays the color image of the original image. The original image is converted to color image and displayed.
	Inverted	Displays the inverted image of the original image. The original image is inverted and the image is displayed.
	Binary	Displays the binary view of the original image. A binary image is generated based on the gray level value set using Set Binary Image Properties. Refer to "Setting Binary Image Properties" on page 348 for details.

Table 9-5. Right-Click Menu Items in Image (cont.)

Option		Description
	Inverted Binary	Displays the inverted binary view of the original image. A binary image is generated, and the inverted view of the binary image is displayed. An Inverted Binary image is generated based on the gray level set using Set Binary Image Properties. Refer to "Setting Binary Image Properties" on page 348 for details.
Smoothen		Renders the image using interpolation to smooth the image. If this is not enabled, images are non-interpolated (pixelated) images. This is useful when GL matrix is overlaid on the images.
Cross Section		Performs a Cross Section Analysis. See "Cross Section Analysis" on page 307 for further information.
Display Contact		Displays the Contact and Contact Report. See "Contact Measurement" on page 332 for further information.
Ruler		Invokes the ruler to measure the distance between two specified points in the image. Refer to "Using the Ruler" on page 301 for further information.
Flux Area		Displays flux area regions and calculates flux area ratio. This option is visible in TransRef comparison mode of Fixed Mode. See "Measuring Flux Area" on page 339 for further information.
Defect Window		Displays or removes a defect window.
GL Matrix		Displays the gray level values of the image in a table (see "Gray Level Matrix Operations" on page 303).
	Show	Shows the GL Matrix.
	Save	Saves the GL Matrix.
	Overlay	Overlays gray level values on the image.
Remove Cross Section		Specifies that the selected cross section bar be removed. See "Cross Section Analysis" on page 307 for further information.
Save As		Saves the original image to another specified file name. You can save the image as png, xpm, jpg, or bmp formats.
Save Displayed Image		Saves images as displayed in the Image Measurement window. You can save the image as png, xpm, jpg, or bmp formats. For example, if you use the Colored view of the image, if you use Save Displayed Image, the Colored view is saved.

3. **Fixed Mode Versus Free Mode:** For Fixed Mode versus Free Mode:

   a. Right-click menu items work differently in Fixed Mode versus Free Mode. In Fixed mode, all the operations are applied to all the images displayed in IMU. However, in Free mode, you can apply any operation to an individual image. For example, in free mode, you can view a Reference image in Color mode and the Defect image in Binary mode. This cannot be done in Fixed mode. Both will be viewed in either Color or Binary.

   a. The following table lists the options enabled in the right click menu of an Image Measurement window child window in either mode. The "Yes" indicates that the option is present and "Checkable" indicates that the option can be toggled on or off (as indicated by a check mark). Right-click menu items work differently in Fixed Mode versus Free Mode. The following table lists the available options in the right click menu of an IMU window display unit in either mode.

Table 9-6. Right-Click Menu Differences in Fixed Mode Versus Free Mode

Option	Fixed Mode	Free Mode
Image View Options: Original, Stretched, Colored, Inverted, Binary and Inverted Binary	Yes Checkable	Yes Checkable
Smoothen	Yes Checkable	Yes Checkable
Cross Section	Yes Checkable	Yes Checkable
Display Contact	Yes Checkable	Yes Checkable
Ruler	Yes Checkable	Yes Checkable
Flux Area	Yes (in TransRef mode) Checkable	No
Defect Window	Yes Checkable	No
GL Matrix	Yes Checkable	Yes Checkable
Remove Cross Section	Yes	No

Table 9-6. Right-Click Menu Differences in Fixed Mode Versus Free Mode

Option	Fixed Mode	Free Mode
Save As	Yes	Yes
Save Displayed Image	Yes	Yes

4. **Right Click Menu States:** Certain settings for various right-click menu items are retained under different circumstances. These circumstances include:
    - Moving to Fixed mode and switching back to Free mode.
    - Switching across different folders.
    - When navigating across defects.
    - Initiating multiple sessions of Calibre DefectReview. When you save a dock layout, the states are stored in the registry and when the user loads dock layout, the states are restored from the registry. Refer to "Saving and Loading a Dock Layout" on page 385 for more details on saving and loading dock layout.
5. The Fixed mode states that are retained are as follows:
    - Images: Original, Stretched, Colored, and so on.
    - Smoothen
    - Cross Section
    - Contour
    - Flux Area
    - Defect Window
    - GL Matrix Overlay
6. In Free Mode, the following settings are retained:
    - Image looks: Original, Stretched, Colored, and so on.
    - Smoothen
    - Cross Section
    - Contour
    - Defect Window

    Note

    Only Image Look and Cross Section Bar are retained per modality setting (D2D, D2DRef, and so on).

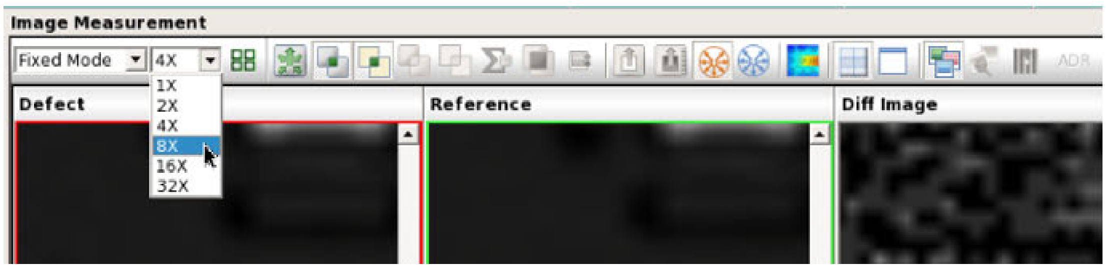
Zooming and Centering Around the Defect

You can zoom in on an image for greater detail using options available in the IMU toolbar.

Procedure

In the IMU toolbar, select the zoom level as shown in the following figure.

Figure 9-20. Zoom and Center on an Image from the Toolbar



Centering around the defect is also performed if Calibre DefectClassify is run prior, which generates defect location information. If the defect location is not present or generated by Calibre DefectClassify, then centering is instead performed around the center of the image.

The following issues apply to zooming around the center of a defect:

- The zoom levels are based upon the displayed image size and not the actual image size. For example, if a display image size is set to 400 then 1X displays a region of 400 x 400 pixels, 2x displays 200 x 200 pixels, and 32x displays 12.5 x 12.5 pixels.
- The last zoom level used is stored in the registry, provided that you save the dock layout.
- The zoom level is shared between Fixed and Free modes. There are no separate settings for either mode.

Creating Custom Functional Images

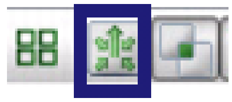
Functional images can be created and displayed in the IMU window. New functional images can be created by specifying operations or functions between images.

By default, four functional image icons are provided in the IMU window toolbar: Absolute Difference, Sum, Average, and Blinking. You can also create Custom functional images.

Procedure

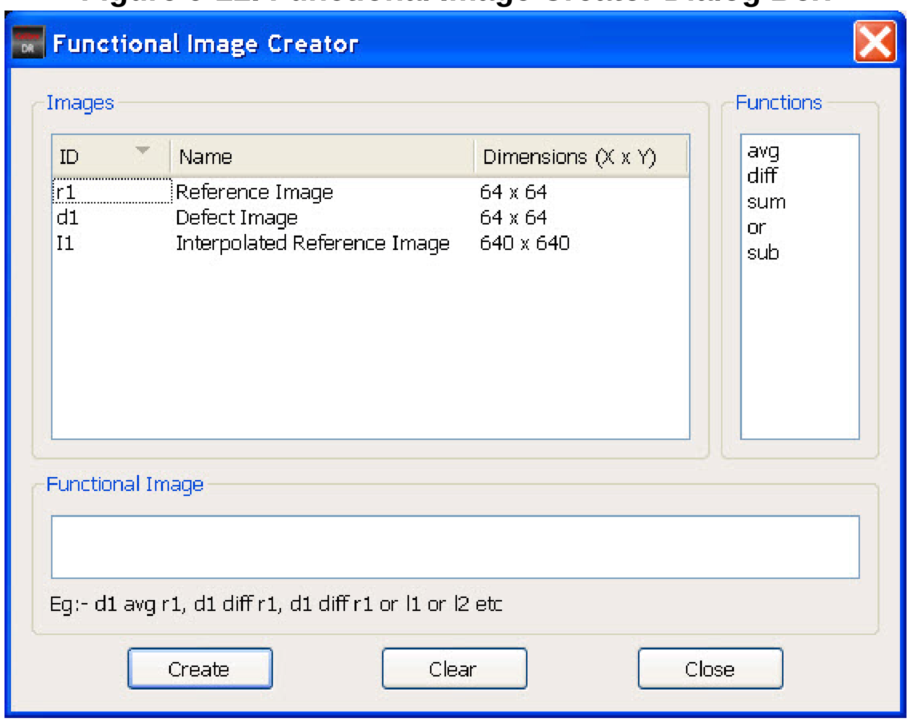
1. In the IMU window, select **Custom** from the **Functional Images** option in the right-click display unit header menu.
2. In the IMU window, click the Create Functional Image button (the icon with five arrows).

Figure 9-21. Create Functional Image Button



A dialog box appears as shown in Figure 9-22. The details of the images displayed in the IMU window are shown in the Images group box and functions are listed in Functions group box.

Figure 9-22. Functional Image Creator Dialog Box



All images related to a defect are listed in this window. For each image, an ID is displayed in the image list. For example, in Figure 9-22, “r1” refers to “Reference Image” and “d1” refers to “Defect Image”.

3. To create a functional image between two images in the Functional Image Creator dialog box, type the functions in the Function Image pane. For example, “d1 avg r1” creates a functional image that is the average of “Defect Image” and “Reference Image”.

   Alternatively, you can also create a function as follows:

   a. In the Functional Image Creator dialog box, click the ID of the first image.

   b. Click the function to be applied between the images.

   c. Click the ID of the second image. The function is displayed in the Functional Image pane.

d. Click **Create** to create the image. The image is created and displayed in the Custom functional area of the IMU window.

e. Click **Clear** to clear the inputs for creating the functional image.

Note
The functional image can only be created between images that have the same number of pixels in X- and Y-direction as well as the same pixel size. A blinking functional image cannot be created by the user.

Manually Swapping Dies

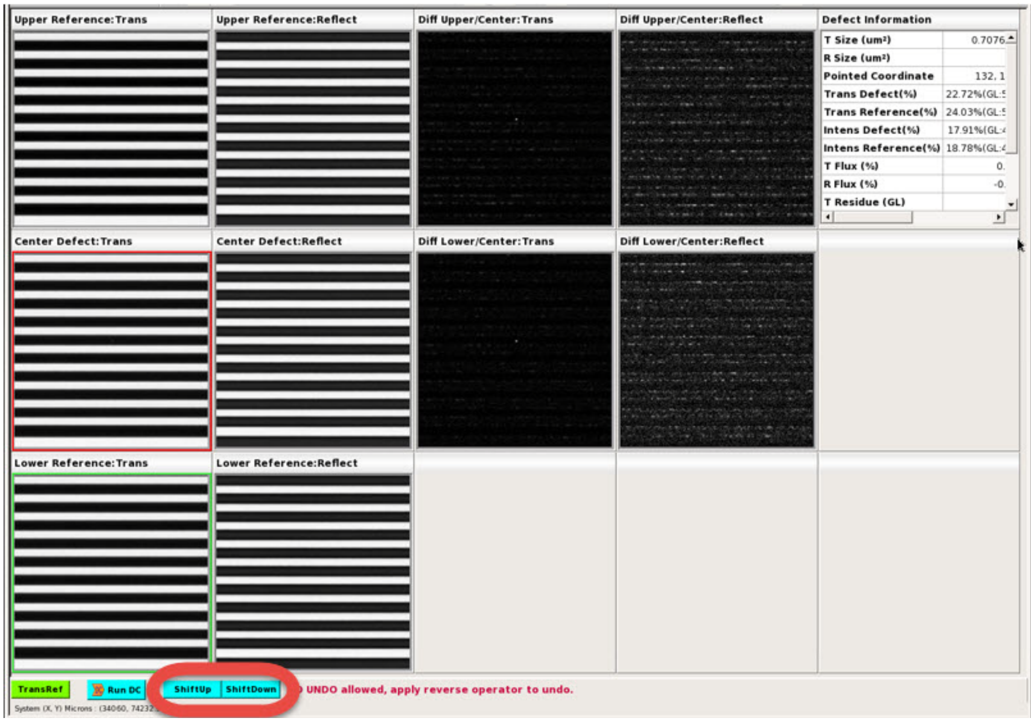
When the inspection tool cannot place the defect in the defect die image correctly, you can correct the placement of the defect from reference die to the correct defect die using Calibre DefectReview in TransRef modality. You can manually swap the defects in the upper or lower dies in an IMU window.

Note
Manually swapping dies is supported only in TransRef modality.

Procedure

1. Set the Image Measurement Unit (IMU) window to TransRef modality. The IMU displays defect images.
2. In the IMU, click the **ShiftUp** and **ShiftDown** buttons at the bottom of the window to change the order, moving the defect images up or down, swapping dies. The defect automatically updates once the positions are shifted.
    - **ShiftUp** moves the defect image to the upper reference image and the lower reference image shifts to the center defect image. The diff and other defect images are updated accordingly.
    - **ShiftDown** moves the defect image to the location of the lower reference image and the upper reference becomes the center defect image.

Figure 9-23. Manual Die Swap in TransRef Modality



Note

These operations cannot be reverted. However, you can undo an operation by performing the opposite (for example, perform a **ShiftDown** to undo a **ShiftUp** operation).

3. Once you finalize the die swap, run Calibre DefectClassify by clicking **Run DC**.

   Calibre DefectClassify runs on a single defect and updates the Defect List columns. During a Calibre DefectClassify run, the tool uses the configuration file specified in the paramFilePath node of the *dat-ini.xml* file.

   Figure 9-24. paramFilePath Node

```
<ADCInfo>
 <adcIniFilePath file="./adc-ini.xml"/>
 <paramFilePath file="param.xml"/>
</ADCInfo>
```

4. You can save changes in your inspection file by selecting **Save** or **Save As**.

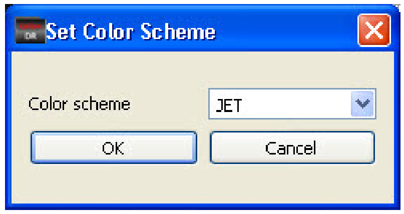
Setting the Image Color Scheme

You can specify a new color scheme to apply to colored images (when you select the Colored option from the right-click menu of an image display) in Calibre DefectReview. The Colored option applies the selected color scheme to the Defect image, Reference image, and so on in the layout based on the image type.

Procedure

1. In the Calibre DefectReview window, select **Settings** > **Set Color Scheme**.

Figure 9-25. Set Color Scheme Dialog Box

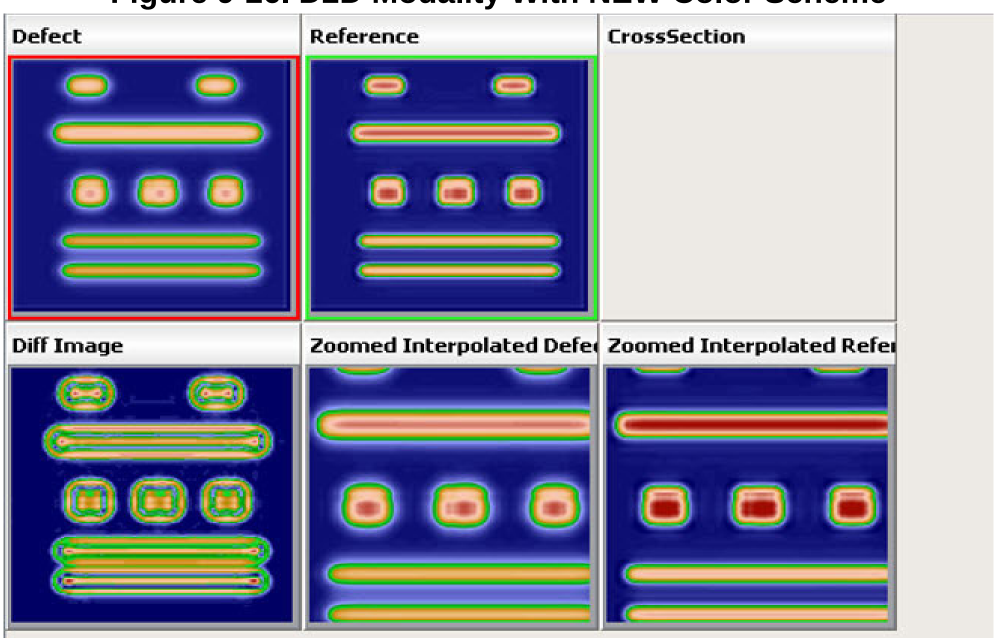


2. Select a color from Color scheme drop down list. The available color schemes are as follows:

    - JET (this is the default)
    - HSV
    - NEW
    - FILE

    Click **Ok**. The selected color scheme is applied while displaying the colored images. Figure 9-26 and shows an example image with the NEW color scheme applied.

Figure 9-26. D2D Modality With NEW Color Scheme



Note

For LDF inspection reports, only JET and HSV color schemes are supported. NEW is not supported as it is a function of defect and reference images that are not present in an LDF file. FILE-based color schemes are only supported for LRF format. When you select either NEW or FILE, then Calibre DefectReview defaults to JET and issues a warning such as “Color scheme NEW or FILE not supported for these images, defaulting to JET”.

FILE-Based Colormaps

In addition to predefined colormaps such as JET and HSV for displaying color images in the IMU, you can specify your own colormaps in a colormap file.

The colormap file should be in the same folder where the defect file is kept and also share the same name as the defect file with the additional extension of *.colormap*. For example, if your defect file is *test.lrf* then colormap file name is *test.lrf.colormap*.

The colormap file is a text file and is organized as follows:

```
[transmitted]
GL[0]=24,34,90                    //GL 0 is mapped to Color (R,G,B)
GL[1]=34,23,34                    //24, 34, 90
...
GL[255]=5,34,90                   //All GLs from 0 to 255 should be
[reflected]                       //mapped to a color.
GL[0]=24,34,90
GL[1]=34,23,34
...
GL[255]=5,34,90
[difference]
GL[0]=24,34,90
GL[1]=34,23,34
...
GL[255]=5,34,90
```

There are 3 sections of the colormap:

- Transmitted — Specifies the colormap to be used for Defect, Reference images for D2D, D2M Comparison and Defect images of NonD2D comparisons.
- Reflected — Specifies the colormap to be used for Reflected Defect, Reflected Reference images of D2DRef comparisons, and Reflected Defect Images of NonD2D comparisons.
- Difference — Specifies the colormap to be used for Diff, Reflected Diff, Sign Diff, and Reflected Sign Diff images.

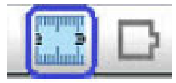
Using the Ruler

Ruler is provided in Image Measurement to measure the distance between two points on the images.

Procedure

1. In the IMU window toolbar, click the **Ruler** button.

Figure 9-27. Ruler Button

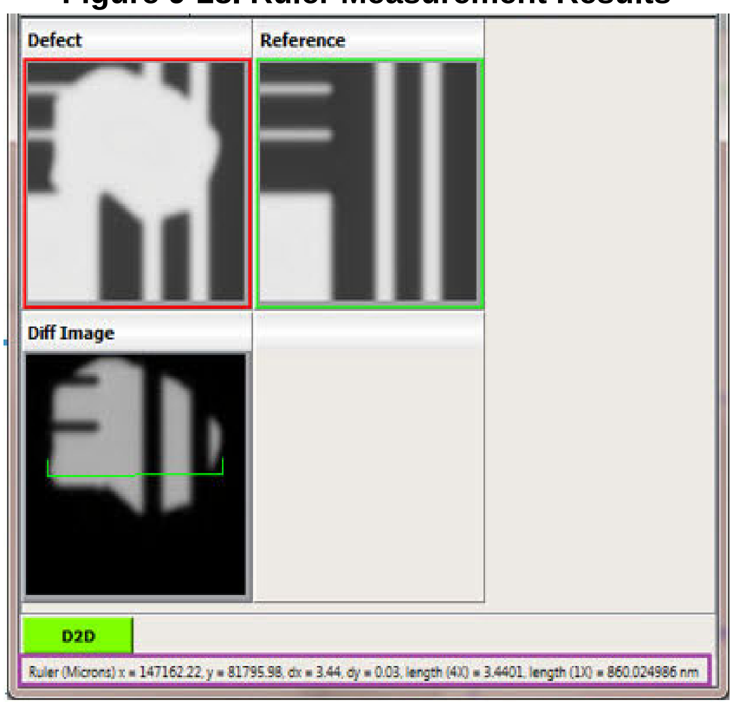


2. Left-click in any image to select a starting point for measurement.
3. Drag the cursor to the end measurement point, then release. A line is visible between the start and end points until the mouse is released.

   The Ruler displays the distance measured between the start point and the end point, and information about the ruler is displayed in the status bar of the IMU window (see Figure 9-28).

   Refer to the status bar description on "The Image Measurement Unit Window" on page 267 for more details.

Figure 9-28. Ruler Measurement Results



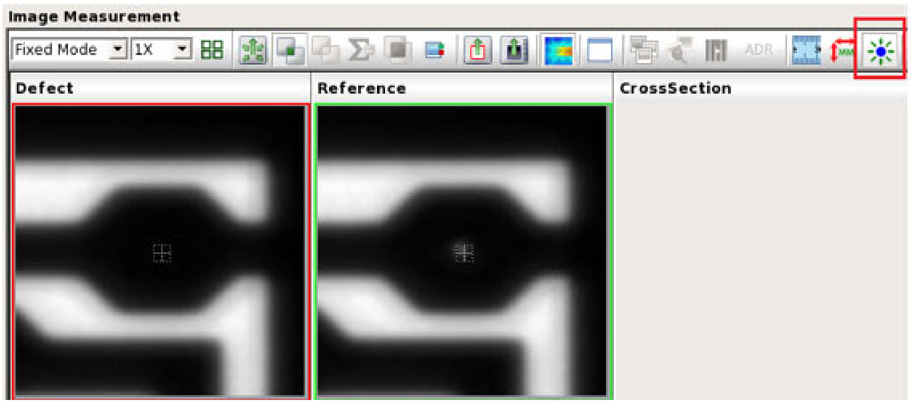
Displaying Measurement Values

The measurement location can be viewed on the defect and reference images using the Display Measurement feature.

Procedure

1. In the IMU tool bar, click the Display Measurement button.

Figure 9-29. Display Measurement



2. To view CD measurement values such as CDVar, LOC, and CDType, run Calibre DefectClassify (see the *Calibre DefectClassify User's Manual* for details).

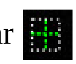
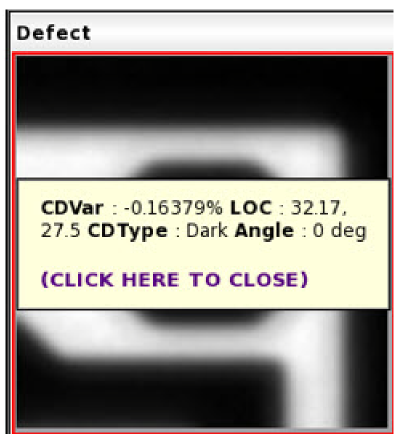
3. In an IMU, double-click the Display Measurement cross bar  on the image. Values are displayed in a tooltip as shown in the following figure.

Figure 9-30. CD Measurement Values



4. To close the tooltip, click the tooltop box.

Gray Level Matrix Operations

A gray level matrix of a grayscale image is a 2D array of image pixels' intensities across its length and width. The pixel intensities are indicative of image texture. You can view, overlay, or save gray level matrices in the IMU window.

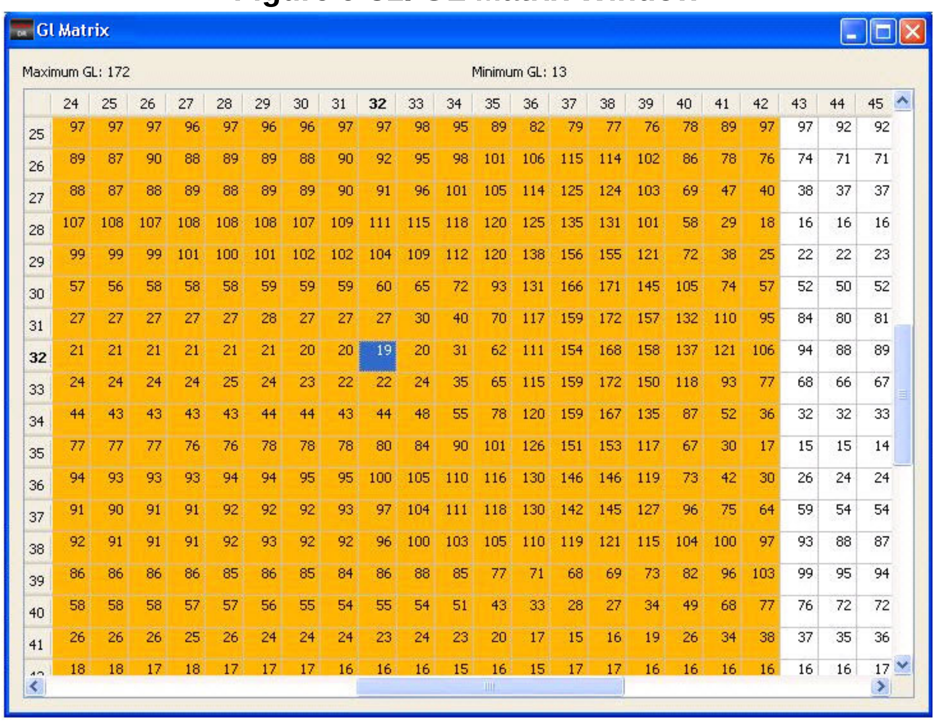
Viewing a Gray Level Matrix

You can view the gray level values in a table by selecting the **GL Matrix > Show** option from a right-click menu.

Procedure

1. Right-click on an image. A popup menu appears.
2. Select **GL Matrix > Show** from the right-click menu to see the gray level values in a table. The GL Matrix window appears, displaying the gray level values.

Figure 9-31. GL Matrix Window



The Gray Level Matrix displays the gray level value of each pixel of the image. The row and column headers indicate the pixel number in X- and Y-directions. The defect window region of the image is highlighted in orange.

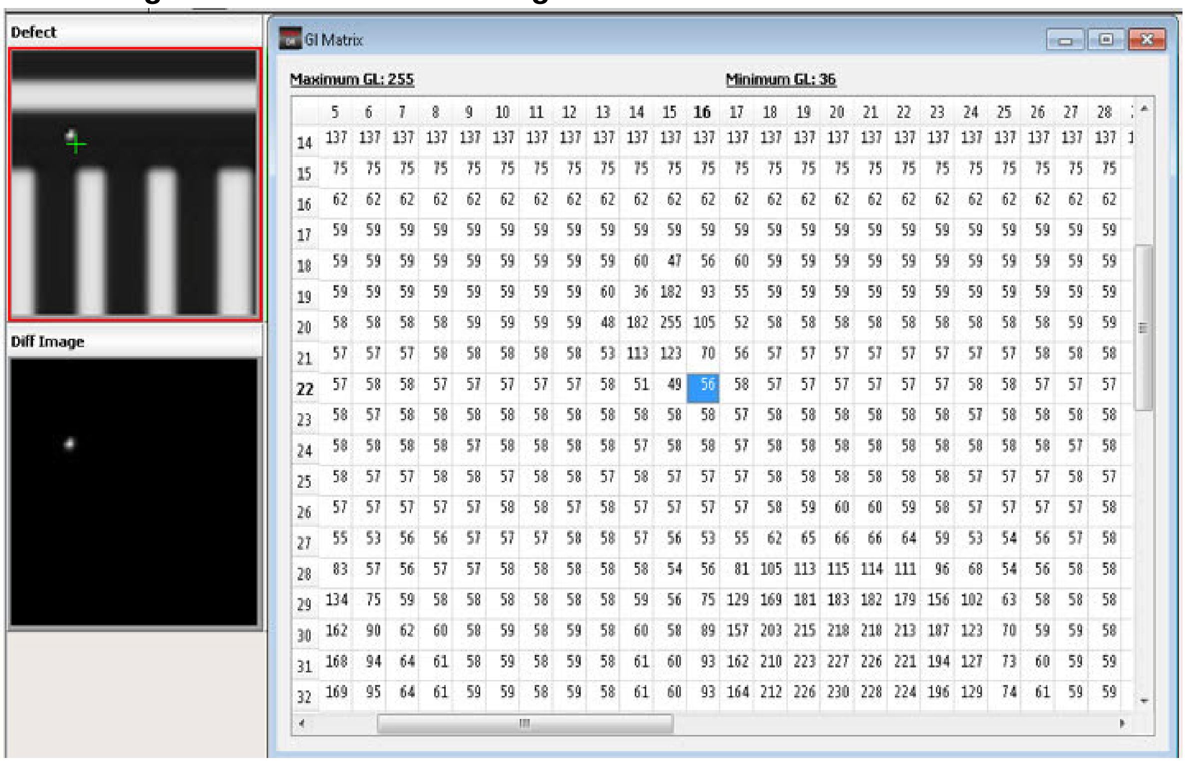
Note

The region is highlighted in orange only when the Defect window is enabled. Otherwise, the table is displayed in white.

You can navigate to other cells in the GL Matrix window using the mouse or arrow keys. By default, the center of the image is selected and the cell is highlighted in the window. A plus marker (+) is displayed on the image indicating the currently selected cell (see Figure 9-32).

The Gray Level Matrix always displays the gray level values of the original image irrespective of the current image view.

Figure 9-32. Marker Showing Current Cell in GL Matrix Window



Overlaying a Gray Level Matrix

You can find the intensity value per pixel of an image in the Image Measurement window by overlaying gray level values onto that image.

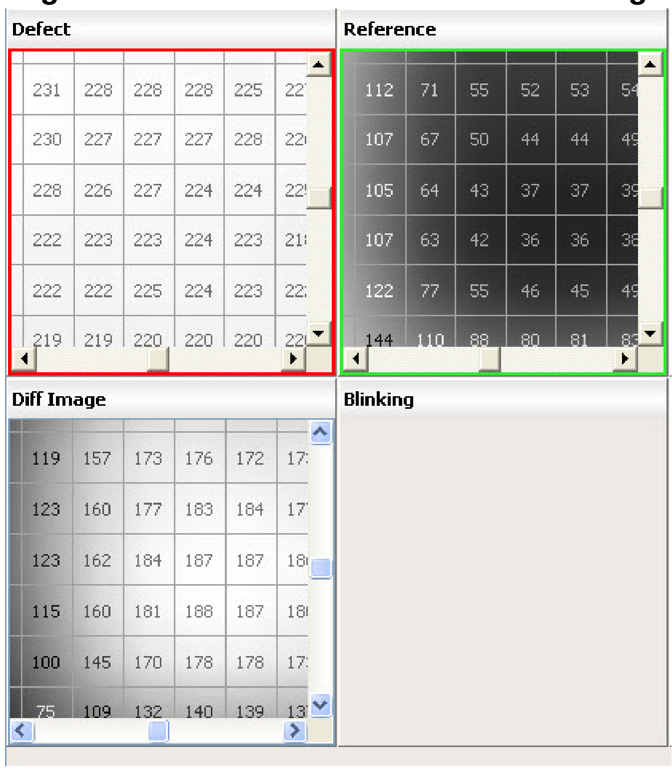
Procedure

1. In the IMU toolbar, click the **GL Matrix Overlay** button.

Figure 9-33. GL Matrix Overlay Button

2. The gray level values are overlaid on the image, as shown in Figure 9-34.

Figure 9-34. Visible GL Matrix on the Image



Note

The current state of the **Overlay** option is retained when navigating between defects.

3. The GL Matrix can be seen only after a certain zoom level. Zoom in on the image if the GL Matrix does not appear after enabling GL Matrix Overlay.
4. The GL Matrix is not available for the following images: Binary, Inverted Binary, Inverted, Defect Threshold Image, Reference Threshold Image, Defect Edge Image, and Reference Edge Image.
5. The overlay option automatically zooms in on images with reference to the Defect and Reference images so that the GL Matrix can be seen on both.

Note

The GL Matrix Overlay can also be enabled by right-clicking the IMU’s image and selecting **GL Matrix** > **Overlay**.

Saving a Gray Level Matrix

The GL Matrix can be saved to a CSV file by selecting the **GL Matrix > Save** option from a right-click menu.

Procedure

1. Right-click on an image. A popup menu appears.
2. Select **GL Matrix > Save** from the right-click menu to save the gray level values in a CSV file. This CSV file can be viewed in a spreadsheet application such as Microsoft Excel.

Cross Section Analysis

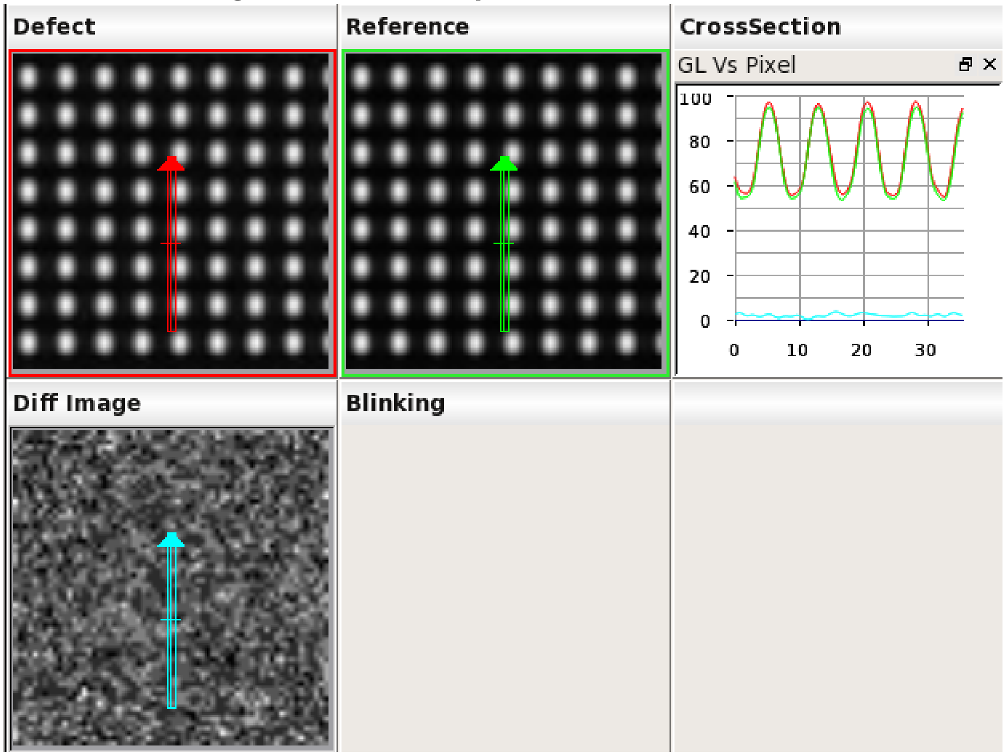
You can perform a cross-sectional analysis in the specified area of any image in the Image Measurement window. The results are plotted in a graph with gray level (GL) values compared against the pixel locations in the selected area of the image.

Cross Section Analysis works differently in Fixed Mode and Free Mode.

The Cross Section Bar

When cross section analysis is performed, a cross section bar is drawn to indicate the analysis region. The cross section bar appears as an arrow within a bounding box (click the Display Cross Section Bar icon in the Image Measurement button bar if it is not displayed).

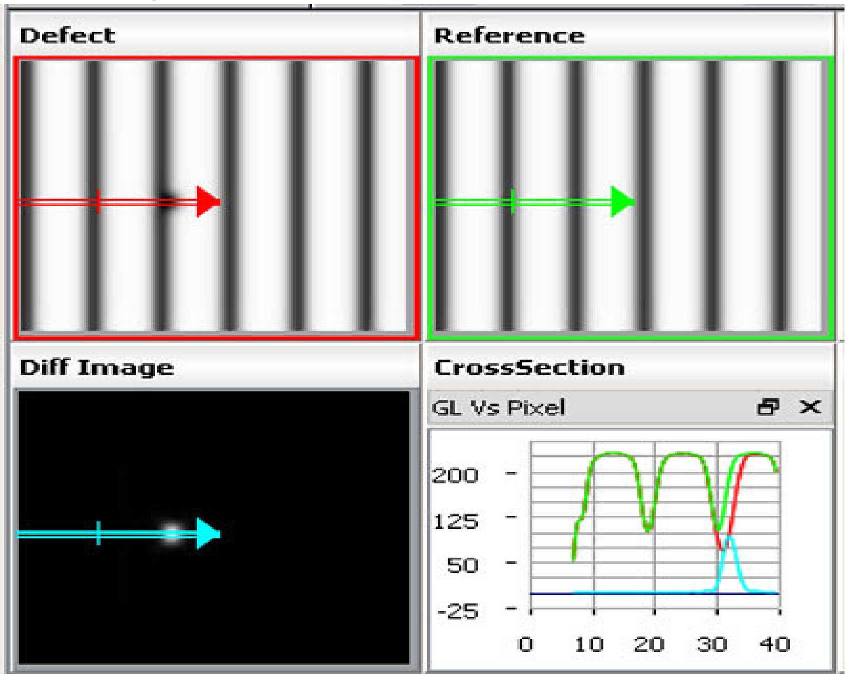
Figure 9-35. Example Cross Section Bar



The gray level (GL) value for the pixels of the cross section area outside an image is never shown.

Figure 9-36 illustrates a cross section plot where the starting point of the cross section bar (the arrow object) is outside the image.

Figure 9-36. Example Cross Section Plot



Cross Section Bar Display Properties

You can modify the default size of the cross section bar in the *dat-ini.xml* file. You can enter the width and height of the cross section bar in the DefaultCsbWidth and DefaultCsbHeight nodes respectively.

Figure 9-37. Setting Default Cross Section Bar Height and Width

```
<NumMeasurements>1</NumMeasurements>
<EnableFixedCsbWidth>false</EnableFixedCsbWidth>
<DefaultCsbWidth>30</DefaultCsbWidth>
<DefaultCsbHeight>30</DefaultCsbHeight>
<CrossSectionBarStepSize>5</CrossSectionBarStepSize>
<ShowGLVsPixelChartButton>true</ShowGLVsPixelChartButton>
</ImuInfo>
```

The width of cross section bar bounding box can also be modified based on the Distance between Measurements and Number of Measurements values specified in CD Measurement Results section of the GL Vs Pixel window (see “CD Measurement Results” on page 326) for further information). You can enable this by setting “false” to the EnableFixedCsbWidth entry in the ImuInfo node of the *dat-ini.xml* file.

Figure 9-38. Activate or Deactivate Fixed Cross Section Bar Width

```
  <NumMeasurements>1</NumMeasurements>
  <EnableFixedCsbWidth>false</EnableFixedCsbWidth>
  <DefaultCsbWidth>30</DefaultCsbWidth>
  <DefaultCsbHeight>30</DefaultCsbHeight>
  <CrossSectionBarStepSize>5</CrossSectionBarStepSize>
  <ShowGLVsPixelChartButton>true</ShowGLVsPixelChartButton>
</ImuInfo>
```

Rotating a Cross Section Bar

You can rotate the position of a cross section bar by selecting options from a right-click menu on the bar itself.

Procedure

1. Right-click on a cross section bar to invoke a popup menu.
2. Select one of the following options from the popup menu.

Table 9-7. Right-Click Menu for Cross Section Bar

Item	Description
Reset	Resets the cross section bar to the original settings after you have rotated or moved it.
Rotate 90 degrees	Rotates image in multiples of 90 degrees in clockwise direction.
Rotate 45 degrees CW	Rotates image in multiples of 45 degrees in clockwise direction.
Rotate 45 degrees CCW	Rotates image in multiples of 45 degrees in counter-clockwise direction.
Rotate any degrees CW	Rotates cross section in a specified angle in clockwise direction. A dialog box appears requesting the rotation angle. Enter the rotation value, then click **Ok**.
Specific Location	Moves and rotates the cross section bar to the specified location and angle. A dialog box appears showing current location and angle. Change the location and or rotation as needed and click **Ok**. This option is only available in Fixed mode

If any of these options are selected, the cross section is rotated (or moved) by the selected angle (or to a selected location) and the cross section plot is updated to reflect the changes. In Fixed Mode, the cross section in all the images is rotated by the selected angle.

The CrossSection Graph (GL Vs Pixel Window)

To access: Appears automatically in the IMU window after a Cross Section Analysis is performed.

The CrossSection window is docked to the IMU window by default and displays only the graph while docked. When undocked, the CrossSection window becomes the GL Vs Pixel window and displays more details.

Description

Figure 9-39 shows the CrossSection window while docked, and Figure 9-40 shows the undocked GL Vs Pixel window. This window can be docked or undocked by double-clicking on the window header or clicking the Maximize button at the top right corner.

Figure 9-39. CrossSection Docked View

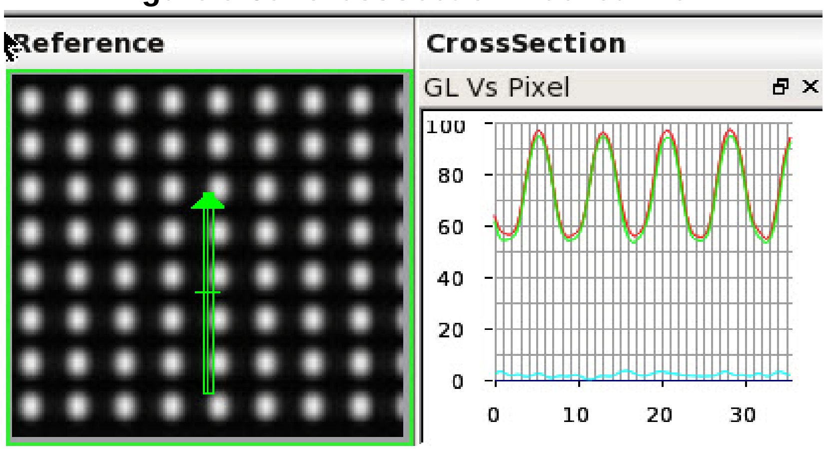


Figure 9-40. GL Vs Pixel Undocked View

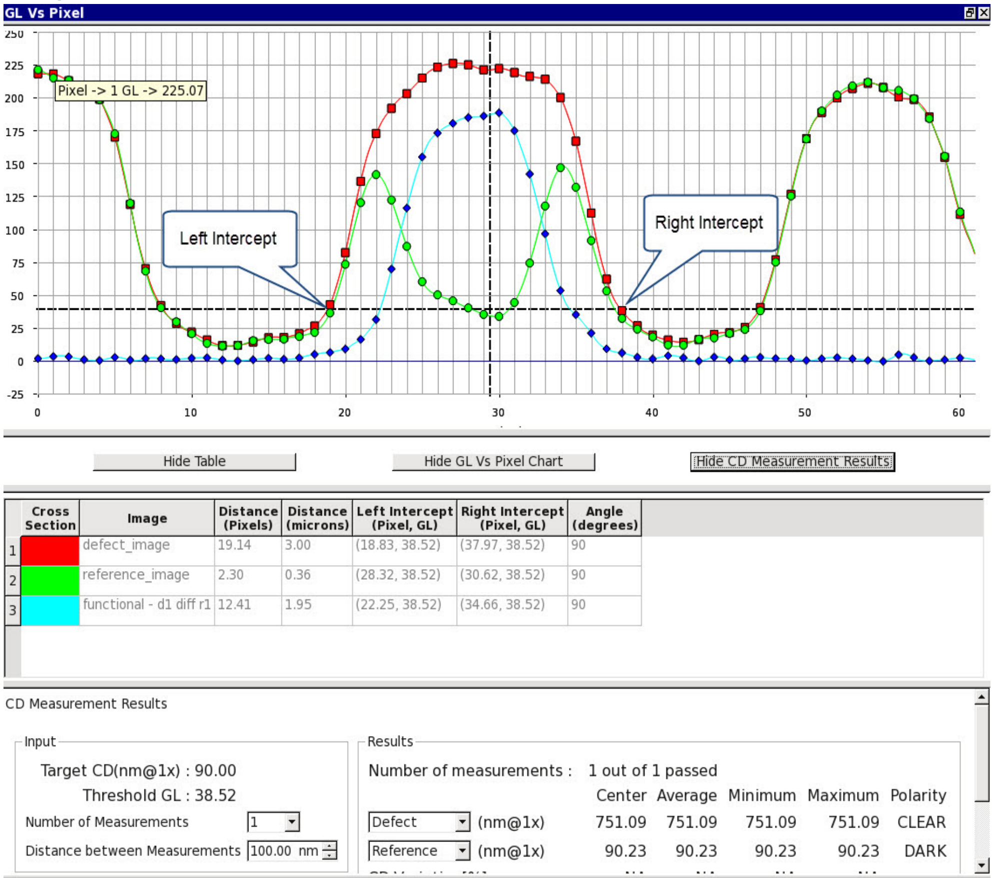
Figure 9-40 illustrates all sections of the GL Vs Pixel window displayed (including the plot, Cross Section Table, and CD Measurement Results). By default, the GL Vs Pixel only initially displays the plot in the undocked view.

The CrossSection graph displays the graph as Gray Level values versus Pixel numbers (location) (GL Vs. Pixel). Pixel numbers are plotted on the X-axis and gray level values are plotted on Y-axis. More details about the cross section plot are displayed if you left-click on the cross section plot.

In the undocked view, the CrossSection graph can be hidden by clicking the **Hide GL Vs Pixel Chart** button. Once the plot is hidden, the button changes into a **Show GL Vs Pixel Chart** button.

If you run Cross Section Analysis, horizontal and vertical dotted lines are projected on the Y- and X-axis of the cross section plot. The horizontal and vertical dotted lines indicate the gray level and pixel values. A tool tip is also displayed when if you hover your mouse pointer over the graph (shown in Figure 9-41).

Figure 9-41. Horizontal and Vertical Line on Cross Section Plot



The CrossSection and GL Vs Pixel windows can be deactivated with the Close button on either window or by clicking on an enabled Display Cross Section Bar button.

Note

If multiple intersection points are found on the plot, Calibre DefectReview considers all the intersections points and reports the intercept information only at the center of the cross section plot. Figure 9-41 displays the cross section plot where a horizontal line of the cross section plot intersects at multiple points with the plot of the Defect and Reference images. However, the intercepts that are considered for this analysis are the ones close to the center of the plot. Figure 9-41 shows callouts of the left and right intercepts (intercepts close to the center of the plot) that are considered for the analysis. If the plot is for an Absolute Difference image, a Difference cross section plot is rendered.

Objects

The following appears only when the GL Vs Pixel window is undocked.

Table 9-8. GL Vs Pixel Window Fields

Field		Description
Cross Section		Displays graphs generated from Cross Section Analysis.
Button Bar		Controls to show or hide different panes in the GL Vs Pixel window.
	Show or Hide Table	Shows or hides the Cross Section Table. "Cross Section Table" on page 315.
	Show or Hide GL Vs Pixel Chart	Shows or hides the GL Vs Pixel Chart. You can activate or deactivate the **Show GL Vs Pixel Chart** button using the ShowGLVsPixelChartButton node in the *dat-ini.xml* file (see "Display or Hide Show GL Vs Pixel Button" on page 315).
	Show or Hide CD Measurement Results	Shows or hides the CD Measurement Results pane.
Cross Section Table		Lists information about the Cross Section lines that are plotted on the Cross Section plot. See "Cross Section Table" on page 315 for further information.
CD Measurement Results		Displays a report of the inputs and results of a CD measurement operation. See "CD Measurement Results" on page 326 for further information

Cross Section Table

To access: Click **Show Table** in the GL Vs Pixel window

The Cross Section Table displays information about the Cross Section lines that are plotted on the Cross Section plot.

Description

A Cross Section Table is displayed in the undocked view. If you left-click on the graph plot line, the left and right intercepts (intersection point of the horizontal line with the cross section results) of the images are computed as shown in Figure 9-41.

Objects

Table 9-9. Cross Section Table Fields

Field	Description
Cross Section	Specifies the color of the cross section lines of the cross section plot.
Image	Specifies the image name which the cross section plot corresponds to.
Distance (Pixels)	When clicked on the cross section plot, a horizontal and vertical dotted line is displayed over the cross section plot. If the horizontal dotted line intersects the cross section line, then the distance between the left intercept and right intercept is measured and displayed in pixels.
Distance (Microns)	Specifies the distance measured between the left and right intercepts in microns.
Left Intercept (Pixel, GL)	Specifies the left intersection point of the horizontal line with the cross section line.
Right Intercept (Pixel, GL)	Specifies the right intersection point of the horizontal line with the cross section line.
Angle (degrees)	Specifies the angle at which the cross section is taken.

If any of the information cannot be computed, then the entries in the table are set to NA, indicating that the entry is not applicable.

Display or Hide Show GL Vs Pixel Button

You can display or hide the **Show GL Vs Pixel Chart** button using the ShowGLVsPixelChartButton node in the *dat-ini.xml* file.

This is illustrated in Figure 9-42.

Figure 9-42. Display or Hide Show GL Vs Pixel Button

```
<NumMeasurements>1</NumMeasurements>
<EnableFixedCsbWidth>false</EnableFixedCsbWidth>
<DefaultCsbWidth>30</DefaultCsbWidth>
<DefaultCsbHeight>30</DefaultCsbHeight>
<CrossSectionBarStepSize>5</CrossSectionBarStepSize>
<ShowGLVsPixelChartButton>true</ShowGLVsPixelChartButton>
</ImuInfo>
```

If the value of the ShowGLVsPixelChartButton node is true, the Hide/Show GL Vs Pixel Chart button appears in the GL Vs Pixel dialog box. Otherwise, the button is not visible.

Performing Cross Section Analysis

You can perform Cross Section Analysis from the IMU window. Cross Section Analysis behaves slightly differently between Fixed Mode and Free Mode.

Use the Cross Section Enabler (Fixed Mode Only)

For Fixed Mode, when performing Cross Section Analysis in Fixed Mode, you must first configure the images using the Cross Section Enabler. The Cross Section Enabler is not available in Free Mode.

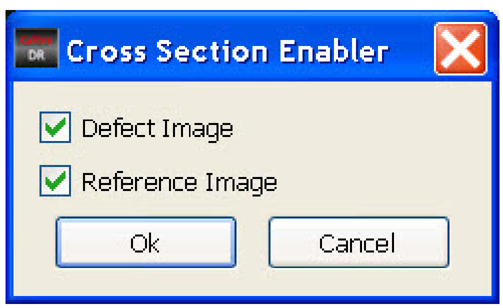
Procedure

1. Click the Cross Section Enabler button in the IMU window toolbar.

Figure 9-43. Cross Section Enabler Button

2. The Cross Section Enabler dialog box appears.

Figure 9-44. Cross Section Enabler Dialog Box



3. In the Cross Section Enabler dialog box, select the images on which you want to see the Cross Section and click **Ok**.
4. Click the Display Cross Section Bar button in the IMU window toolbar. The cross section is computed on images that are selected using the cross section enabler.

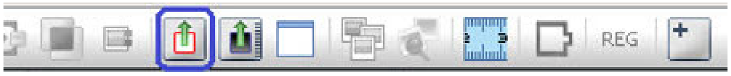
Performing the Analysis

Perform the analysis by using the cross section bar.

Procedure

1. Right-click on a display unit and select **CrossSection** from the menu to display the CrossSection window.
2. If you are in Fixed Mode, click the Display Cross Section Bar button.

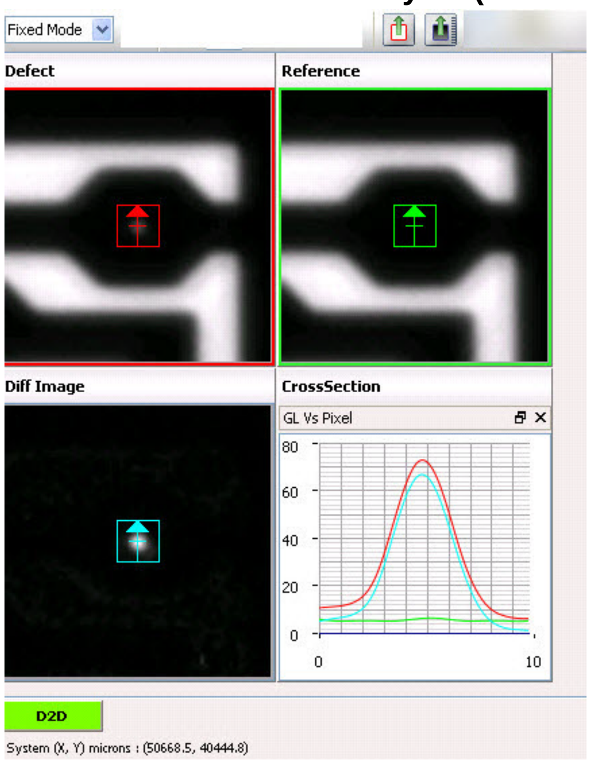
Figure 9-45. Display Cross Section Bar Icon (Fixed Mode)



If you are in Free Mode, select **Cross Section** from the same right-click menu to perform Cross Section Analysis.

The cross section bar (an arrow object) is displayed on the Defect, Reference and Functional images present in IMU window as shown in Figure 9-46.

Figure 9-46. Cross Section Analysis (Fixed Mode)



The graph plot results of a Cross Section Analysis is displayed in the CrossSection display of the IMU window. The color of each plot on the graph corresponds to the color of the cross section bar displayed on the image.

For example, as shown in Figure 9-46, the red plot in the cross section graph corresponds to the Defect image (where the cross section bar is also displayed in red).

The gray level values along the region of the cross section bar are plotted in the Cross Section graph. Interpolation is used in plotting the cross section. The interpolation ratio is specified as described in "Setting Image Interpolation Properties" on page 351.

In Free Mode, Cross Section Analysis renders two cross section bars on an image. Initially, both two bars are shown at the same location, overlapping each other completely. You can select one box and move it by dragging using mouse or keyboard arrow keys.

3. Position the cross section bar to where you want to make your analysis. The cross section bar can be moved by clicking and dragging with your mouse or with arrow keys.

4. To make finer, sub-pixel movements of the cross section:

    a. Click the cross section bar.

    b. Place the mouse pointer over the cross section bar so that the mouse pointer appears as four-arrow headed or single-arrow headed.

    c. Use arrow keys to move in the required direction. The step size (*S*) of the cross section movement is determined by the following equation:

    S = *N* x 1/*Interpolation Ratio*

    where value of *N* can be configured in the *dat-ini.xml* file using the following node:

    <CrossSectionBarStepSize>*N*</CrossSectionBarStepSize>

    You can also change the rotation angle of the cross section bar. See "Rotating a Cross Section Bar" on page 310 for further details.

    Once the cross section bar is in place, the CrossSection graph automatically appears, calculating based on where the bar is located.

5. You can perform a number of additional operations by right-clicking the CrossSection window graph. These include the following:

Table 9-10. Operations in the CrossSection or GL Vs Pixel

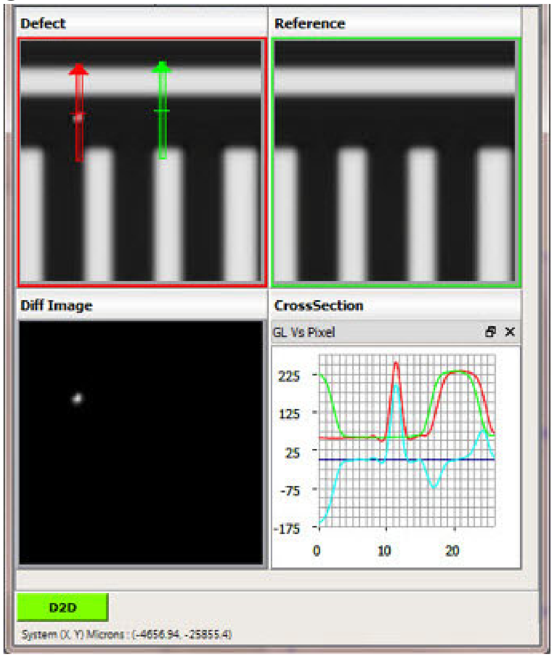
Option	Description
Show All	Show all lines on the plot graph.
Hide All	Hide all lines on the plot graph.
Ruler	Enables a ruler tool to measure differences in gray levels based on distance. You can click on a starting point in the GL Vs Pixel window and then drag a line to an end measurement point. The resulting measurement appears at the bottom of the graph, as shown in Figure 9-47. This option is enabled only when the GL Vs Pixel window is undocked.
Zoom On	Zooms in on the selected region in the graph. This option is enabled only if your mouse pointer is not on any cross section curve on the graph.

Table 9-10. Operations in the CrossSection or GL Vs Pixel (cont.)

Option	Description
Vertical Grid Horizontal Grid	Shows or hides vertical and horizontal grid lines on the graph.

6. To activate and deactivate Cross Section Analysis in Free Mode, right-click on the image and check or uncheck **Cross Section**. Cross Section Analysis can also be deactivated by clicking the Close button of the CrossSection window in Free Mode.

Figure 9-47. Cross Section in Free Mode



In the CrossSection window, the cross section is displayed for the two bars as well as the difference between the cross section lines. As shown in Figure 9-47, the red and green lines correspond to the two cross section lines with red and green bars on the image. The blue graph line in the plot illustrates the difference between the two cross section plots. Initially, both red and green boxes are shown at the same location, overlapping each other, completely. You can select one box using the mouse and move it by dragging using the mouse or keyboard arrow keys.

CD Measurement

CD Measurement computes the critical dimension on any pattern on the image. CD Measurement measures the dimension of the pattern on the image with respect to a gray level value. CD analysis computes the distance between the two pixels with the same gray level value on the pattern.

Measuring Critical Dimension

CD Measurement works along with Cross Section Analysis in the IMU window.

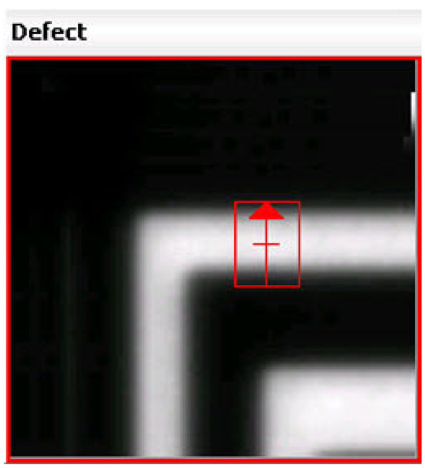
Prerequisites

- You must have set up a Cross Section Analysis (as described in "Cross Section Analysis" on page 307) such that you have a Cross Section Bar displayed (for either Fixed Mode or Free Mode).

Procedure

1. Move the cross section bar to the location where you want to perform CD measurement.

Figure 9-48. Cross Section Bar on a Defect

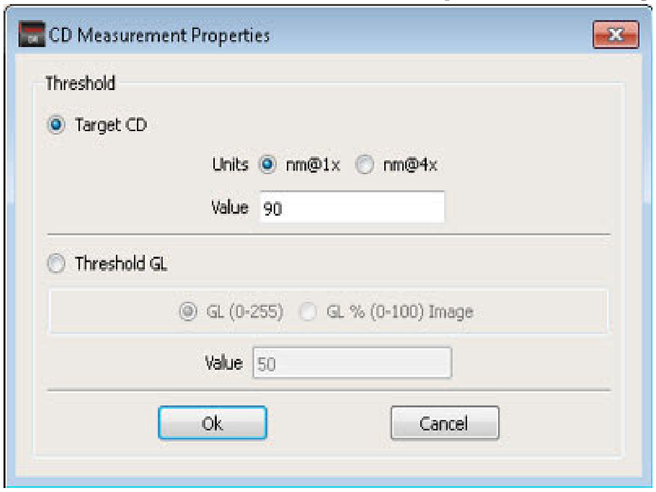


2. Double-click the CrossSection window header to undock it (or click the Maximize button).

3. Set the parameters for CD Measurement using the **Settings** menu. Refer to "Setting CD Measurement Properties" on page 348 for details.

4. Enter either the Target CD or Threshold GL value (as shown in Figure 9-49) and click **Ok**. For further information on Target CD and Threshold GL, see “Gray Level and Target CD Computation” on page 322.

Figure 9-49. CD Measurement Properties Dialog Box



5. Click **Use global GL/Target CD** in the CD Measurement Results section of the GL Vs Pixel window. Click **Show CD Measurement Results** if the section is not visible.

Figure 9-50. Use global GL/Target CD Button

Results

The CD report is updated in the GL Vs Pixel window. CD Measurement is performed based on the Gray Level or Target CD value specified in the CD Measurement Properties dialog box. Refer to “Setting CD Measurement Properties” on page 348 for details.

Gray Level and Target CD Computation

Calibre DefectReview computes the Target CD and Gray Level (GL) using different methods that you can specify.

When performing CD measurement, you can select either Target CD or Threshold GL as the computation method in the CD Measurement Properties dialog box (see “Measuring Critical Dimension” on page 321 for further details).

- Target CD

  The Target CD is the input CD at which the variation is to be measured. If the Target CD is specified, then Calibre DefectReview computes the gray level on the image selected in the second combo box (the Reference image in Figure 9-51) where Target CD is found and applies the gray level to compute the CD on the other image (the Defect image in Figure 9-51). For example, if the Target CD is specified as 90, then Calibre DefectReview computes the gray level as 90 on the reference image, then calculates the CD on the defect image at the same gray level.

- Threshold GL

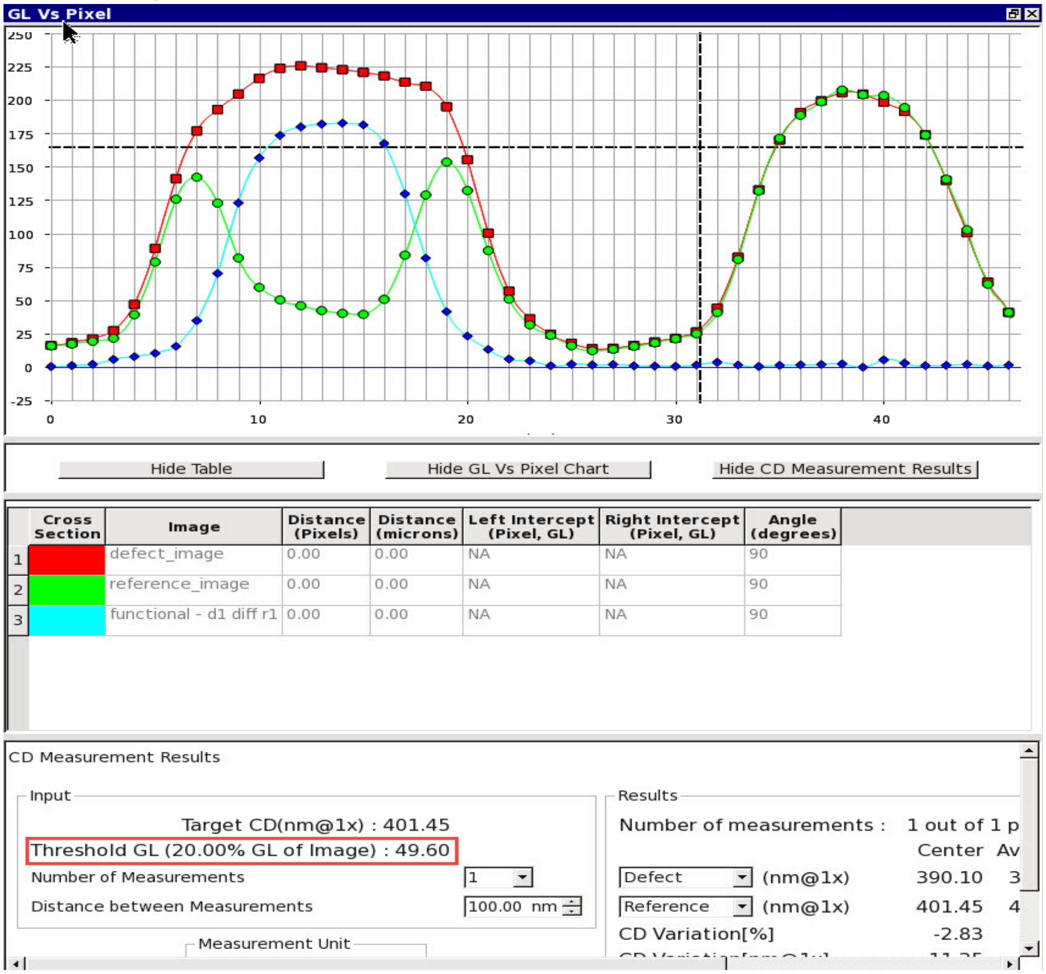
  If Threshold GL (0-255) is specified, then Calibre DefectReview computes the CD on selected images (the Defect and Reference images in Figure 9-51) at the gray level value.

  If Threshold GL % (0-100) Image is specified, then Calibre DefectReview first computes the threshold GL value based on the dynamic range of the image selected in the second combo box (the Reference image in Figure 9-51), then uses the computed GL value to measure CD.

  For example, if you specify 20% as the binarization threshold GL and the dynamic range of the image is 5GL to 248GL, then the value of threshold GL will be calculated using the following formula:

  min + (max - min) * percentage = 5 + (248 - 5) * 0.2 = 49.60

Figure 9-51. CD Based on the Threshold GL % (0-100)

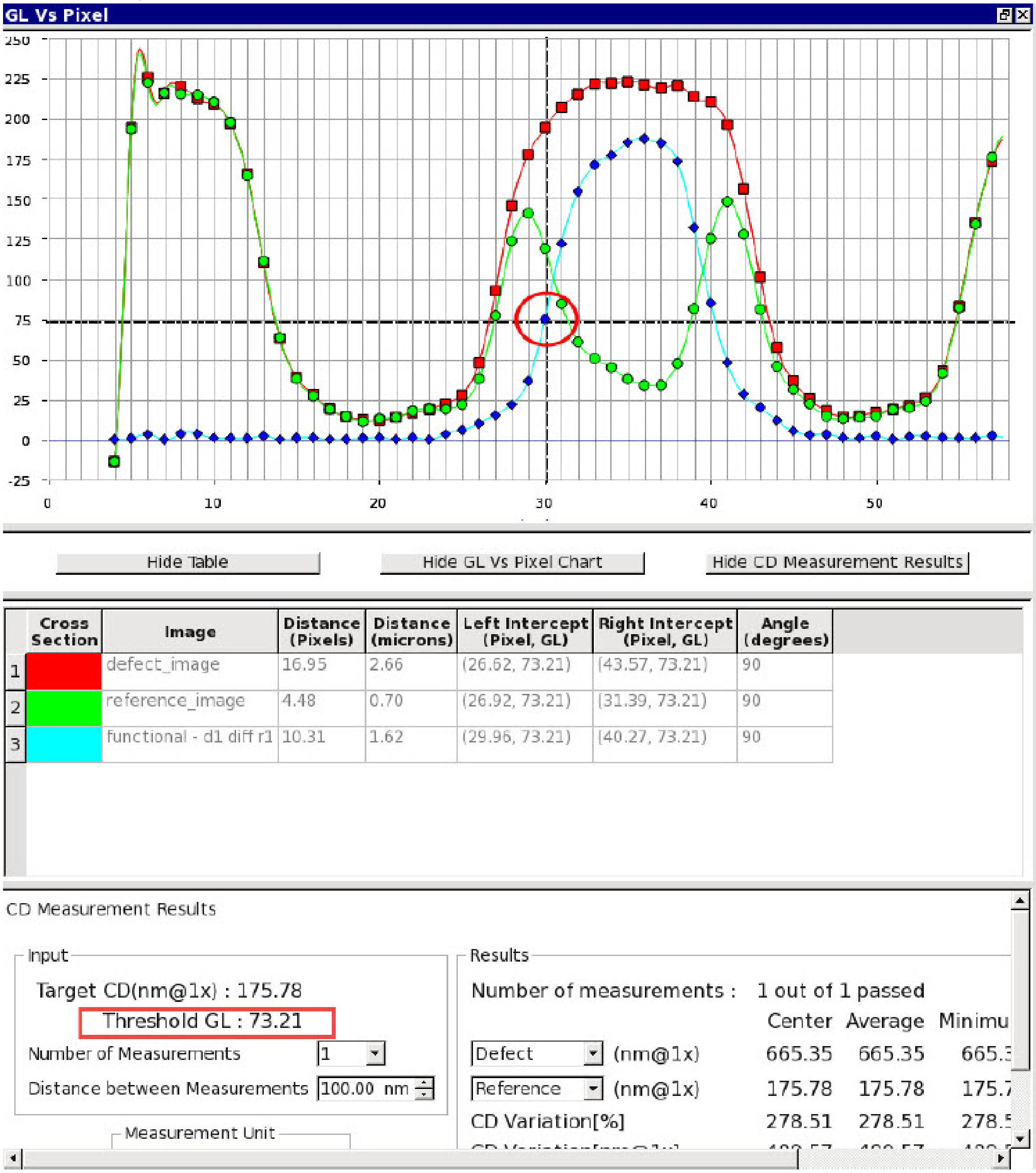


Apart from setting gray level values in "Setting CD Measurement Properties" on page 348 the gray level can be applied by left-clicking the Cross Section plot in the GL Vs Pixel window.

If you left-click the cross section plot area, the gray level value is obtained based on where you clicked in the cross section plot. The CD is then computed on the images based on the gray level value.

For example, as shown in Figure 9-52, if you click the cross section plot at the eight pixel on gray level 73.21, the CD computation is performed based on a value of 73.21 as the gray level.

Figure 9-52. Example CD Computation With Cross Section Plot



CD Measurement Results

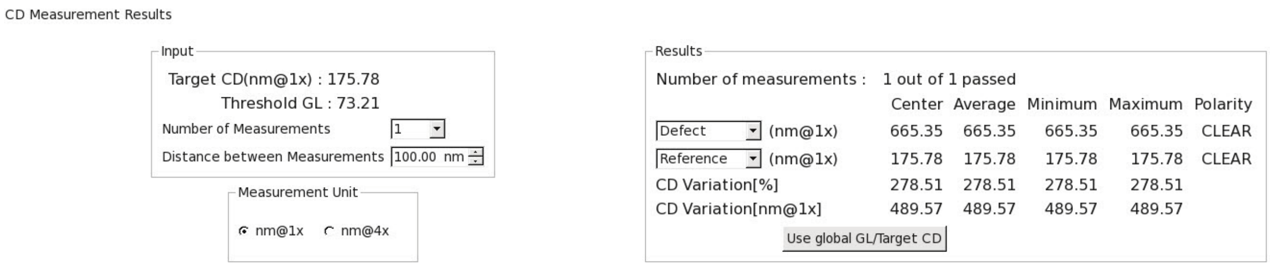
To access: Invoke the GL Vs Pixel window (see "The CrossSection Graph (GL Vs Pixel Window)" on page 311)

The CD Measurement Results section of the GL Vs Pixel window is a report that displays the inputs specified for CD analysis as well as the results.

Description

An example report is shown in Figure 9-53.

Figure 9-53. CD Measurement Results



The CD Measurement Report is divided into three functional areas:

- Input

  The Input area contains the Target CD, Threshold GL, Number of Measurements, and Distance between Measurements used to compute the CD. Note that input values change if you left-click on the CrossSection window plot area.

- Measurement Unit

  The Measurement Unit area allows you to specify the unit to display the results of the CD Measurement operation, either in 1x (wafer) or 4x (mask units).

- Results

  The Results area displays the results of the CD Measurement operation.

Objects

Table 9-11. CD Measurement Results Fields

Fields		Description
Input		Specifies inputs used to compute the CD.
	Target CD	Specifies that the gray level on the second selected image be computed where the Target CD is located and then the results be applied to compute the CD on the other image. Refer to the Usage Notes of this section for an example.

Table 9-11. CD Measurement Results Fields (cont.)

Fields		Description
	Threshold GL	If Threshold GL (0-255) is specified, then Calibre DefectReview computes the CD on the images at the gray level value. If GL % (0-100) Image is specified, then Calibre DefectReview first computes the threshold GL value based on the dynamic range of the second selected image of the current defect. It then takes the computed GL value to measure the CD. Refer to the Usage Notes of this section for examples.
	Number of Measurements	Specifies the number of CD measurements.
	Distance Between Measurements	Specifies the distance between measurements in nanometers between the cross section bar lines. The minimum value that can be entered is calculated as a Pixel Size (in nm) / interpolation ratio. The maximum value is fixed to 200 nm. The default value can be configured using the distanceBetweenMeasurement node in the *dat-ini.xml* file. Refer to the Usage Notes of this section for an example.
Measurement Unit		Reports the results in the units specified by the user. If you select (nm@1x), then all the results of the CD Measurements are displayed in 1x (wafer) coordinates, and if you select (nm@4x), then the results are displayed in mask coordinates.
Results		Reports the results of the CD Measurement operation.

Table 9-11. CD Measurement Results Fields (cont.)

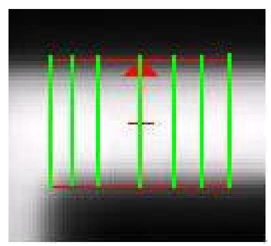
Fields		Description
	Number of Measurements	The cross section bar displays the cross section area on which Cross Section Analysis and CD measurement is computed. The cross section line displayed in the CrossSection window graph displays the plot only for the center line displayed in the cross section bar. The Number of Measurements specifies the number of additional lines to be drawn parallel to the center line. The number of measurements is used to analyze the cross section and CD on a region to view variations of the CD across that region instead of computing only on a single line. For example, if the number of measurements is set to 7, then the Cross section and CD is computed on 7 lines as shown in Figure 9-54. The cross section bar displays the parallel lines on which the computation is done. The line displayed in the cross section bar is considered as the center line. **Figure 9-54. Number of Measurements** 
	First Selected Image Width (nm@1x)	Specifies the CD value calculated on the image selected in the first combo box (drop-down list) and is shown in the unit selected by the user. You can select any image from the drop-down list as the first image. When you navigate defects, the selected image is recorded.
	Second Selected Image Width (nm@1x or nm@4x)	Specifies the CD value is calculated on the second selected image and is shown in the unit selected by the user. . You can select any image from the drop-down list as the second image. During navigation of defects, this selected image is recorded. **Note:** The Target CD value is calculated based on this image value.
	CD Variation[%]	Specifies the CD variation between the first and second selected images and is reported in terms of percentage.
	CD Variation [nm@1x or nm@4x]	Specifies that the CD variation between the first and second selected images and is displayed in units selected by the user.

Table 9-11. CD Measurement Results Fields (cont.)

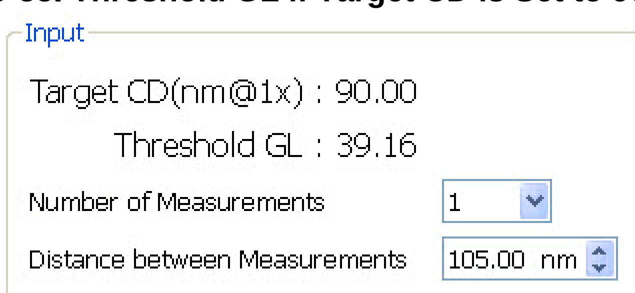
Fields		Description
	Center Average Minimum Maximum	Reports the results of CD variation. Depending on the Number of Measurements, CD could be computed multiple times. • Center — Computes CD values on the center line (center of the cross section bar). • Maximum — Computes the maximum value of all the CD values obtained in first and second selected images, maximum CD variation in percentage, and maximum CD variation in nanometers are reported in the maximum column. • Average — Computes an average of all the CD values obtained in a similar fashion. • Minimum — Computes the minimum value of all the CD values obtained in a similar fashion. For example, if the CD is computed on 7 measurements, then the CD is computed 7 times on the first selected image and 7 times on the second selected image. The maximum, minimum, average, and center line computations are reported in their respective columns.
	Use global GL/Target CD	Updates the CD measurement report with the current input and display settings. If you hover your mouse cursor over this button, it displays the image name on which the Target CD is calculated.

Usage Notes

The following are examples of CD Measurement input:

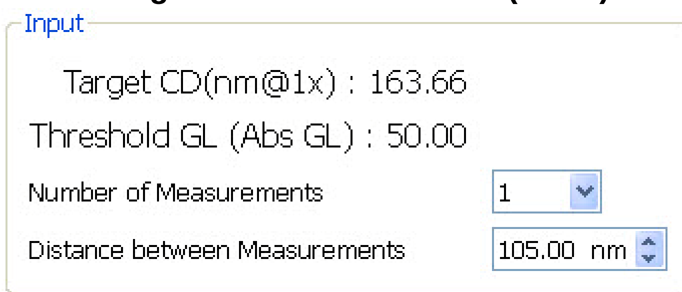
- **Target CD** — The Target CD Value is specified as 90 nm@1x in the CD Measurement Properties dialog box. The Threshold GL is computed by Calibre DefectReview and is displayed as shown in Figure 9-55.

Figure 9-55. Threshold GL if Target CD is Set to 90 nm@1x



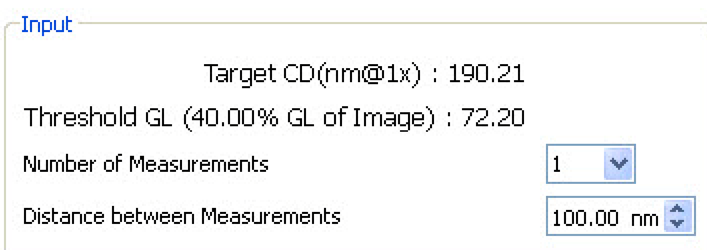
- **Threshold GL (0-255)** — The Threshold GL (0-255) Value is specified as 50 in the CD Measurement Properties dialog box. Calibre DefectReview computes the CD on the first and second selected images at the gray level value and is displayed as shown in Figure 9-56.

Figure 9-56. Target CD if Threshold GL (0-255) is Set to 50



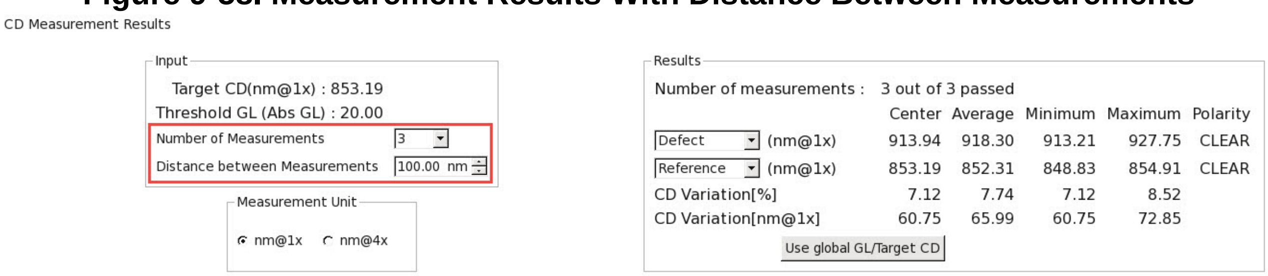
- **Threshold GL % (0-100) Image** — The Threshold GL % (0-100) Image is specified as 40 in the CD Measurement Properties dialog box. Calibre DefectReview first computes the threshold GL value based on the dynamic range of the second selected image of the current defect. It then takes the computed GL value and measures the CD (see Figure 9-57).

Figure 9-57. Input if Threshold GL % (0-100) Image is Set to 40



- **Distance between Measurements** — The Number of Measurements is specified as 3 and the Distance between Measurements as 100 nm (shown in Figure 9-58). In this case, three lines are drawn internally; one in the center and two lines (one on either side of the center line) 100 nm apart from the center line.

Figure 9-58. Measurement Results With Distance Between Measurements



The default value of the Distance between Measurements entry field can be configured using the distanceBetweenMeasurement node in the *dat-ini.xml* file. Figure 9-59 shows an example.

Figure 9-59. distanceBetweenMeasurement Node

```
   <ImageInterpolation>10</ImageInterpolation>
   <ImageWindowSize>64</ImageWindowSize>
   <!--Distance between parallel line in cross-section should be
specified only   in nm -->
   <distanceBetweenMeasurements>100</distanceBetweenMeasurements>
   <!-- Only odd numbers should be specified here. If Even number
 is specified,
        then the nearest odd number is selected-->
   <NumMeasurements>1</NumMeasurements>
```

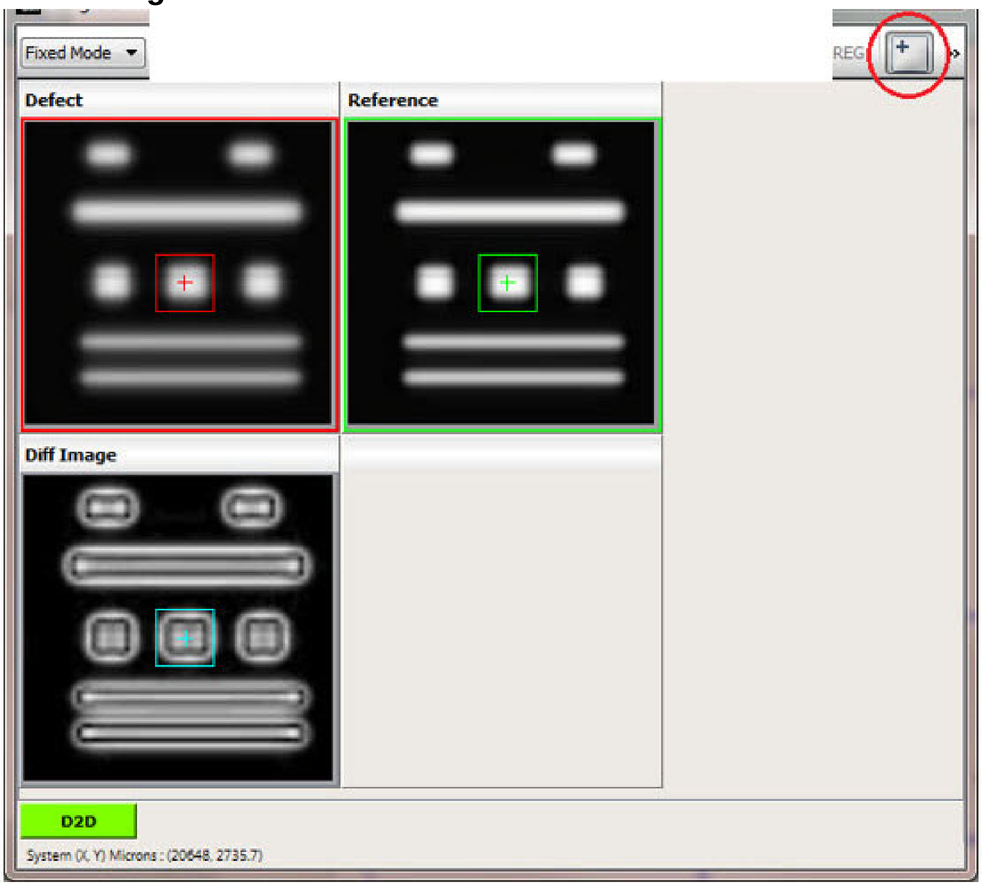
Contact Measurement

Contact Measurement measures the area of contact present on the images.

Contact Measurement works differently in Fixed Mode and Free Mode:

- In Fixed Mode, Contact Measurement is computed on the defect image and the reference image. Contact Measurement boxes are displayed on the defect and reference image as shown in the following figure.

Figure 9-60. Contact Measurement in Fixed Mode



- In Free Mode, Contact Measurement is computed on two locations on the same image. Two Contact Measurement boxes are displayed on the same image as shown in Figure 9-61. The green Contact Measurement box is considered as the reference Contact box in Fixed Mode and Free Mode, and the red Contact Measurement box is considered a defect contact box.

  The Contact is detected on the reference and defect contact boxes, based on the settings specified using **Settings > Set Contact Measurement Properties** (see "Setting Contact Measurement Properties" on page 349 for further information). The contact detected in the reference contact box is called a reference contact, and the contact detected on the defect contact box is called a defect contact.

Figure 9-61. Contact Measurement in Free Mode

Measuring the Area of Contact

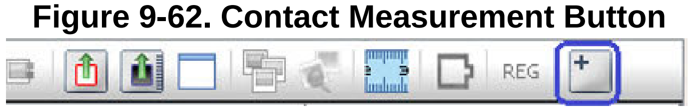
To measure the area of contact on an image, use the Display Contact Measurement Bar button on the IMU window toolbar.

Procedure

1. There are two methods to invoke Contact Measurement, depending on the mode.

    - In Fixed mode, click the Display Contact Measurement Bar button in the IMU window toolbar.

    Figure 9-62. Contact Measurement Button

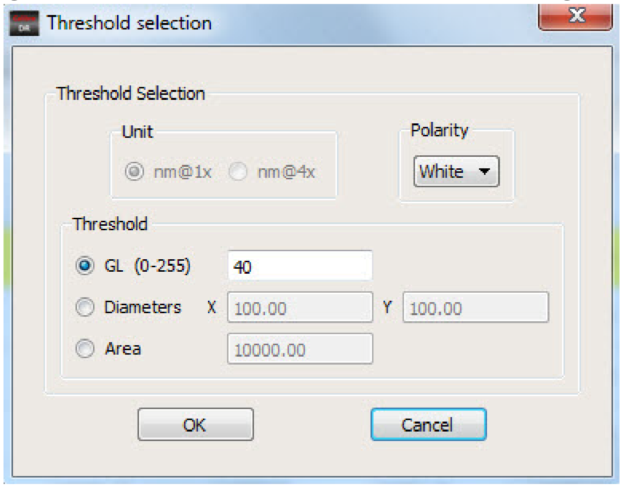
    - In Free mode, right click on an image and select **Display Contact**.

The Contact Measurement box is displayed over the image or images. Note that a **CONTACT REPORT** button appears next to the **Display Contact Measurement** button once it is enabled.

2. Move the Contact Measurement box to the location where the contact is present on the image.

3. Select **Settings > Set Contact Measurement Properties** to invoke the Threshold Selection dialog box. Use this dialog box to set the parameters for Contact Measurement Properties.

Figure 9-63. Threshold Selection Dialog Box



4. In the Threshold Selection dialog box, set the parameters for Contact Measurement Properties. You can choose from the following as input parameters:

   - **Gray level (GL (0-255))** —Specifies a gray level value that is used to detect the contact. Calibre DefectReview finds the contour based on the gray level, in the region where the contact box is placed. The pixels with gray level values less or greater than (based upon the Polarity option) are grouped together to see if contact is formed.

   - **X and Y Diameters (Diameters X, Y)** — Specifies a diameter that is used to detect the contact. Using the X and Y diameter values, a contour is computed on the reference image. The gray level at which the X and Y diameters of the contour matches with the user-specified X and the Y diameters is considered, and the same gray level is applied on the defect image to compute the contact.

   - **Area** — Specifies an area based on which the contact is to be detected. The contact is detected on the reference image using the area specified, and the gray level at which the contact is detected with the specified area value, is used to detect the contact on the defect contact.

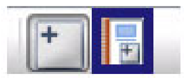
   - **Polarity** — Specifies that the contact is detected based on the polarity. For example, if black is set as the Polarity, then the contact is detected based on the gray level values which are less than the specified gray level. If White is specified as Polarity, then the contact is detected based on the gray level values that are greater than the specified gray level.

Refer to "Setting Contact Measurement Properties" on page 349 for more details.

5. Click the Contact Report button to generate a report on the results.

    - In Fixed mode, the CONTACT REPORT button appears as soon as you clicked the Contact Measurement button,

Figure 9-64. Contact Report Button (Fixed Mode)



    - In Free mode, the **Contact Report** button appears as soon as you select Display Contact.

The Contact Report appears if the contact is found on the location specified. Otherwise, Calibre DefectReview issues a "Contact is not found" message.

Contact Measurement Report

To access: Click the CONTACT REPORT button in the IMU window toolbar

The Contact Measurement Report dialog box displays the results of a Contact Measurement operation.

Description

The Contact Measurement Report is divided into three functional areas:

- Input

  Displays the input that is used to compute the contact.

- Contact Measurement Report

  Displays the results of the Contact Measurement operation.

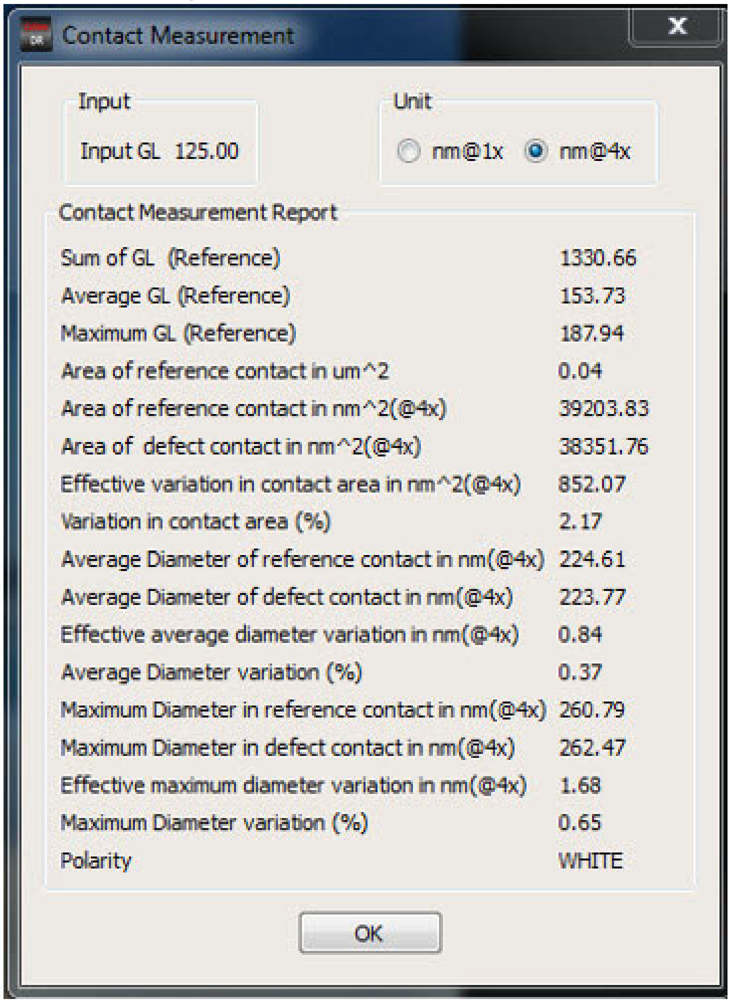
- Unit

  Specifies that the contact measurement be displayed in either **nm@4x** (mask) or **nm@1x** (wafer) coordinates.

For further details on performing a Contact Measurement operation, refer to "Measuring the Area of Contact" on page 333 for further details.

For further details on setting the input, refer "Setting Contact Measurement Properties" on page 349.

Figure 9-65. Contact Report



Objects

Table 9-12. Contact Measurement Report Fields

Field		Description
Input		Displays the input that is used to compute the contact.
Contact Measurement Report		Displays the results of the Contact Measurement operation.
	Sum of GL (Reference)	Displays the sum of all gray level values found in the reference contact.
	Average GL (Reference)	Displays the average of all the gray level values found in the reference contact.
	Maximum GL (Reference)	Displays the maximum gray level value found in the reference contact.

Table 9-12. Contact Measurement Report Fields (cont.)

Field		Description
	Area of reference contact in um^2	Displays the area of reference contact in square microns.
	Area of reference contact in nm^2(@4x)	Displays the area of the reference contact in square nanometers.
	Area of defect contact in nm^2(@4x)	Displays the area of the defect contact in square nanometers.
	Effective variation in contact area in nm^2(@4x)	Displays the Effective variation in area of the reference contact and defect contact in units selected by the user.
	Variation in contact area (%)	Displays the percentage variation in area of the reference contact and defect contact.
	Average Diameter of reference contact in nm(@4x)	Displays the average diameter of the reference contact in units selected by the user.
	Average Diameter of defect contact in nm(@4x)	Displays the average diameter of the defect contact in the units selected by the user.
	Effective average diameter variation in nm(@4x)	Displays the effective variation of average diameter in units selected by the user.
	Average Diameter variation (%)	Displays the average of the diameter variation between the reference contact and defect contact represented by percentage.
	Maximum Diameter in reference contact in nm(@4x)	Displays the maximum diameter of the reference contact in the units selected by the user.
	Maximum Diameter in defect contact in nm(@4x)	Displays the maximum diameter of the defect contact in units selected by the user.
	Effective maximum diameter variation in nm(@4x)	Displays the Effective variation of the maximum diameter in units selected by the user.
	Maximum Diameter variation (%)	Displays the maximum diameter variation between reference contact and defect contact represented by percentage.
	Polarity	Displays the Polarity based on which the contact is computed.
Unit		Specifies if the results of the contact measurement should be displayed in nm@4x or nm@1x coordinates.

Table 9-12. Contact Measurement Report Fields (cont.)

Field		Description
	nm@1x	Specifies that the contact measurement results are displayed in the wafer coordinates (original measurements in mask images / 4).
	nm@4x	Specifies that the contact measurement results are displayed in mask coordinates.

Measuring Flux Area

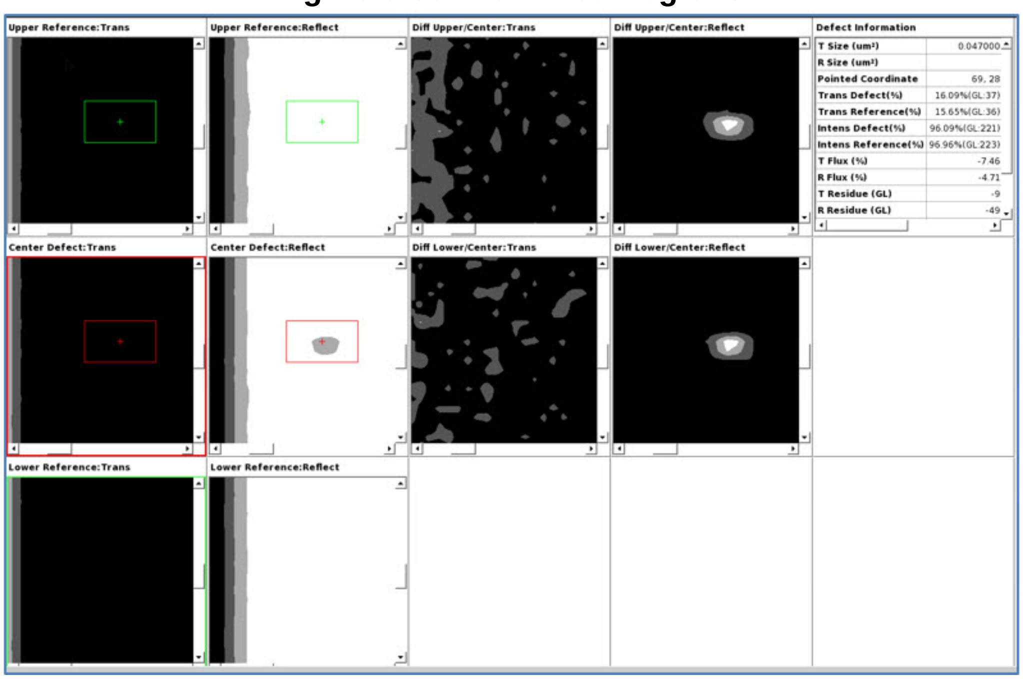
Use the **Flux Area** option in the Image Measurement window to measure the flux area ratio between transmitted defect and reference images.

Procedure

1. To begin measuring the flux area:

    - In the IMU toolbar, click the **Display Flux Area** button. 
    - Right click on an image and select the **Flux Area** option.

    Figure 9-66. Flux Area Regions

    The IMU displays the flux area regions on transmitted, reflected, and respective reference images. By default, flux area regions are displayed around the center of the images, with the default size specified in the *dat-ini.xml* file.

2. After the flux area regions are displayed, you can perform the following operations:
   - Move — Click near the center of the flux area region and move to any position inside the image. You can also click in the flux area region and use keyboard arrow keys to move.
   - Resize — Click near and edge or a corner and move the mouse to resize flux area regions.
   - Reset — Right-click the flux area region and select **Reset** to move the flux area regions to the center of the images and resize to default size.
3. When you save the dock layout using **Dock Layout** > **Save**, the position and size of the flux area region are saved across tool sessions.

Results

The flux area option calculates the flux area ratio percentage between defect and reference images based on the position of flux area region over them. The following example illustrates the method of calculation.

Assume the following values for transmitted images:

- GL value for Quartz region (Intensity of Fore Ground): $I_{fg} = 230$
- GL value for MoSi region (Intensity of Back Ground): $I_{bg} = 30$
- GL matrix of flux area region on defect image: D
- GL matrix of flux area region on reference image: R
- Row index: r
- Column index: c

The flux area ratio is then calculated:

$$\text{Flux Area Ratio} = \left[\frac{\textit{Defect Flux Area}}{\textit{Reference Flux Area}} - 1\right] \times 100\ \% = \left[\frac{\sum_{r,c}\{(D_{r,c} - I_{bg})/(I_{fg} - I_{bg})\}}{\sum_{r,c}\{(R_{r,c} - I_{bg})/(I_{fg} - I_{bg})\}} - 1\right] \times 100\ \%$$

and values placed into a matrix to calculate the defect and reflex flux areas:

D			R		
40	45	40	40	50	45
60	70	75	65	80	80
50	55	55	55	55	60
$D_{r,c} - I_{bg}$			$R_{r,c} - I_{bg}$		
10	15	10	10	20	15
30	40	45	35	50	50
20	25	25	25	25	30

Flux Defect Flux Area = $\sum_{r,c} \{(D_{r,c} - I_{bg}) / (I_{fg} - I_{bg})\}$ = 220 / (230 - 30) = 1.1

Reference Flux Area = $\sum_{r,c} \{(R_{r,c} - I_{bg}) / (I_{fg} - I_{bg})\}$ = 260 / (230 - 30) = 1.3

With the defect and reference flux areas calculated, the flux area ratio percentage is calculated:

$$\text{Flux Area Ratio \%} = \left[\frac{\textit{Defect Flux Area}}{\textit{Reference Flux Area}} - 1\right] \times 100\,\% = \left[\frac{1.1}{1.3} - 1\right] \times 100\,\% = -15.38\,\%$$

The calculated Flux Area Ratio % is reported as T Flux (%) in Defect Information table (refer to "Using the Defect Information Table" on page 288 for details). If you resize or move the Flux Area boxes, Calibre DefectReview automatically recalculates and updates the T Flux (%) value. The calculations are based on the following equations:

Reflected Defect Flux Area = $\sum_{x,y} \{(I_{bg} - I_{DEF}) / (230 - 30)\}$ = (220) / (200) = 1.1 [sq pixels]

Reflected Reference Flux Area = $\sum_{x,y} \{(I_{bg} - I_{REF}) / (230 - 30)\}$ = (255) / (200) = 1.275 [sq pixels]

Ratio = (1.1 / 1.275) – 1.0 = (-0.13725) = -13.7 [%]

The calculated Flux Area Ratio % value is reported as R Flux (%) in the Defect Information table (refer to "Using the Defect Information Table" on page 288 for details). If you resize or move the Flux Area boxes, Calibre DefectReview automatically re-calculates and updates the R Flux (%) value.

The values for Qz and MoSi are fetched using the following attributes from the inspection file:

- LRF X-700
  - Transmitted:
    - Qz level = ShadingResult.TMode.QzPix
    - MoSi level = ShadingResult.TMode.CrPix

        - Reflected:
            - Qz Level = ShadingResult.RMode.QzPix
            - MoSi Level = ShadingResult.RMode.CrPix
- LRF X-800
    - Transmitted:
        - Qz level = ShadingResult.Result.TransBright / 4
        - MoSi = ShadingResult.Result.TransDark / 4
    - Reflected:
        - Qz level = ShadingResult.Result.ReflectDark / 4

The width and height of the flux rectangle displayed in the IMU can be configured using the FluxAreaConfiguration node in the *dat-ini.xml* file. The default width and height of the flux rectangle is 9x9.

Figure 9-67. Flux Area Configuration Node

```
<FluxAreaConfiguration>
 <FluxAreaRectWidthInPixels>9</FluxAreaRectWidthInPixels>
 <FluxAreaRectHeightInPixels>9</FluxAreaRectHeightInPixels>
</FluxAreaConfiguration>
```

Selecting Images for Flux Area

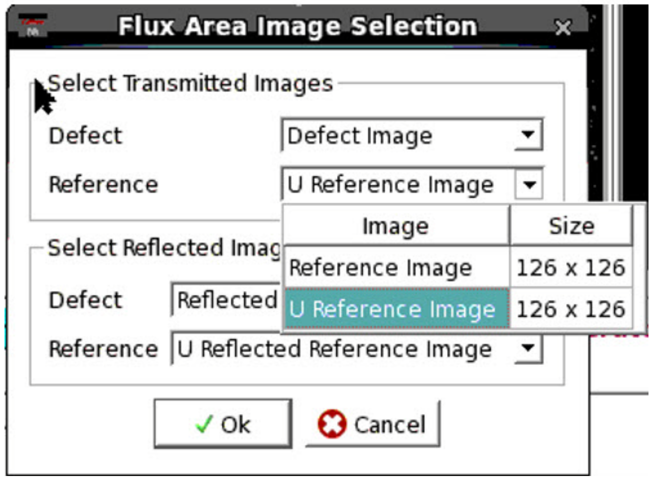
You can select images for flux area ratio calculation by using the **Select Images for Flux Area** button in the Image Measurement window.

Procedure

1. Click the **Select Images for Flux Area** icon in the IMU toolbar .

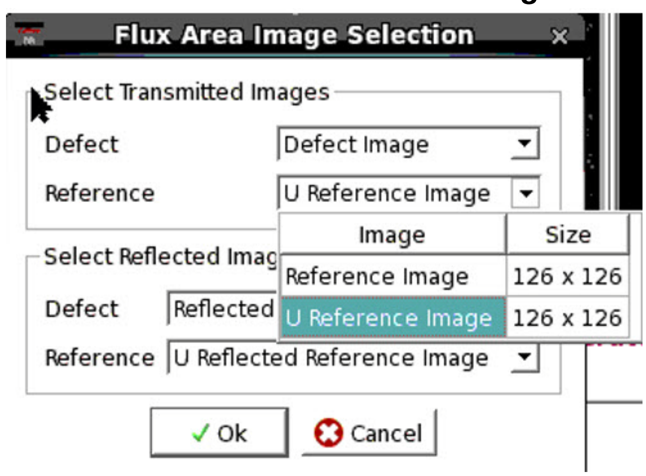
   The Flux Area Image Selection dialog box is displayed.

Figure 9-68. Flux Area Image Selection Dialog Box



2. Select Defect, Reference, Reflected Defect, and Reflected Reference images using the corresponding combo boxes. Make sure you select Defect, Reference, Reflected Defect, and Reflected Reference images of the same size.

Figure 9-69. Defect and Reference Image Selection



3. Click **Ok**. The image selection is also preserved across Calibre DefectReview sessions.

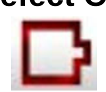
Displaying Defect Contours

Defect Contour shows the contour around the defective region on the images.

Procedure

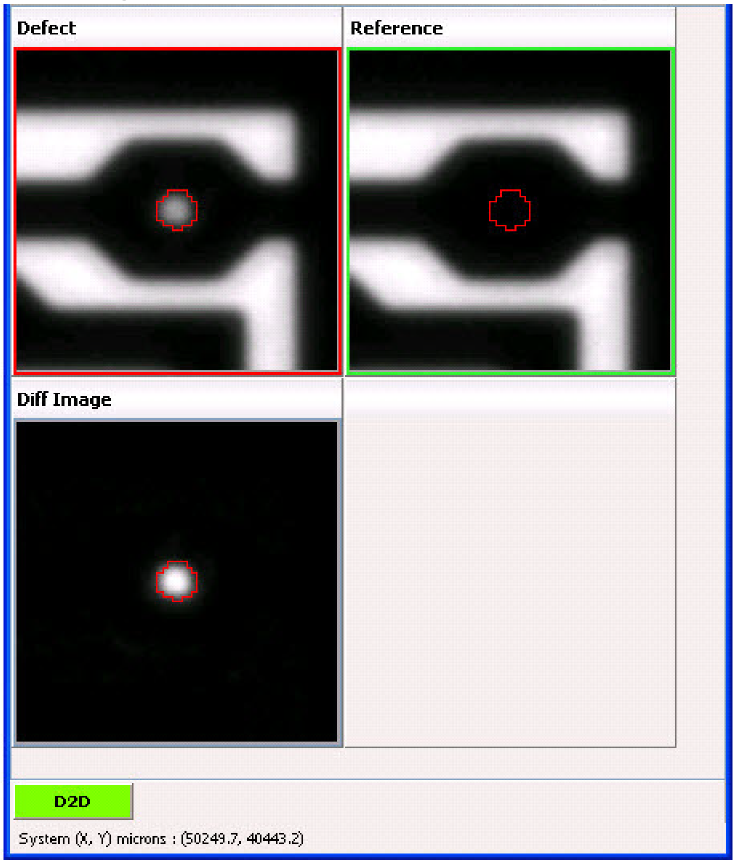
1. Click the Defect Contour button in the IMU window toolbar.

Figure 9-70. Defect Contour Button



2. A contour is displayed in red as shown in Figure 9-71. If the defect contour has any holes, then the holes are displayed in yellow.

Figure 9-71. Defect Contour Example



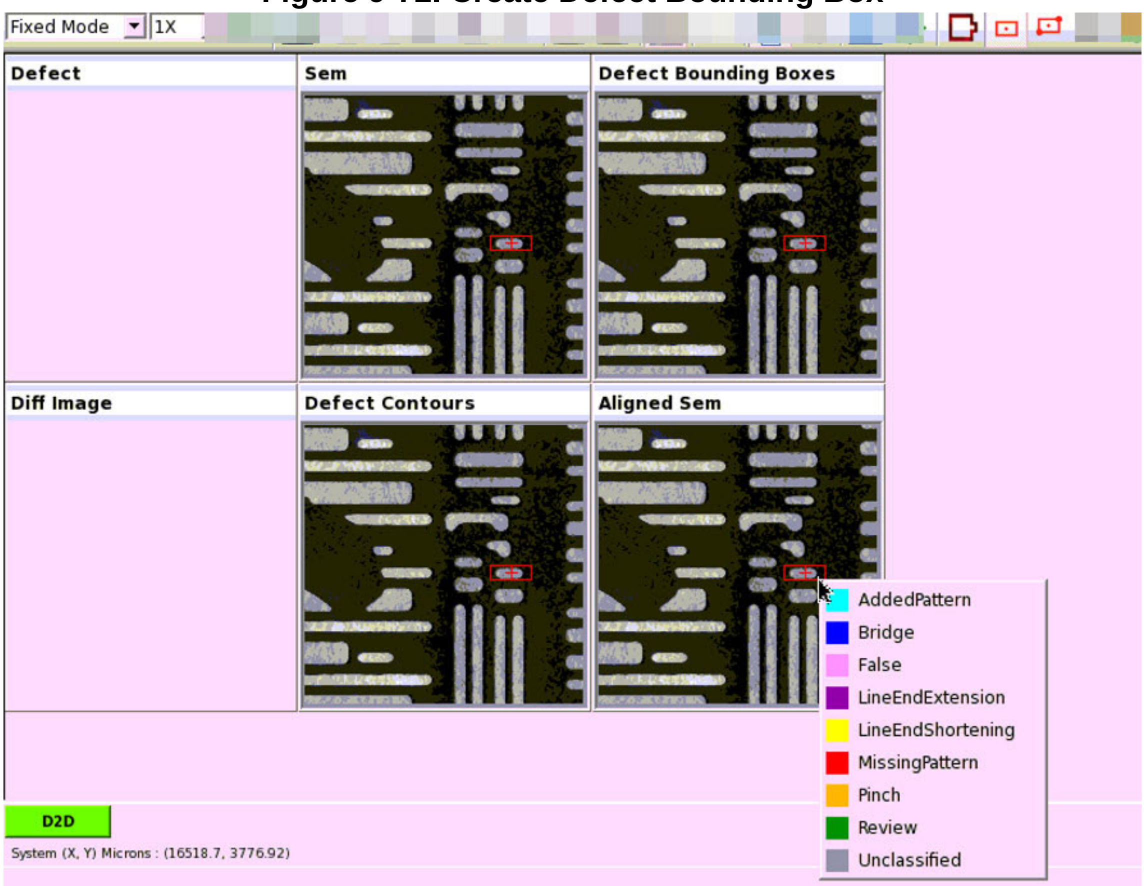
3. Defect Contours can be displayed in the following images:
   - Defect Images
     - Defect
     - Reference
     - Defect2
     - Reference2
     - Reflected Defect
     - Reflected Reference
     - Reflected Defect2
     - Reflected Reference2
   - Functional Images
     - Diff Image

    - Avg Image
    - Sum Image
    - Custom
- All ZI Images
- Other Images

4. In addition to the defects marked after running SEM ADC, defect bounding boxes can be manually created on the IMU using the Create Defect Bounding Box button in the IMU toolbar.

   This button displays a bounding box rectangle on Aligned Sem, Sem, Defect Contours and Defect Bounding Box images. The size and location of the rectangle can be manually adjusted and the Defect Type can be saved with a right click. The type of the existing defects (marked after SEM ADC) can be modified using the right-click option.

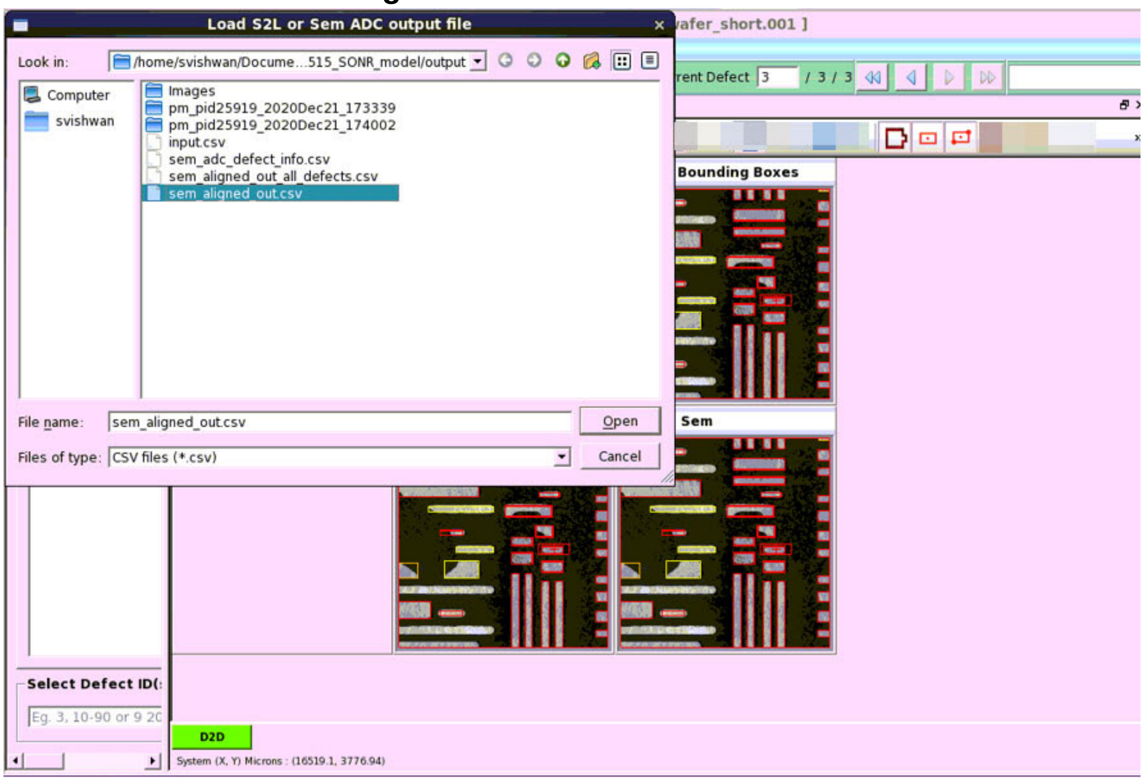
Figure 9-72. Create Defect Bounding Box



5. You can save the created defects using the Save Defect Info button . The manually-created defects are appended either to the *sem_aligned_out.csv* or

sem_aligned_out_all_defects.csv file (based on the your selection in the Load S2L or Sem ADC output file dialog box) and is saved as *sem_adc_defect_ino.csv*.

Figure 9-73. Save Defect Info

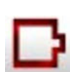


Displaying Defect Parts Location

Defect parts information is a combination of detected lines from each inspection algorithm, capturing the details of locations inspected by an inspection machine. Defect parts are drawn as closed contour paths near to defect regions. These lines are described as the offset from the Defect Reference Pixel and are detected by inspection machines using algorithms. During inspection time, all necessary information is captured in a file called *<IR_NAME>_Defects.ini*. When loading an inspection report, if this optional file is present, Calibre DefectReview reads it and populates the information in the IMU. You can then display defect parts information in the IMU.

Note
This is supported for LRF inspections only.

Procedure

Click the **Defect Contour** icon  in the IMU window toolbar.

The IMU displays all defect parts in red as shown in the following figure. It is displayed for all images.

Figure 9-74. Defect Parts in the IMU

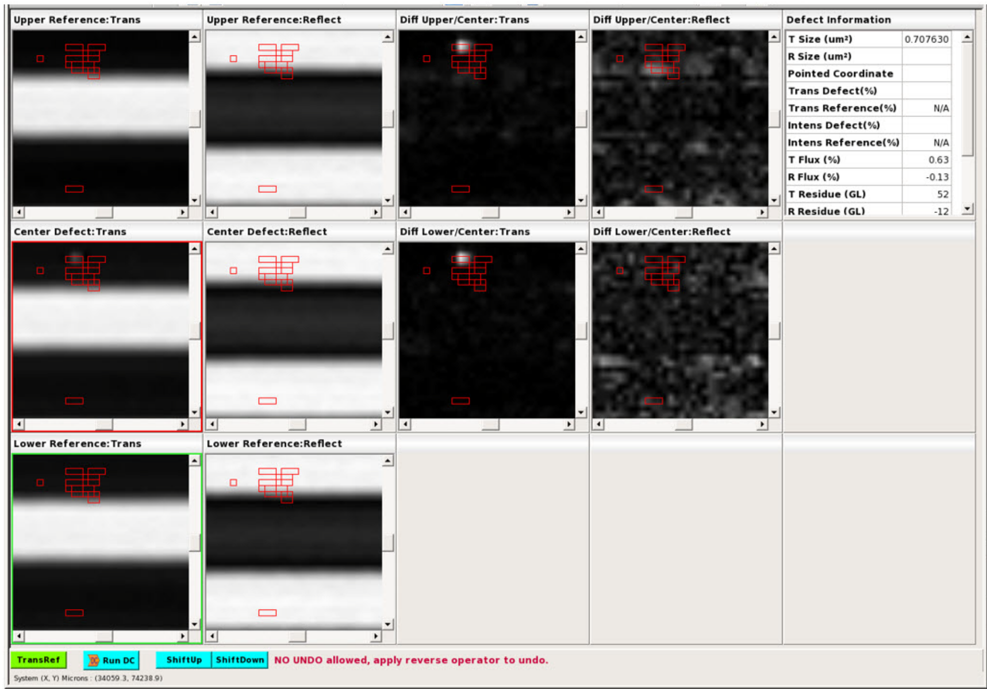


Image Measurement Properties

A number of properties for the Image Measurement Unit window can be set from the Settings menu in the Calibre DefectReview window.

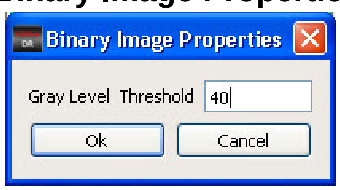
Setting Binary Image Properties

The binary image view for any image needs a gray level threshold value.

Procedure

1. In the Calibre DefectReview window, click **Settings > Set Binary Image Properties**.

Figure 9-75. Binary Image Properties Dialog Box



2. Enter the value of GL (0 to 255) in the Gray Level Threshold text entry field.
3. Click **Ok**.

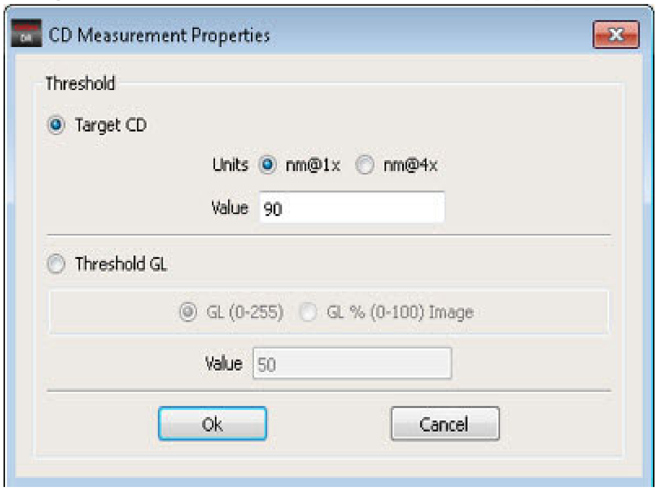
Setting CD Measurement Properties

To measure the CD variation for any defect, you can either set the target CD value or the threshold GL value.

Procedure

1. **Target CD:** In the Calibre DefectReview window, click **Settings** > **Set CD Measurement Properties**.

Figure 9-76. CD Measurement Properties



2. Click **Target CD**.
3. Select the units used for CD measurement by clicking one of the Units options:
    - **nm@1x** — Specifies the target CD value at the1x (wafer) level. This is the default if **Target CD** is selected.
    - **nm@4x** — Specifies the target CD value at the mask level.
4. Enter a value in the Value text box.
5. Click **Ok**. The values in CD Measurement Properties dialog box are remembered across the sessions.
6. **Threshold GL:** In the Calibre DefectReview window, click **Settings** > **Set CD Measurement Properties**.
7. Click **Threshold GL**. Select from one of three options in the threshold GL and enter a corresponding value in the Value text box:
    - **GL (0-255)** — Calculates the threshold GL. The value range is between 0.00 to 255.00. This is the default setting if **Threshold GL** is selected.
    - **GL% (0-100) Image** — Calculates the threshold GL value as a percentage of the dynamic GL range of the whole image. The value range is between 0.00 to 100.00.
8. Click **Ok**. The state of each of these options buttons are remembered in Calibre DefectReview.

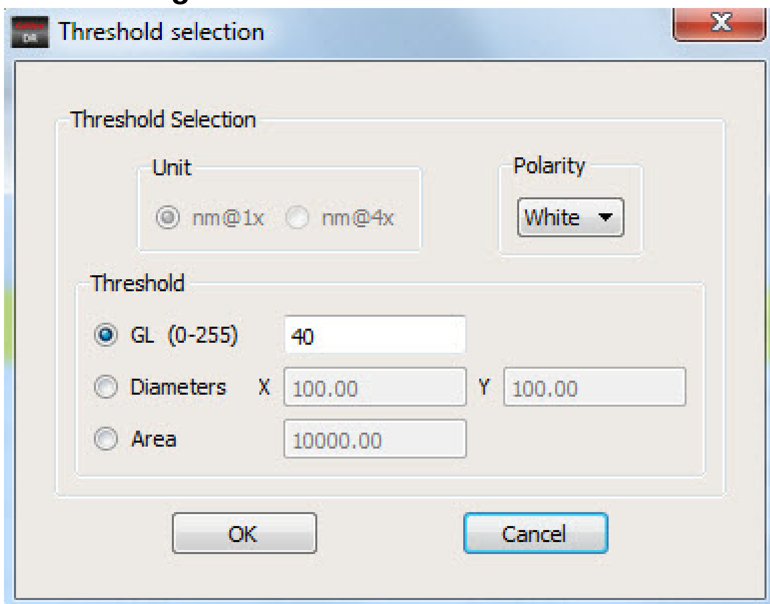
Setting Contact Measurement Properties

To perform contact measurement analysis, you have to set one of three properties: GL (0-255), Diameters of the contact, or Area of the contact.

Procedure

1. In the Calibre DefectReview window, click **Settings > Set Contact Measurement Properties**. The Threshold Selection dialog box appears.

Figure 9-77. Threshold Selection



2. Select one of the following properties to set:
   - Set the Gray Level value for contact measurement:
     i. Click **GL (0-255)**.
     ii. Enter the value.
   - Set X and Y diameters for the contact:
     i. Click **Diameters**.
     ii. Click one of the Unit values to specify the unit used for the X and Y diameter of the contact.
     iii. Enter the values of X and Y diameters.
   - Set the contact area:
     i. Click **Area**.
     ii. Click one of the Unit values to specify the unit used to specify the area.
     iii. Enter the value of the area.
3. Once one of the properties are set, you may want to change the polarity of the contact for the analysis. The polarity can either be white or black. To modify the polarity, select the value from the **Polarity** drop-down list.

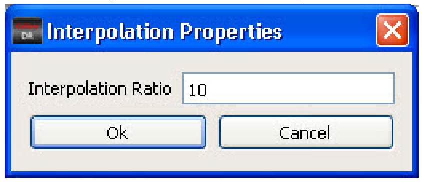
Setting Image Interpolation Properties

An image interpolation property is used to set the interpolation ratio to be used while displaying interpolated images in the Image Measurement Unit window.

Procedure

1. In the Calibre DefectReview window, click **Settings > Set Image Interpolation Properties**.

Figure 9-78. Interpolation Properties Dialog Box



2. Enter the Interpolation Ratio to be used while displaying the interpolated images and click **Ok**.
3. This property is used while displaying the interpolated images in Zoomed Images.

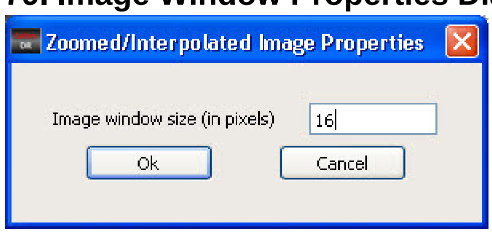
Setting Image Window Properties

An image window property is used to set the window to be displayed while displaying interpolated images (defect window is interpolated in zoomed images) in the Image Measurement Unit window.

Procedure

1. In the Calibre DefectReview window, click **Settings > Set Image Window Properties**.

Figure 9-79. Image Window Properties Dialog Box



2. Enter the Image window size in pixels to be displayed while displaying the interpolated images.
3. Click **Ok**.
4. This property is used while displaying the interpolated images (defect window interpolated images) in Zoomed Images. Refer to section "ZI Images" on page 284 for more details on zoomed images.

Color Scheme for Images

You can specify a new color scheme to apply to colored images from the **Settings** menu in Calibre DefectReview.

For complete details refer to "Setting the Image Color Scheme" on page 298.

Chapter 10
Calibre DefectReview Reports

Calibre DefectReview can output a number of different reports to help you analyze the results of inspections.

The types of reports that can be generated include the following:

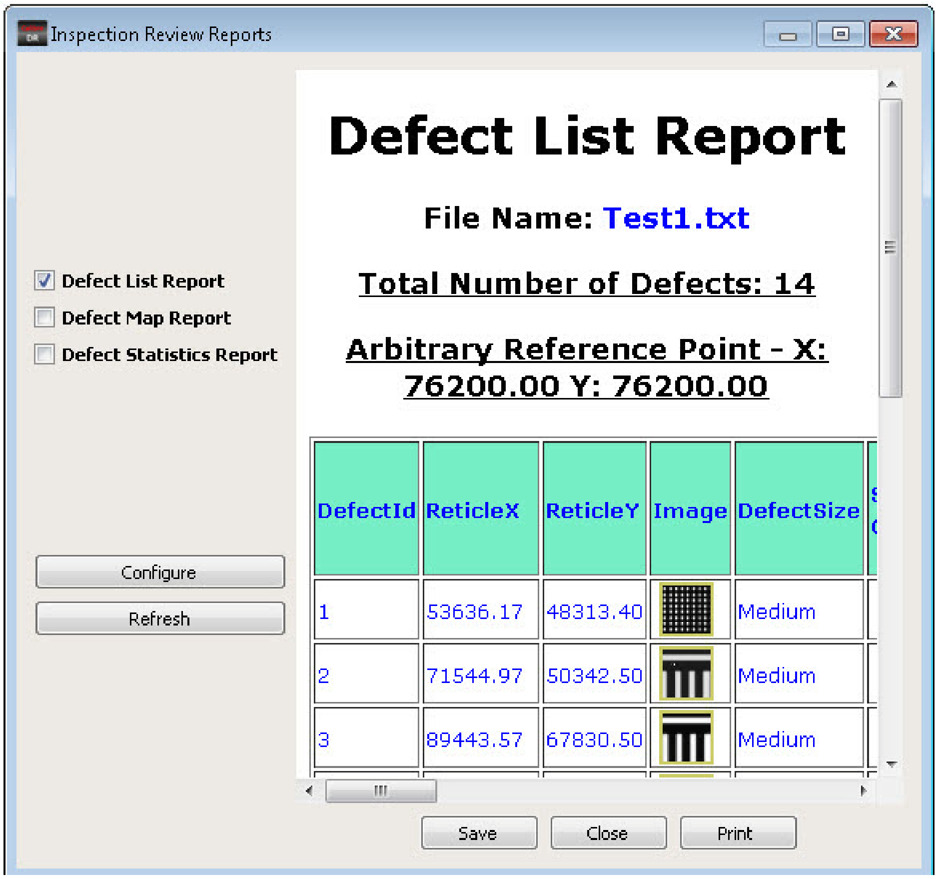
- **Defect List Report** — Displays the system coordinates, Classification Type, and Defect Size (for example, Small, Medium, Large, Xlarge) for each defect in the inspection file. See "Defect List Report" on page 356 for further information.
- **Defect Map Report** — Displays the Defect Map with the scale. See "Defect Map Report" on page 358 for further information.
- **Defect Statistics Report** — Displays a distribution of the defects in terms of the number and percentage of defects by classification type. See "Defect Statistics Report" on page 359 for further information.

Inspection Review Reports Window

To access: In the Calibre DefectReview window, select**Reports > Show Inspection Reports**

The Inspection Review Reports window is the primary interface to display reports, allowing you to select different report types to generate and display, as well as the ability to save or print the results.

Figure 10-1. Inspection Review Reports Window



Description

To view the different reports, click the check boxes corresponding to different report types to view a consolidated report in the report display area.

- Reports are not enabled in the All folder, if multiple inspections are opened.
- Reports are automatically updated with any modification to defect database.
- If the defect database has zero defects, the Defect Map and Defect List report displays the text “No defects found”. The defect statistics report shows the distribution table with a data value of 0 for all cells.

Objects

Table 10-1. Calibre DefectReview Reports Window Fields

Field	Description
Defect List Report	See "Defect List Report" on page 356 for information.
Defect Map Report	See "Defect Map Report" on page 358 for information.
Defect Statistics Report	See "Defect Statistics Report" on page 359 for information.
Configure	Invokes a configuration dialog box to configure what is displayed in the Customer, Engineering, Defect List, and Defect Map reports. See "Report Configuration" on page 360 for further information.
Refresh	Updates reports with current settings. If this button is green, it indicates that there have been modifications to the report that can be updated on the next refresh.
Save	Save the report to a specified output file. See "Saving and Printing Reports" on page 361 for information.
Close	Close the window.
Print	Print the consolidated report. See "Saving and Printing Reports" on page 361 for information.

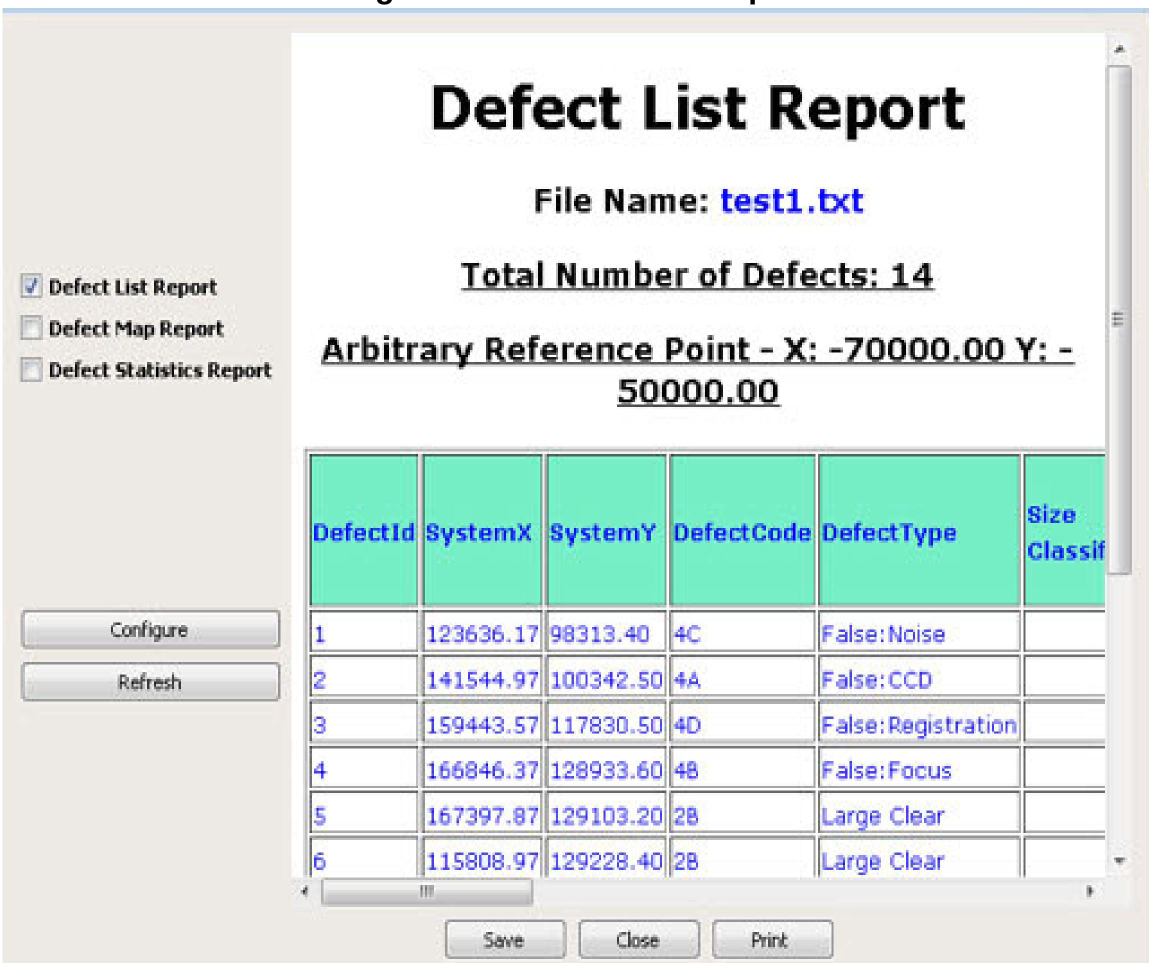
Defect List Report

To access: On the Inspection Review Reports window, click **Defect List Report**.

The Defect List report displays the system coordinates, Classification Type, Defect Size (for example, Small, Medium, Large, Xlarge), and so on for each defect in the inspection file.

You can configure what is displayed on the Defect List report by clicking the **Configure** button to invoke the Configure Report dialog box and selecting the **Defect List Report** tab.

Figure 10-2. Defect List Report



Objects

Table 10-2. Defect List Report Fields

Fields	Description
DefectId	Specifies the defect ID number.
SystemX	Specifies the x-coordinate of the associated defect.
SystemY	Specifies the y-coordinate of the associated defect.

Table 10-2. Defect List Report Fields (cont.)

Fields	Description
Defect Code	Specifies the defect code.
Defect Type	Specifies the defect type.
MachineDefectID	Specifies a unique ID reported by the inspection system.
Image	Displays a thumbnail image of the corresponding defect image.
ReticleX	Specifies that the x-coordinate exists in the inspection file for each defect.
ReticleY	Specifies that the y-coordinate exists in the inspection file for each defect.
Signature	Specifies the name of the user who classified the defect.
PrimaryClassificationComments	Specifies user comments related to Primary Classification.
ComparisonType	Specifies the comparison type of a defect.
Status	Specifies the status of the defect. The status can be Unlocated, Located, or Confirmed
Area	Specifies the area of the defect in units configured in the *dat-ini.xml* file.
DefectSize	Specifies the classification of defects based on defect area.
DefectClassify Columns	Specifies all the Calibre DefectClassify results related to the defect such as MDPPattern Classification, MDPPattern Classification Comment, and Max CD Variation (%).
Secondary classification table	Specifies all the secondary classification codes.
ClassificationHistory	Specifies the code sequence or classification history.

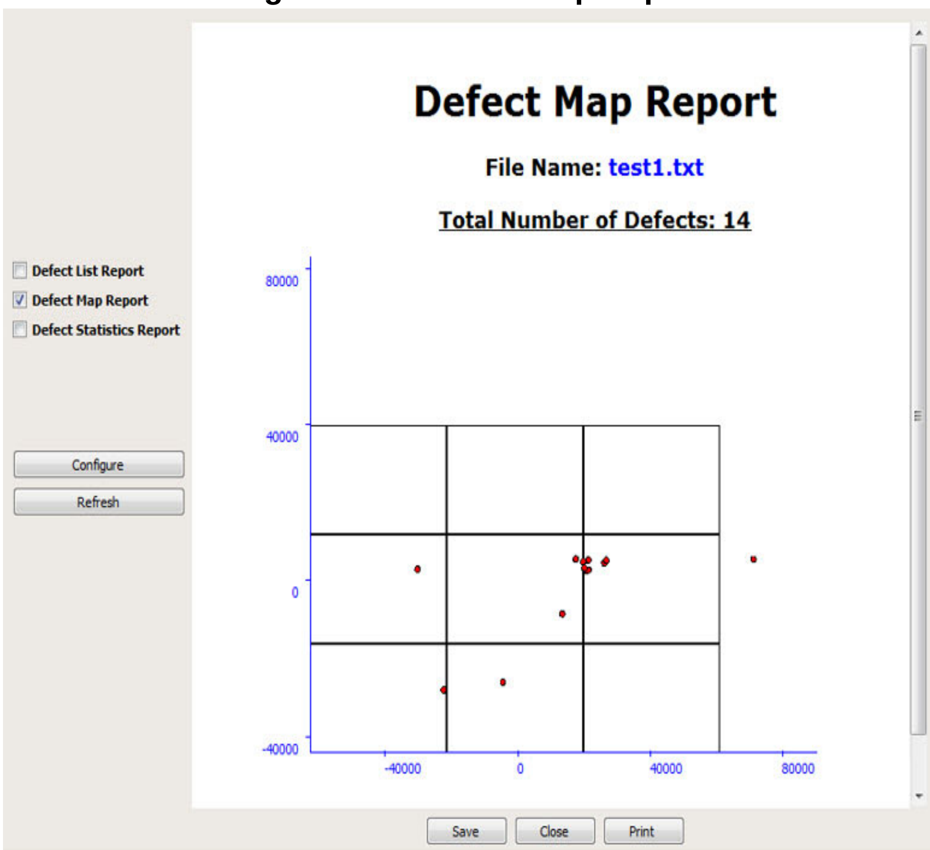
Defect Map Report

To access: On the Inspection Review Reports window, click **Defect Map Report**.

The Defect Map Report displays the Defect Map with the scale.

Description

Figure 10-3. Defect Map Report



Objects

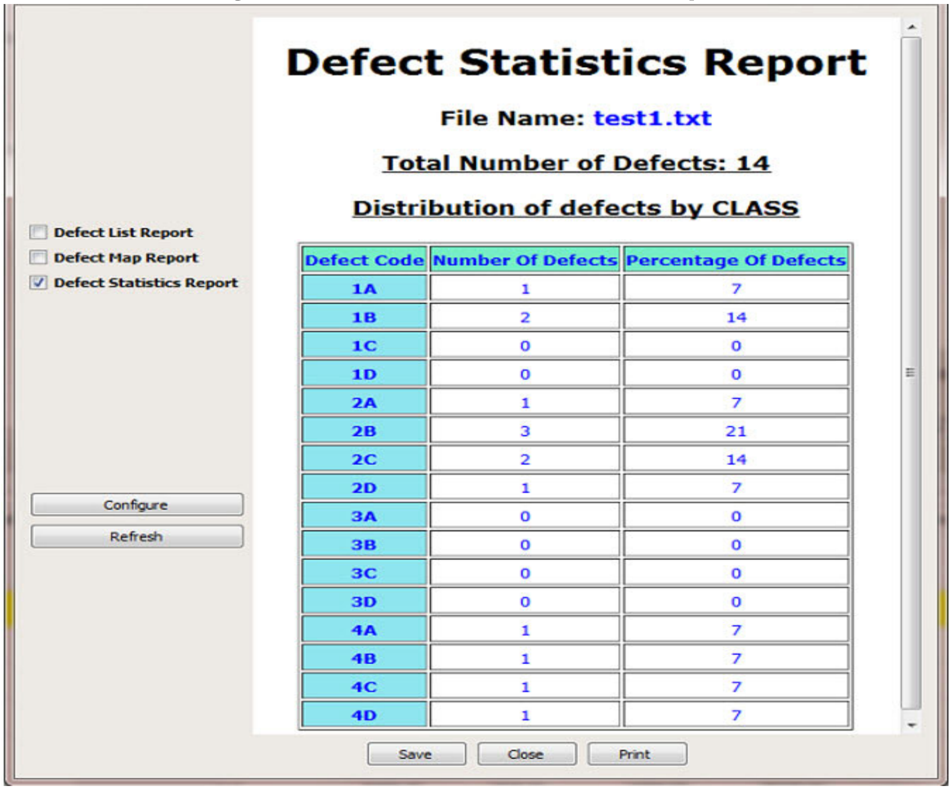
The layout of the Defect Map report is based on what is displayed in the Defect Map window. See "The Defect Map Window" on page 116 for further information.

Defect Statistics Report

To access: On the Inspection Review Reports window, click **Defect Statistics Report**.

The Defect Statistics Report shows a distribution of the defects in terms of the number and percentage of defects by classification type.

Figure 10-4. Defect Statistics Report



Objects

Table 10-3. Defect Statistics Report

Field	Description
Defect Code	Displays the defect code.
Number of Defects	Displays the number of defects detected.
Percentage of Defects	Displays the defect count in terms of percentage of total defects.

Report Configuration

You can configure what information is displayed on each of the different reports in the DefectReview Reports window.

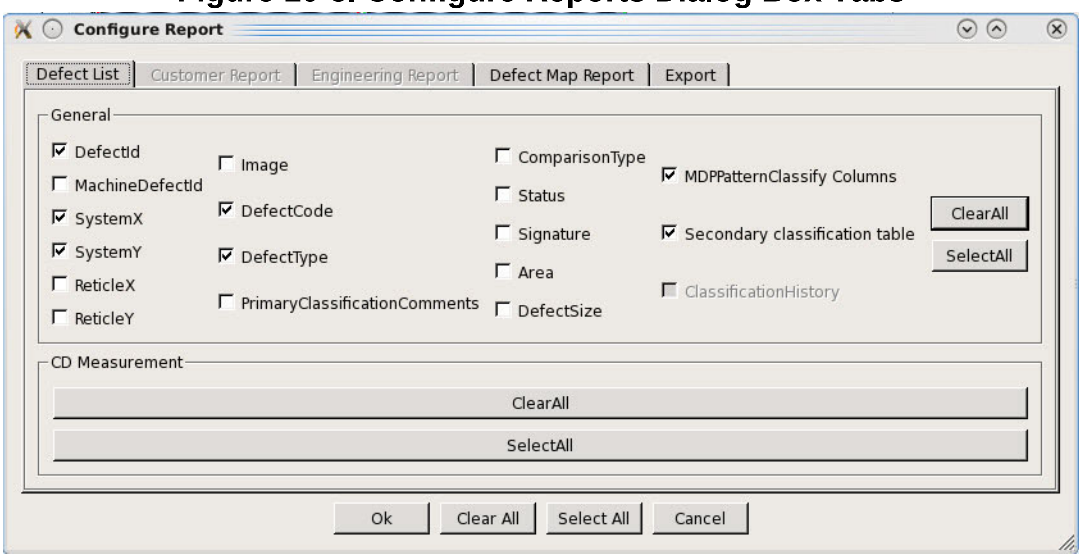
Using the Configure Reports Dialog Box

You can configure the Defect List report and Defect Map report by invoking the Configure Reports dialog box from the Inspection Review Reports window.

Procedure

1. Invoke the Inspection Review Reports window (**Reports > Show Inspection Reports**).
2. Select the reports that you wish to generate in the Inspection Review Reports window.
3. Click the **Configure** button. The Configure Report dialog box appears.

Figure 10-5. Configure Reports Dialog Box Tabs



4. Click one of the tabs listed in Table 10-4 to configure or export a report. Click a check box to activate or deactivate the display of a particular report entry.

Table 10-4. Configure Report Tabs

Tab	Description
Defect List	Select which General or CD Measurement information to display. Only the Defect List columns that are configured to be visible in the *dat-ini.xml* file are enabled in the Defect List configuration options.

Table 10-4. Configure Report Tabs (cont.)

Tab	Description
Defect Map Report	Select Reticle Image, and Highlight Dropout Die(s).
Export	Export the report to an output file. See "Exporting Reports to a Default Location" on page 361 for further details.

5. Click **Ok** to input your changes. The report is updated with the fields selected.

Saving and Printing Reports

The reports in Calibre DefectReview can be saved to HTML format.

Procedure

Perform one of the following operations:

Saving a Report:

a. In the Inspection Review Reports window, click **Save** and specify the report file. The default file name is *<inspection_file>.html*.

a. Click **Ok**. The reports currently displayed are saved into a single consolidated HTML file.

   If the reports to be saved include the Defect Map Report, then apart from the specified file, the Defect Map image file is also created in the same location as that of specified file. The naming convention for the image file is *dm-<inspection file name>.png*.

Printing a Report:

a. In the Inspection Review Reports window, click **Print**.

   Note
   The current combination of reports selected is saved in the registry and restored when the report window is opened the next time.

Exporting Reports to a Default Location

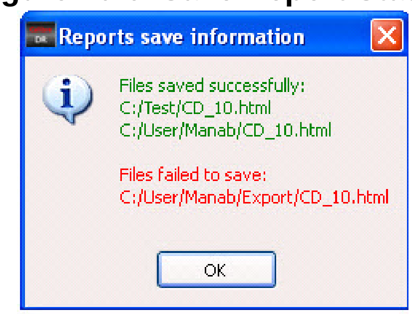
You can configure multiple locations to export your report. You can choose three different locations to save the report file.

Procedure

1. From the Calibre Inspection Review Reports window, click **Configure**.

2. In the Configure Reports dialog box, select the **Export** tab.
    - To save the report file to the inspection file location, click the first **Export to Folder** check-box.
    - To export the report file to other locations, click additional **Export to Folder** check-boxes, then click **Browse** for each entry to select the locations. By default, the option to save the report file to a inspection file location is enabled.
3. After configuring the export locations:
    - To save the configurations, click **Ok** in the **Export** tab.
    - To save the report file in the selected locations, click **Save** in the Calibre Inspection Review Reports dialog box. A dialog box appears, displaying the result of the save operation. Files saved successfully are shown in green; files not saved are shown in red.

Figure 10-6. Save Report Status



    - If no check-boxes are selected in the **Export** tab and **Save** is clicked in the Calibre Inspection Review Reports dialog box, then the Save All Reports dialog box appears. Choose the location and click **Save** to save report file.
4. Note the following:
    - Export reports configurations are remembered in system registry.
    - The saveReports command-line interface command saves the report file in locations specified in the **Export** tab of Configure Report window.

Generating Repeatability Reports

You can generate a separate Repeatability Analysis report (containing Analysis Statistics, Defect Repetition Histogram, and Throughput) and save it as an HTML file.

Procedure

1. In the Calibre DefectReview window, click **Reports > Save Repeatability Reports**. A dialog Saving Repeatability Reports box appears.

2. In the Saving Repeatability Reports dialog box, navigate to the save location and enter the file name.

3. Click **Save**. The Repeatability report is saved to an HTML file.

4. Open the saved file in a web browser.

Figure 10-7. Repeatability Reports

Repeatability Reports

Analysis Statistics

Events Analysis

Total Defects Repeatability(%)	100.00
Average Repeating Per Inspection	0.00
Average Non Repeating Per Inspection	264.00
Must Catch Defects Average CR	100.00
Inspection Number	1
Total Defect Count Per Inspection	264
Repeating Defects Per Inspection	0
Non Repeating Defects Per Inspection	264
Number Of Repeatitions	1
Total Repeatitions Number	264
PDM Repeatitions Number	43

Note

If a Must-Catch file is specified, then the repeatability report also displays Must-Catch Defect Analysis and the Must Catch Detection Matrix.

Chapter 11
Using Utilities

A number of utilities are available that provide additional support for all of the primary operations done in the Calibre DefectReview interface.

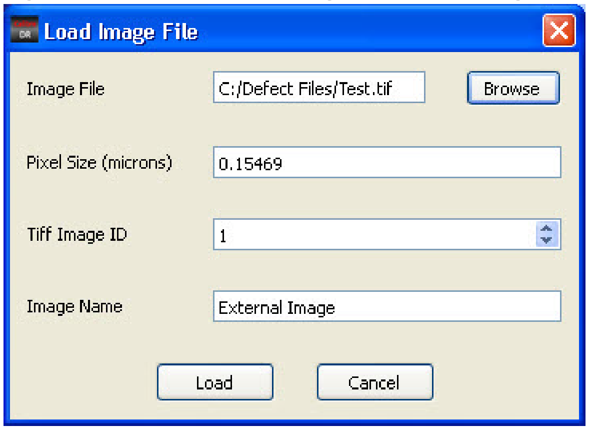
Loading Image Files

A standalone TIFF file image can be loaded into Calibre DefectReview and viewed as an auxiliary image in the Image Management window.

Procedure

1. In the Calibre DefectReview window, select **Utilities > Load Image File**. The Load Image File dialog box appears.

Figure 11-1. Load Image File Dialog Box



2. Click **Browse** and select the TIFF file name. The selected file name is displayed in the Image File text box.

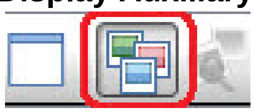
3. Specify the pixel size associated with TIFF image in the Pixel Size (microns) text box. By default, the pixel size of the defect image is displayed. You can modify the pixel size as required.

4. If you specify a file with multiple TIFF images, you can select a particular image in the file. By default, the first image in the multi-TIFF file is selected and displayed in the Tiff Image ID combo box.

5. Click **Load**. The specified TIFF file is loaded into Calibre DefectReview.

6. Right-click in the display unit area of the Image Measurement window, then select **Other Images** > <*loaded_image_name*>. The tool bar icon Display Auxiliary Images in Image Measurement Unit is enabled.

Figure 11-2. Display Auxiliary Images Icon



7. Click the icon. The loaded TIFF file image is displayed in the Image Measurement window.

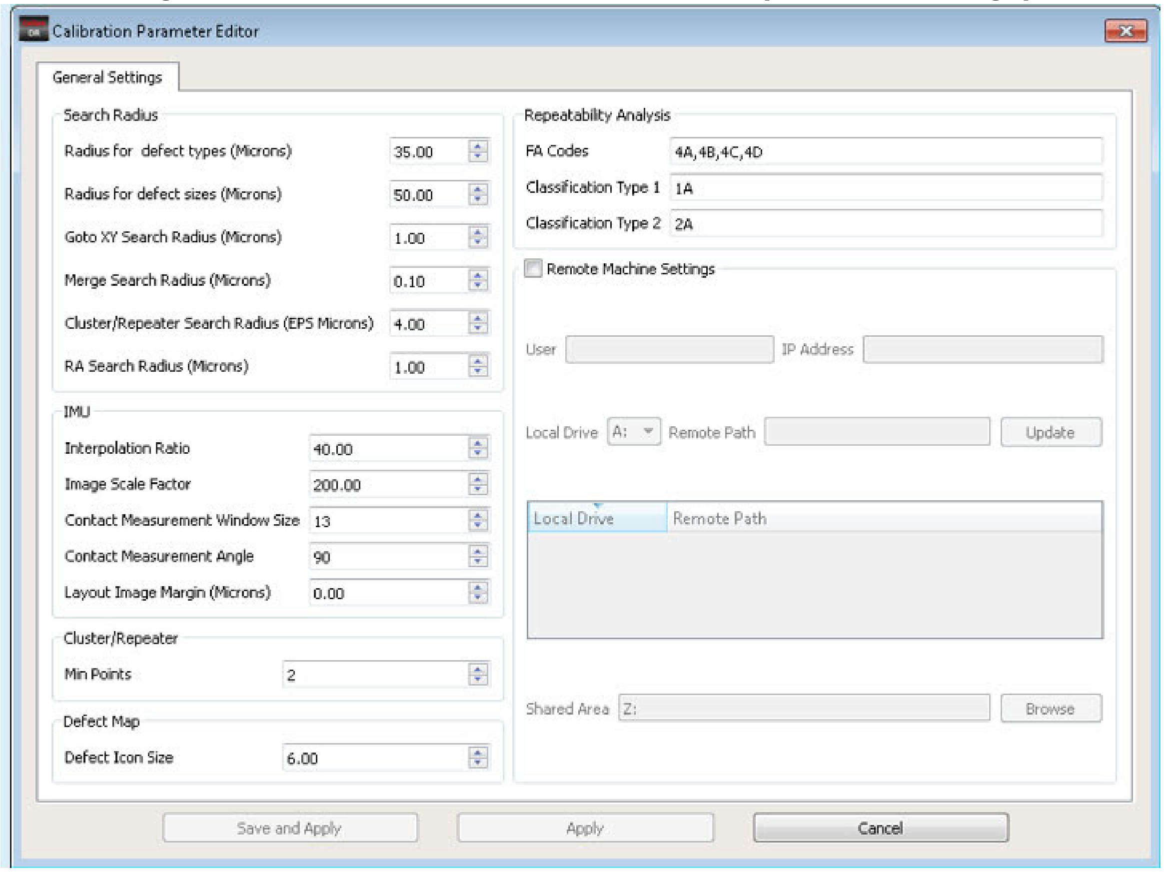
   The loaded TIFF images are associated with the current defect displayed in the Image Measurement window. If you save the inspection file, then the TIFF image is also saved.

Calibration Parameter Modification

The Calibration Parameter Editor allows you to modify the default values used by a number of Calibre DefectReview parameters, including search radius, IMU properties, Repeatability Analysis, and so on.

The Calibre Parameter Editor contains the main editable default parameters for Calibre DefectReview.

Figure 11-3. Calibration Parameter Editor (General Settings)



Editing Calibration Defaults

You can edit most of the Calibre DefectReview calibration default parameters from the **General Settings** tab in the Calibration Parameter Editor.

Procedure

1. In the Calibre DefectReview window, select **Utilities** > **Calibration Parameter Editor**. The Calibration Parameter Editor appears.

2. Click the **General Setting** tab in the Calibration Parameter Editor.
3. Using the Calibration Parameter Editor, modify Calibre DefectReview parameter defaults as needed. Parameters that are specific to a module or analysis are logically grouped. The following table lists the parameters available:

Table 11-1. Calibre Parameter Editor Fields (General Tab)

Field		Description
Repeatability Codes		All the Repeatability Codes are overridden if you change the parameters described in "Repeatability Analysis Parameters" on page 232.
	FA Codes	Specifies default false alarm codes to be used in Repeatability Analysis.
	Classification Type 1 & 2	Specifies default classification codes to be used in Repeatability Analysis.
IMU		
	Interpolation Ratio	Controls the interpolation ratio. IMU utilities such as cross section analysis as well as contact measurement use image interpolation. The maximum ratio is 50.
	Image Scale Factor	Scales the image displayed in the IMU window up or down based on the factor specified.
	Contact Measurement Window Size	Controls the width or height of the window used for contact measurement window is a square window.
	Contact Measurement Angle	Controls the number of diameters used in contact measurement. If the angle is 45 degrees then 4 diameters are used in contact measurement.
	Layout Image Margin	Controls the size of the layout image window. If the value of the layout image margin is 'm', then the layout image window is extended by 'm' in all the 4-directions.
Search Radius		
	Radius for defect types	Specifies a tolerance value in the horizontal-vertical layout of defects. It is assumed in a test mask that defects for a particular type are organized either in a horizontal-vertical fashion that forms a grid line.
	Radius for defect sizes	Specifies a tolerance value in the period in which defects are laid out in a test mask (on each grid line there is a fixed period with which the defects are arranged).
	Goto XY Search Radius	Specifies the search radius to be used searching for a defect by X and Y coordinate location using the Goto XY utility (the **Goto XY** option from the right-click menu in the Defect Map).

Table 11-1. Calibre Parameter Editor Fields (General Tab) (cont.)

Field		Description
	Merge Search Radius	Specifies the search radius to be used by the merge defect utility. If the two defects from different inspections are within the merge search radius of each other, then they are conflicting defects and the merge utility will output only one of the defects (if it is able to resolve the conflict successfully).
	Cluster/Repeater Search Radius	Specifies the search radius to be used by the cluster detection utility.
	RA Search Radius	Specifies the search radius to be used in a Repeatability Analysis. This parameter is overridden if modified as described in "Repeatability Analysis Parameters" on page 232.
Cluster/Repeater		
	Min Points	Specifies the minimum points that should be present in a cluster. The minimum value is 2.
Defect Map		
	Defects Icon Size	Controls the diameter of fixed-size circles used to display defects in the Defect Map.
Remote Machine Settings		The entries in this section assist in generating layout images on a Linux machine. Refer to "Generating a Layout Image" on page 403 for more details.

Once you modify any parameter, the Save and Apply buttons are enabled.

4. To apply the modified parameters for the current session only, click **Apply**.

   To apply the modified parameters for the current session and save changes for future sessions, click **Save and Apply**.

Note

You can use the **Save** option present in the main menu or tool bar menu to save the current inspection file to multiple locations.

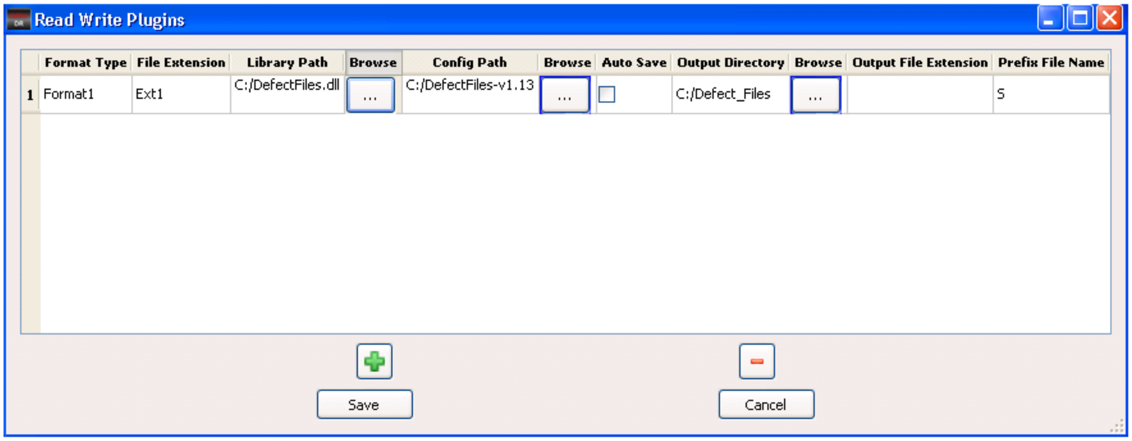
Configuring Read Write Plugins

Read Write plugins provide an interface to specify the external reader or writer plugins to read and write inspection files in different formats. You can configure Read Write plugins using the Calibre DefectReview interface.

Procedure

1. In the Calibre DefectReview window, click **Utilities > Read Write Plugins**. A Read Write Plugins dialog box appears as shown in the Figure 497.

Figure 11-4. Read Write Plugins Dialog Box



2. Enter the plug-in parameters in the Read Write Plugins dialog box.

Table 11-2. Read Write Plugins Dialog Box Fields

Field	Description
Format Type	Specifies the inspection file format.
File Extension	Enter a file extension
Library Path	Specifies a Dynamic Linked Library (DLL) used by Calibre DefectReview to read or write corresponding type of inspection file.
Config Path	Specifies the a configuration file path to be used by the DLL.
Auto Save	When a defect is saved, if you enable Auto Save, then Calibre DefectReview automatically writes the inspection file in the corresponding format. **Note:** If Auto Save is checked, then the output file extension must be provided or else an “Output file extension can not be empty” message is generated.
Output Directory	Specifies the directory or path where the user wants the output file to be saved.
Output File Extension	Specifies the file extension with which the output file has to be saved. Output File Extension is used along with Auto Save.

Table 11-2. Read Write Plugins Dialog Box Fields (cont.)

Field	Description
Prefix File Name	Specifies that the string entered in this field is used as a prefix to the output file name. **Note:** You can add or delete the Read Write Plugins by using plus (+) and minus (-) buttons in the Read Write Plugins dialog box.

3. Click **Save**.

Recording Operations

The user can record the operations which are performed in Calibre DefectReview for a set of files and play it back through Calibre DefectReview CLI or Calibre DefectReview GUI on any other set of files.

Procedure

1. In the Calibre DefectReview window, click **Settings > Set Record Script**.
2. In the dialog box that appears, specify the name of the file in the file dialog. By default the recording output to a script named "*NxDAT_cli_script.tcl*".
3. To start the recording, in the Calibre DefectReview window, select **Utilities > Start Recording**.
4. Perform the desired operations in Calibre DefectReview.
5. To stop recording, select **Utilities > Stop Recording**.
6. Select **Utilities > Run Recorded Script** to play a recorded script in the current session.
7. The operations that are recorded can be played back on any inspection files.

Note

All operations cannot be recorded. Refer to "Calibre DefectReview Tcl Scripting Commands" on page 482 for more details on what operations are supported.

8. You can also use the record script as a Tcl batch command script to automate a run from Calibre DefectReview's command line interface. Refer to "Invoking the Calibre DefectReview CLI" on page 476 for further information.

Auto Clustering

You can group defects displayed in the Defect Map into clusters. Clusters can be generated automatically through the Calibre DefectReview interface.

Procedure

1. In the Calibre DefectReview window, select **Utilities > Auto Cluster**.
2. In the **Auto Cluster** sub-menu, select one of the types:
    - **Cluster** — Groups defects and displays the clusters in the Defect Map.
    - **Break** — Breaks all the clusters and makes them isolated defects.
    - **Shrink** — Shrinks a few defects of a cluster to isolated defects. Refer to section "Shrink Clusters" on page 372 for more details.

Results

Once the defects are clustered, you can view the clustered defects in Defect Map.

You can perform operations on the clusters in the Defect Map (see "Using Cluster-Specific Operations" on page 146) and the Defect List (see "Using Cluster-Specific Operations in the Defect List" on page 166).

The clustering operation can be controlled using two parameters: Cluster Search Radius (EPS Microns) and Min Points. To modify these parameters, use the Calibration Parameters Editor. Refer to section "Calibration Parameter Modification" on page 367 for details on editing parameters.

You can also select the Blob Overlapping method or the Normal method for performing the clustering operation (see "Repeatability Analysis Types" on page 229 for information on these methods). You can configure the clustering method in the *dat-ini.xml* file as shown in Figure 11-5. By default, the Blob Overlapping method is used for clustering the defects.

Figure 11-5. AutoClusteringMethod Node

```
<clusterInfo>
 <eps>4</eps>
 <minpoints>2</minpoints>
 <!-- Possible method BlobOverlapping, Normal -->
 <AutoClusteringMethod method="BlobOverlapping" />
</clusterInfo>
```

Shrink Clusters

You can shrink defects in a cluster to a single defect with the **Utilities > Auto Cluster > Shrink** option. When applied, the shrink operation filters out all defects from a cluster set except one defect from the each set.

For example, in an inspection, there are 13 defects. After forming clusters, Table 11-3 shows the status of all clusters in the Defect List. According to Table 11-3, the following cluster sets are detected: cluster IDs 1_0, 1_1, 1_2, and 1_3. In cluster set 1_0, 1_1, 1_2, and 1_3 there are 2, 5, 3, and 2 defects, respectively.

Table 11-3. Defect ID Versus Cluster Set After Forming Clusters

Table Row	Defect ID	Cluster ID
1	1	1_1
2	2	1_1
3	3	1_1
4	4	1_1
5	5	1_0
6	6	1_1
7	7	1_2
8	8	1_0
9	9	1_2
10	10	1_2
11	11	1_3
12	12	1_0
13	13	1_3

In this scenario, after a **Shrink** operation is applied, the Defect List appears as shown in Table 11-4. From each cluster set, one representative defect is picked up randomly and shown. The rest of the defects related to the set are filtered out. This change is reflected in the Defect Map as well. Since the **Shrink** option filters out defects, you can use the **UnFilter All Filtered** option retrieve all the defects.

Table 11-4. Defect ID Versus Cluster Set After Shrink

Table Row	Defect ID	Cluster ID
1	4	1_1
2	5	1_0
3	7	1_2
4	8	1_0
5	11	1_3
6	12	1_0

Auto Grid Detection

Grid detection utility should be typically used on test mask as the defects are laid out on a grid. This utility provides the option to automatically detect the grid in an inspection and display the grid on the Defect Map to the user. Two grid detection options are provided.

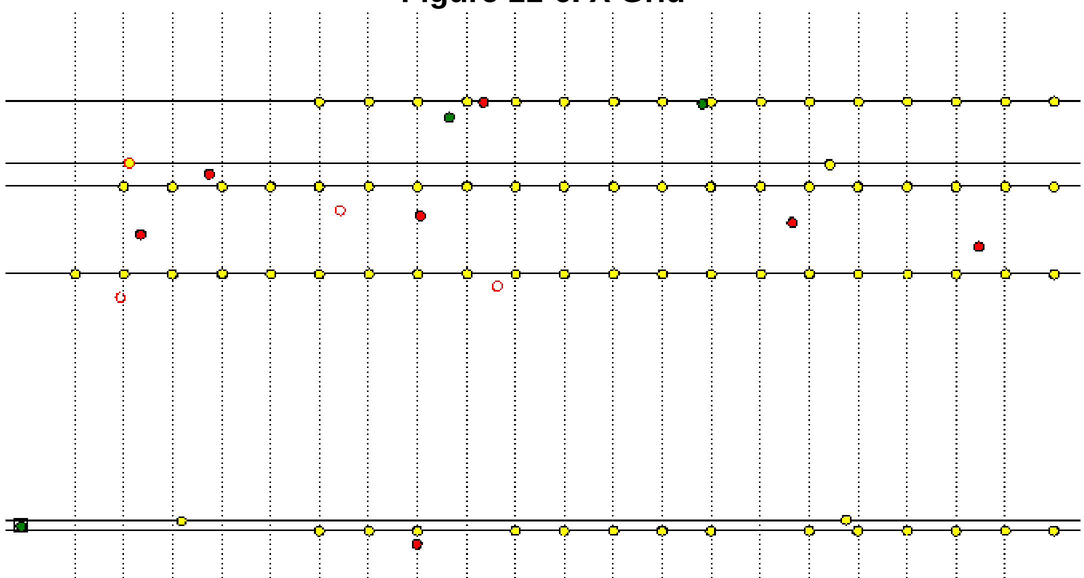
Procedure

1. In the Calibre DefectReview window, select **Utilities > Auto Grid Detection** and choose one of the following sub-options:

    - Select **X-direction** to detect the grid along the X-axis.

      Figure 11-6 illustrates how the X-axis grid is displayed on the Defect Map. The horizontal lines are the grid lines and the vertical lines are the periodicity lines. As the periodicity is in the X direction this grid is known as an X grid. The defects on the grid are shown in yellow.

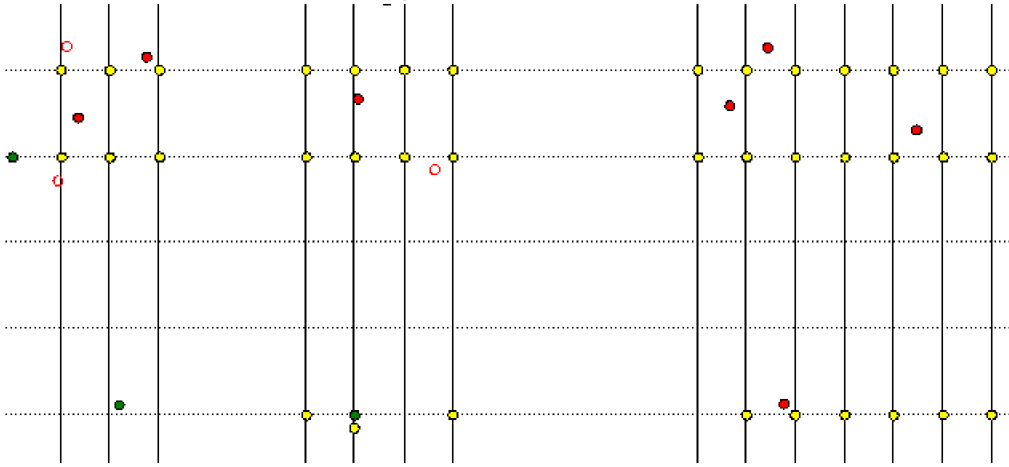
      Figure 11-6. X Grid

    - Select **Y-direction** to detect the grid along the Y-axis.

      Figure 11-7 illustrates how this option is displayed on the Defect Map. The vertical lines are the grid lines and the horizontal lines are the periodicity lines. As the periodicity is in the -direction this grid is known as a Y grid. The defects on the grid are shown in yellow.

Figure 11-7. Y Grid



2. You can optionally adjust the grid search radius through the Grid X Search Radius and Grid Y Search Radius parameters in the Calibration Parameters Editor. Refer to "Calibration Parameter Modification" on page 367 for details on editing parameters.

3. Once grid detection is done, view the grid in the Defect Map. You can perform various operations on the grid and the defects on the grid. Refer to "Using Grid Display Operations" on page 139 for details.

Saving a Defect List

You can save the contents of the Defect List into CSV format.

Procedure

1. In the Calibre DefectReview window, select **Utilities > Save Defect List**. A file chooser dialog appears.

2. Enter the name of the CSV file in the dialog box.

3. Click **Save**.

4. Apart from the attributes displayed in Defect List, the CSV file contains the attributes: Adder, Defect Trend, and Capture Rate values when the Defect List is saved in the All folder.

Saving a Correlation List

You can save the contents of the Correlation List into CSV format only from the ALL folder

Procedure

1. In the Calibre DefectReview window, select **Utilities** > **Save Correlation List**. A file chooser dialog appears

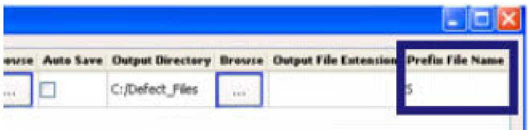
2. Enter the name of the CSV file in the dialog box.
3. Click **Save**.
4. The CSV file contains all the columns displayed in the Correlation List.

Inspection File Export

You can export an inspection file to a generic format depending upon the file extensions.

If the Prefix File Name and Output Directory values are listed in the Read-Write Plugins dialog box (For details on Read Write Plugins refer to section "Configuring Read Write Plugins" on page 369) and the inspection file is exported, the default output file name is determined using a process similar to the following example:

Figure 11-8. Prefix File Name




```
TEST_DEF_FILE.b13_4321.MC1001_1.17-Nov-10.1552.txt
```

the default file name is "S4321". This file name is constructed from the following:

- The letter "S" in the default file name is the string that has been entered in the Prefix File Name field of the Read-Write Plugins dialog box.
- The number "4321" in the file name is the number that appears in the inspection file name before the tool name "MC1001".
- By default, the output file is saved to the directory specified in the Output Directory field of Read Write Plugins dialog box.

You can configure the dat-ini.xml file such that if you delete any defect and export the inspection file, the defect IDs in the TEXT file appear in sequence. This can be configured by setting the useSequentialDefectIds node as true (shown in the following figure).

Figure 11-9. useSequentialDefects Node

```
<KlarfExportSettings enabled="true">
 <KlarfExportTemplateFileInfo type="mask" file="C:\DefectAnalysisTool\bin\mask_export_template.txt"/>
</KlarfExportSettings>
```

Export to Klarf

The Export option can export the KLA and Lasertec inspection reports to a KLA-Tencor's Klarf v1.2 file format. Select **Utilities** > **Export**, and in the dialog box that appears, specify the Klarf file name and click Save to export currently loaded inspection file to Klarf. To configure the Klarf export settings, use the KlarfExportSettings node in the *dat-ini.xml* file.

Figure 11-10. Klarf Export Settings

```
<KlarfExportSettings enabled="true">
 <KlarfExportTemplateFileInfo type="mask" file="C:\DefectAnalysisTool\bin\mask_export_template.txt"/>
</KlarfExportSettings>
```

Mask Export Template File

A template file (*mask_export_template.txt*) is used by the Export feature to write the parameters to Klarf file. The template file is located inside the *C:\DefectAnalysisTool\bin* directory by default.

- In the Single folder, the reference inspection for Export is the currently selected inspection.
- In the All folder, the reference inspection for Export is selected from Repeatability Analysis.
- In the All folder, the list of defects are exported based on common defect analysis; that is, one defect per common group is exported.

The following table illustrates the parameters that are supported using the **Utilities** > **Export** option.

Table 11-5. Supported Parameters in the Export to Klarf Utility

Field	Description
FileVersion	Major version1, minor version 2.
FileTimeStamp	Current Date-Time.
InspectionStationID	Value: MGC, Calibre NxDAT <version>. Calibre NxDAT <version> is updated by Calibre DefectReview.
SampleType	Value: MASK.
SampleSize	Configurable in mask export template file. Default value: 2152400 152400.
ResultsID	Updated by Calibre DefectReview based on reference inspection.
ResultTimestamp	Current Date-Time. Same as FileTimeStamp.
LotID	Updated by Calibre DefectReview based on reference inspection.
SetupID	Updated by Calibre DefectReview based on reference inspection.
Slot	Updated by Calibre DefectReview based on reference inspection.
SampleOrientationMarkType	Configurable in mask export template file. Default value: TEXT.

Table 11-5. Supported Parameters in the Export to Klarf Utility (cont.)

Field	Description
OrientationMarkLocation	Configurable in mask export template file. Default value: DOWN.
CoordinatesMirrored	Configurable in mask export template file. Default value: NO.
SampleCenterLocation	Updated by Calibre DefectReview based on reference inspection.
AlignmentPoints	Updated by Calibre DefectReview based on reference inspection.
DiePitch	Updated by Calibre DefectReview based on reference inspection.
DieOrigin	Updated by Calibre DefectReview based on reference inspection.
InspectionTest	Configurable in mask export template file. Default value: 1.
InspectedAreaOrigin	Updated by Calibre DefectReview based on reference inspection.
InspectedArea	Updated by Calibre DefectReview based on reference inspection.
AreaPerTest	Updated by Calibre DefectReview based on reference inspection.
ClassLookup	Updated by Calibre DefectReview. ClassLookup table is exported as union of all classifications.
DefectRecordSpec	DEFECTID XREL YREL XINDEX YINDEX XSIZE YSIZE DEFECTAREA DSIZE CLASSNUMBER TEST IMAGECOUNT IMAGELIST
DefectList	Updated by Calibre DefectReview.Note that IMAGECOUNT and IMAGELIST columns are not supported in this version and value 0 is reported in the exported file.
SummarySpec	2 TESTNONDEFECT
SummaryList	1 Num of Defects
EndofFile	End of File

Deleting Unselected Defects

You can permanently delete all unselected defects from the Calibre DefectReview interface.

Procedure

1. In the Calibre DefectReview window, select **Utilities** > **Delete Unselected Defects**.
2. All unselected defects are permanently deleted.

Unfiltering All Filtered Defects

You can select single defect or a set of defects. The defects can be selected from the Defect Map or Defect List.

Refer to "Using Rubber Band Selection Mode" on page 128 and "Selecting Defects" on page 163 for information on defect selection in the Defect Map and Defect List.

Procedure

In the Calibre DefectReview window, select **Utilities** > **Unfilter All Filtered**.

Results

All the filtered defects are shown. The Defect List and Defect Map are automatically updated. Once you filter out the defects, all the selected defects are hidden from the Defect List, Defect Map and wafer map

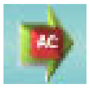
Calibre MDPAutoClassify

Calibre MDPAutoClassify is used to automatically classify defects observed on blank mask substrates. You need a separate license to run it.

For details, refer to the *Calibre MDPAutoClassify User's Manual*.

Launch Calibre MDPAutoClassify from Utilities menu as **Utilities** > **MDPAutoClassify**. This option is also available in the Calibre DefectReview toolbar as an icon.

Figure 11-11. Calibre MDPAutoClassify Toolbar Icon



Calibre DefectClassify

Calibre DefectClassify is used to automatically classify defects observed on pattern mask substrates. Calibre DefectClassify requires a separate license.

For details, refer to the *Calibre DefectClassify User's Manual*.

You can launch Calibre DefectClassify from the **Utilities** > **DefectClassify** menu option in Calibre DefectReview. This tool can also be launched from the Calibre DefectClassify icon in the Calibre DefectReview toolbar.

Figure 11-12. Calibre DefectClassify Icon

Copy Auto Defect Classifications

You can copy all auto defect classification results to manual classification columns in Calibre DefectReview.

Calibre DefectReview copies the defect type classification either from the results of an auto defect classification run or from the previous inspection classification.

If the current defect type classification from an auto defect classification run is False and the defect type classification in the previous inspection is real, then Calibre DefectReview copies the defect type classification from the previous inspection to manual classification. In any other scenario, Calibre DefectReview copies the defect type classification of auto defect classification results to manual classification.

Auto defect classifications are populated after running Calibre DefectClassify. You can launch this utility from **Utilities** > **Copy Defect Classifications** in Calibre DefectReview.

Figure 11-13. Calibre Defect Classifications Icon

The mapping of auto defect classifications and their corresponding manual classifications are maintained in the *dat-ini.xml* file using the autoDefectTierName node.

Figure 11-14. autoDefectTierName Node

```
<MgcSecondaryClassTableMap>
 <!-- The node MgcDecondaryClassTableMap used by DB to define a mapping between manual secondary classification table names
     and corresponding column name in Pattern Classify DB table. Attribute "tableName" is the manual secondary classification table name.
     Attribute "mgcTableName" is the unique generic name of the manual secondary classification table used in DB
     User can change ONLY tableName attribute. This map can be further used in pattern classify to map classification types from
    manual and Pattern Classify secondary tables.
    Added "autoDefectTierName" attribute for mapping between manual and Auto Defect classification tables.
    User can change this attribute's value if they want seperate mapping.-->
 <SecondaryClass tableName="Defect Type Classification" autoDefectTierName="Auto Defect Type Classification" mgcTableName="DefectTypeClassification" mgcDisplayName="Defect Type Classification"/>
 <SecondaryClass tableName="Defect Printability Classification" autoDefectTierName="Auto Defect Printability Classification" mgcTableName="DefectPrintabilityClassification" mgcDisplayName="Defect Printability Classification"/>
 <SecondaryClass tableName="Defect Size Classification" autoDefectTierName="Auto Defect Size Classification" mgcTableName="DefectSizeClassification" mgcDisplayName="Defect Size Classification"/>
 <SecondaryClass tableName="SEM Classification" autoDefectTierName="Auto Defect SEM Classification" mgcTableName="DefectSemClassification" mgcDisplayName="Defect Sem Classification"/>
 <SecondaryClass tableName="Defect Disposition" autoDefectTierName="Auto Defect Disposition" mgcTableName="DefectDispositionClassification" mgcDisplayName="Defect Disposition Classification"/>
 <SecondaryClass tableName="Defect Severity Classification" autoDefectTierName="Auto Defect Severity Classification" mgcTableName="DefectSeverityClassification" mgcDisplayName="Defect Severity Classification"/>
 <SecondaryClass tableName="Defect Progress Classification" autoDefectTierName="Auto Defect Progress Classification" mgcTableName="DefectProgressClassification" mgcDisplayName="Defect Progress Classification"/>
</MgcSecondaryClassTableMap>
<DefectRepeatColorCodes>
 <Range min="1" max="4" color="#00FF00"/>
 <Range min="5" max="9" color="#FFFF00"/>
 <Range min="10" color="#8B0000"/>
</DefectRepeatColorCodes>
```

Manual classification tables are specified under the tableName attribute. You can change autoDefectTierName to modify the mapping. The autoDefectTierName enables you to specify Auto Defect Classification tier names for their corresponding manual classification table names.

Manual classification tables are listed as tableName attributes. You can change the autoDefectTierName to modify the mapping.

During the copy of classifications, Calibre DefectReview displays the mapping information of classification tables that are being used for the copy operation.

Note

This utility is deactivated in the ALL folder.

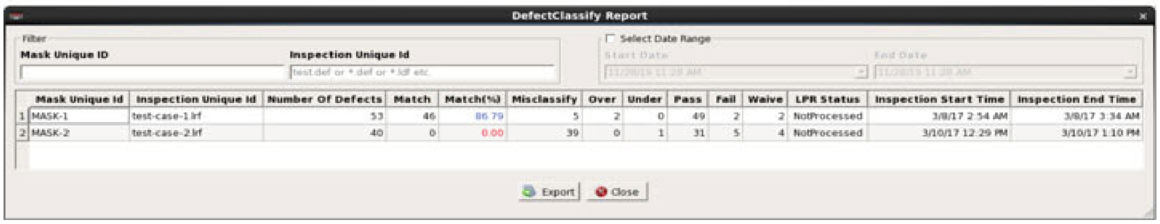
Calibre DefectClassify Report

The Calibre DefectClassify Report is used to analyze the result of Calibre DefectClassify runs on different inspection reports.

Description

Calibre DefectReview searches for all the inspection reports present inside the database and displays their DefectClassify results as shown in the following figure.

Figure 11-15. Calibre DefectClassify Report



Note
You must have a valid defect database set up prior to using this utility.

To generate this report, first run Calibre DefectClassify on your inspection reports, then save the result in the database using **Save To DB**. At any time, if you want to look back or investigate all previous Calibre DefectClassify run results, then click the **Show DefectClassify Report** icon.

Figure 11-16. Calibre DefectClassify Report Icon

Calibre DefectReview supports three methods to search for this report: by mask unique ID, inspection file name, or using the date search.

Objects

Header or Control	Purpose
Mask Unique Id	Represents the unique mask ID present in the database for that inspection file. This is typically provided when you use **Save To DB**.
Inspection Unique Id	Specifies the unique identifier for an inspection.
Number Of Defects	Specifies the total number of defects present in the inspection file.

Header or Control	Purpose
Match	Specifies the number of defects whose operator classification matches exactly with the Calibre DefectClassify classification. This column displays an invalid value of -1 if Calibre DefectClassify is not run on the inspection report.
Match (%)	Specifies the matching rate (Green: over 90%, Sky Blue: 85 to 90%, Orange: 60 to 85%, Red: under 60%). This column displays an invalid value of -1 if Calibre DefectClassify is not run on the inspection report.
Misclassify	This value is equal to [Total number of defects - (Match + Over + Under)]. This column displays an invalid value of -1 if Calibre DefectClassify is not run on the inspection report.
Over	Specifies the number of over-classifications performed by Calibre DefectClassify. This column displays an invalid value of -1 if Calibre DefectClassify is not run on the inspection report.
Under	Specifies the Number of under classification done by DefectClassify. This column displays an invalid value of -1 if Calibre DefectClassify is not run on the inspection report.
LPR Status	Specifies the LPR status and whether or not it requires review, or if LPR has completed or not. For details, refer to the *Calibre DefectClassify User's Manual*.
Pass	Represents the number of defects with a Pass disposition. For more information, refer to the *Calibre DefectClassify User's Manual*.
Fail	Represents the number of defects with a Fail disposition. For more information, refer to the *Calibre DefectClassify User's Manual*.
Waive	Represents the number of defects with a Waive disposition. Waive is a manual classification for the Defect Disposition tier. Whether or not a defect is waived is specified by the user.
Inspection Start Time	Specifies the start time of the inspection.
Inspection End Time	Specifies the end time of the inspection.
Export	Exports the results to a CSV file. A Save Results dialog box appears and you can specify the CSV file to save results in.
Close	Closes the dialog box.

Chapter 12
Dock Layout

The dockable window layout of the Calibre DefectReview interface can be reconfigured using different dock settings. These settings can be saved and exported for future use.

Saving and Loading a Dock Layout

You can save the current dock layout configuration and reload it back into Calibre DefectReview in a future session.

For details on how to configure or arrange the dock layouts into different docking settings, refer to section "Calibre DefectReview Layout Modification" on page 106.

Once you have confirmed your dock layout views, you can save these layout views. The next time you open any other inspection result (IRs) inside Calibre DefectReview, the same dock arragements you saved previously appear. If you want the default dock layout, click **View** > **Show Default View**.

Procedure

1. To save the dock layout configuration, in the Calibre DefectReview window, select **Dock Layout > Save**.
2. During the use of Calibre DefectReview, if you have changed the views again and performed other dock layout arrangements, you can reload your previously-saved layout dock layout. To perform this, in the Calibre DefectReview window, select **Dock Layout > Load**.

   Note the following:

   - The dock layout can be used by all users at the same user level is as the one who saved the layout. For example, if a normal user saves the layout, then all the normal users can load the saved layout. This feature is available only in Calibre DefectReview.
   - Using the **Dock Layout > Save for Restricted User** option, privileged and normal users can save the layout for a restricted user. Whenever a restricted user logs into Calibre DefectReview, a layout saved by privileged or normal users is loaded to Calibre DefectReview. This option is available only in Calibre DefectReview.

- If you save the dock layout, the image states of Fixed and Free mode are stored in the Calibre DefectReview registry. When you reload the dock layout, these states are restored from the Calibre DefectReview registry. Refer to section "Image Measurement Modes" on page 274 for more details on image states in Free and Fixed modes.

Exporting a Display Layout

You can use Calibre DefectReview to export the current display layout and import the exported layout into another system.

Calibre DefectReview maintains three level of users, PRIVILEGE, NORMAL and RESTRICTED. (For further details, "User Permissions Overview" on page 45). During the export of the display layout, the following rules are applied:

- A PRIVILEGE user can export for another PRIVILEGE and RESTRICTED user.
- A NORMAL user can do for another NORMAL and RESTRICTED user.
- RESTRICTED users cannot export or import of display layout.

Procedure

1. To export current display layout, in the Calibre DefectReview window, select **Dock Layout > Export Display Layout**.
2. To export display layout for RESTRICTED user, in the Calibre DefectReview window, select **Dock Layout > Export Display Layout for Restricted**.

   Calibre DefectReview keeps all the display information in a package file(.pkg), so if exporting is successful, the user gets a package file with all display information. Export of the display layout fails if either one of the following is true:

   - One or more windows/Dock widgets are undocked.
   - Calibre DefectReview is running on an extended monitor.
3. To import the package file on any other system, launch the utility *ImportDisplay.exe*. It available in *C:\DefectAnalysisTool\bin* folder. A login dialog box appears.

Figure 12-1. Login Dialog Box

4. Use the same login credentials used to access Calibre DefectReview. Upon a successful login, The Display Importer dialog box appears.

Figure 12-2. Display Importer

5. Click **Browse** and navigate to the package file to import.
6. Click **OK** to import the settings.
7. During import of display layout, the following rules are applied.
    - A PRIVILEGE user import for all user types.
    - A NORMAL user can import for a NORMAL and RESTRICTED user.
    - RESTRICTED users cannot export or import of display layout.

Results

If the import is successful, a popup message box appears indicating a successful import. If there are any errors, another message appears indicating import failure.

If the import display fails, the current settings remain unchanged. The import display fails either of the following condition are true:

- Source and destination system have different resolution.
- An instance of Calibre DefectReview is running during import.

Any system specific settings of Calibre DefectReview such as the import file list, location of last opened inspection file, and so on are not remembered after a display import.

Chapter 13
Layout Import

Layout Import enables you to view layout or mask images corresponding to defects in the reticle. If the reticle is made of multiple layers, then multiple layout images are displayed for each defect.

The process of importing layouts is summarized in three stages:

1. **Data Preparation** — Enter parameters for the input layout image and generate a database.
2. **Data Correlation** — Correlate the data for a reticle with the layout image.
3. **Layout Images Generation** — Generate layout images for a defect.

Data Preparation

In this stage, you use Calibre DefectReview to enter parameters for the input layout images to generate databases.

The following are the inputs for the data preparation stage:

- **Layout File** — The layout file from which the mask is prepared. The layout file can be a GDSII, OASIS, OASIS.MASK, MEBES.JOB, or MEBES file. In the case of a Phase Shift Mask (PSM), the reticle is made up of multiple layout files. In this case, multiple layout must be specified.
- **Layout File Type** —The layout file type can be GDSII, OASIS, OASIS.MASK, MEBES.JOB or MEBES. MEBES file format is owned by AMAT.
- **Output TIFF File** — All the layout images generated are stored in a tiff file.
- **Layer and Datatype Pair** — The logical layer(s) of the layout file from which the data for the mask layer is generated. The actual layout file (GDSII or OASIS) may consist of layout details of multiple mask layers. Hence, you must specify the information about how a mask layer is derived from which logical layers of GDSII or OASIS file. In a MEBES.JOB file, multiple levels are present. If the mask layer is derived from a single level, then the corresponding level must be specified in the Layer and Datatype pair. If the level number is not specified for the MEBES.JOB file, then all levels of MEBES.JOB are used.

  Note

  The Layer and Datatype pair is needed only for GDSII and OASIS layout files. If the Datatype is not specified, it is assumed to be 0. The Datatype is not mandatory in a MEBES.JOB file as it is not required by the MEBES format.

- **Top Cell** — The top cell from where the mask is prepared must be specified. GDSII or OASIS layout files can have multiple top cells.

  Note

  Top Cell is required only for GDSII and OASIS layout files and not for MEBES.

Generating the Database

A database is generated for input layout images using the Data Preparation dialog box (**Layout > Data Preparation**).

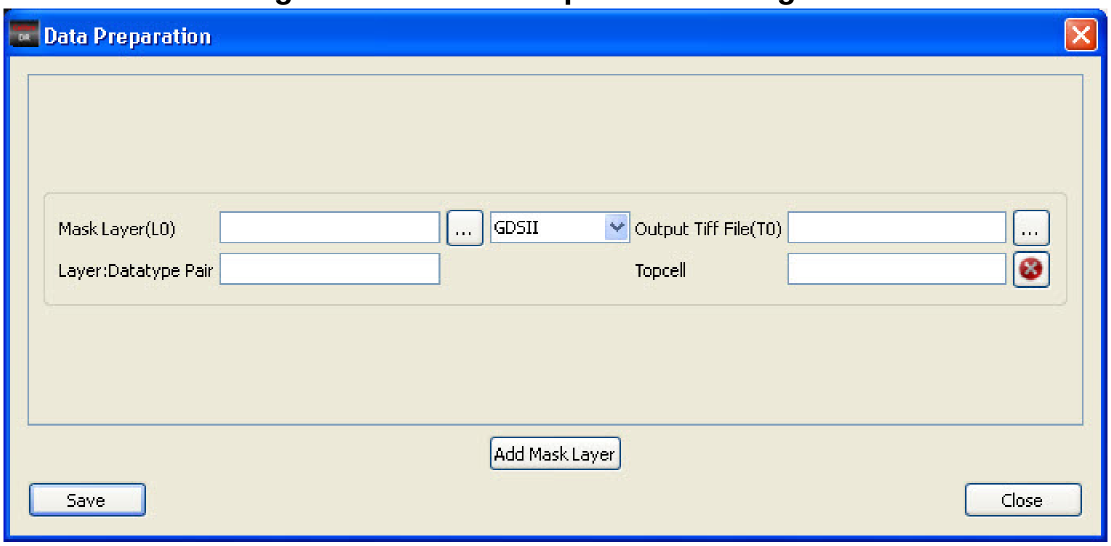
Prerequisites

- For GDSII and OASIS files, the creation of a database is done locally on the Windows machine where Calibre DefectReview was launched. For MEBES.JOB and MEBES files, database creation is done remotely on a Linux machine.

Procedure

1. In the Calibre DefectReview window, click **Layout > Data Preparation**. The Data Preparation dialog box appears.

Figure 13-1. Data Preparation Dialog Box



2. Enter the input layout file in the Mask Layer (L0) text entry box or browse for the file by clicking on the **…** button.

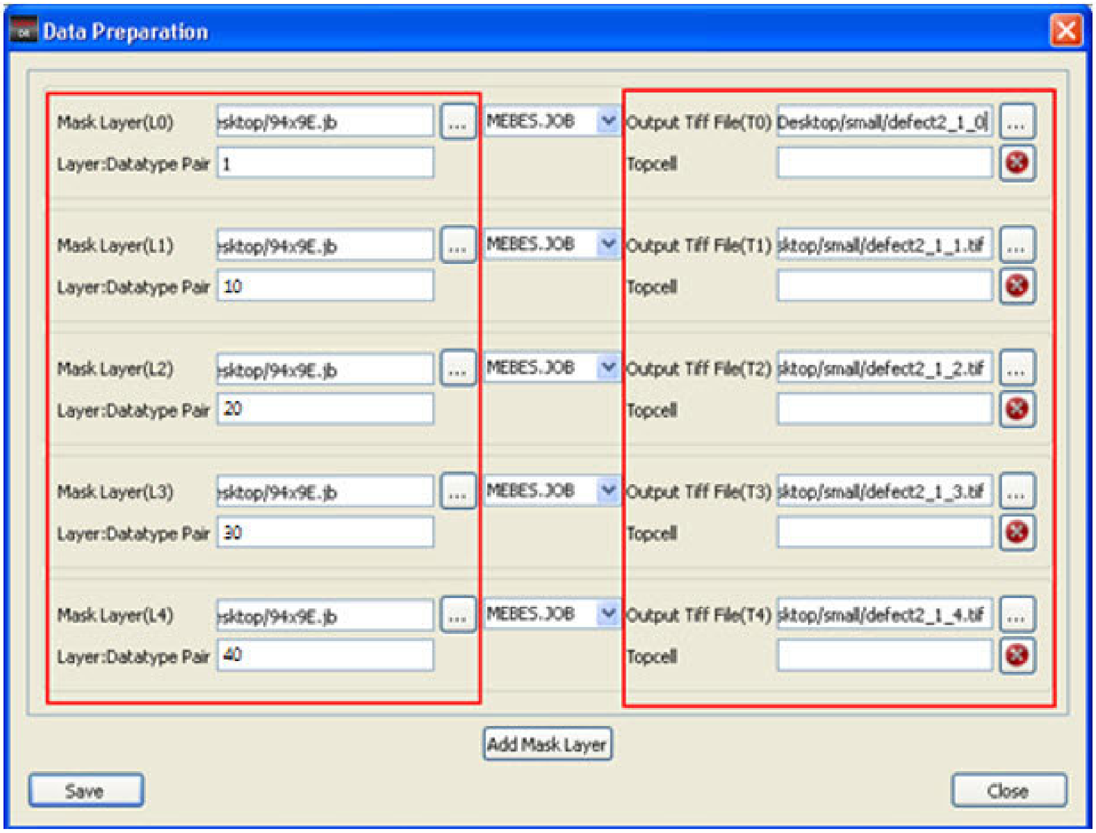
Note

The type of the layout file is automatically updated in the combo box next to the Mask Layer (L0) field. However, you can also manually select the layout type in the combo box.

3. Once the input layout file is specified, all layers in the job deck are populated as a separate mask layers on the Data Preparation dialog box (see Figure 13-2 for an example). The TIFF file path is populated using the following format:

```
defectFilePath_<inspection_number>_<mask_layer_number>.tiff
```

Figure 13-2. Data Preparation Dialog Box With All Layers Displayed



In Figure 13-2, the input mask file generates five mask layers, starting from L0 to L4, and their corresponding image file paths.

4. To enter a separate output TIFF file name or path, enter the new file path in the Output Tiff File text entry field browse for the file by clicking on the **…** button.

Caution

If the TIFF file already exists, it will be overwritten.

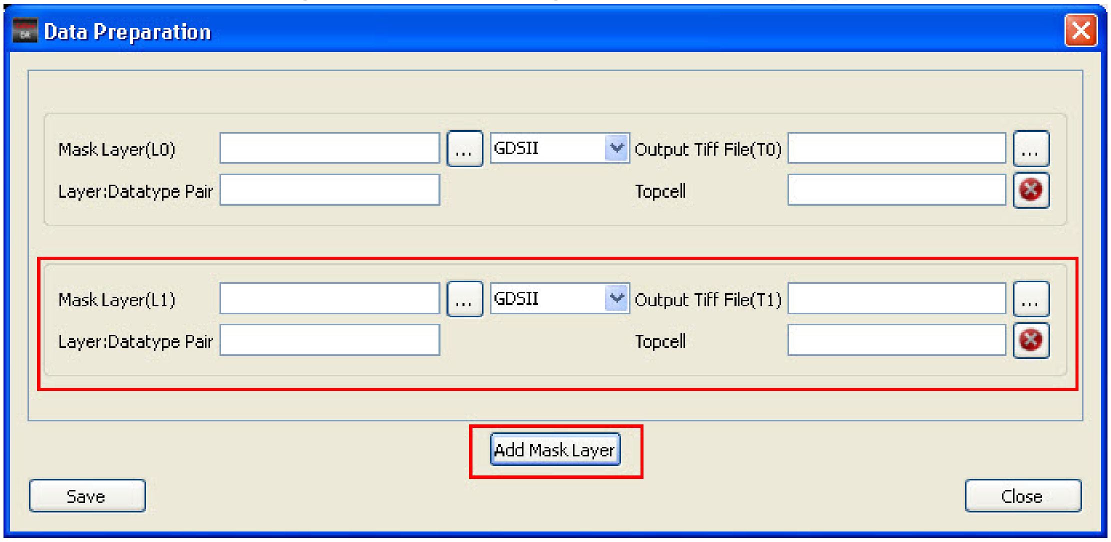
If you select a job deck file that has multiple layers (for example, 1, 93, 95, and 97), then each layer is populated separately as a mask layer (as shown in Figure 13-2). To delete a mask layer, click **Delete** (the red button with an X).

5. Enter the layer and datatype pair or level number (in the case of MEBES.JOB) in the Layer:Datatype pair text entry field.

6. Enter the top cell in the Topcell text entry field.

7. If you want to add values for additional layout files, click **Add Mask Layer**. A set of text entry fields for new mask layer (layout file) are displayed in the dialog box (see Figure 13-3).

Figure 13-3. Adding a Mask Layer (L1)



8. Follow the same steps for entering the values for the new layout file.

9. If you are using MEBES.JOB and MEBES format files, you must set up a remote connection with a Linux machine to generate databases. See "Setting Up Database Creation for MEBES" on page 393 for details.

10. To generate the database, click **Save**. If successful, Calibre DefectReview generates a database for the input layer files. Calibre DefectReview issues a message to indicate successful completion.

    For GDSII and OASIS files, database creation can take a long time. During this time, you can perform any other analysis or operation as the creation is carried out as a parallel process by Calibre DefectReview.

    During database creation, the options to view layout images in the Defect List and Defect Map are temporarily deactivated.

Setting Up Database Creation for MEBES

For GDSII and OASIS files, the creation of a database is done locally on the machine where Calibre DefectReview was launched. For MEBES.JOB and MEBES files, database creation is done remotely on a Linux machine.

For this procedure, an example is used for illustration purposes. This example uses the following:

- On the Linux machine, the MEBES job deck file is located on */g/repository/data/mebes_data.jb*.
- The *mebes_data.jb* file is accessible from a Windows machine using the path *Z:/repository/data/mebes_data.jb*.

- The Linux machine IP address is 10.0.0.112.
- The Linux user login name is manab.
- On the Linux machine, the HOME directory for manab is */home/manab* and this directory is accessible on Windows using the path Y:.

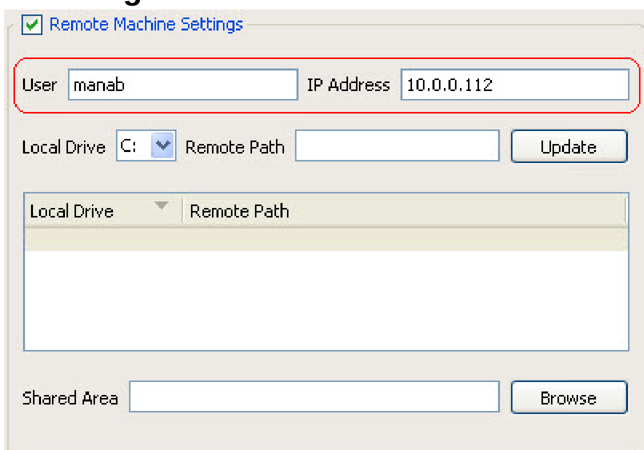
  This type of mapping of Linux drives is done using the **Map Network Drive** options in Windows.

Procedure

1. Launch a Calibre DefectReview session on the Windows machine.
2. In the Calibre DefectReview window, select **Utilities > Calibration Parameter Editor**. This invokes the Calibration Parameter Editor.
3. In Remote Machine Settings section, enter the user name and IP address for the Linux machine (shown in Figure 13-4). For example:

```
User: manab
IP Address: 10.0.0.112
```

Figure 13-4. Reading Remote Machine User Name and IP Address



4. Map the Windows network drives and Linux paths in the Remote Machine Settings section. This enables Calibre DefectReview to convert a Windows path to a Linux path.

   For example, the following mapping information is added for the Z: and Y: drives.

   - Assuming that the Z: drive is already mapped to *\\10.0.0.6\g* and this path is accessible in Linux through */g/*, set the Z: drive mapping in Calibre DefectReview as follows:

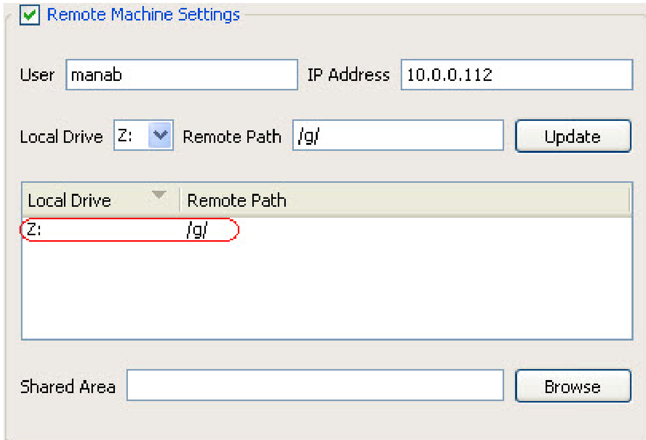
     i. Select the **Z:** drive from Local Drive dropdown list.

     ii. Enter the Linux path */g/* in the Remote Path text box. Calibre DefectReview maps *Z:/repository/data/mebes_data.jb* on Windows to */g/repository/data/*

mebes_data.jb on Linux. It only replaces Z: in the Windows path with */g/* on Linux.

iii. Click **Update** and the mapping information for the Z: drive gets added as shown in Figure 13-5.

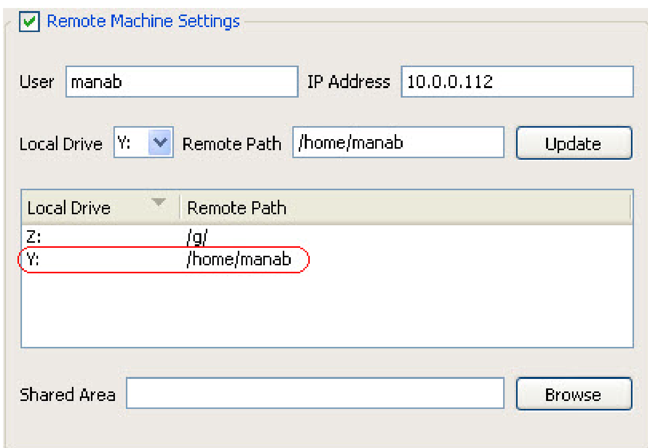
Figure 13-5. Updating the Mapped Local Drive



iv. Select the **Y:** drive from Local Drive dropdown list.

v. Enter the path */home/manab* in the Remote Path entry field and click **Update**. Figure 13-6 shows information for all connected drives.

Figure 13-6. Connected Drives information With Remote Path



If an incorrect mapping is entered, double-click a mapped item and a dialog box appears, asking if you want to delete the mapping.

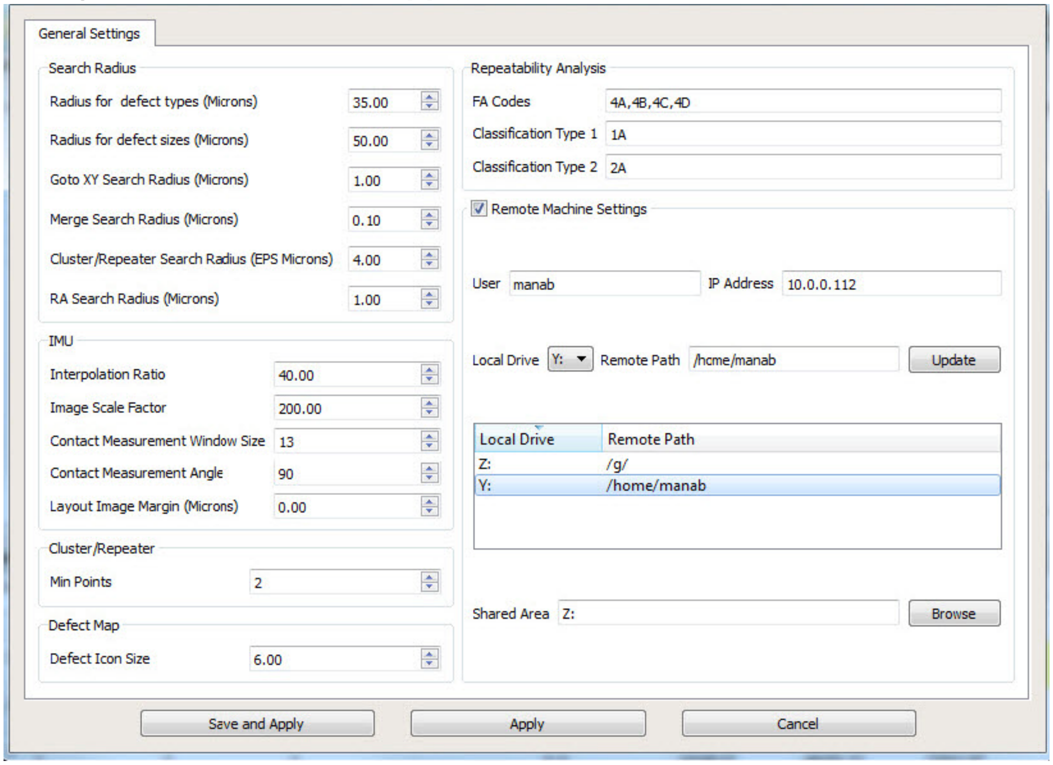
vi. Specify the shared folder (directory) to be used. This folder is used by the Linux process of Calibre DefectReview to create temporary files. The directory must be writable by both the Windows and Linux processes of Calibre DefectReview. You can enter the folder either manually or click **Browse** to select the folder.

5. Click **Save and Apply** to save these settings.

Note

This stage is typically done only once.

Figure 13-7. Save and Apply in the Calibration Parameter Editor



Correlation of Transform Data

After the data preparation stage, correlation of data is performed. At this point, transformations are applied to a layout file. A reticle is created from the layout file after applying these transformations.

The following are different transformations that can be applied to the geometries of the input layout file:

- **Translation** — Translate the geometries on the input layout according to X and Y directions.
- **Rotation** — Rotate the geometries by a specified angle. Only rotations in multiples of 90 degrees are allowed. This rotation is counter-clockwise.
- **Magnification** — Magnify the geometries by a factor of 1X, 4X, or 5X.
- **Reflection** — Reflect the geometries using one of the following parameters: No Mirror, X Mirror, or Y Mirror.

Calibre DefectReview assumes that the layout data is in the first quadrant and the bottom left is at the (0, 0) location. In the transformation step, Calibre DefectReview first applies the rotation about the center of layout data in a counter-clockwise direction. For layout data, the center point of the rotation is always located at (76200, 76200) in microns. The translation is then applied to the rotated data.

For example, if you have specified a rotation of 270 degrees and translation as (1500, 2500) microns, then the layout geometries appear as in the following figures:

Figure 13-8. Layout Data Centered at (76200, 76200) Microns

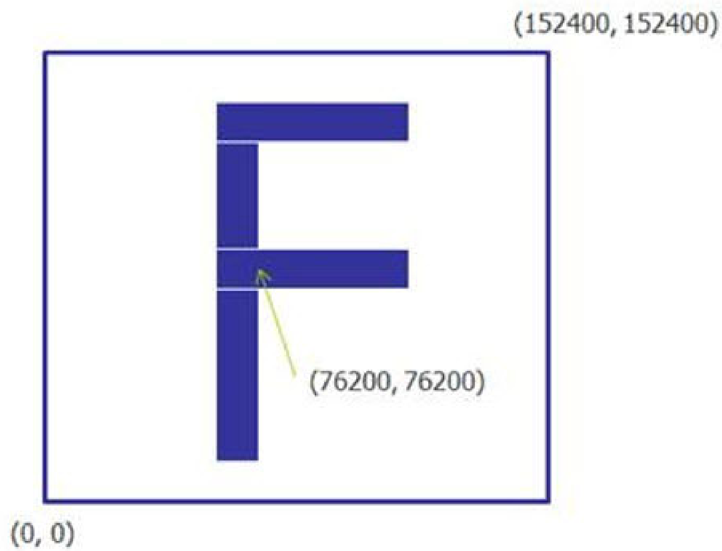
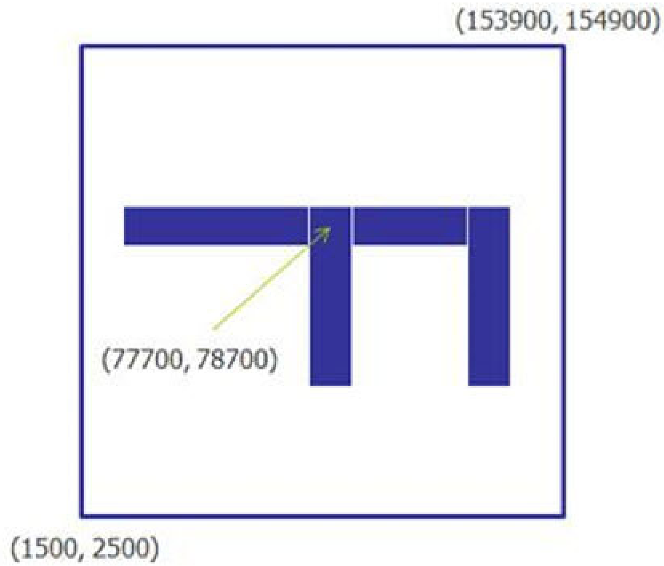


Figure 13-9. Layout Data After Applying Rotation and Translation



Setting Translation and Rotation Properties

Once the data preparation stage is completed, the translation and the rotation values are calculated based on default values provided in the *dat-ini.xml* file. These values can either be modified directly in the file, or through the Correlation dialog box.

Procedure

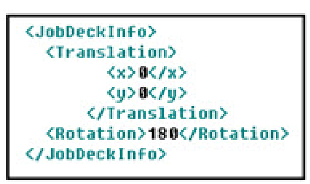
Perform one of the following operations:

Using JobDeckInfo:

a. Open the *dat-ini.xml* file in a text editor.

b. Edit the translation and the rotation values are specified under JobDeckInfo node as shown in the following figure.

Figure 13-10. JobDeckInfo Node



```
<JobDeckInfo>
  <Translation>
        <x>0</x>
        <y>0</y>
      </Translation>
  <Rotation>180</Rotation>
</JobDeckInfo>
```

For rotation, the following conventions are used:

- 0 degrees = Arrows Up

- 90 degrees = Arrows Left
- 180 degrees = Arrows Down
- 270 degrees = Arrows Right

The comments node present in the inspection file specifies the arrow rotation of the reticle. Based on the JobDeckInfo node value and comments node value, the rotation angle of the correlation is calculated.

For example, suppose the value of the comments node in the inspection file is Arrows Right as follows:

```
<comments> Arrows Right </comments>
```

The corresponding reticle image in Defect Map is shown in the Figure 13-11), and the value of Translation and Rotation nodes present in the JobDeckInfo node of the *dat-ini.xml* file is as shown in Figure 13-10, then the rotation angle of the layout file in correlation is 90 degrees as shown in Figure 13-12.

Note
If the comments node does not contain a value, then the rotation angle is calculated based on the default values specified in the inspection file.

Figure 13-11. Reticle Image in Defect Map

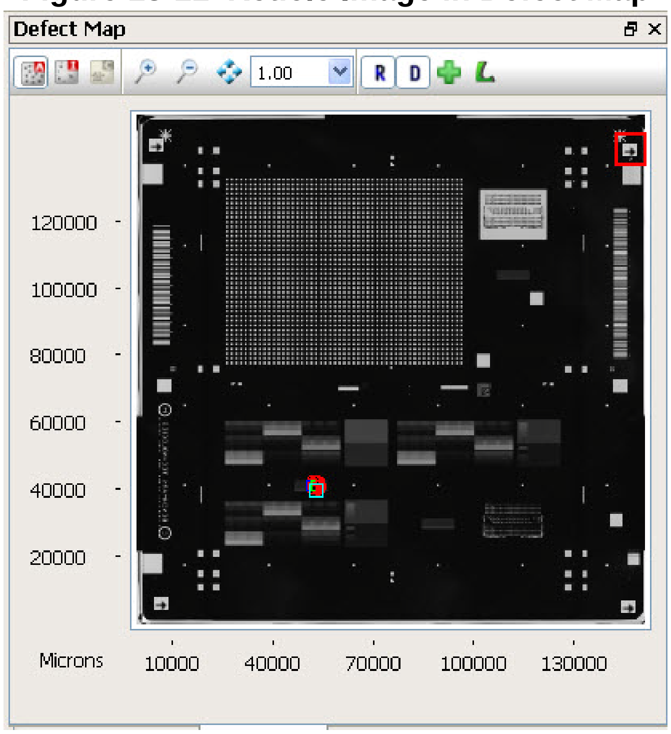
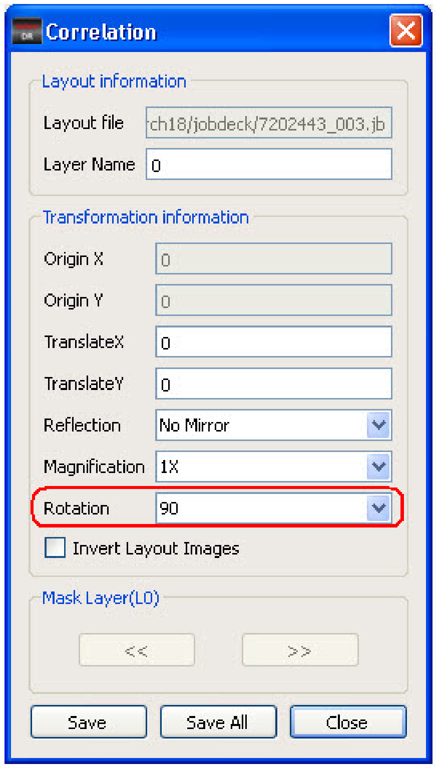


Figure 13-12. Rotation Angle in the Correlation Dialog Box



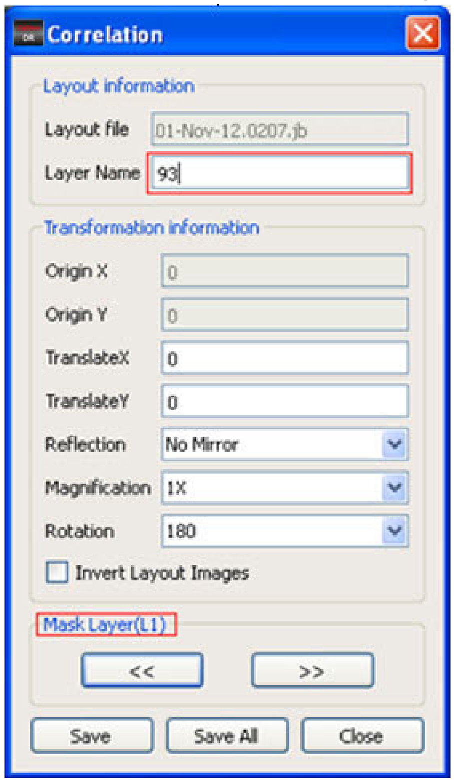
Note

The rotation is always in counter-clockwise direction.

Using the Correlation Dialog Box:

a. Click **Layout** > **Correlation**. A dialog box appears as shown in “Correlation Dialog Box” on page 401.

Figure 13-13. Correlation Dialog Box



Correlation values for all the mask layers are specified in the following sections:

Table 13-1. Correlation Dialog Box Fields

Field		**Description**
Layout Information		
	Layout file	A non-editable text box that displays the layout file specified in the Data Preparation step.
	Name of the layer	Automatically populated to reflect the layer number, such as Layer-1, Layer-93, through Layer-97 for the job deck loaded in the Data Preparation dialog box. If multiple mask layers have same layer number (for example, there are 3 mask layers with layer 99), then the Layer Names in the Correlation dialog are incremented for each layer (for example, 99, 99-1, 99-2). Figure 13-13 shows an automatically populated Layer Name in Correlation dialog box for Mask Layer (L1).
Transformation Information		To enter the transformation parameters, enter values for TranslateX, TranslateY, Reflection, Magnification and Rotation. You can select the values for Reflection, Magnification and Rotation from the combo box.

Table 13-1. Correlation Dialog Box Fields (cont.)

Field		Description
	Origin X Origin Y	Displays the origin coordinates. The transformation parameters Origin X and Origin Y are not editable and the values are as follows: • For GDSII, OASIS, MEBES.JOB, and MEBES files, the values are always 0, 0.
	Translate X Translate Y	Specifies the translation coordinates for the X and Y directions.
	Reflection	Reflect the geometries using one of the following parameters: No Mirror, X Mirror, or Y Mirror.
	Magnification	Magnify the geometries by a factor of 1X, 4X, or 5X.
	Rotation	Rotate the geometries by a specified angle. Only rotations in multiples of 90 degrees are allowed. The rotation is counter-clockwise.
Mask Layer		Navigate through the mask layers using the arrow navigation buttons.
Save		Save transformation settings for the current mask layer.
Save All		Save transformation for all mask layers.
Close		Close the dialog box.

Ignoring Job Deck Layers When Mask Layers are Populated:

a. To ignore any layer during population of multiple mask layers, you can specify the layer numbers in IgnoreLayers node. This option is under JobDeckInfo node in *dat-ini.xml* file.

Figure 13-14 shows an option in which layers 50 and 52-60 are ignored. If the job deck has layers 50,51,52,53, and this job deck is populated, then only layer 51 will be populated in the Data Preparation dialog.

Figure 13-14. Ignoring Job Deck Layers in the dat-ini.xml File

```
<JobDeckInfo>
 <DataPreparation>
  <IgnoreLayers>50, 52-60</IgnoreLayers>
 </DataPreparation>
 <Translation>
  <x>0</x>
  <y>0</y>
 </Translation>
 <Rotation>180</Rotation>
</JobDeckInfo>
```

Note

If any parameter (for example, Mask Layer and Tiff file location) is changed in the Data Preparation dialog box, then during correlation, Calibre DefectReview invalidates all images related to that Mask Layer for all defects present in Calibre DefectReview.

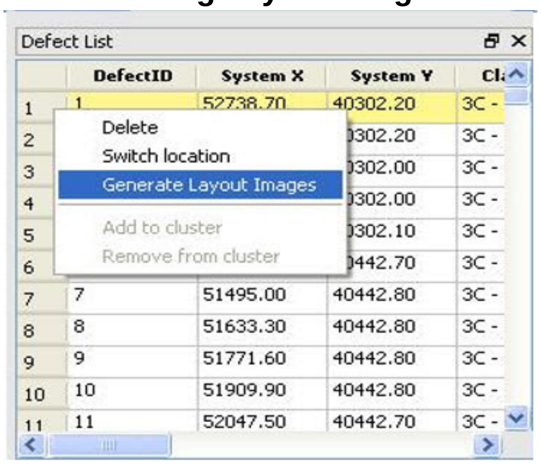
Generating a Layout Image

After the data preparation and correlation stages, layout images can be generated and displayed for a defect.

Procedure

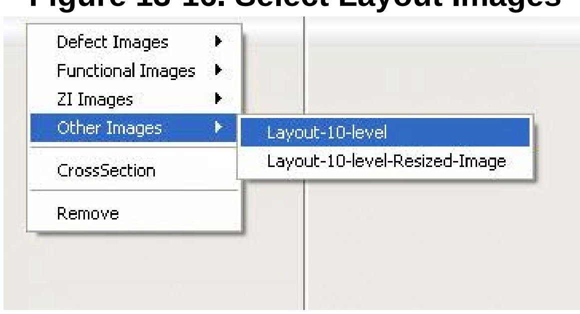
1. Select defect(s) from the Defect List or Defect Map and then select **Generate Layout Images** from the right-click menu.

Figure 13-15. Generating Layout images from Defect List



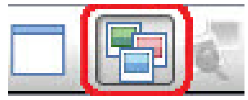
2. You can now view the generated layout images in the Image Measurement Unit window as auxiliary images. Right-click in a display unit and select from the **Other Images** list to specify which layout images should be displayed in the IMU window

Figure 13-16. Select Layout Images



3. Once the images are generated, click the **Auxiliary Image** icon to view the layout images.

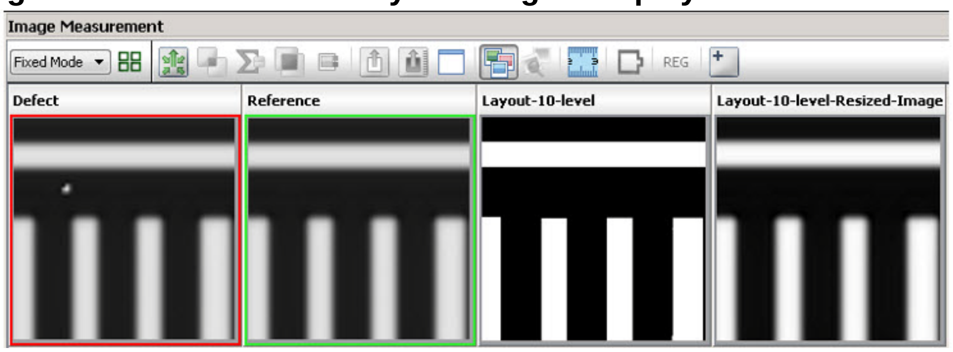
Figure 13-17. Display Auxiliary Images



4. In Figure 13-18, two layout images are generated:

    - **Layout-10-level** — A high resolution layout image. The resolution of this image is fixed to 1024.
    - **Layout-10-level-Resized-Image** — A low resolution layout image. The resolution of this image is same as the resolution of the defect or reference image.

Figure 13-18. Generated Layout Images Displayed in IMU Window



Generated layout images have default display sizes:

- If a defect has a Sem and TIF image, the pixels and pixel size of the layout image are the same as the Sem image.
- If a defect has a Sem bit no TIF image, the pixels and pixel size of the layout image are the same as the Sem image.
- If a defect has no Sem but has a TIF image, the pixels and pixel size of the layout image are the same as the TIF image.
- If a defect has no image associated with it, the layout image size can vary from 3 to 10 microns based upon the defect file format (for example, DEF, LRF, LDF, Klarf).

Cross Probing a Layout

Use the cross probing capabilities of Calibre DefectReview to check where defects are located on layout patterns.

Procedure

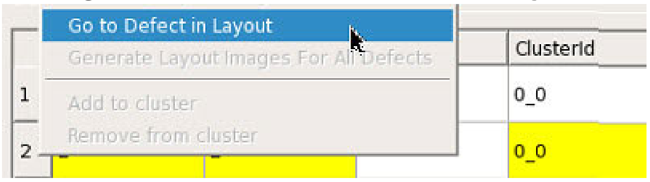
1. In Calibre DefectReview, select **Layout** > **Cross Probe**.

    This option launches Calibre® DESIGNrev™ and loads a layout.

Note
All layout file formats supported by Calibre DESIGNrev can be loaded.

2. To cross probe defects listed in the Defect List to their location in the layout displayed in Calibre DESIGNrev, select the **Go to Defect in Layout** option. As you navigate defects, the cross probe triggers automatically.

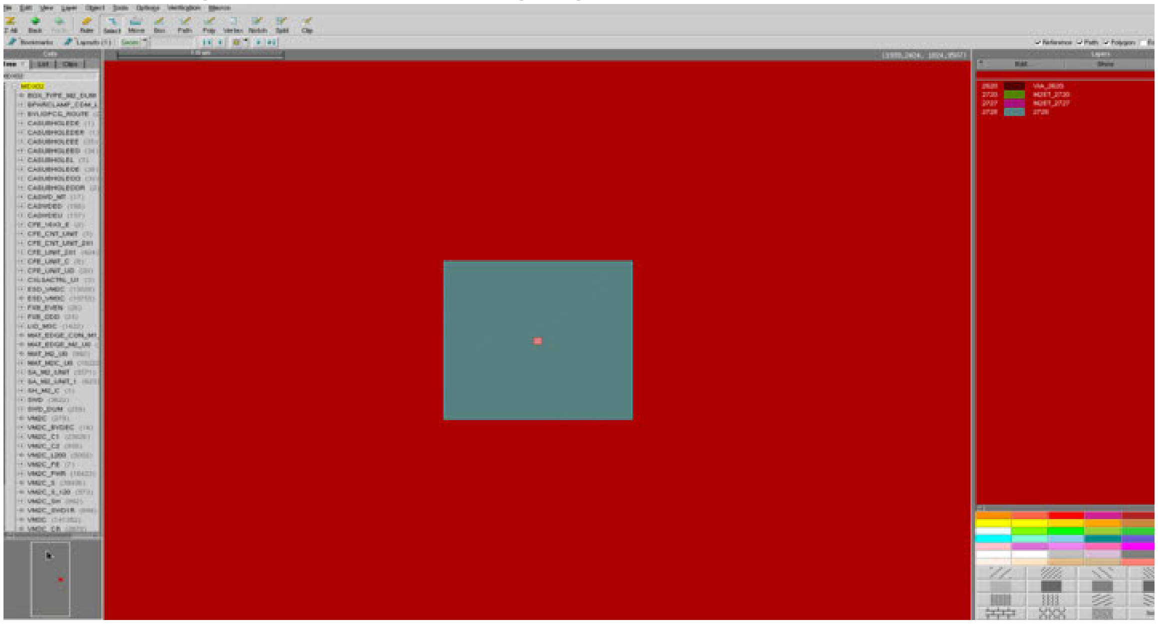
Figure 13-19. Go to Defect in Layout



Results

The defect is highlighted in Calibre DESIGNrev with a center marker and a square with its sides set to the defect size (displayed as a gray box). An example is shown in the following figure:

Figure 13-20. Defect Highlighted in Calibre DESIGNrev



Chapter 14
Applying Transform Operations

The transform functionality of Calibre DefectReview enables you to rotate, flip, and translate defect inspection data.

Rotate

You can rotate defect inspection data by 90°, 180° and 270° in Calibre DefectReview.

Procedure

1. In the Calibre DefectReview window, click **Transform > Rotate**.
2. In the **Rotate** sub-menu, select the degree (**90**, **180**, **270**) to rotate the defect inspection data, or **Reset** to reset the rotation.

   Note

   The rotation is always around the center of the reticle.

3. Figure 14-1 illustrates the contents of the Defect Map and Defect List before rotation and Figure Figure 14-2 illustrates the contents after a 90-degree rotation. The system coordinates in the Defect List are updated after rotation.

Figure 14-1. Inspection Before Applying Rotation

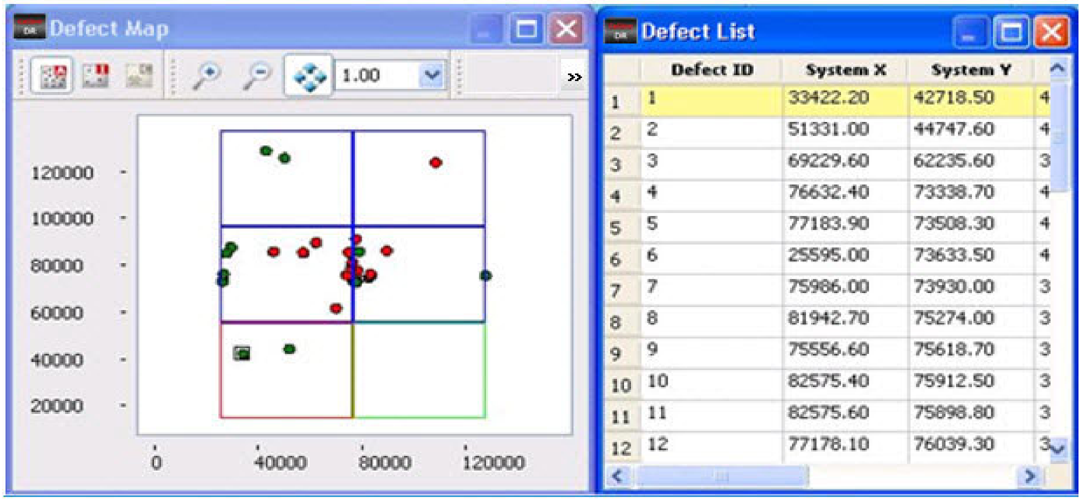
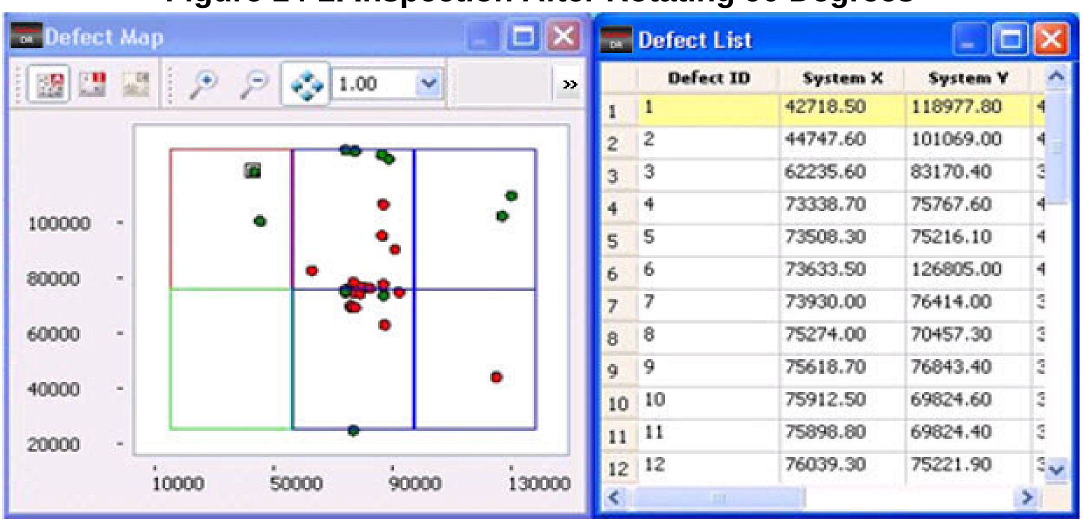


Figure 14-2. Inspection After Rotating 90 Degrees



Flip

You can flip (reflect) the defect inspection data around the X and Y axes in Calibre DefectReview.

The Flip transformation X-Dir and Y-Dir transform the inspection coordinate data across the corresponding axis. For example, the X-Dir selects the X-axis as the reflection axis and transforms the coordinates. Only the Y-coordinate is changed. Similarly, the Y-Dir selects the Y-axis as the reflection axis and transforms the coordinates; only the X-coordinate is changed.

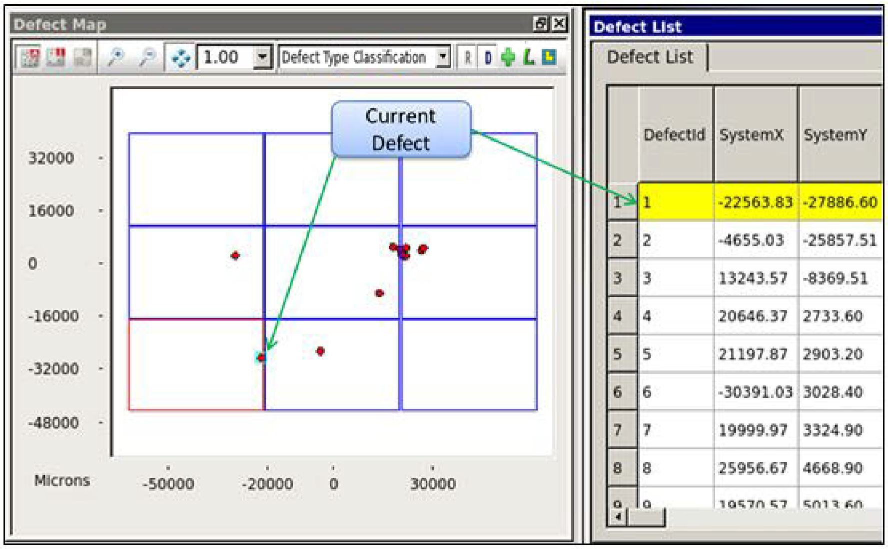
Procedure

1. In the Calibre DefectReview window, click **Transform** > **Flip**.
2. In the **Flip** sub-menu, select the axis (**X-Dir**, **Y-Dir**) to flip the defect inspection data.

Note

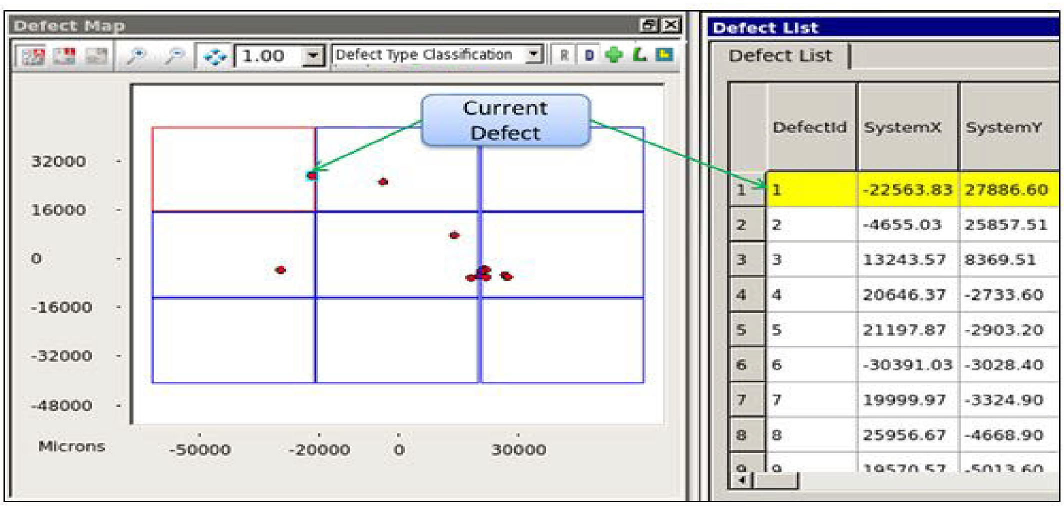
The system coordinates of a defect are updated in the Defect List as well.

Figure 14-3. Inspection Before Applying Flip



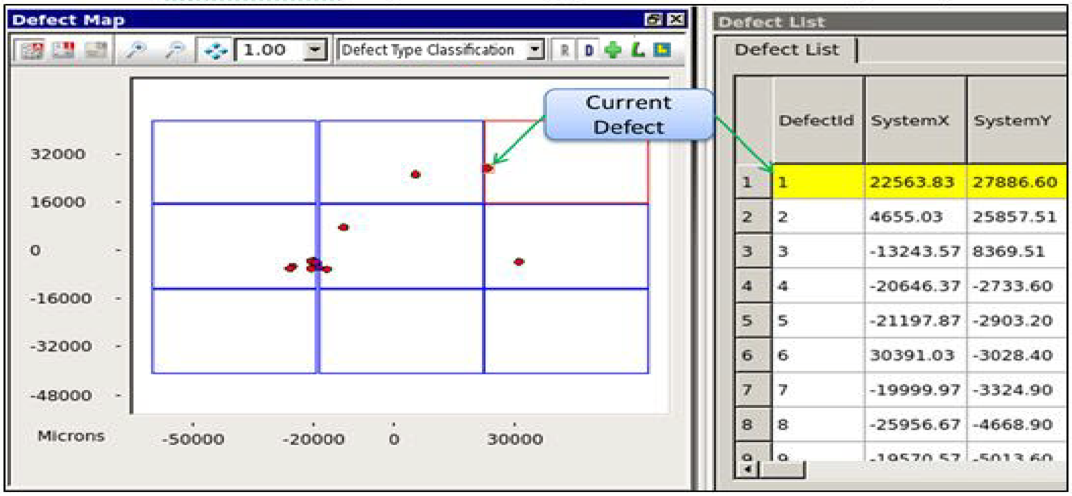
The following figure illustrates the results of an X-Dir flip applied to the previous figure.

Figure 14-4. Inspection Flipped Around X-Axis (X-Dir)



The following figure illustrates the results of a Y-Dir flip applied to the original figure.

Figure 14-5. Inspection Flipped Around Y-Axis (Y-Dir)



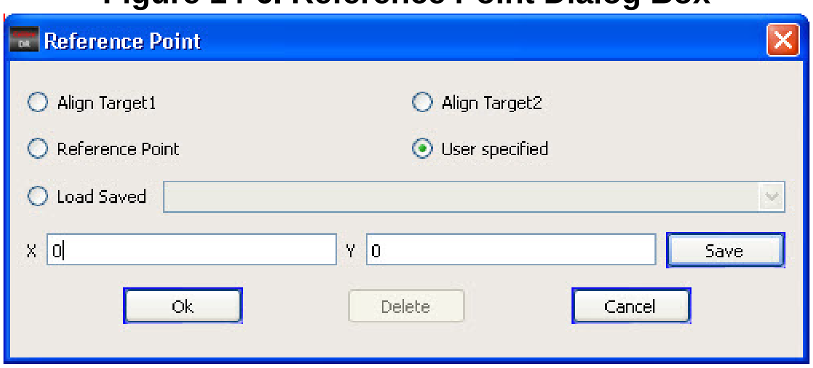
Translate

You can translate defect inspection data by setting alignment and reference points in X and Y directions in Calibre DefectReview.

Procedure

1. In the Calibre DefectReview window, click **Transform** > **Translate**. The reference point dialog box appears.

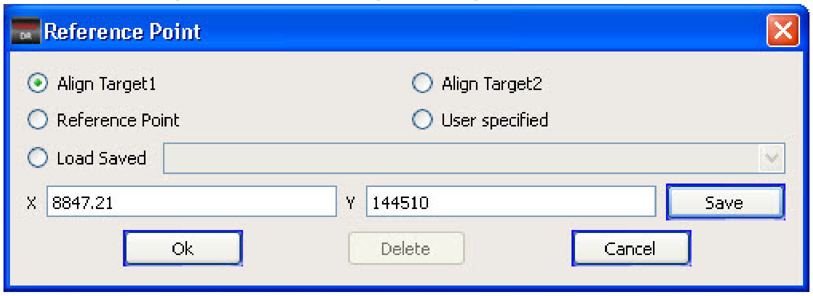
Figure 14-6. Reference Point Dialog Box



2. Select from one of the following options to specify the X and Y translation offsets:

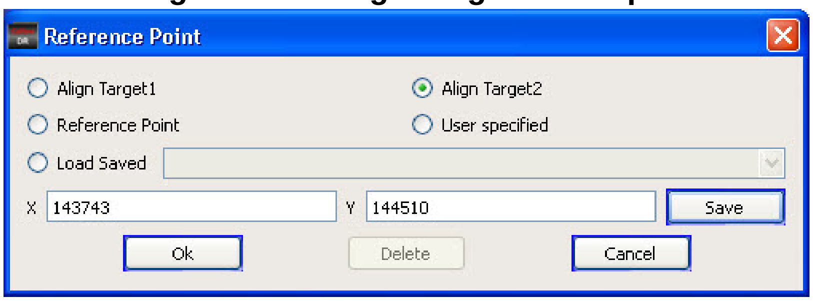
    - **Align Target1** — The X and Y offsets are extracted from the Align Target1 field of defect inspection file and displayed.

Figure 14-7. Align Target1 Example



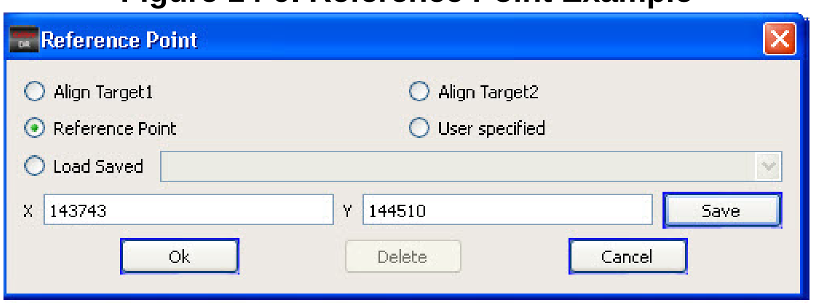
- **Align Target2** — The X and Y offsets are extracted from the Align Target2 field of defect inspection file and displayed.

Figure 14-8. Align Target2 Example



- **Reference Point** — The X and Y offsets are extracted from the Reference Point field of defect inspection file and displayed.

Figure 14-9. Reference Point Example



- **User specified** — Manually enter the X and Y offsets.

Note

In all the four translations, the specified reference point is deduced from the system coordinates of the defect and is shown accordingly in Defect List and Defect Map windows.

3. Click **Ok**. All defect data is translated by the amount specified

Saving and Loading Reference Points

You can save reference points for translation and reload them at a later time.

Procedure

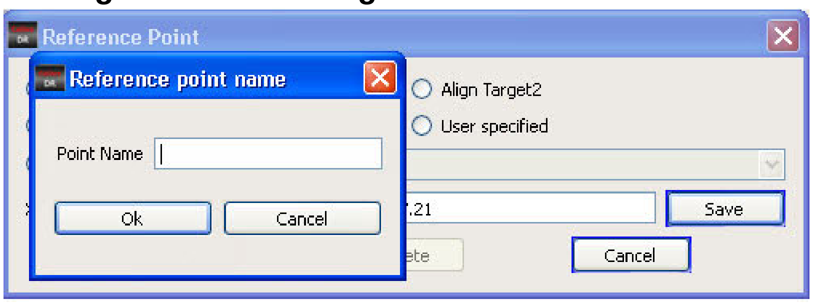
Perform one of the following operations:

Saving a Reference Point by Name:

a. Click **Save** on the Reference Point dialog box. A Reference Point Name dialog box appears.

b. Enter a name for the current point in the Point Name text box.

Figure 14-10. Saving a Reference Point Name



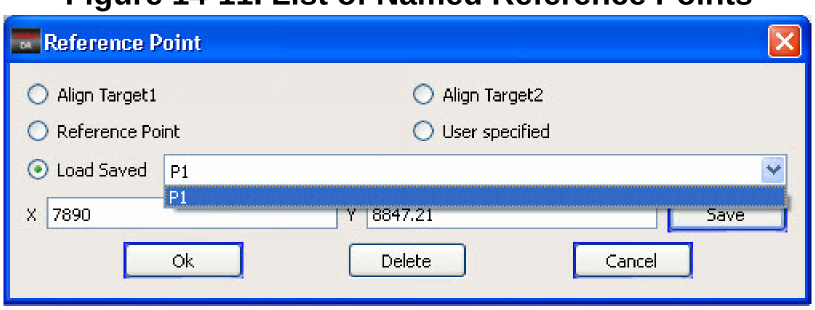
c. Click **Ok**.

Loading a Reference Point:

a. In the Reference Point dialog box, click the **Load Saved** radio button.

b. Select a point name from the drop down menu beside the **Load Saved** option.

Figure 14-11. List of Named Reference Points



c. Click **Ok**.

Automating Inspection Report Alignment

You can use Calibre DefectReview to align multiple inspection reports related to a specific reticle.

These inspections may have been performed using different machines under different circumstances; for example, using Lasertec or a KLA machine, resulting in different inspection report contents. Furthermore, owing to the absence of markers for blank inspections, rotational variance is also added across inspections. In addition to previously-mentioned sources of mismatch, process variation adds further discrepancies such as minor rotation and translation during setting up of the mask, and scale differences due to varying inspection speeds of the machine's scanning heads. Using this automatic alignment functionality of Calibre DefectReview, you can load multiple inspection reports related to a reticle, and automatically align all of them.

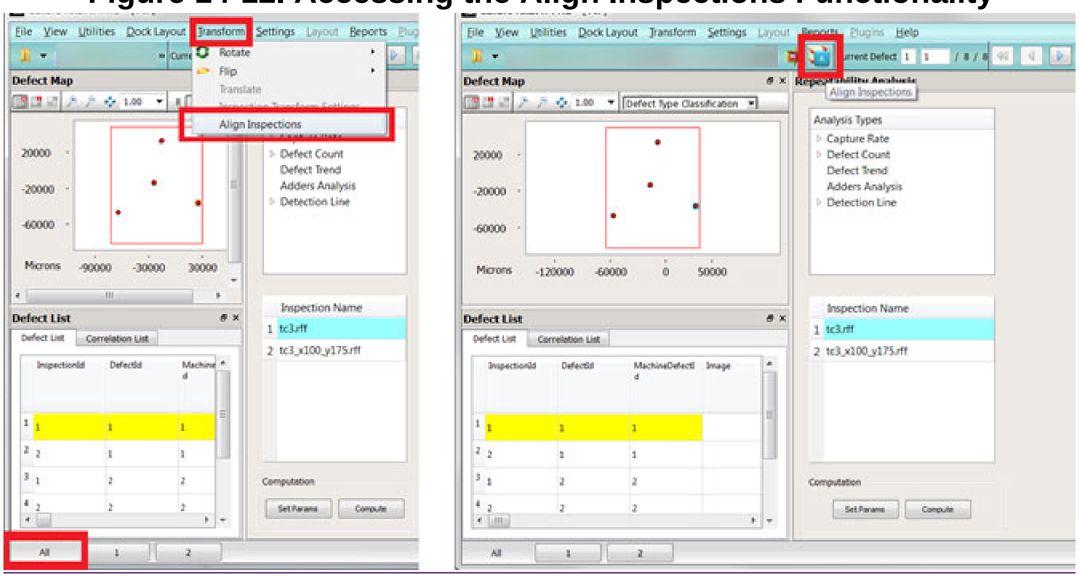
Note

By default, automatic alignment is enabled for all IRs. The center of inspections translates to (76200, 76200) while loading in Calibre DefectReview in the presence of an appropriate license.

Procedure

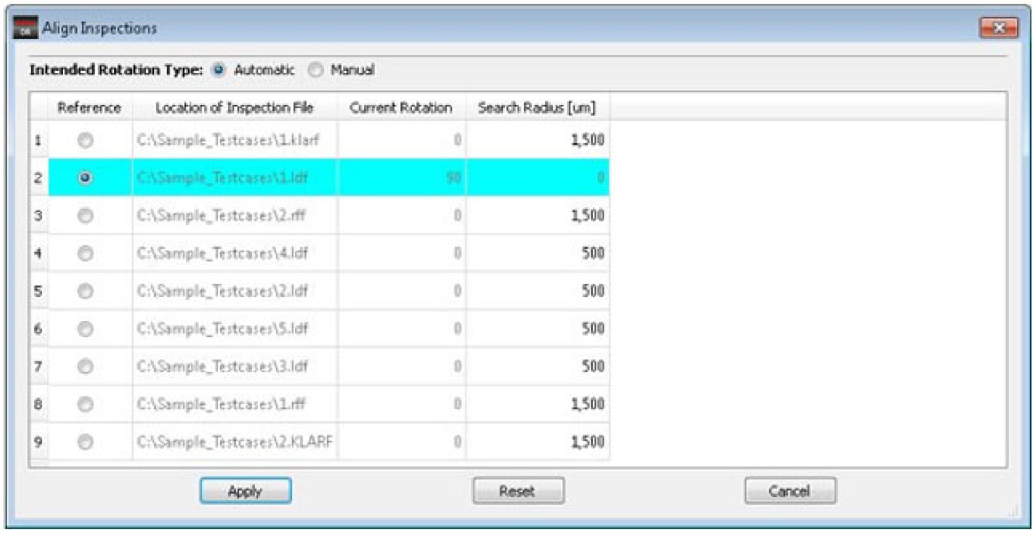
1. Automatic alignment functionality is accessible when the All folder is selected (as seen on the bottom left of Figure 14-12). The **Align Inspections** option can then be accessed from the Transform menu or directly from the toolbar as shown in the following figure. These buttons are deactivated in Single Inspection (SI) folders.

Figure 14-12. Accessing the Align Inspections Functionality



2. Click **Align Inspections** to invoke the Align Inspections dialog box shown in the following figure.

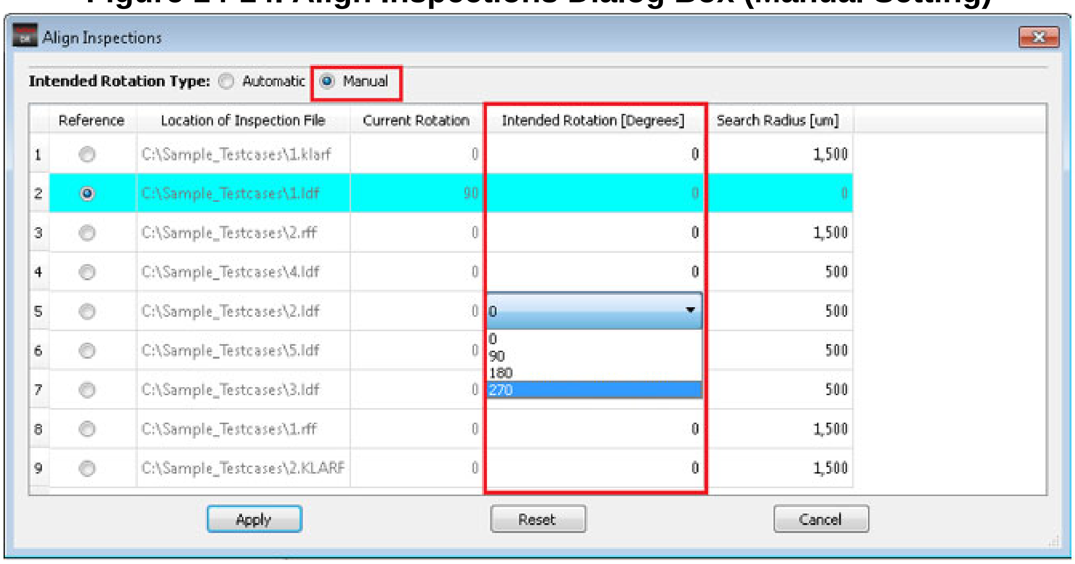
Figure 14-13. Align Inspections Dialog Box



Choose between one of the following modes:

- **Automatic** — In this mode, the tool automatically determines the optimal rotation of secondary blanks relative to the reference blank. This is the default.
- **Manual** — In this mode, you manually specify the amount of rotation to be applied to the secondary blanks as shown in the following figure.

Figure 14-14. Align Inspections Dialog Box (Manual Setting)



3. To align inspections in the Align Inspections window:

   a. Select the reference inspection against which the other inspections are to be aligned. The default is the first loaded inspection.

The Current Rotation column always displays the current rotation of an inspection. This represents the manual rotation (if any) applied by the user before running Align Inspections.

b. If manual mode is chosen, an additional column named Intended Rotation becomes visible. Update the intended rotation for each of the secondary inspections. This refers to the coarse rotation of the mask, measured in degrees. Values of 0, 90, 180 or 270 degrees can be selected from the drop-down combo box. The default value is 0 degrees (all masks are expected to have the same orientation). The default value to be used can be configured in IntendedRotation node in the *dat-ini.xml* file. .For automatic mode, the Intended Rotation column is not visible since the tool internally determines the optimal rotation.

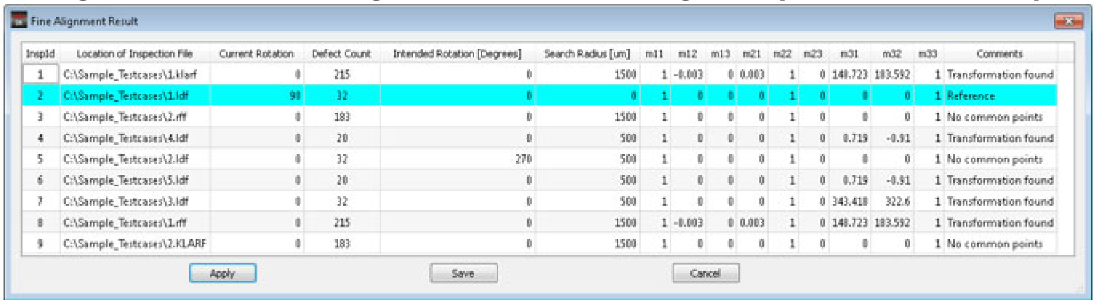
c. Update the search radius. This refers to the maximum distance in micrometers (um) between defect coordinates (by which a defect may shift as a result of rotational, translational, and scaling variations) after compensating for the coarse rotational variation as specified under Intended Rotation. The distance is measured with respect to reference inspection coordinates. Default values are specified and can be configured under the SearchRadius node in the *dat-ini.xml* file.

d. Click **Apply** to accept the inputs and calculate fine alignment values. The Intended Rotation and Search Radius value in the Align Inspections window are remembered for the entire Calibre DefectReview session. Click **Cancel** to skip alignment of inspections. Click **Reset** to reset the Search Radius value. In manual mode, the Intended Rotation values are also reset.

Results

After fine alignment values are calculated, the results are shown in the Fine Alignment Result dialog box, as shown in the following figure.

Figure 14-15. Fine Alignment Result Dialog Box (Automatic Mode)



InspId	Location of Inspection File	Current Rotation	Defect Count	Intended Rotation [Degrees]	Search Radius [um]	m11	m12	m13	m21	m22	m23	m31	m32	m33	Comments
1	C:\Sample_Testcases\1.klarf	0	215	0	1500	1	-0.003	0	0.003	1	0	148.723	183.592	1	Transformation found
2	C:\Sample_Testcases\1.ldf	90	32	0	0	1	0	0	0	1	0	0	0	1	Reference
3	C:\Sample_Testcases\2.rff	0	183	0	1500	1	0	0	0	1	0	0	0	1	No common points
4	C:\Sample_Testcases\4.ldf	0	20	0	500	1	0	0	0	1	0	0.719	-0.91	1	Transformation found
5	C:\Sample_Testcases\2.ldf	0	32	270	500	1	0	0	0	1	0	0	0	1	No common points
6	C:\Sample_Testcases\5.ldf	0	20	0	500	1	0	0	0	1	0	0.719	-0.91	1	Transformation found
7	C:\Sample_Testcases\3.ldf	0	32	0	500	1	0	0	0	1	0	343.418	322.6	1	Transformation found
8	C:\Sample_Testcases\1.rff	0	215	0	1500	1	-0.003	0	0.003	1	0	148.723	183.592	1	Transformation found
9	C:\Sample_Testcases\2.KLARF	0	183	0	1500	1	0	0	0	1	0	0	0	1	No common points

In this dialog box:

- The dialog box contains multiple rows, one for each of the loaded inspections.
- The “Current Rotation” column shows the current rotation of each inspection. This represents the manual rotation, if any, applied by the user before running Align Inspections.
- The “Defect Count” column shows the number of defects in their respective inspections.

- In Automatic mode, the defect column for rotation of blank masks is named “Optimal Rotation [Degrees]” with values determined automatically by the tool. The values represent the rotation of each blank relative to the reference blank inspection. In Manual mode, the defect column is instead named “Intended Rotation [Degrees]”. The values shown in this case represent the rotation of secondary blanks as specified by the user, copied from the previous dialog box.
- Together, the parameters m11, m12, m13, m21, m22, m23, m31, m32, and m33 are the coefficients of calculated fine alignment transformations. Application of these transformations results in the maximum number of common defects between respective inspections and the reference inspection.
- The Comments column adds further information on the obtained transformation.
- Click **Save** to export the contents of the result table to a *.csv* file.
- Click **Cancel** to close the GUI window without applying the transformation.
- Click **Apply** to apply the calculated transformation to the respective inspections to align them with the reference inspection. Upon completion of transformation, the following message box appears confirming the completion of alignment process
- Click **OK** to close all the windows

The configuration file *dat-ini.xml* contains nodes relevant to automatic alignment functionality as shown in the following figure.

Figure 14-16. Automatic Alignment Parameters in dat-ini.xml

```
<AutoInspectionAlignment>
 <DefaultLimits>
  <IntendedRotation>0</IntendedRotation>
  <SearchRadius>
   <LasertecToLasertec>1000</LasertecToLasertec>
   <LasertecToKLA>1500</LasertecToKLA>
   <KLAToKLA>1500</KLAToKLA>
   <AeraToAera>3</AeraToAera>
   <AeraToKlarf>3</AeraToKlarf>
   <AeraToLasertec>100</AeraToLasertec>
   <Default>1000</Default>
  </SearchRadius>
 </DefaultLimits>
</AutoInspectionAlignment>
```

The following are the related nodes and their respective values:

- IntendedRotation — Specifies the default coarse rotation of masks.
- SearchRadius — Specifies the maximum shift between corresponding defects across inspections. Multiple default values are defined depending on constituent inspection sources. The following are the default search radii for different inspections:
    - 1000um, between two Lasertec (LDF) inspections

- 1500um, between a Lasertec (LDF) and KLA inspections
- 1500um, between two KLA inspections

Note

For Lasertec LRF inspection report formats, separate search radii are not specified and a default search radii of 1000um is used. You must manually fine-tune and reduce the search radii as needed.

Specifying a Base Inspection

You can specify any inspection as a base for comparison to others.

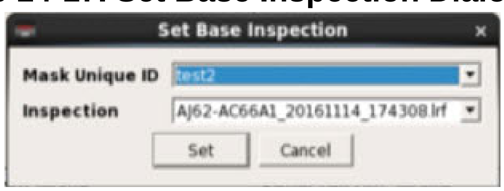
Procedure

Note

This capability is available only for normal and privileged users. The **Base IR** icon and **Base Inspection Settings** menu option does not appear for other user types.

1. To specify a base inspection, click the **Base IR** icon in the Calibre DefectReview tool bar or select **Utilities** > **Base Inspection Settings**. This invokes the Set Base Inspection dialog box.

Figure 14-17. Set Base Inspection Dialog Box



2. In the Set Base Inspection dialog box, you can specify an inspection as base through the Mask Unique ID and Inspection name.
3. Click **Set** to set the base inspection.

Chapter 15
Defect Database

Mask Inspection data comes from different sources: blank manufacturers, mask houses, wafer and production facilites. The data must pass through different stages of inspection and analysis. The Calibre DefectReview defect database enables you to manage, analyze, and generate all information required to track and manage defects. Once inspections and defect attributes are stored in the database, they can be used for further analysis in the future such as region analysis, defect source analysis, and blank defect transfer analysis.

For further information on defect trend analysis, refer to "Using Defect Management" on page 431.

Note

You should have MySQL® Community Server v5.7.11 installed as a database server.

Database Server Post-Installation Setup

After you install the MySql database server, you can create databases and users. You will also need to update MySql attributes such as max_allowed_packet and max_questions before you start using the defect database from Calibre DefectReview.

Creating a Database User

You must create a user to run the MySQL database.

Procedure

1. Login to the MySQL Database Server.

```
mysql -h <host> -u <root_user> -p <root_password>
```

2. To create a database user, enter the following command from the MySql prompt:

```
CREATE USER 'dbuser'@'localhost' IDENTIFIED BY 'WelCome!23';
```

If you attempt to create a new database user with the following:

```
username: dbuser
password: WelCome!23
```

This user already exists in Calibre DefectReview by default and does not need to be created. You can otherwise create a database username of your choice, but remember to create a similar profile in Calibre DefectReview (see "User Management" on page 50 for details).

Creating a Database in MySQL

In order to use a Defect Database in Calibre DefectReview, you must create it first in the MySQL Database Server.

Procedure

1. Login to the MySQL Database Server.

```
mysql -h <host> -u <root_user> -p <root_password>
```

2. To create a new database, run the following command from the MySQL prompt:

```
create database MgcDefectManagementDB;
```

3. To verify the new database exists, run following command:

```
show databases;
```

4. Grant a user (created in "Creating a Database User" on page 420 and is used to login to Calibre DefectReview) full privileges to the database (created in Step 2) by entering the following commands:

```
GRANT ALL PRIVILEGES ON MgcDefectManagementDB.* TO 'dbuser'@'%'
IDENTIFIED BY 'WelCome!23' WITH GRANT OPTION;
FLUSH PRIVILEGES;
```

Note

You must repeat step 4 every time a new database or user is created.

5. Run the following command to verify the user's privileges:

```
SELECT * FROM information_schema.user_privileges;
```

Figure 15-1. Verifying User Privileges

```
mysql> SELECT * FROM information_schema.user_privileges;
+-------------------------+---------------+-------------------------+--------------+
| GRANTEE                 | TABLE_CATALOG | PRIVILEGE_TYPE          | IS_GRANTABLE |
+-------------------------+---------------+-------------------------+--------------+
| 'dbuser'@'%'            | def           | SELECT                  | YES          |
| 'dbuser'@'%'            | def           | INSERT                  | YES          |
| 'dbuser'@'%'            | def           | UPDATE                  | YES          |
| 'dbuser'@'%'            | def           | DELETE                  | YES          |
| 'dbuser'@'%'            | def           | CREATE                  | YES          |
| 'dbuser'@'%'            | def           | DROP                    | YES          |
| 'dbuser'@'%'            | def           | RELOAD                  | YES          |
| 'dbuser'@'%'            | def           | SHUTDOWN                | YES          |
| 'dbuser'@'%'            | def           | PROCESS                 | YES          |
| 'dbuser'@'%'            | def           | FILE                    | YES          |
| 'dbuser'@'%'            | def           | REFERENCES              | YES          |
| 'dbuser'@'%'            | def           | INDEX                   | YES          |
| 'dbuser'@'%'            | def           | ALTER                   | YES          |
| 'dbuser'@'%'            | def           | SHOW DATABASES          | YES          |
| 'dbuser'@'%'            | def           | SUPER                   | YES          |
| 'dbuser'@'%'            | def           | CREATE TEMPORARY TABLES | YES          |
| 'dbuser'@'%'            | def           | LOCK TABLES             | YES          |
| 'dbuser'@'%'            | def           | EXECUTE                 | YES          |
| 'dbuser'@'%'            | def           | REPLICATION SLAVE       | YES          |
| 'dbuser'@'%'            | def           | REPLICATION CLIENT      | YES          |
| 'dbuser'@'%'            | def           | CREATE VIEW             | YES          |
| 'dbuser'@'%'            | def           | SHOW VIEW               | YES          |
| 'dbuser'@'%'            | def           | CREATE ROUTINE          | YES          |
| 'dbuser'@'%'            | def           | ALTER ROUTINE           | YES          |
| 'dbuser'@'%'            | def           | CREATE USER             | YES          |
| 'dbuser'@'%'            | def           | EVENT                   | YES          |
| 'dbuser'@'%'            | def           | TRIGGER                 | YES          |
| 'dbuser'@'%'            | def           | CREATE TABLESPACE       | YES          |
```

6. Configure the server name and database name in the *dat-ini.xml* file so they point to a valid database and server. The Database type (DbType node) and port number (Port Number) can remain the same.You must provide the base directory of a network drive where the defect images can be stored.

Figure 15-2. Configuring the Server and Database Name

```xml
<DatabaseInspection>
 <DbSettings>
  <!-- DbType: MySQL, MSSQL -->
  <DbType>MySQL</DbType>
  <ServerNameOrDSN>localhost</ServerNameOrDSN>
  <PortNumber>3306</PortNumber>
  <DbName>MgcDefectManagementDB</DbName>
  <!-- DbImagesBaseDir: A mandatory base dir path where defect images should be stored. The dummy value need to be
       replaced with valid directory by the user -->
  <DbImagesBaseDir>/home/dummydir</DbImagesBaseDir>
  <DbSearchRadius>1.0</DbSearchRadius>
  <!-- DbConnTimOutInSeconds: An optional time-out time to connect to database. DB connection throws error after time
       specified if not able to connect to database. If not set in dat-ini.xml file, then
       default value of 2 seconds is used. -->
  <DbConnTimeOutInSeconds>2</DbConnTimeOutInSeconds>
  <!-- If DbServerReconnect is set to "true", the lost db connection is re-established. If value is not set to "true", the lost connection can not be re-established.
       Default value in MDPDefectReview is set to "true". Values other than "false" (case insensitive) are considered as "true".
       MySQL closes the client connection if connection is inactive for the time defined in wait_timeout and inetractive_timeout in MySql server.
       Default value for wait_timeout and interactive_timeout is 28800 seconds (8 hours)  -->
  <DbServerReconnect>true</DbServerReconnect>
 </DbSettings>
 <MgcSecondaryClassTableMap>
  <!-- The node MgcDecondaryClassTableMap used by DB to define a mapping between manual secondary classification table names
      and corresponding column name in Pattern Classify DB table. Attribute "tableName" is the manual secondary classification table name.
  Attribute "mgcTableName" is the unique generic name of the manual secondary classification table used in DB
  User can change ONLY tableName attribute. This map can be further used in pattern classify to map classification types from
     manual and Pattern Classify secondary tables.
     Added "autoDefectTierName" attribute for mapping between manual and Auto Defect classification tables.
     User can change this attribute's value if they want seperate mapping.-->
  <SecondaryClass mgcDisplayName="Defect Disposition Classification" mgcTableName="DefectDispositionClassification" tableName="Defect Disposition" autoDefectTierName="Auto Defect Disposition"/>
  <SecondaryClass mgcDisplayName="Defect Printability Classification" mgcTableName="DefectPrintabilityClassification" tableName="Defect Printability Classification" autoDefectTierName="Auto Defect Printability Classification"/>
  <SecondaryClass mgcDisplayName="Defect Progress Classification" mgcTableName="DefectProgressClassification" tableName="Defect Progress Classification" autoDefectTierName="Auto Defect Progress Classification"/>
  <SecondaryClass mgcDisplayName="Defect Sem Classification" mgcTableName="DefectSemClassification" tableName="SEM Classification" autoDefectTierName="Auto Defect SEM Classification"/>
  <SecondaryClass mgcDisplayName="Defect Severity Classification" mgcTableName="DefectSeverityClassification" tableName="Defect Severity Classification" autoDefectTierName="Auto Defect Severity Classification"/>
  <SecondaryClass mgcDisplayName="Defect Size Classification" mgcTableName="DefectSizeClassification" tableName="Defect Size Classification" autoDefectTierName="Auto Defect Size Classification"/>
  <SecondaryClass mgcDisplayName="Defect Type Classification" mgcTableName="DefectTypeClassification" tableName="Defect Type Classification" autoDefectTierName="Auto Defect Type Classification"/>
 </MgcSecondaryClassTableMap>
 <DefectRepeatColorCodes>
  <Range min="1" max="4" color="#00FF00"/>
  <Range min="5" max="9" color="#FFFF00"/>
  <Range min="10" color="#8B0000"/>
 </DefectRepeatColorCodes>
</DatabaseInspection>
```

The defect database setting attributes are:

- DbType

  A required attribute that specifies the database management system (DBMS) type in which the database is created. This attribute can be set as “MySql” if MySql DBMS is being used.

- ServerNameOrDSN

  A required attribute that specifies the server machine where the DBMS is set up and works as database server for tools such as Calibre DefectReview. You must supply a valid server name where the database is set up.

- PortNumber

  A required attribute that specifies the connection through which the database server and clients communicate with each other. This attribute is set to 3306.

- DbName

  A required attribute that specifies the database name in which the mask and inspection information are going to be stored. You must create the database in the database server before tools such as Calibre DefectReview attempt to connect to the database. You must supply a valid database name.

- DbImageBaseDir

  A required attribute that specifies the drive location where the mask-related images (such as defect images) are to be stored. You must provide the path to a networked drive to store the images. The image meta data is stored in the database.

- DbSearchRadius

A required attribute that is used to find the correlated defects across inspections from the same mask. The default value is 1 micron.

- DbConnTimeOutInSeconds

  An optional attribute that specifies the maximum time (the duration in seconds) a Calibre DefectReview client can attempt to connect to the database. An error is issued after the time specified if a connection does not occur. If not otherwise set in the *dat-ini.xml* file, the default value is 2 seconds.

  Note

  The DbConnTimeOutInSeconds attribute is applicable only in AOI Linux. In Windows, the client may attempt a longer duration to connect before issuing an error.

- DbServerReconnect

  An optional attribute used to reconnect to the database server if the connection is lost (such as wait or interactive timeouts). The default value is set to true. If this node is not present in the *dat-ini.xml* file or set to a value other than false, value is considered true.

  The MySQL database server closes the client connection if the connection is inactive for the time defined by the wait_timeout and inetractive_timeout arguments in the MySql server. The default value for both wait_timeout and interactive_timeout is 28800 seconds (8 hours). If DbServerReconnect is not set to false, the lost connection between Calibre DefectReview and the database server is re-established when Calibre DefectReview attempts to connect to the server.

- MgcSecondaryClassTableMap

  A required attribute that specifies a mapping between manual secondary classification table names (configured in the *dat-ini.xml* file) and the generic names used by the automatic pattern classification tables. For details, refer to the *Calibre DefectClassify User's Manual*.

  The manual secondary classification table names may vary from user to user, which are mapped to generic names in Calibre DefectReview and DefectClassify. The attributes in this node are:

  - tableName — The name of manual secondary classification table. You can change this attribute value.
  - mgcTableName — The unique generic name for secondary classification tables used to map manual classification tables from different user and Calibre DefectReview's automatic defect pattern classification table names. This attribute's value must not be modified.
  - mgcDisplayName — Used to illustrate pattern classification table names in Calibre DefectReview components such as those in the Defect Management

interface. For details, refer to "Using Defect Management" on page 431. You can change the value of this attribute.

- DefectRepeatColorCodes

  For details, refer to "Demarcating Repeats" on page 134.

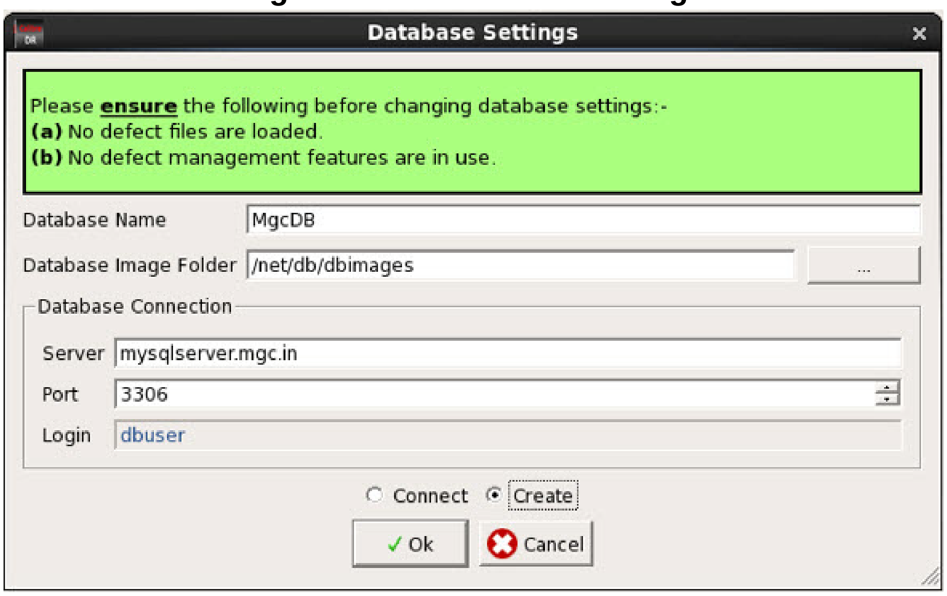
Creating and Connecting to a Database using Calibre DefectReview

You can generate a database for Calibre DefectReview and connect to it through the Database Settings dialog box.

Procedure

1. In Calibre DefectReview, select **Utilities** > **Database Settings**.

Figure 15-3. Database Settings



2. Select **Create** to create the database. Specify the database name, database image folder path, server, and port number.

3. Click **OK**. A database is created if did not exist previously. If database already exists, the older database and images in the database image folder are deleted and a new database with the specified database name is created.

4. To connect to existing database, select **Connect**, specify the database name, database image folder path, server, and port number, then click **OK**.

   You can also perform these operations using the command line interface of Calibre DefectReview. Refer to "Calibre DefectReview Command Line Interface" on page 475 for information.

Note the following:

- While updating or creating the database settings, make sure that no defect files are loaded in the GUI.
- No defect management functionality is being used.
- Changing database settings while other functionality accesses the database can result in undefined behavior.
- While creating a database, the Database and Database Image Directory are deleted and recreated if they already exist. The contents of the Database Image Directory are deleted.

Setting MySQL Attributes

There are two MySQL attributes, max_allowed_packet, and max_questions, that you set to use the Defect Database from Calibre DefectReview.

The max_allowed_packet attribute controls the maximum size of its communication buffer. As we are storing the files as blobs, max_allowed_packet size should be large enough to store the files

The max_questions attribute of the MySQL table illustrates how many queries a user can execute within one hour. A value of 0 for max_questions means that infinite queries can be executed. The value for this attribute should be 0 (zero).

Procedure

1. To set max_allowed_packet, use one of the following methods:

    - Add the following to the *my.cnf* file, then restart the MySQL server:

      ```
      max_allowed_packet=1073741824
      ```

      With a Linux-based operating system, this file is in */etc/my.cnf*.

    - In the following method to update the max_allowed_packet size, the value of max_allowed_packet is reset to default if the MySQL server is restarted:

      i. Log in to the MySQL Database server.

      ```
      mysql -h <host> -u <root_user> -p <root_password>
      ```

      ii. Run the following command from the MySQL prompt:

      ```
      SET GLOBAL max_allowed_packet=1073741824;
      ```

      iii. To check the max_allowed_packet size, run the following from the MySQLprompt:

      ```
      show variables like 'max_allowed_packet';
      ```

2. To set max_allowed_packet:

   a. Run following command from a MySQL prompt:

   ```
   SET GLOBAL max_allowed_packet=1073741824;
   ```

   b. To check the max_allowed_packet size, run following commands:

   ```
   show variables like 'max_allowed_packet';
   ```

3. To set max_questions:

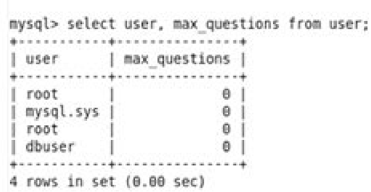
   a. Run the following commands to update the max_questions attribute value:

   ```
   use mysql;
   Update user set max_questions=0 where user='dbuser';
   flush privileges;
   ```

   b. To check the value of max_questions, run following commands:

   ```
   use mysql;
   select user, max_questions from user;
   ```

Figure 15-4. Checking max_questions



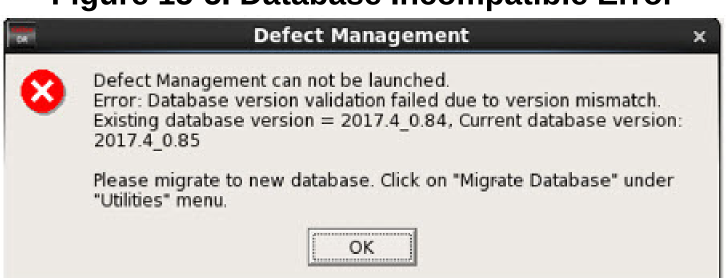
```
mysql> select user, max_questions from user;
+-----------+---------------+
| user      | max_questions |
+-----------+---------------+
| root      |             0 |
| mysql.sys |             0 |
| root      |             0 |
| dbuser    |             0 |
+-----------+---------------+
4 rows in set (0.00 sec)
```

Migrating a Database

Database migration is the process of importing legacy data to a new database format. Typically, the changes are done to support new functionality or to improve tool efficiency. Calibre DefectReview should always use the latest database format updates.

When you use any database features such as the Defect Management window, Open Inspection File(s) from Database, or Save To DB, and you see the following error message:

Figure 15-5. Database Incompatible Error



This indicates that the latest version of Calibre DefectReview is no longer compatible with your legacy database and you must migrate to a new one.

Prerequisites

- The migration process should be performed by the server administrator. You must close all running instances of Calibre DefectReview, including all database connections, before starting the migration process.
- The server administrator should keep a backup of the existing database before starting migration. This is required to keep your data safe if, for any reason, migration fails. Generally, backup of the mysql database is performed using the mysqldump command as follows (though the server administrator can use other database utilities as well):

  ```
  mysqldump -h<host_name> -u<user_name> -p<password> <database_name> |
  mysql -h<host_name> -u<user_name> -p<password> -A
  -D<new_databse_name>
  ```

  For example:

  ```
  mysqldump -hdbserver.domain.com -udbuser -pWelCome\!23
  MgcDefectManagementDB | mysql - hdbserver.domain.com -udbuser
  -pWelCome\!23 -A -D MgcDefectManagementDB_backup;
  ```

  - Refer to the ServerNameOrDSN and DbName node in the *dat-ini.xml* file for the host_name and database_name respectively.
  - On Windows, use the full path of mysqldump command. Typically it is *C:\Program Files\MySQL\MySQL Server 5.7\bin\ mysqldump*.
- Save a backup of your database image directory (the location specified in the DbImagesBaseDir node in *dat-ini.xml*).

  For example, you have defined the image folder location in *dat-ini.xml* as */home/dummydir*. You create a backup using the following command:

  ```
  cp -r /home/dummydir /home/dummydir_backup
  ```

  Note

  On Windows, manually copy the image folder. Database migration may run for several hours. Do not close the Calibre DefectReview GUI during this time, as it may corrupt the database

Procedure

1. To migrate the database to the latest version, click the Migrate icon in the toolbar (see Figure 15-6) or select **Utilities** > **Migrate Database** (see Figure 15-7).

Figure 15-6. Database Migration Icon

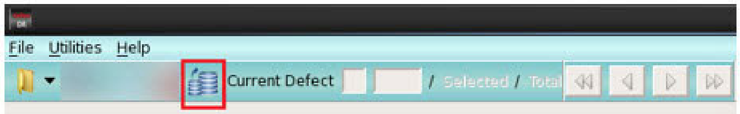
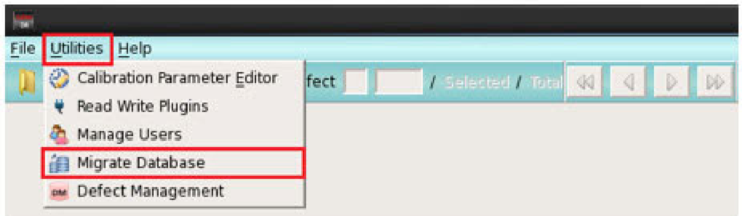
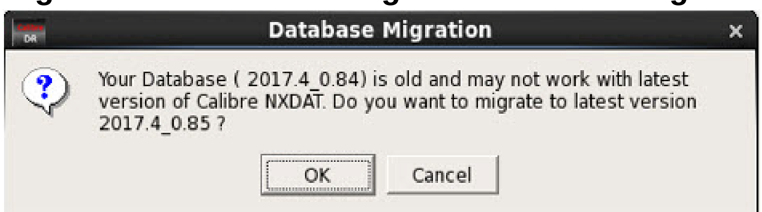


Figure 15-7. Database Migration Option



2. After invoking the migration process, the following dialog box appears.

Figure 15-8. Database Migration Initial Dialog Box



   Click **OK** to proceed.

3. A second dialog box appears, as shown in the following figure.

Figure 15-9. Database Migration Second Dialog Box

   Click **OK** to migrate the database.

4. During the migration process, Calibre DefectReview displays a progress bar.

Figure 15-10. Database Migration Progress Bar

   The migration might take time to complete. However, the amount of time depends on amount of data present in the database. The progress bar continues until Calibre DefectReview completes the migration updates.

   The migration process is complete once the following dialog box appears.

Figure 15-11. Database Migration Success

Results

Once database migration is completed successfully, you can use the latest features with the most current version of Calibre DefectReview.

Chapter 16
Using Defect Management

Calibre DefectReview supports a defect management interface that enables you to interact with inspections and defects stored in the database management system. A mask is inspected for defects multiple times at regular intervals. Over time, the number of inspections and defects increases, making it difficult to perform defect trend analysis across inspections using a file and disk-based storage system.

Using the **Save to DB** option (as described in "Save an Inspection File" on page 97), you can save inspections and their attributes to the database. Using the process described in "Opening Inspection File(s) from a Database" on page 93, you can load the inspections and their attributes from the database.

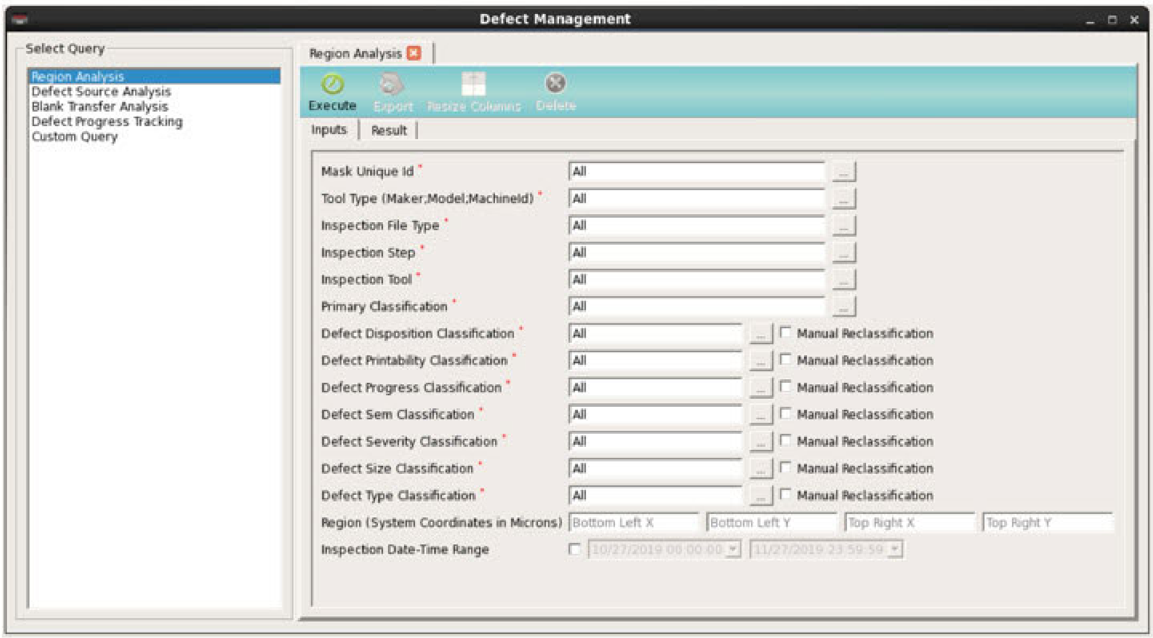
The Defect Management window provides the capability to perform defect trend analysis across inspections. Some examples include region analysis, defect source analysis, blank defect transfer analysis, and defect progress tracking.

Defect Management Window

To access: In the Calibre DefectReview window, select **Utilities** > **Defect Management**

The Defect Management Window provides the capability to perform defects trend analysis across inspections. Examples include region analysis, defect source analysis and blank defect transfer analysis.

Figure 16-1. Defect Management Window



Note

You must have database server connectivity in order to use the Defect Management window. Refer to "Defect Database" on page 419 for instructions on setting up a database server.

Description

You can also invoke the Defect Management window by clicking the Defect Management window icon in the Calibre DefectReview window.

Figure 16-2. Defect Management Window Icon

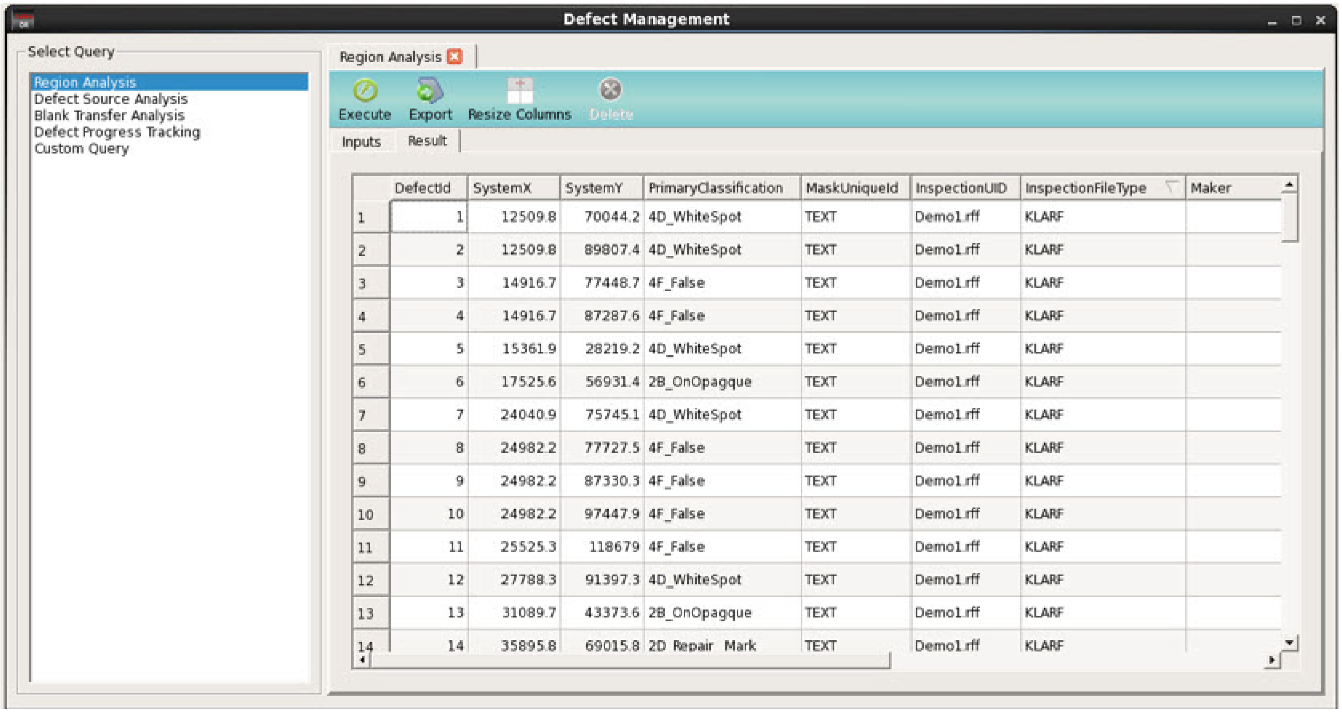
Select a query from the Select Query pane to the left of the window, invoking a specific Query tab. Each Query tab in the Defect Management window contains a toolbar that enables you to perform operations such as executing a query, exporting results to CSV file, and resizing results table columns.

Figure 16-3. Defect Management Query Toolbar

Results Table

The results of queries are displayed in tabular format for further analysis. The following figure illustrates the results of region analysis in tabular format. You can reduce the number of results by applying filters and rerunning the queries.

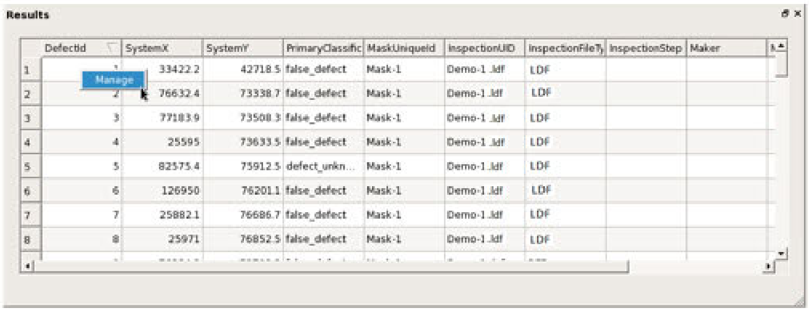
Figure 16-4. Results Table



To launch an inspection in the Calibre DefectReview main window with only defects available in the results table, double-click in an inspection row in the table. This opens an inspection in the same Calibre DefectReview window if there is no other inspection open. A new inspection opens in a new Calibre DefectReview window if there are other inspections already open.

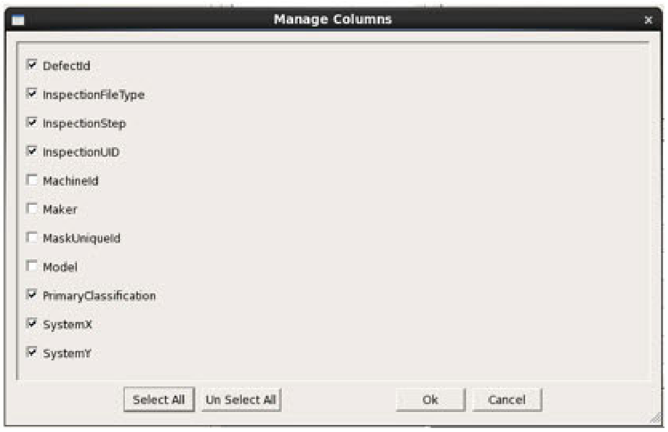
You can show or hide columns of the results table by right-clicking on result table's horizontal header and selecting the **Manage** option as shown in following figure.

Figure 16-5. Manage Columns Option



After you select the **Manage** option, a Manage Columns dialog box appears.

Figure 16-6. Manage Columns Dialog Box (Defect Management)

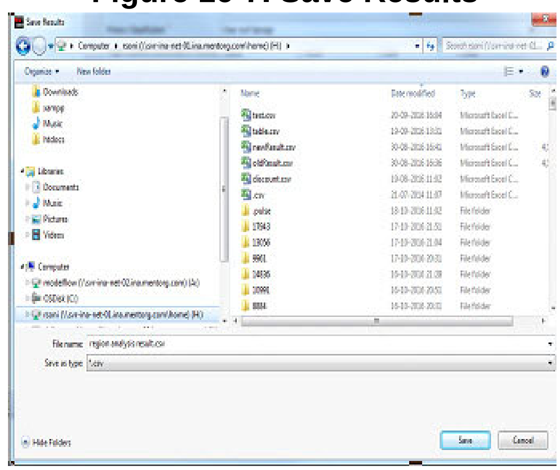


To select all columns, click **Select All**. To unselect all columns click, **Un Select All**. After selecting your columns, click **Ok** to display selected columns values in result table.

Note
At least one column must be selected or an error message is generated.

Objects

Object	Description
Select Query	Select a query type for analysis: Region Analysis, Defect Source Analysis, or Blank Transfer Analysis.
Region Analysis tab	Analyze defect attributes in a specified mask region. See "Performing Region Analysis" on page 440 for further information.
Defect Source Analysis tab	Finds the defect and inspection where a defect was first detected. See "Performing Defect Source Analysis" on page 441 for further information.

Object	Description
Blank Transfer Analysis tab	Finds whether a defect from blank inspection is transferred to patterned inspection at later stages of inspections. See “Performing Blank Transfer Analysis” on page 443 for further information.
Defect Progress Tracking tab	Tracks a mask defect’s properties across inspections to find substantial deviations. See “Defect Progress Tracking (DPT)” on page 445 for further information.
 Execute	Runs a query once the filters are specified.
 Export	Exports the results to CSV file once results of a query is available. After you click Export, a Save Results dialog box appears. Specify the CSV file name and click the **Save** button to save the results to file. **Figure 16-7. Save Results** 
 Resize Columns	Resizes the result table columns to its contents. When you click Resize Columns, the following warning message is displayed in a dialog box: `Resizing columns may take time if table contains large number of rows. Do you want to continue?` When you click **Yes** in the warning message dialog box, the result table columns are resized to their contents’ size.

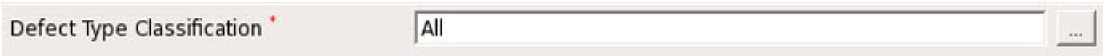
Using Query Filters

By default, a query is executed on a complete mask and the result may contain a large amount of data to analyze. You can apply filters to the data before query execution to analyze a specific set of inspection data.

Procedure

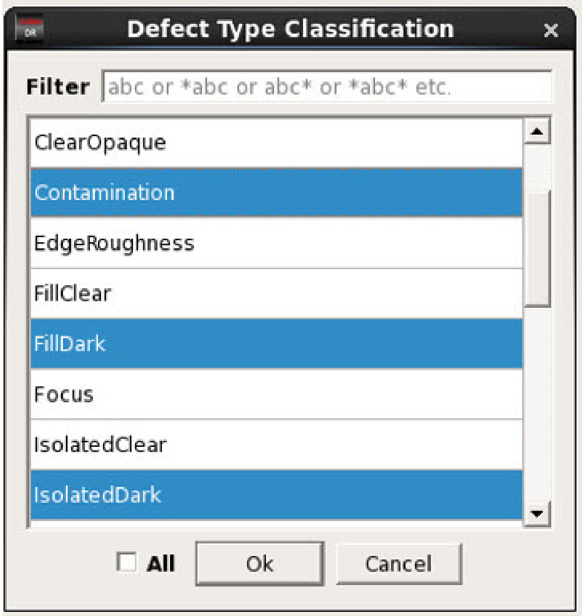
1. You can select multiple value filters when performing queries. To select multiple value filters, click the **...** button next to the filter input boxes.

Figure 16-8. Multiple Value Filter



A Defect Type Classification dialog box appears as shown in following figure.

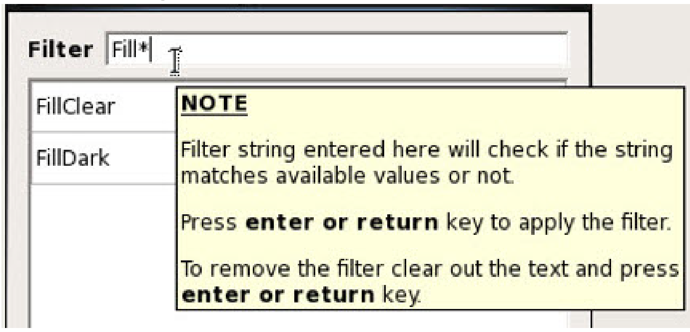
Figure 16-9. Multiple Value Selection



You can select multiple values in the filter input box using a comma (,) as a delimiter. Multiple values in a filter can be combined with an OR operation. For example, in Figure 16-9, Contamination, FillDark, and IsolatedDark are used as Defect Type Classification filters. In the query result, all the defects with Defect Type Classification as Contamination, FillDark, or IsolatedDark are shown if no other filter is applied.

Values in selection windows appear in sorted order. If there is a longer list of values, you can narrow down the list by applying search keys with the wildcard asterisk (*) as shown in the following figure.

Figure 16-10. Wildcard Filter



The asterisk wildcard can be placed before, after, or around a partial string for search (for example, *abc, abc*, *abc*).

The following query filters can be applied in combination (using the AND operator):

- Mask Unique Id — Mask Unique Id is used to identify inspections from same mask. You can run query on inspection data from one or multiple masks. By default, inspections from all the masks are selected.

  Figure 16-11. Mask Unique Id

  - In the Mask Unique Id input box, the mask unique ID, related blank mask unique ID, and link mask unique ID are displayed for selection. Refer to "Reticle Information File (RIF)" on page 79 for details on blank and link mask unique IDs. A query run considers all related mask IDs of a selected mask unique ID.
  - Finding related mask unique IDs of a selected mask unique ID works recursively with linked blank and link mask unique IDs.

- Tool Type — Tool Type contains information about inspection manufacturer, model and machine ID. To analyze the inspections based on maker, model, and machine ID, select the tool types from the Tool Type list box by clicking the **...** (ellipsis) button. By default, inspections from the entire manufacturer are considered for query from the database.

  Figure 16-12. Tool Type (Maker, Model, MachineId)

- Inspection File Type — Inspection File Type represents a type of inspection file that can be Klarf, LDF, and so on. To filter inspections based on file type select the file types from the Inspection File Type list box by clicking the **...** (ellipsis) button. By default, all kind of inspections are considered.

  Figure 16-13. Inspection File Type

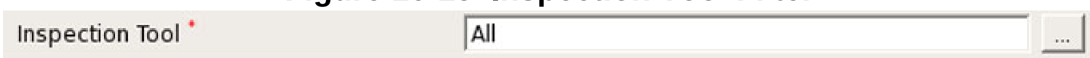
  

- Inspection Step — Inspection Step identifies the stage of mask inspection such as incoming, after resist coat, and after clean. To analyze inspection data from a specific inspection stage, select inspection steps from the Inspection Step list box by clicking the **...** (ellipsis) button. By default, inspections from the entire set of inspection steps are considered.

Figure 16-14. Inspection Step

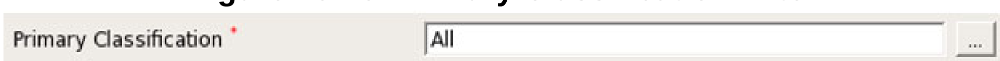
- Inspection Tool — Inspection Tool identifies the tool used for inspection. To analyze inspection data from a specific tool, select inspection tools from the Inspection Tool list box by clicking the **...** (ellipsis) button. By default, inspections from the entire list of inspection tools are considered.

Figure 16-15. Inspection Tool Filter



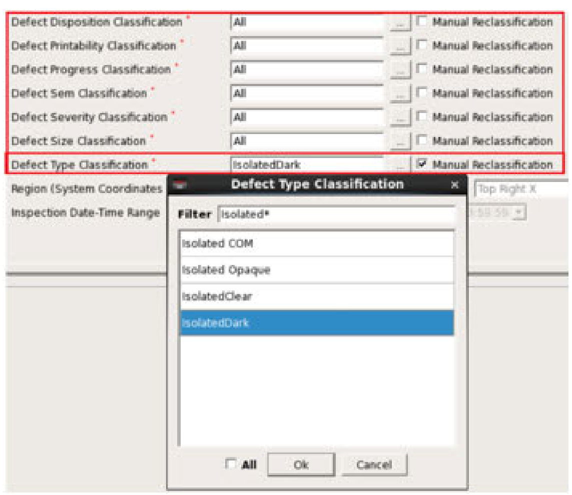
- Primary Classification — You can apply primary classification codes as filters to select the desired defects. To apply the filter, select codes from the Inspection Tool list box by clicking the **...** (ellipsis) button. By default, all the codes are considered and no primary classification filter is applied.

Figure 16-16. Primary Classification Filter



- Multi-tier Classification Filters — You can apply multi-tier classifications as filters to select the desired defects. The multi-tier classification tables are shown in the following figure.

Figure 16-17. Filters Based on Multi-Tier Classifications



To select multi-tier classifications, click the **...** (ellipsis) button. For example, in this figure, IsolatedDark of Defect Type Classification is selected to find the defects.

- **Overwriting Pattern Classification with Manual Reclassification** — During manual review of multi-tier classification of defects, automatic pattern classification can be overwritten by manual reclassification. The same can be applied in the filters to select the defects. If the **Manual Reclassification** option is not selected, only classifications generated by Calibre DefectClassify are considered for filtering the results. However, if **Manual Reclassification** is selected, it is prioritized over Calibre DefectClassify's classifications. For details on Calibre DefectClassify, refer to the *Calibre DefectClassify User's Manual*.
  The following table illustrates the defects that are shown in the results when IsolatedDark is selected as the filter and the **Manual Reclassification** option is enabled.

Table 16-1. Filtering When Manual Reclassification is Enabled

Defect Id	Automatic Pattern Classification (Defect Type Classification)	Manual Reclassification (Defect Type Classification)	Displayed in Result
1	Isolated Dark	Isolated Dark	Yes
2	OnEdgeDark	Isolated Dark	Yes
3	Isolated Dark	OnEdgeDark	No
4		Isolated Dark	Yes
5		Isolated Dark	No
6	Isolated Dark		Yes

Note

The classification tables are populated from the MgcSecondaryClassTableMap node in the *dat-ini.xml* file. Classification types for each table are populated from the corresponding classification table under the SecondaryClassifications node of the *dat-ini.xml* file. If classification tables are configured for multiple inspection report formats in the *dat-ini.xml* file, then the classification types are taken as a union of types from all inspection report classification tables.

- Region (System Coordinates in Microns) — You can select defects within a mask region for analysis by specifying bottom left X and Y coordinates and top-right X and Y coordinates. All the defects satisfying the region are considered by the query. By default, region is considered as full mask (-76200, -76200, 76200, 76200).

Figure 16-18. Region (System Coordinates in Microns)

- Inspection Date-Time Range — You can select inspections based on inspection start time. All the inspections with inspection start time falling within the date-time range are considered for query. For defect source analysis and blank defect transfer analysis, the output inspection's start time should also satisfy the date-time range criteria. By default, all the inspections are considered for query irrespective of their inspection start time.

Figure 16-19. Inspection Date-Time Range

- Search Radius (Microns) — To find common defects, specify the search radius in microns. A default value is picked from RA search radius. For details of RA search radius, refer to “Editing Calibration Defaults” on page 367. The maximum search radius that can be specified is 10 microns.

2. After selecting the filters in the Defect Type Classification dialog box, click the **Ok** button.

Performing Region Analysis

You can use the Defect Management window to find defects to analyze their attributes in a specified mask region.

Procedure

1. In the Defect Management window, select the Region Analysis query from Select Query options.
2. To narrow down the results, apply filters such as Mask Unique Id, Primary Classification, and Regions (System Coordinates in Microns) to filter the defects which do not satisfy the filter criteria. Refer to “Using Query Filters” on page 435 for information on query filters.

Results

The following figure illustrates the Region Analysis inputs and query result.

Figure 16-20. Region Analysis Inputs

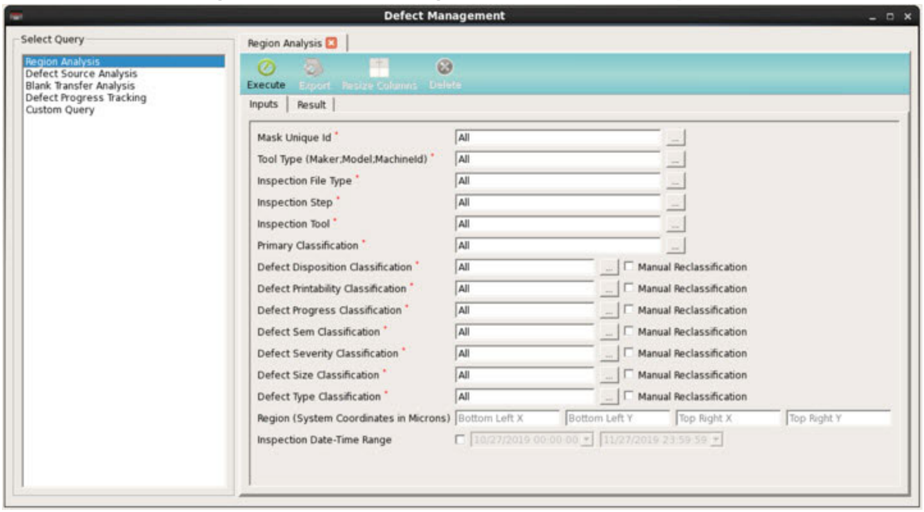
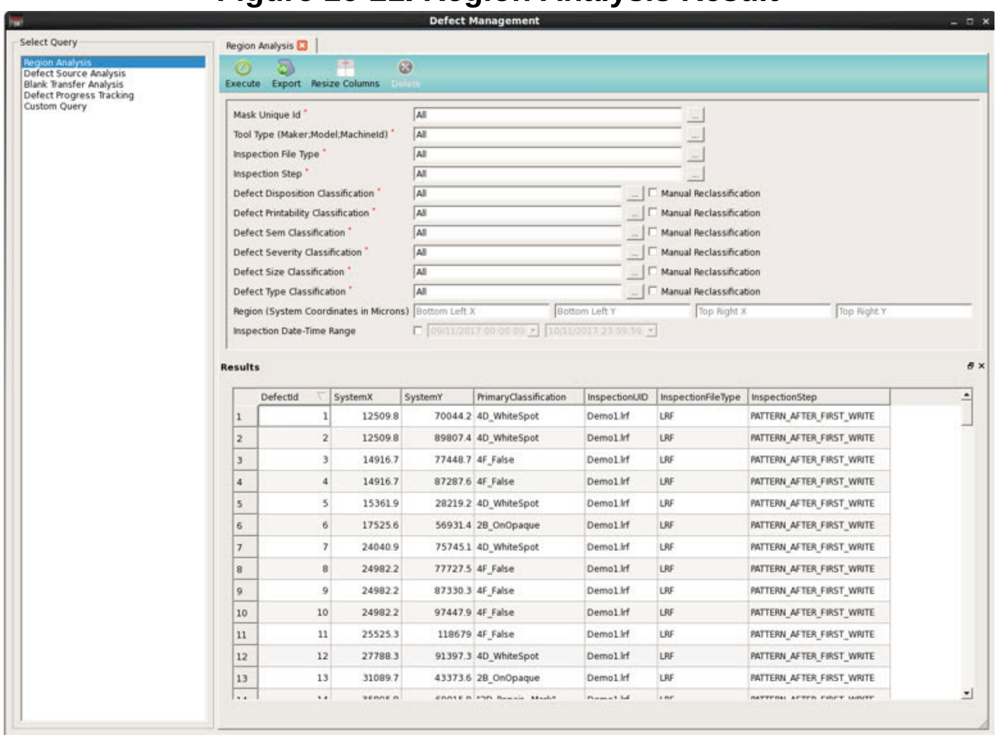


Figure 16-21. Region Analysis Result



Performing Defect Source Analysis

You can use the Defect Management window to find the defect and the inspection where the defect was first detected.

Procedure

Select Defect Source Analysis query from Select Query options.

A defect D1 is considered to be the source of another defect D2 if:

- D1 and D2 are both available within a search radius specified.
- D1 is detected before D2 (D1's inspection start time is equal to or less than D2's inspection start time).

Both D1 and D2 should belong to same mask (the mask unique ID should be same).

Results

The following figure illustrates the Defect Source Analysis inputs and query result.

Figure 16-22. Defect Source Analysis Inputs

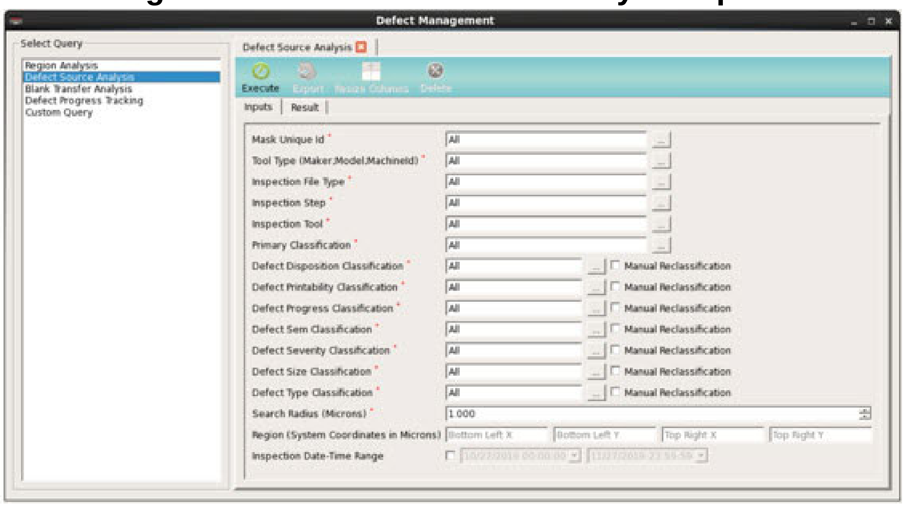
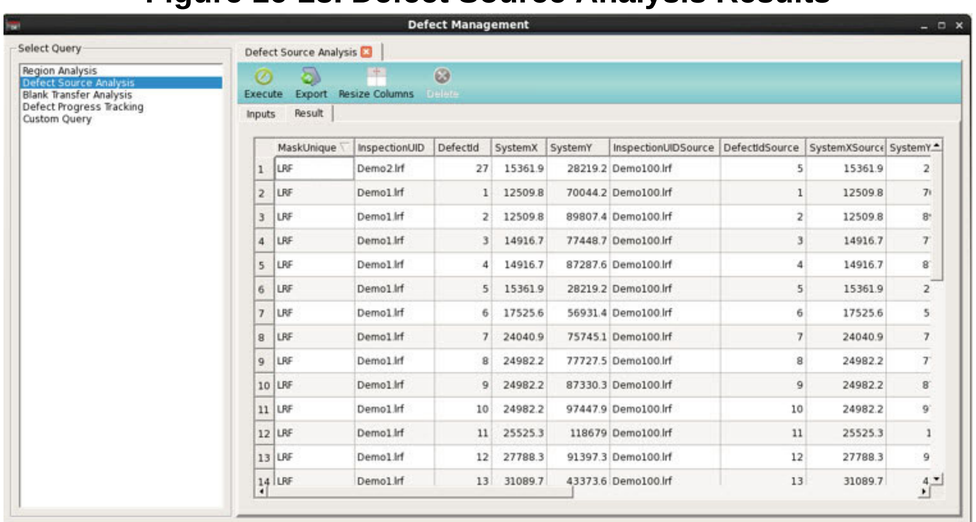


Figure 16-23. Defect Source Analysis Results



Performing Blank Transfer Analysis

You can use the Defect Management window to find whether a defect from blank inspection is transferred to patterned inspection at later stages of an inspection.

Procedure

In the Defect Management window, select the Blank Transfer Analysis query from Select Query options.

A defect D1 from blank inspection B1 is considered to be transferred to defect D2 in a pattern inspection P1 if:

- Both defects are within the search radius specified.
- D1 is detected in a blank inspection before D2 is detected in a patterned inspection (D1's inspection start time is equal to or less than D2's inspection start time).

Both D1 and D2 should belong to the same mask (the mask unique ID should be the same).

Results

The following figure illustrates the Blank Transfer Analysis inputs and query results.

Figure 16-24. Blank Transfer Analysis Inputs

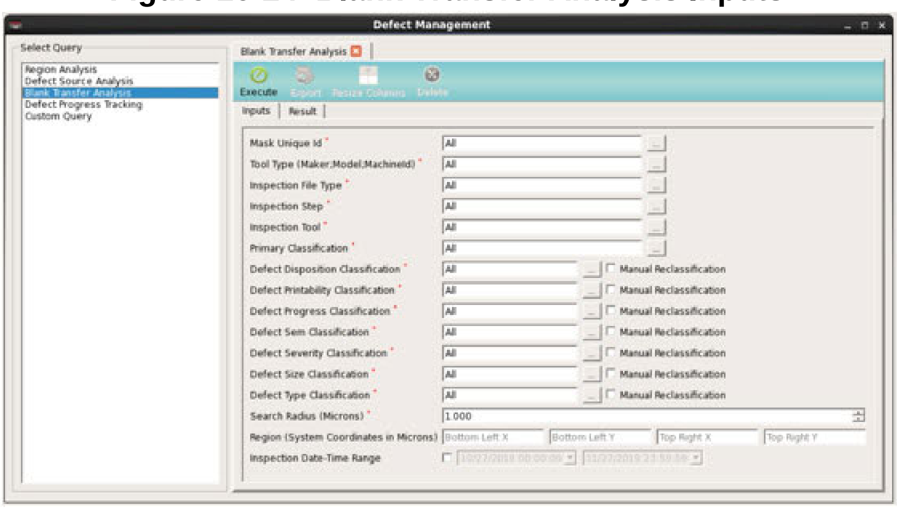
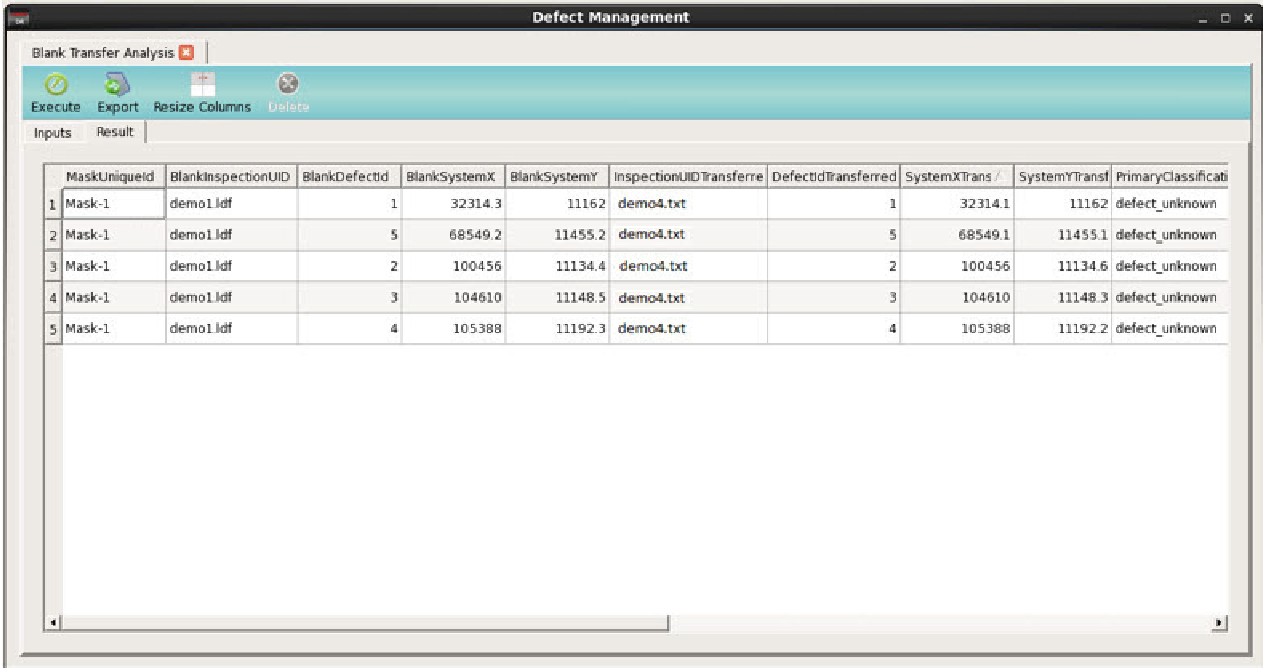


Figure 16-25. Blank Transfer Analysis Result



	MaskUniqueId	BlankInspectionUID	BlankDefectId	BlankSystemX	BlankSystemY	InspectionUIDTransferre	DefectIdTransferred	SystemXTrans	SystemYTransf	PrimaryClassificati
1	Mask-1	demo1.ldf	1	32314.3	11162	demo4.txt	1	32314.1	11162	defect_unknown
2	Mask-1	demo1.ldf	5	68549.2	11455.2	demo4.txt	5	68549.1	11455.1	defect_unknown
3	Mask-1	demo1.ldf	2	100456	11134.4	demo4.txt	2	100456	11134.6	defect_unknown
4	Mask-1	demo1.ldf	3	104610	11148.5	demo4.txt	3	104610	11148.3	defect_unknown
5	Mask-1	demo1.ldf	4	105388	11192.3	demo4.txt	4	105388	11192.2	defect_unknown

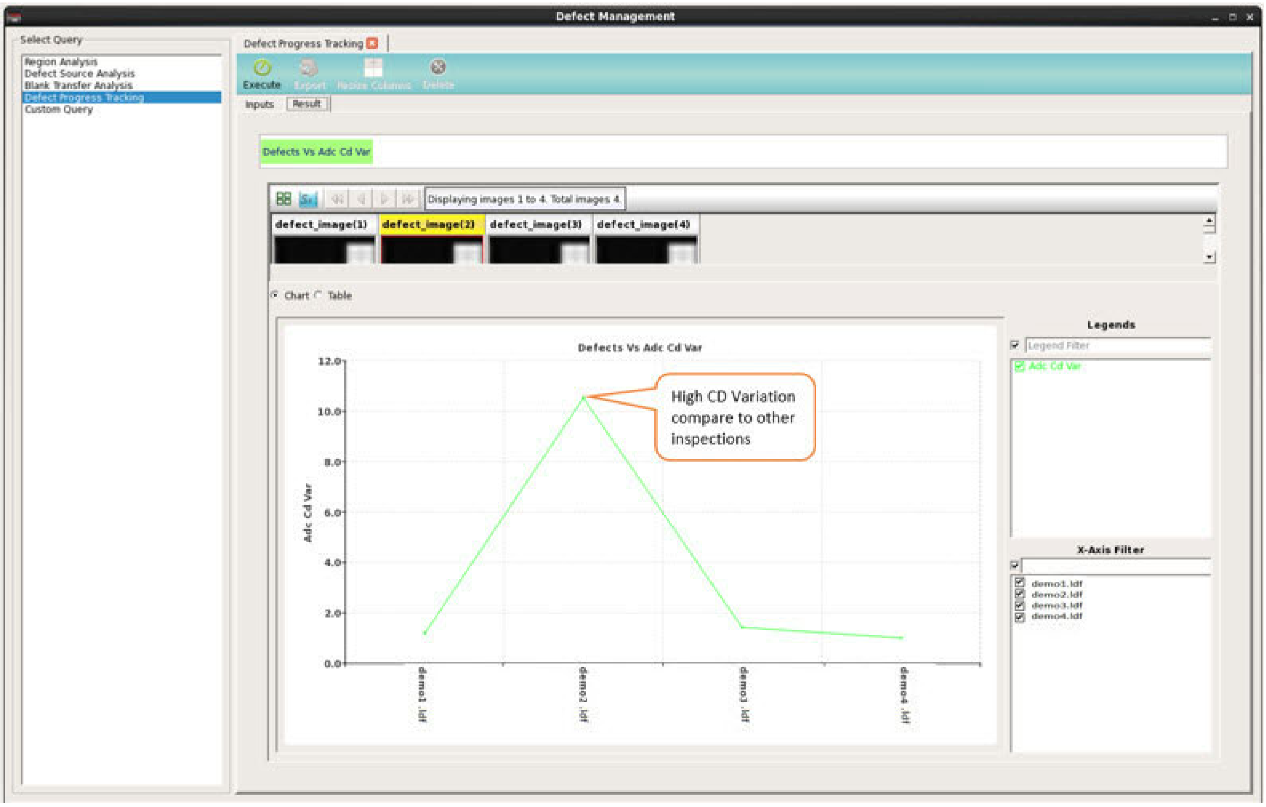
Defect Progress Tracking (DPT)

You can use Defect Progress Tracking (DPT) to track mask defect properties across inspections to find a substantial deviation in any defect's property.

Description

The following figure illustrates a defect's CD variation collected by Calibre DefectClassify for each inspection of a patterned mask. In this example, the CD variation of a defect is high for inspection *Demo-2.ldf*, which causes the inspection to raise a warning, requiring further review and investigation.

Figure 16-26. Defect Progress Tracking of Defect CD Variation



Objects

- DPT Query

  Select **Defect Progress Tracking** option in the Select Query pane.

- DPT Types and DPT Inputs

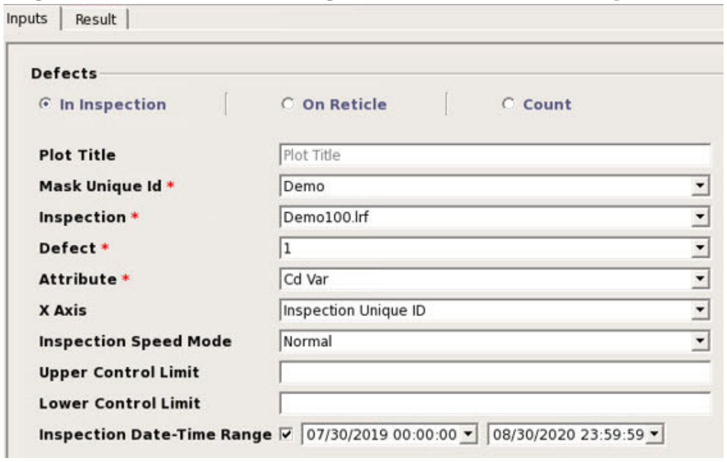
  The DPT Types and DPT Inputs regions allow you to track a defect by selecting from several different methods.

  - Defects In Inspection

To track a defect in an inspection, specify the mask, the inspection from the mask, the defect from the inspection, and the defect property to track. Click the **Execute** button at the top of the window to generate the DPT plot.

Figure 16-27. Execute in the Button Bar

Figure 16-28. Tracking a Defect in an Inspection



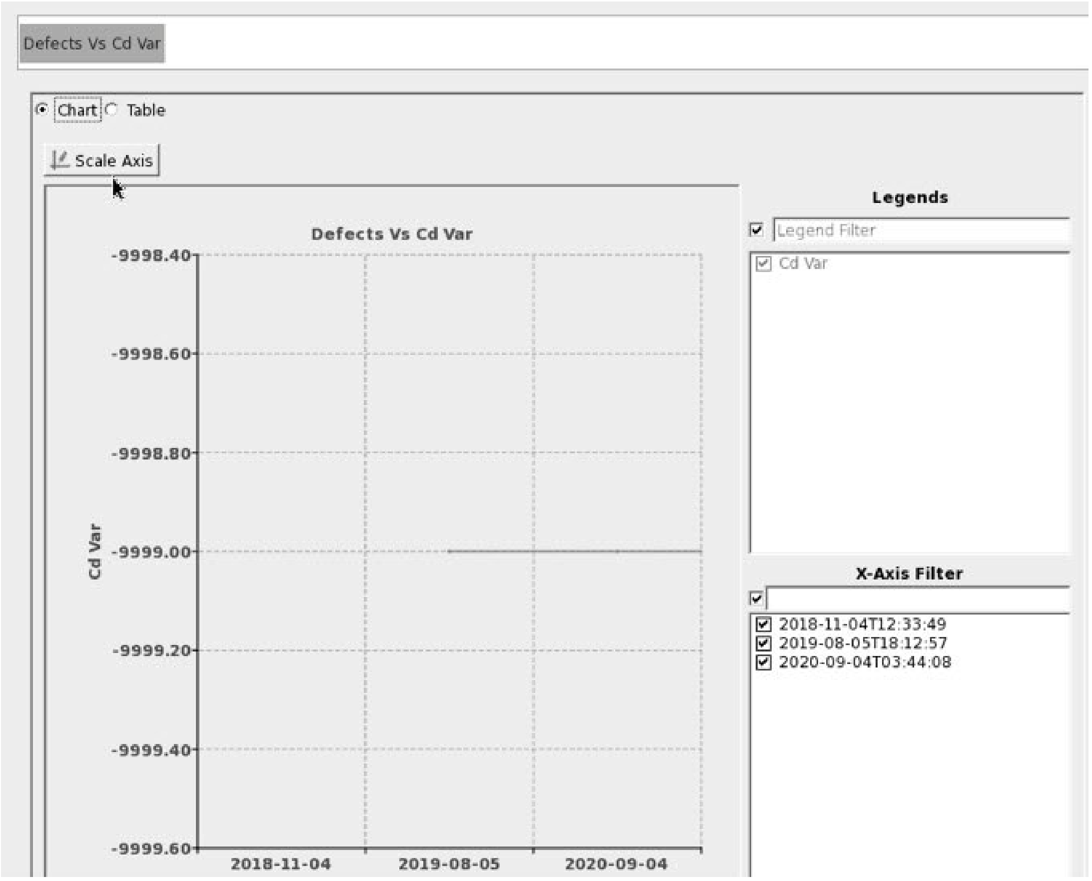
Defect attributes supported for trend analysis are:

- **Defect Area** — Specifies the area of defect reported by an inspection tool (supplied through inspection report file).
- **Defect Size** — Specifies the size of the defect reported by Calibre DefectClassify.
- **CD Var** — Specifies the CD variation of defect reported by Calibre DefectClassify.
- **Transmittance** — Specifies the transmittance of a defect reported by Calibre DefectClassify. The transmittance value of a defect blob is calculated as a ratio of the minimum GL of defect blob to the maximum GL value assigned to a pixel in a large clear region by an inspection machine. For example, if the GL value of the darkest pixel in the blob is 170 and the maximum GL value of a pixel in a larger clear region is 255, the transmittance value is 170 / 255 = 0.66.
- **Reflectance** — Specifies the reflectance of a defect reported by Calibre DefectClassify. The reflectance value of a defect blob is calculated as a ratio of the maximum GL of defect blob to the maximum GL value assigned to a pixel in a large clear region by an inspection machine. For example, if the GL value of the brightest pixel in the blob is 70 and maximum GL value of the pixel in larger clear regions is 255, then transmittance value is 70 / 255 = 0.27.

- **Transmittance Residue** — Specifies the transmitted residue of a defect reported by Calibre DefectClassify. Residue is maximum absolute value of the difference of transmitted defect and reference image.
- **Reflectance Residue** — Specifies the reflected residue of a defect reported by Calibre DefectClassify. Residue is the maximum absolute value of the difference between the reflected defect and reference image.
- **T Flux** — Specifies the transmitted flux ratio. Refer to "Measuring Flux Area" on page 339 for further details.
- **R Flux** — Specifies the reflected flux ratio. Refer to "Measuring Flux Area" on page 339 for further details.
- **X Axis** — An optional parameter defining the x-axis. This can either be set to Inspection Start Date (default) or Inspection Unique ID based on which x-axis label is currently displayed in the result chart.

  The following figure illustrates the x-axis displayed when Inspection Start Date is selected:

Figure 16-29. X-Axis (Inspection Start Date)



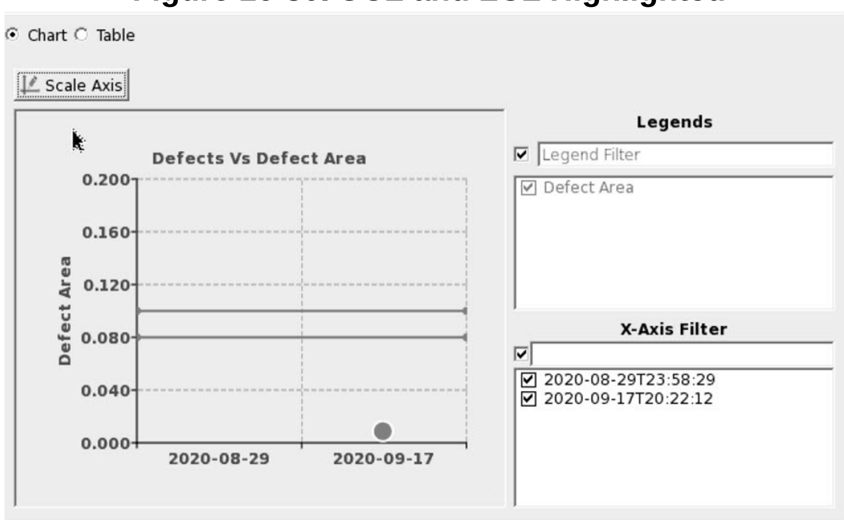
- **Inspection Speed Mode** — An inspection report is inspected either in Normal or Fast mode. You can generate a defect progress tracking chart for Normal mode inspections, Fast mode inspections, or both.

Upper and Lower Control Limits can optionally be defined for attributes such as Defect Area:

- Upper Control Limit (UCL) — An optional value establishing an upper limit for any inspection, and then highlighting violations in the result chart.
- Lower Control Limit (LCL) — An optional value establishing a lower limit for any inspection, and then highlighting violations in the result chart.

The following figure illustrates a result of a DPT query where the UCL value is set to 0.8 and the LCL is set to 0.3 for the Defect Area. The actual value of 0.07 lies outside the UCL and LCL values and is highlighted in red. The UCL and LCL values are also highlighted in red lines on the chart.

Figure 16-30. UCL and LCL Highlighted



- **Inspection Date-Time Range** — An optional value that specifies a date and time range to analyze defects from a particular time period (for example, tracking the size of a defect from inspections performed between January 1st, 2019 and December 31st, 2019).
- **Scale Axis** — The range of the y-axis can be modified using the **Scale Axis** button. The required minimum and maximum values is specified in the Scale Axis dialog box. Auto sets the default range for the y-axis. Click **Apply** to set the range on the Chart view and close the dialog box, or **Ok** to apply the changes without closing the dialog box.

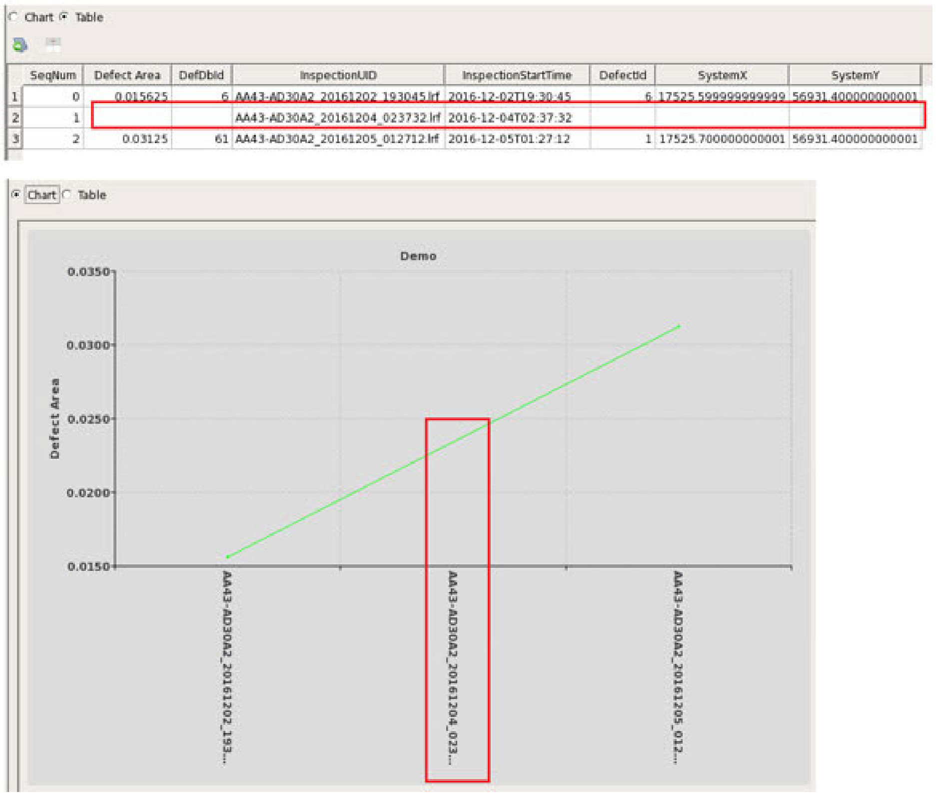
Figure 16-31. Set Axis Range

The following points apply:

- In the Mask Unique Id drop down box, the mask unique ID, related blank mask unique ID, and link mask unique ID are displayed for selection. Refer to “Reticle Information File (RIF)” on page 79 for details on blank and link mask unique IDs.
- Once a mask unique ID is selected, inspections from all related mask unique IDs from the selected mask unique ID are displayed in the Inspection drop down box.
- Finding related mask unique IDs of a selected mask unique ID works recursively with linked blank and link mask unique IDs.
- In the results displayed, all the Inspection Reports (IRs) available for the specified mask unique ID are displayed even though the specified defect is not

selectable in the IRs. As shown in following figure, the defect is not detected in the highlighted IR:

Figure 16-32. IR With Missing Defect

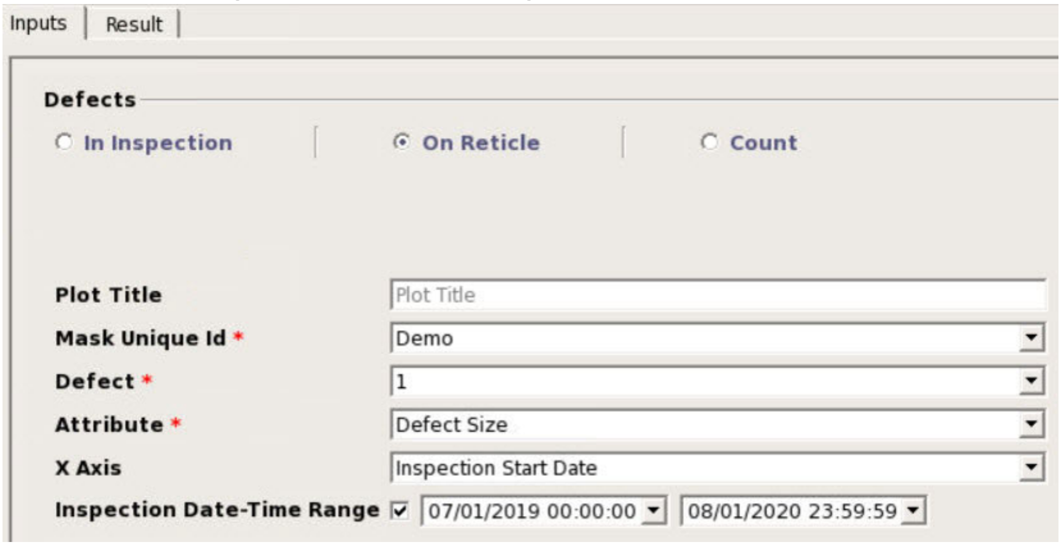


This behavior also applies to the Defect On Reticle option.

- Defect On Reticle

  To track a defect on the reticle, specify the mask, defect on mask and the defect property to track. Click **Execute** to generate the DPT plot. The defect attributes supported are Defect Area as well as Calibre DefectClassify attributes such as Defect Size, CD Variation, Transmittance, Reflectance, Transmittance Residue, and Reflectance Residue.

Figure 16-33. Tracking a Defect on a Reticle



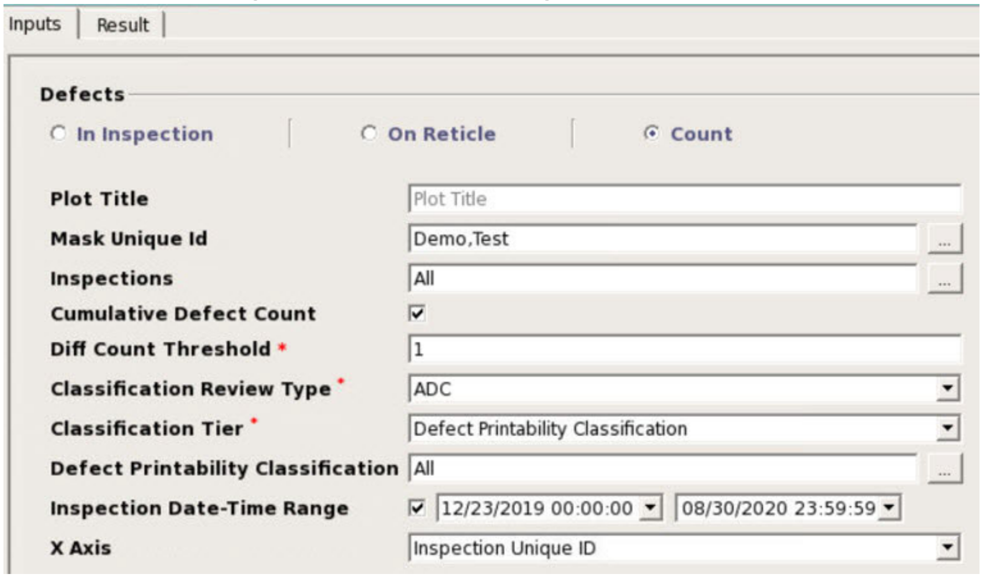
The following apply:

- The defects across an inspection from a mask are correlated when you save the inspections to the database. In the Defect combo box in Figure 16-28, only one defect (that works as reference) from the list of common defects is displayed for selection.
- In the Mask Unique Id drop down box, the mask unique ID, related blank mask unique ID, and link mask unique ID are displayed for selection. Refer to "Reticle Information File (RIF)" on page 79 for details on blank and link mask unique IDs.
- Once a mask unique ID is selected, inspections from all related mask unique IDs from the selected mask unique ID are displayed in the Inspection drop down box.
- Finding related mask unique IDs of a selected mask unique ID works recursively with linked blank and link mask unique IDs.
- The x-axis can either be set to the Inspection Start Date (the default) or the Inspection Unique ID based on the **X Axis** label displayed in the result chart.

o Defects Count

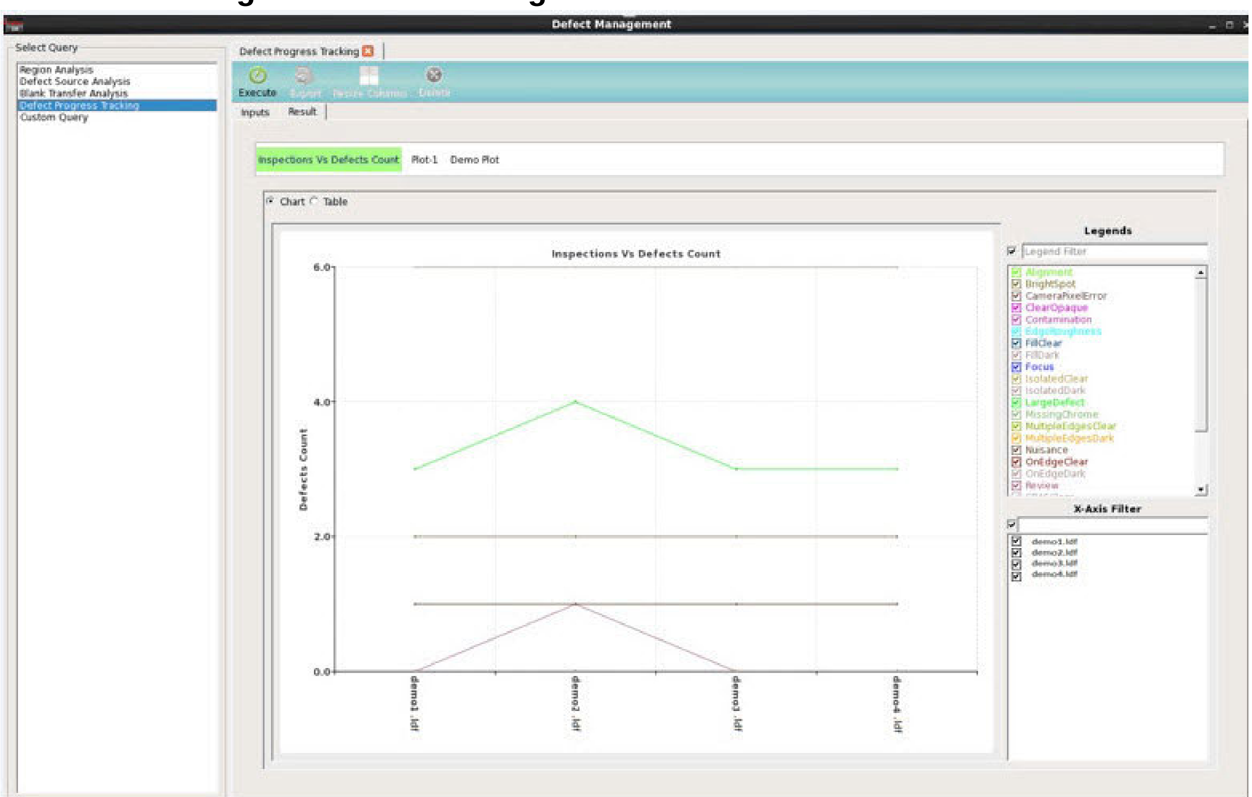
To track defect count for each class of defects across inspections, specify the mask, inspections of the selected mask, classification review type (ADC/OPC/BOTH), secondary classification tier, defect classification types of selected classification tiers, and inspection date-time range as shown in following figure.

Figure 16-34. Tracking Defect Count



Click **Execute** to generate the results as shown in the following figure.

Figure 16-35. Tracking Defect Count for Classifications



The following apply:

- In the Mask Unique Id drop down box, the mask unique ID, related blank mask unique ID, and link mask unique ID are displayed for selection. Refer to "Reticle

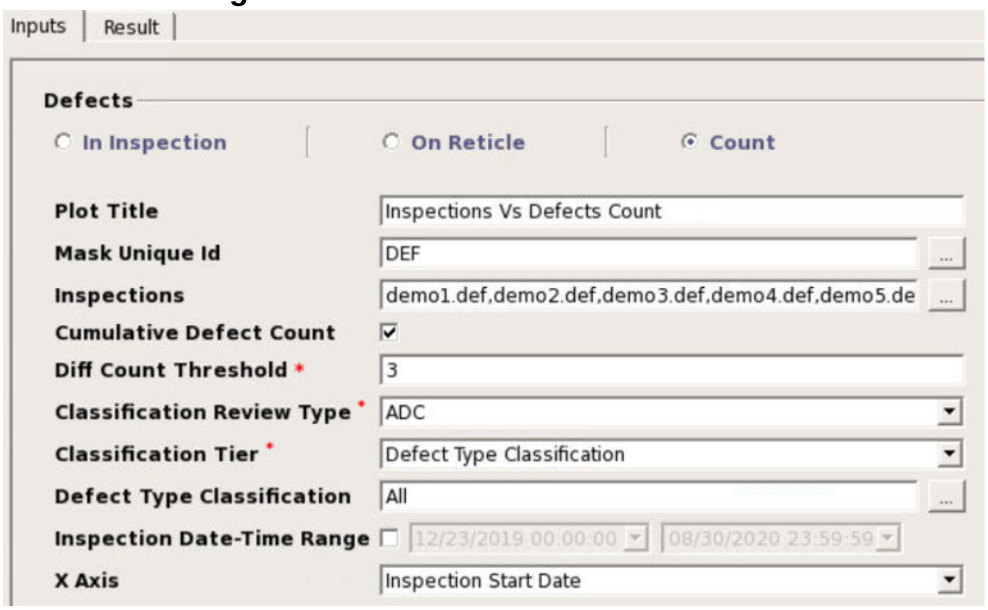
Information File (RIF)” on page 79 for details on blank and link mask unique IDs.

- Once a mask unique ID is selected, inspections from all related mask unique IDs from the selected mask unique ID are displayed in the Inspection drop down box.
- Finding related mask unique IDs of a selected mask unique ID works recursively with linked blank and link mask unique IDs.

o Highlight Increasing Defects Across Inspections (Count)

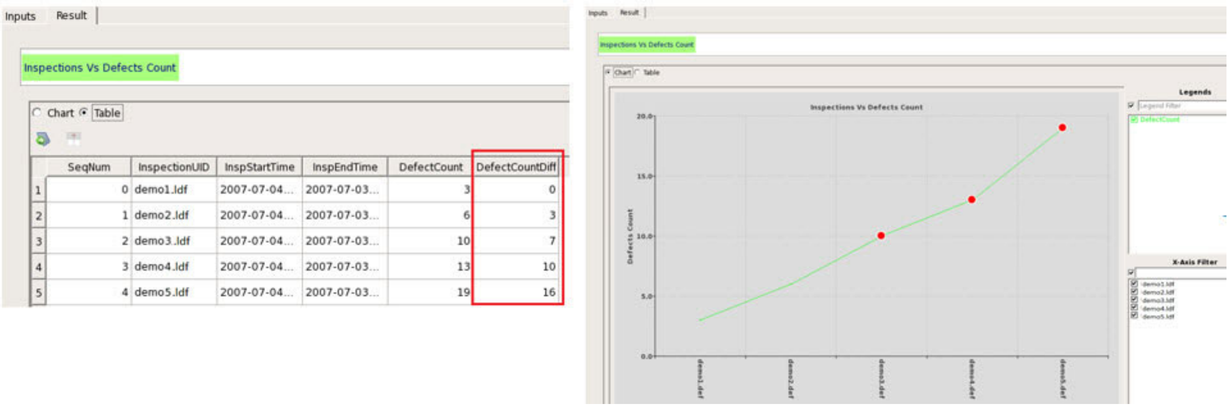
Defect count accumulation on subsequent inspections can be highlighted by specifying values for Cumulative Defect Count and Diff Count Threshold as shown in the following figure.

Figure 16-36. Cumulative Defect Count



The following figure shows an example result highlighting inspections that exceeded the specified threshold of three defects past the initial count from the first inspection. Any inspections that passed the threshold are highlighted in red filled circles. In the figure, a difference in the defects count between the base inspection and subsequent inspections *demo3.ldf*, *demo4.ldf*, and *demo5.ldf* went beyond the than Diff Count Threshold of 3 (refer to “Specifying a Base Inspection” on page 417 for information on setting a base inspection). If the base inspection was not set, the difference in the defects count is taken between the first inspection *demo1.ldf* and subsequent inspections *demo3.def*, *demo4.ldf*, and *demo5.ldf*.

Figure 16-37. Cumulative Defect Count Results



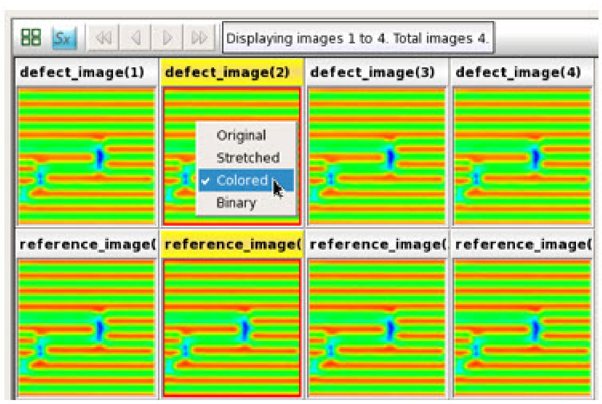
The following apply to Cumulative Defect Count:

- The results are sorted based on the inspection start time.
- The first inspection based on the Start Time is considered as the reference inspection.
- When the Cumulative Defect Count is selected, Classification Review Type supports ADC and OPC. BOTH is not allowed when this option is specified.

- DPT Image Viewer

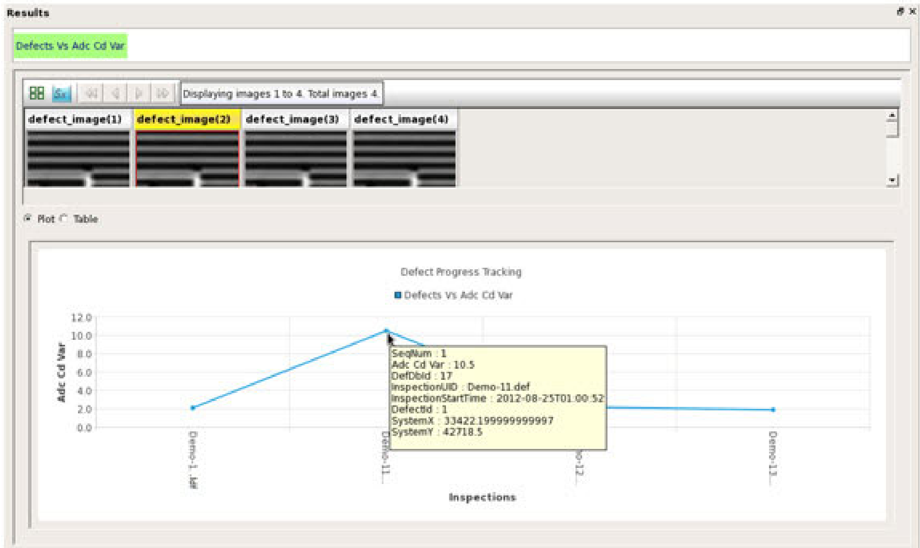
  The image viewer facilitates deeper analysis of defect images. As shown in following figure, you can change the image to Stretched, Colored, Binary, or keep as Original for manual analysis.

Figure 16-38. DPT Image Viewer



To navigate a defect's image for analysis, click the defect on the plot as shown in following figure. The corresponding image's title box is highlighted in yellow.

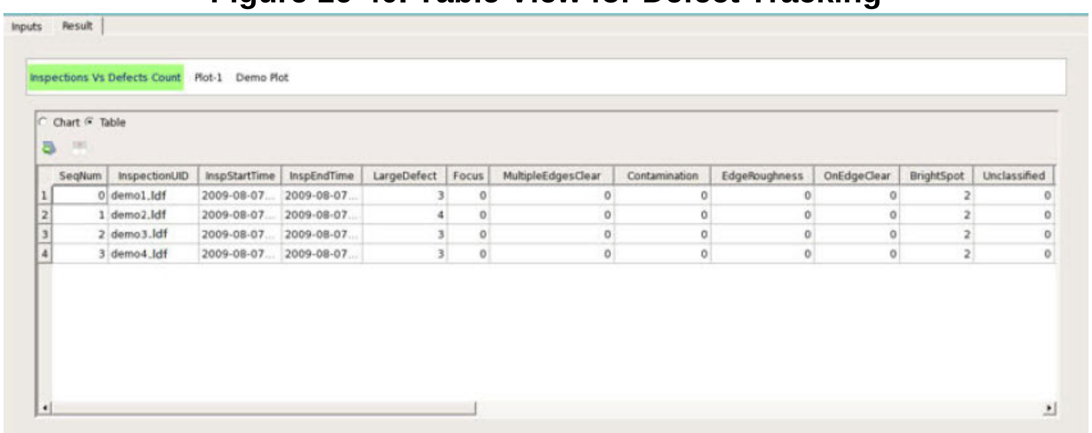
Figure 16-39. Image Navigation from a Plot's Defect



- DPT Results

  You can visualize defect progress using the plot and table views as shown in the following figure.

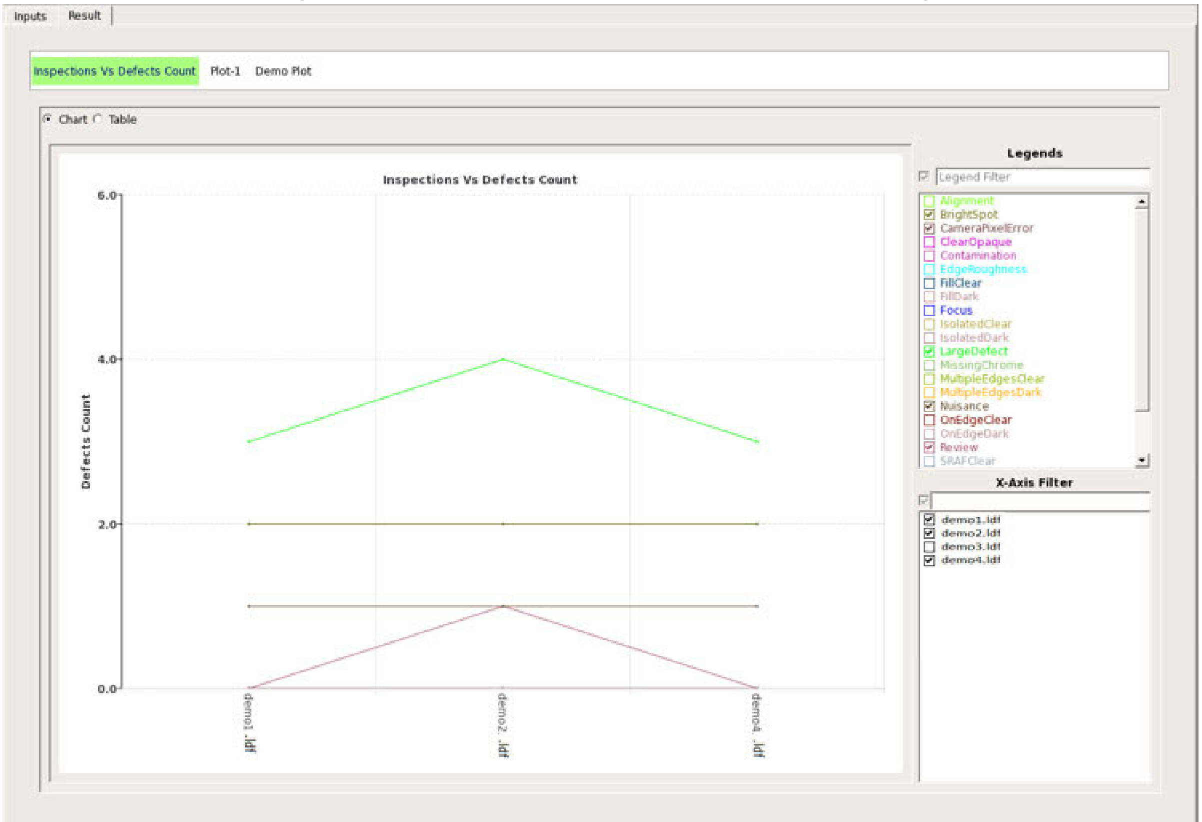
Figure 16-40. Table View for Defect Tracking



To launch an inspection run in the Calibre DefectReview main window with only defects available on the result table, double-click on an inspection row in the result table. This opens an inspection in a new Calibre DefectReview window if there are other inspections already open.

To analyze the result using a chart, click the **Chart** radio button. The result is illustrated in the following figure.

Figure 16-41. Chart View for Defect Tracking



To activate or deactivate a classification series, check or uncheck options displayed in the Legends pane. To activate or deactivate an inspection from the X-Axis, check or uncheck inspections from the X-Axis Filter pane.

When executed, a query may have either the Table or Charts or both types of results. You can configure the default results view using the DmQueryResultView node in the *dat-ini.xml* file. The default results view is set for Table view.

Figure 16-42. Query Result View Configuration

```
<DmQueryResultView>
 <RegionAnalysis>table</RegionAnalysis>
 <DefectSourceAnalysis>table</DefectSourceAnalysis>
 <BlankTransferAnalysis>table</BlankTransferAnalysis>
 <DefectProgressTracking>chart</DefectProgressTracking>
 <CustomQuery>table</CustomQuery>
</DmQueryResultView>
```

If you want to retain notes, the RegionAnalysis, DefectSourceAnalysis, and BlankTransferAnalysis currently only keep tabular results. The option for configuration is provided for future enhancements.

Launching Track Defect From the Defect List

DPT provides a snapshot of the defect attributes across the multiple inspections during a specified time interval. You can launch the DPT window from the Defect List to review changes of any attribute values across multiple inspections.

Prerequisites

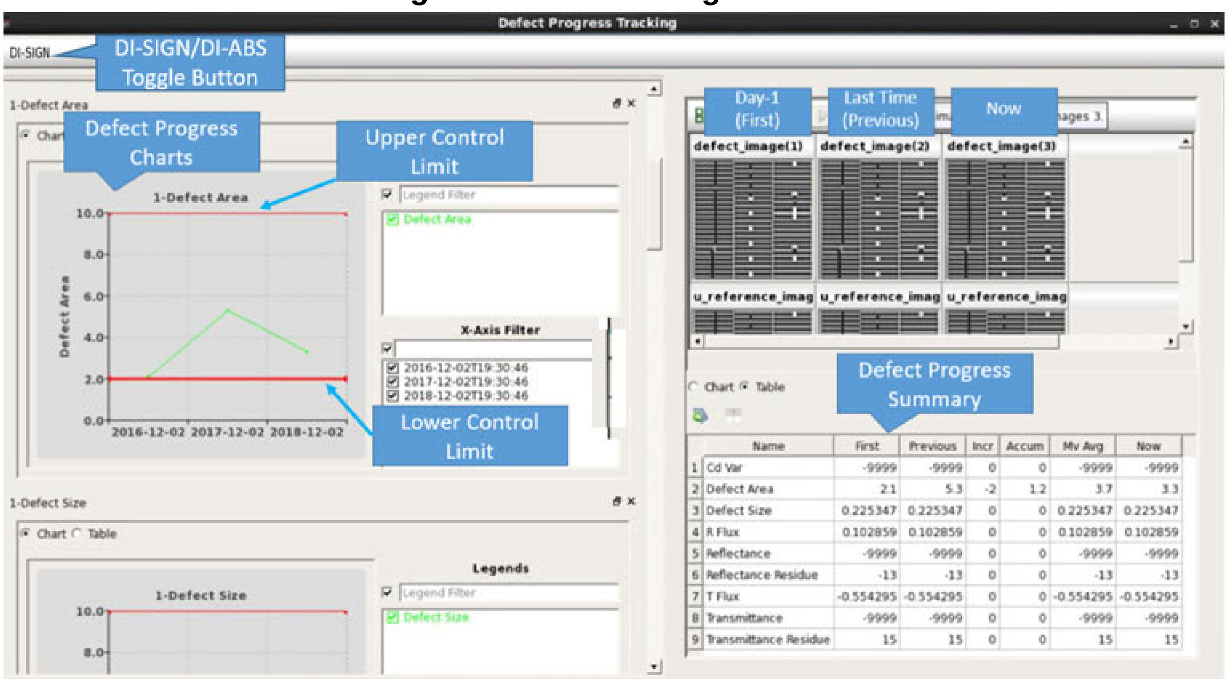
- An inspection report loaded from a defect database.

Procedure

1. To track a defect across inspections from a mask, right-click a defect's row header in the Defect List window and choose **Track Defect** from the popup menu.

   The Defect Progress Tracking window appears and results are generated for all supported attributes such as Cd Var, Defect Area, Defect Size, Reflectance, Reflectance Residue, Transmittance, Transmittance Residue, Reflectance Flux (R-Flux), and Transmittance Flux (T-Flux).

Figure 16-43. Tracking Defects



2. Review the progress of an attribute through the Defect Progress Charts. To toggle the sign of values between signed and absolute values, click the **DI-SIGN** and **DI-ABS** button. Toggling between **DI-SIGN** and **DI-ABS** also impacts the IMU's Defect Information attribute values sign.

   Upper and Lower Control Limits for each attribute are selected from values specified in the DefectArea node in the *dat-ini.xml* file.

Figure 16-44. Upper and Lower Control Limits in DefectArea Node

```
<Thresholds>
  <DefectAttributes>
  <CDVar>
   <UpperControlLimit>0.05</UpperControlLimit>
   <LowerControlLimit>0</LowerControlLimit>
  </CDVar>
 <!-- Unit of DefectArea is Square Microns such as 0.05 square microns -->
  <DefectArea>
   <UpperControlLimit>0.05</UpperControlLimit>
   <LowerControlLimit>0</LowerControlLimit>
  </DefectArea>
  <Size>
   <UpperControlLimit>0.05</UpperControlLimit>
   <LowerControlLimit>0</LowerControlLimit>
  </Size>
 <!-- Unit of TransmittedResidue is GL such as 10 GL -->
  <TransmittedResidue>
   <UpperControlLimit>10</UpperControlLimit>
   <LowerControlLimit>0</LowerControlLimit>
  </TransmittedResidue>
 <!-- Unit of ReflectedResidue is GL such as 10 GL -->
  <ReflectedResidue>
   <UpperControlLimit>10</UpperControlLimit>
   <LowerControlLimit>0</LowerControlLimit>
  </ReflectedResidue>
 <!-- Unit of MaxTransmittance is % such as 10% -->
  <MaxTransmittance>
   <UpperControlLimit>10</UpperControlLimit>
   <LowerControlLimit>0</LowerControlLimit>
  </MaxTransmittance>
  <MaxReflectance>
   <UpperControlLimit>10</UpperControlLimit>
   <LowerControlLimit>0</LowerControlLimit>
  </MaxReflectance>
  <TransmittedFlux>
   <UpperControlLimit>10</UpperControlLimit>
   <LowerControlLimit>0</LowerControlLimit>
  </TransmittedFlux>
  <ReflectedFlux>
   <UpperControlLimit>10</UpperControlLimit>
   <LowerControlLimit>0</LowerControlLimit>
  </ReflectedFlux>
 </DefectAttributes>
</Thresholds>
```

Images for day-1 (first), last time (previous) and now (current) are displayed in the upper-right region of the Defect Progress Tracking window. The Defect Progress Summary table illustrates the following:

- **Attribute Values** — The values of all the supported attributes from First, Previous and Current inspections
- **Incr (Incremental Difference)** — The differences of attribute values between the current and previous inspections.
- **Accum (Accumulative Difference)** — The differences of attribute values between the current and first day inspections.
- **Mv Avg (Moving Average)** — The Moving Average, computed as follows:

Figure 16-45. Computing Moving Average

$$F_t = \frac{A_{t-1} + A_{t-2} + A_{t-3} + ... + A}{n}$$

where

- F_t = Forecast
- n = Number of periods to be averaged
- $A_{t\text{-}num}$ = Actual occurrence in the past period for up to n periods. The value for n is selected from the Moving AvgInspCount node in the *data-ini.xml* file.

Figure 16-46. MovingAvgInspCount Node

```
<DptSettings>
 <MovingAvgInspCount>3</MovingAvgInspCount>
</DptSettings>
```

For example, for Defect ID 5, the inspections in the database are in chronological order: I1, I2 I3, I4, I5, I6 I7, I8, I9 and I10. In this scenario, the current inspection loaded in the Wafer Defect Management window is I7.

A_*i* represents the attribute value for Defect ID 5 in the inspection *i*. If n (the number of periods) = 4, then the Moving Average is computed as follows:

Moving Average = (A_3 + A_4 + A_5 + A_6) / 4

If the current inspection is I3, then with n = 4, the Moving Average is computed as follows:

Moving Average = (A_1 + A_2) / 2

The following issues apply:

- If the first inspection loaded into the Wafer Defect Management window is from the database, the previous inspection is not available. In such cases:
  - The previous inspection's image is not available.
  - The Incr column is empty.
  - The Mv Avg column is empty.
- All the inspections are present in the chart on the x-axis, but do not have a corresponding point in the plot. Those inspections where the defect is absent are ignored in the computation of columns in the Defect Progress Summary table.

Custom Query Interface

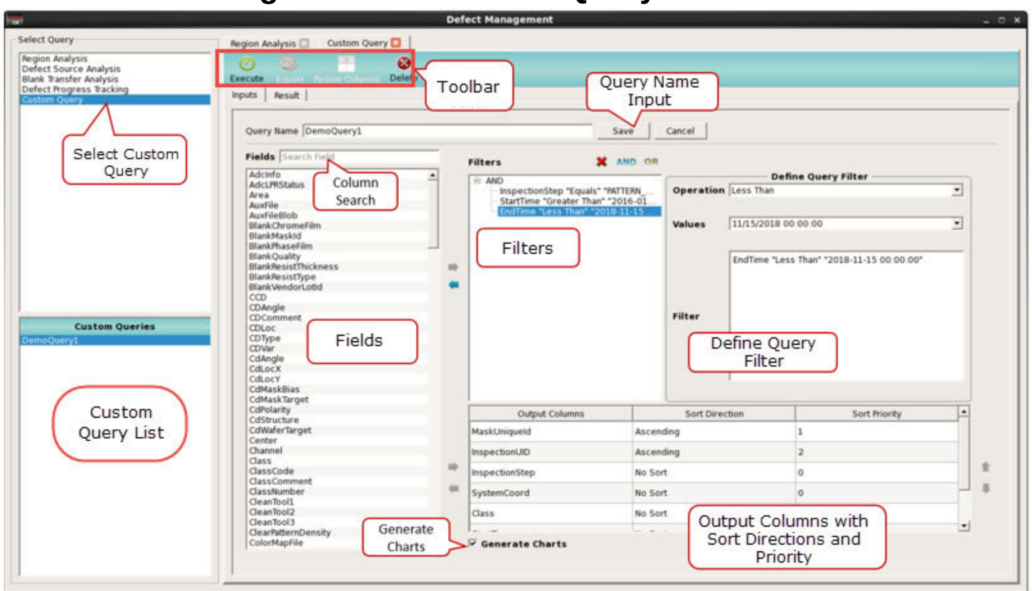
To access: In the Defect Management window click **Custom Query** in the Select Query pane.

Using the Custom Query interface, you can define your own query with desired output columns and apply custom filters. This enables you to use any column for output and filters. The custom query results are displayed in tabular format along with charts representing the Defect Map of a defect's system coordinates.

Description

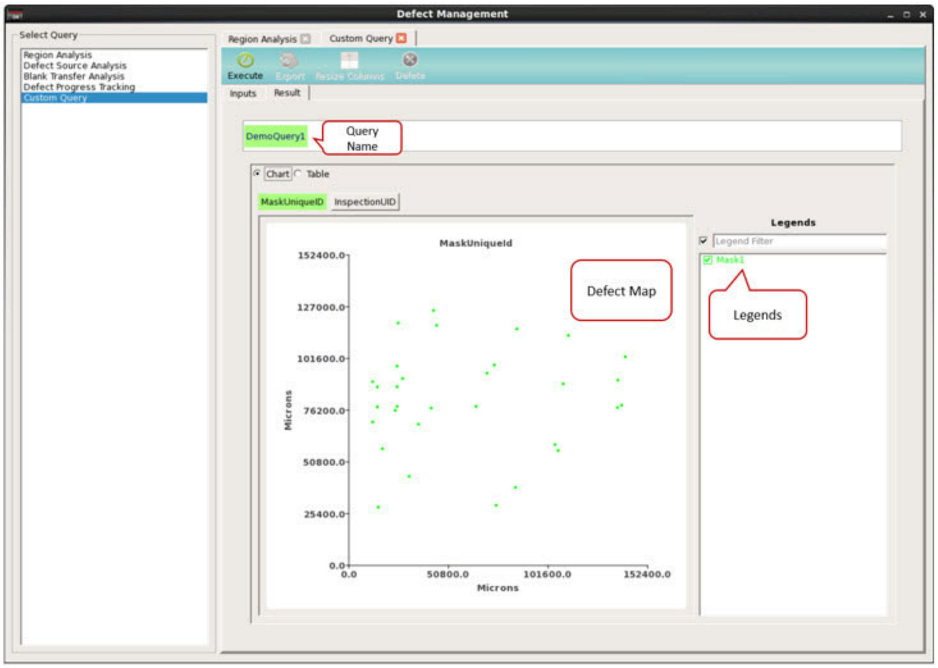
The following figure illustrates the functional areas of the Custom Query interface.

Figure 16-47. Custom Query Interface



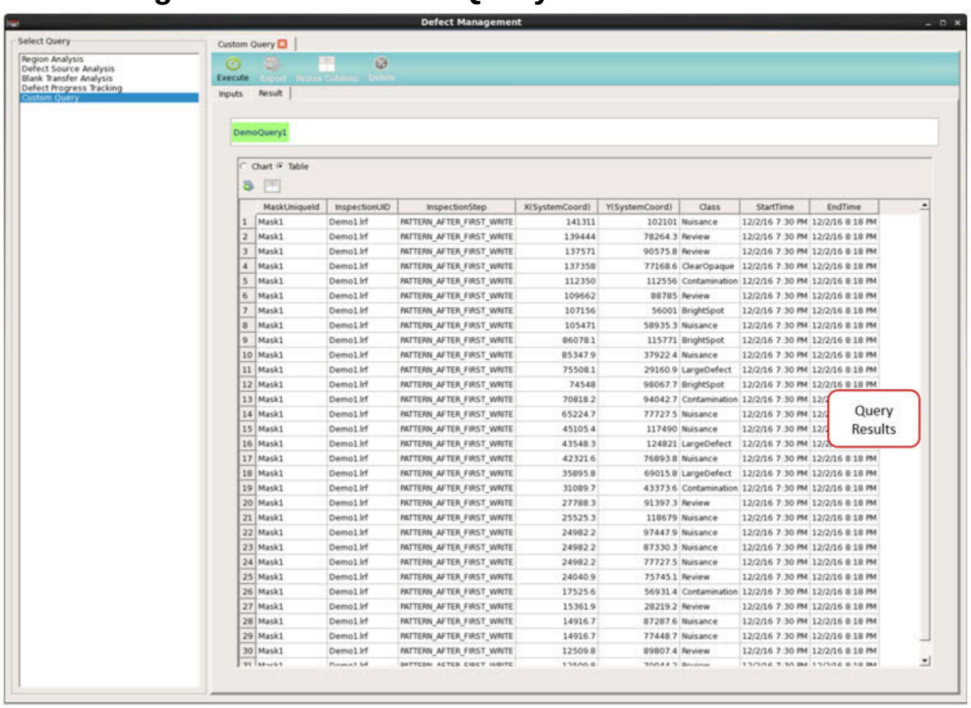
The following figure illustrates a query result as a Defect Map. The Defect Map is generated when the **Generate Charts** option is enabled in the Custom Query interface.

Figure 16-48. Custom Query With Defect Map



The following figure illustrates a query result in tabular format.

Figure 16-49. Custom Query With Results Table



Objects

- Select Custom Query

  Select the Custom Query option to invoke the Custom Query interface.

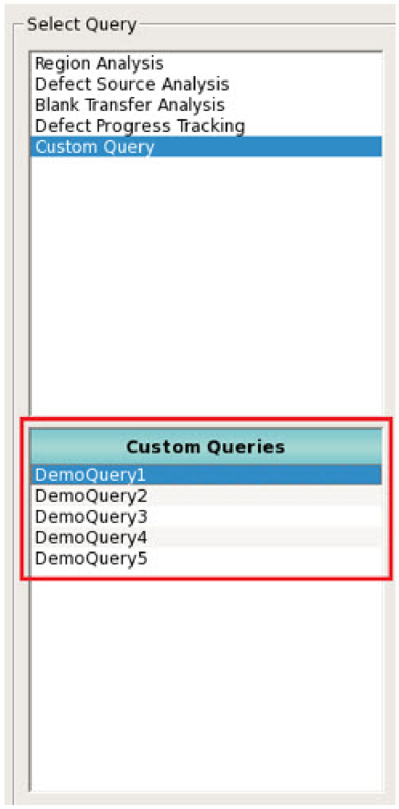
- Custom Query List

  Displays available custom queries created and saved during previous sessions. To save a custom query, specify a query name and click on **Save** button in the Query Name field.

Figure 16-50. Save Custom Query

The saved queries names are then listed in the Custom Queries pane.

Figure 16-51. Saved Custom Queries



To reload an existing query definition, select a query from the Custom Queries list. To delete a saved query, select the query and click the Delete icon in the Custom Query interface toolbar.

The query is saved into the *dat-ini.xml* file under the CustomQueries node as shown in the following figure.

Figure 16-52. Saved Custom Query Properties in the dat-ini.xml File

```xml
<CustomQueries>
 <CustomQuery name="DemoQuery1" generateChart="true">
  <QueryType name="AND">
   <Condition value="PATTERN_AFTER_FIRST_WRITE" name="InspectionStep" operator="Equals"/>
   <Condition value="2016-01-01 00:00:00" name="StartTime" operator="Greater Than"/>
   <Condition value="2018-11-15 00:00:00" name="EndTime" operator="Less Than"/>
  </QueryType>
  <OutputColumns>
   <Column name="MaskUniqueId" sortPriority="1" sortOrder="Ascending"/>
   <Column name="InspectionUID" sortPriority="2" sortOrder="Ascending"/>
   <Column name="InspectionStep" sortPriority="0" sortOrder="No Sort"/>
   <Column name="SystemCoord" sortPriority="0" sortOrder="No Sort"/>
   <Column name="Class" sortPriority="0" sortOrder="No Sort"/>
   <Column name="StartTime" sortPriority="0" sortOrder="No Sort"/>
   <Column name="EndTime" sortPriority="0" sortOrder="No Sort"/>
  </OutputColumns>
 </CustomQuery>
</CustomQueries>
```

- Toolbar

  The following buttons are on the Custom Query Toolbar. You can perform the following operations from this toolbar:

  ### Figure 16-53. Custom Query Toolbar

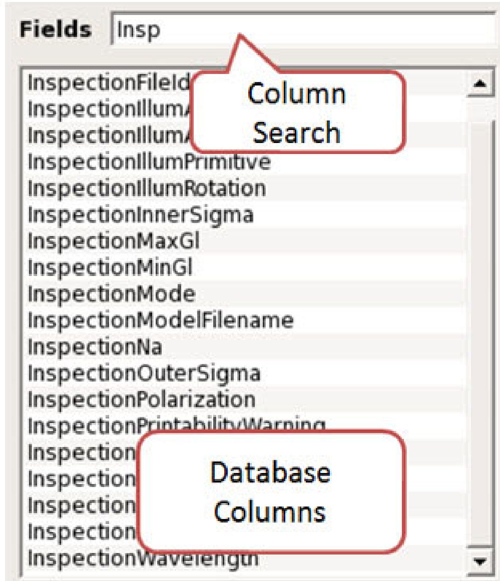
  

  - **Execute** — Runs the query.
  - **Export** — Exports query settings to a file.
  - **Resize Columns** — Resizes a column display.
  - **Delete** — Deletes a selected query.

- Fields

  This pane contains all the reticle, inspection, and defect attributes that can be used to form a custom query. Enter a string in the Column Search field to search attribute names. The database columns are displayed in the pane.

Figure 16-54. Custom Query Fields

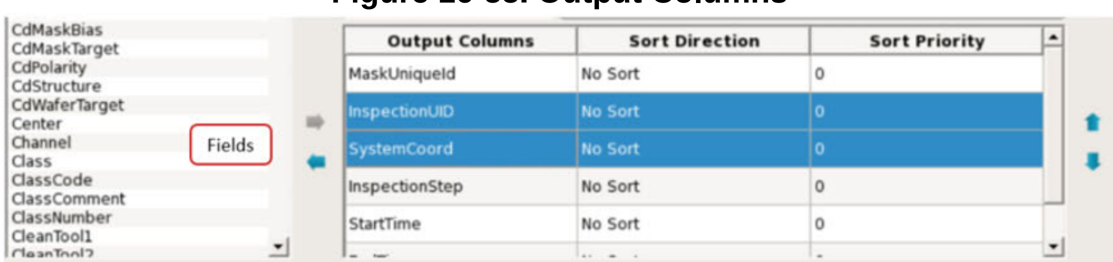


- Output Columns

  This pane contains the list of attributes to be displayed in output result table. The columns are selected from attributes listed under the Fields pane. You must select at least one attribute from the Fields pane as the Output Column to execute the custom query. You can assign Sort Priority and Sort Direction to each of the output columns using the drop-down box. You can also re-order the fields in the box in order to change order of the columns in the result table.

  Attributes such as MaskUniqueId, InspectionUID, and SystemCoord are added to the list if they are not selected manually. These attributes are required for the Defect Map view.

Figure 16-55. Output Columns



  - To add an output column, select the column from the Fields list and click the blue right arrow button.
  - To remove one or more output columns, select the columns from the Output Columns list and click the blue left arrow button.
  - To move one or more contiguous rows up, select the rows and click the blue up arrow button.

- To move one or more contiguous rows down, select the rows and click the blue down arrow button.
- To assign the sort direction to an output column, click an entry in the Sort Direction list and select Ascending, Descending, or No Sort from the drop-down menu. The No Sort option is the default.
- To Assign Sort Priority to an output column, click an entry in the Sort Priority list and select the priority number from the drop-down menu.The sort priority value ranges from 0 to *N*, where *N* is the number of output columns. By default, the sort priority is 0. A sort priority 0 means that sorting not is applied to this column. 1 is the highest sorting priority while *N* is the lowest.

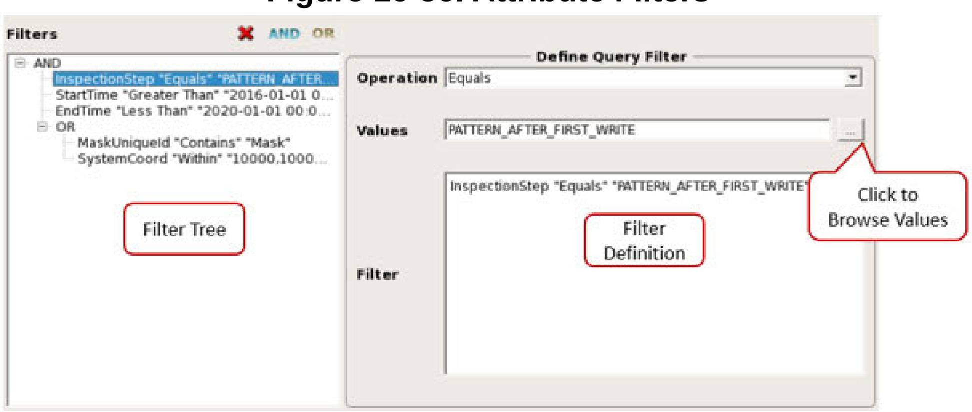
• Filters

Filters provide flexibility when applying conditions to produce the desired output. For example, you can apply conditions such as Equals or Does Not Equal on reticle, inspections, and defect attributes and you can concatenate various columns using the AND and OR operations.

As illustrated in the following figure, MaskUniqueId and SystemCoord are joined with the OR operation. The result of the OR operation is then joined with the InspectionStep, StartTime, and EndTime columns using the AND operation. The result of filtering can be expressed as the following logical expression:

Result = (InspectionStep Equals 'PATTERN_AFTER_FIRST_WRITE') AND (StartTime Greater Than '2016-01-01 00:00:00') AND (EndTime Less Than 2020-01-01 13:00:00) AND (MaskUniqueId Contains 'Mask' OR SystemCoord Within '10000, 10000, 200000, 200000').

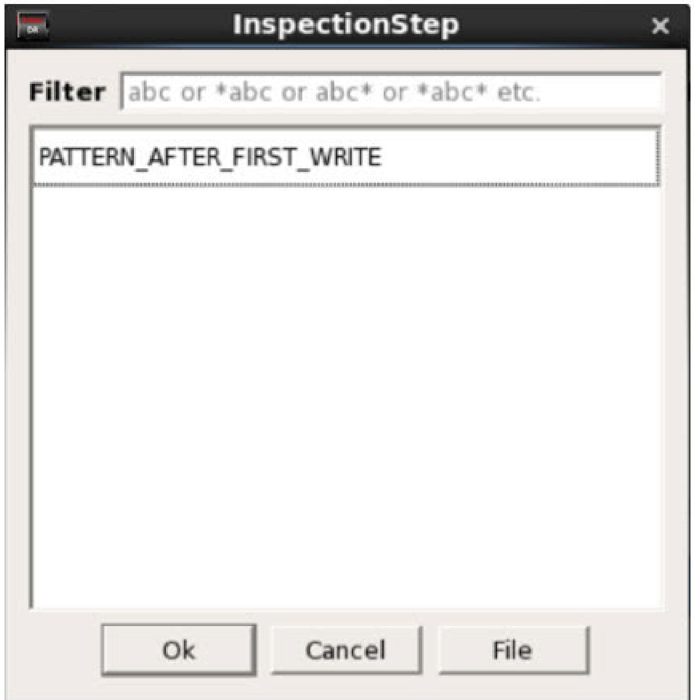
Figure 16-56. Attribute Filters



- Only two operators, AND and OR, are supported for joining filters applied on attributes.
- The top row under Filters tree can only be an operator (AND or OR).
- Initially, the Filters section is empty. No filtering is applied.

- Clicking the Browse button (**...**) next to the Values field allows you to select values from the database as shown in the following figure.

Figure 16-57. Select Database Values

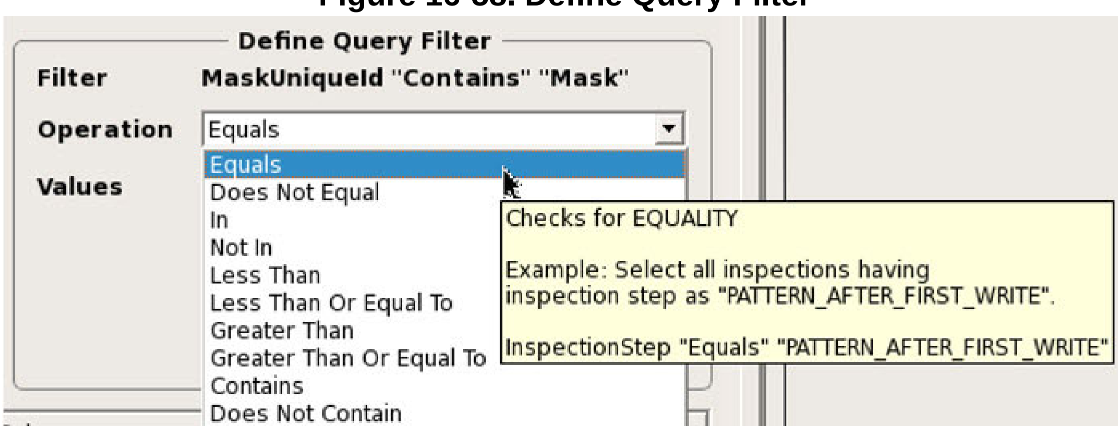


- For the In and Not In operations, you can import values from a CSV file by clicking the **File** button.

- Define Query Filter

  The Define Query Filter pane lists all the operations that are supported to filter your queries. A description and example of each operator can be viewed in the tooltip (hover your cursor over each operator to view).

Figure 16-58. Define Query Filter



The supported operations are listed in the following table.

Table 16-2. Attribute Filter Operations

Operation	Results Description	Values Field Example	Results Example
Equals	Produces output if the value specified matches a column value present in the database. The input is considered as a single value.	PATTERN_AFTER_FIRST_WRITE	InspectionStep “Equals” “PATTERN_AFTER_FIRST_WRITE” (Select all inspections containing the inspection step PATTERN_AFTER_FIRST_WRITE)
Does Not Equal	Produces output where the value specified does not match a column value present in the database. The input is considered as a single value.	PATTERN_AFTER_FIRST_WRITE	InspectionStep “Does Not Equal” “PATTERN_AFTER_FIRST_WRITE” (Select all inspections not containing the inspection step PATTERN_AFTER_FIRST_WRITE)
In	Produces output if any of the values specified match with a column value present in the database. The input can consist of multiple values separated by commas (,).	Review, Nuisance, ClearOpaque	Class “In” “Review, Nuisance, ClearOpaque”. (Select all defects where the defect class matches with Review or Nuisance or ClearOpaque)
Not In	Produces output where values specified do not match a column value present in the database. The input can consist of multiple values separated by commas (,).	Review, Nuisance, ClearOpaque	Class “Not In” “Review, Nuisance, ClearOpaque”. (Select all defects where the defect class does not match with Review, Nuisance and ClearOpaque)

Table 16-2. Attribute Filter Operations (cont.)

Operation	Results Description	Values Field Example	Results Example
Less Than	Produces output where the values in the database are less than the value specified. The input is considered as a single value.	12/31/16 1:00 AM	StartTime “Less Than” “2016-12-31 13:00:00” (Select all defects where inspections are performed before Dec. 31st, 2016 1 AM)
Less Than Or Equal To	Produces output where values in the database are less than or equal to the value specified. The input is considered as a single value.	12/31/16 1:00 AM	StartTime “Less Than Or Equal To” “2016-12-31 13:00:00” (Select all defects where inspections are performed before or on 3Dec. 31st, 2016 1 AM)
Greater Than	Produces output where the values in the database are greater than the value specified. The input is considered as a single value.	12/31/16 1:00 AM	StartTime “Greater Than” “2016-12-31 13:00:00” (Select all defects where inspections are performed after Dec. 31st, 2016 1 AM)
Greater Than Or Equal To	Produces output where the values in the database are greater than or equal to the value specified. The input is considered as a single value.	12/31/16 1:00 AM	StartTime “Greater Than Or Equal To” “2016-12-31 13:00:00” (Select all defects where inspections are inspected after or on Dec. 31st, 2016 1 AM)
Contains	Produces output if values from the database contains the value specified. This process is similar to substring matching. The input is considered as a single value.	Mask	MaskUniqueId “Contains” “Mask” (Select all the mask information where MaskUniqueId contains Mask as a substring such as NewMaskPlate, Mask100 and so on)

Table 16-2. Attribute Filter Operations (cont.)

Operation	Results Description	Values Field Example	Results Example
Does Not Contain	Produces output if the values from the database do not contain the value specified. This process is similar to substring matching. The input is considered as a single value.	Mask	MaskUnique Id "Does Not Contain" "Mask" (Select all mask information where MaskUniqueId does not contain Mask as a substring such as NewMaskPlate, Mask100 and so on are not output)
Within	This operator is only available for geometry data types such as SystemCoord, Scale, and Center. It takes Bottom Left X, Bottom Left Y, Upper Right X, and Upper Left Y coordinates as inputs and the result contains values that lie within the bounding rectangle specified during input.	Bottom Left X : 10000 Bottom Left Y: 10000 Top Right X: 200000 Top Right Y:200000	SystemCoord "Within" 10000,10000,200000,2000 00 (Select all the defects where SystemCoord lie within the bounding rectangle formed by 10000,10000,200000,2000 00)

Note

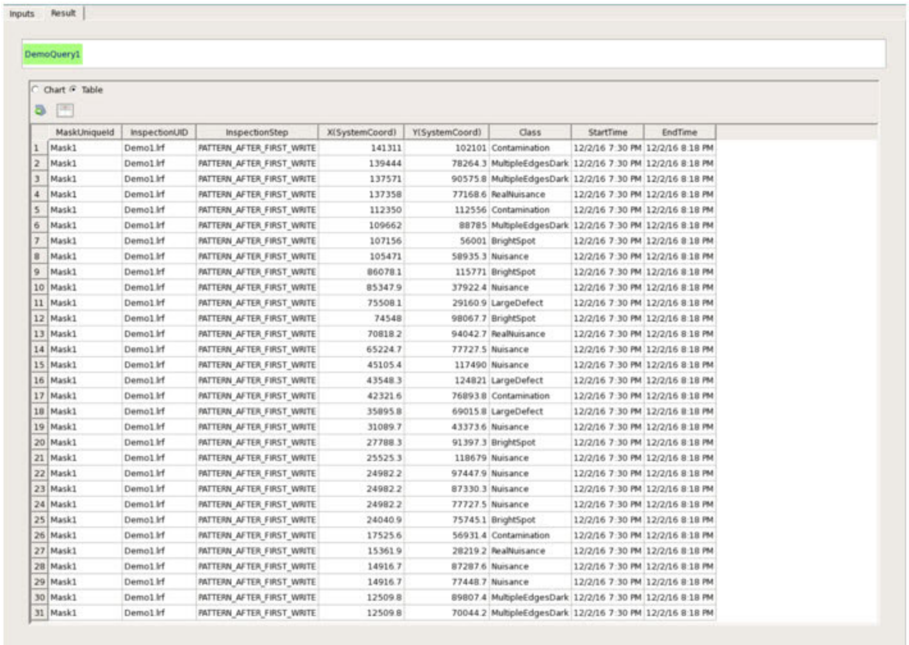
Special handling rules apply when using the MaskUniqueId query. Refer to "Special Handling of the Mask Unique ID Field" on page 473 for information.

- Query Results

  The custom query results are grouped by Masks and Inspections and displayed as a table and charts. You must select at least one attribute from Field as Output Column to execute the custom query.

  Using a tabular format to display query results, you can visualize custom columns properties as illustrated in the following figures. Columns such as Detector, CCD, and ComparisonType are multi-value attributes. The value of these columns for a defect are shown in same row, separated by commas if there is more than one value for the defect.

Figure 16-59. Custom Query Output in Tabular Format



	MaskUniqueId	InspectionUID	InspectionStep	X(SystemCoord)	Y(SystemCoord)	Class	StartTime	EndTime
1	Mask1	Demo1.lrf	PATTERN_AFTER_FIRST_WRITE	141311	102101	Contamination	12/2/16 7:30 PM	12/2/16 8:18 PM
2	Mask1	Demo1.lrf	PATTERN_AFTER_FIRST_WRITE	139444	78264.3	MultipleEdgesDark	12/2/16 7:30 PM	12/2/16 8:18 PM
3	Mask1	Demo1.lrf	PATTERN_AFTER_FIRST_WRITE	137571	90575.8	MultipleEdgesDark	12/2/16 7:30 PM	12/2/16 8:18 PM
4	Mask1	Demo1.lrf	PATTERN_AFTER_FIRST_WRITE	137358	77168.6	RealNuisance	12/2/16 7:30 PM	12/2/16 8:18 PM
5	Mask1	Demo1.lrf	PATTERN_AFTER_FIRST_WRITE	112350	112556	Contamination	12/2/16 7:30 PM	12/2/16 8:18 PM
6	Mask1	Demo1.lrf	PATTERN_AFTER_FIRST_WRITE	109662	88785	MultipleEdgesDark	12/2/16 7:30 PM	12/2/16 8:18 PM
7	Mask1	Demo1.lrf	PATTERN_AFTER_FIRST_WRITE	107156	56001	BrightSpot	12/2/16 7:30 PM	12/2/16 8:18 PM
8	Mask1	Demo1.lrf	PATTERN_AFTER_FIRST_WRITE	105471	58935.3	Nuisance	12/2/16 7:30 PM	12/2/16 8:18 PM
9	Mask1	Demo1.lrf	PATTERN_AFTER_FIRST_WRITE	86078.1	115771	BrightSpot	12/2/16 7:30 PM	12/2/16 8:18 PM
10	Mask1	Demo1.lrf	PATTERN_AFTER_FIRST_WRITE	85347.9	37922.4	Nuisance	12/2/16 7:30 PM	12/2/16 8:18 PM
11	Mask1	Demo1.lrf	PATTERN_AFTER_FIRST_WRITE	75508.1	29160.9	LargeDefect	12/2/16 7:30 PM	12/2/16 8:18 PM
12	Mask1	Demo1.lrf	PATTERN_AFTER_FIRST_WRITE	74548	98067.7	BrightSpot	12/2/16 7:30 PM	12/2/16 8:18 PM
13	Mask1	Demo1.lrf	PATTERN_AFTER_FIRST_WRITE	70818.2	94042.7	RealNuisance	12/2/16 7:30 PM	12/2/16 8:18 PM
14	Mask1	Demo1.lrf	PATTERN_AFTER_FIRST_WRITE	65224.7	77727.5	Nuisance	12/2/16 7:30 PM	12/2/16 8:18 PM
15	Mask1	Demo1.lrf	PATTERN_AFTER_FIRST_WRITE	45105.4	117490	Nuisance	12/2/16 7:30 PM	12/2/16 8:18 PM
16	Mask1	Demo1.lrf	PATTERN_AFTER_FIRST_WRITE	43548.3	124821	LargeDefect	12/2/16 7:30 PM	12/2/16 8:18 PM
17	Mask1	Demo1.lrf	PATTERN_AFTER_FIRST_WRITE	42321.6	76893.8	Contamination	12/2/16 7:30 PM	12/2/16 8:18 PM
18	Mask1	Demo1.lrf	PATTERN_AFTER_FIRST_WRITE	35895.8	69015.8	LargeDefect	12/2/16 7:30 PM	12/2/16 8:18 PM
19	Mask1	Demo1.lrf	PATTERN_AFTER_FIRST_WRITE	31089.7	43373.6	Nuisance	12/2/16 7:30 PM	12/2/16 8:18 PM
20	Mask1	Demo1.lrf	PATTERN_AFTER_FIRST_WRITE	27788.3	91397.3	BrightSpot	12/2/16 7:30 PM	12/2/16 8:18 PM
21	Mask1	Demo1.lrf	PATTERN_AFTER_FIRST_WRITE	25525.3	118679	Nuisance	12/2/16 7:30 PM	12/2/16 8:18 PM
22	Mask1	Demo1.lrf	PATTERN_AFTER_FIRST_WRITE	24982.2	97447.9	Nuisance	12/2/16 7:30 PM	12/2/16 8:18 PM
23	Mask1	Demo1.lrf	PATTERN_AFTER_FIRST_WRITE	24982.2	87330.3	Nuisance	12/2/16 7:30 PM	12/2/16 8:18 PM
24	Mask1	Demo1.lrf	PATTERN_AFTER_FIRST_WRITE	24982.2	77727.5	Nuisance	12/2/16 7:30 PM	12/2/16 8:18 PM
25	Mask1	Demo1.lrf	PATTERN_AFTER_FIRST_WRITE	24040.9	75745.1	BrightSpot	12/2/16 7:30 PM	12/2/16 8:18 PM
26	Mask1	Demo1.lrf	PATTERN_AFTER_FIRST_WRITE	17525.6	56931.4	Contamination	12/2/16 7:30 PM	12/2/16 8:18 PM
27	Mask1	Demo1.lrf	PATTERN_AFTER_FIRST_WRITE	15361.9	28219.2	RealNuisance	12/2/16 7:30 PM	12/2/16 8:18 PM
28	Mask1	Demo1.lrf	PATTERN_AFTER_FIRST_WRITE	14916.7	87287.6	Nuisance	12/2/16 7:30 PM	12/2/16 8:18 PM
29	Mask1	Demo1.lrf	PATTERN_AFTER_FIRST_WRITE	14916.7	77448.7	Nuisance	12/2/16 7:30 PM	12/2/16 8:18 PM
30	Mask1	Demo1.lrf	PATTERN_AFTER_FIRST_WRITE	12509.8	89807.4	MultipleEdgesDark	12/2/16 7:30 PM	12/2/16 8:18 PM
31	Mask1	Demo1.lrf	PATTERN_AFTER_FIRST_WRITE	12509.8	70044.2	MultipleEdgesDark	12/2/16 7:30 PM	12/2/16 8:18 PM

To launch an inspection in the Calibre DefectReview main window with only defects available on results table, double click on an inspection row in the results table. Calibre DefectReview opens an inspection in the same window if no other inspection is currently open. If other inspections are open, a new Calibre DefectReview window is opened.

- Defect Map

  Using the Defect Map, you can view the defects on a reticle map. To enable defect map charts generation, select the **Generate Charts** check box available in the **Inputs** tab. If **Generate Charts** is selected, then columns such as MaskUniqueId, InspectionUID, and SystemCoord are added to the output if not otherwise supplied as they are required to generate a Defect Map.

  The defects are illustrated on a per-mask basis and per-inspection basis. You can also use the legend to filter masks and inspections. The following figures illustrate defects on a reticle map.

Figure 16-60. Defect Map With Defects Group by Mask Unique ID

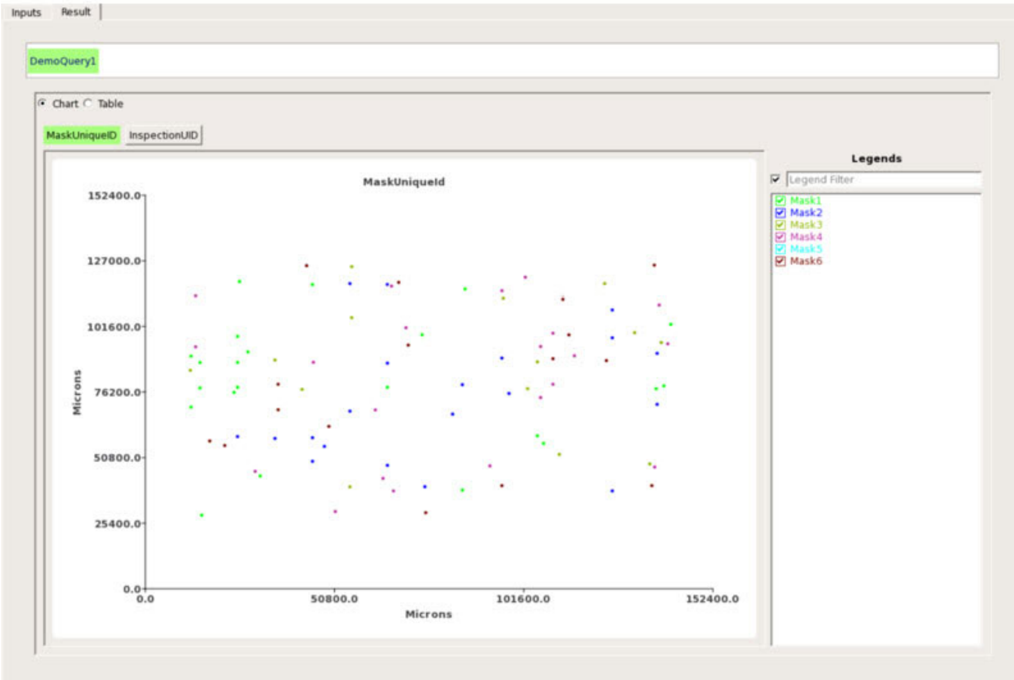
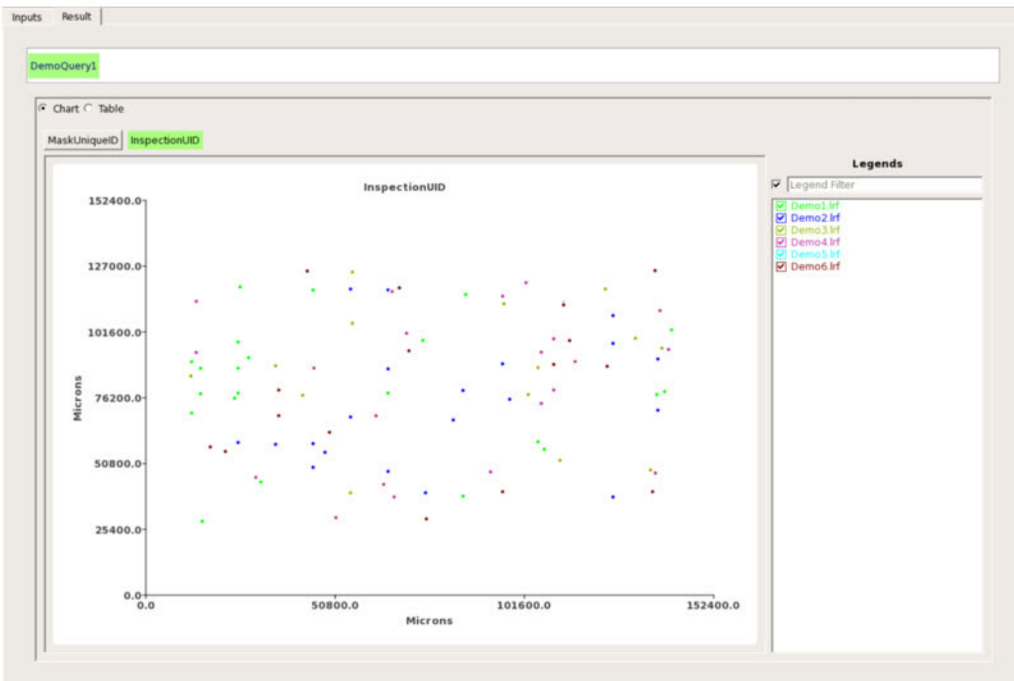


Figure 16-61. Defect Map With Defects Group by Inspection Unique ID

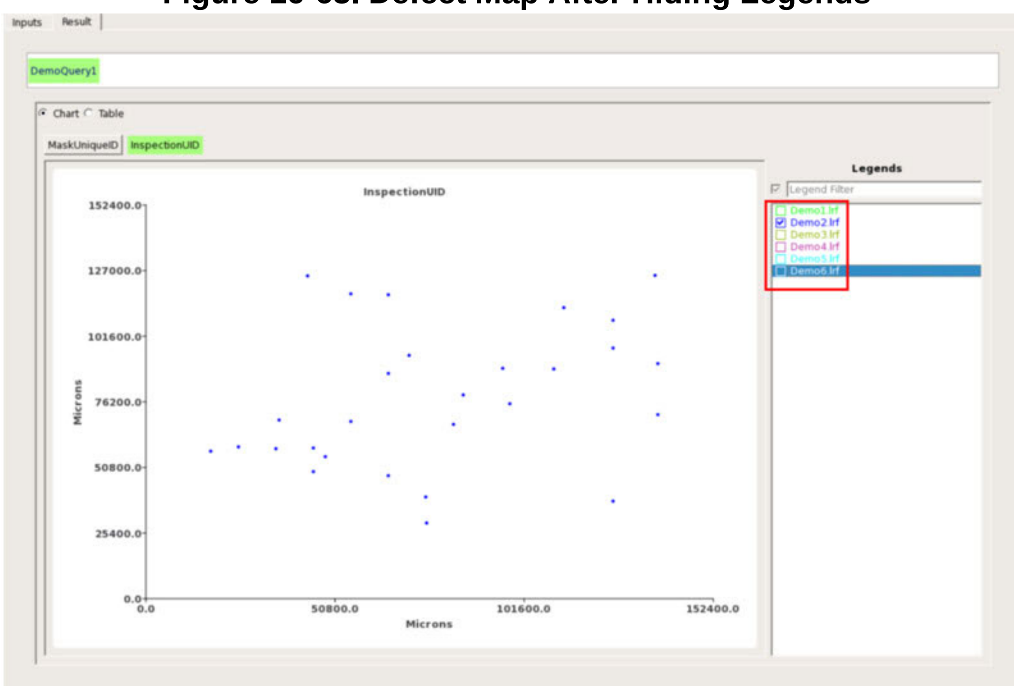


- Legends

  Using the legend, you can select or unselect defects on Defect Map. The following figures illustrate the Defect Map before and after hiding defects from the *Demo1.lrf*, *Demo3.lrf*, *Demo4.lrf*, *Demo5.lrf*, and *Demo6.lrf* inspection legends.

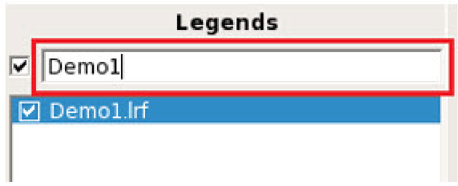
Figure 16-62. Defect Map Before Hiding Legends

Figure 16-63. Defect Map After Hiding Legends



You can further filter the list of inspection legends using the text box at the top of the Legends pane.

Figure 16-64. Custom Query Legends Filter Input



Click the check box at the right of the filter box to select or unselect all the legends.

Figure 16-65. Select-Unselect All Legends

Special Handling of the Mask Unique ID Field

If MaskUniqueId is selected as a filter in the Query Filter utility, then it is treated as a special case in a custom query. This is because all related blank and link mask IDs are also considered as mask IDs.

Refer to "Reticle Information File (RIF)" on page 79 for information on blank and link mask unique IDs.

All operators such as Equals, Does Not Equal, In, Not In, Contains, and Does Not Contain consider all related mask IDs for filtering.

For example, assume the following mask unique IDs are stored in the database:

Table 16-3. Mask Unique IDs and Associated Blank Mask and Link Mask Unique IDs

MaskUniqueId	BlankMaskId	LinkMaskUniqueId
a1	b1	c1
a2	b2	NULL
b1	NULL	NULL
c1	NULL	NULL
c2	NULL	NULL

- Query 1 — MaskUniqueId "Equals" "a1"

  Result — The result contains data from masks a1, b1, and c1 as all are the same or related masks. Masks b1 and c1 are linked as blank and link masks to a1.

- Query2 — MaskUniqueId “Does Not Equal” “a1”

  Result — The opposite of Query1. The result contains data from all masks except masks a1, b1, and c1.

- Query3 — MaskUniqueId “In” “a1, a2”

  Result — The result contains data from masks a1, b1, c1, a2 and b2. Masks b1 and c1 are linked as blank and link masks to a1. Mask b2 is linked as a blank mask to a2.

- Query4 — MaskUniqueId “Not In” “a1, a2”

  Result — The opposite of Query3. The results contains data from all masks except a1, b1, c1, a2 and b2.

- Query5 — MaskUniqueId “Contains” “c”

  Result — The usage of “Contains” and “Does Not Contains” follows a more complex process:

  a. To find the mask IDs, check for “c” as sub-string in MaskUniqueId, BlankMaskId, and LinkMaskUniqueId. The output is a union of matching IDs from these three attributes and columns. In this example, the result after this step is c1 and c2.

  b. From the previous step, search all linked mask IDs. This outputs all related mask IDs. The result after this step are masks a1, b1, c1 and c2. Masks a1 and b1 are linked with c1.

  c. Output result attributes if MaskUniqueId columns have masks from the list generated from the previous step. The final output in this example is a1, b1, “c1” and c2.

- Query6 — MaskUniqueId “Does Not Contains” “a”

  Result — The opposite of Query5. The process is as follows:

  a. Check for “c” as sub-string on MaskUniqueId, BlankMaskId, and LinkMaskUniqueId to find mask IDs. The output is a union of matching IDs from these three attributes or columns. In this example, the results after this step are c1 and c2.

  b. From the previous step, search all linked mask IDs. This outputs all related mask IDs. The results after this step are a1, b1, c1 and c2. Masks a1 and b1 are linked with c1.

  c. Output resulting attributes if the MaskUniqueId columns do not contain masks from the previous step. In this example, the result is a2.

Chapter 17
Calibre DefectReview Command Line Interface

Calibre DefectReview supports an interface that enables you to interact with the tool using a command line. Batch scripts can be written in Tcl that can be loaded into Calibre DefectReview through the command line interface.

Invoking the Calibre DefectReview CLI

The Calibre DefectReview command line interface (CLI) is invoked from a Windows or Linux command shell.

Prerequisites

- If you run Calibre DefectReview in CLI mode without accepting the End User License Agreement (EULA) by running the tool in GUI mode, the tool exits and issues an error message (for example, “EULA must be accepted in GUI mode of tool before using CLI mode”). You must run Calibre DefectReview in GUI mode, log in, and accept the EULA (by clicking “I accept the agreement” in the License Agreement dialog box). An inspection machine vendor must accept the EULA every time the system is rebooted.

Procedure

1. Open a command shell (cmd) window.
2. In the command shell window, go the location where the Calibre DefectReview executable has been installed.

   ```
   cd <installation_dir>/bin
   ```

3. Enter the following command:

   ```
   NxDAT_cli.exe <options> (Windows)
   $NXDAT_MGC_HOME/bin/nxdat <options> (Linux)
   ```

   where <*options*> are command line options described in “Calibre DefectReview Command Line Interface Syntax” on page 478.

4. You can create a batch Tcl scripting file using supported Calibre DefectReview commands to run from the command line.

   To create the Tcl scripting file, use one of the following methods:

   - Open a text editor and enter the supported Calibre DefectReview Tcl scripting commands. See “Calibre DefectReview Tcl Scripting Commands” on page 482 for further information. Save the file with a .tcl extension
   - Alternatively, you can record supported Calibre DefectReview operations and output to a Tcl script file. The script file can then be used as a batch execution script for future Calibre DefectReview sessions through its command line interface. This can be set up through the Calibre DefectReview GUI (**Settings > Set Record Script**). See “Recording Operations” on page 371 for further information.

   Note

   If the operations not supported in the CLI are performed in the Calibre DefectReview GUI, those operations are not recorded.

5. In the command shell, run the following command:

```
NxDAT_cli.exe -c <tcl_file_name> -i <defect_file_name> (Windows)

$NXDAT_MGC_HOME/bin/nxdat -c <tcl_file_name> -i <defect_file_name>
(Linux)
```

If you are running multiple Tcl scripting files:

```
NxDAT_cli.exe -c <tcl_file_name> -i <inspect_file1> <inspec_file2>
... <inspec_filen> (Windows)

$NXDAT_MGC_HOME/bin/nxdat -c <tcl_file_name> -i <inspect_file1>
<inspec_file2> ... <inspec_filen> (Linux)
```

Note

By default, automatic alignment is enabled for all inspection reports in Calibre DefectReview. The center of inspections translates to (76200, 76200) while loading in CLI mode in Calibre DefectReview in the presence of an appropriate license.

Calibre DefectReview Command Line Interface Syntax

The Calibre DefectReview command line interface executable contains a number of options to run from the command line.

There are two invocation modes. The first mode is the default -m review mode and works with the inspection file. The second mode is the -m pcserver mode. In this case, Calibre DefectReview runs as a server to monitor a particular shared folder for inspection files. It picks the inspection file automatically and runs Calibre DefectClassify on it, saving the result to the database for further analysis.

Usage

The following is the -m review mode syntax (default):

{**NxDAT_cli.exe** | **nxdat**}[-m review]
{{**-c** | **--cli**} [***tcl_filename***]} [-h | --help] [-v | -version]
[{-r | --reference} <*ref_name*>] [{-i | --inspections} *insp_name*] [{-d |-- dir} *dir_name*]
[{-e | --exitstatus} *log_file*}]

The following is the -m pcserver mode syntax:

{**NxDAT_cli.exe** | **nxdat**}**-m pcserver**
{**-q** | **--enfolder**} ***foldername***
{**-r** | **--lrffolder**} ***insp_folder_name***
{**-p** | **--configfile**} ***name***
{-t | --retry} *num*
{-x | --timeout} *time*

Arguments

- {**-c** |**--cli**} [***tcl_filename***]

  A required keyword that instructs Calibre DefectReview to run in command line mode without a GUI. The ***tcl_filename*** optionally specifies a Tcl-based batch script file (see "Calibre DefectReview Tcl Scripting Commands" on page 482 for further information).

- -h | -- help

  An optional keyword that lists the supported command line options.

- -v | --version

  An optional keyword that displays the Calibre DefectReview version number.

- {-r | --reference} *ref_name*

  An optional keyword that specifies the name of the reference inspection.

- {-i | --inspections} *insp_name*

  An optional keyword that displays a list of inspections related to a specified inspection file.

- {-d | --dir} *dir_name*

  An optional keyword that specifies a directory containing inspection files.

- {-e | --exitstatus} *log_file*

  An optional keyword that specifies a log file to store the exit status.

- {**-q** | **--enfolder**} ***foldername***

  A required keyword used by -m pcserver mode that specifies the folder name containing END files. The search method is recursive.

- {**-r** | **--lrffolder**} ***insp_folder_name***

  A required argument used by -m pcserver mode if you want to run Calibre DefectReview to monitor a particular shared folder for inspection files. Calibre DefectReview picks the inspection file automatically and runs Calibre DefectClassify (refer to the *Calibre DefectClassify User's Manual* for details) on it and saves the result to the database for further analysis (see "Saving Calibre DefectClassify Results Automatically in CLI Mode" on page 480 for further details).

- {**-p** | **--configfile**} ***name***

  A required argument used by -m pserver mode that specifies the configuration file or folder name. For further details, refer to the *Calibre DefectClassify User's Manual*.

- {-t | -- retry} *num*

  An optional keyword used by -m pcserver mode that specifies the number of retries to run Calibre DefectClassify if it fails.

- {-x | --timeout} *time*

  An optional keyword used by -m pcserver mode that specifies the time (in seconds) to wait for a Calibre DefectClassify run to complete. The default value is 6 hours. Specify -1 to keep the tool from a timeout. This option should be used when a Calibre DefectClassify run takes longer than 6 hours.

Description

Executes the Calibre DefectReview tool from the command line. You can also define the log file name under the ExitStatusLogFile node in the *dat-ini.xml* file as shown in the following figure:

Figure 17-1. ExitStatusLogFile Node

```
<ExitStatusLogFile>cli_activation_log.txt</ExitStatusLogFile>
```

The log file path may be a relative or absolute file path. If you specify a relative path, the Calibre DefectReview creates the file in application directory on Windows (*C:\DefectAnalysisTool\bin*) and in your workspace on Linux (*$HOME/.calibrenx_workspace*). If the file path contains any director name (for example *C:\reports\cli_activation_log.txt*), you must create the directory (you must also create the *reports* directory) before running in CLI mode.

Saving Calibre DefectClassify Results Automatically in CLI Mode

The Calibre DefectReview command line interface can be configured to run Calibre© DefectClassify™ automatically and save the results to a database. Currently, this is supported only for LRF inspection reports (both lrfX700 and lrfX800 formats are supported).

Procedure

At a command prompt, run the following command:

```
NxDAT_cli.exe -m pcserver -q <end_file_folder>
-r <shared_folder_location_containing_IRs>
-p <config_file_folder>
(Windows)

$NXDAT_MGC_HOME/bin/nxdat -m pcserver -q <end_file_folder>
-r <shared_folder_location_containing_IRs> -p <config_file_folder>
(Linux)
```

This command runs Calibre DefectReview continuously and searches for the file *inspection_report.END* inside the *end_file_folder* every five seconds. Once the folder is found, the following steps are applied to the inpection file (to terminate the command, press Ctrl-C):

a. The primary classification of the previous defect is copied to the current defect's primary classification.

b. Automatic defect classification is triggered.

c. The tables generated from automatic defect classification are copied to the manual secondary classifications tables if the value of the AutoCopyDCToManualClassification node is set to true in the *dat-ini.xml* file.

Figure 17-2. AutoCopyDCToManualClassification Node

```
<!-- Used in automation in batch mode. If AutoCopyDCToManualClassification is set to true,
    copy the Defect Classify secondary tier classifications results to manual secondary classifications.
    Default is false if value not supplied. -->
<AutoCopyDCToManualClassification>false</AutoCopyDCToManualClassification>
```

The node is set to false by default.

d. The inspection is saved to a database.

In step a, the previous defect is defined as the most recent correlated to the current defect. As illustrated in the following table, defects on the same rows from different inspections (I1, I2, I3, and I4) are correlated defects.

Table 17-1. Previous Defects

I1	I2	I3	I4
D11	D21	D31	D41

Table 17-1. Previous Defects (cont.)

I1	I2	I3	I4
D12	D22		D42
	D23		D43

In this example, we assume that inspections are analyzed in the following order: I1, I2, I3, and I4. The previous defects for D41, D42, and D43 are D31, D22, and D23, respectively.

During automation, if there is more than one inspection file, the oldest file (according to the file's modification time) is analyzed first. After a successful run, the *inspection_report.END* file is deleted and Calibre DefectClassify continuously searches for another .END file.

The shared folder must contain other required files to run successfully. For example, to run Calibre DefectClassify, the parameter file should be inside *config_file_folder*.

A log file *NxDAT-mdppc-server-v<nxdat-version>-Release.log* is generated and called from the same location as the Calibre DefectReview log file.

For further information on Calibre DefectClassify and its configuration file, refer to the *Calibre DefectClassify User's Manual*. The configuration file is required to run Calibre DefectClassify.

Examples

The following example checks for *inspection_report.END* files inside */home/user/end_file_folder*. Once the file is found, Calibre DefectReview searches the corresponding LRF inspection report in */home/user/lrf_IR/* and the parameter file in */home/user/config_file_folder*. If the file is found, it triggers Calibre DefectClassify and automatically saves the result to the database. The *inspection_report.END* file is deleted if the run is successful.

```
$NXDAT_MGC_HOME/bin/nxdat -m pcserver -q /home/user/end_file_folder/
-r /home/user/lrfIR/ -p /home/user/config_file_folder/
```

Calibre DefectReview Tcl Scripting Commands

The Calibre DefectReview CLI supports a number of operations that can be scripted or recorded into a Tcl file.

Table 17-2. Calibre DefectReview Scripting Commands

Command	Description
advselection	Selects defects from the Advanced Selection list in the Defect Selection window.
autocluster	Clusters defects of files currently-loaded in Calibre DefectReview.
basicselection	Selects defects from the Basic Selection list in the Defect Selection window.
classify	Sets a specified defect to a classification type.
createmgcdb	Creates a database in the database server.
copymdppatclass	Copies Auto Defect classifications to manual classifications.
deleteunselected	Deletes all defects which are not selected for analysis.
detectgrid	Detects a grid on an inspection in the specified direction.
getdbmaskuid	Retrieves the unique mask ID from the defect database for an inspection file.
getfilemaskuid	Extracts a mask unique ID from an inspection file.
imagetolayout	Performs image to layout alignment.
ra_classify	Classifies all specified defects detected after performing Repeatability Analysis.
ra_compute	Performs Repeatability Analysis (RA) on the opened inspection files.
ra_delete	Deletes all specified defects detected after performing Repeatability Analysis (RA).
ra_save	Saves the Repeatability Analysis results of a specified inspection and analysis type to a specified format.
rangeselection	Enables Advanced Selection defects to be entered in as ranges.

Table 17-2. Calibre DefectReview Scripting Commands (cont.)

Command	Description
rectselection	Enables Advanced Selection defects to be entered in as rectangles.
save	Saves an opened inspection file in Calibre DefectReview.
saveall	Saves all opened inspection files in Calibre DefectReview.
saveas	Saves an open inspection file with a new name in Calibre DefectReview.
savedbtofile	Saves an inspection database to a file.
savedefectlist	Saves information displayed in the Defect List in CSV format.
savetodb	Saves inspection file(s) opened in Calibre DefectReview to the Defect Database.
savereport	Saves selected reports of the specified inspection to a single consolidated HTML report file.
savereticleinfotodb	Saves the Reticle Information File (RIF) to a defect database.
selection	Select defects to be used for analysis.
setdbuser	Sets the user name and password for running CLI commands related to the defect database.
translate	Translate the inspection with X and Y coordinates.

advselection

Calibre DefectReview Tcl Scripting Commands

Selects defects from the Advanced Selection list in the Defect Selection window.

Usage

advselection *filterId* [0 | 1]

Arguments

- ***filterId***

  A required argument that specifies the filter defect selectors. This is identical to the same argument used by the basicselection command.

- 0 | 1

  An optional keyword pair that activates or deactivates the selected defect. If set to 0, the defect selector is left in the Defect Selection list. If set to 1, the defect is filtered out.

Description

This command is used in conjunction with the selection command to select defects from the Advanced Selection list. Refer to "Applying Advanced Selection" on page 191 for information on the Advanced Selection list.

Examples

In this example, three inspection files (*test1.txt*, *test2.txt*, and *test2.txt*) are opened and only the first 20 defects (defect ID 1 to 20) are selected. The following commands are specified in a Tcl file, *test.tcl*:

```
basicselection 0 0 1
basicselection 0 1 1
basicselection 0 2 1
..........................
..........................
rangeselection 7 include 1 1 20
..........................
..........................
selection
saveall
```

To run this file, Calibre DefectReview is executed in a shell window using the following command:

```
NxDAT_cli.exe -c test.tcl -i test1.txt test2.txt test3.txt
```

Related Topics

basicselection

selection

rangeselection

rectselection

deleteunselected

autocluster

Calibre DefectReview Tcl Scripting Commands

Clusters defects of files currently-loaded in Calibre DefectReview.

Note

Clustering is done within each inspection file and not across inspection files.

Usage

autocluster *inspectionId radius minpoints*

Arguments

- ***inspectionId***

  A required argument that identifies an inspection using an ID number.

- ***radius***

  A required argument that specifies the search radius. The units used for radius depend on the units specified in the *dat-ini.xml* file. For more details on unit configuration, refer to "Unit of Measurement Configuration" on page 125.

- ***minpoints***

  A required argument that specifies the minimum number of defects within the search radius needed to open a inspection file.

Examples

In this example, for two opened inspection files (*test1.txt* and *test2.txt*), if there are three or more defects in test1.txt that fall within a search radius of 10 microns, they must be clustered. The following commands are specified in a Tcl file, *test.tcl*.

```
autocluster 1 10 3
saveall
```

To run this file, Calibre DefectReview is executed in a shell window using the following command:

```
NxDAT_cli.exe -c test.tcl -i test1.txt  test2.txt
```

basicselection

Calibre DefectReview Tcl Scripting Commands

Selects defects from the Basic Selection list in the Defect Selection window.

Usage

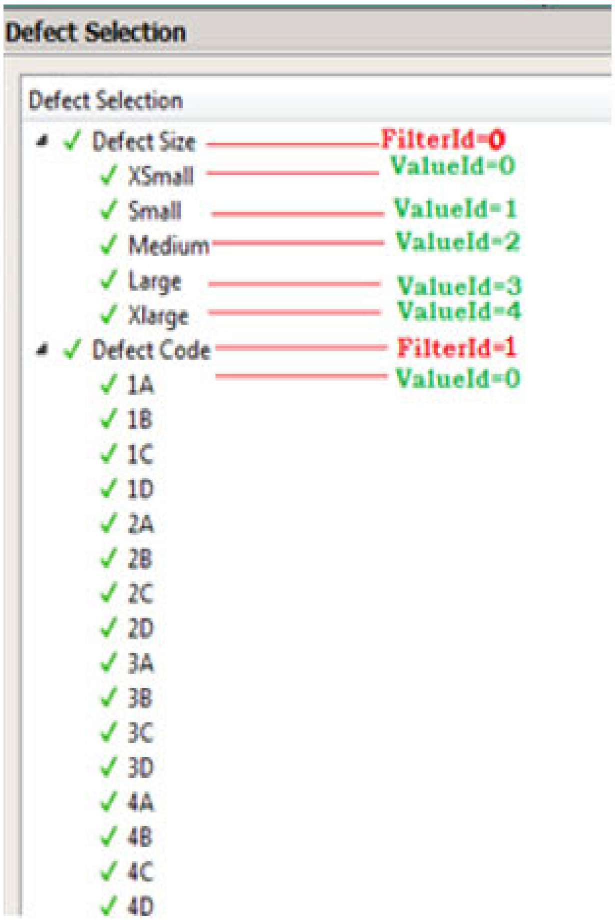
basicselection *filterId ValueId* {**0** | **1**}

Arguments

- ***filterId***

  A required argument that specifies the filter defect selectors. The value of filterId depends upon the order of filters in Calibre DefectReview GUI. For example, if the order of filters is as shown in Figure 17-3, then the filterId of Defect Size is 0, Defect Code is 1, and so on.

Figure 17-3. Order of Filters



Note

To filter out or to select even a single filter, all filters must be specified in the Tcl file. It is recommended that you use the Recording method to generate the Tcl file and then activate or deactivate the particular filter based on your requirements. See "Recording Operations" on page 371 for further information.

- ***valueId***

  A required argument that specifies the value ID of defect selector attributes (the child nodes beneath the defect selectors). For example, in Figure 17-3, the valueId of the XSmall attribute is 0, a Small attribute is 1 and so on. Similarly, the valueId of 1A is 0, 1B is 1 and so on.

- {**0** | **1**}

  A required keyword pair that activates or deactivates the selected defect. If set to 0, the defect is left in the Defect Selection list. If set to 1, the defect is filtered out.

Description

This command is used in conjunction with the selection command to select defects from the Basic Selection list. Refer to "Applying Basic Selection" on page 191 for information on the Basic Selection list.

Examples

In this example, in the open inspection file *test1.txt*, all defects with the defect code 1B must be filtered out and then the defect list must be saved. The following commands are specified in a Tcl file, *test.tcl*:

```
basicselection 0 0 1basicselection 0 1 1
basicselection 0 2 1
basicselection 0 3 1
basicselection 0 4 1
basicselection 1 0 1
basicselection 1 1 0
basicselection 1 2 1
basicselection 1 3 1
basicselection 1 4 1
basicselection 1 5 1
basicselection 1 6 1
basicselection 1 7 1
basicselection 1 8 1
basicselection 1 9 1
basicselection 1 10 1
basicselection 1 11 1
basicselection 1 12 1
basicselection 1 13 1
basicselection 1 14 1
basicselection 1 15 1
basicselection 2 0 1
basicselection 2 1 1
basicselection 2 2 1
basicselection 2 3 1
basicselection 2 4 1
basicselection 2 5 1
basicselection 2 6 1
basicselection 2 7 1
basicselection 2 8 1
basicselection 2 9 1
basicselection 2 10 1
basicselection 2 11 1
basicselection 2 12 1
basicselection 2 13 1
basicselection 2 14 1
basicselection 2 15 1
basicselection 2 16 1
basicselection 3 0 1
basicselection 3 1 1
basicselection 3 2 1
basicselection 3 3 1
basicselection 3 4 1
basicselection 3 5 1
basicselection 3 6 1
basicselection 4 0 1
basicselection 4 1 1
basicselection 4 2 1
basicselection 4 3 1
basicselection 4 4 1
basicselection 4 5 1
basicselection 5 0 1
```

```
basicselection 5 1 1
basicselection 5 2 1
basicselection 5 3 1
basicselection 5 4 1
basicselection 5 5 1
basicselection 5 6 1
basicselection 6 0 1
basicselection 6 1 1
basicselection 6 2 1
basicselection 6 3 1
basicselection 6 4 1
basicselection 6 5 1
advselection 7 0
advselection 8 0
selection
savedefectlist 1
basicselection 3 1 1
basicselection 3 2 1
basicselection 3 3 1
basicselection 3 4 1
basicselection 4 0 1
basicselection 4 1 1
basicselection 4 2 1
advselection 5 0
advselection 6 0
advselection 7 0
advselection 8 0
advselection 9 0
advselection 10 0
basicselection 11 0 1
basicselection 11 1 1
basicselection 11 2 1
basicselection 11 3 1
basicselection 11 4 1
basicselection 11 5 1
basicselection 11 6 1
basicselection 11 7 1
basicselection 11 8 1
basicselection 11 9 1
basicselection 11 10 1
basicselection 11 11 1
basicselection 11 12 1
basicselection 11 13 1
basicselection 11 14 1
basicselection 11 15 1
basicselection 11 16 1
basicselection 11 17 1
basicselection 11 18 1
basicselection 11 19 1
basicselection 11 20 1
basicselection 11 21 1
basicselection 11 22 1
basicselection 11 23 1
basicselection 11 24 1
basicselection 12 0 1
basicselection 12 1 1
selection
savedefectlist 1
```

```
saveall
```

To run this file, Calibre DefectReview is executed in a shell window using the following command:

```
NxDAT_cli.exe -c test.tcl -i test1.txt
```

Related Topics

selection

advselection

rangeselection

rectselection

deleteunselected

classify

Calibre DefectReview Tcl Scripting Commands

Sets a specified defect to a classification type.

Usage

classify *inspectionId defectId classification_type*

Arguments

- ***inspectionId***

  A required argument that identifies an inspection using an ID number.

- ***defectId***

  A required argument that identifies a defect using an ID number.

- ***classification_type***

  A required argument that specifies a defect's classification type.

Examples

In this example, in the open inspection file *test1.txt*, a defect with a defect ID of 3 must be classified as chrome_spot. The following commands are specified in a Tcl file, *test.tcl*:

```
classify 1 3 Pinhole
saveall
```

To run this file, Calibre DefectReview is executed in a shell window using the following command:

```
NxDAT_cli.exe -c test.tcl -i test1.txt
```

copymdppatclass

Calibre DefectReview Tcl Scripting Commands

Copies Auto Defect classifications to manual classifications

Usage

copymdppatclass *inspectionId*

Arguments

- ***inspectionId***

  A required argument that identifies an inspection using an ID number.

Description

This commands allows you to can copy Calibre Auto Defect classification results to manual classification columns in Calibre DefectReview. For details about setting up the mapping of the classifications, refer to "Copy Auto Defect Classifications" on page 380.

Examples

In this example, Calibre Auto Defect classifications are to be copied to manual classifications using mapping information provided in the *dat-ini.xml*.file. The following commands are specified in a Tcl file, *test.tcl*:

```
copymdppatclass 1
```

To run this file, Calibre DefectReview is executed in a shell window using the following command:

```
NxDAT_cli.exe -c test.tcl -i test1.def
```

createmgcdb

Calibre DefectReview Tcl Scripting Commands

Creates a database in the database server.

Usage

createmgcdb {**-d** | **-n** ***db_name*** **-f** ***db_image_folder*** **-s** ***db_server*** **-p** ***db_server_port***}

Arguments

- **-d**

  A required parameter directing Calibre DefectReview to use database settings from DbSettings node of the *dat-ini.xml* file.

- **-n** ***db_name***

  A required parameter that identifies name of the database to be created. If a database of the same name already exists, it is deleted and recreated.

- **-f** ***db_image_folder***

  A required parameter that identifies the database image folder that is to be created. If a folder of the same name already exists, it is deleted and recreated. The contents of the folder are also deleted.

- **-s** ***db_server***

  A required parameter that identifies the database server address and name.

- **-p** ***db_server_port***

  A required parameter that identifies the database server port number. You can use the default port number 3306.

Description

The createmgcdb command allows you to create a database by using parameter settings in the *dat-ini.xml* file or by setting them directly in the command itself. The createmgcb command has prerequisites that are described in "Defect Database" on page 419. The setdbuser command must be called before using the createmgcdb command. This is required because createmgcdb requires database server credentials to create the database.

Examples

In this example, a user named "user1" is already created with the password "welcome" in Calibre DefectReview and in the defect database. The following command is specified in a Tcl file, *test.tcl*.

```
createmgcdb -s mysqlserver.mgc.in -p 3306 -n MgcDB -f /net/db/dbimages/
```

Alternatively, you could use the following:

```
createmgcdb -d
```

To run this file, Calibre DefectReview is executed in a shell window using the following command. In this case, *test1.txt* is an inspection file (a dummy inspection file).

```
NxDAT_cli.exe -c test.tcl -i test1.txt
```

deleteunselected

Calibre DefectReview Tcl Scripting Commands

Deletes all defects which are not selected for analysis.

Usage

deleteunselected

Arguments

None.

Description

This command is used in conjunction with the selection command to select defects from the Advanced Selection list.

Examples

In this example, in the open inspection file *test1.txt*, XSmall defects are filtered out and then the unselected defects are deleted. The following commands are specified in a Tcl file, *test.tcl*.

```
basicselection 0 0 0
...
...
...
basicselection 4 0 1
...
...
selection
deleteunselected
saveall
```

To run this file, Calibre DefectReview is executed in a shell window using the following command:

```
NxDAT_cli.exe -c test.tcl -i test1.txt
```

Related Topics

basicselection

advselection

rangeselection

rectselection

selection

detectgrid

Calibre DefectReview Tcl Scripting Commands

Detects a grid on an inspection in the specified direction.

Usage

detectgrid *inspectionId* [1 | 0]

Arguments

- ***inspectionId***

  A required argument that identifies an inspection using an ID number.

- 1 | 0

  An optional argument that specifies the direction (X or Y) to compute a Repeatability Analysis (RA). Value of direction will be either 0 (X direction) or 1 (Y direction). By default, the grid is generated in Y direction.

Examples

In this example, in the open inspection file *test1.txt*, a grid is generated in the X direction is to be detected to compute a Repeatability Analysis. The following commands are specified in a Tcl file, *test.tcl*.

```
detectgrid 1 0
ra_compute 1  NA NA False:Noise False:Focus
saveall
```

To run this file, Calibre DefectReview is executed in a shell window using the following command:

```
NxDAT_cli.exe -c test.tcl -i test1.txt
```

getdbmaskuid

Calibre DefectReview Tcl Scripting Commands

Retrieves a unique mask ID from the defect database for an inspection file.

Usage

getdbmaskuid ***inspection_file***

Arguments

- ***inspection_file***

  A required argument that identifies an inspection file related to the mask ID.

Description

This command is used to retrieve a mask ID from the Calibre DefectReview defect database. For further information on the defect database, refer to "Defect Database" on page 419.

Examples

In this example, an inspection file name is matched with the corresponding mask (mask unique ID) present in the defect database, and then the mask unique ID is returned.

It is assumed that the defect database contains the mask unique ID and inspection information before running this command. Calibre DefectReview returns an empty string if mask unique ID is not found. The following commands are specified in a Tcl file, *test.tcl*.

```
getdbmaskuid test1.txt
```

To run this file, Calibre DefectReview is executed in a shell window using the following command:

```
NxDAT_cli.exe -c test.tcl -i test1.txt
```

getfilemaskuid

Calibre DefectReview Tcl Scripting Commands

Extracts mask unique ID from an inspection file.

Usage

getfilemaskuid *inspectionId*

Arguments

- ***inspectionId***

  A required argument that identifies an inspection using an ID number.

Description

Given an inspection file, the getfilemaskuid command extracts a mask unique ID from the file. This command can be used to automate a process to load an inspection, perform processing (such as executing Auto Defect Classification in Calibre DefectClassify), and save the inspection to a database such as MySql database. As a mask unique ID is required to store an inspection in a database, use this command to retrieve the mask unique ID from the inspection file. For more information on automating Calibre DefectClassify processes, refer section Saving "Saving Calibre DefectClassify Results Automatically in CLI Mode" on page 480.

Note

For an LRF inspection file, the first name of the MaskNames attribute values is used as the mask unique ID during automation.

Examples

In this example, mask unique ID is extracted from an inspection file (*test1.txt*). The following commands are specified in a Tcl file, *test.tcl*:

```
getfilemaskuid 1
```

To run this file, Calibre DefectReview is executed in a shell window using the following command:

```
NxDAT_cli.exe -c test.tcl -i test1.txt
```

imagetolayout

Calibre DefectReview Tcl Scripting Commands

Performs image to layout alignment.

Usage

imagetolayout *paramfile*

Arguments

- ***paramfile***

  A required argument that specifies an XML file containing the image to layout alignment input parameters. It should be in the same order and format as the corresponding parameters saved from the Calibre DefectReview GUI.

Description

This command aligns a SEM image to a layout based on input from an XML file.

Examples

In this example, the SEM image to layout alignment is run using the *s2l_params.xml* file as input. The following is specified in a Tcl file, *test.tcl*:

```
imagetolayout s2l_params.xml
```

This line should be followed by a save or saveas command to save the aligned parameters.

To run this file, Calibre DefectReview is executed in a shell window using the following command:

```
NxDAT_cli.exe -c test.tcl -i test1.001
```

ra_classify

Calibre DefectReview Tcl Scripting Commands

Classifies all specified defects detected after performing Repeatability Analysis.

Usage

ra_classify *analysisType groupType classificationType*

Arguments

- ***analysisType***

  A required argument that specifies the analysis type order number. This is identical to the same argument in the ra_delete command.

- ***groupType***

  A required argument that specifies the group type order number. The value of groupType is based on the order in which they appear. This is identical to the same argument in the ra_delete command.

- ***classificationType***

  A required argument that specifies the classification type.

Description

This command is a scripting version of similar functionality available in the Calibre DefectReview Repeatability Analysis window. See "The Repeatability Analysis Window" on page 226 for further information.

Note

Before and after performing any operation related to Repeatability Analysis, the analysis must be computed (see "ra_compute" on page 503).

Examples

In this example, for two opened inspection files (*test1.txt* and *test2.txt*), all Shrinking defects are to be classified as chrome_spot. The following commands are specified in a Tcl file, *test.tcl*.

```
ra_compute 1 NA NA False:Noise False:Focus
ra_classify 5 1 Review
ra_compute 1 NA NA False:Noise False:Focus
saveall
```

To run this file, Calibre DefectReview is executed in a shell window using the following command:

```
NxDAT_cli.exe -c test.tcl -i test1.txt test2.txt
```

Related Topics

ra_compute

ra_delete

ra_save

ra_compute

Calibre DefectReview Tcl Scripting Commands

Performs Repeatability Analysis (RA) on the opened inspection files.

Usage

ra_compute ***radius mcdFile direction*** [***falseAlarmCodes***]...

Arguments

- ***radius***

  A required argument that specifies the Repeatability Analysis search radius. The search radius parameter is used for the following analysis types:

  - Capture Rate
  - Defect Trend
  - Adder Analysis
  - Detection Line

  The value is in units configured in the *dat-ini.xml* file. For more details on configuring units, refer to "Unit of Measurement Configuration" on page 125.

- ***mcdFile***

  A required argument that specifies a Must Catch Defects file. Use NA if it does not apply.

- ***direction***

  A required argument that specifies the direction of the detection line in using a Must-Catch file. You can specify one of the following: 0 for x-direction, 1 for y-direction, and NA if it does not apply.

- *falseAlarmCodes*

  An optional parameter that specifies codes used to indicate if an alarm is false (versus real). The False Alarm codes are listed in the False Alarm Codes pane in the Repeatability Analysis window.

Description

This command is a command-line version of similar functionality available in the Calibre DefectReview Repeatability Analysis window. See "Repeatability Analysis Parameters" on page 232 for further information.

Examples

In this example, two opened inspection files (*test1.txt* and *test2.txt*) must have Repeatability Analysis performed on each file. The following commands are specified in a Tcl file, *test.tcl*.

```
ra_compute 1  NA NA False:Noise False:Focus
saveall
```

To run this file, Calibre DefectReview is executed in a shell window using the following command:

```
NxDAT_cli.exe -c test.tcl -i test1.txt test2.txt
```

Related Topics

ra_classify

ra_delete

ra_save

ra_delete

Calibre DefectReview Tcl Scripting Commands

Deletes all specified defects detected after performing Repeatability Analysis (RA).

Usage

ra_delete *AnalysisType groupType*

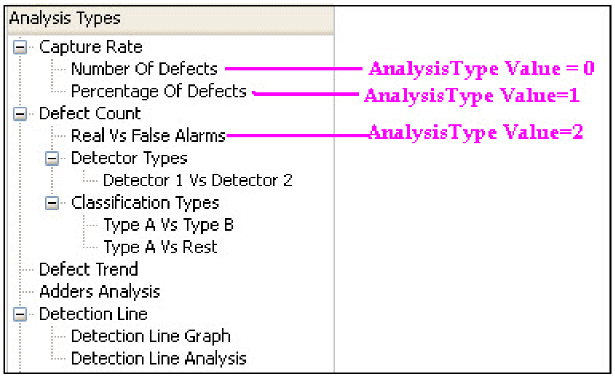
Arguments

- ***AnalysisType***

  A required argument that specifies the analysis type order number. The value of AnalysisType depends upon the order of Analysis Types in Calibre DefectReview GUI.

  For example, if the order of the Analysis Types (see "Repeatability Analysis Types" on page 229 for further information) in the Repeatability Analysis window is as shown in Figure 17-4, then the AnalysisType value of Number Of Defects is 0, Percentage Of Defects is 1 and so on.

  Figure 17-4. Order of Analysis Types

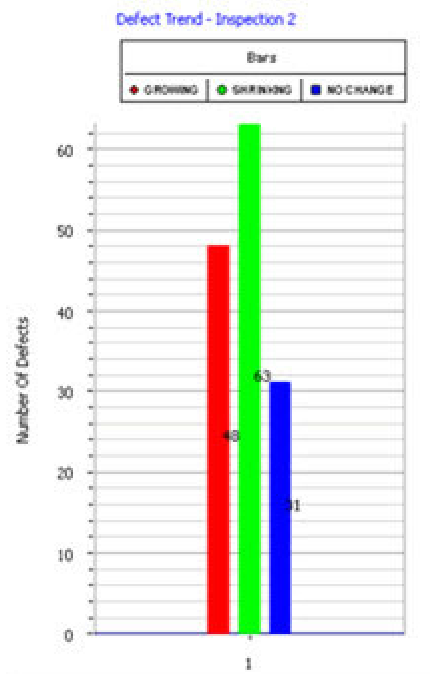
  

- ***groupType***

  A required argument that specifies the group type order number. The value of groupType is based on the order in which they appear.

  For example, if the order of the Detection Line Graph (see "Generating a Detection Line Plot" on page 242 for further information) in the Repeatability Analysis window is as shown in Figure 17-5, the groupType of Growing defects is 0, Shrinking is 1, No Change is 2.

Figure 17-5. Order of groupType



Description

This command is a scripting version of similar functionality available in the Calibre DefectReview Repeatability Analysis window. See "Repeatability Analysis Parameters" on page 232 for further information.

Note

Before and after performing any operation related to Repeatability Analysis, RA has to be computed.

Examples

Example 1

In this example, for two opened inspection files (*test1.txt* and *test2.txt*), all Growing defects are to be deleted. The following commands are specified in a Tcl file, *test.tcl*.

```
ra_compute 1 NA NA False:Noise False:Focus
ra_delete 6 0
ra_compute 1 NA NA False:Noise False:Focus
saveall
```

To run this file, Calibre DefectReview is executed in a shell window using the following command:

```
NxDAT_cli.exe -c test.tcl -i test1.txt  test2.txt
```

Example 2

In this example, three opened inspection files (*test.txt*, *test1.txt*, and *test2.txt*) must have all Adder defects deleted. The following commands are specified in a Tcl file, *test.tcl*.

```
ra_compute 1 NA NA False:Noise False:Focus
ra_delete 7 0
ra_compute 1 NA NA False:Noise False:Focus
saveall
```

To run this file, Calibre DefectReview is executed in a shell window using the following command:

```
NxDAT_cli.exe -c test.tcl -i test1.txt test2.txt test3.txt
```

Related Topics

ra_compute

ra_classify

ra_save

ra_save

Calibre DefectReview Tcl Scripting Commands

Saves the Repeatability Analysis results of a specified inspection and analysis type to a specified format.

Usage

ra_save *mode AnalysisType inspectionId*

Arguments

- ***mode***

  A required argument that specifies the format of the output file (for example, PNG, JPEG)

- ***AnalysisType***

  A required argument that specifies the analysis type order number. This is identical to the same argument in the ra_delete command.

- ***inspectionId***

  A required argument that identifies an inspection using an ID number.

Description

This command is a scripting version of similar functionality available in the Calibre DefectReview Repeatability Analysis window. See "The Repeatability Analysis Window" on page 226 for further information.

Note

Before and after performing any operation related to Repeatability Analysis, the analysis must be computed (see "ra_compute" on page 503).

Examples

In this example, for two opened inspection files (*test1.txt* and *test2.txt*), the results of a Repeatability Analysis must be saved in PNG format. The following commands are specified in a Tcl file, *test.tcl*.

```
ra_compute 1  NA NA False:Noise False:Focus
ra_save PNG 5 1
saveall
```

To run this file, Calibre DefectReview is executed in a shell window using the following command:

```
NxDAT_cli.exe -c test.tcl -i test1.txt test2.txt
```

Related Topics

ra_compute

ra_delete

ra_classify

rangeselection

Calibre DefectReview Tcl Scripting Commands

Enables Advanced Selection defects to be entered in as ranges.

Usage

rangeselection *filterId* {include | exclude] ***rangeCount*** [*ranges*]...

Arguments

- ***filterId***

  A required argument that specifies the filter defect selectors. This is identical to the same argument used by the basicselection command.

- include | exclude

  An optional keyword pair that specifies whether the defects selected are included or excluded from the range specified in the command.

- ***rangeCount***

  A required argument that specifies the total number of separate ranges. For example, to select defects with IDs 20 to 30 and 50 to 60, rangeCount would be 2 (two separate ranges). Assuming, filterId for the defect ID filter is 3, the following is the example of the command to select 2 ranges:

  ```
  rangeselection 3 include 2 20 30 50 60
  ```

- [*ranges*]...

  An optional argument that specifies range of values to use as a filter. For example, for a defect ID filter, range = [20 30] signifies select defects with defect IDs ranging from 20 to 30.

Description

This command is used in conjunction with the selection command to select defects from the Advanced Selection list. Refer to "Applying Advanced Selection" on page 191 for information on the Advanced Selection list.

Examples

In this example, three opened inspection files (*test.txt*, *test1.txt*, and *test2.txt*) must have the first 20 defects selected (defect ID 1 to 20). The following commands are specified in a Tcl file, *test.tcl*.

```
basicselection 0 0 1
basicselection 0 1 1
basicselection 0 2 1
...
...
rangeselection 7 include 1 1 20
...
...
selection
saveall
```

To run this file, Calibre DefectReview is executed in a shell window using the following command:

```
NxDAT_cli.exe -c test.tcl -i test1.txt test2.txt
```

Related Topics

basicselection

advselection

selection

rectselection

deleteunselected

rectselection

Calibre DefectReview Tcl Scripting Commands

Enables Advanced Selection defects to be entered in as rectangles.

Usage

rectselection *filterId* [include | exclude] ***boxCount*** [*boxes*]...

Arguments

- ***filterId***

  A required argument that specifies the filter defect selectors. This is identical to the same argument used by the basicselection command.

- include | exclude

  An optional keyword pair that specifies whether the defects selected are included or excluded from the rectangular region specified in the command.

- ***boxCount***

  A required argument that specifies the number of boxes.

- [*boxes*]...

  An optional argument that specifies the coordinates of the rectangle. Coordinates are specified as X-bl (Bottom left X coordinate), Y-bl (Bottom left Y coordinate), X-tr (Top right X coordinate) and Y-tr (Top right Y coordinate). Additional rectangles can be specified.

Description

This command is used in conjunction with the selection command to select defects from the Advanced Selection list. Refer to "Applying Advanced Selection" on page 191 for information on the Advanced Selection list.

Examples

In this example, two opened inspection files (*test1.txt* and *test2.txt*) must have defects selected located between system X coordinates 50 and 200 and system Y coordinates 20 and 300). The following commands are specified in a Tcl file, *test.tcl*.

```
basicselection 0 0 1
basicselection 0 1 1
basicselection 0 2 1
...
...
rectselection 8 include 1 50 20 200 300
...
...
saveall
```

To run this file, Calibre DefectReview is executed in a shell window using the following command:

```
NxDAT_cli.exe -c test.tcl -i test1.txt test2.txt
```

Related Topics

basicselection

advselection

rangeselection

selection

deleteunselected

save

Calibre DefectReview Tcl Scripting Commands

Saves an inspection file opened in Calibre DefectReview.

Usage

save *inspectionId*

Arguments

- ***inspectionId***

  A required argument that identifies an inspection using an ID number.

Examples

In this example, for two open inspection files (*test1.txt* and *test2.txt*), the first defect of both files are classified, and the files are then saved individually. The following commands are specified in a Tcl file, *test.tcl*.

```
classify 1 1 Pindot
classify 2 1 Pindot
save 1
save 2
```

To run this file, Calibre DefectReview is executed in a shell window using the following command:

```
NxDAT_cli.exe -c test.tcl -i test1.txt test2.txt
```

saveall

Calibre DefectReview Tcl Scripting Commands

Saves all opened inspection files in Calibre DefectReview.

Usage

saveall

Arguments

None.

Examples

In this example, for two opened inspection files (*test1.txt* and *test2.txt*), the first defect of both files are classified, and then the inspection files are saved. The following commands are specified in a Tcl file, *test.tcl*.

```
classify 1 1 Review
classify 2 1 Review
saveall
```

To run this file, Calibre DefectReview is executed in a shell window using the following command:

```
NxDAT_cli.exe -c test.tcl -i test1.txt test2.txt
```

saveas

Calibre DefectReview Tcl Scripting Commands

Saves a inspection file opened in Calibre DefectReview to a new filename.

Usage

saveas *inspection_filename_prefix inspectionId*

Arguments

- ***inspection_filename_prefix***

  A required argument that identifies the prefix to be added to the copied inspection filename.

- ***inspectionId***

  A required argument that identifies an inspection using an ID number.

Examples

In this example, for two open inspection files (*test1.txt* and *test2.txt*), the second inspection file (*test2.txt)* must be saved as *copy_test2.txt*. The following commands are specified in a Tcl file, *test.tcl*.

```
saveas copy 2
```

To run this file, Calibre DefectReview is executed in a shell window using the following command:

```
NxDAT_cli.exe -c test.tcl -i test1.txt test2.txt
```

savedbtofile

Calibre DefectReview Tcl Scripting Commands

Saves an inspection database to a file.

Usage

savedbtofile *inspectionId file_path*

Arguments

- ***inspectionId***

  A required argument that identifies an inspection using an ID number.

- ***file_path***

  A required argument that identifies the file path to save the inspection.

Description

The savedbtofile command has prerequisites that are described in "Defect Database" on page 419. This command is used to save the contents of an inspection to a user-specified file.

Examples

In this example, an inspection file (*demo.txt*), is saved to*/tmp/demo.txt*.The following commands are specified in a Tcl file, *test.tcl*:

```
savedbtofile 1 /tmp/demo.txt
```

To run this file, Calibre DefectReview is executed in a shell window using the following command:

```
NxDAT_cli.exe -c test.tcl -i demo.txt -l
```

savedefectlist

Calibre DefectReview Tcl Scripting Commands

Saves information displayed in the Defect List in CSV format.

Usage

savedefectlist [*inspectionId*]

Arguments

- *inspectionId*

  An optional argument that identifies an inspection using an ID number. The Defect List is saved as *<defect_file_name>.csv* in the directory where the corresponding inspection file is present. For example, if you specify *inspectionId* as 2 and the filename of inspection id 2 is *test2.txt*, located in *C:\abc*, then the Defect List is saved as *c:\abc\test2.csv*.

  If *inspectionId* is not specified, then the All folder's Defect List is saved in the current directory as *defectlist.csv*.

Examples

In this example, a defect test file (*test1.txt*) must have Small defects filtered out and then have all defects exported into CSV format. The following commands are specified in a Tcl file, *test.tcl*.

```
basicselection 0 0 1
basicselection 0 1 0
basicselection 0 2 1
basicselection 0 3 1
basicselection 0 4 1
basicselection 1 0 1
basicselection 1 1 1
basicselection 1 2 1
basicselection 1 3 1
basicselection 1 4 1
basicselection 1 5 1
basicselection 1 6 1
basicselection 1 7 1
basicselection 1 8 1
basicselection 1 9 1
basicselection 1 10 1
basicselection 1 11 1
basicselection 1 12 1
basicselection 1 13 1
basicselection 1 14 1
basicselection 1 15 1
basicselection 2 0 1
basicselection 2 1 1
basicselection 2 2 1
basicselection 2 3 1
basicselection 2 4 1
basicselection 2 5 1
basicselection 2 6 1
basicselection 2 7 1
basicselection 2 8 1
basicselection 2 9 1
basicselection 2 10 1
basicselection 2 11 1
basicselection 2 12 1
basicselection 2 13 1
basicselection 2 14 1
basicselection 2 15 1
basicselection 2 16 1
basicselection 3 0 1
basicselection 3 1 1
basicselection 3 2 1
basicselection 3 3 1
basicselection 3 4 1
basicselection 3 5 1
basicselection 3 6 1
basicselection 4 0 1
basicselection 4 1 1
basicselection 4 2 1
basicselection 4 3 1
basicselection 4 4 1
basicselection 4 5 1
basicselection 5 0 1
basicselection 5 1 1
basicselection 5 2 1
basicselection 5 3 1
basicselection 5 4 1
basicselection 5 5 1
basicselection 5 6 1
```

```
basicselection 6 0 1
basicselection 6 1 1
basicselection 6 2 1
basicselection 6 3 1
basicselection 6 4 1
basicselection 6 5 1
advselection 7 0
advselection 8 0
selection
savedefectlist 1
```

To run this file, Calibre DefectReview is executed in a shell window using the following command:

```
NxDAT_cli.exe -c test.tcl -i test1.txt
```

savetodb

Calibre DefectReview Tcl Scripting Commands

Saves inspection file(s) opened in Calibre DefectReview to the Defect Database.

Usage

savetodb *inspectionId maskuniqueid*

Arguments

- ***inspectionId***

  A required argument that identifies an inspection using an ID number.

- ***maskuniqueid***

  A required argument that represents mask unique ID for an inspection.

Description

The savetodb command has prerequisites that are described in "Defect Database" on page 419.

The savetodb command aligns inspection reports before saving to database. Refer sections Save To DB in "Save an Inspection File" on page 97 and "Automating Inspection Report Alignment" on page 412 for details.

While searching for a reference inspection for alignment, inspections from all related masks from the same physical reticle such as blank and link masks (searched recursively) are considered. The first inserted inspection from all the linked masks available in the database is considered as the reference for auto alignment during a Save To DB operation. Refer to "Reticle Information File (RIF)" on page 79 for details on the blank and link mask unique IDs.

The following illustrates an example: you have a physical reticle with a mask unique ID M1, and that is linked with a blank mask unique ID 2 and a link mask unique ID M3, and that is again linked with mask unique IDs M4 and M5. When storing an inspection with a mask unique ID M1, the first inserted inspection (from M1, M2, M3, M4, and M5) is used as the reference inspection for alignment.

An existing inspection is overwritten if the same inspection is saved to the database again with same mask unique ID. An inspection's unique instance is maintained based on the inspection unique ID. The inspection name is treated as the inspection unique ID while saving to the database.

An error is issued during a Save To DB operation if the inspection already exists in the database with a different mask unique ID. The inspection cannot be part of multiple reticles.

Note

The default user name used to connect to the database is "dbuser".

Examples

In this example, an inspection file (*test1.txt*), and its attributes (including defect list) are saved to a database. The following commands are specified in a Tcl file, *test.tcl*:

```
savetodb 1 mask-1
```

To run this file, Calibre DefectReview is executed in a shell window using the following command:

```
NxDAT_cli.exe -c test.tcl -i test1.txt
```

savereport

Calibre DefectReview Tcl Scripting Commands

Saves selected reports of the specified inspection to a single consolidated HTML report file.

Usage

savereport *inspectionId report_type_ids*

Arguments

- ***inspectionId***

  A required argument that identifies an inspection using an ID number.

- ***report_type_ids***

  A required argument that specifies the order of the report types. The value of report_type_ids depends on the order of the reports in the Calibre DefectReview Reports window.

  For example, the order of the reports in the Reports window is as shown in Figure 17-6. The report_type_ids of Defect List Report is 1, Defect Map Report is 2 and so on.

Figure 17-6. Order of Reports

Examples

In this example, in the open inspection file *test1.txt*, the results of the Defect Report must be saved. The following commands are specified in a Tcl file, *test.tcl*:

```
savereport 1 2
saveall
```

To run this file, Calibre DefectReview is executed in a shell window using the following command:

```
NxDAT_cli.exe -c test.tcl -i test1.txt
```

savereticleinfotodb

Calibre DefectReview Tcl Scripting Commands

Saves the Reticle Information File (RIF) to a defect database.

Usage

savereticleinfotodb ***reticle_info_file***

Arguments

- ***reticle_info_file***

  A required argument that identifies a reticle information file (*.rif*) using the specified file name.

Examples

In this example, the reticle information contained in *test1.rif* about inspection *test1.txt* is saved to a database. The following commands are specified in a Tcl file, *test.tcl*:

```
savereticleinfotodb test1.rif
```

To run this file, Calibre DefectReview is executed in a shell window using the following command:

```
NxDAT_cli.exe -c test.tcl -i test1.txt
```

selection

Calibre DefectReview Tcl Scripting Commands

Select defects to be used for analysis.

Usage

selection

Arguments

None.

Description

This command is used in conjunction with other selection commands to select defects for analysis. These defects are displayed in the Defect Selection window (see "The Defect Selection Window" on page 188 for complete information).

The Defect Selection window contains main selection categories:

- **Basic Selection** — Attributes such as Defect Status that have known or pre-defined values (for example, Unlocated, Located and Confirmed). See "Applying Basic Selection" on page 191 for information.
- **Advanced Selection** — Attributes such as Defect Location and so on, for which values can be entered as a series of ranges or rectangles. See "Applying Advanced Selection" on page 191 for information.

The other selection commands include the following:

- If you are selecting defects from the Basic Selection list, also use basicselection.
- If you are selecting defects from the Advanced Selection list, also use advselection.
    - If the values of Advanced Selection defects are to be entered in ranges, then use rangeselection.
    - If the values of Advanced Selection defects are to be entered in as rectangles, then use rectselection.
- To delete all defects not selected for analysis, use deleteunselected.

Examples

The following is a partial example illustrating where this command is used.

```
basicselection 0 0 1
basicselection 0 1 1
basicselection 0 2 1
...
...
rangeselection 5 include 1 1 2
...
...
selection
saveall
```

Related Topics

basicselection

advselection

rangeselection

rectselection

deleteunselected

setdbuser

Calibre DefectReview Tcl Scripting Commands

Sets a user name and password for running CLI commands related to the defect database.

Usage

setdbuser *user-name password*

Arguments

- ***user-name***

  A required argument that identifies a Calibre DefectReview user by login name.

- ***password***

  A required argument that identifies the user password for Calibre DefectReview.

Description

The user name and the password should already be created in Calibre DefectReview and also in the Calibre DefectReview defect database. For further information on the defect database, refer to "Defect Database" on page 419.

Examples

A user ID called "user1" is created with the password "welcome" in Calibre DefectReview and in the defect database. The following command is specified in a Tcl file, *test.tcl*. In this example, *test1.txt* is an inspection file (any inspection file).

```
setdbuser user1 welcome
```

To run this file, Calibre DefectReview is executed in a shell window using the following command:

```
NxDAT_cli.exe -c test.tcl -i test1.txt
```

translate

Calibre DefectReview Tcl Scripting Commands

Translates the inspection with X and Y coordinates.

Usage

translate *inspectionId x-coord y-coord*

Arguments

- ***inspectionId***

  A required argument that identifies an inspection using an ID number.

- ***x-coord***

  A required argument that identifies the X coordinate of the transformation.

- ***y-coord***

  A required argument that identifies the Y coordinate of the transformation.

Description

This command translates the inspection to specified X and Y coordinates.

Examples

In this example, the first inspection (*test1.txt*) is translated to the lower left (0, 0) location. The following commands are specified in a Tcl file, *test.tcl*.

```
translate 1 0 0
```

To run this file, Calibre DefectReview is executed in a shell window using the following command:

```
NxDAT_cli.exe -c test.tcl -i test1.txt
```

Chapter 18
Using Wi2Mi

Wi2Mi is the Calibre DefectReview Wafer Inspection to Mask Inspection defect analysis tool. It maps wafer defects to the mask field cycle.

Invoking the Wi2Mi GUI

The Wi2Mi tool is a separate program that runs independently of Calibre DefectReview. It can be run interactively in a GUI or from a command line.

Prerequisites

- Calibre DefectReview is installed
- A valid Wi2Mi license is present

Procedure

1. Start Wi2Mi with one of these two methods:

   - On the Windows desktop, double-click the Wi2Mi shortcut icon.

     Figure 18-1. Calibre Wi2Mi Icon

   - On the Windows desktop, select **Start** > **All Programs** > **DefectAnalysisTool** > **Wi2Mi**.

   A window appears with a Login dialog box displayed.

2. Enter your user name and password in the Login dialog box.

   The main window updates the User and Type settings. Type refers to the user permission levels.

3. Load a mask inspection file, a wafer inspection file, or both.

   a. In the Wi2Mi window, select **File > Open Wi2Mi**.

      The Open Mask and Wafer files dialog box appears.

   b. In the dialog box, specify the inspection file(s). Each field accepts only one file. You can

      - type a filename
      - select from a list of recently opened files (black icon)
      - browse for the file (folder icon, then **Open...**)
      - set up an advanced search (folder icon, then Search and Open). The interface is the same as "Inspection File Search" on page 59.

      If the files are not valid for Wi2Mi, the tool returns either a Calibre DefectReview parse error or an invalid file error.

Results

After a valid mask or wafer inspection file is loaded, the main window displays several child windows.

Related Topics

User Permissions Overview

User Permissions in Wi2Mi

As specified for Calibre DefectReview, three user permission levels (Privileged, Normal, and Restricted) are supported for Wi2Mi. The three user permission levels differ in the features available to them. Privileged users have access to all features of Wi2Mi.

There are several restrictions imposed on Normal and Restricted users of the Wi2Mi tool.

Normal Users

The following restrictions are applicable to Normal users:

- You cannot delete the defects from the inspection file.

Restricted Users

In addition to restrictions imposed on Normal users, the following are also applicable to Restricted users:

- You do not have permission to modify the Wi2Mi Layout.
    - You cannot dock, undock, or close dock widgets.
    - You cannot save or load previously-saved dock layouts (the **Dock Layout** option is deactivated).
    - You cannot use the **View** menu.
- You cannot use the **Plugins** menu. The **Read Write Plugins** menu item in the **Utilities** menu is deactivated.
- You cannot classify multiple defects at once. You cannot classify multiple defects via Defect List, Defect Map, Repeatability Analysis. If Restricted users try to classify multiple defects in any of the previously-mentioned modules, a warning message is displayed.

Configuration of Wi2Mi Utilities and Settings Menu

To configure the menu items under the **Utilities** and the **Settings** menu for Normal and Restricted users, the node UserFeatureControl is available under the datInfo node in the *dat-ini.xml* file.

Figure 18-2. Wi2Mi UserFeatureControl Node in dat-ini.xml File

```
<UserFeatureControl>
 <User type="NORMAL" >
  <UtilitiesFeatureList>
   <Feature name="Calibration Parameter Editor" >ENABLED</Feature>
   <Feature name="Read Write Plugins" >ENABLED</Feature>
   <Feature name="Manage users" >ENABLED</Feature>
   .
   .
   .
   <Feature name="Translate" >ENABLED</Feature>
   <Feature name="Alignment Info" >ENABLED</Feature>
   </UtilitiesFeatureList>
  <SettingsFeatureList>
   <Feature name="Set Binary Image Properties" >ENABLED</Feature>
   <Feature name="Set CD Measurement Properties" >ENABLED</Feature>
   <Feature name="Set Contact Measurement Properties" >ENABLED</Feature>
   <Feature name="Set Image Interpolation Properties" >ENABLED</Feature>
   <Feature name="Set Image Window Properties" >ENABLED</Feature>
   <Feature name="Set Image Registration Properties" >ENABLED</Feature>
   <Feature name="Set Reference Point" >ENABLED</Feature>
   <Feature name="Set Record Script" >ENABLED</Feature>
   </SettingsFeatureList>
 </User>
</UserFeatureControl>
```

Only the state of those menu items under the **Utilities and Settings** menu whose states are not defined by the restrictions imposed on Normal and Restricted users, are configurable through the *dat-ini.xml* file. Since the **Read Write Plugins** menu item under the **Utilities** menu is deactivated for Restricted users, the corresponding feature is not listed under the corresponding node for Restricted users

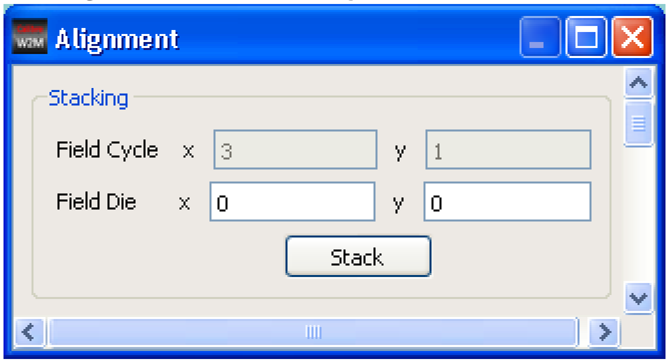
The menu items can be activated or deactivated by setting appropriate value of the state in *dat-ini.xml* file. The value of the state can be either ENABLED or DISABLED. By default, all the menu items are enabled. The menu items which are deactivated for the Normal users are deactivated for the Restricted users as well.

Wafer Stacking

The Wi2Mi tool helps analyze and compare the mask and wafer inspection data. The reticle data is printed on a wafer in a step-and-repeat method. A wafer is placed on a stage and is exposed to the mask data upon each unit displacement. To compare the mask data with the corresponding wafer data, the wafer needs to be folded. In Wi2Mi folding of wafer data such that the folded wafer pattern matches the mask field is known as "stacking."

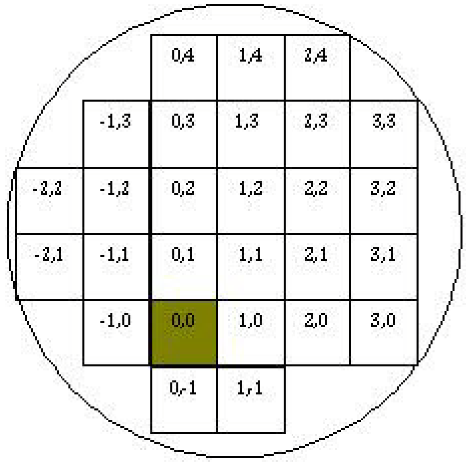
To stack the wafer data, the Wi2Mi tool requires values for Field Cycle and Field Die. (See Figure 18-3.) Field Cycle is read from the mask inspection file. Field Die is set in the Alignment dialog box.

Figure 18-3. Field Cycle and Field Die



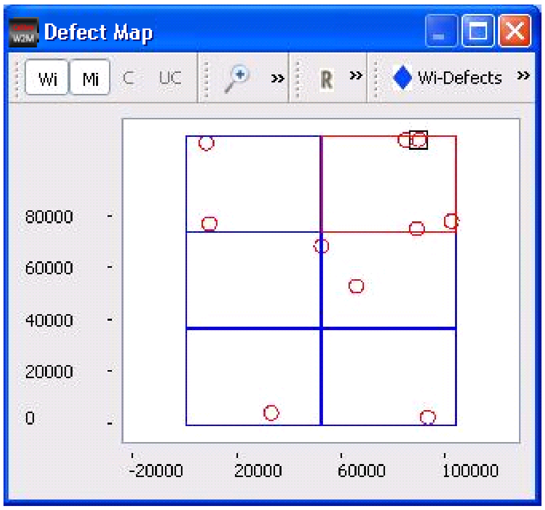
Field Die indicates the wafer die index that is to be used as the reference die for stacking. This value maps to the lower left bottom die of the reticle. The following figure shows wafer die index (0,0) as the field die.

Figure 18-4. Wafer With Field Die Coordinates



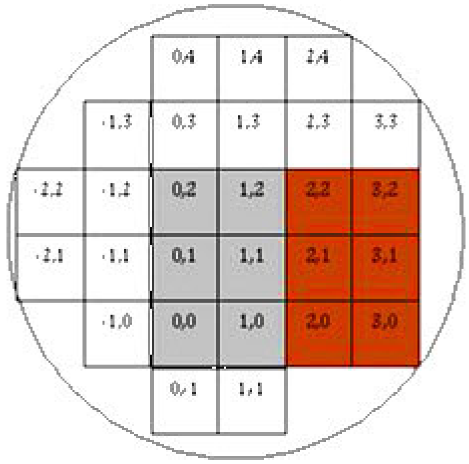
Field Cycle indicates the number of dies in the mask field in the x and y direction, as displayed in the Defect Map window. The following figure shows the reticle with a field cycle of (2, 3); that is, 2 dies along the x-axis and 3 dies along the y-axis.

Figure 18-5. Field Cycle in Defect Map Window



Stacking proceeds across a wafer. For example, for a Field Cycle of (2,3) and Field Die of (0,0), the wafer die (0,0) (as in Figure 18-4) is the field die. It maps to the lower-left corner on the mask field, shown in grey in the following figure. The field cycle value indicates the base die extends 2 dies across and 3 dies high, hence dies (0,0), (1,0), (0,1) (1,1) (0,2) and (1,2) represent a mask field. The first mask field is known also as the base die. The next mask field, shown in red in Figure 18-6, is (2,0), (3,0), (2,1),(3,1), (2,2) and (3,2).

Figure 18-6. Stacked Field Cycles on Wafer



This mask field is stepped across the wafer until all wafer dies are exhausted.

These patterns are mapped on to the base die. This process is “stacking”. At the end of stacking, the stacked wafer data field cycle matches the reticle field cycle. In the Wi2Mi “Stacking and Alignment” window, you can select the Field die and then click the stack button. This stacks the wafer defects and is displayed on the Defect Map.

By default, when you load the mask and wafer inspection files Wi2Mi stacks the wafer data. It uses the default Field Die specified in the *dat-ini.xml* file.You can change the Field Die value in the Alignment dialog box, and restack the wafer data by clicking **Stack**.

Related Topics

Invoking the Wi2Mi GUI

Alignment

Stacked wafer data may not correlate to the mask data. When this occurs, you may need to transform the mask data using operations such as reflection (flipping), rotation, and translation in order to align the mask and wafer data.

Alignment values are specified in the Alignment dialog box and applied when you click the **Align and Correlate** button in the window. The settings can be saved with **Utilities > Alignment Info > Save Current Settings**. For example, if you set Reflection to X and then save it, the reflection nodes change in the *wi2mi-settings.xml* file. Figure 18-7 shows the alignmentInfo node. The value of 1 for xReflection indicates that reflection must be applied. The value of 0 for yReflection indicates no flip.

Figure 18-7. xReflection and yReflection in wi2mi-settings.xml

```
<alignmentInfo>
 <fieldDie x="0" y="0"/>
 <scale>4</scale>
 <xReflection>1</xReflection>
 <yReflection>0</yReflection>
 <rotation>180</rotation>
 <offset x="0" y="0"/>
</alignmentInfo>
```

Scaling

Mask data is printed on the wafer with a step-and-repeat method. That is, the mask contains an image of the pattern that has to be printed multiple times on the wafer. This process makes use of a projection lens which reduces the mask image and transfers it onto the wafer. Hence, in Wi2Mi when the mask and wafer defects have to be compared, the wafer defects are scaled up, typically 4x. This is known as “scaling.”

Wi2Mi automatically calculates the scale factor and displays it in the Scale field in the Alignment dialog box. The scale factor calculation is

$$\text{scale factor} = \frac{\sqrt{(\text{mask} - \text{Xpitch})^2 + (\text{mask} - \text{Ypitch})^2}}{\sqrt{(\text{wafer} - \text{Xpitch})^2 + (\text{wafer} - \text{Ypitch})^2}}$$

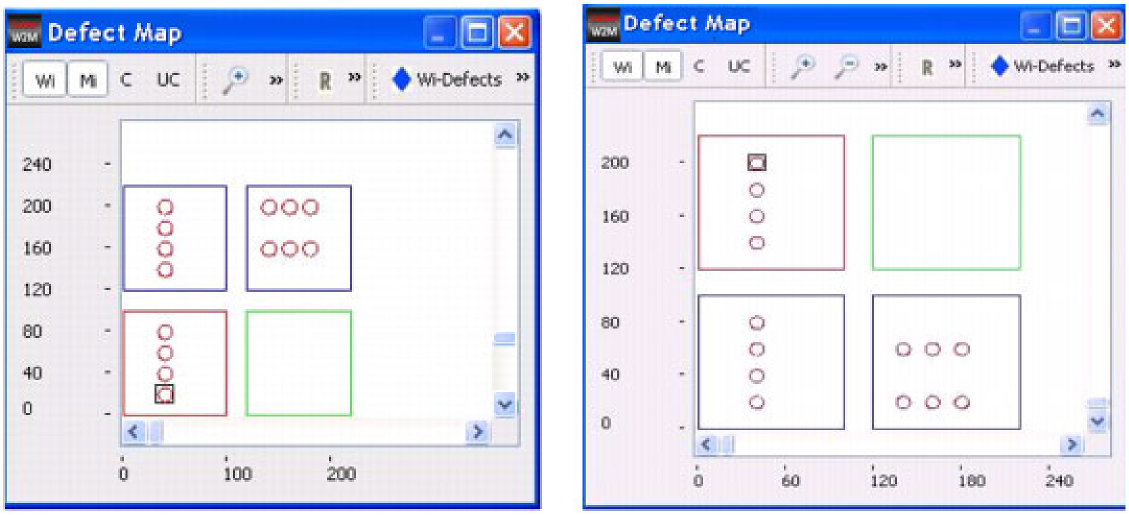
You can change the scale factor using the Scale field. Wafer defects are scaled up by this amount and displayed in the Defect Map window.

Reflection

During photolithography the mask data may be flipped along the x-axis or y-axis before it is printed on the wafer. If you need to compare data from such a process then the mask data has to be flipped before analysis. This is known as “reflection”.

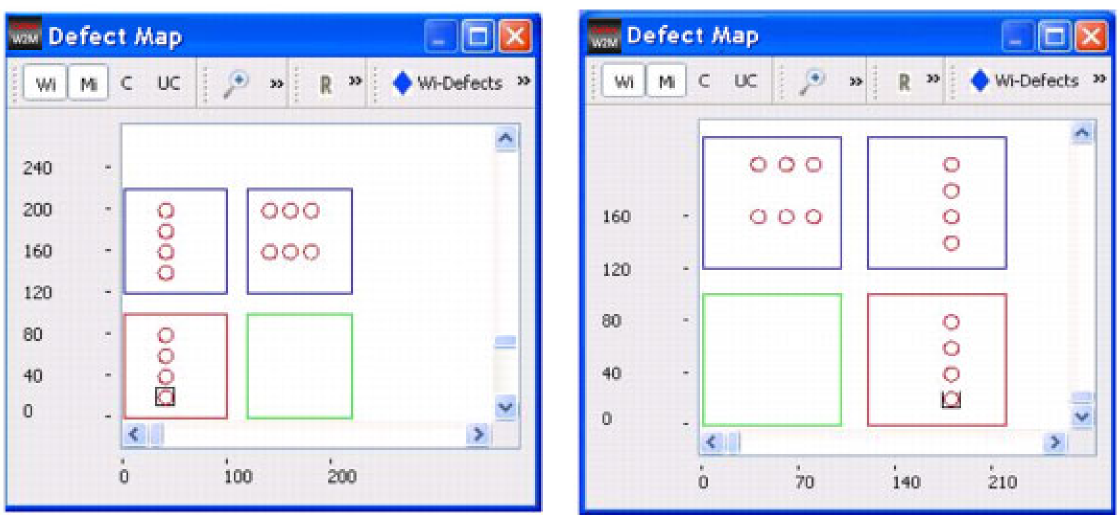
Flipped data is translated so that its bottom lower-left corner coincides with the previous bottom lower-left corner, as shown in Figure 18-8 and Figure 18-9. The data can be flipped along either the x or y axis, but not both at the same time. You specify reflection in the Alignment dialog box.

Figure 18-8. Mask Inspection Data With X-Reflection



Before (no reflection) After x-reflection

Figure 18-9. Mask Inspection Data With Y-Reflection



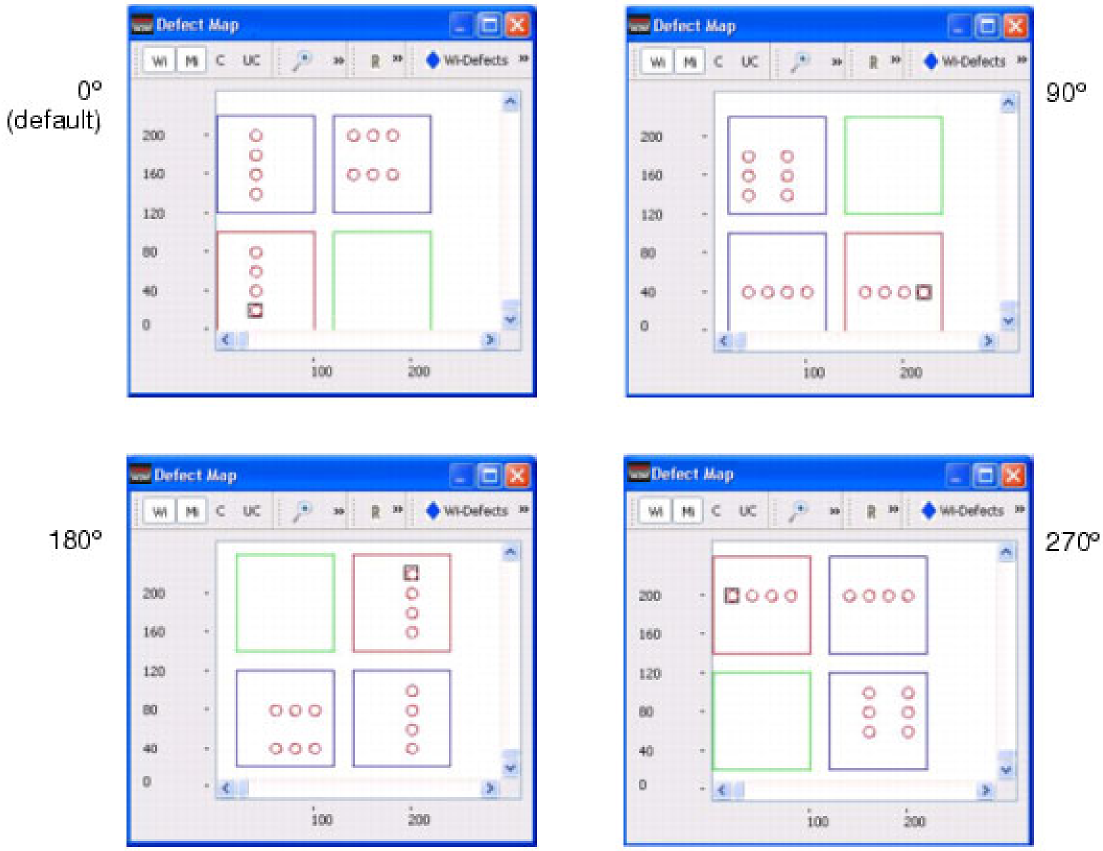
Before (no reflection) After y-reflection

Rotation

The direction of the mask and wafer data that you are inspecting may be different. In order to align the two in the same direction, the mask data may need to be rotated.

You specify the angle of rotation in the Alignment dialog box. Rotations are restricted to 90, 180, and 270 degrees, moving anti-clockwise. Wi2Mi shifts the mask data after rotation so that the lower left coordinates of the field cycle display remain the same.

Figure 18-10. Rotated Mask Data



Translation

In addition to the automatic translation of wafer stacking and aligning after rotation or reflection, you can specify an additional offset. This can be done in the Alignment dialog box by either entering a specific Offset value or selecting a mask defect and wafer defect. When you click **Align** or **Align and Correlate**, the Offset fields update.

Related Topics

Wafer Stacking

Alignment Dialog Box

Wi2Mi Interface Reference

The Wi2Mi defect analysis tool uses some of the same window names as the main Calibre DefectReview interface. However, the functionality is not identical.

Wi2Mi Main Window

To access: see "Invoking the Wi2Mi GUI" on page 529

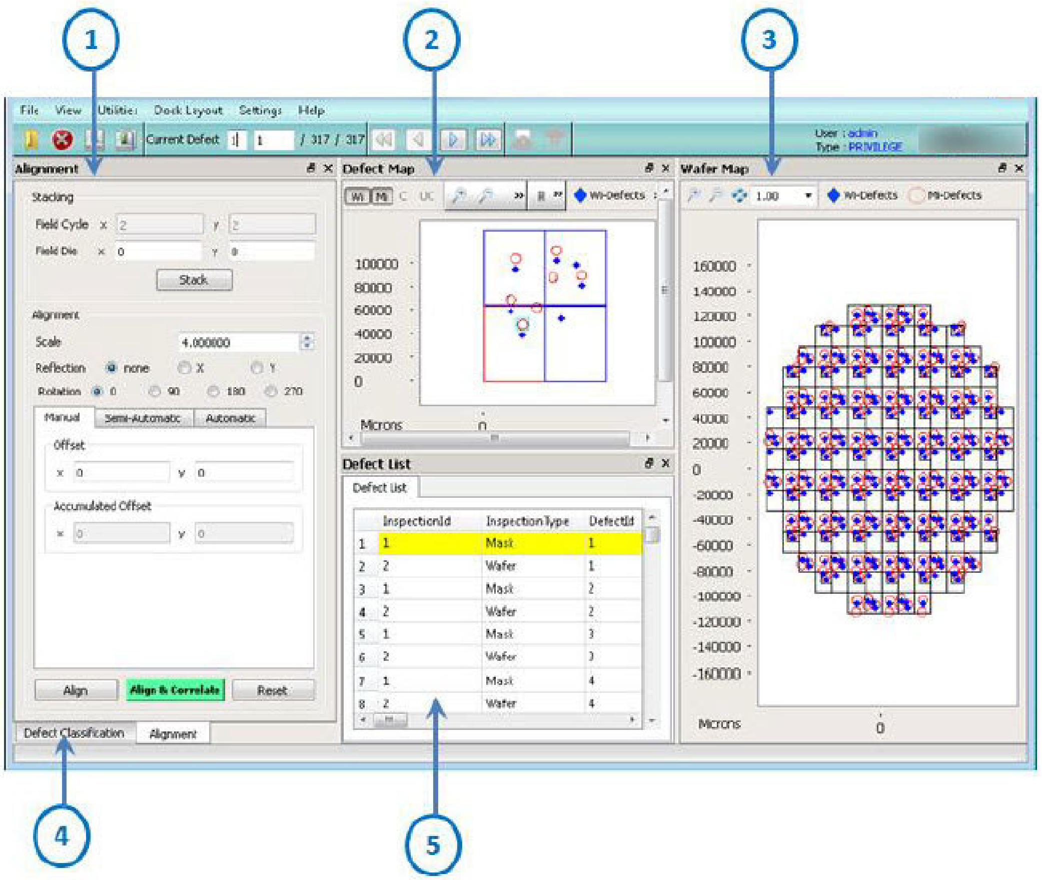
The Wi2Mi interface is organized into several key functional regions. These regions do not appear until after a wafer or mask inspection file has been loaded.

Description

Any windows that have been closed or minimized can be reopened through the **View** menu. Different arrangements can be saved and loaded through the **Dock Layout** menu.

Most windows are identical to those in the Calibre DefectReview main window. The Wi2Mi tool adds the Alignment dialog box. Its controls for scaling, reflection, rotation, and offset allow you to adjust the overlay between mask and wafer inspection data.

Figure 18-11. Initial Wi2Mi Window



Objects

Table 18-1. Wi2Mi Window Contents

Region	Description
Alignment Dialog Box (1)	Controls stacking and alignment. Refer to "Alignment Dialog Box" on page 544for details.
Defect Map (2)	Provides a graphical view of the defects as well as a way to spatially navigate defects. Refer to "Wi2Mi Defect Map Window" on page 546for details.
Wafer Map (3)	Provides a graphical view of all wafer defects, with mask die replicated on the corresponding wafer die. It also provides a convenient spatial way to navigate defects. Refer to "Wi2Mi Wafer Map" on page 556.
Defect Classification (4)	Provides an interface for classifying mask and wafer defects. By default, it is docked with the Alignment dialog box and appears as a tab at the bottom.
Defect List (5)	Provides a table view of the mask and wafer defect properties. The Defect List enables you to navigate defects based upon their sorted properties. Every defect is entered as one row with each attribute in a column. Few attributes are hidden by default. Refer to "Wi2Mi Defect List Window" on page 551.
Repeatability Analysis	Provides analysis results among successive inspection reports, such as information detailing the number of added, common and missing defects between the mask and the wafer inspection. Refer to "Repeatability Analysis in Wi2Mi" on page 558.

As with Calibre DefectReview, all menus, menu items, and access to features can be customized through the UserFeatureControl node in the *dat-ini.xml* file.

Table 18-2. Wi2Mi Menu Bar Options

Menu Item		Description
File		
	Open Wi2Mi	Open mask and wafer inspection files.
	Close All	Closes currently-open files and unloads the files from the current session.
	Save	Saves the current status of the inspection file into the file itself. This overwrites the inspection file.
	Save As	Saves the current status of the inspection file into another file. Clicking **Save As** opens a form that has an option entitled "Exclude filtered defects while saving files". This option enables Wi2Mi to save the file (both mask and wafer) without the filtered defects in them.

Table 18-2. Wi2Mi Menu Bar Options (cont.)

Menu Item		Description
	Exit	Closes the current session.
	Close All	Closes all Calibre DefectReview windows.
View		
	Show Default View	Shows the dock windows of Defect Map, Defect List, Wafer Map and Alignment window tabs over the Defect Classification window in the default layout.
	Defect Selection	Shows or hides the Defect Selection window.
	Defect Map	Shows or hides the Defect Map window.
	Defect List	Shows or hides the Defect List window.
	Image Measurement	Shows or hides the Image Measurement window.
	Defect Classification	Shows or hides the Defect Classification window.
	Repeatability Analysis	Shows or hides the Repeatability Analysis window.
	Wafer Map	Shows or hides the Wafer Map window.
Utilities		
	Translate	Saves one inspection as another inspection.
	UnFilter All Filtered	Displays all the defects which are filtered out from the Defect List, Defect Map, and wafer map. The **Align & Correlate** button in the Alignment window is highlighted in green , indicating Repeatability Analysis must be recomputed. See "Unfiltering All Filtered Defects" on page 379 for details.
	Calibration Parameter Editor	Provides an interface to edit the default values for parameters used by Calibre DefectReview and allows you to save inspection files in multiple locations. Refer to "Calibration Parameter Modification" on page 367 for details.
	Read Write Plugins	Specifies the external reader or writer plug-ins to read or write inspection files in different formats. Refer to "Configuring Read Write Plugins" on page 369 for details.
	Manage Users	Adds or deletes users. Refer to "User Management" on page 50 for details.
	Save Defect List	Saves the contents of the Defect List into CSV format. Refer to "Saving a Defect List" on page 375 for details.

Table 18-2. Wi2Mi Menu Bar Options (cont.)

Menu Item		Description
	Delete Unselected	Deletes all the unselected defects. Refer to "Deleting Unselected Defects" on page 379 for details.
	Alignment Info	Provides functionality for saving or loading of alignment information. Two operations are supported: • **Save Current Settings** — Saves the current alignment information settings in the *dat-ini.xml* file. • **Load Previous Settings** — Loads previously saved alignment information settings from the Load Previous Settings option of Alignment Info can be used to load the previously saved alignment information settings from the *dat-ini.xml* file.
Dock Layout		
	Save	Saves the layout configuration of Wi2Mi. Refer to "Saving and Loading a Dock Layout" on page 385 for details.
	Load	Loads the previously saved layout configuration into Wi2Mi. "Saving and Loading a Dock Layout" on page 385 for details.
Settings		
	Set Binary Image Properties	Sets the gray level threshold for conversion of images to the binary format. Refer to "Setting Binary Image Properties" on page 348 for details.
	Set CD Measurement Properties	Sets the target CD value or the threshold GL value for CD measurement. Refer to section "Setting CD Measurement Properties" on page 348 for details.
	Set Contact Measurement Properties	Sets the gray level value or X and Y diameter of the contact or area of the contact for contact measurement. Refer to "Setting Contact Measurement Properties" on page 349 for details.
	Set Image Interpolation Properties	Sets the image interpolation ratio to be used when displaying interpolated images in Image Measurement. Refer to "Setting Image Interpolation Properties" on page 351 for details.
	Set Image Window Properties	Sets the window size when displaying interpolated images in Image Measurement. Refer to "Setting Image Window Properties" on page 351 for details.
	Set Reference Point	Sets the alignment and reference points to be used for translating defect inspection data in X and Y direction. Refer to "Translate" on page 410 for details.

Table 18-2. Wi2Mi Menu Bar Options (cont.)

Menu Item		**Description**
	Set Color Scheme	Sets the selected color scheme for displaying the colored images. For more details, refer to "Color Scheme for Images" on page 352.
	Set Record Script	Specifies a TCL script for storing the commands to be recorded. Refer to "Recording Operations" on page 371 for details.
Help		
	Calibre DefectReview — Wi2Mi	Launches a documentation viewer for Calibre DefectReview. This feature requires Acrobat Reader (version 9.0 or higher) to be installed.
	About Calibre DefectReview — Wi2Mi	Displays the version number, target installer and build date of the tool.

Usage Notes

The following are errors related to inspection file opening:

- If the TEXT file does not contain the Defect List, the error is displayed for both mask and wafer files:

```
DefectList info not present in <pathname>
```

- If the wafer file is not a wafer inspection file the error:

```
<pathname>/<wafertextfile>.txt is not in Wafer TEXT format
```

- If the input mask inspection file's inspection type is not mask:

```
<pathname>/<wafertextfile>.txt is not in Mask TEXT format
```

Once you click the **OK** or **Abort** button in the dialog box where these messages appear, the Calibre DefectReview main window is displayed. To open a Wi2Mi session, you must select **File** > **Open Wi2Mi**

Related Topics

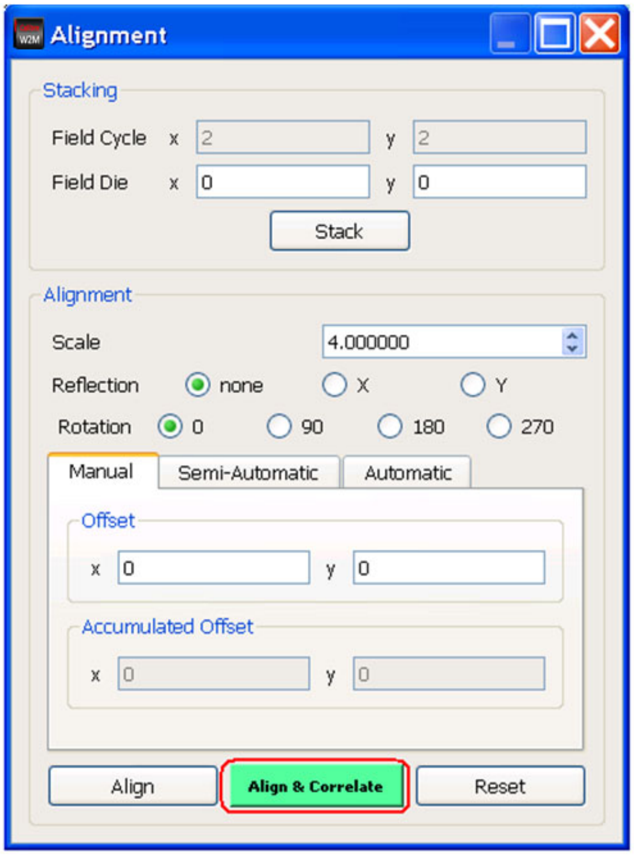
Configuration of Utilities and Settings Menus

Alignment Dialog Box

To access: **View** > **Alignment**

The Wi2Mi Alignment dialog box allows you to adjust the overlay between mask and wafer inspection data.

Figure 18-12. Alignment Dialog Box With Automatic Tab



Objects

Table 18-3. Alignment Dialog Box Contents

Field	Description
Stacking Fields	Specifies how many dies in a field cycle and which die in the wafer data is the base die. See "Wafer Stacking" on page 532.
Alignment	
Scale Reflection Rotation	As described in "Alignment" on page 534.
Manual Tab	Contains fields for specifying an x offset and a y offset. The units are as specified in the UnitOfMeasure node in the *dat-ini.xml* file.

Table 18-3. Alignment Dialog Box Contents (cont.)

Field	Description
Semi-Automatic Tab	Specifies the coordinates of a mask defect and a wafer defect, and automatically calculates offset. You can either enter the coordinates in the x and y fields of the MI defect and WI defect fields, or click **Select Mi and Wi Defects** and then click in the Defect Map window.
Automatic Tab	Specifies the coordinates of a mask defect and a wafer defect, and automatically calculates offset. You can either enter the coordinates in the x and y fields of the MI defect and WI defect fields, or click **Select Mi and Wi Defects** and then click in the Defect Map window.
Buttons	**Align —** Aligns mask and wafer data using the values in the rest of the dialog. Does not perform any analysis. **Align and Correlate —** Aligns mask and wafer data, and identifies common defects in the Repeatability Analysis display. **Reset —** Sets the fields in the Alignment dialog box to the default values. Text on page 583 says "that is the value which was displayed before any modification." These are set in the *wi2mi-settings.xml* file.

Usage Notes

Until data is correlated with the current settings, the **Align and Correlate** button is green. After you correlate data, the button returns to grey.

Once the mask and wafer data have been aligned, the offset fields reset to 0.

Related Topics

Repeatability Analysis

Wi2Mi Defect Map Window

To access: in the Wi2Mi main window, **View** > **Defect Map**

The Wi2Mi Defect Map provides a graphical view of both the mask and wafer defects. It also lets you navigate and edit defects.

Description

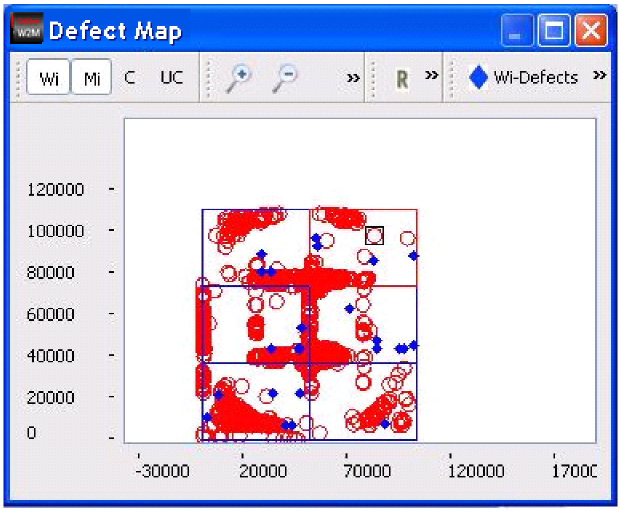
The Defect Map window provides a graphical view of all the defects of an inspection. Both the mask and the wafer defects are displayed in the Defect Map as shown in Figure 18-13.

The main differences from the Calibre DefectReview Defect Map are as follows:

- The icon bar's Defect Display Mode buttons switch between mask and wafer defects. There is no way to view isolated or clustered defects.
- Mask inspection defects are only shown as red empty circles.
- The display also includes filled blue diamonds, which represent wafer defects.
- You can right-click on the Defect Map and select the Filter option. This allows you to filter out the selected defects from the Defect Map this operation can be used. When the user filters the defects from the Defect Map the defects in the Defect List and wafer map gets updated accordingly. Once you filter out the selected defects, the **Align & Correlate** button in the Alignment window gets highlighted which indicates that repeatability analysis must be re-run.

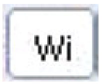
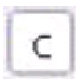
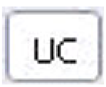
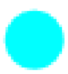
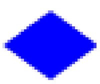
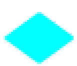
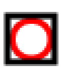
You can modify the dimension of the circle or diamond depicting the defects by changing it through calibration parameter editor. Highlighted defects are still shown in cyan and the currently selected defect has a red box, as with the main Defect Map.

Figure 18-13. Wi2Mi Defect Map Window



Objects

Table 18-4. Wi2Mi Defect Map Window Contents

Control	Description
Defect Display Modes	
	Shows or hides wafer defects.
	Shows or hides mask defects.
	Shows common defects. Common defects are the defects that occur in the same location on both the mask and wafer.
	Shows non-replicated (uncommon) defects. Uncommon defects are defects which are on the mask or wafer but not both.
Defect Codes	
	Mask defects are shown as a hollow red circle.
	Highlighted mask defects are shown as a filled cyan circle.
	Wafer defects are shown as a filled blue diamond.
	Highlighted wafer defects are shown as a filled cyan diamond.
	The current defect is shown by a black box.

Usage Notes

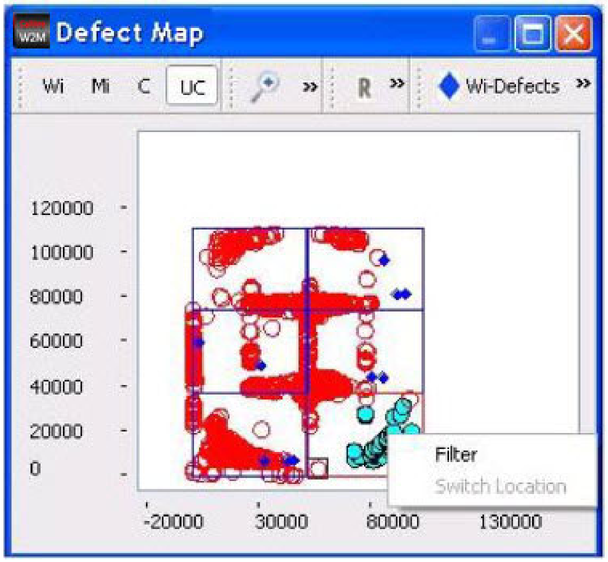
Understanding Scale

The Defect Map shows the X and Y scale. The scale is updated with zoom, resize and scroll of the Defect Map. The defects on the Defect Map are in mask coordinate system. The unit of the scale displayed is in the units specified in the *dat-in.xml* file. For more details on unit configuration, refer to "Unit of Measurement Configuration" on page 125.

Operations on a Defect

To select the defects on the Defect Map, refer to "Rubber Band Selection Mode" on page 128. You can perform different operations on the defects. The operations are shown on a menu, when you right click on a specific defect or a set of selected defect.

Figure 18-14. Operations on the Wi2Mi Defect Map



The general operations that the user can perform on the defects from the Defect Map are:

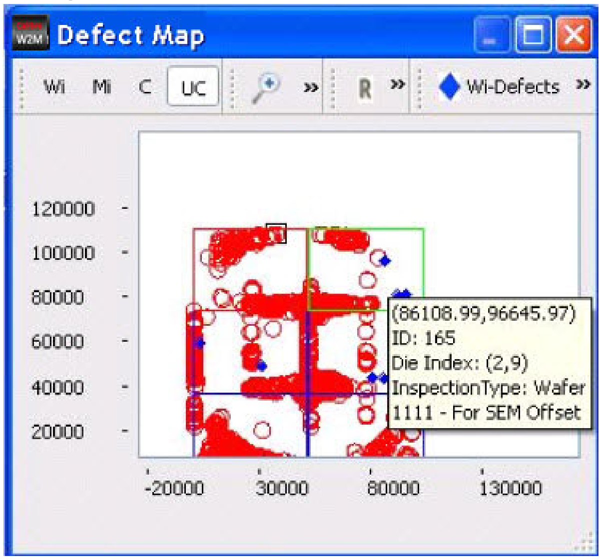
- **Filter** — To filter out the selected defects from the Defect Map this operation can be used. When you filter defects from the Defect Map, the defects in the Defect List and Wafer Map are updated accordingly. Once you filter out the selected defects, the **Align & Correlate** button in the Stacking and Alignment window is highlighted, indicating that the repeatability analysis must be updated.
- **Switch Location** — To switch the location of a defect between the defect die and the reference die, select the **Switch Location** option. This option is deactivated in TEXT inspection files (both mask and wafer) and is enabled only in XML mask inspection files.

Viewing Information

The wafer map shows tool tip with information about a defect. You can view the tool tip on any defect by placing the mouse on that defect. An arrow is shown with the tool tip initially. The following are examples of tool tips on a defect:

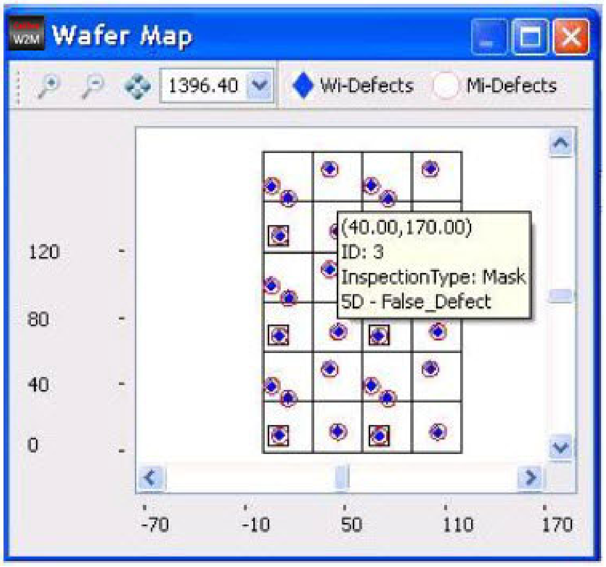
- **Wafer Defect** — The tool tip on the wafer defect has the information about the defect coordinates (with regards to wafer sample coordinates) of the defect in the units configured by the user in the units specified in the *dat-in.xml* file (refer to "Unit of Measurement Configuration" on page 125), the defect number (ID), die index (Die Index), the inspection type (Inspection Type), and the classification type (as shown in the following figure).

Figure 18-15. Wafer Defect Tool Tip



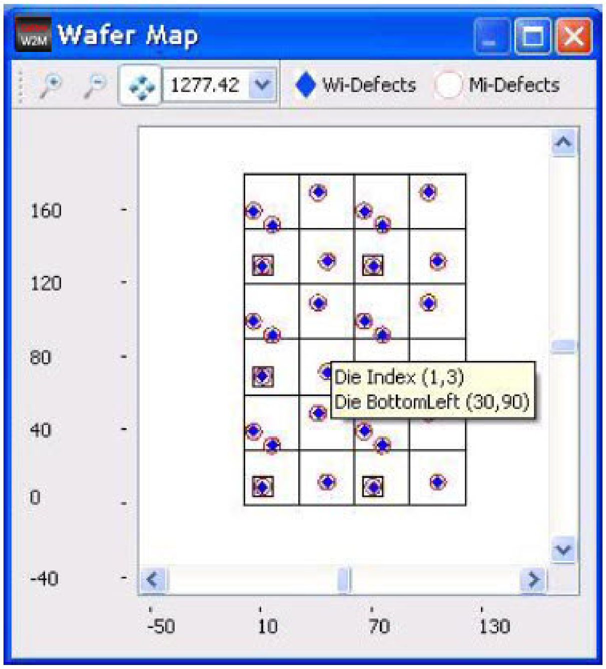
- **Mask Defect** — The tool tip on the mask defect has the information about the defect coordinates (with regards to wafer sample co-ordinates) of the defect in the units configured by the user in the *dat-in.xml* file, the defect number (ID), the inspection type (Inspection Type), and the classification type (as shown in the following figure).

Figure 18-16. Tool Tip on Mask Defect



- **Tool Tip on Wafer Map** — If you move the mouse cursor on an area in the wafer map where there are neither mask defects nor wafer defects, then the tool tip shows the die index of the current die and the current die bottom left coordinates (as shown in the following figure).

Figure 18-17. Tool Tip on Wafer Map



Wi2Mi Defect List Window

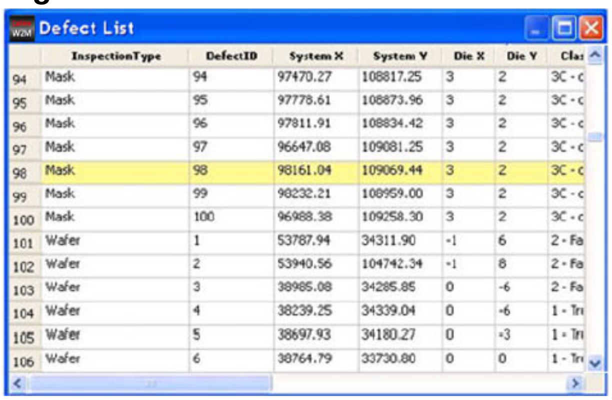
To access: in the Wi2Mi main window, **View** > **Defect List**

The Defect List provides a table view of all the defects. The Defect List table has both mask and wafer defects listed.

Description

The Defect List provides the user the option to navigate over the defects as well as edit defects of an inspection as provided in Calibre DefectReview. Every defect is entered as one row with each attribute in a column. Few attributes are hidden by default. The current defect is highlighted in Defect List in yellow color as shown in the following figure.

Figure 18-18. Wi2Mi Defect List Window



	InspectionType	DefectID	System X	System Y	Die X	Die Y	Cla:
94	Mask	94	97470.27	108817.25	3	2	3C - c
95	Mask	95	97778.61	108873.96	3	2	3C - c
96	Mask	96	97811.91	108834.42	3	2	3C - c
97	Mask	97	96647.08	109081.25	3	2	3C - c
98	Mask	98	98161.04	109069.44	3	2	3C - c
99	Mask	99	98232.21	108959.00	3	2	3C - c
100	Mask	100	96988.38	109258.30	3	2	3C - c
101	Wafer	1	53787.94	34311.90	-1	6	2 - Fa
102	Wafer	2	53940.56	104742.34	-1	8	2 - Fa
103	Wafer	3	38985.08	34285.85	0	-6	2 - Fa
104	Wafer	4	38239.25	34339.04	0	-6	1 - Tr
105	Wafer	5	38697.93	34180.27	0	-3	1 - Tr
106	Wafer	6	38764.79	33730.80	0	0	1 - Tr

Objects

- InspectionId

  Specifies the number ID for the inspection. This attribute is hidden by default. The inspection ID 1 represents Mask defect and inspection ID 2 represents Wafer defect.

- InspectionType

  Specifies whether a defect is a Mask defect or a Wafer defect

- DefectId

  Specifies an integer ID for a defect assigned by Wi2Mi. It is unique within an inspection.

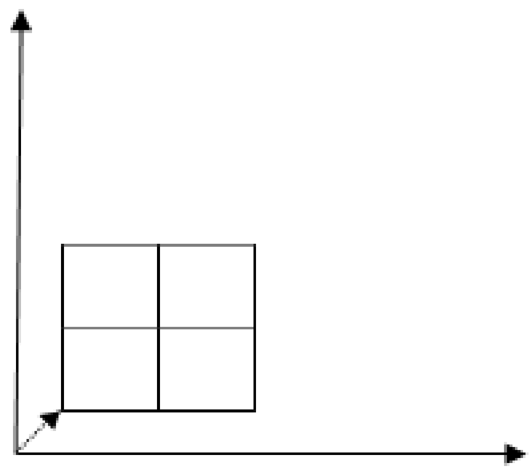
- MachineDefectId

  Specifies the unique ID reported by Inspection System.

- System coordinates (X, Y)

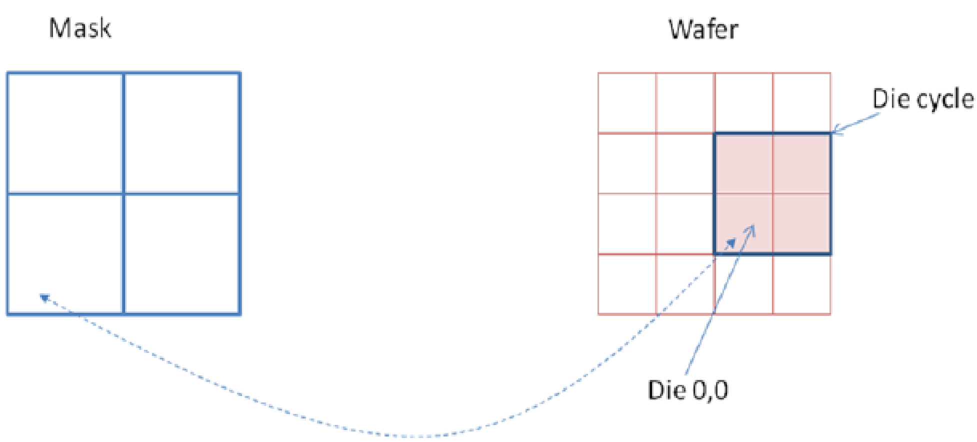
  The mask defect system coordinates specify the defect location in the Defect Map in the mask coordinate system. The wafer defect system coordinates specify the defect location in the Defect Map after the wafer defects are stacked, aligned, and translated to the mask coordinate system. The System X and System Y values are displayed in separate columns. The units of system coordinates are in the units configured in the *dat-ini.xml* file. For more details on the configuration of units, refer to "Unit of Measurement Configuration" on page 125.

In Wi2Mi, the SystemX and SystemY coordinates are modified differently in the cases of Mask and Wafer defects. For Mask defects, all coordinates are translated with respect to the bottom left die, bottom left corner (0,0) as shown in the following figure.



In case of Wafer defects, all the coordinates are stacked and scaled up when they are displayed in the Defect Map. The scaling factor is as defined in the *dat-ini.xml* file .

The die (0, 0) in the Wafer Map corresponds to the bottom left die of the reticle die cycle as shown in the following figure.



- Reticle coordinates (X, Y)

  Specifies the coordinates that exist in the inspection file for each defect. The ReticleX and ReticleY coordinates are displayed in separate columns in the same unit as the system coordinates. This attribute is hidden by default

- DieX

  Specifies the X index of the die to which the defect belongs.

- DieY

  Specifies the Y index of the die to which the defect belongs.
- ClassificationType

  Specifies the classification type of the defect. It is shown as <Defect Code –Defect Type>.
- PrimaryClassificationComments

  Displays any user-created comment related to Primary classification of the defect.
- Adders

  The attribute columns can be re-arranged by dragging and dropping them in the Defect List.

Note

The attribute columns can be re-arranged by dragging and dropping them in the Defect List.

Usage Notes

Operations on Defects

From this window, you can perform different operations on the defects. The operations are displayed on a menu when you right click on any row header. The operations include:

- **Filter** — Filters out the selected defects from the Defect List. When the user filters the defects from the Defect List the defects in the Defect Map and wafer map gets updated accordingly. Once the user filters out the selected defects the Align & correlate button in the Stacking and Alignment window gets highlighted which indicates that repeatability has to be updated.

Operations on Attributes

Various operations can be performed on attributes in the Defect List. These operations include:

- **Sorting Based on Attributes** — You can sort the Defect List based on any of the listed attributes. To do so, left click on the column header for the attribute. An arrow symbol is shown on the right corner of the column header cell when sorting is applied. Once the Defect List is sorted, navigation between the defects (to the next or previous defects) is done in the sorted order of Defect List.
- You can perform the following operations (identical to operations in the main Defect List window) from a right-click menu on any defect attribute:
  - Hide
  - Show
  - Show All
  - Resize All to Contents
  - Manage

Wi2Mi Defect Classification Window

To access: in the Wi2Mi main window, **View** > **Defect Classification**

The WiMi Defect Classification window provides an interface for classifying mask and wafer defects.

Description

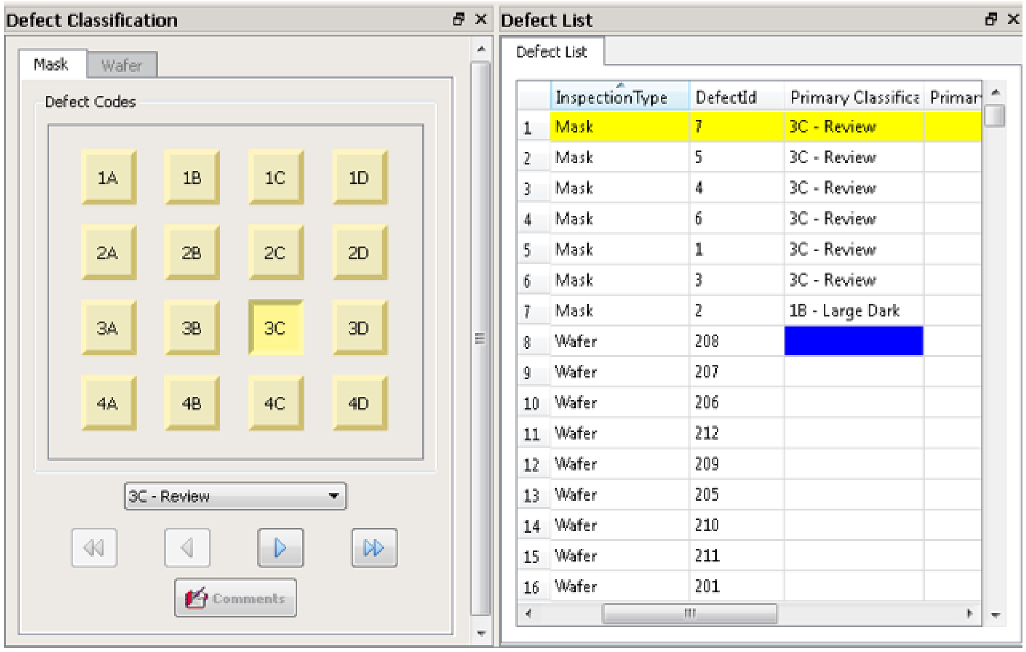
In Wi2Mi the Defect Classification window has two tabs. The first tab always displays mask inspection defect codes and the second tab always displays wafer inspection defect codes. The Defect Classification codes are read from the respective inspection files. The tab order of the two inspections is fixed.

Figure 18-19. Wi2Mi Defect Classification Window

When you navigates through the defects either in the Defect List or Defect Map, the defect code of the current defect is highlighted. The classification tab of the current defect is also enabled and highlighted while the other tab is deactivated.

Consider the example shown in Figure 18-20. The defect selected on the Defect List is a mask defect with an ID 2. The classification type of the defect is 2B. The defect code is shown as pressed in the Defect Classification window. In the Defect Classification window the mask tab is enabled and wafer tab is deactivated.

Figure 18-20. Wi2Mi Defect Classification Example



The tabs in the Wi2Mi Defect Classification Window contain controls similar to the Calibre DefectReview version. See "Defect Classification" on page 207 for further information.

Objects

Table 18-5. Wi2Mi Defect Classification Window Objects

Object	Description
Mask tab	Displays codes for mask defects.
Wafer tab	Displays codes for wafer defects.
Navigation buttons	Navigates to the first, previous, next, or last defect in the inspection. 
Comments button	Enables you to add comments to individual defects.

Wi2Mi Wafer Map

To access: in the Wi2Mi main window, **View** > **Wafer Map**

The Wi2Mi wafer map provides another graphical view of all the wafer defects and mask defects.

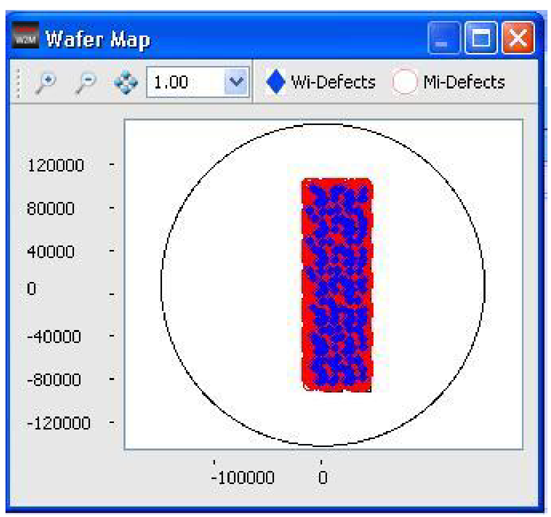
Description

Wafer defects are mapped on the Wafer Map window with the actual coordinates present in the inspection file. The complete wafer data is presented as an unfolded wafer (unlike the Defect Map where the wafer defects are stacked over the base die). The complete reticle data is replicated on the wafer map. Each wafer die index corresponding mask die is identified by using the stacking parameters (that is, the Field die and Field cycle). All the defects in the mask die are scaled up and dumped on the corresponding wafer die index on the wafer map. The mask defects in the wafer map are in the wafer sample coordinate system.

You can navigate over the defects in the wafer map. Unlike the Defect Map, no operations are supported on the Wafer Map except for navigation. The Wafer Map helps you get a complete view of the wafer with mask defects mapped on to it.

When the two inspection files are loaded the initial Wafer Map window appears, as shown in the following figure.

Figure 18-21. Wi2Mi Wafer Map



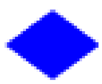
You can navigate by left-clicking any defect on the map. The current defect is updated and all information about the current defect is also updated in other Wi2Mi windows such as Defect Classification, Defect List and Defect Map.

Scale in the Wafer Map

The scale of Wafer Map is that of the sample coordinate system in the wafer inspection file. The mask and wafer defects are displayed with respect to this coordinate system. The unit of the scale displayed is in the units configured in the *dat-ini.xml* file. For more details on the configuration of units, refer to “Unit of Measurement Configuration” on page 125.

Objects

Table 18-6. Wi2Mi Wafer Map Window Contents

Control	Description
	Mask defects are shown as a hollow red circle. Tool tips on a wafer defect contain the coordinates (with regards to wafer sample coordinates) of the defect in the units configured in the *dat-ini.xml* file, the defect number (ID), die index (Die Index), the inspection type (Inspection Type), and the classification type.
	Wafer defects are shown as a filled blue diamond. Tool tips on a mask defect contains the coordinates (with regards to wafer sample coordinates) of the defect in the units configured in the *dat-ini.xml* file, the defect number (ID), the inspection type (Inspection Type), and the classification type.
	Shows common defects. Common defects are the defects that occur in the same location on both the mask and wafer.
Zoom Controls	View any desired section or part of the Defect Map using the zoom controls. See “Additional Zoom Controls” on page 120 for information on additional zoom controls that are not on the tool bar.
	Zoom in.
	Zoom out.
	Fit to window. The default zoom factor is 1.00.
	Set zoom factor. The current zoom factor is always displayed. You enter an exact value in this field or select from existing zoom factors in the dropdown list. The minimum zoom value that can be entered is 1.00.

Repeatability Analysis in Wi2Mi

Repeatability Analysis in Wi2Mi provides analysis results among successive inspection reports, such as information detailing the number of added, common and missing defects between the mask and the wafer inspection.

Performing Repeatability Analysis in Wi2Mi

Repeatability Analysis is performed across mask and wafer inspection data. The reference inspection in Wi2Mi is always the mask inspection file.

The "added" defects are defects present exclusively on mask and not on the wafer. A mask defect that corresponds to a defect on the wafer within a given search radius is called as a common defect. The missing defects are defects that are present exclusively on the wafer and not on the mask.

Procedure

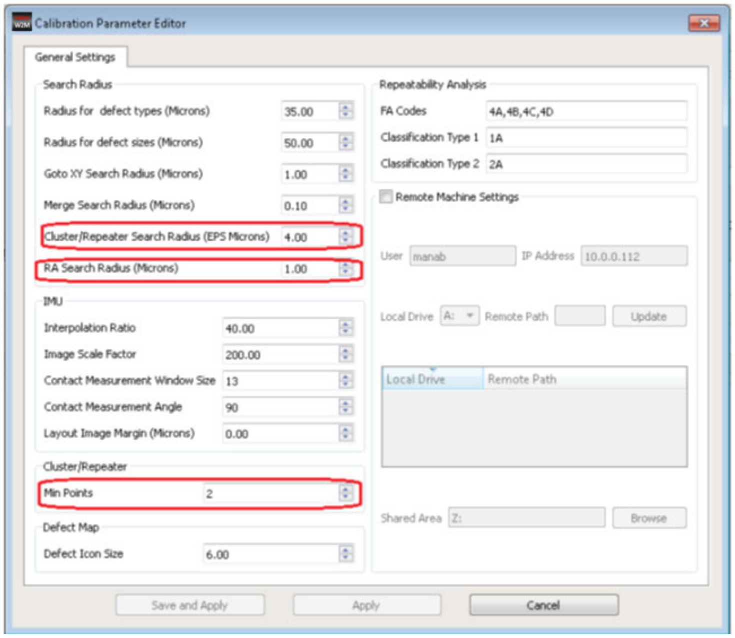
1. Load two valid inspection files. Note that even after the two valid inspection files are loaded, the Repeatability Analysis window is initially empty and hidden.

   Correlation of mask and wafer data means identifying the mask defects that are common to wafer defects. When the reticle field is replicated on the wafer, defects on the reticle are repeated on the wafer. To identify such mask and wafer defects (common defects), the Wi2Mi tool considers the common search radius which gives the tolerance of the mask and wafer defect location

2. Set the Common Search Radius.

   This can either be one by editing the Common Search Radius in the *dat-ini.xml* file, or be edited in the Calibration Parameter Editor.

Figure 18-22. Setting Search Radius in the Calibration Parameter Editor



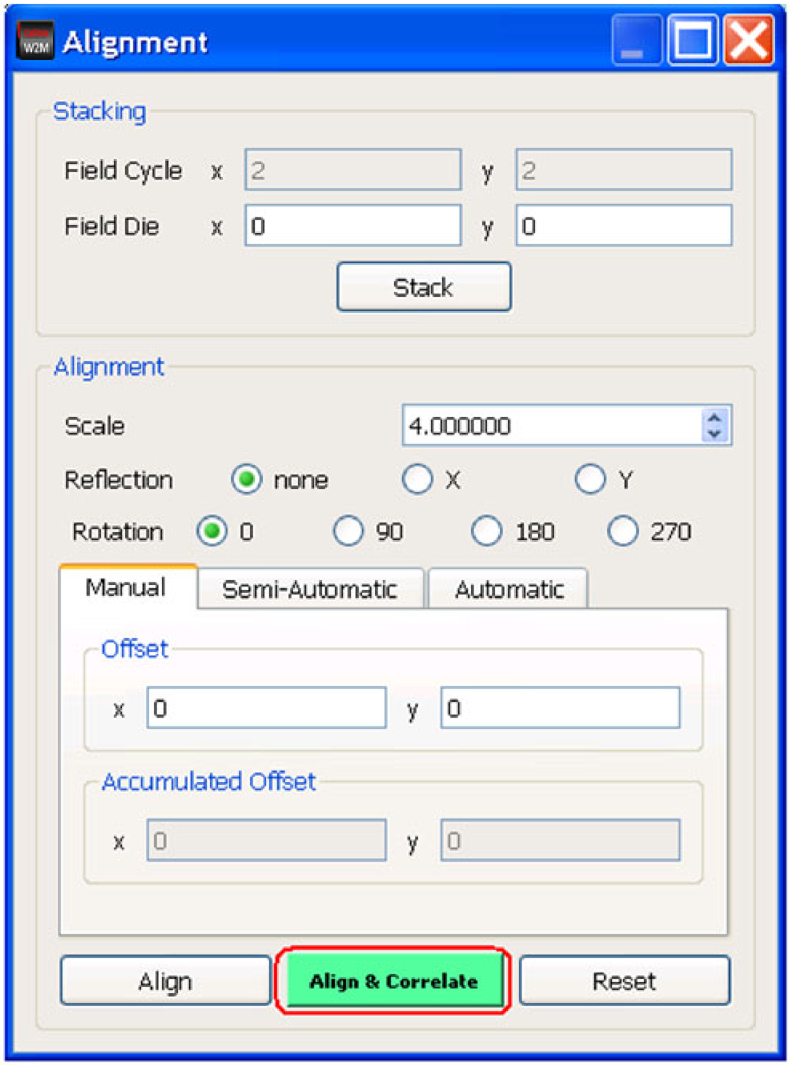
You can optionally edit the Repeater Set Search Radius. This parameter is used to identify the wafer repeater defects within the given search radius. The Min Points parameter determines the number of defects which has to fall within the given Repeater Set Search Radius to be identified as a repeater group.

Click the **Apply** button to apply changes.

3. To view the Repeatability Analysis click the **Align & Correlate** button on the Alignment Window.

   The following figure shows an example.

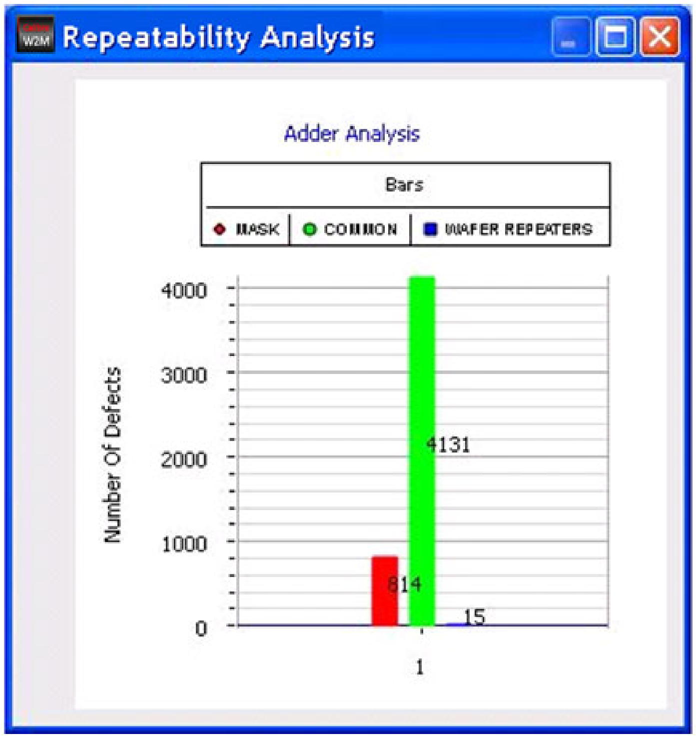
Figure 18-23. Alignment Dialog Box With Align & Correlate Button



Results

The Repeatability Analysis window shows the graph of adder, common, and missing defects as shown in the following figure.

Figure 18-24. Wi2Mi Repeatability Analysis Results



See "Wi2Mi Repeatability Analysis Window" on page 562 for a complete description of this window.

Wi2Mi Repeatability Analysis Window

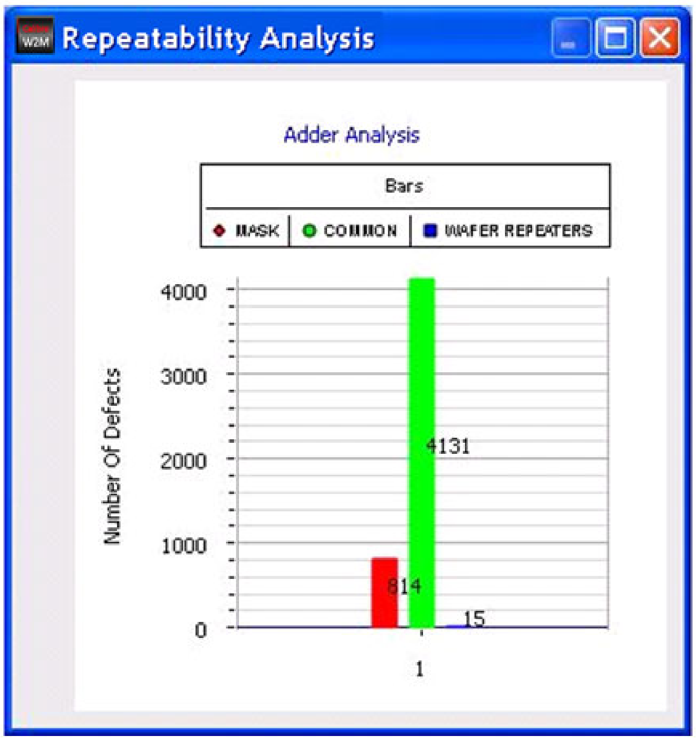
To access: perform the process described in “Performing Repeatability Analysis in Wi2Mi” on page 558

The Repeatability Analysis window displays a bar graph that details the number of added, common and missing defects between the mask and the wafer inspection.

Description

Once you set up a repeatability analysis run and click the **Align & Correlate** button, the Repeatability Analysis window shows the graph of adder, common and missing defects as shown in the following figure.

Figure 18-25. Wi2Mi Repeatability Analysis Window



Repeatability Analysis results are displayed as bar charts. You can apply various operations on the defects represented in a given bar of bar charts by right-clicking on any bar. These include:

- **Highlight** — Highlights the defects falling in a bar. The defects are highlighted in the Defect Map and Wafer Map in cyan. The defects are also highlighted in the Defect List in yellow. You can highlight defects of multiple bars at the same time. To undo the highlight, re-click the Highlight option of the specific bar.
- **Filter** — Filters out the defects represented in a bar. The defects which are filtered out are not deleted from the inspections. Once you click the filter option, then the corresponding defects in the Defect Map, Defect List and the Wafer Map are also filtered. After the defects are filtered, the **Align & Correlate** button in the Alignment

widget is highlighted indicating that the Repeatability Analysis must be recomputed.If the user wants to view all the defects once again after filtering, **Utilities** > **UnFilter All Filtered** option from the main menu bar.

- **Copy Common Classification** — Copies the classification code from one inspection to another inspection. Along with the classification code, the defect size is also copied. The operation can be done only on common defects. On the mask and wafer bar in the Repeatability Analysis window, this option is deactivated

  You can copy the classification size from either Mask to Wafer or Wafer to Mask, described in the following sections.

Mask to Wafer

For the Mask to Wafer option, the mask defect code is copied to corresponding wafer repeater set. For each mask defect the corresponding wafer set is identified and the defect code is copied onto each of the repeater set defect. The wafer defect code which has to be copied is taken from the translation table. Refer to “Translation Table” later in this section for more information.

The mask defect size is scaled down and copied to each of the defects in the wafer repeater set. The scaling factor is read from the Stacking and Alignment window.

After the codes are copied, the classification code is updated in Defect Map, Defect List and Wafer Map windows.

Wafer to Mask

For the Wafer to Mask option, the wafer defect code copied from wafer to mask. For each of the mask (common) defects, the corresponding wafer repeater group is identified. From the wafer repeater set, the defect code is detected. The criteria to detect the defect code from the repeater set is as follows:

- If only one real defect is present in the wafer repeater group, then that classification is considered.
- If more than one real defect is present, the classification which is repeated most number of times is copied.
- If there is a tie in classification type, the classification of the wafer defect with maximum size is considered.
- If there is a tie in defect size, one arbitrary classification is considered.
- If all the defects are of false type, then the most repeated classification is considered. Refer to “Wafer False Alarm” later in this section for a description of false defects.
- If there is a tie in classification type, then the classification of the wafer defect with maximum size is considered
- If there is a tie in defect size, then one arbitrary classification will be considered.

Once the defect code is identified from the wafer repeater set, the corresponding mask defect code is picked up from the translation table and copied to the mask defect. Refer to “Translation Table” later in this section for details.

The wafer defect size is scaled up and copied to the mask defect. The scaling factor is from the Stacking and Alignment window.

Translation Table

To copy the classification code from one inspection to another a translation table is provided in the *dat-ini.xml* file. The translation table gives a mapping between mask and wafer defect codes. The translation table in the *dat-ini.xml* file is as follows:

```
<classificationTranslationTable>
     <translationData maskCode="1A" waferCode="AA"/>
     <translationData maskCode="3C" waferCode="AB"/>
</classificationTranslationTable>
```

When you copy the Defect Classification from one inspection to other, the classification code mapping from the translation table is used.

If you have not provided the defect code mapping in the translation table, an error message displays the defect code for which the corresponding code is not present. The following example error appears if the entry “5D” is not found in the translation table when performing a copy common classification from mask to wafer:

```
No entry for 5D in translation table. Coppy Classification failed.
```

Wafer False Alarm

When you select **Copy Common Classification** > **Wafer to Mask**, the defect code must be identified from the wafer repeater set. To do this, the you can ignore the false defect codes present in the repeater set by using the following code in the *dat-ini.xml* file:

```
<waferFalseCode>
     <waferFalseInfo defCodes="2, 0"/>
</waferFalseCode>
```

The wafer defect code “2, 0” is considered as a false defect code.

Objects

Table 18-7. W2Mi Repeatability Analysis Window Fields

Field	Description
Number of Defects	The number of mask (adder), common, and wafer (missing) defects is shown on a bar graph. • Red indicates the mask defects. These are defects that are present exclusively on the mask and not a part of common defects (for example, adder defects). • Green indicates common defects. • Blue indicates wafer defects. These are defects that are present exclusively on the wafer and not as a part of common defects (for example, missing defects).

Chapter 19
Wafer Defect Management

The Wafer Defect Management tool in Calibre DefectReview is used to open and inspect a wafer file, supporting a number of utilities to assist in analyzing wafer files.

Invoking the Wafer Defect Management GUI

The Wafer Defect Management tool is a separate program that runs independently of Calibre DefectReview. It can be run interactively in a GUI.

Prerequisites

- Calibre DefectReview is installed.
- A valid Calibre Wafer Defect Management license is present.

Procedure

1. To invoke the Wafer Defect Management tool, perform one of the following:

    - Enter the following at a command line:

        ```
        $NXDAT_MGC_HOME/bin/nxdat -m wafer
        ```

    - Double-click the Wafer Defect Management shortcut icon.

Figure 19-1. Wafer Defect Management Icon

The Calibre DefectReview window appears with a login dialog box.

2. Enter your user name and password in the login dialog box. The main window updates the User and Type settings. The type refers to the user permission levels.

3. Load one or more wafer inspection files by choosing **File** > **Open Inspection(s)**. A wafer files dialog box appears.

4. In the dialog box that appears, open one or more wafer inspection files and click **Open**.

   For further details on adding or opening multiple wafer inspection files, refer to "Multiple Inspection Operations" on page 109.

   Note

   Currently, database operations are not supported on wafer files.

5. You can add an inspection on top of other inspection files already opened by clicking **Add Inspection(s)**.

   Note

   The Wafer Defect Management tool currently supports Klarf 1.2 and 1.8 wafer files.

   If the files are not valid wafer files, the tool returns either a Calibre DefectReview parse error or it asks for another wafer file.

Wafer Defect Management Interface Reference

The Wafer Defect Management tool uses some of the same window names as the main Calibre DefectReview interface. However, some of the functionality is not identical.

Wafer Defect Management Main Window

To access: See "Invoking the Wafer Defect Management GUI" on page 567.

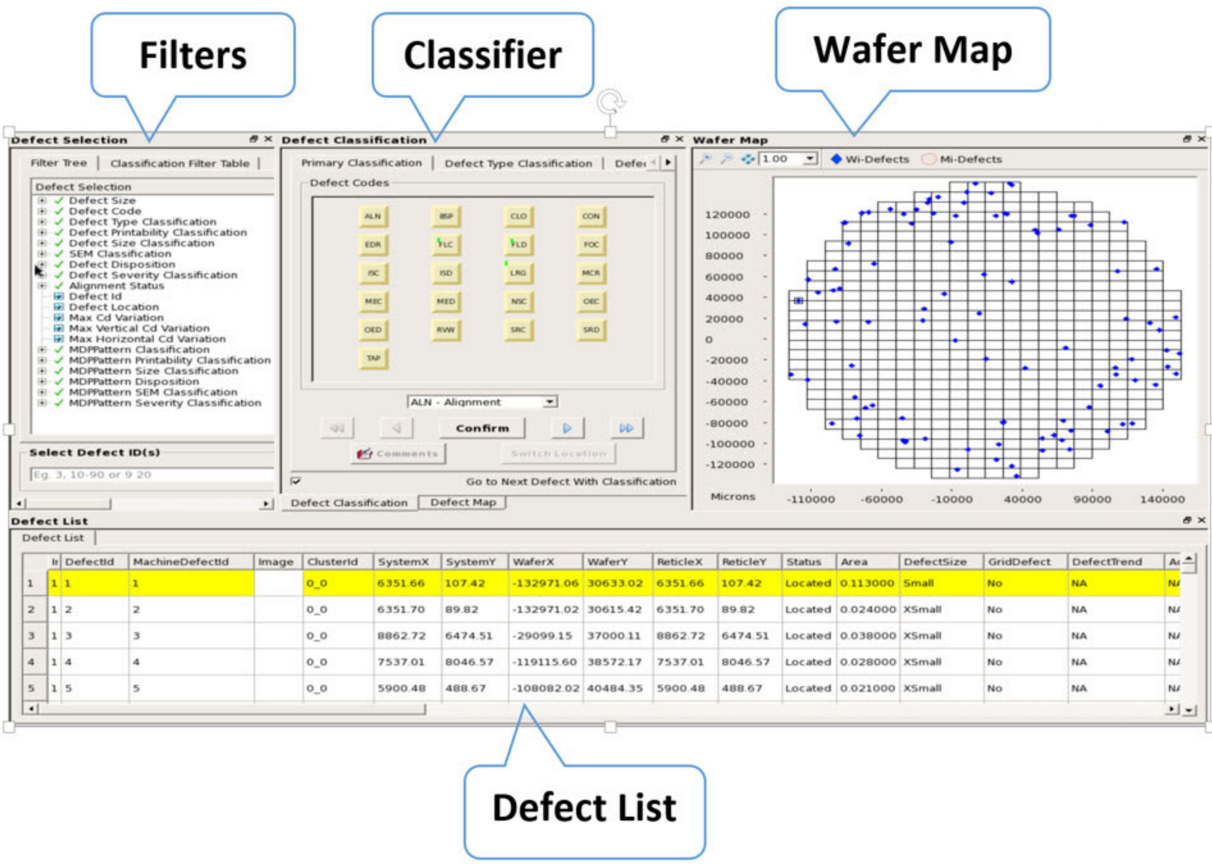
The Wafer Defect Management window is organized into several key functional regions.

Description

Any windows that have been closed or minimized can be reopened through the **View** menu. Different arrangements can be saved and loaded back through the Dock Layout menu.

Most windows are identical to those in the Calibre DefectReview main window. The Wafer Defect Management tool adds the Wafer Map window. It shows defects across the entire wafer

Figure 19-2. Wafer Defect Management Main Window



Objects

Region	Description
Wafer Map	Provides a graphical view of all wafer defects, with the mask die replicated on the corresponding wafer die. It also provides a convenient way to spatially navigate defects. See "Wafer Defect Management Wafer Map Window" on page 572 for information.

Region	Description
Defect Classification (Classifier)	Provides an interface for classifying wafer defects. By default, it is docked with the Defect Map (Die Map) dialog box and appears as a tab at the bottom. This is identical in function to the Calibre DefectReview Defect Classification window. See "Defect Classification" on page 207 for information.
Defect List	Provides a table view of the mask and wafer defect properties. The Defect List enables you to navigate defects based upon their sorted properties.Every defect is entered as one row with each attribute in a column. Few attributes are hidden by default. See "Wafer Defect Management Defect List Window" on page 579 for information.
Defect Selection (Filters)	Provides different filtering options to reduce the number of defects displayed. It helps you to focus only on critical defects.

All menu bar options are the same as Calibre DefectReview. However, there are additional options available for the Wafer Defect Management tool, as listed in the following table.

Table 19-1. Wafer Defect Management Menu Bar Options

Menu Item		Description
View		
	Show Default View	Shows the dock windows of Defect Map, Defect List, Wafer Map and Alignment window tabs over the Defect Classification window in the default layout.
	Defect Selection	Shows or hides the Defect Selection window.
	Defect Map	Shows or hides the Defect Map window.
	Defect List	Shows or hides the Defect List window.
	Image Measurement	Shows or hides the Image Measurement window.
	Defect Classification	Shows or hides the Defect Classification window.
	Repeatability Analysis	Shows or hides the Repeatability Analysis window.
	Wafer Map	Shows or hides the Wafer Map window.

Wafer Defect Management Wafer Map Window

To access: In the Wafer Defect Management window, select **View** > **Wafer Map**.

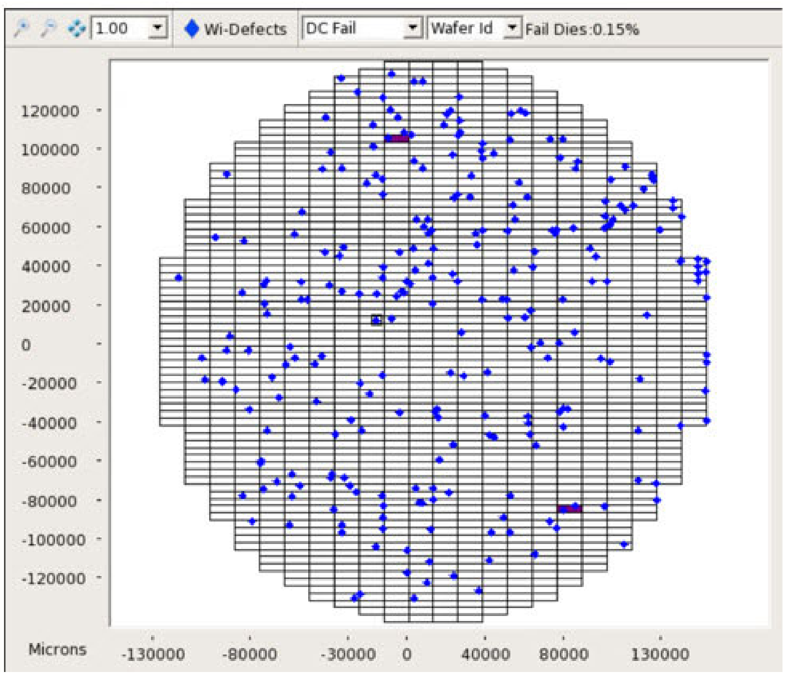
The Wafer Defect Management wafer map provides another graphical view of all the wafer defects.

Description

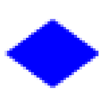
Wafer defects are mapped on the Wafer Map window with the actual coordinates present in the inspection file. The complete wafer data is presented as an unfolded wafer. Absolute coordinates are calculated using the wafer die index and die pitch mentioned in the inspection report.

You can navigate over the defects in the wafer map. Unlike the Defect Map, no operations are supported on the Wafer Map except for navigation. The Wafer Map helps you get a complete view of the wafer defects.

Figure 19-3. Wafer Defect Management Wafer Map



Objects

Control	Description
	Wafer defects are shown as a filled blue diamond. Tool tips on a mask defect contains the coordinates (with regards to wafer sample coordinates) of the defect in the units configured in the *dat-ini.xml* file, the defect number (ID), the inspection type (Inspection Type), and the classification type.

Control	Description
Zoom Controls	View any desired section or part of the Wafer Map using the zoom controls. See “Additional Zoom Controls” on page 120 for information on additional zoom controls that are not on the tool bar.
	Zoom in.
	Zoom out.
	Fit to window. The default zoom factor is 1.00.
1.00	Set zoom factor. The current zoom factor is always displayed. You enter an exact value in this field or select from existing zoom factors in the dropdown list. The minimum zoom value that can be entered is 1.00.
Color Dies	Set color dies in the Wafer Map according to options available under this combo box. The coloring shows various information in the wafer. For example, a die can show DC Fail status for each of the dies. Currently, coloring is enabled for DC Fail statuses only. Refer to “Wafer Map Coloring” on page 573 for information.
Wafer Id	View the die colors according to the parameters of wafer file. The colors used depend on the attribute value from IR. This is enabled when Color Dies is selected.
Fail Dies:0.15%	Shows the percentage of Fail dies, calculated as (Fail Dies x 100) / Total Dies. This is displayed when Color Dies is selected.

Wafer Map Coloring

You can color the dies on a wafer to indicate status using the Wafer Map.

The coloring highlights different information on the wafer. For example, a die can show a DC Fail status for each of the dies. Currently, coloring is enabled for DC Fail statuses only.

DC Fail indicates that there is a broken circuit due to faulty power nets. It has a severe effect for chips because broken or short circuits can damage a chip. Calibre DefectReview tracks DC Fail statuses as a classification status. You can manually classify a defect as DC Fail through reviewing the wafer. Once you mark one or more defects as DC Fail, you can open the wafer map and color dies by DC Fail status. Calibre DefectReview colors dies that have at least one defect classified as DC Fail. Once the dies are detected as Fail dies for a faulty power net, you can discard chips made from those dies.

Coloring Rules

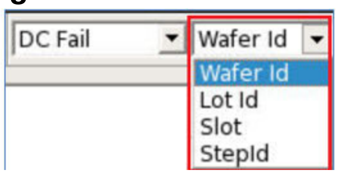
Die colors are controlled from the *dat-ini-wafer.xml* as shown in the following figures. Colors are defined in hex code. You can change the colors as needed.

Figure 19-4. WaferMapInfo Node

```
<waferMapInfo>
 <defaultGrouping groupID="Wafer Id"/>
 <dcFailColoring>
  <color name="#800080" group="single"/>
  <color name="#ffa500" group="single"/>
  <color name="#ffc0cb" group="single"/>
  <color name="#ff0000" group="single"/>
  <color name="#008000" group="single"/>
  <color name="#33ff33" group="multi"/>
 </dcFailColoring>
</waferMapInfo>
```

There are four parameters in an inspection report that you can color on a wafer map. They are displayed in a combo box shown in the following figure.

Figure 19-5. Select Color



The default value is Wafer Id but this can be configured in *dat-ini-wafer.xml* (in the groupID attribute of defaultGrouping node). You must select a group.

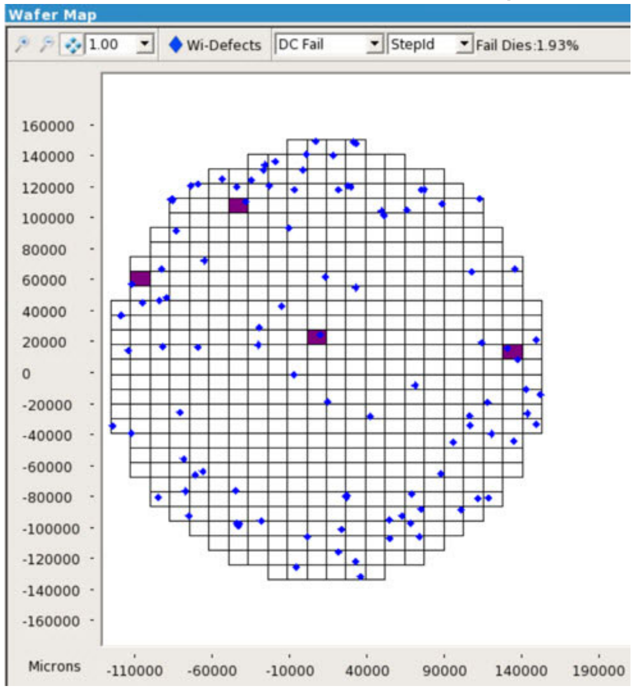
Once you select the group, dies are colored using the color defined in the color node. You can change the color by modifying the name attribute. Colors are specified in hex code. If a die has at least one defect with DC Fail Status = Fail, then it is called a defect die. Each group is given the same color for the defect die. If a defect die is from multiple groups, it should use a unique color (green as specified in *dat-ini-wafer.xml* for group= “multi”).

For example, five inspections are opened and the group has been selected as StepID for all inspections. Some inspections have the same StepID, so there are a total three different types of StepIDs: ISO, GT, and SN. The list of inspection reports are as follows:

- Inspection Report 1 (IR1): StepID = ISO
- Inspection Report 2 (IR2): StepID = GT
- Inspection Report 3 (IR3): StepID = SN
- Inspection Report 4 (IR4): StepID = ISO
- Inspection Report 5 (IR5): StepID = GT

If the inspections in the order specified (IR1 to IR5), ISO is the first StepID (as IR1 is loaded first) reported in the tool. The first color with group= “single” is assigned to ISO (in this example, it is MAGENTA).

Figure 19-6. Defect Dies Colored Magenta in IR1



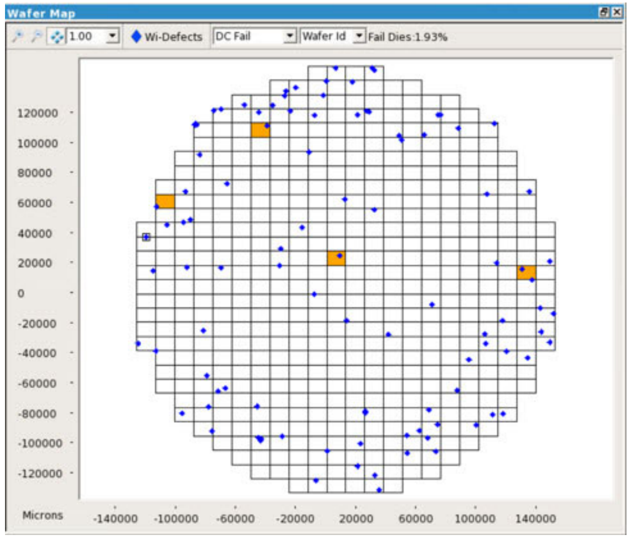
Similarly, GT and SN are assigned the second and third colors respectively. In this example, they are assigned ORANGE and PINK. The following are the color assignments for each group:

- ISO = MAGENTA
- GT = ORANGE
- SN = PINK

If there are defect dies, they will use the following color assignments:

- IR1 dies are colored in MAGENTA.
- IR2 dies are colored ORANGE.
- IR3 dies are colored PINK.
- IR4 dies are colored MAGENTA (group is ISO).
- IR5 dies are colored ORANGE (group is GT).

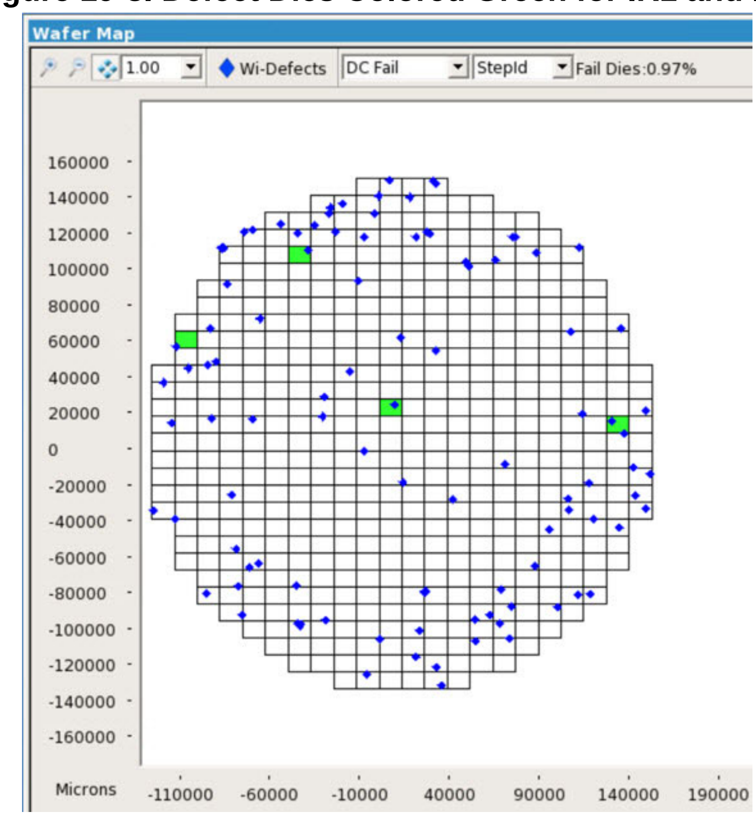
Figure 19-7. Defect Dies Colored Orange in IR2



Switching to the ALL folder where all inspections dies overlap each other, the defect dies are assigned colors using the following methods:

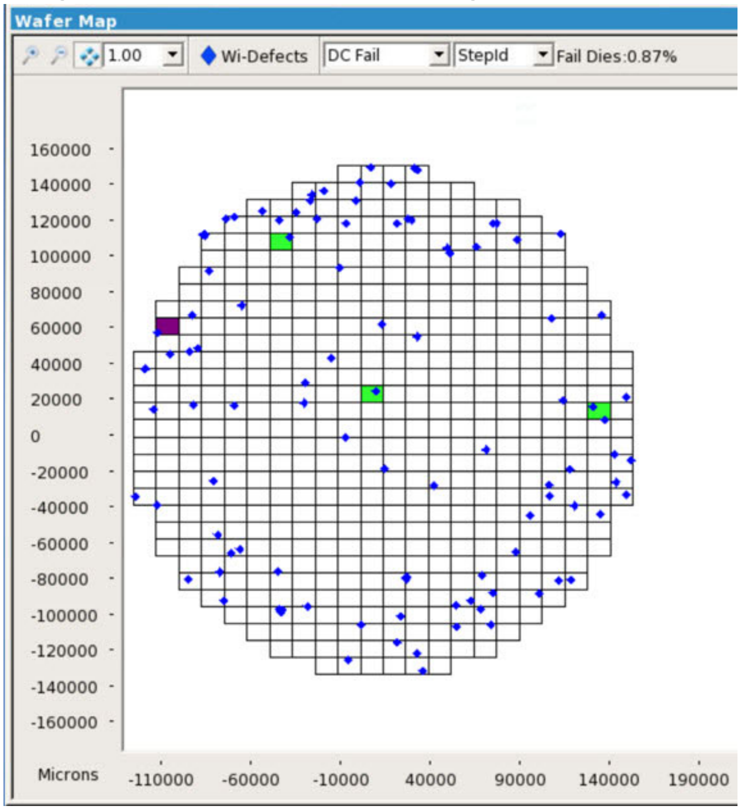
- If defect die number 2 is reported from IR1 and IR2 both, then it is colored GREEN because this defect die has multiple group values (ISO and GT).

Figure 19-8. Defect Dies Colored Green for IR1 and IR2



- If defect die number 3 is reported from both IR1 and IR4, then it is colored MAGENTA because this defect die has a single group (ISO).

Figure 19-9. Dies Colored Magenta and Green



- If defect die number 4 is reported from both IR3 and IR5, then it is colored GREEN because this defect die has multiple groups (SN and GT).
- If defect die number 5 is reported from IR1, IR2 and IR4, then it is colored GREEN because this defect die has multiple groups (ISO, GT and ISO).

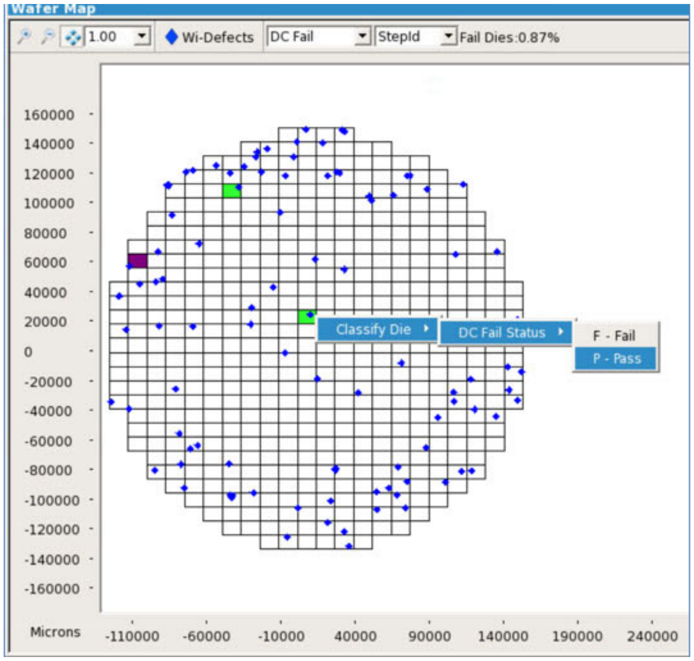
Changing Wafer Map Die Colors Manually

You can change a die’s color by manually classifying the die in the Wafer Map.

Procedure

To change a wafer map die color, right-click on the die and select a colored status. For example, a die is incorrectly colored as Fail in the following figure. To correct the status, right-click on that die and change the DC Fail Status to Pass.

Figure 19-10. Manual Classification of Dies in the Wafer Map



Once classified, the Wafer Map utility searches for all defects inside that die and changes the DC Fail Status to the new classification and changes the die color. This feature is supported only for DC Fail Status. For more information on wafer map die coloring, refer to “Wafer Map Coloring” on page 573.

Note

Dies are colored based on Fail dies. No default colors are assigned for Pass status.

Wafer Defect Management Defect List Window

To access: In the Wafer Defect Management window, select **View** > **Defect List**

The Defect List provides a table view of all the defects. It shows wafer defects with all its attributes.

Description

The Defect List enables you to navigate and edit defects of an inspection as provided in Calibre DefectReview. Every defect is entered as one row with each attribute in a column. A few attributes are hidden by default. The current defect is highlighted in Defect List in yellow as shown in the following figure.

Figure 19-11. Wafer Defect Management Defect List

Defect List

Defect List

	DefectId	MachineDefectId	SystemX	SystemY	WaferX	WaferY	ReticleX	ReticleY	Pattern Classification Id	DC Fail Status	DC Fail Status Comment	Status	DefectSize
1	1	1	-33.64	175.10	-139356.41	30700.72	-33.64	175.10		P - Pass		Located	Small
2	2	2	-5.00	5.00	-139327.77	30530.62	-5.00	5.00		F - Fail		Located	XSmall
3	3	3	-29.91	217.46	-37991.83	30743.09	-29.91	217.47		P - Pass		Located	XSmall
4	4	4	-35.32	224.48	-126687.99	30750.11	-35.32	224.48		P - Pass		Located	XSmall
5	5	5	-48.17	233.71	-114030.72	40229.42	-48.17	233.72		F - Fail		Located	XSmall
6	6	6	-51.92	175.04	-114034.48	40170.74	-51.92	175.04		F - Fail		Located	Small
7	7	7	4.33	135.03	12722.85	40130.73	4.33	135.03		P - Pass		Located	XSmall

Note

All defect attributes defined in the wafer file (Klarf 1.2 and 1.8 formats) appear in the Defect List, even if they are not specified in the *dat-ini-wafer.xml* file.

Objects

- InspectionId

  Specifies the number ID for the inspection.

- DefectId

  Specifies an integer ID for a defect assigned by Wafer Defect Management. It is unique within an inspection.

- MachineDefectId

  Specifies the unique ID reported by Inspection System.

- System coordinates (X,Y)

  This represents the modified wafer defect coordinates. Defect coordinates can be modified when translation on reticle coordinates are applied.

- Reticle coordinates (X, Y)

  Specifies the coordinates that exist in the inspection file for each defect. The ReticleX and ReticleY coordinates are displayed in separate columns in the same unit as the system coordinates.

- WaferX

  Specifies the absolute value X coordinate of a wafer defect. Absolute values are calculated using the X dieIndex and die pitch extracted from file.

- WaferY

  Specifies the absolute value of Y coordinate of a wafer defect. Absolute values are calculated using the Y dieIndex and die pitch extracted from file.

- ClassificationType

  Specifies the classification type of the defect. It is shown as <Defect Code – Defect Type>.

- PrimaryClassificationComments

  Displays any user-created comment related to Primary classification of the defect.

- Detector

  Specifies the detector type of the defect. There may be more than one detector type associated with a defect. In that case, all the detector types (a maximum of five) are displayed with a comma separator. For TEXT inspection files, this column is empty.

- Area

  Specifies that the area of the defect is displayed in the units configured in the *dat-ini.xml* file. For more details on the configuration of units, refer to "Unit of Measurement Configuration" on page 125.

- FOV

  Specifies the Field of View (FOV) of the defect. The FOV information is from the ADCFOV column in the Klarf 1.8 file.

- DC Fail Status

  Specifies the status of the DC Failure. This classification column is manually configured in the *dat-ini.xml* file.

- DC Fail Status Comment

  Specifies a comment regarding the DC Fail Status. This classification column is manually configured in the *dat-ini.xml* file.

Usage Notes

Additional columns may appear that corresponds to functionality from the Calibre DefectReview Defect List. The attribute columns can be rearranged by dragging and dropping them in the Defect list.

Operations on Defects

From this window, you can right-click on any row header and select **Filters**. This filters out the selected defects from the Defect List. When you filter defects from the Defect List, the defects in the Defect Map and Wafer Map are also updated accordingly.

Operations on Attributes

A number of operations can be performed on attributes in the Defect List. Refer to "Attribute Operations in the Defect List" on page 168 for further information.

Image to Layout Alignment

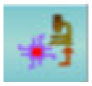
Once you have successfully loaded a wafer file, you can align SEM images with layout images. This is performed with the Calibre DefectClassify tool.

Procedure

There are two ways to launch Calibre DefectClassify:

- In the Calibre DefectReview window, select **Utilities** > **Image to Layout Alignment**.
- Click the Image to Layout Alignment icon in the Calibre DefectReview toolbar.

Figure 19-12. Image to Layout Alignment Icon



Refer to the *Calibre DefectClassify User's Manual* for full details.

Viewing DFM Data Analysis Results

DFM Data Analysis (DFDMA) is a method of pattern classification used to assist wafer defect analysis by applying various clustering and classification techniques to defect information obtained from wafer inspections. The DFMDA output can be read by the Wafer Defect Management tool by clicking the DFMDA icon in the toolbar.

The DFDMA utility performs the following operations:

- Data sorting (using a proximity algorithm)
- Geometrical comparison (using DFM_PATTERN_CLASSIFY)
- Feature extraction (certain dimension measurements are computed for all input data points)
- Output (provided in a *Summary.csv* file, renamed to *Summary_DFMDA_output.csv*)

The DFM Data Analysis flow is described in the *DFM Data Analysis User's and Reference Manual*.

Prerequisites

- The *Summary.csv* file output from the DFM Data Analysis utility must be renamed *Summary_DFMDA_output.csv*.
- The DFMDA output file *Summary_DFMDA_output.csv* must be in the same location as the wafer inspection file. The *Summary_DFMDA_output.csv* is required for the DFMDA run.

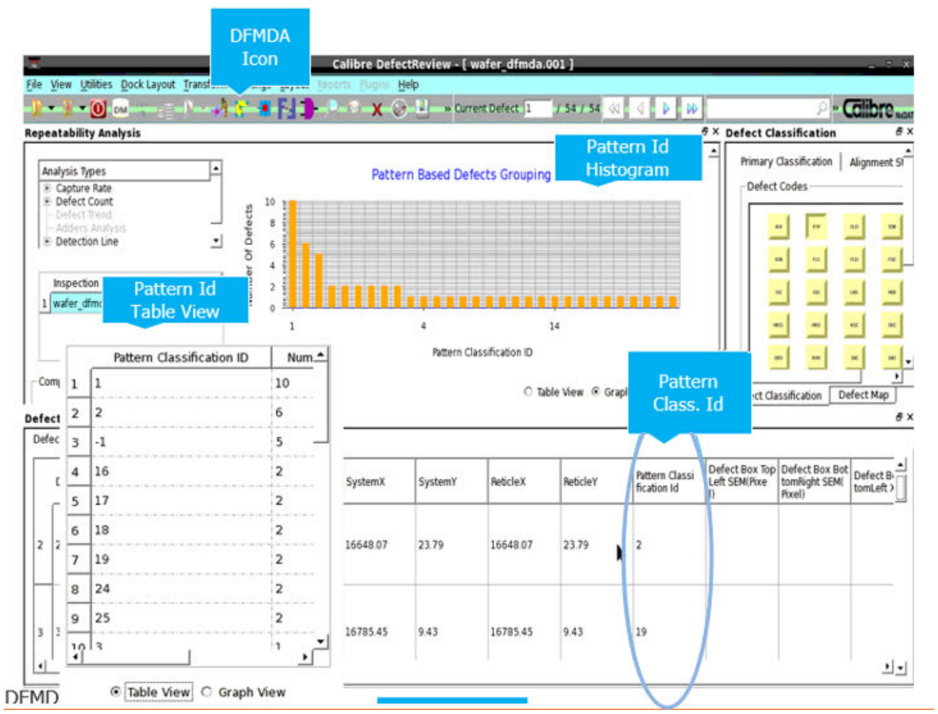
Procedure

1. Click the DFMDA icon in the Wafer Defect Management toolbar.

   The tool reads the *Summary_DFMDA_output.csv* file and populates the respective attributes.

2. The Pattern Classification Id column in the Defect List is updated with the corresponding ClassId entry from the *Summary_DFMDA_output.csv* file. The Repeatability Analysis dialog box displaying the Pattern Classification Id histogram appears, as shown in the following figure.

Figure 19-13. Defect List With Updated Pattern Classification ID



Several other columns are also displayed in the Defect List, as described in the following table.

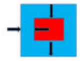
Table 19-2. Defect List Columns Updated by DFMDA

Column	Description
CX, CY	Specifies the center coordinates of the pattern used for DFMDA run. This is the converted layout coordinates from Klarf XREL and YREL.
clusterID	Specifies the ID assigned for each defect after location/coordinates-based clustering.
cluster_size	Specifies the defect count in each cluster ID.
Density	Specifies the design density (layouts and polygons) calculated in each pattern clip. The pattern clip is from the DFMDA pattern classification definition. While performing pattern-based classification, the design attributes are extracted from each pattern clip.
Min_c	Specifies the minimum corner-to-corner distance in the pattern clip.
Min_s	Specifies the minimum space in the pattern clip. The pattern clip definition is the same as the density.
ClassID	Specifies the ID assigned to each defect coordinates after pattern classification is done.
Class_size	Specifies the number of defects in each class ID, which is how many defects have the same pattern inside the pattern clip as defined by a DFMDA pattern classification run.
Coordinates	Specifies a small marker (2 nm x 2 nm) generated for input to a pattern classification run. This is based on center coordinates identified after the defect is located.
TEST_SIZE	Specifies the number of tests in the defect inspection that includes this pattern failure. This number indicates how many tests a particular class ID or type of pattern has appeared after Process Window Qualification (PWQ) analysis (for example, one test means one different exposure and focus condition). This provides an estimate as to how many exposure and focus conditions containing this failure pattern have occurred.

Using Design Rule Checking (DRC)

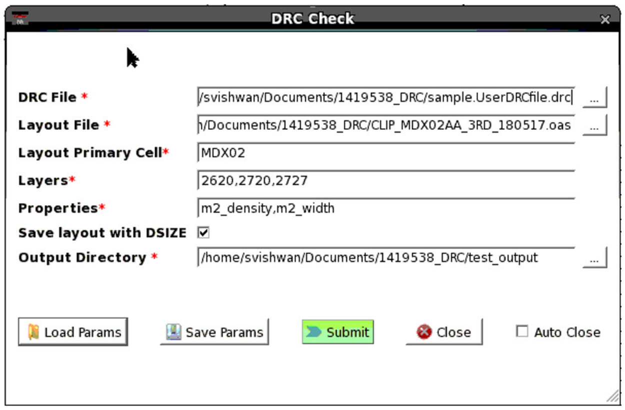
You can run a simple Design Rule Check (DRC) from the Wafer Defect Management tool using a basic interface (a subset of features from Calibre® Interactive™ nmDRC).

Procedure

1. To initiate a DRC run, click the DRC icon  in the Wafer Defect Management toolbar.

   The DRC dialog box opens.

   Figure 19-14. DRC Dialog Box

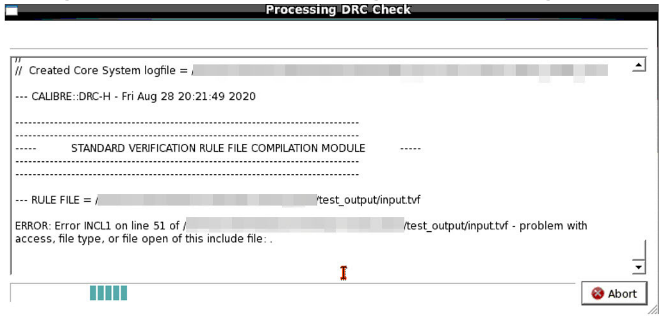
   

2. Set the DRC run parameters in the DRC dialog box.

   - **DRC File** — Specifies the path to the DRC file.
   - **Layout File** — Specifies the path to the layout file
   - **Layout Primary Cell** — Specifies the primary cell name in the layout.
   - **Layers** — Specifies layers in the layout (in a comma-separated list) where the DRC check to be executed.
   - **Properties** — Specifies the property values (in a comma-separated list) generated from the DRC run.
   - **Save layout with DSIZE** — When enabled, saves the new layout with the squares of size DSIZE marked at the defect locations in the specified layout. This is saved in the location specified by Output Directory.
   - **Output Directory** — Specifies where the final output *drcresults.rdb* and the intermediate files are generated.

3. Click **Submit** to initiate the run. Once the DRC run is successful, the corresponding values of the properties specified in the Properties field are read from the *drcresults.rdb* file and the Defect List is updated with those columns. You can abort the run by clicking the **Abort** button.

Figure 19-15. DRC Progress Dialog Box



4. Additionally, you can perform the following operations from the DRC dialog box:
   - **Load Params** — Loads an input settings from an existing XML file.
   - **Save Params** — Saves input settings to an XML file.
   - **Auto Close** — Specifies that the DRC dialog box and the progress dialog box automatically close after the run.

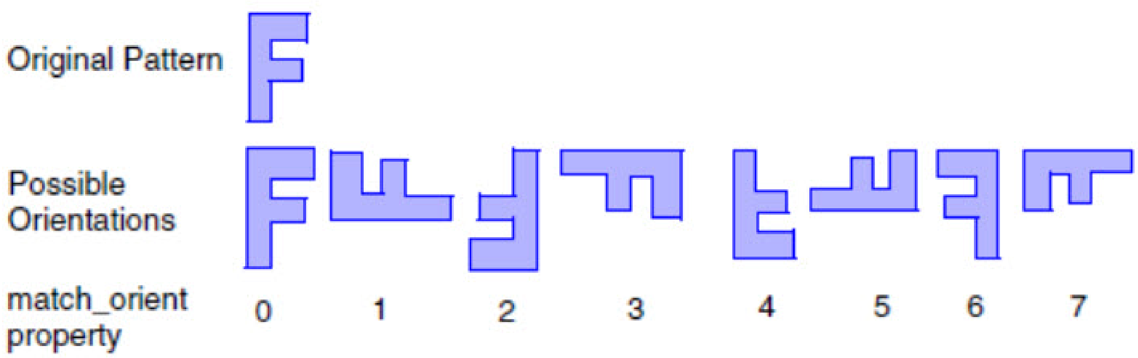
Performing Pattern Based Defects Grouping

In Wafer Defect review, you can group defects based on the similarity of patterns they land into the design. If multiple defects have similar patterns, they can be grouped together or classified as defects affected by similar patterns.

One use case is to find patterns that cause defects and determine how many defects are introduced by these types of patterns. If it is found to be a design problem, the issue can be corrected at design time.

Calibre DefectReview can find matches from eight different orientations as shown in following figure.

Figure 19-16. Pattern Orientations



The patterns used to group pattern-based defects are picked from locations defined by the SystemX and SystemY coordinates in the Defect List.

Prerequisites

- Set NXDAT_MGC_HOME to the path of your Calibre DefectReview installation.
- Set MGC_HOME to the path of your Calibre installation.
- Launch the Wafer Defect Management tool (as described in "Invoking the Wafer Defect Management GUI" on page 567). The Pattern Based Defects Grouping window is enabled only after opening a wafer defect file in the Calibre DefectReview main window.

Procedure

1. To perform pattern-based defects grouping, perform one of the following:
    - Click the Pattern Based Defects Grouping icon in the Calibre DefectReview toolbar.

    Figure 19-17. Pattern Based Defect Grouping Icon

    - Select **Utilities** > **Pattern Based Defect Grouping**.

    The Pattern Based Defects Grouping dialog box appears.

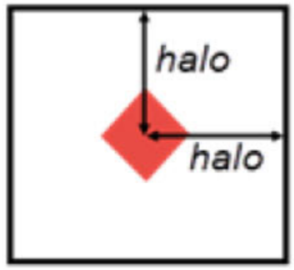
    Figure 19-18. Pattern Based Defects Grouping Dialog Box

2. Enter the inputs for pattern based defects grouping, including:
    - Layout File — A required parameter that specifies a layout file. Currently, the OASIS format is supported.
    - Layers — A required parameter that specifies layers to be considered for extracting patterns for match. You can specify a list of layer numbers or list of layer number and data type pairs separated by commas. Multiple mask layers can be added using the green plus (+) button. Note that layers are often referred to as target layers.
    - HALO (um) — A required keyword set that defines the halo region that is centered on the defect location. The target layer shapes of the design within the bounds of the halo region are used for pattern classification. The halo size is specified in microns.

The following figure illustrates that the width of the square halo region is 2 * halo value specified by user.

Figure 19-19. HALO Region



- Allowed Shift (um) — A required keyword set that performs auto-centering of the pattern location if the value supplied is greater than zero.

  The value provided defines a square search region centered on the shape located on the defect location with a width of 2 * value. An internal algorithm uses target layer edges and vertices within the search region to optimize the location of the pattern center. If any target layer edges or vertices exist within the shape from the defect location, they contribute to auto-centering regardless of the Allowed Shift value. If no target layer edges are found within the search region, the pattern center is not adjusted.

  The Allowed Shift value is recommended to be at least half the halo size set with HALO.

- Output Directory — Specifies the path of the directory where the output file and log files are created.
- Save Params — Clicking this button saves the current settings in the Pattern Based Defects Grouping window into an XML file.
- Load Params — Click this button to load all required inputs from an existing settings XML file into this window. The XML file must be in a specific format that is generated when clicking **Save Params**.
- Auto Close — When **Submit** is clicked and if Auto Close is checked, the Pattern Based Defects Grouping window closes when the process runs successfully. If any error occurs during execution or if the process is terminated, the window remains open.

3. Click **Submit** to group the defects.

Results

The output and log files are created inside the directory specified in Output Directory of the Pattern Based Defects Grouping dialog box.

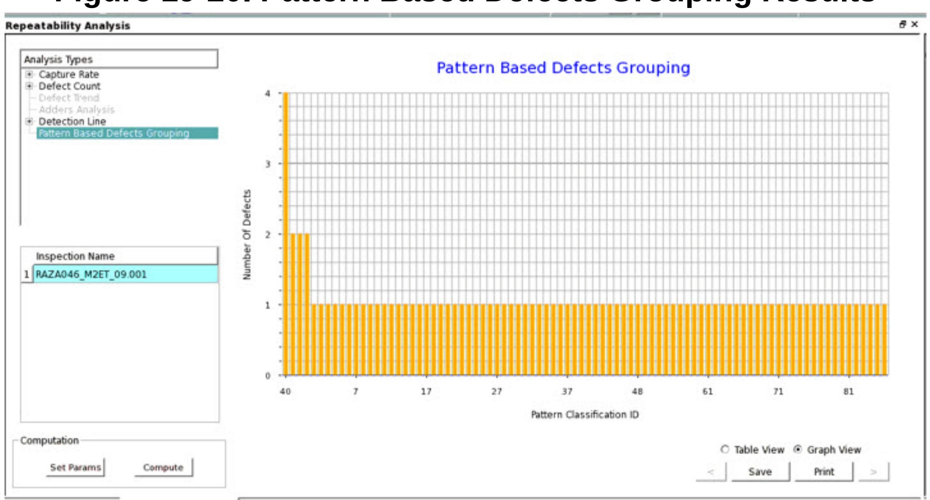
The results of the pattern match are displayed under the Pattern Classification Id column in the Defect List. A valid Id is a non-zero positive number. An Id of -1 represents a value where no pattern is found in order to run pattern matching. Defects with the same Pattern Classification Id are considered to have similar patterns in a defect location and region as defined by the SystemX, System Y and Halo regions.

Note

Performing a Save or SaveAs saves the Pattern Classification Id value. This value is displayed when you reload the same inspection report.

The histogram view of the Pattern Classification Id can be analyzed inside the Repeatability Analysis window. The histogram is sorted on the Pattern Classification Id group count (the group having the greatest and least number of defects appear first and last, respectively). With the help of histograms, you can identify defects belonging to similar groups with greater ease. You can also highlight, filter-in, and filter-out defects of the same group in the Defect List, Defect Map, and Wafer Map by right-clicking on the histogram and selecting the corresponding option.

Figure 19-20. Pattern Based Defects Grouping Results



Cross-Probing Defects to Schematic and Power Nets

You can use Calibre DefectReview to cross-probe a wafer defect to schematic nets in a schematic viewer, allowing you to locate nets impacted by the defect. Similarly, defects can be cross-probed to schematic and layout viewers for the DC Fail Analysis (highlighting power nets in schematic and layout viewers).

Prerequisites

- The following environment variables must be set:
  - Set NXDAT_MGC_HOME to the path of the Calibre DefectReview installation.
  - Set MGC_HOME to the path of the Calibre installation.

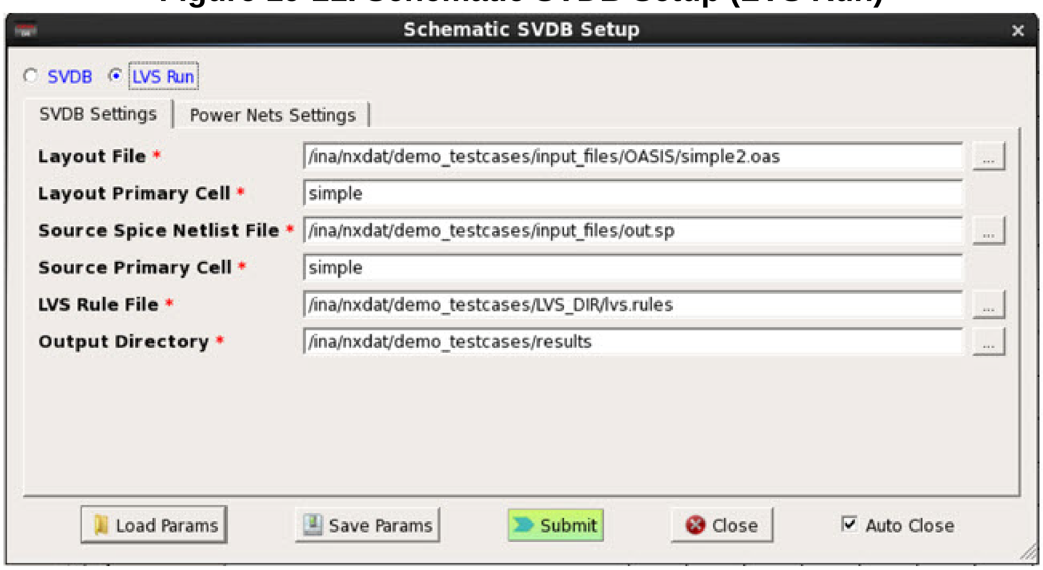
- Add *MGC_HOME/bin* to the PATH environment variable.

- Launch the Wafer Defect Management tool.
- Open a wafer defect file in the Calibre DefectReview window.
- Have valid licenses for Caliber DESIGNrev, Calibre LVS, and Calibre RVE.

Procedure

1. Before cross-probing, you must first generate an LVS SVDB directory from a Calibre LVS run and load it through the Schematic SVDB Setup dialog box. To open the Schematic SVDB Setup window, click the  button or select **Utilities** > **Schematic Nets Extractor**.
2. The following are the methods used to generate an SVDB directory from a Calibre LVS run:
   - Set up a Calibre LVS run to generate the directory.
     i. In the Schematic SVDB Setup dialog box, select **LVS Run** to generate an SVDB directory to be used for cross-probing defect-to-schematic nets. Click the **SVDB Settings** tab.

Figure 19-21. Schematic SVDB Setup (LVS Run)



     ii. Enter the following inputs in the **SVDB Settings** tab as described by the table for each input:

Table 19-3. Inputs for Calibre LVS Run

Input	Description
Layout File	A required parameter that specifies a design file pathname. Currently, OASIS format is supported.

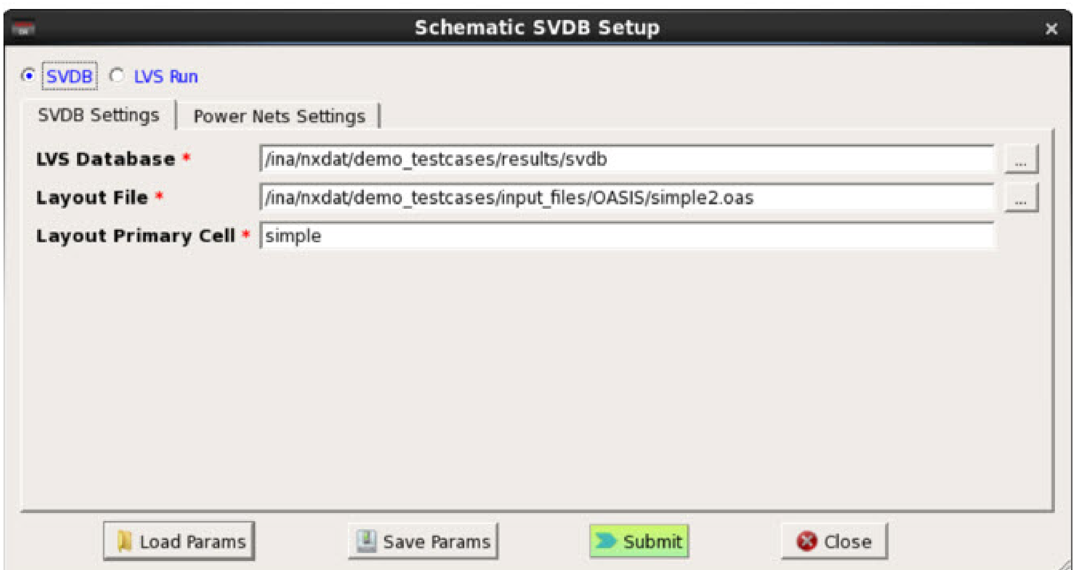
Table 19-3. Inputs for Calibre LVS Run (cont.)

Input	Description
Layout Primary Cell	A required parameter that specifies the layout top-level cell name.
Source Spice Netlist File	A required parameter that specifies the source database pathname for Calibre LVS. A source SPICE netlist (*.*sp*) file must be specified.
Source Primary Cell	A required parameter that specifies a cell name for SPICE source systems.
LVS Rule File	A required parameter that specifies the Calibre LVS rule file containing connectivity extraction information needed for the Calibre LVS run.
Output Directory	A required parameter that specifies the output SVDB directory where the log, error, and other related files are generated as a result of the Calibre LVS run.

- Select an existing SVDB directory generated from a previous Calibre LVS run.

  i. In the Schematic SVDB Setup dialog box, select **SVDB**, then select the **SVDB Settings** tab.

Figure 19-22. SVDB Settings



  ii. In the **SVDB Settings** tab, enter the following input:

Table 19-4. SVDB Settings Tab

Input	Description
LVS Database	A required parameter that specifies the SVDB directory path.

Table 19-4. SVDB Settings Tab (cont.)

Input	Description
Layout File	A required parameter that specifies the design file path name. Only OASIS format is currently supported. The layout file is required to launch Calibre DESIGNrev for cross-probing defects to nets locations in the layout.
Layout Primary Cells	A required parameter that specifies the layout's top-level cell name. Net names affected by the defect region are extracted from the primary cell supplied.

If you are cross-probing power nets, you must also enter information in the **Power Nets Settings** tab for either **LVS Run** or **SVDB** settings. These options are used to highlight power nets affected by defects in a layout viewer.

Figure 19-23. Power Nets Settings

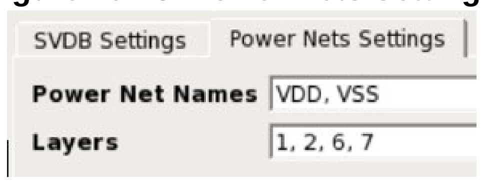


Table 19-5. Power Nets Settings Tab

Input	Description
Power Net Names	An optional parameter that lists power net names separated by a comma. If a defect affects one or more specified power nets, the affected power nets are highlighted in the schematic and layout viewer. This is used only for power net highlighting and is not required for cross-probing nets to schematics.
Layers	An optional parameter that specifies layers used to retrieve net names. By default, all the layers from layout are considered. This is used only for power net highlighting and is not required for cross-probing nets to schematics.

Click **Submit** to start a Calibre LVS run. At the end of successful run, an SVDB directory is generated in the Output Directory specified. If a failure occurs, you can check the log and error files generated in the Output Directory.

3. Additionally, use the following controls to save, close, and load dialog box settings:

   - **Save Params** — Saves the current settings of the Schematic SVDB Setup dialog box in an XML.

   - **Load Params** — Loads a pre-existing XML file containing Schematic SVDB Setup settings.

- **Auto Close** — Automatically closes the Schematic SVDB Setup dialog box when the run completes successfully. If there is any error in execution or if the process is terminated, the dialog box remains.

4. To cross-probe defects in Calibre RVE and Calibre DESIGNrev:

   - To cross-probe a defect listed in Calibre DefectReview to schematic nets in a schematic and layout viewer, in the Defect List, select a defect, right-click on its row header, and select **Highlight Nets in Schematic**.

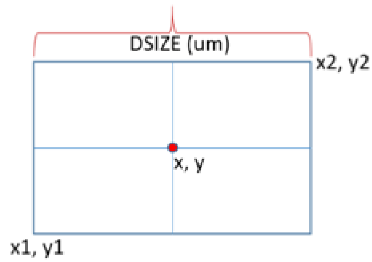
     If the SVDB was not previously set up, the SVDB Setup dialog box appears. Specify the required inputs in the **SVDB Settings** tab (as listed in Figure 19-22) and click **Submit**.

   - To highlight power nets in the schematic and layout viewers, select a defect and right-click in the Defect List's row header and select **Highlight Power Nets**.

     If the SVDB was not previously set up, the SVDB Setup dialog box appears. Specify the required inputs in the **SVDB Settings** and **Power Nets Settings** tabs (as listed in Figure 19-22 and Figure 19-23) and click **Submit**.

To retrieve names of nets affected by a defect, the defect region is used instead of just defect location. The defect region is specified using defect's DSIZE as follows:

Figure 19-24. Specifying Defect Region Using DSIZE



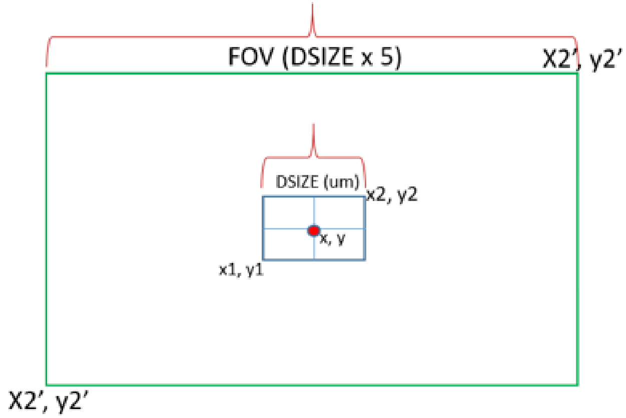
x1 = x – (DSIZE / 2), y1 = y – (DSIZE / 2)

x2 = x + (DSIZE / 2), y2 = y + (DSIZE / 2)

Where (x, y) is the defect location. The minimum defect region window size is 1x1 micron.

To highlight nets or power nets in schematic and layout viewers, the defect region is specified in same way as when retrieving net names. The Field of View (FOV) region to zoom in on in a layout viewer is set to five times greater than DSIZE. The minimum FOV region is 10x10 microns. In the layout viewer, highlighted nets are clipped to the FOV size.

Figure 19-25. FOV Region and DSIZE



Results

The following figures show an example of cross-probing nets affected by a defect in Calibre RVE and Calibre DESIGNrev.

Figure 19-26. Cross-Probe Defect-affected Nets in Calibre RVE

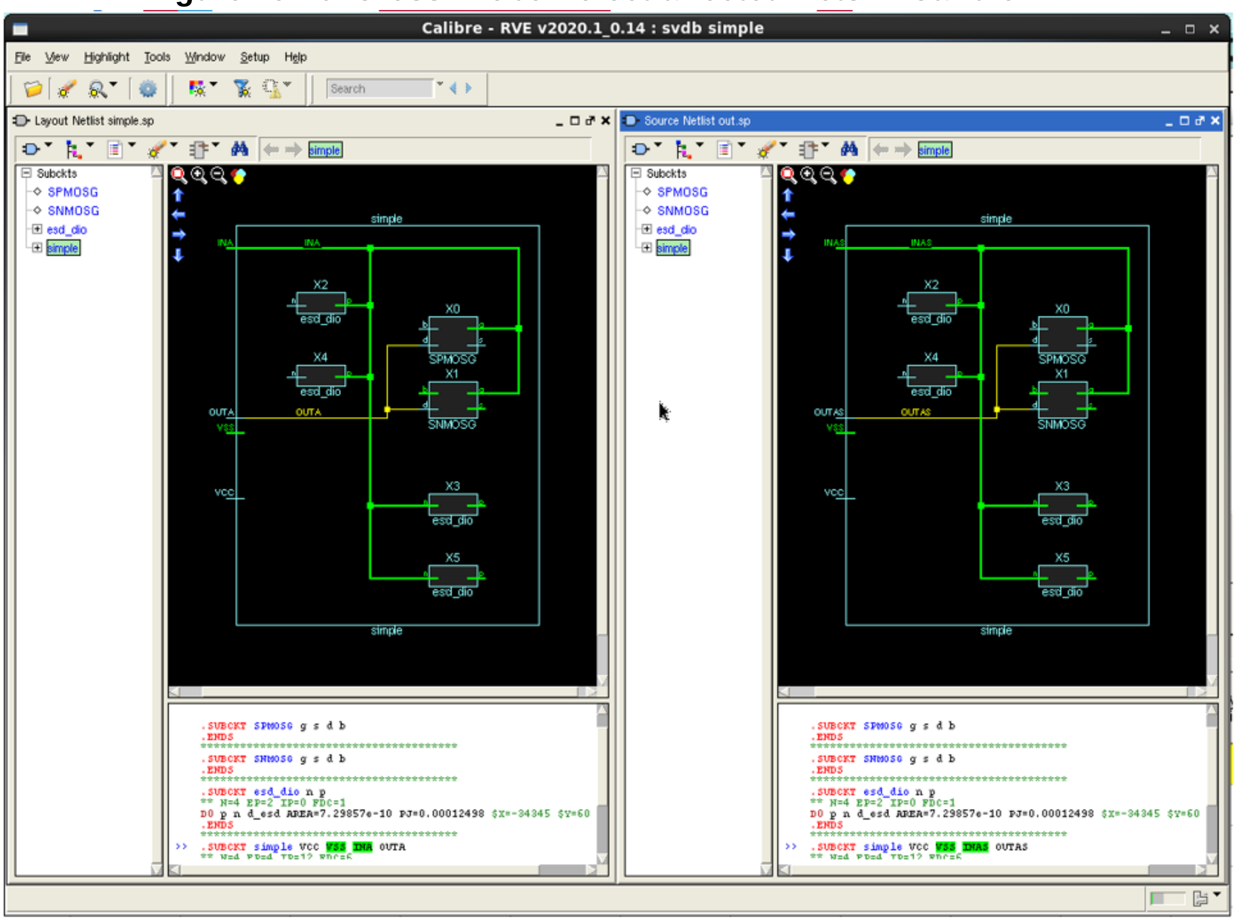
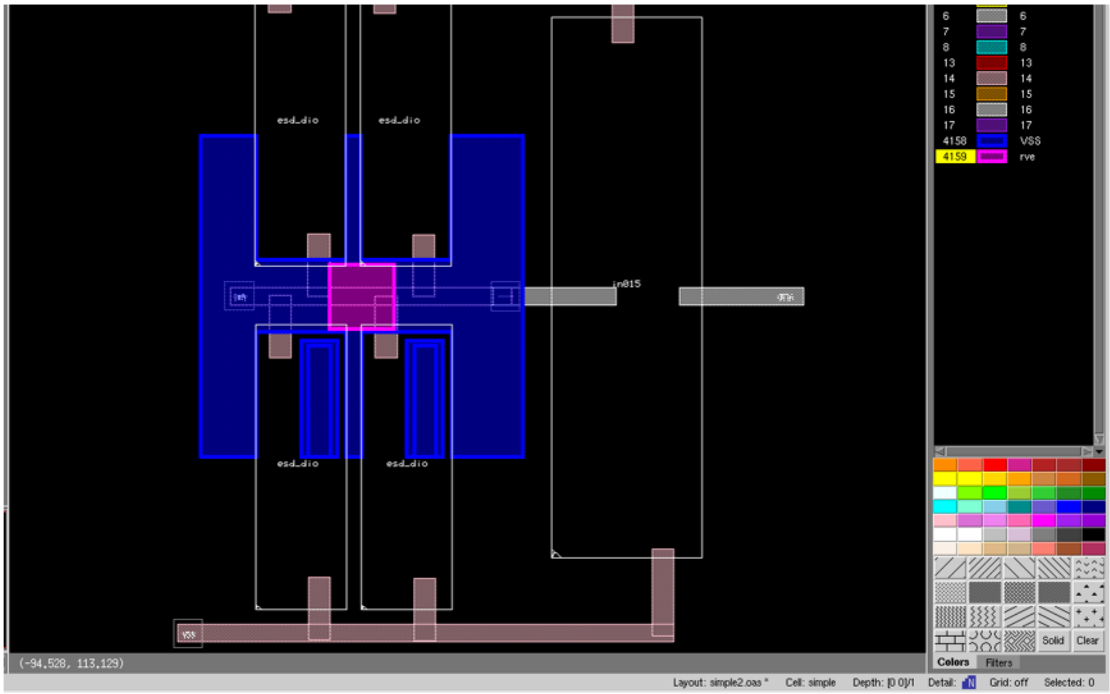


Figure 19-27. Cross-Probe Defect-affected Nets in Calibre DESIGNrev



Appendix A
Frequently Asked Questions

This appendix contains brief answers to commonly or frequently asked questions (FAQ) and also provides links to corresponding detailed information in this manual.

How Do I Set Up a PRO Floating License?

There are two tasks involved in setting up a PRO floating license: setting up the license server and setting the LM_LICENSE_FILE environment variable.

Information on setting up licensing is in the *Calibre Administrator's Guide*.

Why is Calibre DefectReview Not Starting With Windows?

Calibre DefectReview software requires the VC runtime redistributable software (Visual C++ Redistributable for Visual Studio 2015) and the MATLAB compiler runtime (MCR - Matlab Compiler Runtime v2015).

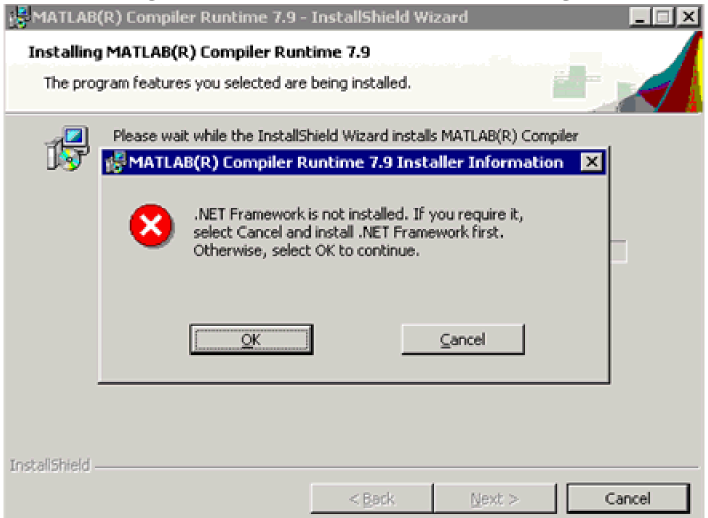
Calibre DefectReview may fail to start if the VC redistributable is not installed. If the Calibre DefectReview log file says that MCR initialization failed after installing the VC redistributable, try installing *C:\DefectAnalysisTool\VC_runtime_redistributables\vc_redist.x86.exe*. If it is not available in the package, then send a request to support.sw.siemens.com.

Why Do I Get an Error Message When Installing MCR?

When installing the MATLAB compiler runtime (MCR), an error message may appear when the VC redistributable is not installed. Try installing the VC redistributable, located in *C:*

DefectAnalysisTool\VC_runtime_redistributables\vcredist_x86.exe, and then attempt to install MCR again.

Figure A-1. MCR Error Message



How Do I Configure a Custom Functional Image in the IMU?

The IMU provides functional images for absolute difference, average, blinking, and sum. New functional images are created by specifying operations between images, usually the reference image and a defect image.

Restrictions and Limitations

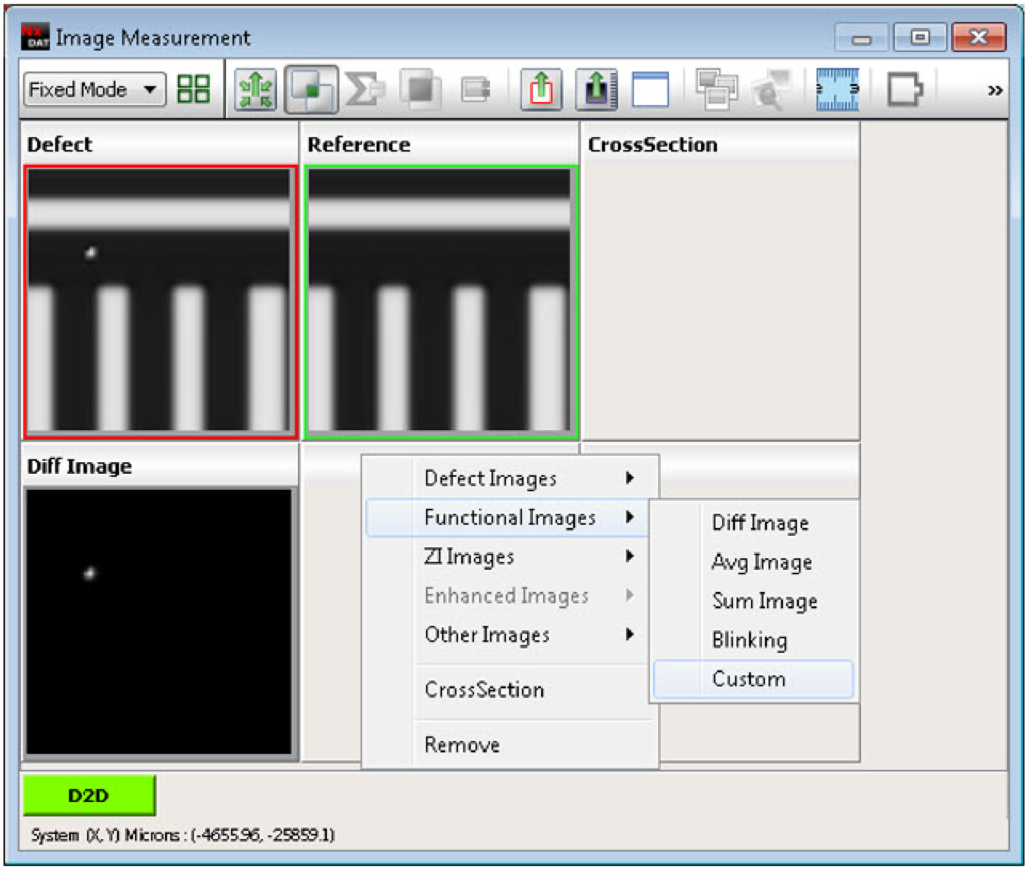
- Functional image can only be created between images which have same number of pixels in X and Y as well as the same pixel size.
- You cannot create blinking functional images.

Prerequisites

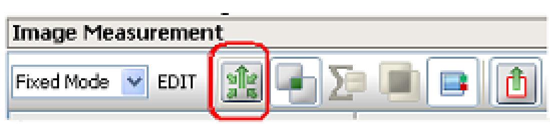
- The Image Measurement window is open.
- At least two images are open.

Procedure

1. In the IMU, open the context menu by right-clicking on an image place holder.

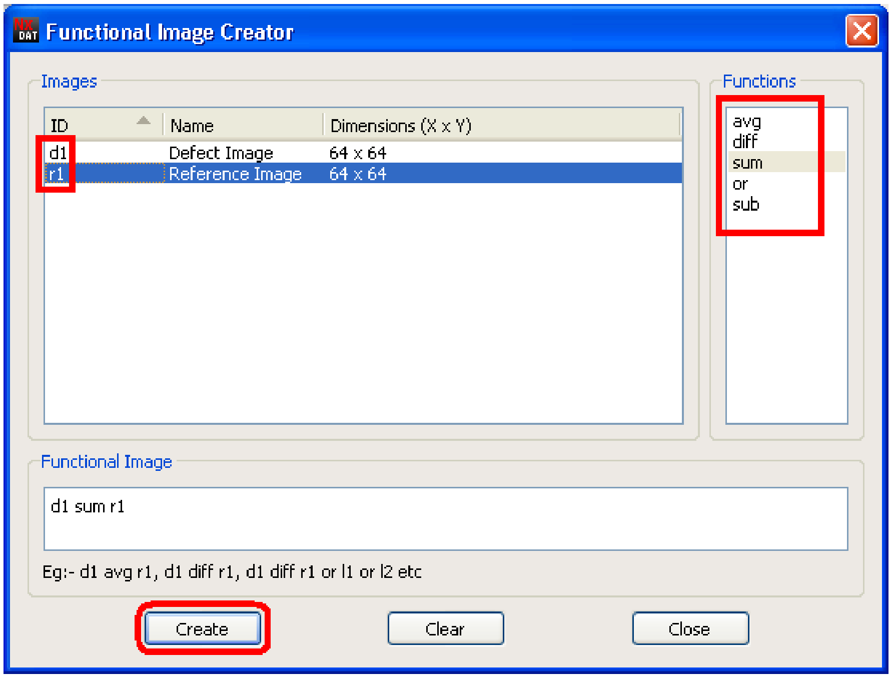


2. Select **Functional Images** > **Custom**.
3. Click the**Create Functional Image** button to open the Functional Image Creator dialog box.



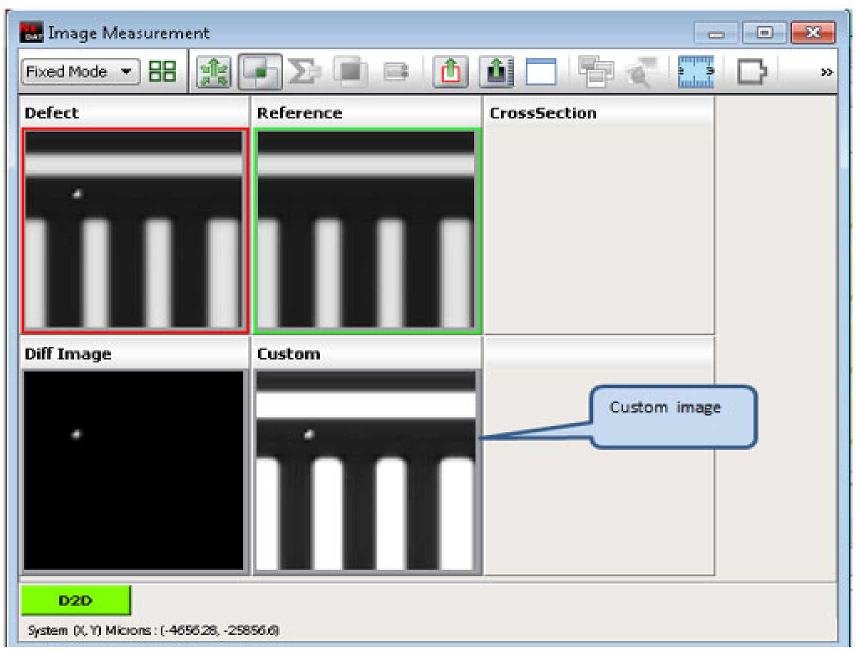
4. In the Functional Image Creator dialog box, define the function.
   a. Click the ID of the first image.
   b. Click the function to be applied between the images.
   c. Click the ID of the second image.

d. Click **Create**.



Results

The image is created and displayed in the functional area of the IMU.



How Do I Change the IMU Grid Layout?

The IMU grid layout is the two-dimensional array in which the display units (images and cross-section results) are arranged. The change only persists through the session unless you save the dock layout.

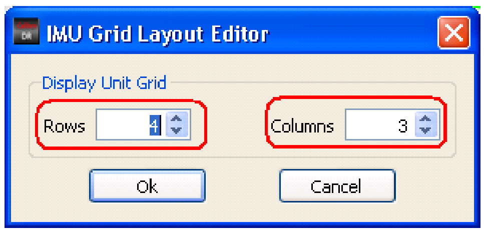
Prerequisites

- The IMU is open.

Procedure

1. Click the **Edit** button to open the IMU Grid Layout Editor.

2. In the IMU Grid Layout Editor, enter the number of rows and columns and click **OK**.



3. To save the grid layout for future sessions, select **Dock Layout** > **Save**.

Related Topics

Configuring the Image Grid Display

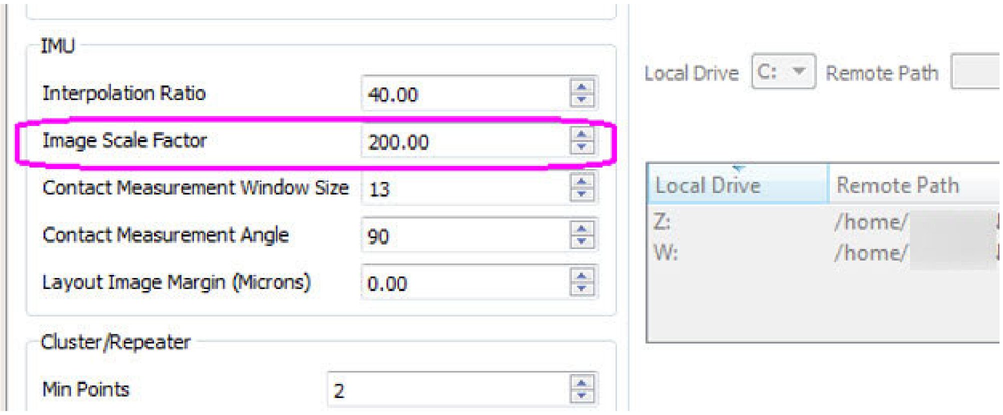
How Do I Increase the Size of Images?

The initial image size in the Calibre DefectReview IMU is set in the Calibration Parameter Editor.

Procedure

1. In the Calibre DefectReview main window, select **Utilities** > **Calibration Parameter Editor**.

2. In the Calibration Parameter Editor dialog box, set the Image Scale Factor. By default, this is 197.



How Do I Automatically Classify Defects?

Calibre DefectReview can automatically classify defects based on the size as reported by the mask inspection machine. However, it cannot represent different defect sizes with different colors or be configured to give a warning message on large defects.

Procedure

1. In the*dat-ini.xml* file, define the classifications. Units are in square microns. The syntax is as follows:

```
<DefectSizeClassification>
   <area range="[min1,max1)" type=”label1” />
   <area range="[min2,max2)" type=”label2” />
   ...
   <area range="[minN,maxN]” type="labelN” />
</DefectSizeClassification>
```

   Notice that the upper end of all but the last range are closed with a “)”, meaning “up to, but not including, the max value.” This is to prevent a defect that exactly matches a boundary value being placed in two classes.

2. Enable the Defect Size column by setting the “visible” node to yes. For example,

```
<column name=”DefectSize”>
   <visible>yes</visible>
   <miShow>yes</miShow>
   <siShow>yes</siShow>
   <specdeftype>yes</specdeftype>
   <valuetype>string</valuetype>
   <multiValue>0</multiValue>
</column>
```

3. Save the *dat-ini.xml* file.

4. Restart Calibre DefectReview.

Results

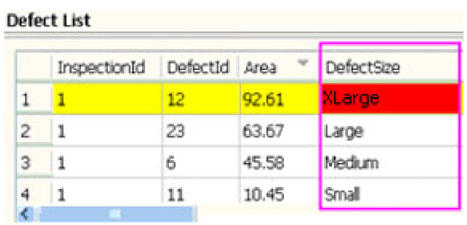
When loading an inspection file, the Defect Size column displays the classification of defects according to the area range specified in the DefectSizeClassification node.

To further filter defects belonging in a specific range, set a defect size filter in the Defect Selection widget.

Examples

For a DefectSizeClassification that classifies defect areas under 12 square microns as “Small”; 12 to 13 square microns as “Medium”; 13 to 14 square microns as “Large”; and 14 to 18 square microns as “Xlarge”, the node and Defect List would look as follows:

```
<DefectSizeClassification>
   <area range="[0,12)" type=”Small” />
   <area range="[12,13)" type=”Medium” />
   <area range=”[13,14)” type=”Large” />
   <area range="[14,18]” type="Xlarge” />
</DefectSizeClassification>
```


Defect List

	InspectionId	DefectId	Area	DefectSize
1	1	12	92.61	XLarge
2	1	23	63.67	Large
3	1	6	45.58	Medium
4	1	11	10.45	Small

Related Topics

Automatic Defect Classification Using Defect Size

Appendix B
Calibre DefectReview GUI Quick Reference

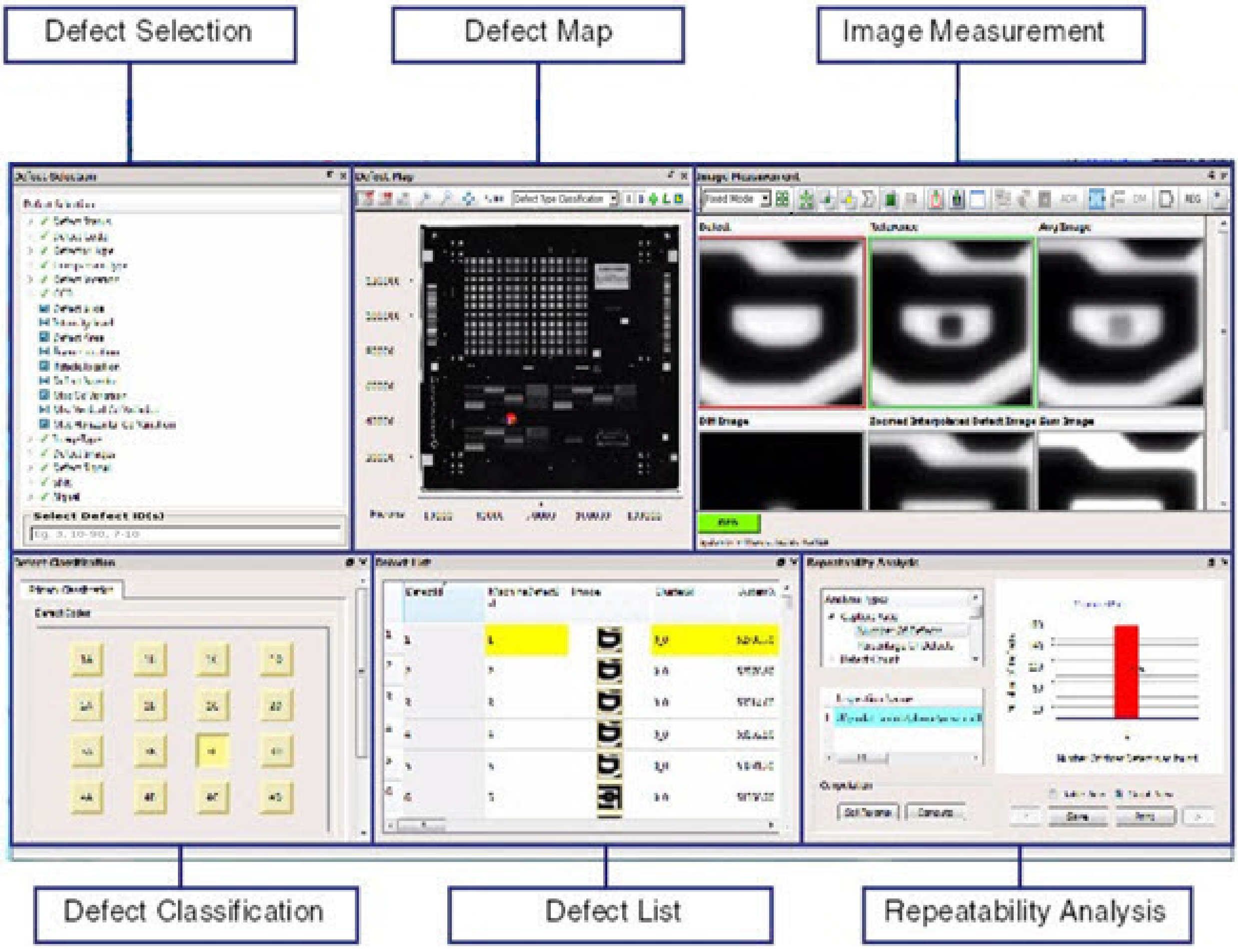
The Calibre DefectReview main window contains a number of functional regions for defect analysis and classification.

Calibre DefectReview Window GUI Reference

To access: Install Calibre DefectReview and invoke as described in "Invoking Calibre DefectReview on Windows Hosts" on page 41.

The Calibre DefectReview interface is organized into several dockable and resizable sub-windows, each with key functionality.

Figure B-1. Functional Areas of the Calibre DefectReview Window



Objects

The following table describes each functional area of the Calibre DefectReview main window.

Table B-1. Calibre DefectReview Functional Areas

Window	Description
Defect Map	Provides a graphical view of the defects as well as a convenient spatial way to navigate defects. Refer to "Defect Map" on page 115 for details.

Table B-1. Calibre DefectReview Functional Areas (cont.)

Window	Description
Defect List	Provides a table view of the defect properties. The Defect List enables you to navigate defects based upon their sorted properties. Refer to "Defect List" on page 157 for details.
Defect Selection	Provides options to select a subset of defects present in the input inspection file. Refer to "Defect Selection" on page 187 for details.
Defect Classification	Provides an interface for classifying defects. Refer to "Defect Classification" on page 207 for details.
Image Measurement	Displays defects and provides utilities for analyzing images associated with a defect. Refer to "Image Measurement" on page 265 for details.
Repeatability Analysis	Provides an interface to analyze multiple inspections together and perform repeatability analysis on these inspections. Refer to "Repeatability Analysis" on page 225 for details.

The following table lists all options on the Calibre DefectReview menu bar.

Table B-2. Calibre DefectReview Menu Bar Options

Menu Item		Description
File		
	Open Inspection(s)	Opens a single inspection file or a set of inspection files and loads the files into Calibre DefectReview. If this option is clicked from a session with loaded files, the new files are opened in a new session.
	Open Database Inspection(s)	Opens a single or multiple inspection results present in a database.
	Save Reticle Info to DB	Saves a Reticle Information File to a database.
	Search And Open Inspection(s)	Opens a dialog box to search for inspection files.
	Add Inspection(s)	Opens one or more inspection file.
	Search And Add Inspection	Works the same as Search And Open Inspection(s) with except you only open a single inspection to add to the current Calibre DefectReview session.
	Refresh	Re-loads the inspection file.
	Close	Closes a single inspection in Calibre DefectReview session where multiple inspections are open.
	Close All	Closes currently-open files and unloads the files from the current Calibre DefectReview session.

Table B-2. Calibre DefectReview Menu Bar Options (cont.)

Menu Item		Description
	Save	Saves the current status of the inspection file into the file itself. This overwrites the inspection file.
	Save As	Saves the current status of the inspection file into the default working folder.
	Save to DB	Saves the current inspection file to a database.
	Exit	Closes the current session of Calibre DefectReview.
	Exit All	Closes all the opened sessions of Calibre DefectReview.
View		
	Show Default View	Shows the Defect Map, Defect List, Defect Selection, Defect Classification and Image Measurement Unit in the default layout.
	Defect Selection	Shows or hides the Defect Selection window.
	Defect Map	Shows or hides the Defect Map window.
	Defect List	Shows or hides the Defect List window.
	Image Measurement	Shows or hides the Image Measurement window.
	Defect Classification	Shows or hides the Defect Classification window.
	Repeatability Analysis	Shows or hides the Repeatability Analysis window.
Utilities		
	Calibration Parameter Editor	Provides an interface to edit or modify the default values for parameters used by Calibre DefectReview and allows you to save inspection files in multiple locations. Refer to "Calibration Parameter Modification" on page 367 for details.
	Read Write Plugins	Provides an interface to specify the external reader or writer plug-ins to read or write inspection files in different formats. Refer to "Configuring Read Write Plugins" on page 369 for details.
	Manage Users	Provides an interface to add or delete users. Refer to "User Management" on page 50 for details.
	Start Recording	Starts recording the operations performed on currently loaded files. "Recording Operations" on page 371.
	Stop Recording	Stops recording the operations performed on currently loaded files. Refer to "Recording Operations" on page 371 for details.

Table B-2. Calibre DefectReview Menu Bar Options (cont.)

Menu Item		**Description**
	Run Recorded Script	Runs the steps recorded in the script file. Refer to "Recording Operations" on page 371 for details.
	Save Defect List	Saves the contents of the Defect List into CSV format. Refer to "Saving a Defect List" on page 375 for details.
	Delete Unselected	Deletes all the unselected defects. Refer to "Deleting Unselected Defects" on page 379 for details.
	Auto Cluster	Performs auto clustering of defects based on specified cluster parameters in normal mode or by looking in reference. Refer to "Auto Clustering" on page 371 for details.
	Auto Grid Detection	Performs auto grid detection on the defects in X or Y direction. Refer to "Auto Grid Detection" on page 374 for details.
	Load Image File	Loads a standalone image file to Calibre DefectReview. Refer to "Loading Image Files" on page 365 for details.
	Unfilter All Filtered	Shows all filtered defects. Refer to "Unfiltering All Filtered Defects" on page 379 for details.
	Export	Converts inspection files into text format.
Dock Layout		
	Save	Saves the layout configuration of Calibre DefectReview. Refer to "Saving and Loading a Dock Layout" on page 385 for details.
	Load	Loads the previously saved layout configuration into Calibre DefectReview. Refer to "Saving and Loading a Dock Layout" on page 385 for details.
	Save for Restricted User	Saves the layout configuration for restricted users of Calibre DefectReview. Refer to "Saving and Loading a Dock Layout" on page 385 for details.
	Export Display Layout	Exports the display layout of Calibre DefectReview. Refer to "Exporting a Display Layout" on page 386 for details.
	Export Display Layout for Restricted	Exports the display layout of Calibre DefectReview for RESTRICTED users. Refer to "Exporting a Display Layout" on page 386 for details.
Transform		
	Rotate	Rotates the mask. Refer to "Rotate" on page 407 for details.

Table B-2. Calibre DefectReview Menu Bar Options (cont.)

Menu Item		Description
	Flip	Flips the mask. Refer to "Flip" on page 408for details.
	Translate	Translates the mask. Refer to "Translate" on page 410 for details.
	Inspection Transform Settings	Sets transformations for each of the inspection file format. Refer to "Saving and Loading Reference Points" on page 412 for details.
	Align Inspection	Aligns multiple inspection reports related to a specific reticle. Refer to "Automating Inspection Report Alignment" on page 412 for details.
Settings		
	Set Binary Image Properties	Sets the gray level threshold for conversion of images to the binary format. Refer to "Setting Binary Image Properties" on page 348 for details.
	Set CD Measurement Properties	Sets the target CD value or the threshold GL value for CD measurement. Refer to section "Setting CD Measurement Properties" on page 348 for details.
	Set Contact Measurement Properties	Sets the gray level value or X and Y diameter of the contact or area of the contact for contact measurement. Refer to "Setting Contact Measurement Properties" on page 349 for details.
	Set Image Interpolation Properties	Sets the image interpolation ratio to be used when displaying interpolated images in Image Measurement. Refer to "Setting Image Interpolation Properties" on page 351 for details.
	Set Image Window Properties	Sets the window size to be displayed when displaying interpolated images in Image Measurement. Refer to "Setting Image Window Properties" on page 351 for details.
	Set Reference Point	Sets the alignment and reference points to be used for translating defect inspection data in X and Y direction. Refer to "Translate" on page 410 for details.
	Set Color Scheme	Sets the selected color scheme for displaying the colored images. For more details, refer to "Setting the Image Color Scheme" on page 298
	Set Record Script	Provides interface to specify a TCL script for storing the commands to be recorded. Refer to "Recording Operations" on page 371 for details.
Layout		

Table B-2. Calibre DefectReview Menu Bar Options (cont.)

Menu Item		**Description**
	Data Preparation	Provides interface to enter and save the inputs for preparing layout data. Refer to "Data Preparation" on page 390 for details.
	Correlation	Provides interface to edit the transformation parameters for the layout file. Refer to "Correlation of Transform Data" on page 397 for details.
Reports		
	Show Inspection Reports	Displays the reports generated by Calibre DefectReview. Refer to "Inspection Review Reports Window" on page 354 for details.
	Save Repeatability Reports	Provides option to save the repeatability reports generated by Calibre DefectReview. Refer to section "Generating Repeatability Reports" on page 362 for details.
Help		
	Calibre DefectReview Help	Launches a documentation viewer for Calibre DefectReview.
	Calibre MDPAutoClassify	Launches the documentation for Calibre MDPAutoClassify.
	About Calibre DefectReview	Displays the version number, target installer and build date of the tool.

The following table lists all options on the Calibre DefectReview tool bar.

Table B-3. Calibre DefectReview Tool Bar

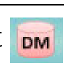
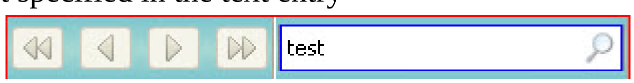
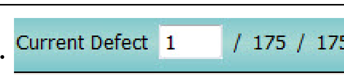
Control	**Description**
Open Inspection(s) 	Opens a single inspection file or a set of inspection files and loads the files into Calibre DefectReview. If this option is clicked from a session with loaded files, the new files are opened in a new session.
Defect Management 	Opens the Defect Management window, which allows you to perform defect trend analysis across inspections. Some example includes region analysis, defect source analysis and blank defect transfer analysis.
Base Inspection 	Specifies an inspection report as a base for comparing different inspection reports. This icon is visible only for normal and privileged users.
Migrate Database 	Updates a legacy inspection database to be compatible with the current version of Calibre DefectReview.

Table B-3. Calibre DefectReview Tool Bar (cont.)

Control	Description
Show DefectClassifyReport	Displays a report used to analyze the result of Calibre DefectClassify runs on different inspection reports.
Open Inspection Database	Opens a single or multiple inspection results present in the database.
Add Inspection(s)	Adds one or more inspections to existing Calibre DefectReview sessions.
Search and Add Inspection	Opens a dialog box to search for an inspection file and add it to the existing Calibre DefectReview session.
Refresh	Re-loads the inspection file.
Close	Closes a single inspection in Calibre DefectReview session when multiple inspections are opened
Close All	Closes the currently opened files and unloads the files from the current Calibre DefectReview session.
Save	Saves the current status of the inspection file into the file itself. This overwrites the inspection file.
Save As	Saves the current status of the inspection file into another file.
Save to DB	Saves the current inspection file to a database.
Information	Displays the mask, recipe and setup information.
DefectClassify	Invokes the Calibre DefectClassify tool, which enables automatic classification of defects observed on a patterned mask. See the *Calibre DefectClassify User Manual* for information
MDPAutoClassify	Invokes the Calibre MDPAutoClassify tool, which is used for automatic classification of defects observed on a blank mask substrate. See the *Calibre MDPAutoClassify User Manual* for information.
Navigate Defects	Navigates to the first, previous, next, or last defect, or to the defect specified in the text entry field. 
Current Defect	Displays the current defect number. 

Glossary

critical dimension (CD)

The width measured on any pattern of a defect image based on a GL value. The critical dimension is more commonly referred to as “CD.”

CSV file

Comma separated values file.

current defect

The defect which is currently selected. The current defect is displayed as follows:

- It is highlighted in the Defect Map and Defect List.
- The images are displayed in the IMU.
- The classification code is highlighted in Defect Classification.
- The defect ID is displayed in the current defect box present in tool bar.

current selected defect

See current defect.

dat-ini.xml file

An XML file used by Calibre DefectReview to specify all default tool behavior. This file is used by all Calibre DefectReview tools, including Wi2Mi.

dock widget

A widget that can be attached to the edge (docked) inside the main window in any GUI layout or floated (undocked) as a top-level window on the desktop. Dock widgets can be moved inside their current area, moved into new areas and floated (for example, undocked) by the user.

die-to-die inspection (D2D)

An inspection that compares two dies of a mask for defects.

die-to-die reflected (D2DRef)

A D2D inspection in which one die is reflected across the X or the Y axis relative to the other die.

field cycle

A value indicating the number of dies in the x and y directions in the mask field.

field die

The index of the wafer die that is used as the reference for die stacking. The field die maps to the lower-left bottom die of the reticle.

gray level (GL) value

The value of a pixel indicating the relative intensity.

image registration

Sets of data acquired by sampling the same scene or object at different times, or from different perspectives, will be in different coordinate systems. Image registration is the process of transforming the different sets of data into one coordinate system. Registration is necessary in order to compare or integrate the data obtained from different measurements.

inspection file or defect file

A file generated from a mask inspection system containing defects found during an inspection run.

inspection database

A database created using the Data Preparation utility in Calibre DefectReview. The Data Preparation utility searches the defect coordinates in the entire mask and shows the layout or mask images corresponding to the defect.

reflection

Data that has been flipped around the x-axis or y-axis, then translated so that the coordinates of the entire area are the same as before. Data cannot be reflected across both the x-axis and y-axis; only one reflection can be applied at a time.

See also *rotation*, *x-reflection*, and *y-reflection*.

reticle coordinate

A coordinate in the inspection file that gives the location of each defect. Unlike the system coordinate, the reticle coordinate does not change.

rotation

A process that rotates the data in an anti-clockwise direction. Rotations are limited to multiples of 90 degrees. Rotating data also updates the system coordinates.

scale factor

The number by which the wafer inspection data is resized so that the wafer inspection data and mask inspection data are comparable. In Calibre DefectReview, the following formula is used:

$$\text{scale factor} = \frac{\sqrt{(mask - Xpitch)^2 + (mask - Ypitch)^2}}{\sqrt{(wafer - Xpitch)^2 + (wafer - Ypitch)^2}}$$

stacking

A method of arranging the dies in the wafer data such that the order matches that of the dies of the reticle cycle. This rearrangement is necessary in order to compare the mask and wafer inspection data.

system coordinate

A coordinate used in the Calibre DefectReview graphical interface that is relative to an arbitrary reference point. The system coordinate is initially equal to the reticle. If the arbitrary reference point is redefined, then the system coordinate changes.

x-reflection

Mask data that has been flipped across the x-axis and translated to coincide with the previous lower-left bottom of the field cycle.

y-reflection

Mask data that has been flipped across the y-axis and translated to coincide with the previous lower-left bottom of the field cycle.

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Third-Party Information

Details on open source and third-party software that may be included with this product are available in the *<your_software_installation_location>/legal* directory.