YesVision™ User Manual

Version 2.7

For YTV Series AOI Systems

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Table of Content

1 Introduction

1.1 Automated Optical Inspection

Automated Optical Inspection (AOI) is a way of checking the assembly quality of printed circuit boards using machine vision techniques. In the last 10 years it has grown from a high tech gimmick with little practical value to become an indispensable part of the SMT assembly process.

AOI is much more than just inspection. Due to its consistent and repeatable nature, AOI is not only far superior to the human inspector in visual inspection; it is also an effective process control tool. Compared to other testing techniques, AOI has many advantages. It is inherently intuitive to setup. There is no need to understand the functionality of the circuitry or components to conduct an effective AOI inspection.

YESTech AOI systems are true yield enhancement solutions.

1.2 YESTech AOI Systems

YesTech's YTV- Series AOI systems are designed to provide a fast return on investment for its owner by combining high performance, ease of setup with low machine cost. YesTech's goal is to design and build AOI systems that can be easily justified and used on every SMT line.

To achieve high benefit to cost ratio YesTech engineers look into technologies available through the consumer product markets. Because of mass production consumer products usually have a much higher benefit to cost ratio than industrial products. Take the PC as an example, high end PC's performance is on par with the industrial workstation but at a fraction of its price. This means the PC has a much higher performance to cost ratio compared to industrial workstations. YESTech AOI systems use the PC's processing power for image processing. To augment the performance YTV-2080 AOI has an array PC architecture that combines the processing power of multiple PCs for high-speed inspection.

An other example is YesTech's Thin Camera™. Camera is a very important component of an AOI machine. High-resolution color cameras like the one used on the YesTech AOI machines can cost up to $5000 each in the industrial camera market. YesTech's Thin Camera™ combines the technology used in high quality digital still camera and the high transfer rate of the USB 2 bus to achieve the same quality and performance of industrial cameras at an order of magnitude less in cost. The low cost and the compact form factor of the Thin Camera™ also allows YesTech AOI systems to deploy many cameras (up to 8 in YTV-2080), to increase inspection speed and defect coverage.

YesTech's YTV-F1 and M1 AOI machines can be used in three areas of the SMT line; post paste print, pre-reflow and post-reflow. The YTV-B3 AOI can be used offline on a work bench.

YesTech's engineering team has many years of experience designing AOI machines. YTV Series is designed using state of the art 3D modeling technology. Not only is it a superb design produced in record time, there is also a complete set of easily understandable assembly documentation. Both of which allow the YesTech AOI machines to be manufactured fast, precise and cost effective.

1.2.1 System Block Diagram for YTV-F1

```
                                    ┌──────────────────────────────┐
                                    │           XY Stage           │
                                    └──────────────────────────────┘

        USB 2                        ┌──────────┐   ┌──────┐     24 and 5 V Power
                                     │  Camera  │───│ LCB  │
                                     │ Assembly │   └──────┘
                                     └──────────┘
                                  ┌──────────────────┐
                                  │ Top Light Assembly│
                                  └──────────────────┘
                              ┌──────────────────────────┐
                              │    Side Light Assembly    │
                              └──────────────────────────┘

        ┌────────────────────────────────────────────────────────────┐
        │ Auto Width Adjust Conveyor with Pneumatic Board Clamp and hard Stop │
        └────────────────────────────────────────────────────────────┘

              ┌──────────────┐              ┌──────────────┐
              │   EBOX 1     │              │   EBOX 2     │
              │  I/O Control │              │Servo Motor Control│
              └──────────────┘              └──────────────┘

                                   IEEE 1284        ┌──────────────┐
                                                    │ Air Inlet and│
                                                    │ Requlator /and│
                                                    │    Filter    │
    ┌──────────┐        ┌──────────┐                └──────────────┘
    │  SMEMA   │        │          │
    │Interface │        │    PC    │              Ethernet
    │Connectors│        │          │
    └──────────┘        └──────────┘

              ┌──────────┐  ┌──────────┐  ┌──────────┐
              │ Keyboard │  │   LCD    │  │  Mouse   │
              │          │  │ Monitor  │  │          │
              └──────────┘  └──────────┘  └──────────┘
```

3

1.2.2 System Block Diagram for YTV-B3

```
+-----------------------------------------------+--------+
|                  X Stage                      | Servo  |
|                                               | Motor  |
+-----------------------------------------------+--------+
       +------------------------------------+
       |          Camera Assembly           |
       +------------------------------------+
          +------------------------------+
          |       Top Light Board        |
       +------------------------------------+
       |          Side Light Board          |
       +------------------------------------+


          +------------------------------+
          |         Board Fixture        |
          +------------------------------+
     +-----------------------------------------+--------+
     |                Y Stage                  | Servo  |
     |                                         | Motor  |
     +-----------------------------------------+--------+


   +-------------------------------+    +------------------+
   |                               |    | Servo Controller |
   |            PC                 |    |       and        |
   | USB          Parallel Port    |    |     Driver       |
   +-------------------------------+    +------------------+
              |    |    |
                                              Ethernet
   +--------+  +-------+  +----------+
   |Keyboard|  | Mouse |  | Monitor  |
   +--------+  +-------+  +----------+
```

1.3 YESTech Automated X-ray Inspection System

YesTech's YTX-6000 is a fully automated X-ray inspection system. It can couple with an AOI machine to perform dual technologies inspection. The combined technologies result in unprecedented defect coverage, it allows both visually accessible and hidden defects (BGA solder defects for example) to be detected.
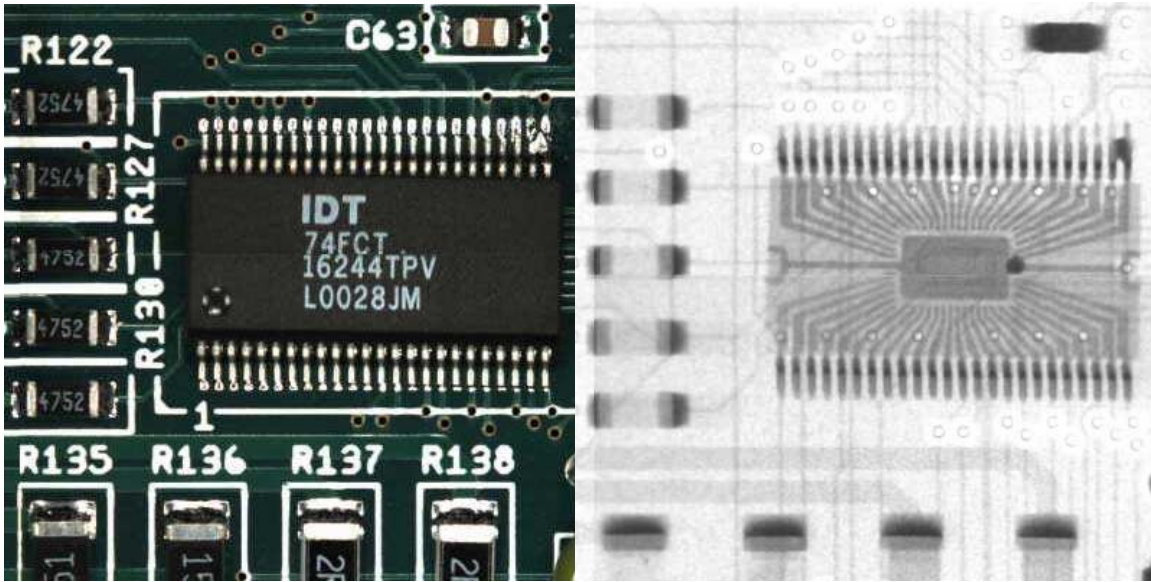
1.3.1 System Block Diagram for YTX-6000

USB2

X-ray
Camera

EBOX 1

I/O Control

X-ray
Intensifier

USB2

Alignment
Camera
Assembly

LCB

45 degree
mirror

Top Light
Assembly

Side Light Assembly

Left Shutter

Conveyor

XY Stage

Right Shutter

Z
Stage

EBOX 2

Servo Motor
Control

X-ray Tube

X-ray Power
Supply

RS232

USB2

PC

IEEE 1284

Keyboard

LCD
Monitor

Mouse

6
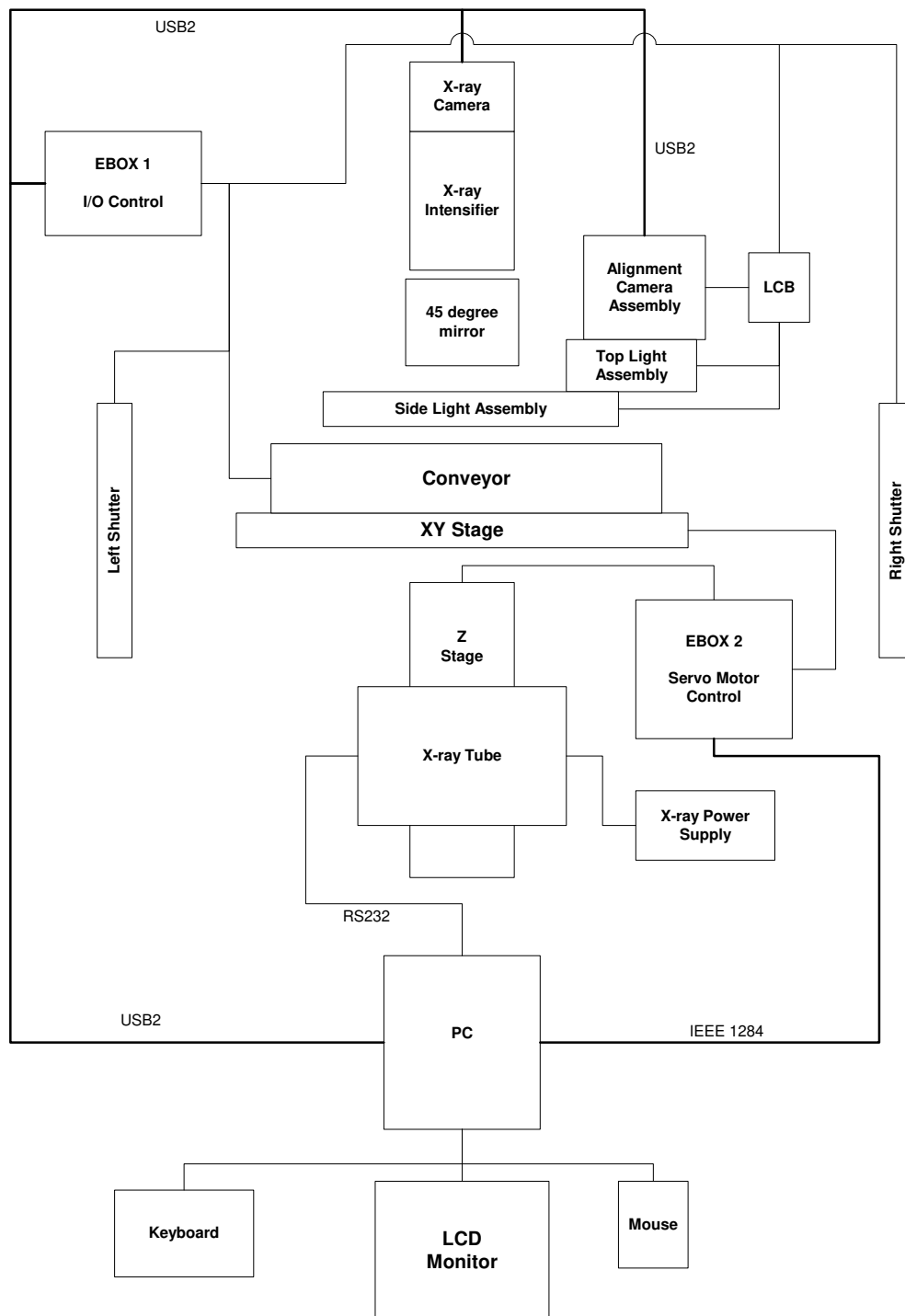
1.4 System Software

YesVision™ is the control software for both the YTV Series AOI machines and YTX-6000 inline X-ray inspection machine. It is specially designed for the Microsoft Window XP operating system. The user interface is application oriented. That means it is oriented towards SMT processes as oppose to machine vision functions. SMT workers will find it intuitive to use. It allows users to create a complete inspection recipe in a matter of minutes. YesVision™ is a powerful image processing engine that utilizes the processing power of the PC to perform complex machine vision operations. Moreover, YesVision™ can be deployed in parallel to harness the processing power of multiple PCs.
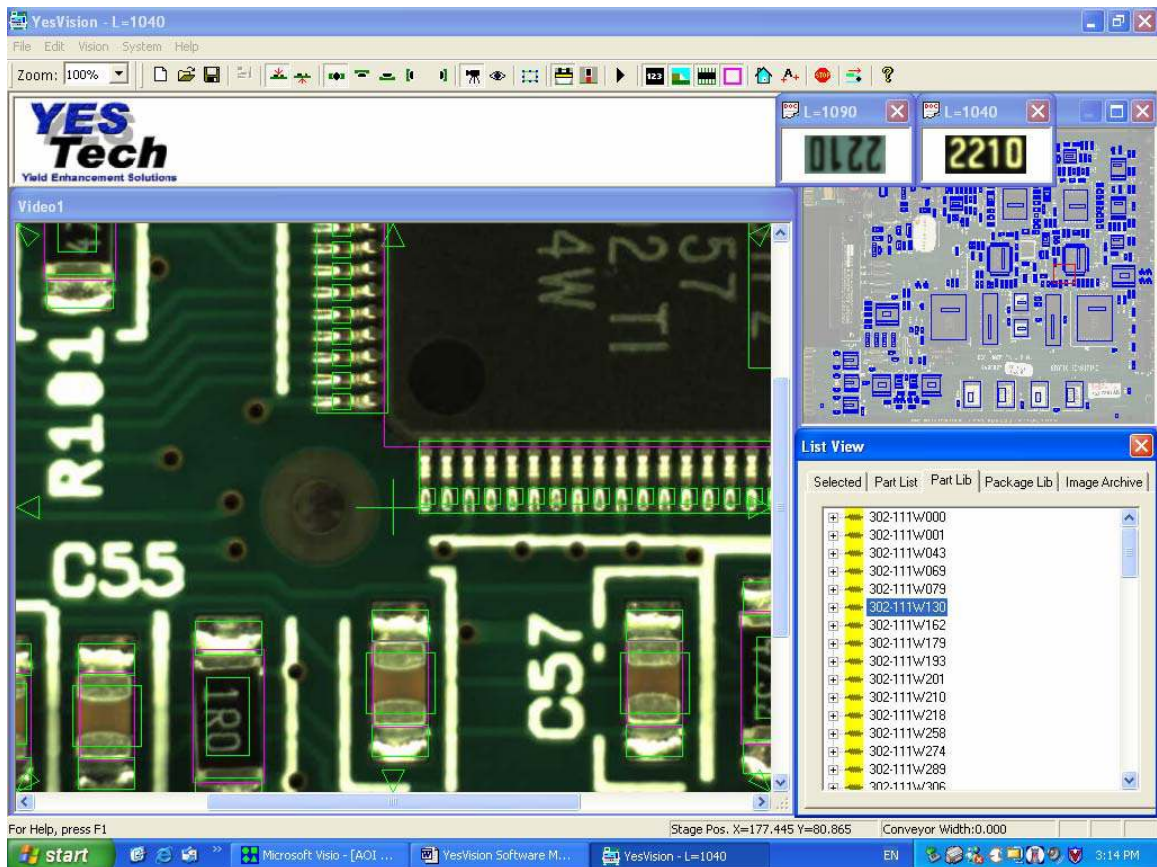
2 YTV-F1 Unpacking and Installation

YesTech typically sends field service engineers to install its YTV-F1 series AOI machines and to provide training to the new customers. However, it is not difficult to install and tune a newly arrived AOI machine. This section describes the steps:

2.1 Unpack

After unloading the machine from the truck, users should remove all the packaging material and lift the machine off the wooden pallet. The YTV-F1 series AOI weighs about 2000 lbs; you will need a power fork-lift to do that. The best place to insert the fork is from the back of the machine under the base frame.

All YTV machines have castors allowing it to be easily wheeled around by two people once on level ground. After moving the machine to the desired position user should lower its four leveling pads so that they lift the wheels up and support the entire weight of the system.

2.2 Remove Shipping Bracket

There is a red color shipping bracket (shown right) that holds the XY stage in place for shipping. It must be removed before operation.

2.3 Connect the Machine

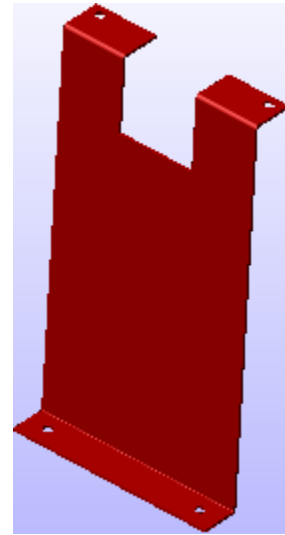The YTV-F1 AOI machine requires 120V single phase AC power. It draws about 7 amps of continuous current. Because of its low power consumption, it can be plugged into any common electrical outlet. A 40 psi or higher air pressure will be needed for the operation of pneumatic board clamp and board stops.

User should also connect the power and signal cables to the computer monitor which is disconnected during shipment.

Although not necessary, it is a good idea to connect Ethernet to the machines master computer. There is an extension that extends the network socket from the back of the computer to the back of the machine. User should plug the network cable to that extension.

2.4 Power On

The AC power first enters the machine via a circuit breaker which is mounted inside the base cabinet and can be reached by opening the lower back panel. This circuit breaker is left in the ON position when the machine leaves the factory; in normal circumstances there should be no need for the user to touch it. After the circuit breaker the power then reaches the emergency stop (E-Stop) switch and the power key switch both in front of the

machine. To power on the user needs to pull the E-Stop to its out position. The keys for the front power key switch are tire-wrapped onto the red shipping bracket during shipment. User should remove and insert the key into the key switch and turn it clockwise to unlock the power.

The last step in the power on process is to turn on the computer. The computer can be reached from the front of the machine by opening the lower front cabinet doors. The user may also need to turn on power to the LCD monitor. The computer and the monitor get their power from a UPS (Un-Interruptible Power Supply). There are times the UPS need to be reset. There is a red momentary push button on the UPS, pushing it will reset the UPS. The red button can be reached from the back when the back panel is opened. In fact the reset button is located below the main circuit break mentioned earlier.

2.5 Verify Calibration

After the computer boots up, the user needs to double click on the YesVision™ software icon on the desktop to launch the YesVision™ control software. The software will prompt user to log in please log in the default account as:

User Name: **user**
Password: **user**

This is the default account with all the privileges. Later the user can setup different user accounts according to the specific need. Please refer to section 20 **User Administration** for details.

As an optional final step user can enter "Machine Builder" mode to verify machine calibration. First the user needs to do is "Home the Conveyor". Please refer to section 9 **SMEMA Conveyor Setup** for details. Afterward the user should run the Self Test to verify all the machine calibrations. Refer to section 26 **Calibration and Verification** for details.

3   YTV-B3 Unpacking and Installation

YTV-B3 is designed to be installed by the customer. It is simple and straight forward to install and tune a newly arrived YTV-B3 AOI machine. This section describes the steps:

3.1   Unpack

After unloading the machine from the delivery truck, users should remove all the packaging material and lift the machine off its wooden crate. The YTV-B3 AOI weights about 170 lbs; you will need two persons to lift it.

Please do not try to lift the machine by grabbing on the fiberglass cover. Instead handle the system only by the solid metal base plate under the system.

3.2   Install Computer & LCD Monitor

For protection during shipping, the computer and LCD monitor are packed and shipped separately. Users need to unpack the computer and assemble the LCD monitor and place it on top or beside the system where it can be comfortably viewed by the operator.

3.3   Connect the Machine

The YTV-B3 AOI machine accepts 110 - 220V single phase AC power. It draws about 3 amps of continuous current. Because of its low power consumption, it can be plugged into any common electrical outlet. The AOI machines do NOT require a high pressure air supply. The 3 remaining connections in the bottom left corner of the back of the machine are to the computer and consist of 1 parallel and 2 USB cables.

Users should also connect the power and signal cables to the LCD monitor.

Although not necessary, it is a good idea to connect Ethernet to the machine's computer.

3.4 Power On

The AC power first enters the machine via a socket at the back of the machine. The power enters a circuit breaker which is mounted inside the cabinet and can be reached by opening the back panel. This circuit breaker is left in the ON position when the machine leaves the factory; in normal circumstances there should be no need for the user to touch it. After the circuit breaker the power then reaches the emergency stop (E-Stop) switch and the power key switch both in front of the machine. To power on the user needs to pull the E-Stop to its out position. The keys for the power key switch are tire-wrapped onto the handle of the front door during shipment. Users should remove and insert the key into the key switch and turn it clockwise to unlock the power.

The last step in the power on process is to turn on the computer. The user may also need to turn on power to the LCD monitor.

3.5 Verify Calibration

After the computer boots up, the user needs to double click on the YesVision™ software icon on the desktop to launch the YesVision™ control software. The software will prompt user to log in please log in the default account as:

User Name: **user**
Password: **user**

This is the default account with all the privileges. Later the user can setup different user accounts according to the specific need. Please refer to section 20 **User Administration** for details.

As an optional final step the user can enter "Machine Builder" mode to verify machine calibration. Refer to section 26 **Calibration and Verification** for details.

4 YTX-6000 Unpacking and Installation

YES Tech typically sends field service engineers to install the YTX-6000 machines and to provide training to the new customers. However, it is not difficult to install and tune a newly arrived YTX-6000 machine. This section describes the steps:

4.1 Unpack

After unloading the machine from the truck, users should remove all the packaging material and lift the machine off the wooden pallet. The YTX-6000 weighs about 5000 lbs; you will need a power fork-lift to do that. The best place to insert the fork is from the back of the machine under the base frame.

All YTX-6000 machines have castors allowing it to be wheeled around by 2 to 4 people once on level ground. After moving the machine to the desired position the user should lower its four leveling pads so that they lift the wheels up and support the entire weight of the system.

4.2 Remove Shipping Bracket

There is a red colored shipping bracket that holds the XY stage in place for shipping. It must be removed before operation.

4.3 Install the LCD Monitor

The LCD monitor is removed during shipment, during installation it is to be re-attached. When the YTX-6000 leaves the factory, the monitor arm assembly would be attached to the left side of the machine. However, the monitor arm assembly can be attached to either the left or the right side of the machine. During installation user would decide which side would be the most appropriate for attaching the monitor arm assembly.

4.4 Install the X-ray Tube

To prevent damage during shipment, the X-ray tube is removed from the machine and shipped in its own protective package. The X-ray tube needs to be installed into the machine during installation. The X-ray tube is held by 4 (1 ½" length ¼ 20 thread) screws. A (3/16") T-handle allen wrench is shipped with the system for those screws. (shown right)
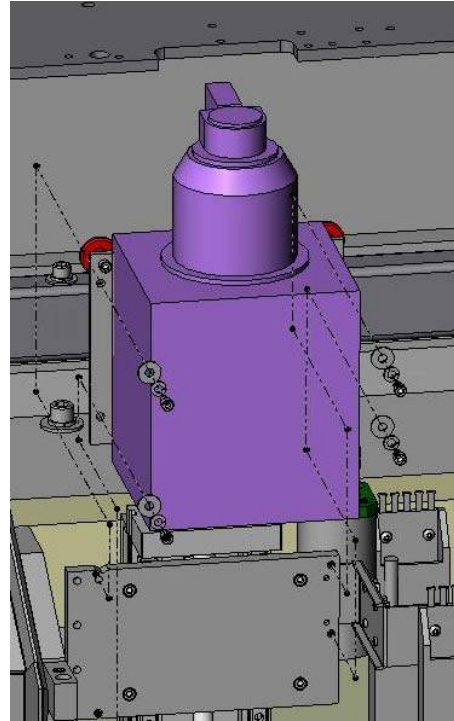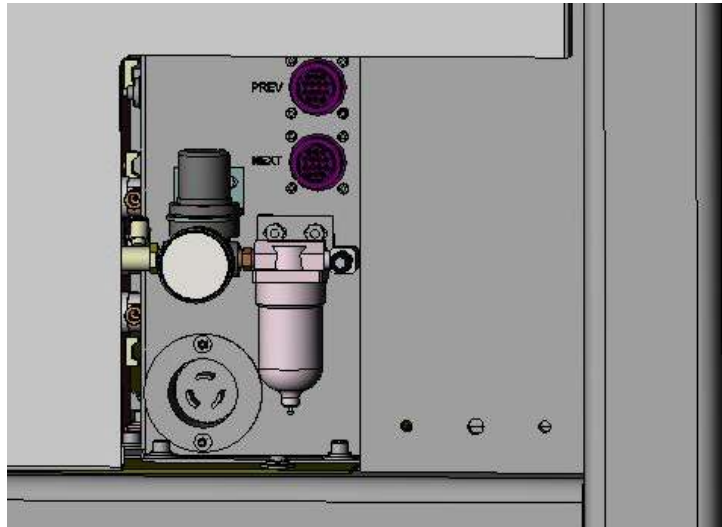
There is a protective stainless steel cover covering the X-ray emitting port. It needs to be removed before operation.

4.5 Connect the Machine

The YTX-6000 machine requires 120V single phase AC power. It draws about 7 amps of continuous current. Because of its low power consumption, it can be plugged into any common electrical outlet. The system also needs compressed air to operate its pneumatics, an 80 psi or higher air pressure will be required. Air inlet requires ¼ inch OD tubing.

Although not necessary, it is a good idea to connect Ethernet to the machine's computer. There is an extension that extends the network socket from the back of the computer to the left side of the machine. Users should plug the network cable into that extension.

4.6 Power On

The AC power first enters the machine via a circuit breaker which is mounted inside the base cabinet and can be reached by opening the lower back panel. This circuit breaker is left in the ON position when the machine leaves the factory; in normal circumstances there should be no need for the user to touch it. After the circuit breaker the power then reaches the emergency stop (E-Stop) switch and the power key switch both in front of the machine. To power on the user needs to pull the E-Stop to its out position. The keys for the front power key switch are tire-wrapped onto the red shipping bracket during

shipment. Users should remove and insert the key into the key switch and turn it clockwise to unlock the power.

The last step in the power on process is to turn on the computer. The computer can be reached from the front of the machine by opening the lower front cabinet doors. The user may also need to turn on power to the LCD monitor. The computer and the monitor get their power from a UPS (Un-Interruptible Power Supply). There are times when the UPS needs to be reset. There is a red momentary push button on the UPS, pushing it will reset the UPS. The red button can be reached from the back when the back panel is opened. In fact the reset button is located below the main circuit break mentioned earlier.

4.7 Verify Calibration

After the computer boots up, the user needs to double click on the YesVision™

software icon on the desktop to launch the YesVision™ control software. The software will prompt the user to log in, use the following User Name and Password:

User Name: **user**
Password: **user**

This is the default account with all the privileges. Later the user can setup different user accounts according to their specific needs. Please refer to section 20 **User Administration** for details.

As an optional final step users can enter "Machine Builder" mode to verify machine calibration. The first thing the user needs to do is "Home the Conveyor". Please refer to section 9 **SMEMA Conveyor Setup** for details. Afterward the user should run the Self Test to verify all the machine calibrations. Refer to section 26 **Calibration and Verification** for details.

5 User Interface Basics

The software's user interface is designed around its users. There are four types of users:

1. **Builder**
   YESTech employees who build the AOI machines use this mode of the software to calibrate and verify machine functionality.

2. **Maintenance**
   Maintenance personnel will use this mode of the software to ensure the machine's hardware integrity and calibration accuracy.

3. **Programmer**
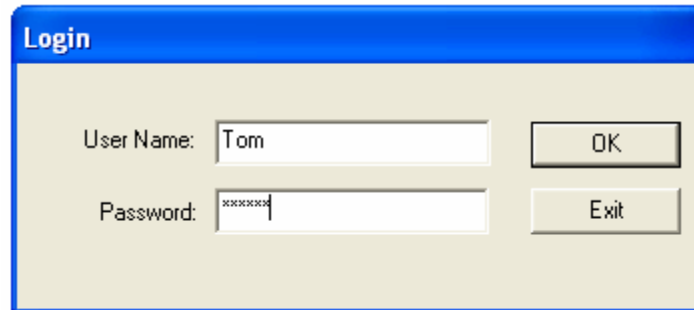   People who create and modify the inspection recipes will use this mode of the software.

4. **Operator**
   People who operate the system and run the inspection recipes will use this mode of the software to run/inspect boards.
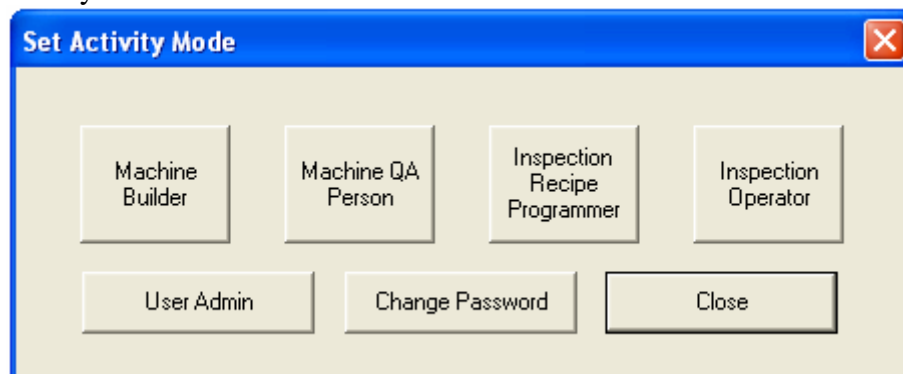
For each user mode the user interface is optimized to allow the users to achieve maximum efficiency. For example, in the builder mode the primary concern of the user is to identify any problem with the machine's electrical or mechanical hardware. In this case the software presents the user with a low level hardware control interface that allows him or her to insolate any problem quickly and take corrective actions. Also in this mode the software presents comprehensive self test features which objectively determine machine quality and production readiness.

5.1 Login

Each user mode is protected by password; a system administrator assigns access privilege to users based on the activity that user needs to perform. When the software starts a prompt for the user to login will appear.

Login

User Name: Tom

Password: ******

OK

Exit

Based on the user's access privilege, the appropriate user interface is selected. In case the user has multi-mode privileges the following dialog will appear for the user to select activity mode.

Set Activity Mode

| Machine Builder | Machine QA Person | Inspection Recipe Programmer | Inspection Operator |

| User Admin | Change Password | Close |

5.2   Video View

This window displays a video image of the board captured by the camera. A crosshair is provided to indicate the exact position of the camera. Image can be shown in 3 zoom levels 50%, 100% and 200%. The unique video navigation feature allows the user to control the position of the camera by pointing and clicking in this window. Pointing the mouse at a feature in the image and double click the system will move and center the feature with the crosshair. Arrows are also provided to allow incremental camera movement.
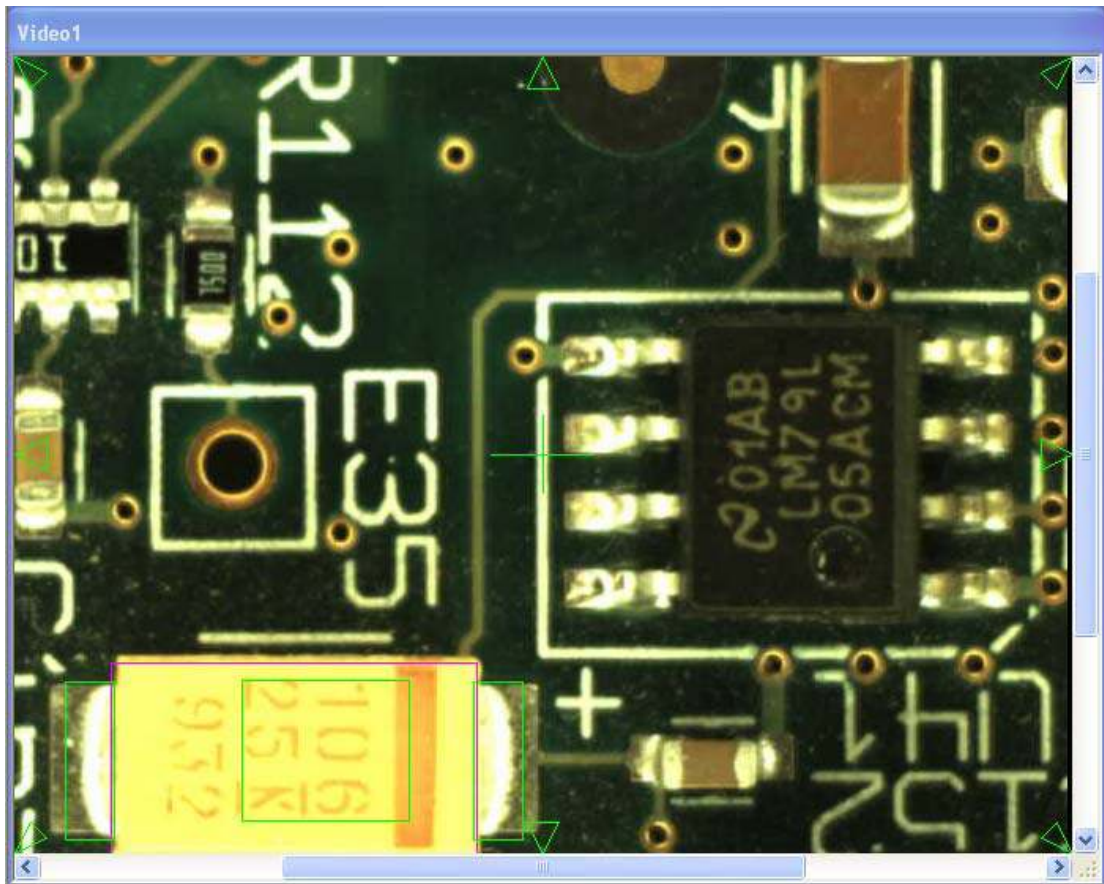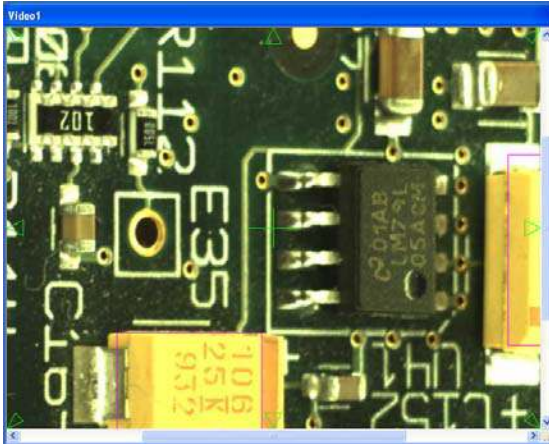
For systems with side cameras, the side views can be observed via this window.
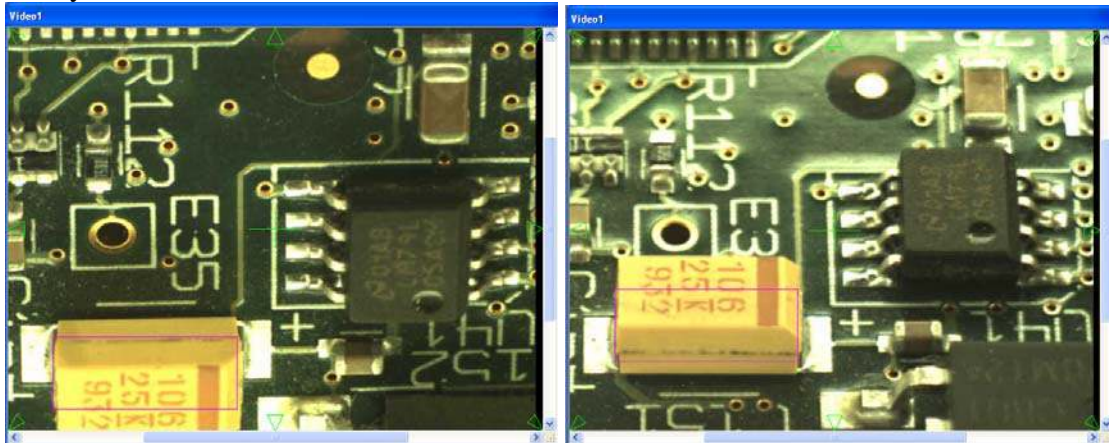
Back View

Front View

Left View
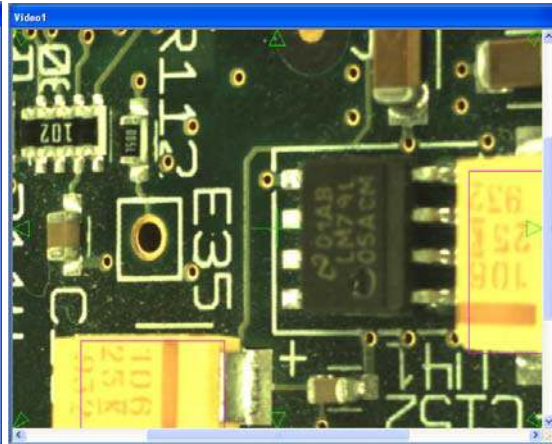
Right View

5.3   Map View

The Map View Window provides a complete view of the entire PCB. Each time a new part is trained, a small rectangle will appear on the Map View indicating the part position. A moving red rectangle marks the current camera position. The Map View is also a navigating tool: double-clicking the trackball (or mouse) on the map will move the camera to the corresponding position on the board.
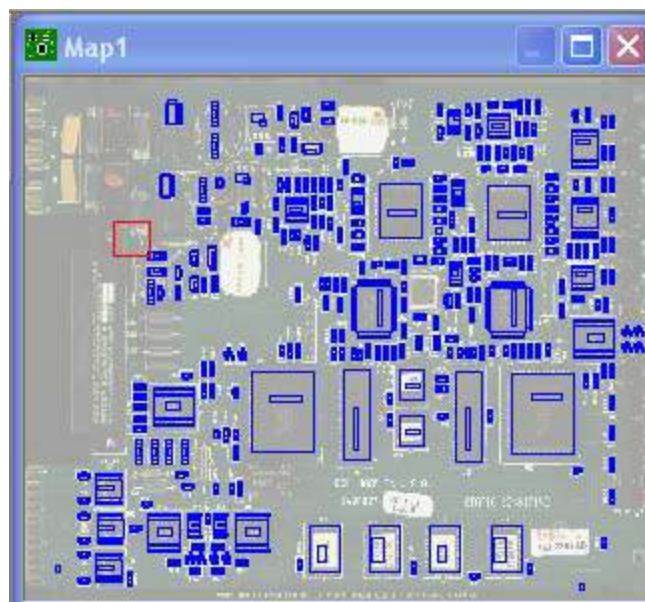
5.4   List View

This View has five pages: **Selected, Part List, Part Lib, Package Lib and Image Archive**. The **Selected** page lists the selected parts by Reference ID for review or walk through. The **Part List** page lists the entire part list of the board by reference ID. The **Part Lib** page lists parts by part number. The
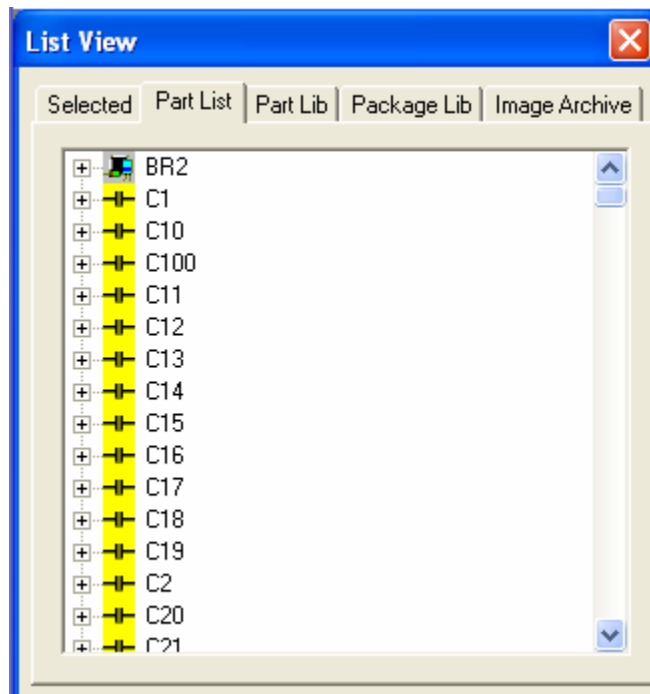
Package Lib page lists parts by package name. Lastly, the **Image Archive** page lists the available Image Set in the Image Archive for the current recipe.

In both the **Part List** page and **Selected** pages, the user can move the camera to the part on the board by double-clicking on the part ID in the list.

5.5   Main Menu

The main menu is customized to the activity mode the user log into. Recipe Programmer's main menu is different from that of the Machine Builder. To the right is the Recipe Programmer's main menu.

Most of the main items are either self-explanatory or their functions are explained in the later sections of this document. The sub-menu **ToolBar** and **Window** will be described here. The ToolBar sub-menu contains all the function that the button ToolBar provides. Its sole purpose is to allow users to use programmable keyboard accelerator to access the functions of the ToolBar. Programmable keyboards can provide one touch access to all the commonly used function of the software. They are commonly use to speed up the defect review process.

The Window sub menu handles window layout related features. In the YesVision software user can move and re-size the windows of the software. When the software is closed it will remember the window layout, and will restore it when the software re-starts. This menu provides 5 selections:

Show Status Window
Re-display the Status window after it was being closed.

Hide List View
Close the List View Windows.

To Default Layout
Re-layout the windows to default positions.
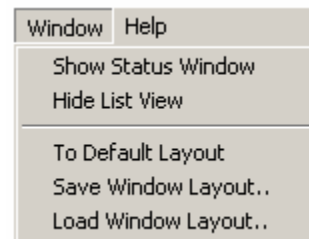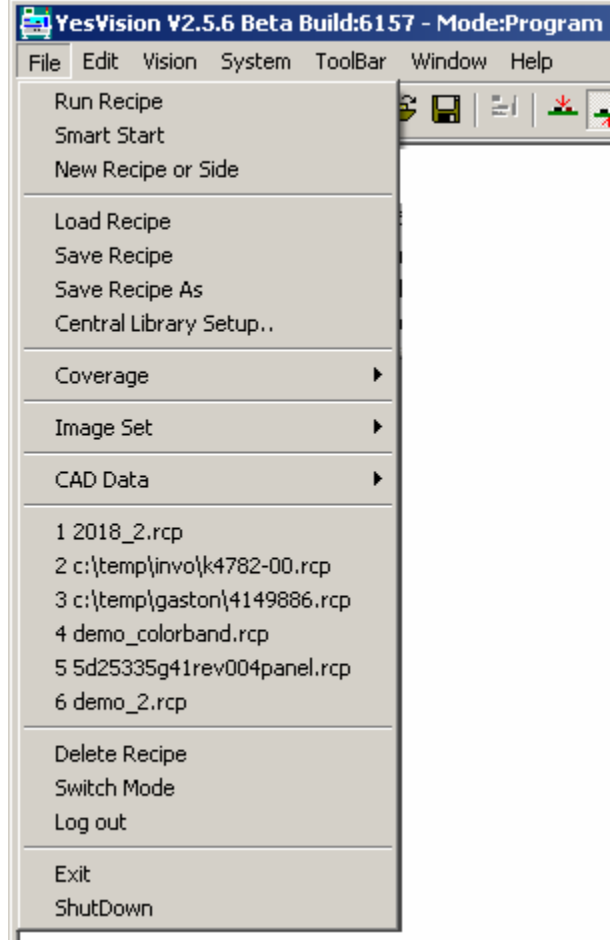
Save Window Layout
Save the current window layout to a disk file.

Load Window Layout
Load window layout from a disk file and layout the windows according to it.

5.6 Tool Bar

The toolbar buttons provide shortcuts for the commonly used menu selections:
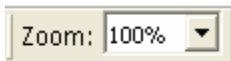
Zoom: 100% Video View Zoom factor selection.

Create new recipe.

Load recipe file from disk.

Save current recipe to disk.

Toggle on or off line.

Select top or bottom side part list for inspection. The left bottom selects the top side while the right bottom selects the bottom side.

Camera view selection; from the left to the right top view, back view, front view, left view and right view.

Select Capture mode.

Select Live mode.

Select Color filters, color, gray, red, green and blue. (only present for system with Fusion lighting)

Train new part manually without CAD data.

Toggle side light on or off.

Toggle top light on or off.

Select RGB light of Fusion lighting

Run Inspection.

Inspect Current Screen

These 4 buttons enable or disable the display of the region or interest boxes on the overlay. From left to right they enable/disable marking boxes, solder boxes, lead bank boxes and part body boxes.

Move to home position.

Perform fiducial alignment.

Move the XY stage and camera assembly away from the board area so that user can access the board using the front door.

Stop all motion and process.

Feed board on the conveyor.

Activate on-line help feature.

5.7 Status View

The status view displays various status information for the inspection process.

Optionally users can open a second status window using the pop-up menu item **Show Status2 View** from the first Status View. The second status window displays status information for a FIFO (First-In-First-Out) buffer used during downstream review and Back-Side AOI operations.

6 Inspection and Defect Review Step by Step

6.1 Step1: Load the Recipe
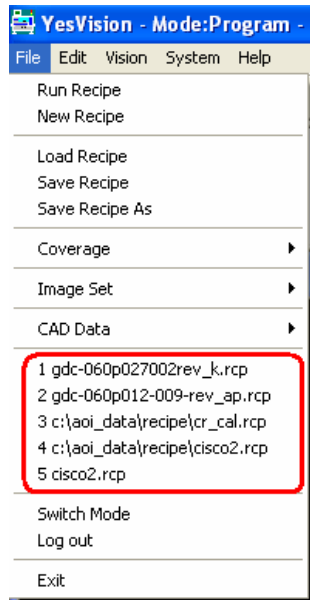
Inspection process starts by selecting and loading the correct inspection recipe from a disk file. To load the recipe click the Load Recipe button [icon] or select it from the list of recently loaded recipes in the File menu.

6.2 Step2: Run the Inspection

After the recipe is loaded clicking the Run button will launch the Run Inspection dialog. In this dialog the user can set various options for the inspection process.
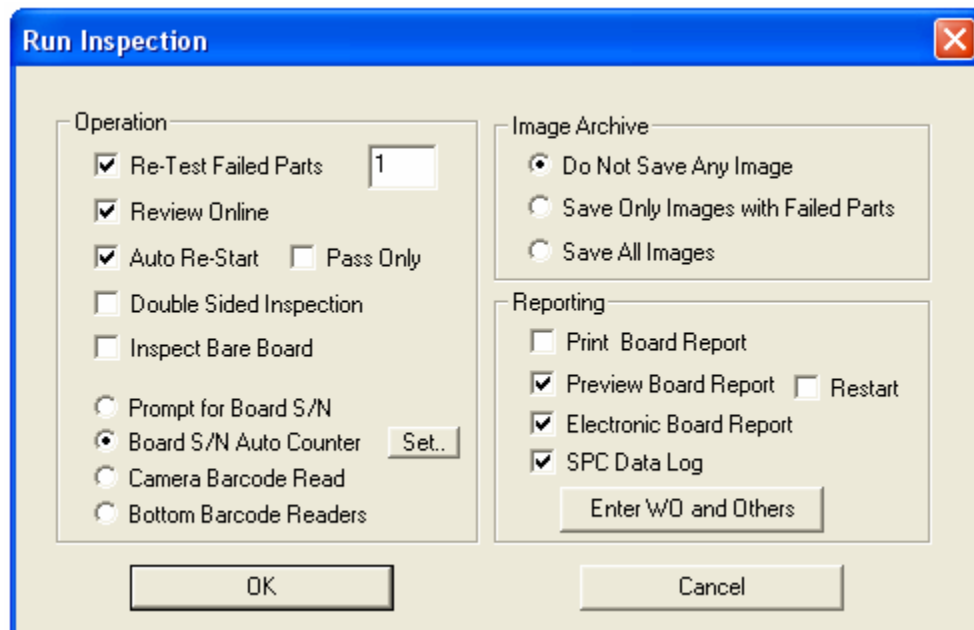
The options in this dialog are arranged in 3 groups, **Operation, Image Archive** and **Reporting**.

In the **Operation** group there are 5 check boxes and 3 radio buttons.

Re-Test Failed Parts
Enable or Disable the Re-Test feature. The re-testing of failed parts reduces the false call rate. The number defines the re-test criteria. For example if a 3 is entered the system will retest any frame having 3 or more failures. The default number is 1; re-test every failure.

Review Online
Select online or offline review. If online review is not selected user must select one of the save image options in the Image Archive to allow offline review.

Auto Re-Start
If enabled, this feature will repeat the inspection step for the next board without the user pressing the Next button in the Result Dialog Box.

Double Sided Inspection
If enabled, this feature sets the machine to perform double sided inspection. In double sided inspection mode, once the top side is inspected, the system will prompt the user to turn the board over for inspection of the bottom side. The defect report for double sided inspection will contain both top and bottom side defects. Please refer to section 16 for details.
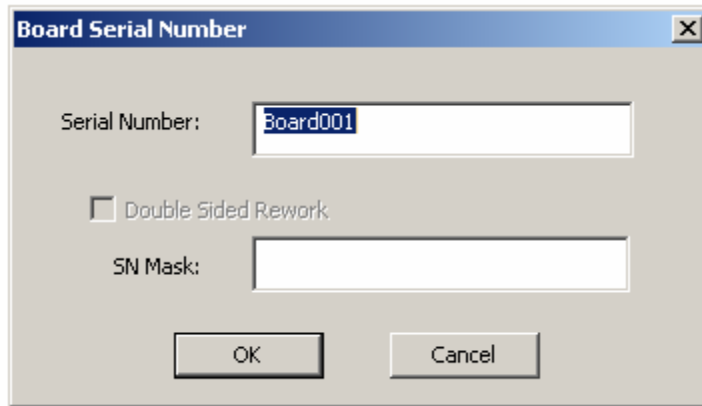
Inspect Bare Board
If enabled, this feature indicates to the machine that a bare board is placed in the machine and the machine will perform a bare board test for the inspection recipe. With the bare board test all "marks" and "solder" inspection boxes are supposed to fail. In the review process for bare boards, this system reviews "marks" and "solder" inspection boxes that passed.

The three radial buttons in the operation group are used to select the method in which the boards are tracked.

Prompt for S/N
Prompts the user for the board's serial number before inspection with the following dialog.

This is the appropriate selection when using a hand held barcode reader since it generates an output via the keyboard interface. If the serial number of the board follows certain pattern user can setup a **SN Mask** to verify that pattern. For example if the serial number must always starts with AF and follows by 4 digits. Then a mask of "AF????" can be use to ensure correct number is entered.

Board S/N Auto Counter
The software will automatically generate a serial number for the board. Users can instruct the software to compose the serial number by pressing the **Set Button**. The **Set Button** brings up the follow dialog.
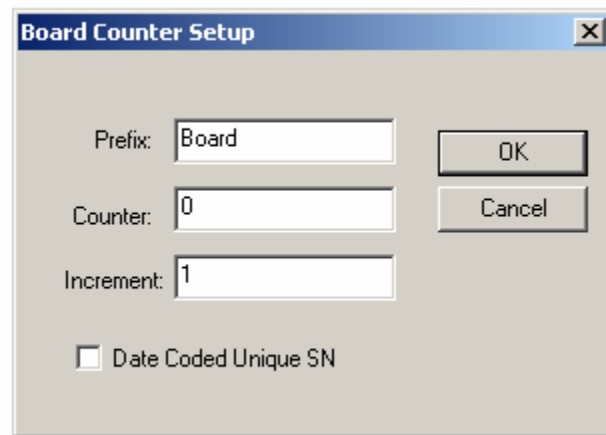

The software will generate the next serial number: Board001
The **Data Coded Unique SN** check box enables a feature for the software to generate serial number base on the date. The number generated will be unique and non-repeating for all the boards inspected on the AOI machine. If there are more than one AOI machine in the same facility user should use the Prefix field to identify individual machine.
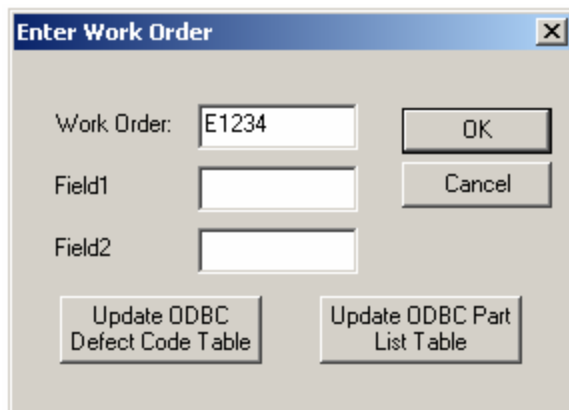
Camera Barcode Read
With this option selected the system will use one of the cameras to read the barcode from the board. The recipe needs to have the part with Reference ID "BARCODE" in the part list.

Bottom Barcode Reader
This selection will enable if the optional bottom side barcode reader is installed.
When is item is selected the software will get the board's SN using the bottom
barcode reader. Refer to section 19.6 for this optional accessory.

In the **Image Archive** group the user selects the image storing options. User can save
all the images, save only the image with defects, or not save any images. For offline
defect review the user needs to at least save the defect images.

In the **Reporting group** there are 5 check boxes and 1 button. The first 4 check boxes
deal with defect reports for each individual board . The first one is for printing
without previewing. The second one is for previewing on screen before printing. The
Restart check box allows the user to optionally restart the inspection process while
previewing defects on screen. **Electronic Board Report** creates defect reports in
JPEG format in the recipe's report folder. The **SPC Data log** is a summary report.
One data fields WO (Work Order) and two user definable fields in the SPC data
record can be entered by pressing the **Enter WO and Others** button. The follow
dialog will display:

The **Update ODBC Defect Code Table** button when pressed will update the
DefectCode table in the ODBC database using on the information from the **defect.ini**
file. The **Update ODBC Part List Table button** creates a PartList table for the
current recipe in the database.

Pressing the **Ok** button on the **Run Inspection** dialog will start the inspection process.
The process involves locating the fiducials and inspecting all the parts based on the
recipe. At the end of the inspection the result dialog will appear. Based on the
inspection results the dialog may show "Fail" or "Pass"

6.3   Step3: Review the Defect

Defect review can be done online or offline. The online review process starts with the user pressing the **Review** button in the **Inspection Result** dialog. The machine steps through each defect and displays the Review Failed Parts dialog as shown below.

During defect review the user verifies the defect visually. If there is a true defect, the user should classify it accordingly using the **Defect Classification** drop down list. The data in the list come from file **Defect.ini** in the INI folder of the software. If there is *NOT* a true defect, in other words, a false call is made by the machine; the user can press the **Ignore** button to have it removed from the defect list.

There is a pop-up menu for less frequently used functions. To display the menu, point the mouse inside the dialog and depress the right mouse button. The **Skip Fixed Parts** item remove parts in the review list that has been modified. The **Ignore Part** selection ignores part with multiple defects with one click. The **Move Back** selection "undo" the Ignore or Next button.

Users can optionally log the false calls by selecting **Log False Call** in the **Recipe Options**. When **Log False Call** is selected the **Ignore** button will change to **False Call** button. Pressing the **False Call** button classifies the defects as false calls and leaves them in the defect list. The **Index** specifies the classification that the **False Call** buttons link to. For example if the false call classification is in line 12 in the **defect.ini** then the Index should be set to 12. In the defect report the total number of false calls on the board is reported.

Recipe programmers can fine-tune the inspection recipe during defect review. An alternate template can be added to handle new alternate component markings; inspection pass score can be adjusted to handle random noise in the image.

The **Next** button on the Review Failed Parts dialog moves to the next defect whether it is on the same part or next part. The **Next Part** button moves to the first defect on next part of the defect list.

The following is a sample Defect.ini file:

```
[01] Unclassified
[02] Missing Part@S
[03] Wrong Part@S
[04] Tombstone Part
[05] BillBoard Part
[06] Skew Part
[07] Wrong Polarity
[08] Lead Solder Bridge
[09] Bend Lead
```

```
[10] Insufficient Solder
[11] Solder defects
[12] False Call
```
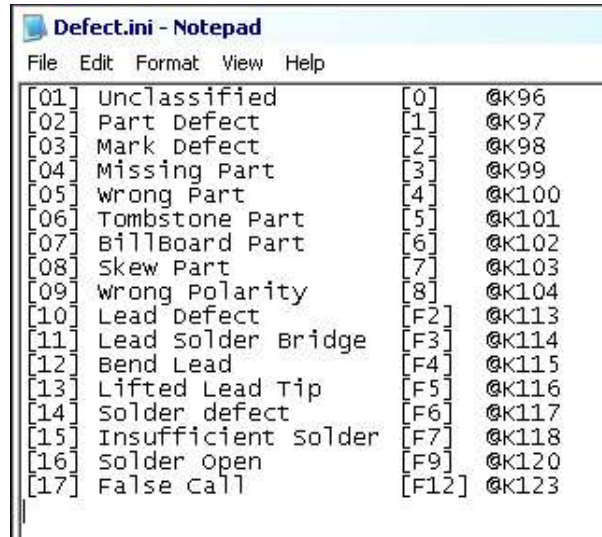
When there is a missing part defect e.g. U1 is missing the AOI would probably detect one marking defect, some lead defects and many solder defects for the same reference designator (U1). However, if U1 is missing the user probably does not care about the other defects the system detects. To simplify defect review, the software has two main types of defects: Singular and Multiple. One Reference ID can have only one singular defect. Missing part is a good example of the singular defect.

In the **defect.ini** file the **@S** symbol trailing the defect description indicates that the defect is a singular defect. Defects without @S are of type Multiple.

User can assign default classification based on the inspection type (mark, solder and lead) to speed up the defect classification process. The following section can be found in **YesVision.ini** file.

```
[Review]
DefaultMarkClass=1
DefaultLeadClass=8
DefaultSolderClass=10
QuickNext=0
```

User can also assign a keyboard "shortcut" key to each classification. Compared to selecting the defect classification from the pull down list box, pressing the short cut key is a lot faster. By default the function keys and the keys on the numerical key pad are assigned to classification. Pressing the shortcut key has the same effect as selecting a classification from the pull down list. The @K symbol follow by the key code assign a key to a defect line. On the right shown a sample define INI file with the first 9 defects assigned

```
Defect.ini - Notepad
File  Edit  Format  View  Help
[01] Unclassified        [0]   @K96
[02] Part Defect         [1]   @K97
[03] Mark Defect         [2]   @K98
[04] Missing Part        [3]   @K99
[05] Wrong Part          [4]   @K100
[06] Tombstone Part      [5]   @K101
[07] BillBoard Part      [6]   @K102
[08] Skew Part           [7]   @K103
[09] Wrong Polarity      [8]   @K104
[10] Lead Defect         [F2]  @K113
[11] Lead Solder Bridge  [F3]  @K114
[12] Bend Lead           [F4]  @K115
[13] Lifted Lead Tip     [F5]  @K116
[14] Solder defect       [F6]  @K117
[15] Insufficient Solder [F7]  @K118
[16] Solder Open         [F9]  @K120
[17] False Call          [F12] @K123
```

to number key 0-8, and the rest of the defects assigned to the Function keys.

6.4   Step4: Preview and Print out defect Report

If **Preview** or **Print Report** is selected in the **Run Inspection** dialog, the defect report will preview or print after the review process.

After the report the result dialog will reappear. Pressing the **Next** button on it will start the inspection process for the next board.

6.5 User Practice

On the YesVision™ software installations CD there are two inspection recipes **Demo_1.rcp** and **Demo_2.rcp**. Users are encouraged to load them up and practice the inspection and defect review process. Demo1 is a single sided board; Demo2 is a double sided board.

The two recipes have corresponding **ImageSets;** users can run them in offline mode without the actual PC board. Users can select offline mode by pressing the online/offline button on the toolbar.

The two demo recipes are not installed automatically by the installation program. They need to be copied from the CD to the computer's hard disk before use. If you cannot find them on the computer's hard drive please copy them from the Installation CD to the computer's hard drive before attempting to load them. The folder where they can be found is **AOI_Data\Recipe**.

7   Recipe Creation Step by Step

7.1   Step1: Prepare CAD data

Although CAD data is not absolutely necessary to create inspection recipes, certainly if CAD data for the board is available, users should use it to speed up the recipe creation process. First one must convert the CAD data to YCD format (YesTech Cad Data) before importing to the machine. Microsoft Excel can be used for the formatting tasks. The User may also use more specialized CAM software such as CircuitCAM for the tasks. YES Tech supplies a conversion utility in the form of an Excel macro to convert any column data into YCD format. The utility can be found in folder. **C:\Aoi_Data\CAD_Data**.

YCD files are ASCII text files. There are two main sections in the file; **Header** and **Part List**. The header section looks like this:

YES Tech CAD Utility v2.2.xls
Microsoft Excel Worksheet
378 KB

```
.YESTECH_CAD
[Header]
Version=        1
RecipeName=     gdc-060p027002rev_k.rcp
ScaleFactor=    1000.000
InvertXPos=     0
InvertYPos=     0
RotationDir=    1
RotationOffset=0
BoardWidth=     238.154
BoardHeight=    159.513
BoardRotation= 0
PNLib=          c:\aoi_data\recipe\gdc-060p027002rev_k\Settings.lib
CentralLib=
PkgLib=         C:\AOI_Data\StdPkg\StdPkg_Post.pkg
PkgNameMap=
IsTopSide=      1
```

All items in the header are optional. If specific information is not provided in the YCD file, the default value will be used. If the board size information is not provided the software will prompt the user to define board size.

```
Version         – Version of the YCD file should always be 1
RecipeName       - Name of the inspection recipe.
ScaleFactor      - Scale factor used for the XY position should be 1
                 for um, 25.4 for mil, 1000 for mm and 25400 for
                 inches.
InvertXPos       - Can be 0 or 1 to indicate if the X positions of
                 the part are inverted.
InvertYPos       - Can be 0 or 1 to indicate if the Y positions of
                 the part are inverted.
RotationDir      - Part rotation direction can be 1 for counter
                 clockwise or -1 for clockwise.
RotationOffset  - Rotation Offset this value is added to the
                 rotation parameter of every part.
```

31

```
BoardWidth         - The Width of the board.
BoardHeight        - The height of the board.
BoardRotation       -Can be 90, 180 or 270 which indicates the physical
                    rotation of the board relative to the CAD
                    orientation.
PNLib              - File path to the local Part number library.
CentralLib         - File path to the central library.
PkgLib             - Specifies which standard package library to use.
PkgNameMap          -Specifies the package name map file. Package name
                    map converts the package names used in the CAD data
                    to that of the standard package library.
IsTopSide          - Can be 1 or 0 to specify if this is the top or
                    bottom side CAD data.
```

The part list section list the information for every part.

The following information is required:
1. Part Reference ID
2. Part Number
3. X Coordinate of the part center
4. Y Coordinate of the part center
5. Part Rotation

The following information is recommended:
6. Part Package
7. Part Description

Here is a sample fragment of the Part List section.

```
[PartList]
RefID.      P/N          XPos    YPos    Rtn     Pkg     Extensions
FiduLeft    ----          12.097  10.471  0.00    ----
FiduRight   ----         211.93    5.17   0.00    ----
R63         ----         157.41  113.29   0.00    ----
R132        ----          72.19   51.21 270.00    ----
R102        302-111W000  100.94   76.60 270.00    1206    RES,SMT,1/8W,1%,0.00
R125        302-111W000  214.08   67.67 270.00    1206    RES,SMT,1/8W,1%,0.00
R73         302-111W001  156.89  103.89   0.00    1206    RES,SMT,1/8W,1%,10.00
R74         302-111W001  170.88  103.89   0.00    1206    RES,SMT,1/8W,1%,10.00
R93         302-111W001  164.51   91.82 270.00    1206    RES,SMT,1/8W,1%,10.00
R100        302-111W001  156.24   85.48 270.00    1206    RES,SMT,1/8W,1%,10.00
R887        302-111W043  204.94   96.19 270.00    1206    RES,SMT,1/8W,1%,27.00
R888        302-111W043  162.03   80.65   0.00    1206    RES,SMT,1/8W,1%,27.00
R891        302-111W043  158.58   65.15   0.00    1206    RES,SMT,1/8W,1%,27.00
R892        302-111W043  158.58   68.45   0.00    1206    RES,SMT,1/8W,1%,27.00
R72         302-111W069  144.11  102.00 270.00    1206    RES,SMT,1/8W,1%,51.10
..
..
[PartListEnd]
```
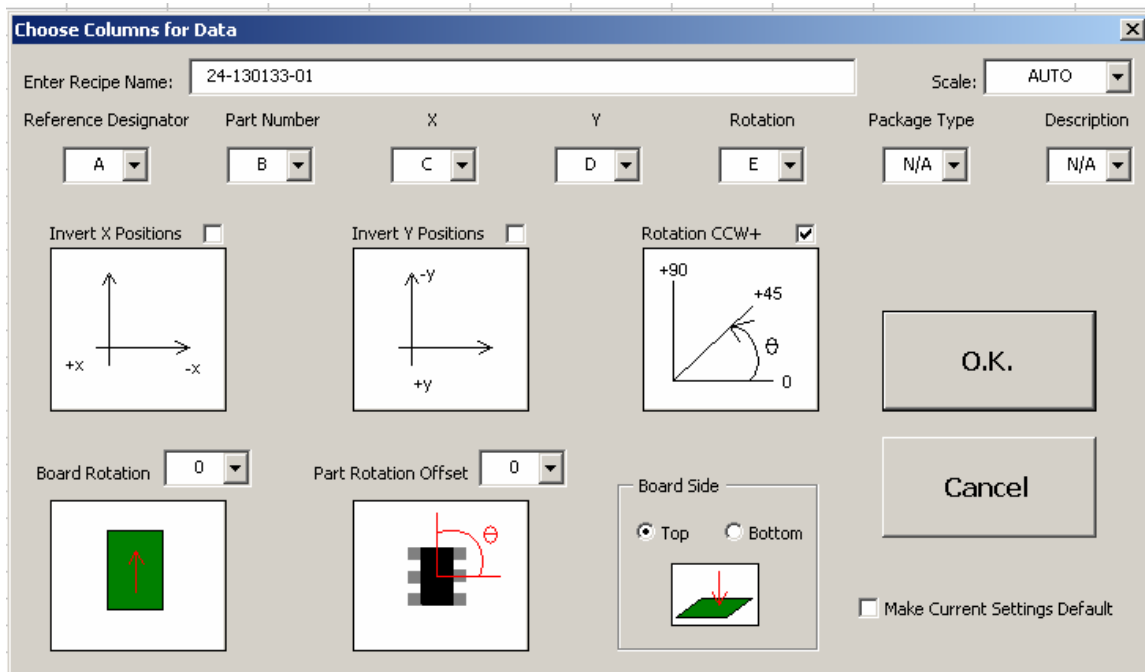
The YES Tech CAD Utility (YES Tech CAD Utility v2.2.xls
                                    Microsoft Excel Worksheet
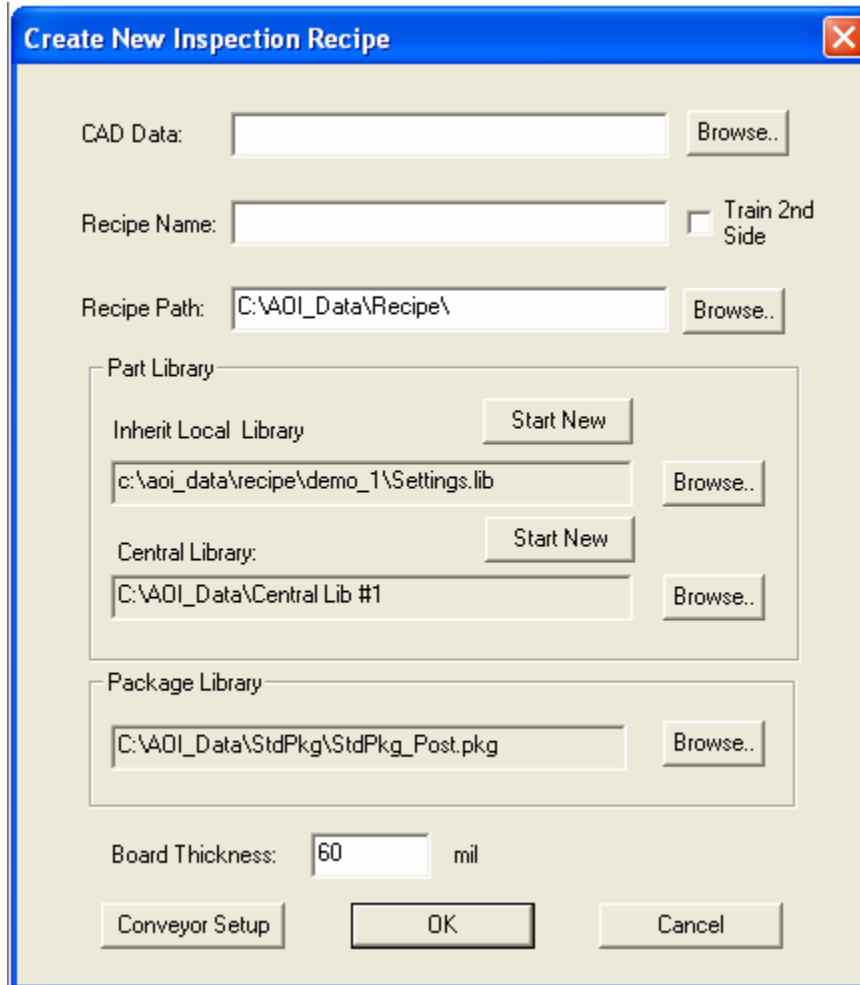   378 KB   ) gathers header information
from the graphical user interface and collects CAD data in any column format to generate
the YCD file. The following are some of the screen shots of the CAD utility.

CLICK TO RUN CAD UTILITY

Data Cleanup

Delete unnecessary rows of data
then click O.K. to continue

O.K.   Cancel

Choose Columns for Data

Enter Recipe Name: 24-130133-01   Scale: AUTO

Reference Designator	Part Number	X	Y	Rotation	Package Type	Description
A	B	C	D	E	N/A	N/A

Invert X Positions ☐   Invert Y Positions ☐   Rotation CCW+ ☑

O.K.

Board Rotation 0   Part Rotation Offset 0   Board Side

Cancel

Top   Bottom

☐ Make Current Settings Default

In addition to YCD format the YesVision software can also import CAD data in CXF format. The CXF format is the CAD format that CR Technology's AOI import.

33

7.2   Step2: Define New Board Parameters

After the .YCD file has been created the user can start creating a recipe by pressing the **New Board** button⬚. The following dialog will display:


Press the **Browse** button on the right of the CAD data box to load the corresponding CAD data file (.YCD). With the exception of the **Recipe Path** box, the information from the Header section of the CAD data will automatically populate the other text boxes in the dialog.

Pressing **Ok** on the **Create New Inspection Recipe** dialog will start the interactive process of defining board size, defining alignment marks, and capturing the board image. Depending on the information provided in the CAD data some of the steps may be skipped. Here is a flow chart of the process:
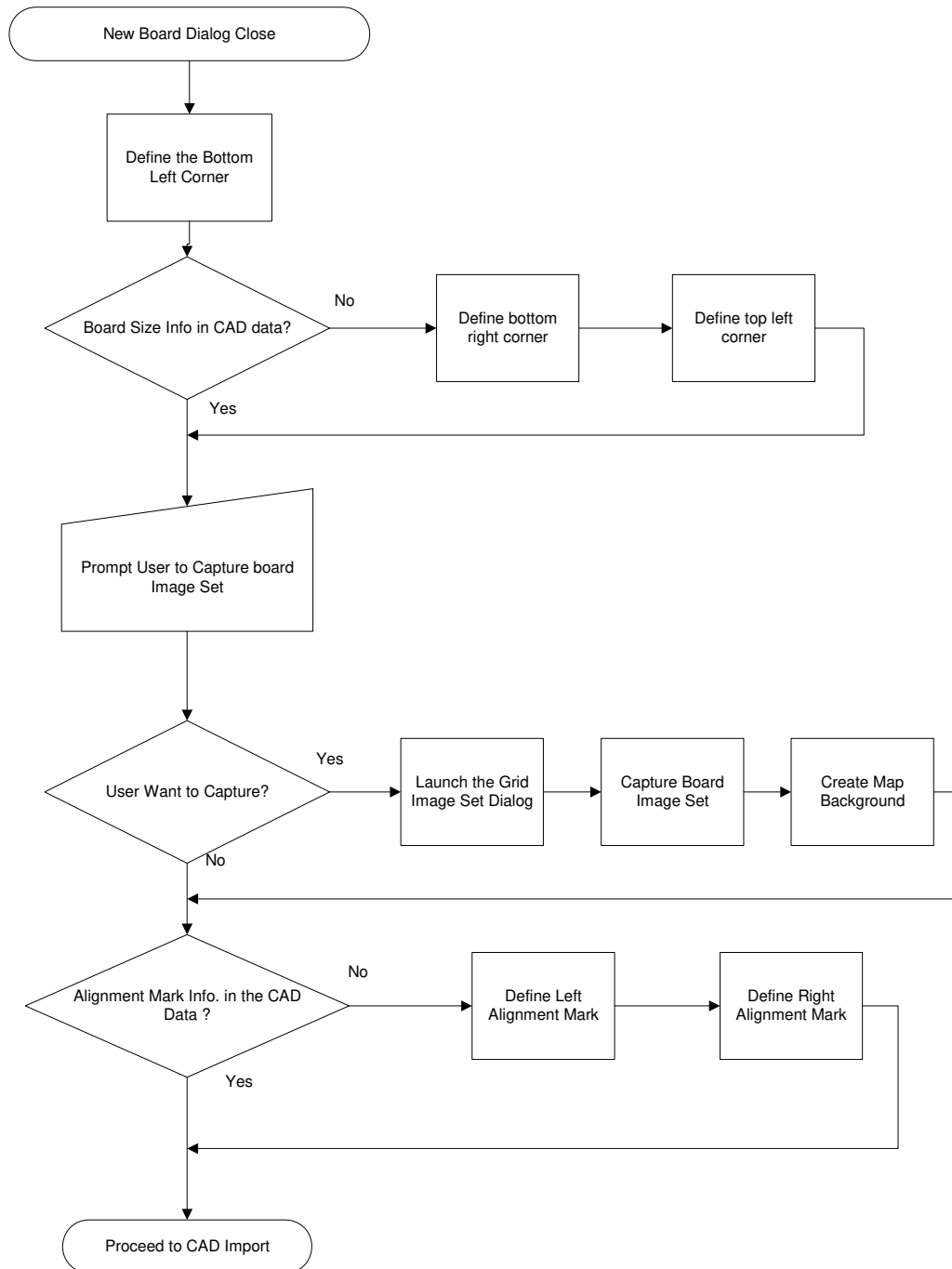
7.3   Step3: Import CAD data

The software analyzes the part position information from the CAD data and sequentially positions the camera over three parts on the board. The objective is to verify the position of that part. The first part selected by the system is the one closest to the bottom left corner of the board (the systems origin) interpreted from the CAD data. Next is the part closest to the bottom right corner of the board and finally the part at the top left corner of the board. For each part, the camera will focus over the corresponding corner it thinks the part should be in. A prompt dialog box will display

and the user should move the highlighted ROI (region of interest) on the video window so that it is on top of the corresponding part, and then click **OK**. The prompt dialog box appears as follows:
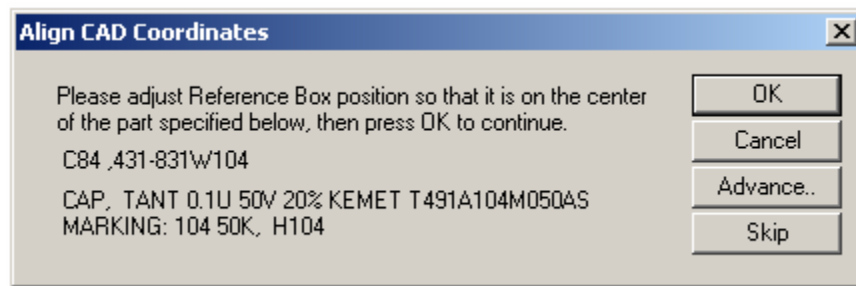
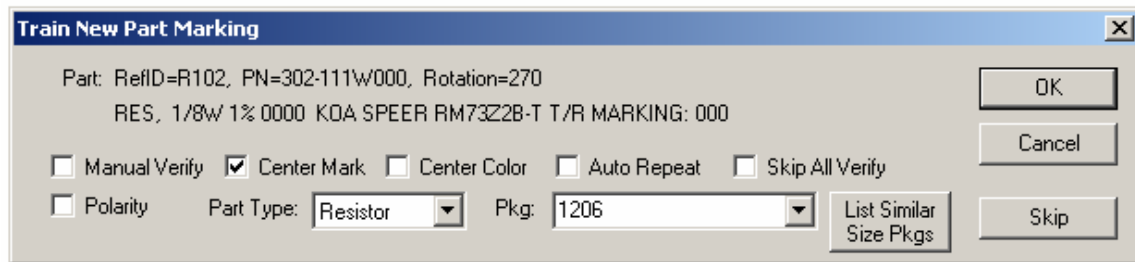When the **OK** button is clicked, the software records the part position. Based on the part position of the three parts located on the extreme corners of the board, the software compensates for any differences in the coordinate systems between the system that generated the CAD data and the system reading it. The factors compensated are XY scaling difference, board rotation and XY axis skew. The Skip button on the dialog box allows the user to select a different reference part. It is recommended to select a small part, such as a chip, as a reference part because for big parts it becomes more difficult to determine the center position. Also during this process the user can use the **Shift-Ctrl** and the **Arrow Key** to move or re-size the box for more accurate alignment if needed.

If the prompted part is not at the supposed corner of the board, the CAD data header information may be incorrect in describing the CAD data. Pressing the **Advance..** button launches the dialog on the right that allows user to adjust the coordinate system of the CAD data.
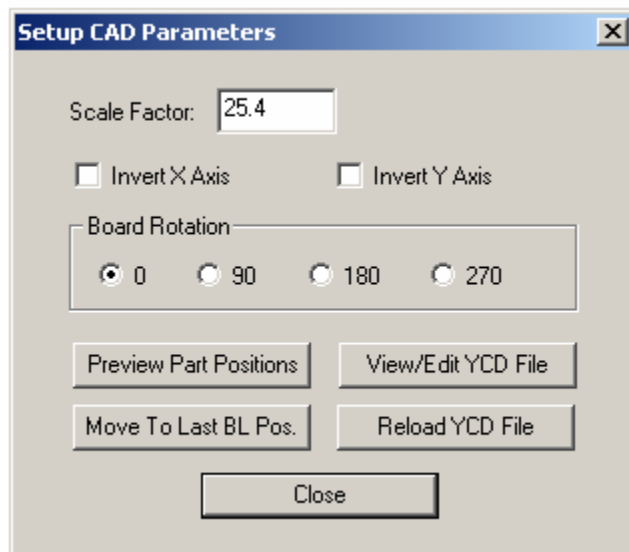
After the coordinate system is adjusted, the system will move the camera to view each part one by one. The user is prompted by the following dialog box on every new part to train.

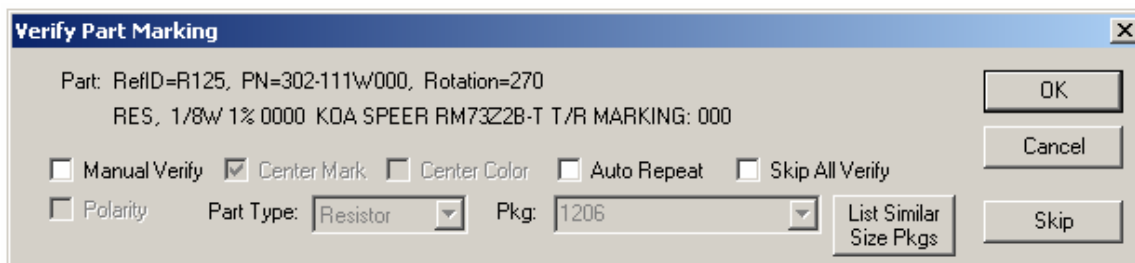Users should verify and/or modify the **Polarity** and **Center Mark** check boxes for the part's marking if needed. Users should also select the correct **Part Type** and **Package** type for the part. The **Package** selection list changes with the selection of **Part Type**. For example if **Part Type** *resistor* is selected, only the packages for resistors will be listed. To have the software list all the available packages select *Misc.* for part type. If the correct package cannot be found *NO_PKG* should be selected for package. Pressing the **Skip** button on this dialog will skip training the part and result in the part **NOT** being inspected.

If the part in the CAD data is already in the part library the dialog will appear slightly differently for the user to verify the part's marking:
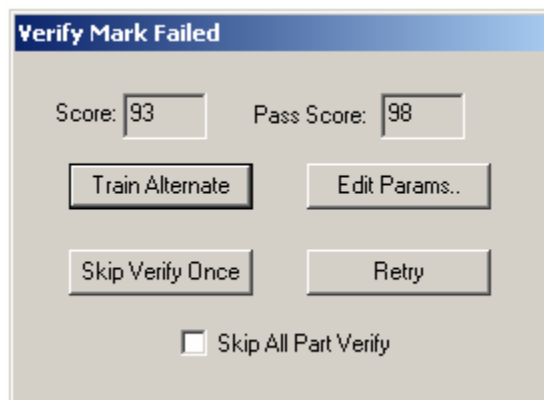

The part marking verification will inspect the part's marking and if it passes the part is placed in the inspection list of the recipe. If the inspection fails the following dialog will display:

Train Alt - Train alternate templates
Edit Param. - Launch the part parameter dialog for the user to change the marking parameters, such as lowering the pass score.
Skip Verify - Skip the verification for this part only.
Retry - Return to the **Verify Part Marking** dialog.

The **Skip All Verify** check box can turn off part verification for all parts. This check box is also on the **Verify Part Marking** dialog or **Train New Part** dialog. When marking verification is turned off the part is still added to the inspection list only it will not be verified. The verification process is commonly used as "First Article Inspection" for the assembly. This way the user can create an inspection recipe and do the first article inspection at the same time.

This process is complete when all the parts imported are verified.

The part import process can be aborted at any time by pressing the **Cancel** button on the dialog box or the **Stop** button on the main button bar. The parts that are imported up to this point will remain in the part list. To resume the import process, simply select **CAD Data, Import CAD** from the file menu. Since the part information in the CAD file merges with the part information in the recipe, there is no danger of importing the same part twice.

7.4 Step4: Fine-Tune the Inspection Parameters

After CAD import the user should run 3 to 5 boards to fine tune the inspection parameters. It is also recommended to run a bare board test to make sure the inspection thresholds are not set too loose.

7.5 User Practice

Users can practice the recipe creation process by using the demo **ImageSets** and demo CAD data files. The sample CAD data files can be found in folder:

 C:\AOI_Data\CAD_Data\Demo

The CAD data belongs to two boards: **Demo1** and **Demo2**. **Demo1** is a single sided board with 3 sets of CAD data files:

Demo1_Full.ycd - contains all the information (required and optional) for creating the recipe.
Demo1_Min.ycd – contains only the required information for creating the recipe.

Users should practice creating recipes using each of the files to see how the additional (optional) information in the CAD data aid in the recipe creation process.

The third CAD file is named **Demo1_PkgNM.ycd** the file is similar to **Demo1_Full.ycd** with the exception that the package names in the **Demo1_PkgNM.ycd** file do not match the package names in the standard package library. User should create a recipe using this file to understand the usage of the package name map feature.

Demo1_Auto.ycd illustrates the usage of SmartCAD feature described in the next section.

The Demo2 board is a double sided board with two CAD files, **Top.ycd** and **Demo2_Bottom.ycd**. Users can use these two files to practice creating double sided inspection recipes.

7.6 SmartCAD

During normal CAD import the software requires users to correctly state the CAD data's axis orientation, scale, and rotation information in the header section of the YCD file. For users who have not dealt with CAD data regularly it may be difficult to provide such information to the software. The SmartCAD™ feature helps users to determine such information by asking the user to locate several parts (3 to 6) on the board. Based on user's input the software calculates the required information.

To use the SmartCAD feature all the user needs to do is to put the word "Auto" to the scale factor line in the header section of the YCD file. (ScaleFactor=Auto). In the beginning of the CAD import process the following welcome dialog will display indicating that the software is utilizing the SmartCAD feature.
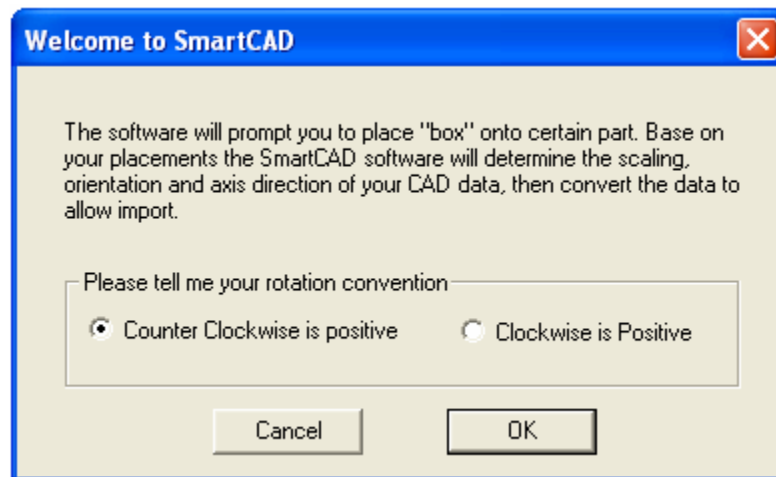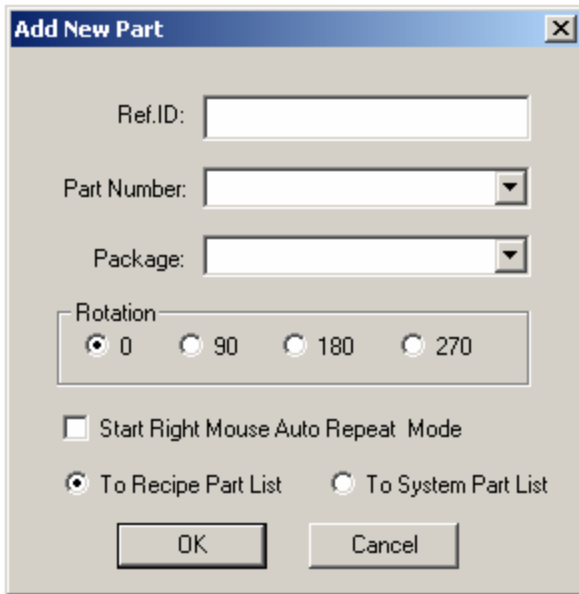
Although SmartCAD is very efficient in determining needed information from "mystery" CAD data, it should be used with caution. This is because we want to encourage consistent usage of CAD data throughout the PCB assembly process. CAD data is the basis of the PCB assembly process. SmartCAD lets users create usable AOI recipes without knowing much about the CAD data. One can create a perfectly functional AOI recipe using SmartCAD even when the PCB is placed 90 or 180 degree from the

intended orientation. This can lead to bad consequences in the future when the user tries to use the more advanced features such as the central library and standard package library. Sharing part information across inspection recipes requires a consistent application of part rotation information.

8 Train Part without CAD data

It is possible to train parts without CAD data. To add parts this way first move the camera so that the part to be trained is in the field of view, then press the Add part button

 on the toolbar. The dialog on the left will display.

On the dialog the user should enter the **Reference ID** of the part to be trained, and select from the **Part Number** list if the part is in the part library. If the part is not in the part library but its package is in the package library then the corresponding package of the part should be selected. Specify part rotation by selecting from one of the radio button in the **Rotation** group.

After pressing OK on the **Add New Part** dialog the user must specify the part's exact location by overlaying a region of interest box on the part.

The **Start Right Mouse Auto Repeat Mode** check box starts the auto repeat mode for adding multiple parts. Its operation will be explained in the next section. The T**o Recipe Part List** and **To System Part List** radio button select which part list the newly created part is added to. User should select **To Recipe Part List** for all cases except during the setup of SmartStart™ (refer to section 17).
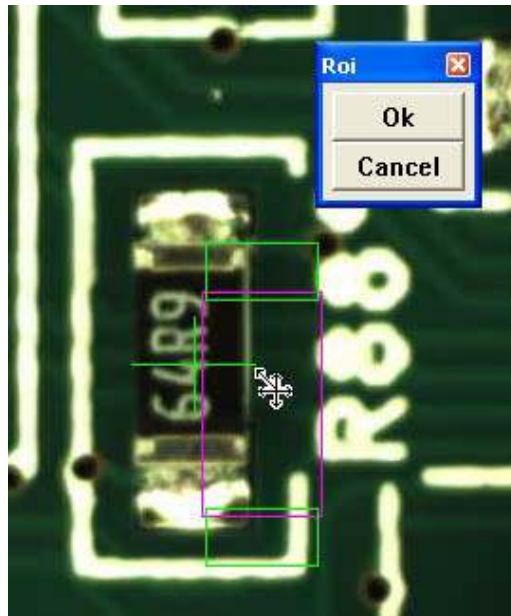
The user is not allowed to type in the new part number or package on the **Add New Part** dialog. The **Part Number** and **Package** list boxes can only be used to select from existing part numbers and packages. If the user needs to create a new part number he/she can do so in the **Edit Part Parameter** dialog.

After the part outline box (the purple box) is created, the user can display the part's pop up menu by right clicking inside the part outline box.

Edit Parameters   -launches the part parameter dialog as follows:
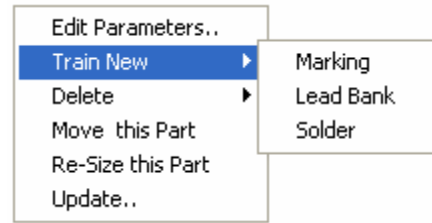
From the top, **Reference ID** shows the Reference designator of the part**. Rotation** indicates the part rotation. The **Rotate** button when pressed rotates the part 90 degrees counter clockwise.

The **PN** list box allows the user to select the part number from the part library. For a new part number the user can type it into the box. Then use the part Update feature to add it into the part library.

The **Package** group contains one list box and three buttons. The user can use the list box to select a part package. To enter an unlisted package the user can type it into the list box then use the update feature to add it into the package library. The package list can be quite long, three buttons are provided to make package selection easier. The **List All** button lists all the packages in the package library. The **Similar Size** button lists only the packages that are approximately the same size as the current part. The **Similar Type** button lists only the packages of the same or similar type.

The arrow buttons on the right of the PN and Package name, when pressed will select the current PN or package from the List View window, this allow easy access to the Walk Through functions for the current PN or package.

The **Skip Flags** group shows the three skip flags for the part. They are **Marks, Leads** and **Solders**. The **Type** list box allows the user to select the part type for the part. The last edit box shows the description of the part.

The **Flip Side View** is for side angle inspection. The **LBO Page 2** is use only in Large Board Option (LBO) to identify parts on page 2. **The Is Through Hole Part** check box work with the **Create Bottom Partlist** feature in through hole inspection.

Train New   **-**Trains new mark, lead and solder inspection boxes for the part.

Delete   -Deletes the current part, or some of the inspection boxes.

Move this Part   -Moves the current part.

Rotate Part 90   -Rotate the part 90 degree counter-clockwise

Resize this Part   -Resizes the part outline of the part.

Skip Failed Solders   -Use only for X-ray BGA inspection on YTX-6000 machine, to skip the BGA ball with are block by the component on the oppose side.

Update   -Launches the following dialog to allow updating the part number library and/or package library using the current part as reference.
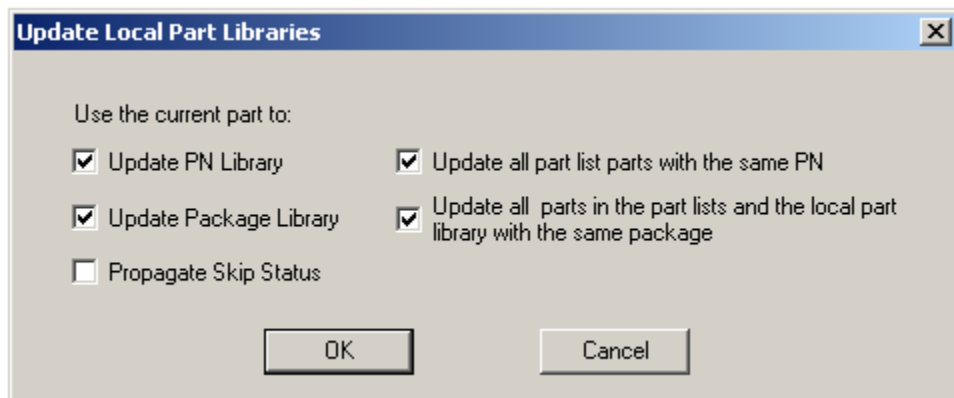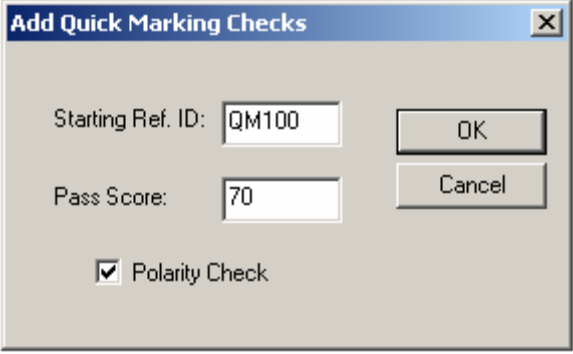
8.1 Auto Repeat Mode and Quick Marking Check

A convenient way of adding multiple parts when there is no CAD data available is to utilize the Auto Repeat Mode. In this mode the Add Part function will be repeated when user press the right mouse button. In a scenario where user need to add many of the same part number all over a board, the auto repeat mode would save a lot of mouse click.

During the auto repeat mode, user can press the "R" key to rotate a part 90 degree. Also in the auto repeat mode the Reference ID of a part increment each time a part is

added. For example user setup the part R10 as the first part to add, then the second part added will be assigned with Reference ID of R11, and the third will be R12, etc..

The Quick Marking Check function is similar to the Auto repeat function in operation. It is designed to allow the quick adding of template matching inspections without worrying about the part numbers or reference IDs of the inspection. It allows a inspection region to be set simply by drawing a box on the screen. To start the Quick Marking Check function selects **Add Quick Parts** from the **Vision** menu. The following dialog will be displayed where user enters the initial Reference ID, Pass Score and Polarity attribute.
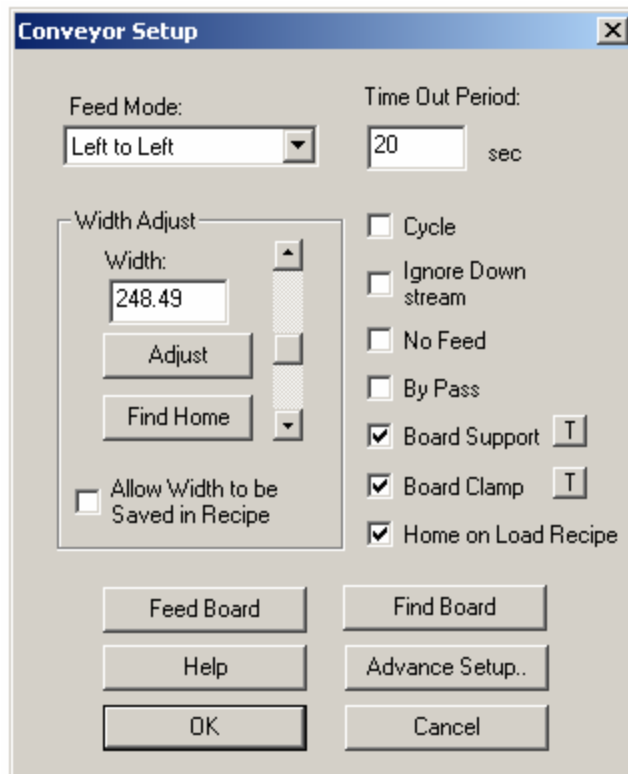

Just like the auto repeat function, the Quick Mark Check function is repeated by pressing the Right mouse button.

9 SMEMA Conveyor Setup

The YTV-F1 and M1 Series AOI machines are equipped with single section bi-directional conveyors with motorized width adjust. The width of the conveyor will adjust accordingly when a new recipe is loaded.

The conveyor setting for the recipe can be setup using the **Conveyor Setup** dialog, shown on the left. The **Feed Mode** selects the feed direction for the board in and out. The **Width Adjust** group deals with the width control of the conveyor. The **Find Home** button moves the conveyor width to its minimum width that should be 50 mm. If the conveyor width is not 50mm after finding home the limit switch position should be adjusted.

The **Cycle** check box is used only in trade show demonstration. It allows the board to reverse its feed direction once it reaches the exit so that the board can be fed in and out repeatedly. The **Time Out Period** sets the time that the conveyor feed motor will run without seeing a board at the entry. The **Ignore Down Stream** check box if enable will ignore the down stream conveyor's SMEMA busy single. The **No Feed** check box will prevent the board from feeding after inspection. It is needed when the user wants to inspect the same board repeatedly. The **By Pass** check box selects the by pass mode of operation of which the machine will pass any board down once it enters the system without performing any inspection.

The **Allow Width to be Saved in Recipe** checkbox if checked will save the current conveyor width to the recipe. Next time when the recipe is loaded the conveyor will open to this width. However, the software cannot adjust the width if there is a board on the conveyor during recipe loading. If there occurs the software will defer the width adjustment until the board is removed from the conveyor.

Board Support and **Board Clamp** are two options that can be purchased for the AOI machine. They are pneumatically operated. To use them will require high pressure air supply at 60 or more PSI.

The Board Support option consists of a pair of pins which come up to support the back side of a board. Board support corrects board sag on thin and large board. The board support pins have magnetic bases which can be positioned anywhere under the board. The Board Clamp option consists of a pair of clamps which clamp down on the top and the bottom edge of the board along the conveyor belt. Used with the board support, the board clamp helps de-warp the board for a more accurate inspection.

The two small "T" buttons behind the Board Support and Board Clamp check boxes are for the user to exercise the two mechanisms.

The **Home on Load Recipe** check box if checked will home the conveyor before adjusting to the recipe width every time a new recipe is loaded. The **Feed Board** button has the same function as the Feed Board button on the button tool bar. The **Find Board** button executes the find board function that runs the conveyor for a few second until one of the conveyor sensor is triggered. The function is executed automatically during the software starts-up to prevent board damage by the auto-width adjust mechanism when a board is accidentally left on the conveyor between sensors.

The SMEMA connectors of the machine are located on the right side of EBOX 1 which can be seen when the back panel is opened. The SMEMA connector on top is for the upstream conveyor (previous) and the SMEMA connector below is for the down stream conveyor (next). Despite some of the claims, not all conveyor equipment is truly SMEMA compliant. SMEMA specifies an edge triggered signaling scheme and lots of conveyor equipment with level trigger schemes still claim to be SMEMA compatible. The YesVision software makes its SMEMA signal configurable to accommodate for those conveyors. Pressing the **Advance Setup** Button launch the dialog on the right.

During normal board feeding, a board reaches the middle sensor, it slow down, and slowly creep towards the hard stop. The **Slow Down Time-out** is the time from the moment the middle sensor is triggered to the time inspection begin. It is the time the board move in slow speed mode. The **Slow Speed Factor** set the speed of the slow speed mode. The slow speed is always a fraction

of the overall speed. The overall feed speed is controlled by adjusting the power supply voltage of the conveyor feed motor (shown below).

In left to right feed mode, to feed board from inspection position to the right require retracing the hard stops. In order to retract the hard stops freely, the board needs to be back-out from it first. The **Backout Time-out** set the time for the board to back-out from the stops. In normal operation for left to right or right to left feed mode, the system will allow the next board to enter the machine while the current board is exiting the machine. The overlapping way of feeding save time; if this overlapping is undesirable user can disable it by checking the **Delay Ready Signaling** check box.

In addition to standard SMEMA YesTech's AOI also provide a signal that indicate the inspection status, it can be used to signal the downstream equipment. It is called the Good/Bad Board Signal. The signal come out from U8 pin 10 and is isolated by solid state relay (SSR) U18 on the I/O board, then emerged as OUT6+ and OUT6- lines and connect to screw terminal ST3's pin 5 and pin6. There are two 12 pin screw terminal on the I/O board, the ST3 is the one on the right. This signals characteristic can be configured using the **Good/Bad Board Signal** section of the **Conveyor Advance Setup** dialog.

In the last section on the dialog user configure signal timings for the SMEMA signals and the Good/Bad Board signal.

10   AOI Inspection Methodology

YesVision™ software organizes inspection into three types: **Marking, Lead Bank** and **Solder.** Each part can have any number and combination of these three types of inspections. A chip part (e.g. 0805) may have one marking and two solder inspections. An SOIC14, on the other hand, may have one marking, two lead banks and 14 solder inspections.

There are two light settings for the inspections: **Side light** (bright field) and **Top light** (dark field). On systems with side view cameras there are five views for inspections: **Top View**, **Back View, Right View, Front View and Left View**.
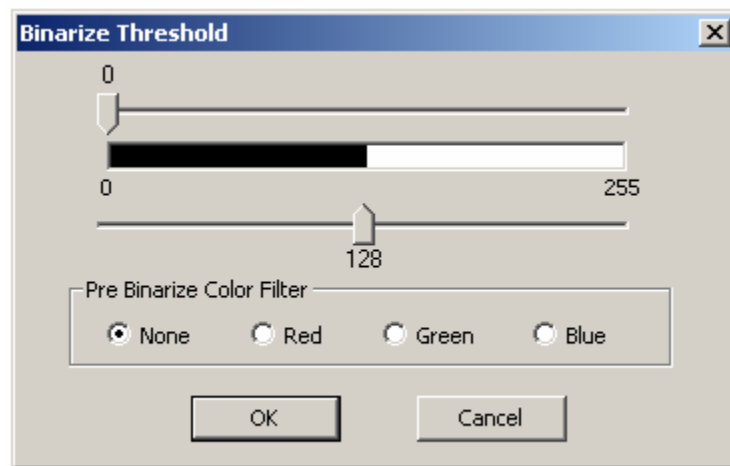
Inspections are conducted in two processing steps: Preprocessing and Decision. The Preprocessing step prepares the image and the Decision step determines the Pass/Fail. The two steps use various machine vision algorithms to accomplish the task.

10.1 Preprocessing

The preprocessing step is common for the 3 inspection types. Including NONE there are 5 preprocessing algorithms:

NONE   - No preprocessing (default)
Red Filter   - Pass the image through red color filter.
Green Filter   - Pass the image through green color filter.
Blue Filter   - Pass the image through blue color filter.
Binarize   - Binarize the image into two gray levels, black and white.

The first 4 preprocessing algorithms have no parameters and the **Binarize** algorithm has one that is set with the following dialog:

10.2 Mark Inspection

Edit Mark Params..
Train Alternate
Display Template
Edit Alternate
Set Search Area
Train Dependent Tmp.
Move
Delete

Test
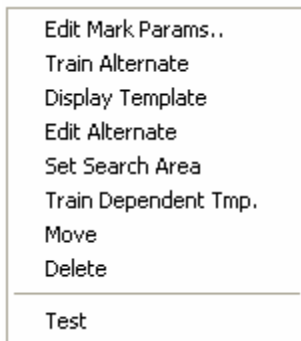
Mark inspection is designed to verify the markings on the part. The default algorithm for mark inspection is pattern matching. Other available algorithms are Barcode reading, color inspection, resistor color band inspection and OCR. On the left is the parameter dialog for mark inspection. After the Mark inspection box is created, user can display the Mark pop up menu by pressing the right mouse button while pointing at the inspection box. There can be more than one mark inspection box per part. Users may use one with side lighting to verify part's marking and the other with top light to verify the polarity dimple.

**Edit Mark Params..**   - Launches the Mark parameter dialog.
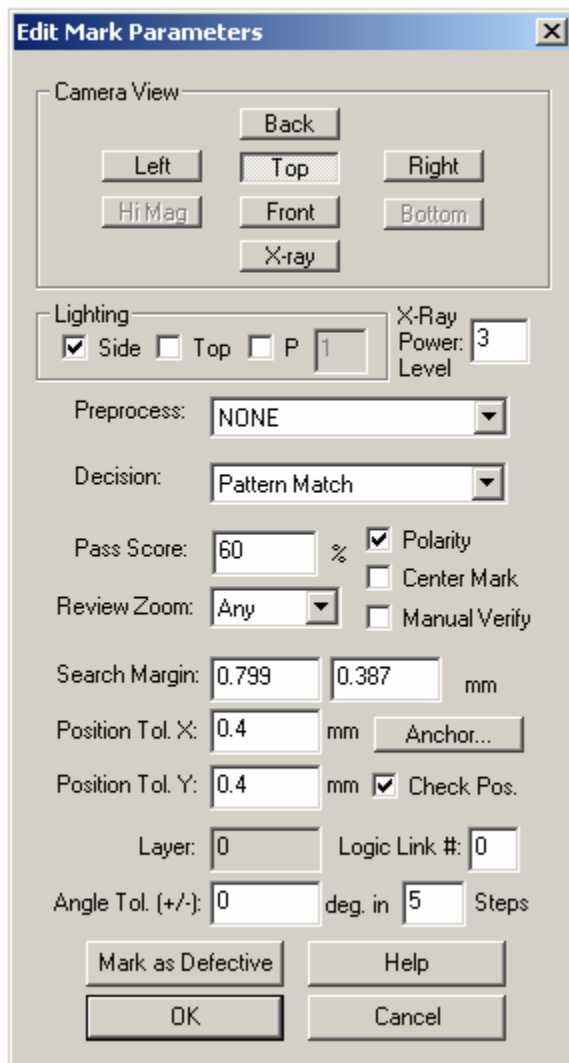
The **Camera View** group selects the view of the inspection. The **Lighting** group selects the lighting. The **PreProcess** pull-down lists the available preprocessing algorithms and the **Decision** pull-down lists the decision algorithms. The **Pass Score, Polarity, Center Mark and Search Margin** parameters apply only to the Pattern Match algorithm. The Pass Score sets the sensitivity of the acceptance. 100% means a perfect match. Acceptable pass scores for part inspection are between 40 to 80%. If **Polarity** is unchecked the software will accept images that are 180 degree rotated from the original image template. **Center Mark** if checked indicates the mark inspection box is always at the center of the part. **Manual Verify** if checked indicates that the user wants to review the part regardless of the test result. That means the mark will always appear in the review list. **Review Zoom** selects the preferred zoom level for reviewing. The **Search Margin** indicates a margin around the template's original position that the software will search for a match. If the **Check Pos.** check box is checked, the software will also verify the position of the mark after it has been found. **Position Tol. X** and

49

Position Tol. Y sets the position tolerance of the mark inspection. The **Anchor** button launches the Anchor Setup dialog. Any marking can be use to anchor other inspection boxes. Please refer to section 13.4 for details on using anchors. The **Mark as Defective** button manually force the inspection state to be set to Fail.

Train Alternate	- Train alternate template for Pattern Match algorithm.
Display Template	-Display the templates trained.
Edit Alternate	-Launch the following dialog for the user to edit each alternate template.
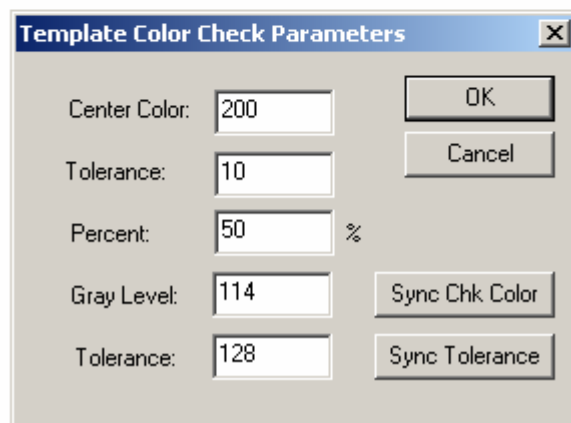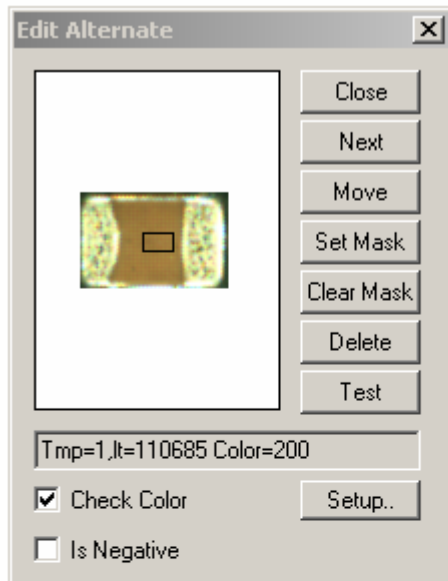
The **Next** button displays the next template in the list. The **Delete** button deletes the current template from the list. The **Set Mask** button starts the process that allows the user to create a "Don't Care" mask on the template. The **Clear Mask** button clears the "Don't Care" mask off the template. And lastly the **Test** button conducts a pattern matching test using the current template on the current image.

The template matching function is performed in gray scale. Optional user can able a feature to check for color match in the middle of the template. The **Check Color** check box enable or disable color check function for the center of the template. The Setup button launches **Template Color Check Parameters** dialog. Please refer to Color Inspection section for the meaning of those parameters.

The **Sync Chk Color** button updates the state of the **Check Color** check box to all the alternate templates. The **Sync Tolerance** button updates the tolerances (center color tolerance, percent and gray level tolerance) of all the alternate template to that of the current template.

The **Is Negative** check box is for making the template a negative template. A negative template is a template of a defect. During inspection it must score lower than any positive templates for the inspection to pass, regardless of what the Pass Score is set to. It is use to detect defective parts which look very close to the good parts.

Set Search Area	-Set the area on the image inside of which the software will search for a match. This operation will change the Search Margin parameter
Train Dependent Tmp	-Add a dependent template to the current alternate template.
Move	-Move the mark inspection box.
Delete	-Delete this mark inspection box.
Test	-Run the test on this inspection box.

If Bar Code is selected as the decision algorithm menu item **Bar Code Params** will be added to the **Mark** pop up menu that will launch the bar code parameter dialog.

Barcode inspection is for reading the board's serial number from a barcode. To do so the user needs to train a special part and name it "BARCODE" (set its RefID to BARCODE.) Then add a mark inspection box for the part and select Bar Code as the decision algorithm.

In the Bar Code Parameters dialog the Code Type group selects the type of barcode to read. In the Verify group the user can enable/disable the code length verification and also set the code length to verify. Code types such as Code 39 do not have a checksum mechanism, thus incorrect parameter setup could result in a wrong data string being read. The verify code length is a self verifying mechanism provided that the length of the serial number is known in advance. In addition to verify the length, it is also possible to supply a Mask string to verify the content of the code. For example if the code must start with AF follow by 4 digits, then a mask of "AF????" can be used to verify the content. The **Is Half of a Barcode** check box is for reading barcodes larger than the field of view of the camera. Please find the explanation of this feature near of end of this section. The **Is 2nd Part** check box is for reading serial number composes from two separate barcodes. In these cases, two separate Mark inspection boxes should be trained one on each barcode. And on the second barcode box, the **Is 2nd Part** check box should be checked. The software will concatenate the string from two barcode to form the board's or block's serial number.

In other instances, the data string in the barcode contains more than the board serial number. For example in a 10 digit barcode the first 6 characters may represent the boards assembly number and the last 4 characters represent boards serial number. In this case, we can set the Serial number reporting **start** parameter to 7 and length to 4 to extract just the board serial number from the barcode data string.

In setting up the region of interest for barcode reading it is important to leave several bar spaces in the beginning and at the end of the barcode as shown above. The barcode algorithm needs those white areas in the image to determine the start of the barcode. Also, in cases where the contrast of the barcode is not high (e.g. when the background is not white) you may need to use a binarize preprocess for the barcode reading to function correctly. Lastly, barcode is rotation sensitive. A barcode oriented horizontally as above needs to have a part rotation of 0 degree. A vertically oriented barcode should have a part rotation of 90 or 270 degree.
Below are some examples of the supported code type.
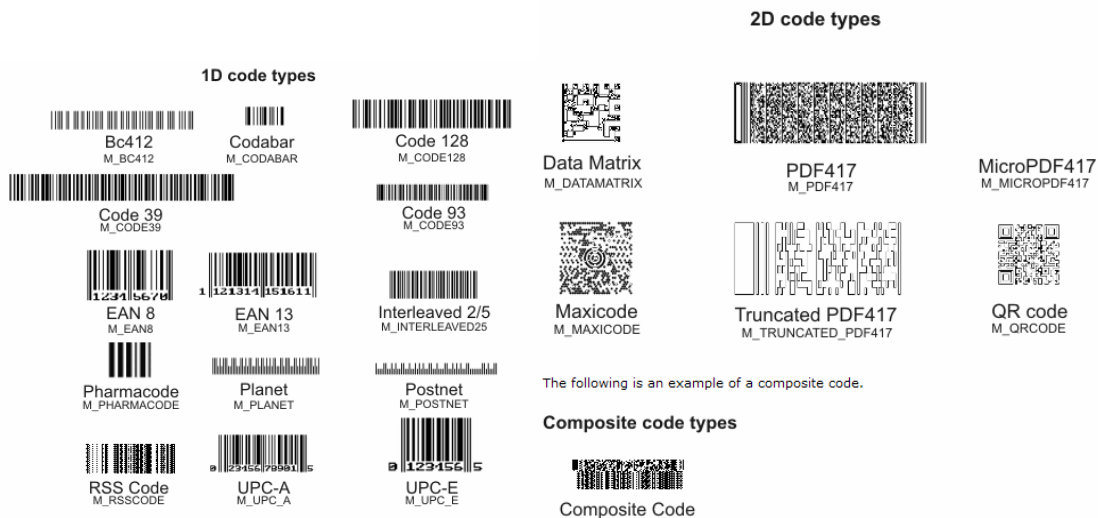
With version 2.4.9 or later versions of the YesVision software, it is possible to read barcodes larger than the field of view of the camera. The software stitches two images together before performing the barcode read operation. To utilize the feature user should train two marking boxes each for half of the barcode.
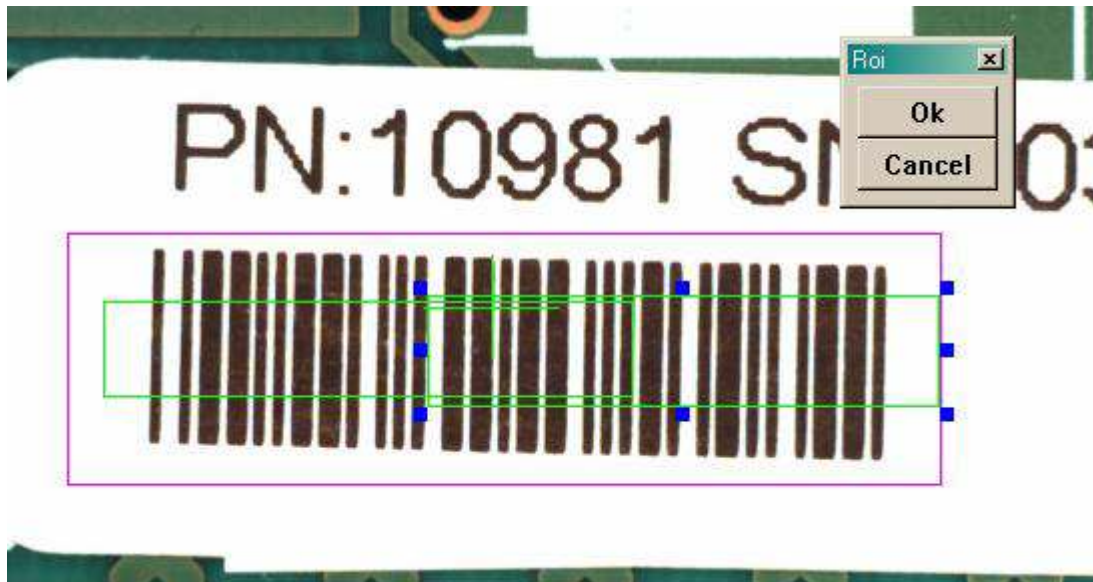
The two boxes must overlap to allow the stitching operation to work. Both marking should have Decision algorithm set to Barcode. In the Bar Code Parameters dialog the **In half of a barcode** check box needs to be checked.

Bottom Side Camera Assembly

There are instances where barcodes are placed on the bottom side of the board instead of the top. YesTech supplies an optional bottom camera for reading barcodes from the bottom of the board.
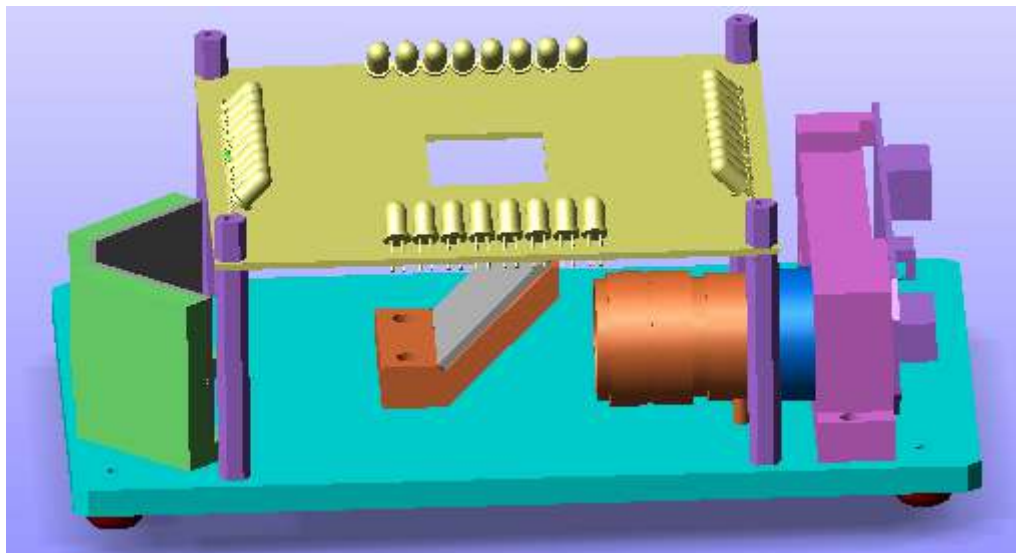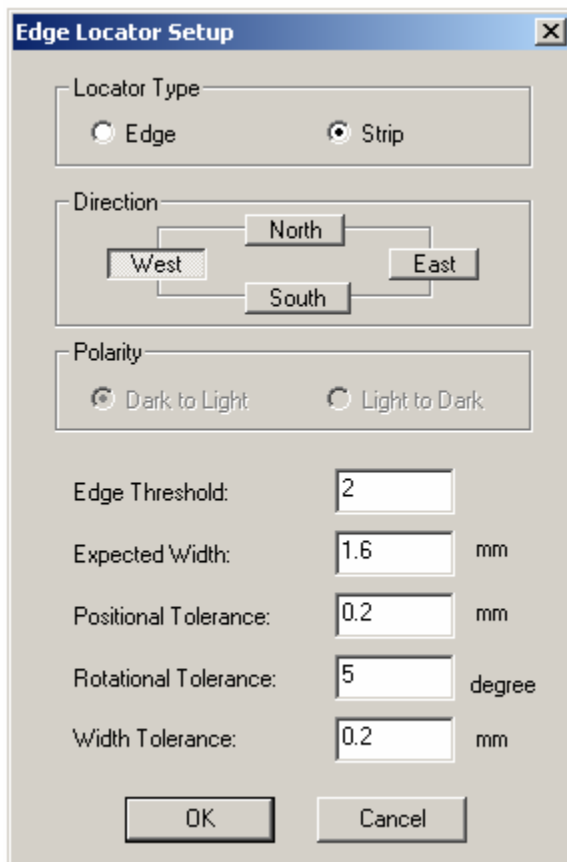

The third decision algorithm for mark is **Color Inspection.** If it is selected, an additional item, **Color Check Params..,** would be added to the mark's pop up menu. The selection will launch the following dialog:
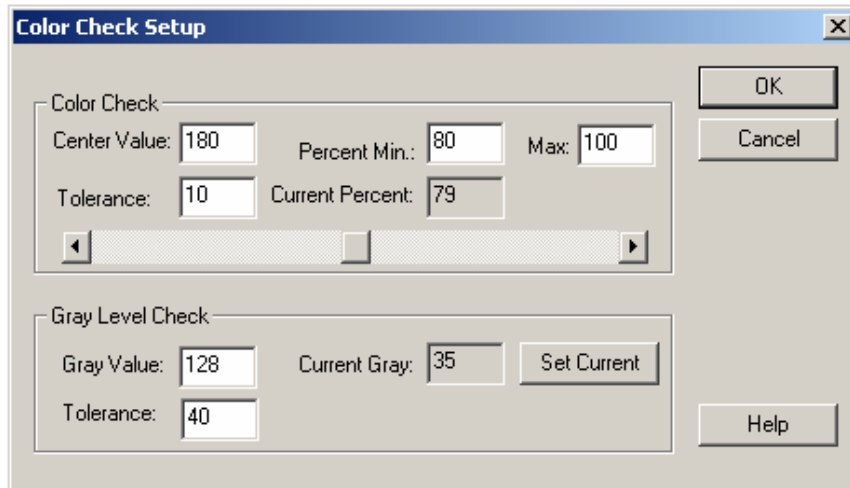
The algorithm does a color match check and a gray level check. For the color match check, the color for each pixel in the inspection box is computed. If the percentage of pixels that the color matches is higher than the required percent, then the color check test pass. During setup the software high-lights the matching pixels with green overlay interactively. User should experiment by adjusting the scroll bar and observe the change in the high-light. For the gray level check, the average gray value of all the pixels in the region of interest is computed and compared to the preset value. If the test value falls within the tolerance a PASS is reported and vice versus. The algorithm works best on brightly colored components.


Another decision algorithm for mark is Edge Locator. The edge locator locates edges' position and angle down to ¼ pixel resolution. If edge locator is selected, an additional item, **Edge Locator Params..**, would be added to the mark's pop-up menu. The selection will launch the dialog on the left. In this dialog user setup the parameters for the edge locator. Edge locator can locate edge or strip. A strip is defined as a pair of edges of the opposite polarity. The **Direction** parameter selects the direction for the edge or strip. The West and East directions select vertical edges and the North and South director are for horizontal edges. In order to set Polarity the direction must first be set. In considering polarity user should think the search operation start from the outside moving toward the center. For example if the direction is West, search operation goes from left to right. If direction is East search

operation goes from right to left. The **Edge Threshold** defines the minimum edges strength. Edge strength ranges from 0 to 100. The **Expected Width** set the expected width of a strip. The positional, rotational and width tolerance define the tolerance for the position, angle and width.

The other two decision algorithms for mark are the color band resistor inspection and OCR. Please refer to sections 10.5 and 10.7 later in this document for a detailed description.

10.3 Lead Bank Inspection
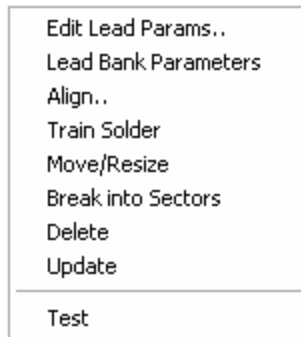
Lead Bank inspection checks for solder bridges between leads. The default algorithm for lead bank inspection is Blob analysis. Currently there are three algorithms for lead inspection, Blob Analysis, BGA Group and Fusion Lead. BGA Group is an X-ray inspection algorithm for the YTX-6000 machine. BGA Group is explained in section 11.2. The Fusion Lead algorithm can only be used in YTV-M1 machines with RGB light.

Edit Lead Params..
Lead Bank Parameters
Align..
Train Solder
Move/Resize
Break into Sectors
Delete
Update

Test

After a lead bank inspection box is created, the user can display the Lead Bank pop up menu by pressing the right mouse button while pointing at the inspection box.

Edit Lead Params. -Launches the Lead Parameters dialog.
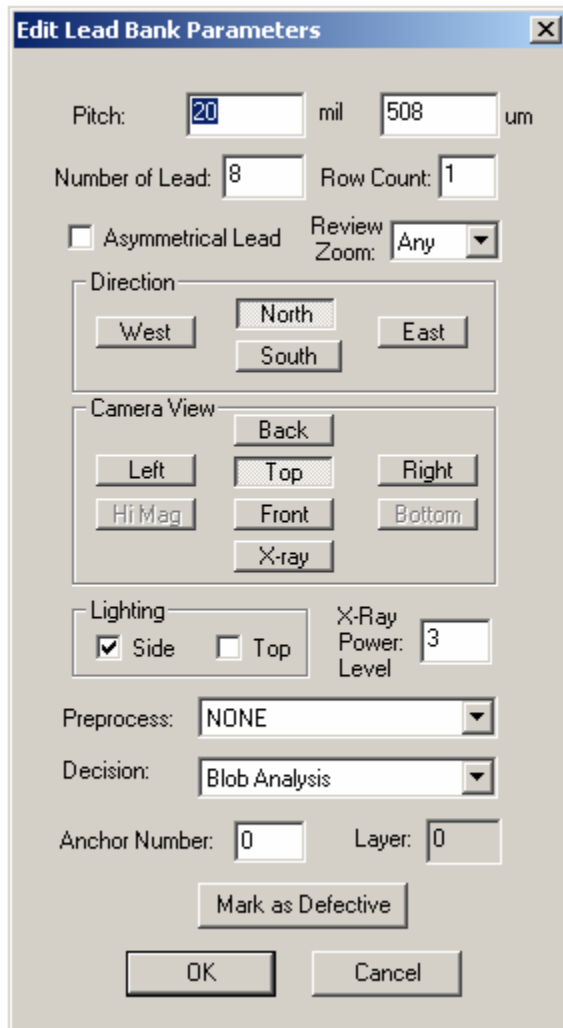
On this dialog the user sets the pitch of the lead, the number of leads in the lead bank**,** the direction**,** the view**,** the lighting and the algorithm selection.
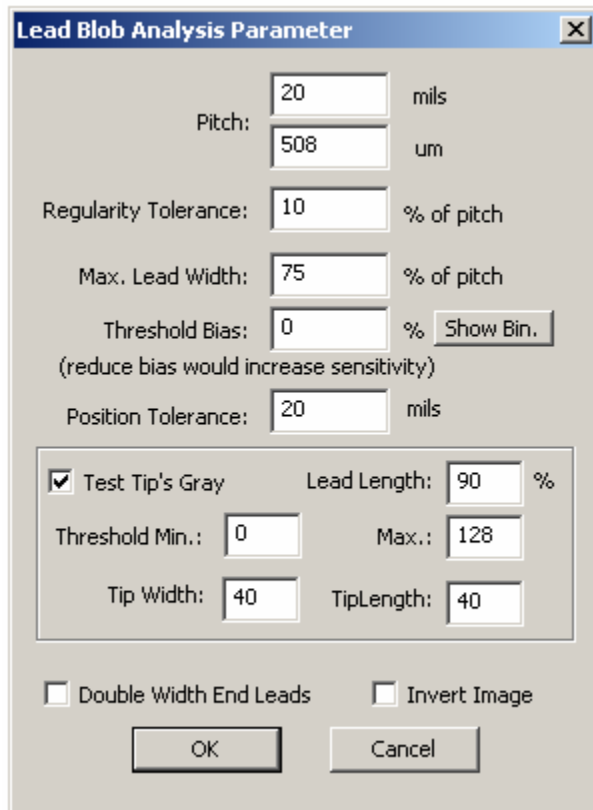
The **Asymmetrical Lead** check box should be checked if the lead arrangement for the part is not symmetrical. For example on SOT-25 parts there are two leads on one side but three on the opposite. The **Row Count** should always be 1 for all the normal components. Multiple rows of leads per side is for pin array inspection or BGA solder ball or solder paste inspection only.

The **Review Zoom** list box selects the preferred zoom level for reviewing this lead area during the defect review process.

Lead bands can be anchored by a marking for precise positioning. See section 13.4 for details.

The **X-ray Power Level** applies only to X-ray inspection on YTX-6000.

Lead Bank Parameters - Launches the Lead Bank Parameter dialog

Pitch is the separation from one lead to the next. It can be in mils or microns. (Typical values are 20 mils, 25 mils, 50 mils)

High **Regularity Tolerance** means the lead to lead separations are the same from lead to lead. Set this tolerance to detect bent leads or missing leads. A value of 10% is typical for this parameter. It can range from 5 to 50%.

Max. Lead Width defines the maximum apparent width of a lead. Set this parameter to detect bridging or lead off pad conditions. A value of 65% is typical for this parameter. It can range from 50 to 95%.

Threshold Bias can be used to increase or decrease the inspection sensitivity. Reducing the **Threshold Bias** e.g. – 10% will increase the sensitivity of the detection. The **Show Bin** button displays the binarized image.

Position Tolerance checks for lead position shift.

Test Tip Gray checks the brightness level on the tip of the lead pad to detect for lifted pin defect conditions.   Normally a lead solder is wetted up to the lead's heal and toe so there should be little or no solder on the tip of the pad. Amble solder on the tip of the pad indicates a lifted condition. See section 10.3.1 for the parameter settings.

On some board layouts the end pad is made twice the width of the other lead pad. The **Double Width End Leads** check box informs the software of such layout.

Invert Image check box if checked will invert the pixel value of the image before performing the analysis.

Align.. - Launches a dialog to allow alignment of lead bank inspection box.
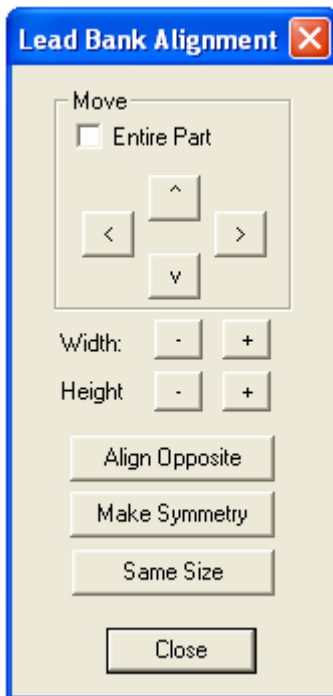
Using this dialog the user can move and size the Lead inspection box. The **Align Opposite** button will align or create the lead inspection on the opposite side of the part. The **Make Symmetry** button moves the lead box so that it is symmetrical with respect to the centroid of the part. The **Same Size** button makes all the lead boxes the same size.

Train Solder -Trains the solder inspection within the lead bank.
Move/Resize -Moves or resizes the lead bank inspection box.
**Break into Sectors** -Breaks up a long lead bank into smaller sectors.
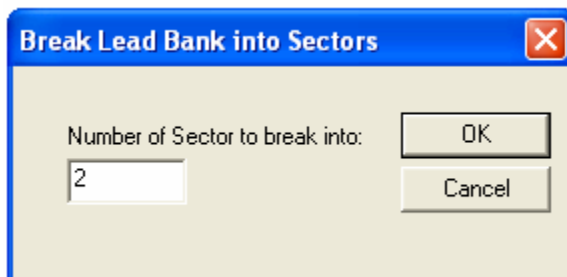
When reviewing a defect that is on the edge of a long lead bank, depending on the viewing zoom level, the defect could be outside the video view window. Breaking the lead bank into smaller sectors ensures the lead defect be shown on the screen during review.

Delete -Deletes the inspection box.

Update   -Uses the current lead bank as reference to update the parameters of other lead banks. The following dialog sets the scope of the update.
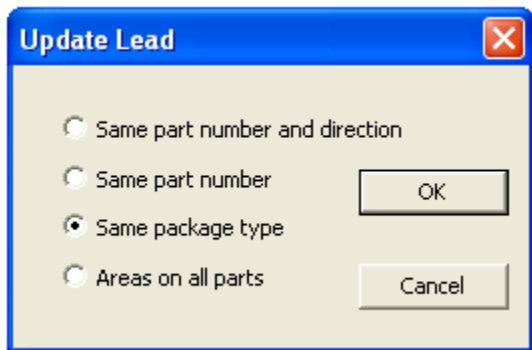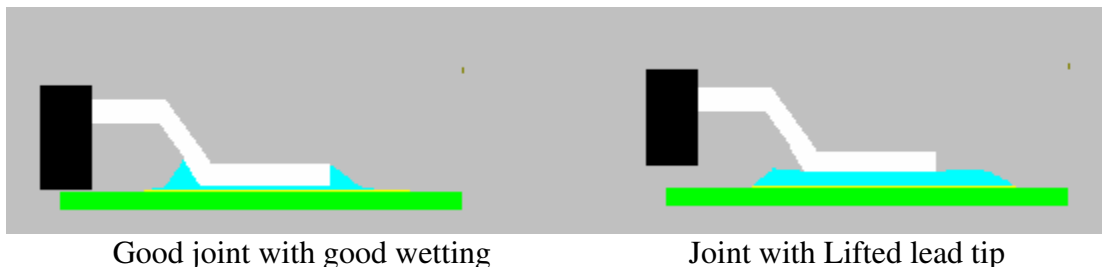

Test   -Tests the lead bank inspection on the current image.

10.3.1   Detecting Lifted Lead Tip

Lifted lead tip is a defect condition where solder does not wick up to the lead due to either co-planarity problem or contamination on the surface of the lead.

Good joint with good wetting   Joint with Lifted lead tip

On a good solder joint solder adheres to the surface of the lead and forms a slope leading up to the lead. On a lifted lead tip the solder is not able to wick up to the lead so it is evenly distributed on the pad surface. In other words, on a normally soldered lead solder is wetted up to the lead's heal and toe so there should be little or no solder on the pad area in front of the tip of the pad. Amble solder on the area of the pad indicates a lifted condition. Viewing from the top and with lighting from the sides the difference in the distribution of the solder makes the hi-light on the solder look quite different between good and lifted solder joints. The YesVision software detects the difference in the solder, hi-light's the position, and detects the defect condition.
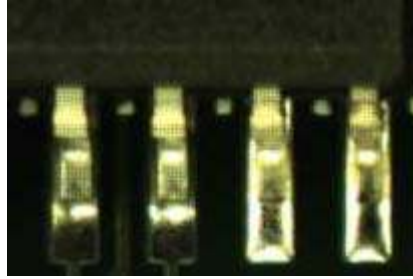
The right two leads are lifted. See how much brighter the tip of these pads look.
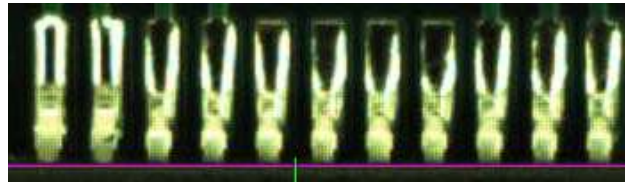
The left two leads are lifted.

Side view of the same lead bank to confirm the lifted tip condition.

To enable detection of lifted leads the user should check the **Test Tip's Gray** check box on **the Lead Blob Analysis dialog**. To accurately detect the lifted lead it is essential that the test box is right in front of the lead tip at the very edge of the pad. The **Lead Length** parameter sets the distance from the component body. It is a percentage of the lead box length. The **Tip Width** and **Tip Length** parameters set the side of the test box. They are a percentage of the pitch. The Threshold parameter sets the pass/fail limits for the gray value of the test box.

To ensure the test boxes are at the right position the user also needs to make sure the outside edge of the lead bank test box is at the edge of the pad.
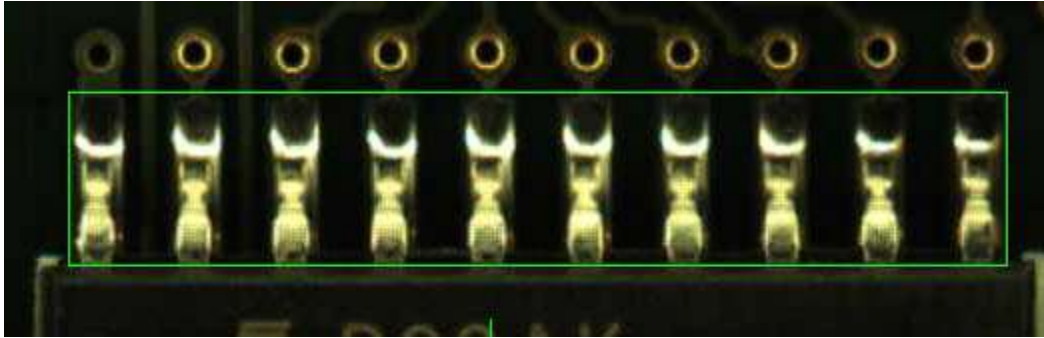
Correct placement of the lead bank box
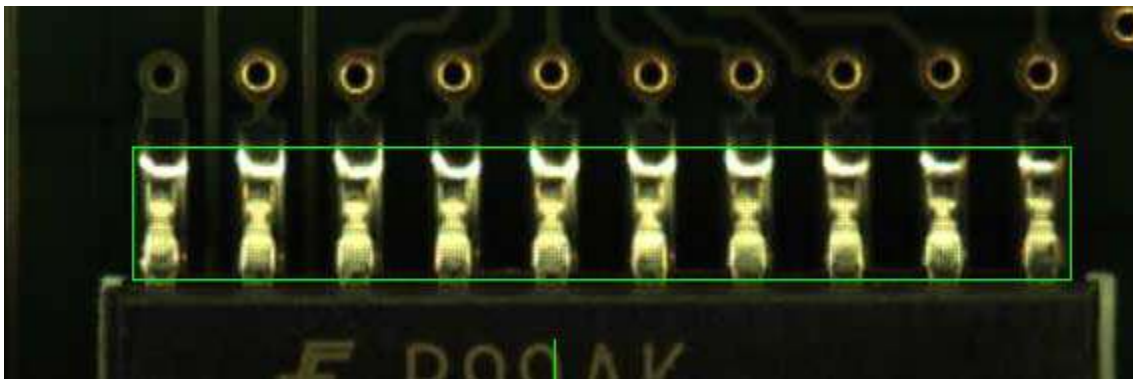
Wrong placement of the lead bank box where the outer tip of the pads area are not enclosed within the box.

Limitations

There are certain pads geometries that the lifted lead detection algorithm will not work with. One is when the pad is so short that there is little or no area in front of the tip. Second, is when there is excessive solder on that pad and solder is always on the area in front of the tip even in good solder joints.

10.4 Solder Inspection

Solder inspection is designed to verify the solder quality on each individual pin of the component. The default inspection uses top lighting and histogram analysis to detect insufficient solder conditions.
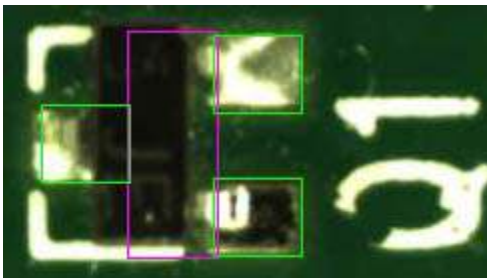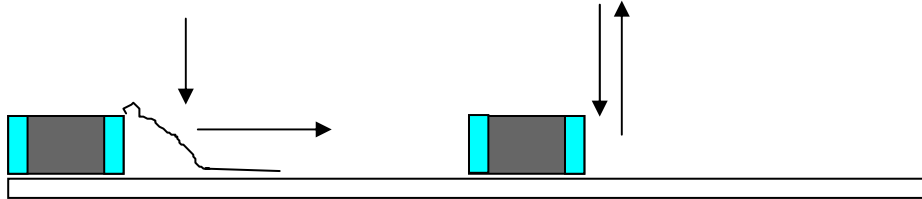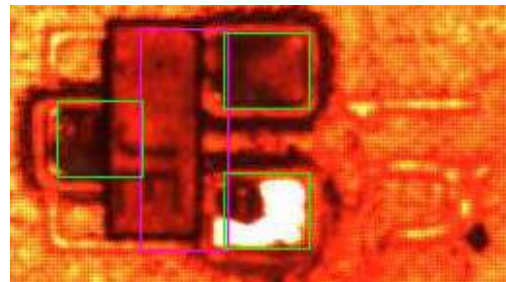
Side light Image   Same Image Under Top Light
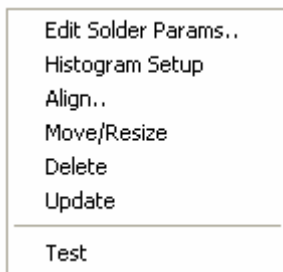
After the solder inspection box is created, the user can display the solder pop up menu by pressing the right mouse button while pointing inside the solder inspection box.

Edit Solder Params.   -Launches the Solder Parameters dialog.

The user may enter the solder box's pin number by typing it in the **Pin Number** box on the dialog. Pressing the **Set Pin 1** button for the Pin 1 inspection box will cause the software to set the pin numbers for all solder boxes using a counterclockwise convention.

The rest of the buttons on the dialog set the **Direction, Camera View** and **Lighting** for the inspection. The user can also select a preprocess and a decision algorithm for the inspection.

Currently there are five decision algorithms for the solder inspection box: **Histogram Inspection**, **Pattern Matching, BGA Analysis, Solder Blob Analysis, PTH Solder Analysis and Fusion Solder**. The BGA Analysis is an X-ray inspection algorithm for the YTX-6000 machine; it is explained in section 11.3. Fusion Solder is for YTV-M1 machine with RGB light. Solder Blob Analysis and PTH Solder Analysis are through-hole inspection algorithms; they will be explained in section 10.6.1 and 10.6.2. All solder inspection boxes can be anchored by a marking box. Please refer to section 13.4 on the functionality of anchors. The **X-ray Power Level** and the **Skip** feature are mainly for X-ray inspection on the YTX-6000 machines.
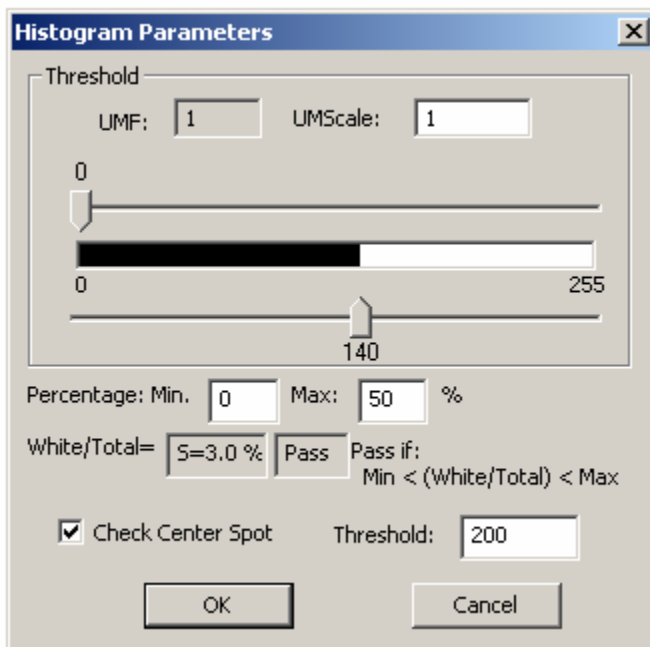
Histogram Setup - Launches the Histogram parameters dialog.

Histogram inspection uses a threshold value to binarize the image into black or white pixels. The algorithm then makes a decision based on the ratio between the two. The **UMF** and **UMScale** are used for uniformity compensation which is disabled by default.

When used with top lighting, histogram inspection can effectively detect insufficient solder defects.

The **Check Center Spot** is for detecting unwett or excess solder conditions on chip devices. See pictures below:
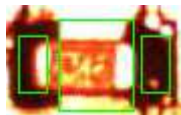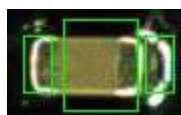
Good Solder with Top and Side light
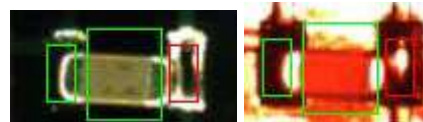
Unwett solder with top and side light

The "Check Center Spot" checks for a bright round spot in the center of the box. If such a spot is found the algorithm returns a fail status.

Pat Match Param.. -Launches the pattern matching parameter dialog.
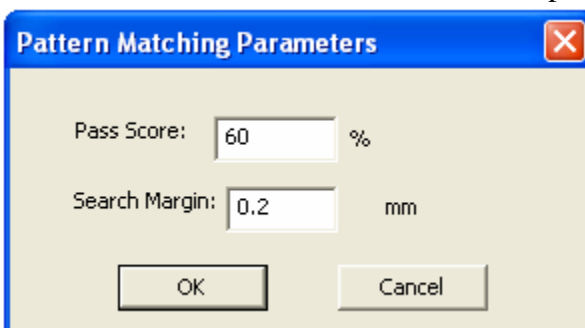
Pattern matching is more commonly used in Mark inspection, but can also be used in solder inspection. The idea is to use a known "good" solder joint

as a template to check the others against. During inspection the image of every joint is compared to the template and dis-similar joint images (defined by the pass score) are rejected.

Align.   -Launches a dialog for the user to align the solder
                                    inspection boxes.
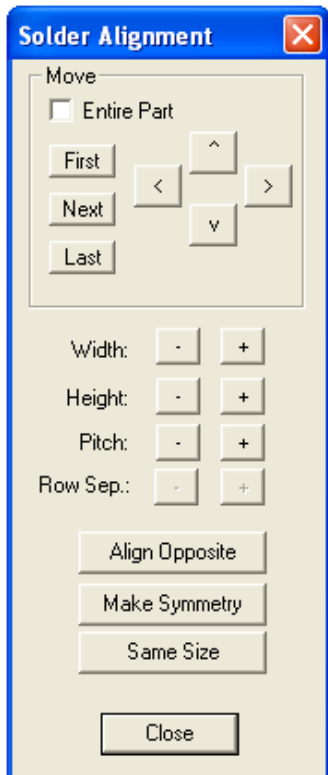
Using this dialog the user can move and size the solder inspection boxes. The **Width** and **Height** buttons increase and decrease the rectangular area of the inspection box. The **Pitch** button increases or decreases the pitch between inspection boxes. The **Row Sep.** button is normally disabled. It will be enabled only if the Row Count is greater than 1. When it is enabled it adjusts the row separation for the pins. The **Align Opposite** button will align or create the lead inspection in the opposite direction of the part. The **Make Symmetry** button moves the lead box so that it is symmetrical with respect to the centroid of the part. The **Same Size** button makes all the solder boxes the same size.

Move/Resize   -Moves and/or Resizes the solder inspection box.
Update   -Uses the current solder box as reference to update other
                                   solder boxes on other parts.
Test   -Inspects the solder on the current image.

10.5 Color Banded Resistor Inspection

Despite the rapid advancement in surface mount technology, the last generation through-hole technology has stubbornly held on especially in areas where high reliability is essential. There is no sign of this through-hole technology being displaced by surface mount technology any time soon. Ironically the AOI technology, a byproduct of surface mount technology, is now mature enough to serve the through-hole technology. Many through-hole boards are hand assembled. There are high chances of random assembly error in through-hole boards. This make the builder of through-hole boards interested in the AOI technology.
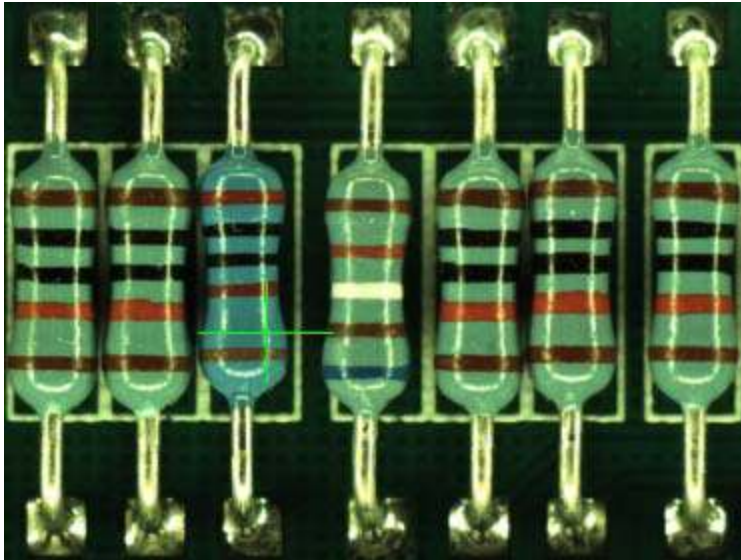
The value and the tolerance of through-hole resistors are coded in color bands. To verify these values the inspection machine has adapted to read color. With its white light and color cameras, the YTV series AOI machine is perfect for the task. A special software algorithm has been developed based on the coding system of the color band. Axial-leaded resistors use a color-band marking scheme to indicate resistor values. The first two or three bands are digit values followed by a multiplier and the last is a tolerance band.   See the table and example below:

Digit Value	Color	Multiplier
	Silver	0.01
	Gold	0.1
0	Black	1
1	Brown	10
2	Red	100
3	Orange	1k
4	Yellow	10k
5	Green	100k
6	Blue	1 M
7	Violet	10M
8	Gray	
9	White	

1st digit
2nd digit
3rd digit
multiplier   tolerance
brown 1%
red   2%
gold 5%
silver 10%
none 20%

example: red-yellow-black-red-brown is a
2,4, 0 and 100 multiplier for a 24k 1% resistor
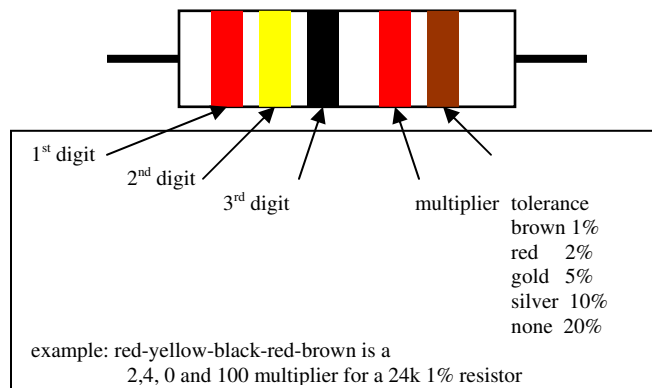
The inspection algorithm is associated with mark inspection. To inspect color band resistors the user must define a marking box that covers the body of the resistor. Select **Resistor Color Band** as the decision algorithm. Once the Resistor Color Band algorithm is selected a menu item called **Color Band Params**. will be added to the mark's pop up menu. Selecting this item will launch the Resistor color Band Parameters dialog shown on the right. On this dialog the user can enter the value and the tolerance of the resistor. Knowing the coding system the software can determine the color band arrangement based on the resistance value and tolerance the user entered. In case the user does not understand the coding system of the resistor he or she can still train the AOI machine by providing the color band arrangement from a sample board. This technique it called "Enter by Color" it is accomplished by pressing the **Enter By Color Band** button. For 1% resistor there are two standards one uses 4 bands the other use 5 bands. The **Bands** group select between the standards.
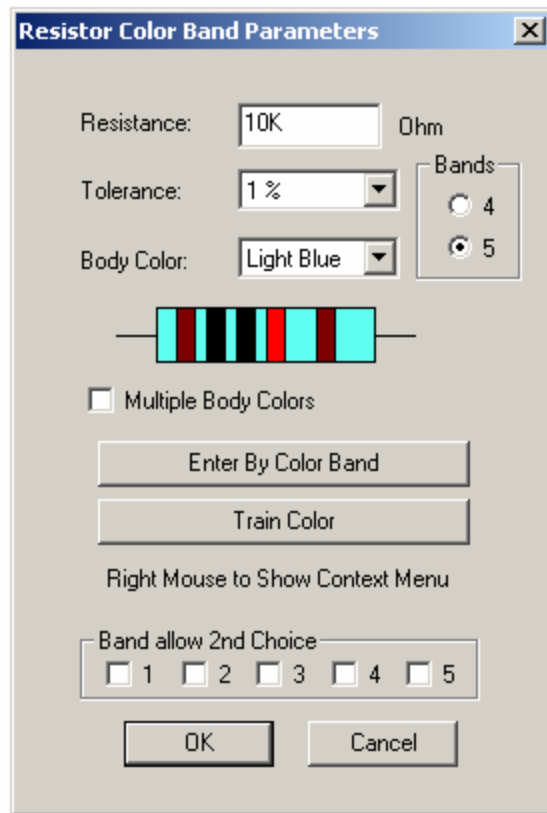
The **Enter By Color Band** button launches the **Enter By Color Band** dialog. Using the dialog the user can use the pull down lists to specify the color band arrangement. Although the **Enter By Color Band** dialog does not require the user to understand the color band coding system, the user still has to know the band direction in order to use the dialog. Putting Band 5 color in Band 1 list will result in an error. Fortunately, even by guessing which color goes first, the user will have a 50% chance of getting it right the first time.

The software must learn the characteristics of each color before the software can distinguish between them. This leads to the training process. During color training the user provides the software with samples of each color. This is done using the **Train Color** dialog. For example to train the brown color the user first selects Brown from the

Color list box. Using the arrow buttons, he or she positions the selection square (small green box on the image) onto a brown band on the actual resistor and presses the train button. Multiple samples of the same color can be trained to compensate for color variations. The software will use a statistical average of all the samples to represent the color.

Inside the software each trained color is stored as a three dimensional reference color vector. The three dimensions being red green and blue (R, G, B). During inspection sample colors are taken from the image of the resistor and "Distances" are calculated from the sample color to each reference color vector. The software reads color by finding the reference/sample pair with the minimum distance.

On the **Train Color** dialog the **Test** button will calculate the "distances" from the color in the selection box to each reference color. It can be used to verify the training of each color. The **Clear 1** button deletes the last trained color template. The **Clear** button clears the training for the current color and body. The **Clear BC** button clears the training for all colors of this body color.
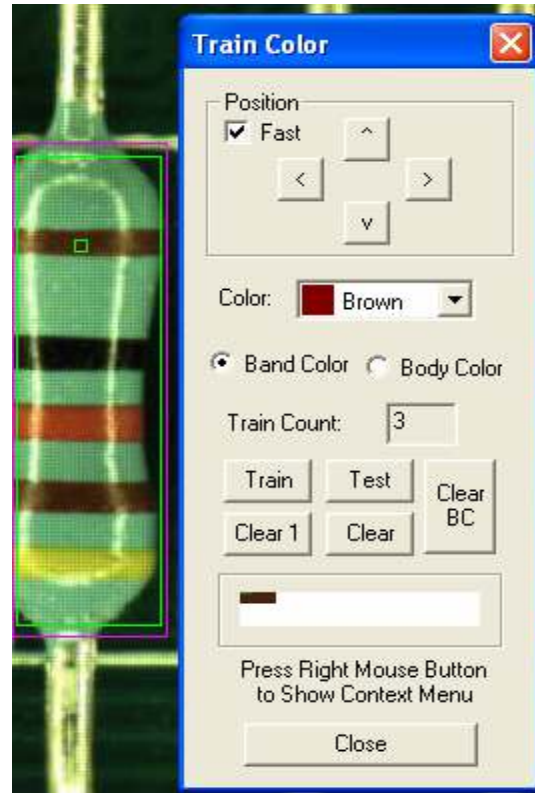
The through-hole resistors come in a variety of background colors. By default the software organizes its reference color matrix based on the background colors of the resistor. There is a set of reference colors per background color. Each reference color has to be trained before they can be used during inspection. Rather than having the user start from ground zero, the software ships with a default color matrix that serves as the starting point for users. The color matrix is saved as **ColorMatrix.txt** in the **C:\Program Files\AOI\ini** folder. Instead of organizing color data by backgrounds, user can also select to have the color data organized by part numbers. For simple boards with less than 10 different part numbers organized color data by background work perfectly. But when the board become more complicated organized by part number provide better results.

To help automate the process of training color band resistors, the CAD import has been enhanced to allow the user to specify the resistor's value and tolerance in the YCD file. Here is a fragment of the YCD file for color band resistor training.

```
[PartList]
Ref.ID P/N               X     Y    Rot'n  Pkg     Extension
R73    GDC-300-020-010  7230  2300 270    600     ALGO=10 1.00 5% 1/2W
R99    GDC-300-020-010  4370  500  270    600     ALGO=10 1.00 5% 1/2W
R52    GDC-300-020-043  1180  2970 270    600     ALGO=10 4.30 5% 1/2W
R53    GDC-300-020-043  1350  2970 270    600     ALGO=10 4.30 5% 1/2W
R14    GDC-300-020-100  725   5585 0      600     ALGO=10 10  5% 1/2W
R8     GDC-300-020-100  3720  5740 270    600     ALGO=10 10  5% 1/2W
R9     GDC-300-020-100  4600  5740 270    600     ALGO=10 10  5% 1/2W CC
..
..
```

The ALGO=10 specifies the **Resistor Color Band** algorithm; it is followed by the resistance such as 10 (for 10 Ohm) or 10K (for 10K Ohm) or 5.6M (for 5.6 Meg Ohm). Then follow by the tolerance percentage (1%, 2%, 5% or 10%). With the YCD in this format, through-hole resistor components can be trained easily using the CAD import process.

After inspection during the defect review the software provides visual aid to help the user make a decision on the nature of the defect.
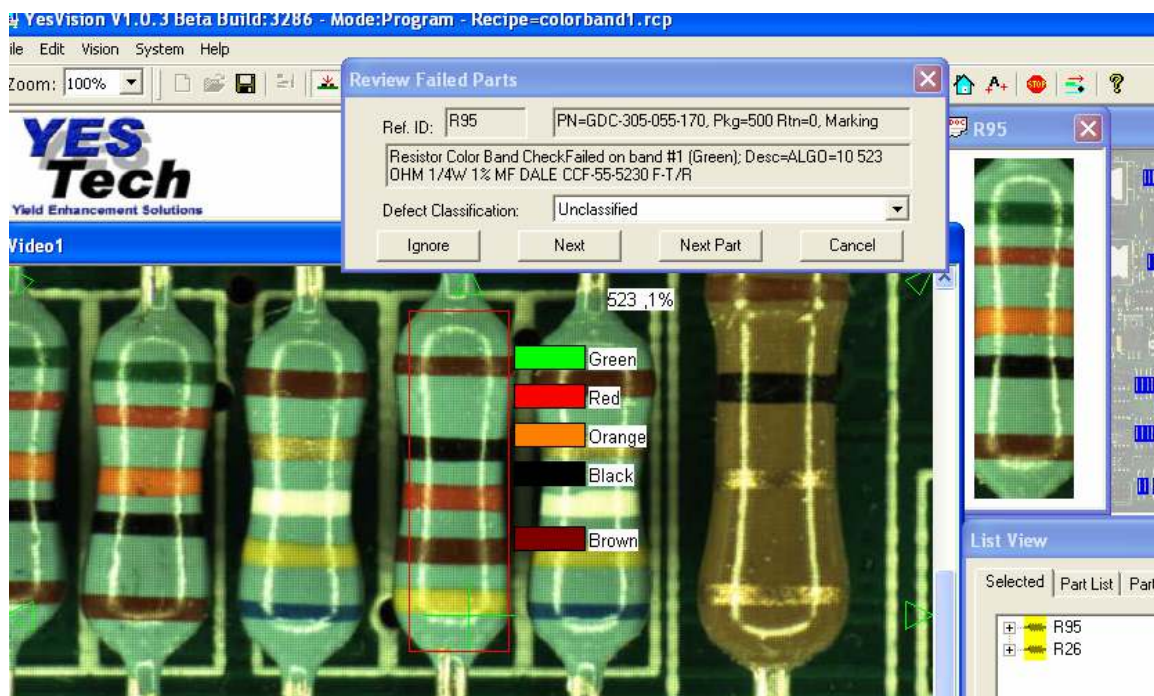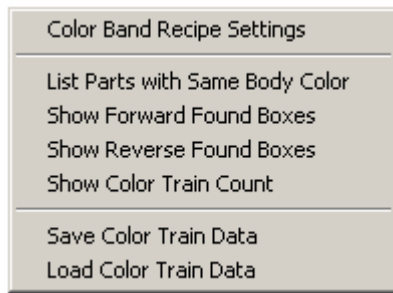
There is a context menu for the **Resistor Color Band Parameters** dialog. This menu will display when the user right clicks the mouse anywhere on the Resistor Color Band Parameters dialog.

Color Band Recipe Settings
Launches the dialog on the right for setting color band parameters for this recipe.
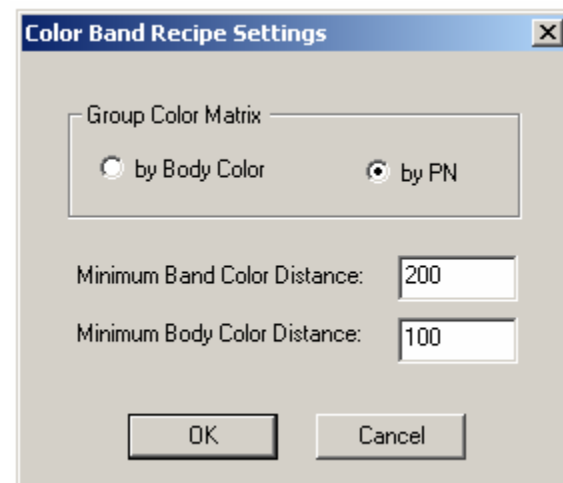
List Parts with Same Body Color
Lists the color band resistor parts in the part list that have the same body color as the current part.

Show Forward Found Boxes
Shows the boxes around the area that the software used for color samples. The found positions would only be available after an inspection.
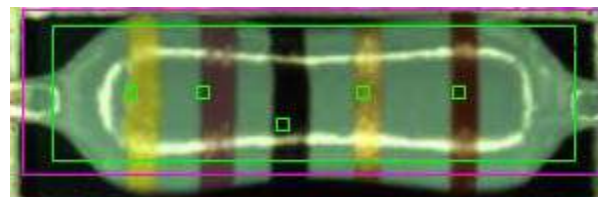
Show Reverse Found Boxes
Show the color found position rectangles for the reverse scan. The found positions would also only be available after an inspection.

Show Color Train Count
Show the number of trained templates for each color.

Save Color Train Data
Color train data normally saves with the recipe. This menu selection allows the color train data to be saved into a separate file.

Load Color Train Data
Load color data from a disk file.
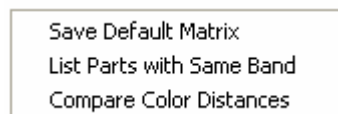
The Train Color dialog also has a context menu. It has the following selections:

Save Default Matrix
Save default color matrix at C:\Program Files\Aoi\ini\ColorMatrix.txt
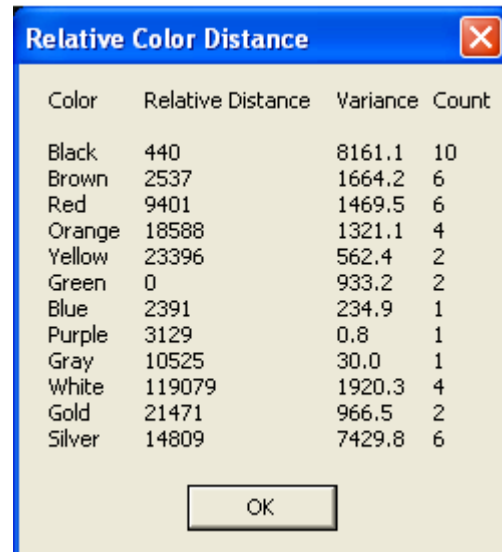
List Parts with Same Band
List the color band resistors that have the
same body color of the current part and have
one or more bands of the selected color . The
list will appear in the **Selected** page of the
List View.

Compare Color Distances
Display the relative color distance between the
colors. When the color distances for two
colors are very close the software may have
difficulties distinguishing them. This menu
selection helps the user to identify the
confusing color pair.
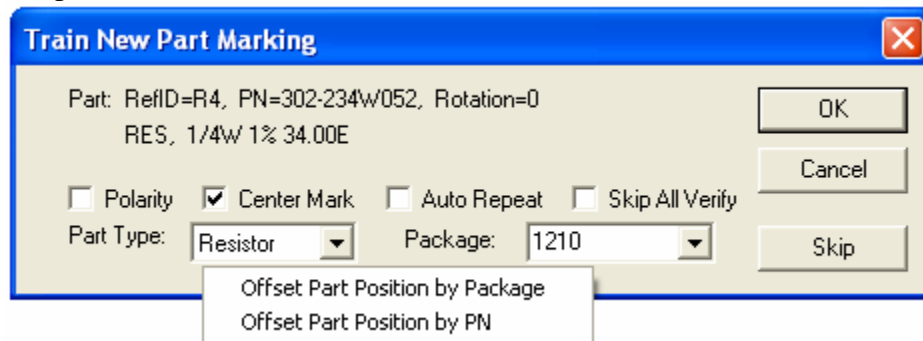
Relative Color Distance

Color	Relative Distance	Variance	Count
Black	440	8161.1	10
Brown	2537	1664.2	6
Red	9401	1469.5	6
Orange	18588	1321.1	4
Yellow	23396	562.4	2
Green	0	933.2	2
Blue	2391	234.9	1
Purple	3129	0.8	1
Gray	10525	30.0	1
White	119079	1920.3	4
Gold	21471	966.5	2
Silver	14809	7429.8	6

OK

There are special software features added in the CAD import process to facilitate
through-hole board training. Compared to that of the SMT parts, CAD data for through
hole parts usually contains pin 1 position data opposed to centroid position data. During
CAD import, the YesVision™ software allows the user to offset the position based on
package or part number.

Train New Part Marking

Part: RefID=R4, PN=302-234W052, Rotation=0
    RES, 1/4W 1% 34.00E

[ ] Polarity   [✓] Center Mark   [ ] Auto Repeat   [ ] Skip All Verify
Part Type: Resistor ▼   Package: 1210 ▼

OK
Cancel
Skip

Offset Part Position by Package
Offset Part Position by PN

10.6 Through Hole Solder Inspection

YTV AOI machines can also be used to inspect solder defects for through-hole boards. The type of solder defects detectable by the machine are missing or insufficient solder, no wire (also known as pin-not-thru) and bridging. The inspection is done by looking at the bottom side of the board.

Good Joint   Insufficient   No Wire

Good Joint   No Wire   No Solder   Insufficient Solder
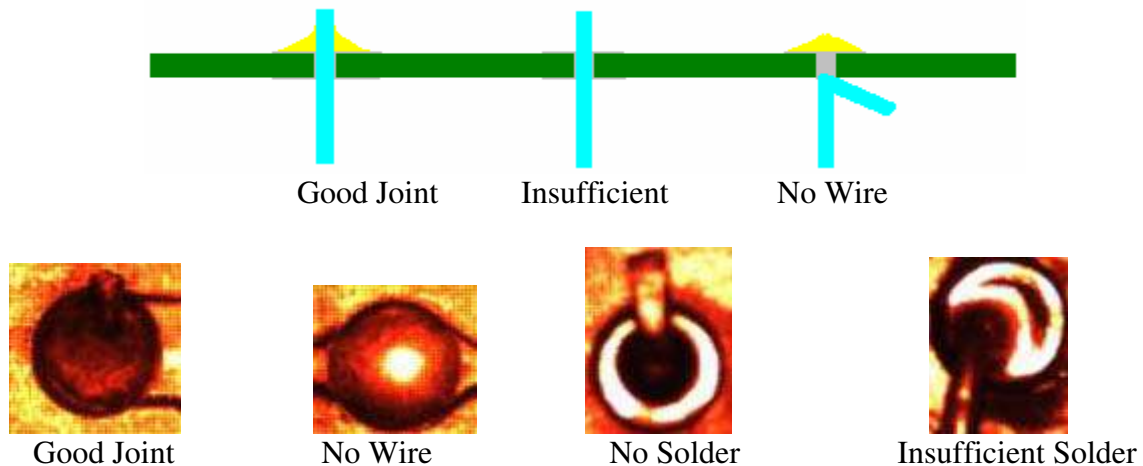
The YesVision software offers special features to facilitate through hole solder inspection. The bottom side inspection recipe can be created automatically after the top side recipe has been created. The software creates the bottom side recipe by mirroring the top side.

To inspect solder for through-hole, users need to create and fine-tune the inspection recipe for the top side as usual. After which they need to flip the board over along its Y axis (see illustration), from **File** menu select **New Board**, check the **Train 2nd Side** box, then press **OK**. The software will prompt users to locate the three corners of the board, and then train fiducial marks. After that, it will scan the board and create a map view background image for the bottom side.

Flip along the Y axis
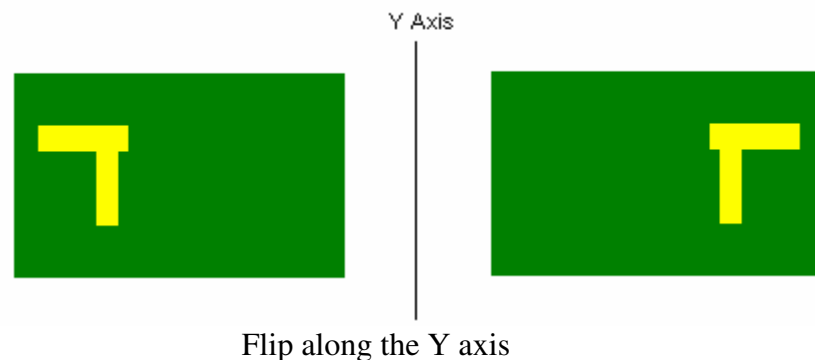
After the **New Board** process is completed, the user can create the part list for the bottom side. To do so select "**Create Bottom PartList**" from the vision menu. The following dialog will display:
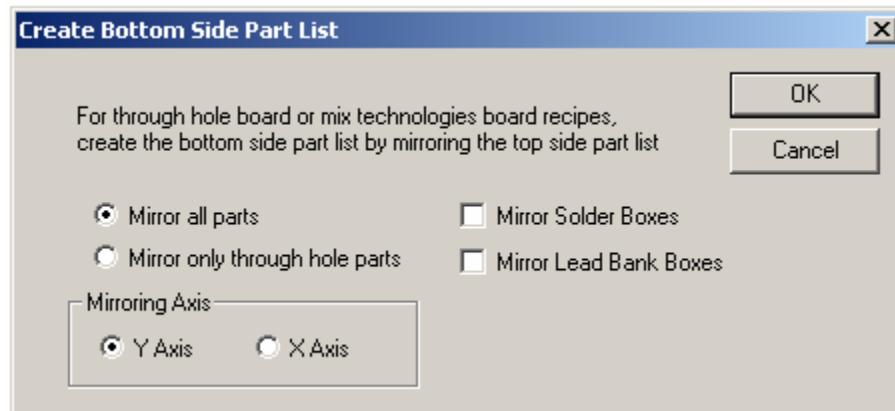
The software will then create the bottom side part list by mirroring the top side part list of the recipe. The part list creation process is automatically followed by a part alignment process very similar to "Resync Centroid" of which the user is prompted to locate three parts. Bases on the user input the software will precisely place all the parts.

The Create Bottom Part List process only creates the part outline box (purple box) for every part. The user still needs to add solder inspection boxes and lead inspection boxes to complete the recipe.

In order to detect the "no-wire" condition, users must select **Check Center Spot** when defining parameters for solder inspection.

72
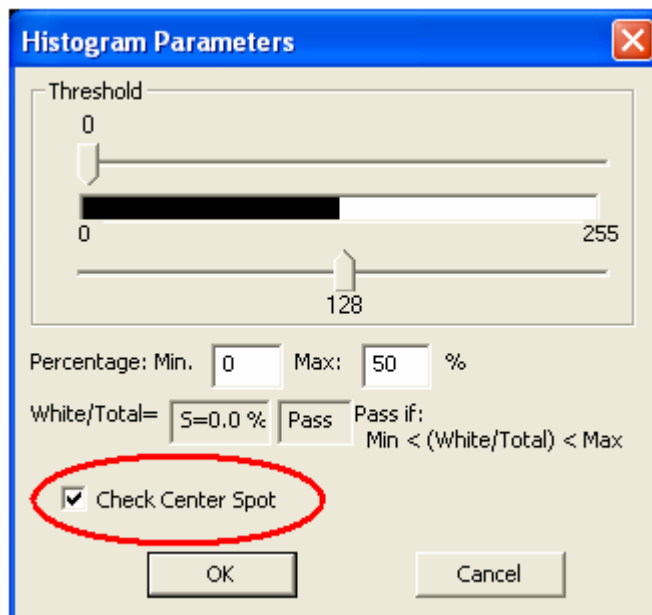
10.6.1 Solder Blob Analysis

This algorithm performs blob analysis on the solder joint and compares its characteristic against defined parameters. Here is the parameter setup dialog
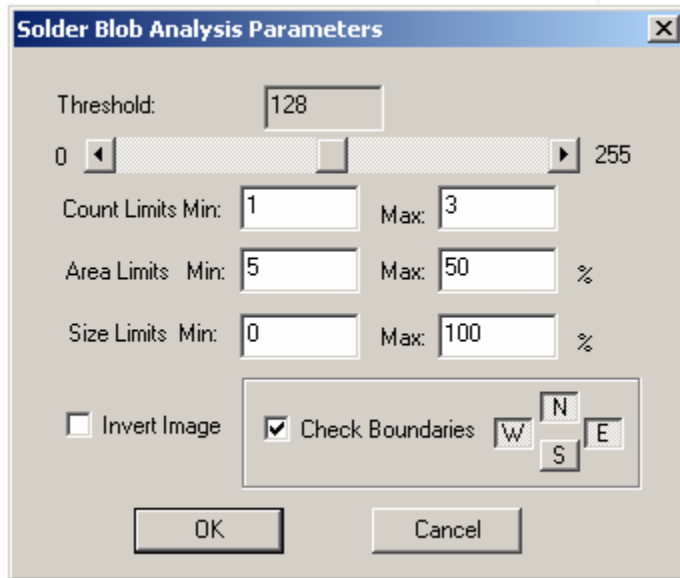
The **Threshold** is used to binarize the image for blob analysis. **Count Limits** set the expected number of blob to be found. **Area Limits** set the minimum and maximum size of the expected blobs. **Size Limits** set the minimum and maximum size (Width and Height) of the expected blobs.

The **Invert Image** check box if checked will invert the image before the analysis. The **Check Boundaries** check box enables the boundary check. Boundary check fails if any blob touches the perimeter of the inspection box.

10.6.2 PTH Solder Analysis

Plated Through-Hole (PTH) solder analysis algorithm is a new class of algorithm that analysis solder joint in both side and top light, and render a decision base on the combined results. The light selected for this algorithm is called the "One-Pass Light", lighting number 4. No other lighting selection is allowed for this algorithm. This algorithm performs blob analysis on through-hole solder joint in both light. It setup dialog has two pages:
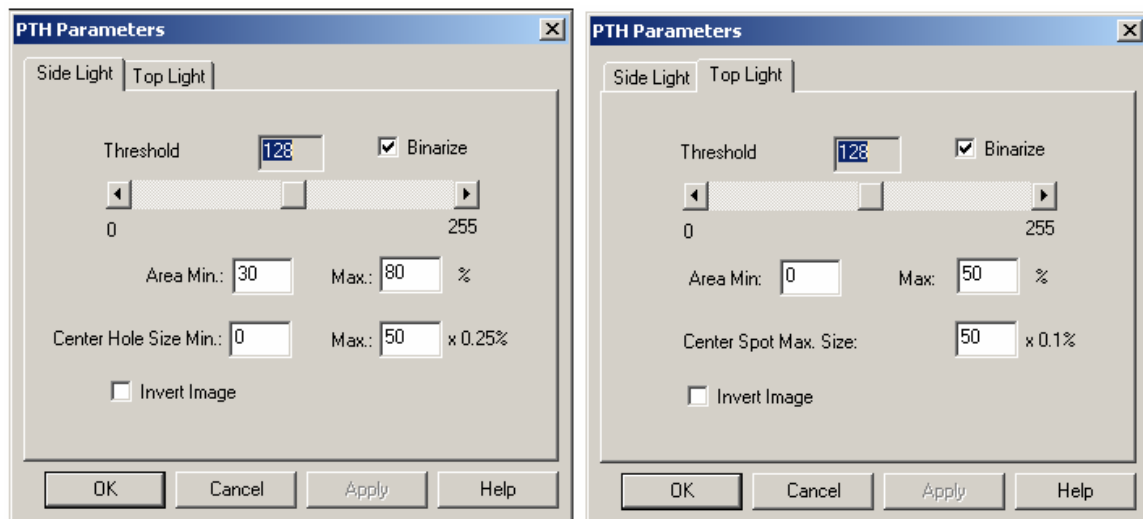
10.7 OCR

Optical Character Recognition refers to the image process technique that involves reading text from an image and translating it into a form that the computer can manipulate (for example, into ASCII text). In PCB inspection applications OCR can be used to enhance traceability. That includes reading the serial numbers from the PCB and date or lot codes from important components. The YesVision software is capable of OCR.

In the YesVision software the OCR feature is implemented as a Mark inspection algorithm. It provides a powerful and easy to use function set for reading and verifying character strings. The feature can read and verify mechanically generated, uniformly spaced, character strings of known lengths. The feature is designed to operate even on degraded images, with up to a few degrees of rotation in the target string.

There are two main usages of the OCR feature in the YesVision software.

1. Reading the Serial Number of the board.
2. Reading the date or lot code of selected components and log the data into the ODBC database.
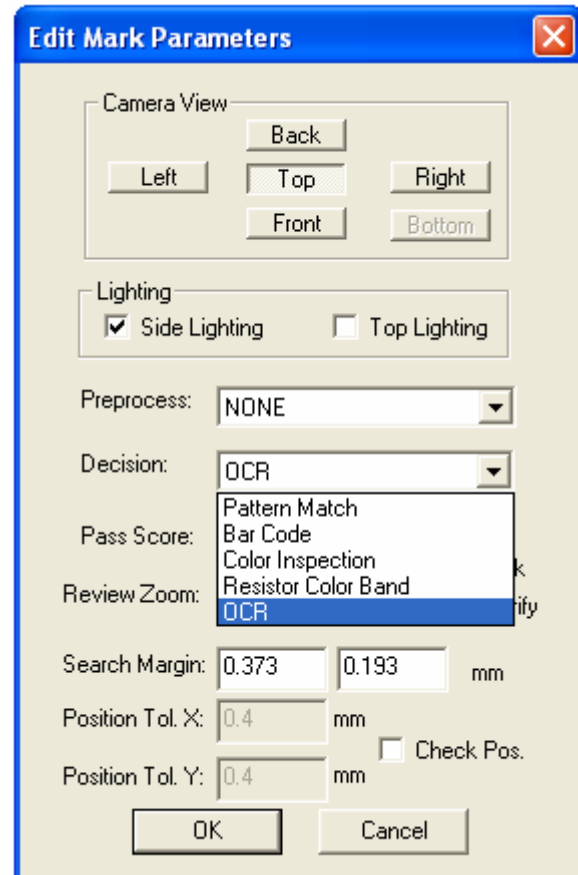
To use OCR to read the serial number of the board, the user must create a part and set its RefID to BARCODE. They must then train a mark and set the **Decision** algorithm for OCR. To track a date or lot code on a component, the user can enable the **OCR Data Track** option from the **Recipe Option** dialog. The data will be logged into a table called **OCR_Track** in the ODBC database.

Before any character can be read by OCR, the software must learn the character set. This is done by presenting the sample characters to the software. The software organizes the training data into fonts. Each font has a character set that contains the characters that had been trained. The font data is stored with the rest of the recipe's data.
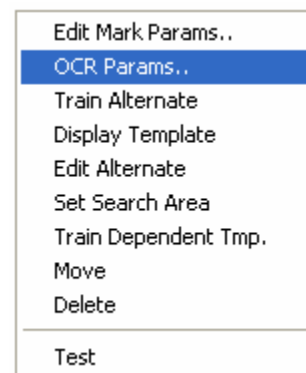
To start using this feature, users can select OCR from the decision list box in the **Edit Mark Parameters** dialog.
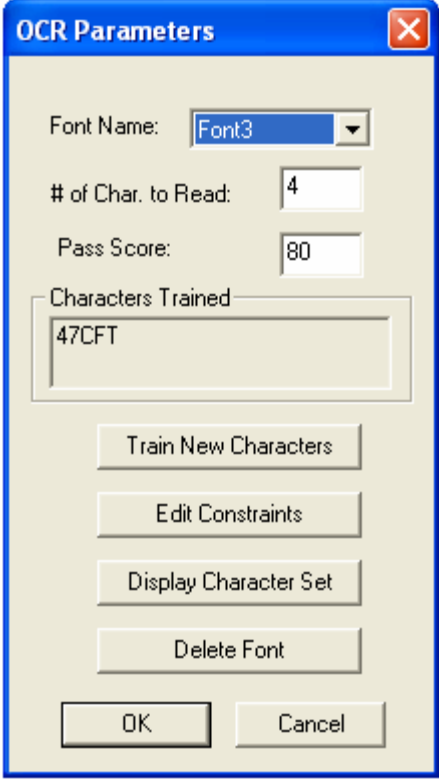
After the OCR algorithm is selected a menu item called **OCR Params..** will appear in the pop up menu. Selecting it will launch the **OCR Parameters** dialog.

The OCR Parameters dialog is the main dialog for OCR. The **Font Name** selects the font of the character to read**. # of Char. to Read** sets the number of character to read. The YesVision software allows users to read character strings up to 20 characters in length. The Pass Score sets the acceptance criterion for the quality of the print. The Pass Score goes from 0 to 100, 100 being a perfect match.

The **Train New Characters** button launches the **Train New Character** dialog. The **Edit Constraints** button launches a **Constraints** dialog. Display Character Set displays the trained character set on screen. The **Delete Font** button deletes the selected font.
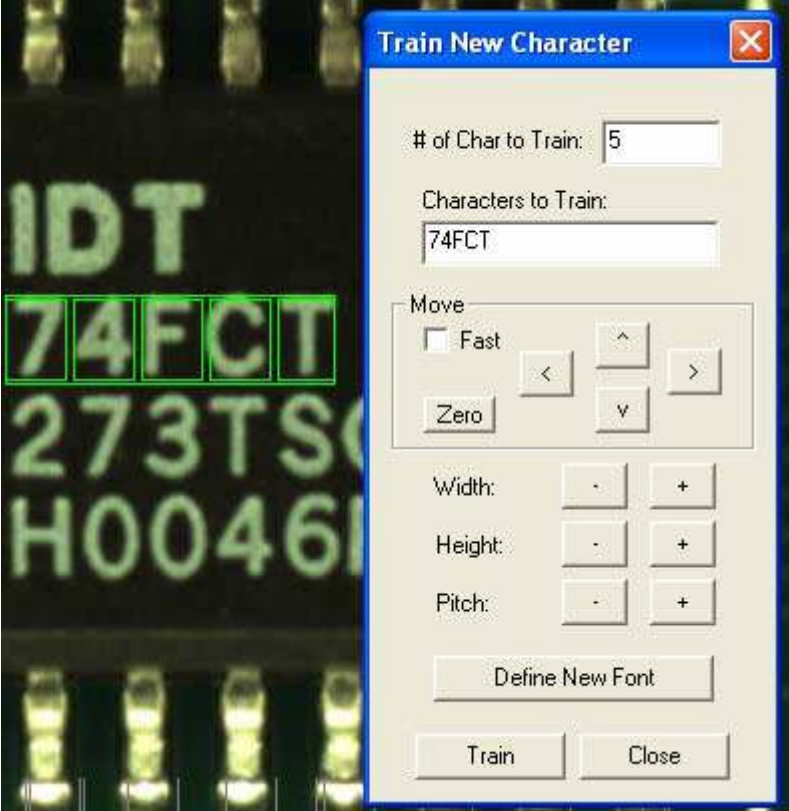
The Characters Trained box shows all the characters trained in the selected font set.

The **Train New Characters** dialog allows the user to train new characters into the Character Set of the specified font. On this dialog the **# of Char to Train** specifies the number of characters to train (not to be confused with the number of characters to read.) In the **Characters to Train**

edit box the user should type in the character string to be trained. The **Move** group has 6 buttons that control the train boxes. The width, height and pitch of the boxes are also adjustable. With the boxes at the right location and character string entered, pressing the **Train** button will train the characters into the font set. **The Define New Font** button launches the **Define New Font** dialog for the user to enter the name and important parameters for a new font to be created. One important point to remember is that the character Width, Height and Pitch parameters have to be set before pressing the **Define New Font** button. Performing these steps in the wrong order will result in an unusable font set.
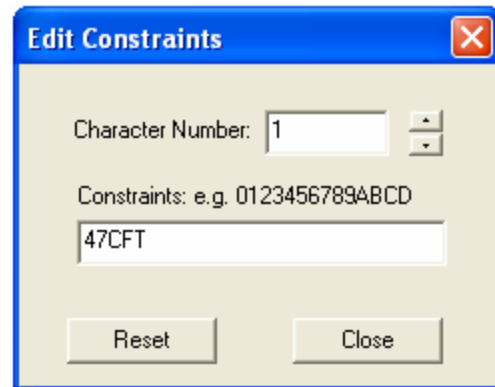
The OCR read operation compares each character in the target image to each character in the font to find the best match. You might know beforehand that certain characters (or type of characters) should appear at specific positions in the string. If this is the case, you can speed up and increase the robustness of the read operation by restricting the comparison to only those characters in the font. To do so you set **Constraints**.

Pressing the **Edit Constraint** button on the **OCR Parameter** dialog launches the **Edit Constraints** dialog. The constraint is set one character position at a time. After clicking reset the constraint contains the complete character set of the font. To restrict a character from being read in the string, simply delete that character from the constraint text box.

76

10.8 Inspection with Side Angle Camera

The automated optical inspection works most efficiently using the top view camera. However, certain types of devices such as some surface mount LED's may have polarity markings printed on the side of the component hidden from the top view. Solder joints on PLCC packages are also not visible from the top view. In such cases a side view camera angle can supply the missing information for complete defect detection. In short, the side angle cameras complement the top view cameras to provide an optimized inspection.

A side camera is also highly useful during defect review. It gives the operator more information about the defect for better defect classification.

A side camera can do a better job reading the markings etched on shiny metallic or rough textured surfaces. Here are some pictures for comparison.
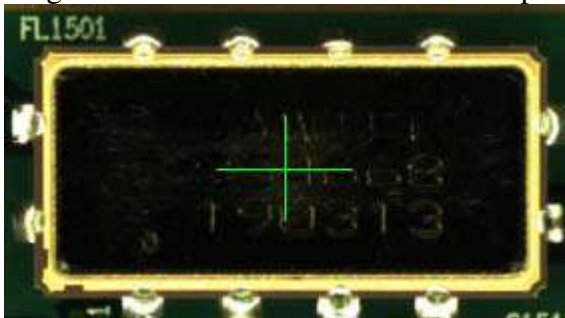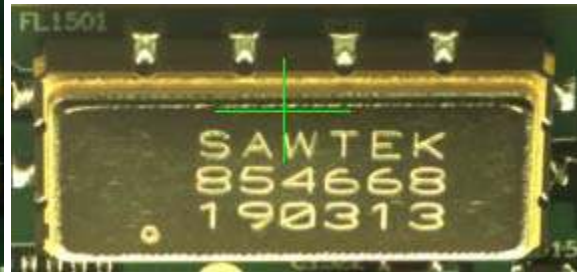
| Crystal Top View | Same crystal side view |

| Top View | Side View |
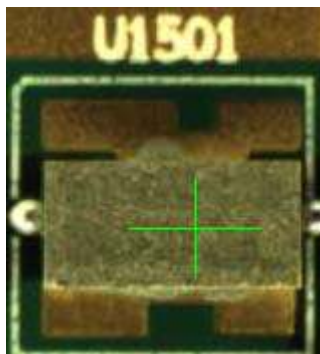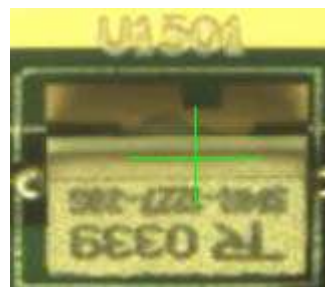
For PLCC and J leaded packages, lead and solder inspection can only be done with side view cameras.
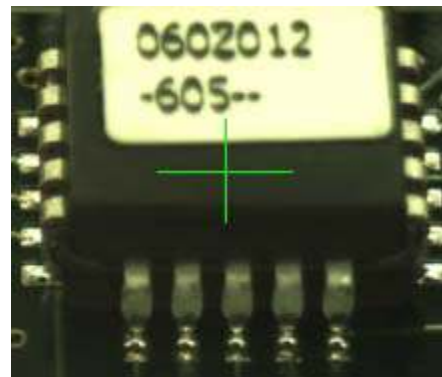
PLCC Top View   PLCC Side View showing leads and solder joints

On a QFP it is possible to inspect for lifted leads using the top view camera and the pattern matching algorithm. You can further use the side view camera during defect review to see if the lead is lifted beyond the acceptance criteria.
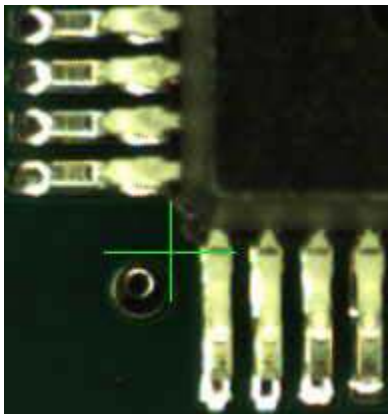
Top View of lifted QFP Leads   Top View of good QFP Leads
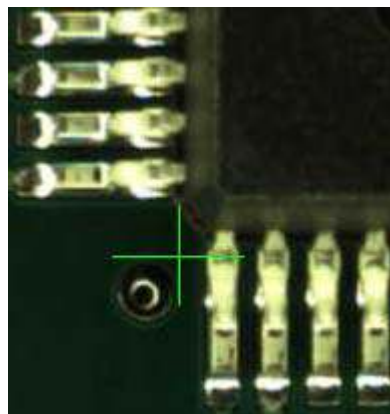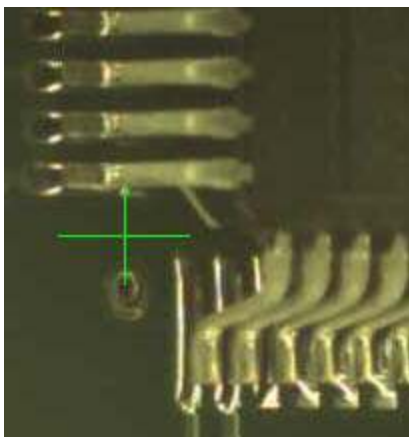
Side View of lifted QFP Leads   Side View of good QFP Leads
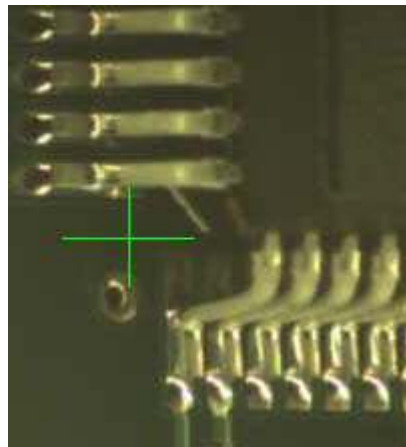
Precautions with Side Angle Inspection

Calibration factors need to be carefully considered for effective side angle inspection. Since side angle inspection is sensitive to board thickness, the software compensates for this with a thickness offset that must be set accordingly. Also, the raw image from the side camera is distorted due to perspective. The pixel is trapezoidal in shape and is different in size depending upon its location on the screen. To compensate for such distortion the incoming images are warped to generate equal sized square pixels. (Please refer to section 26.11 for the warp compensation parameter calibration.)

Here are the steps to verify that the settings are correct for board thickness and perspective compensation:

1. Right click the mouse in an area not designated as an inspection box and select **Setup..** from the pop up.
2. In the **Video Parameters** dialog first uncheck **Enable** under Perspective Correction for Side Views. Close the dialog by clicking **OK**.
3. Move the stage so that the vide cross hair is lined up with an easily identifiable mark on the PCB e.g. a silk screen mark.
4. Switch from top view to a side view and see if the mark you chose lines up with the cross hair. If not you will need to adjust the **Thickness Offset** in the **Video Parameters** dialog until it does. You can also use the **Measure Height** feature from the pop up menu to determine the thickness offset.
5. After entering the correct thickness offset in the **Video Parameters** dialog use the Measure height feature again and determine the calibration board's thickness value. (Cal. board thickness is the height where the camera offset is calibrated. During new recipe creations the software needs the value to deduce the correct thickness offset from the board's thickness value entered by the user.)
6. **Enable** the Perspective Correction in the **Video Parameters** dialog.
7. Switch from top view to the side views and see if the same mark lines up with the cross hair. If not, you will have to adjust the warp offsets (dx, dy) until it does.
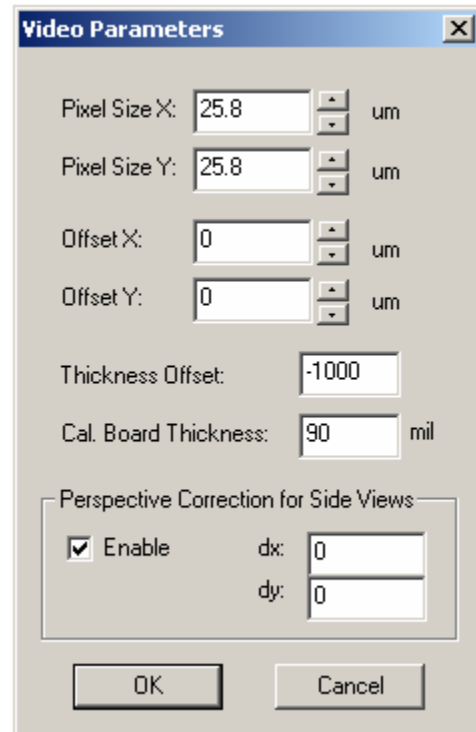
The Pixel Size for all 4 side view cameras should be 23.5 x 23.5 um after perspective correction. If the warp offsets have never been setup on the system before, the initial recommended settings on the following page should be used:

Offset	Back View	Front View	Left View	Right View
dx	100	100	300	-2600
dy	-1300	1300	0	0

Optical inspection requires a direct line of sight to the part being inspected. Side angle cameras inspect parts with a line of site that forms a 45 degree angle with the board. It is possible that taller components adjacent to the target part will obstruct the cameras field of view. The software provides a way to circumvent the problem by inspecting the part from the opposite side. To do so the user needs to check the **Flip Side View** check box in the part parameter dialog. This attribute for the part is set in relation to the reference designator (location e.g. R1, C12...). It saves with the recipe but it does not update via part number or package. This allows each individual blockage problem to be dealt with on a per location bases.

10.9 Fusion Lighting

10.9.1 Introduction

Starting from May 2007 the Fusion lighting system replaces the Red and White light to become the standard lighting system on all YesTech's AOI systems. It incorporated the latest developments in LED lighting technology to push AOI defect detection capability to a new level. The Fusion lighting is completely compatible with the Red and White lighting scheme that is replaced. Its feature set is a super-set of the old lighting feature. That mean it can do everything the old light can and more. It utilizes 4 different color LEDs to illuminate circuit boards in 3 different angles.
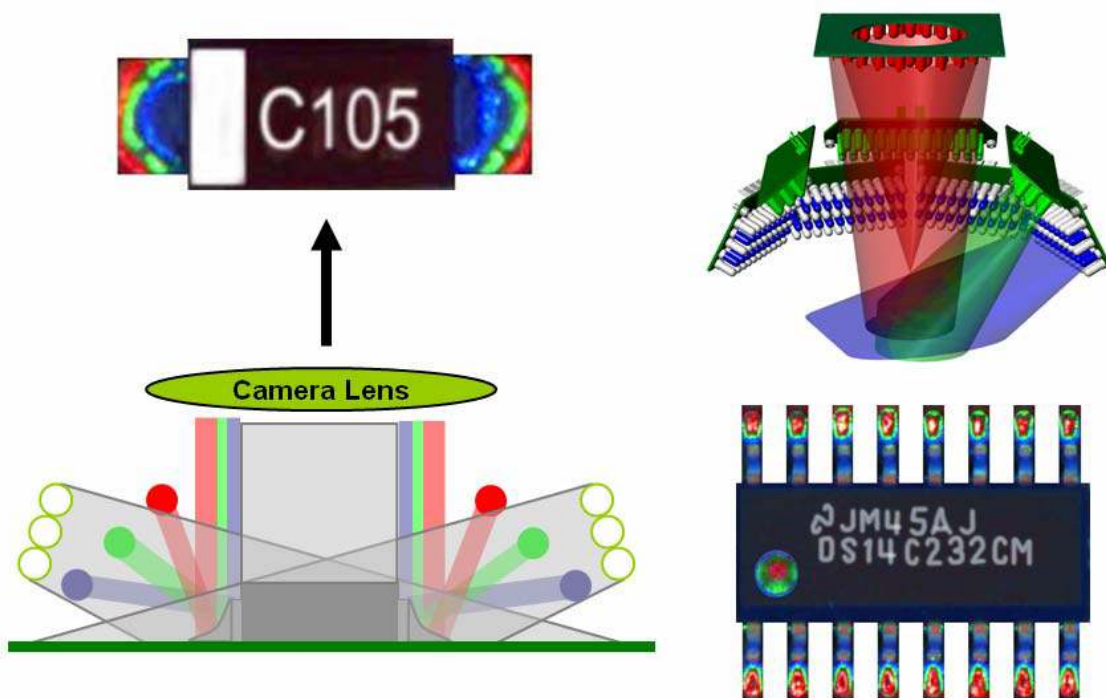
10.9.2 Setting Light Presets

With Fusion lighting the scheme is organized as light presets, when specifying lighting for inspection the preset number is used. There are 5 pre-defined presets, 1 default presets and 4 user definable presets. The pre-defined presets are hard-coded and are not user changeable. They are:

Preset 0 - No light
Preset 1 - Side Light (low angle white light)
Preset 2 - Top Light (high angle red light)
Preset 3 - Both Side and Top Light
Preset 4 - One Pass Light for PTH solder algorithm

The default preset is the RGB light, preset number 5. The RGB light illuminates parts using 3 color LEDs in 3 different angles; blue at low angle, green at median angle and red at high angle.

Camera Lens

The 4 user definable presets are for user to configure for special needs.

The lighting presets are configured using the **Fusion Light Setup** dialog which can be launched from the **Video Setup** dialog. On the top of the dialog user select the Preset number. In the edit box on its right a name can be entered for the preset. Below that is a section represents the light sections of the Fusion lighting; **Top** for top red light, **Green** for 45 degree green light, **Blue** for low angle blue light, 4 **Ws** for white light sections in 4 directions. There are two Top light sections; **F1 Top** and **M1 Top**. They represent 2 light intensities for the top light, **F1 Top** represent an intensity that is comparable with the old F1 top light. It is used in preset 2 and 3. The **M1 Top** represents an intensity for the old M1 top light which is used in preset 5 (the RGB light).

To create a user specific light preset user can perform the following steps:

1. Select the Preset number (6 to 9).
2. Enter a name for the preset.
3. Select the lights segment by using the **Top, Green, Blue and Ws** buttons.
4. Press **Set Light** to change the light based on the selection in step 3.
5. Press **Save Preset** to save the light preset with the recipe.
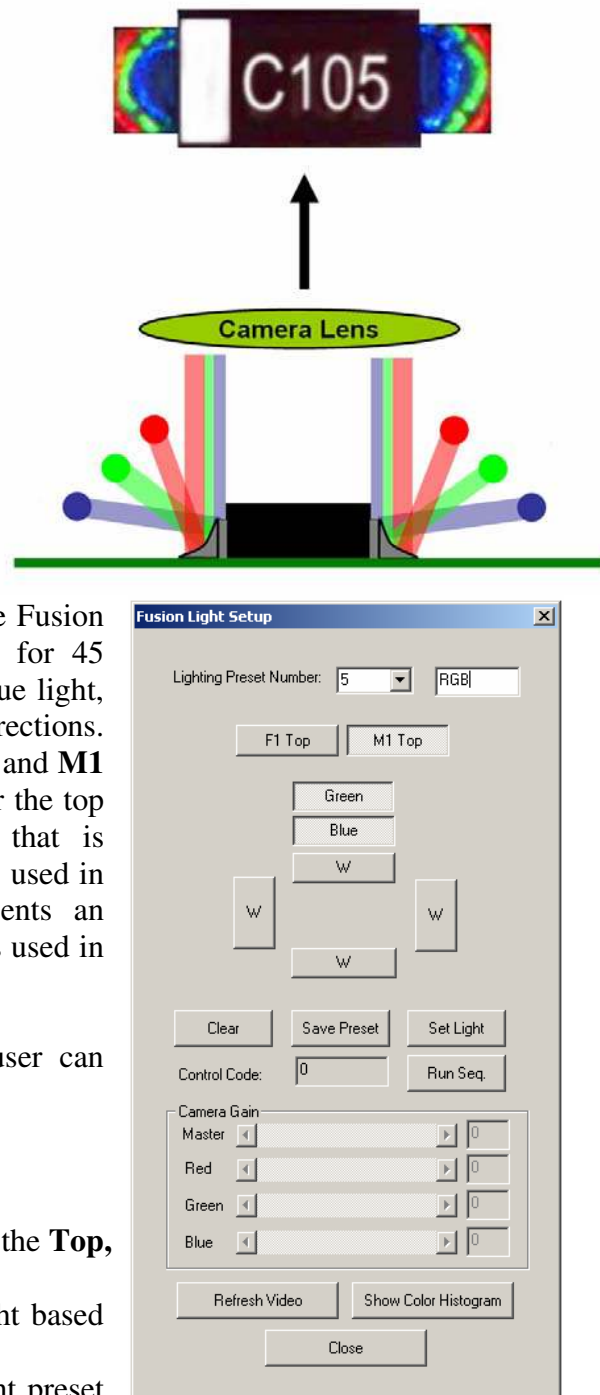
The **Camera Gain** section is for settings camera gain for the M1 machines. For M1 it is possible to have different gain for different light preset. For F1 and B3 machines the camera gain is global, and is set via the **TC Gain/Offset** dialog in the **Machine Builder** mode.

10.9.3 Color Filter

When using RGB light for inspection, different angle of the solder joints are high lighted with different color. In this lighting color filter feature can be used to separate the high lighted portion for image for analysis.
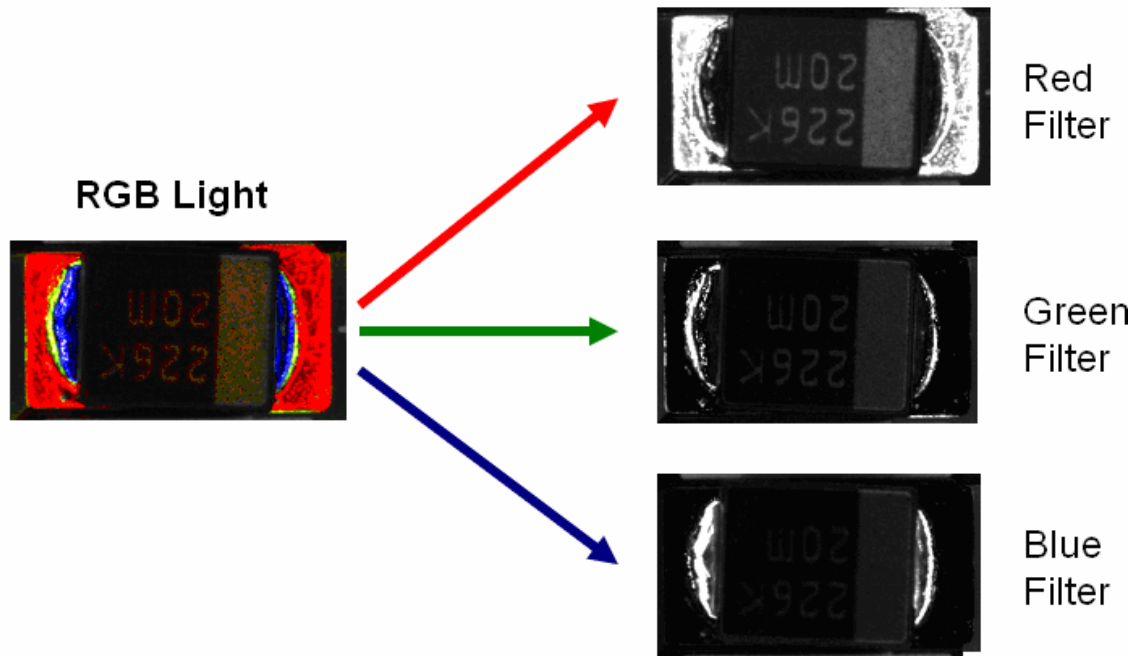
To apply color filter user select the appropriate preprocessing for the inspection box.

10.9.4 Creating Recipe Using RGB Light

To facilitate recipe creation two standard package libraries are created specifically for recipes that use the RGB lighting for inspection. Users should select the appropriate package library in the **Creation New Inspection Recipe** dialog.

Stdpkg_Post_RGB.pkg
This library is for recipes that use RGB light exclusively for all inspections.

Stdpkg_Post_WhiteRGB.pkg
This library is for recipes that use a combination of RGB light and White light for all inspections.

11 X-Ray Inspection Methodology (for BGA Device)

YesVision™ software organizes inspection into three types: **Marking, Lead Bank** and **Solder.** Each part can have any number and combination of these three types of inspections. When we apply X-Ray inspection methodologies for BGA devices, there will be no marking inspection. The available inspections are lead bank and solder inspections. A BGA352 may have six lead banks and 352 solder inspections.

There is only one light and one view for X-Ray inspection: **X-Ray light** and **X-Ray View**. There are several FOV (field of view) choices for X-Ray inspection: 1", 0.5" and 0.25" FOV. For each FOV there are several X-Ray power levels as well. Each power level has its own X-Ray tube voltage, current and spot size settings.

To change the FOV users can point the mouse into the Video area and click the right mouse button to pop up a menu; from the menu select Move Z Axis to launch the **Move Z** dialog.
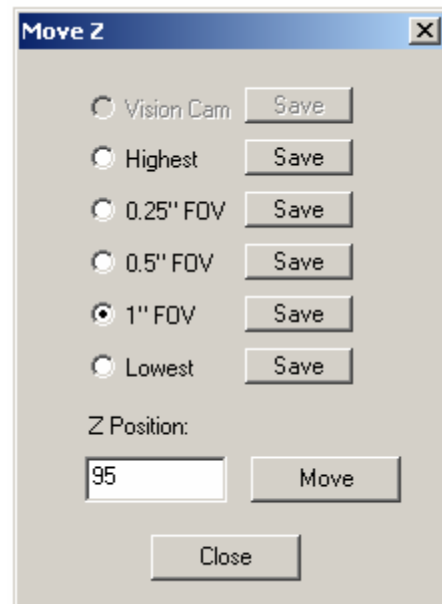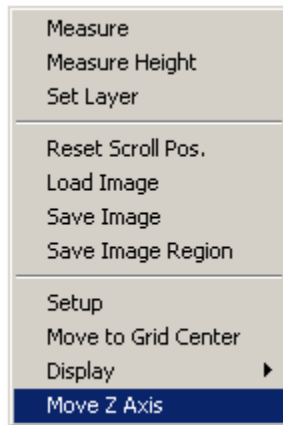
Similar to vision inspections, X-Ray Inspections are conducted in two processing steps: Preprocessing and Decision. The Preprocessing step prepares the image and the Decision step determines the Pass/Fail. The two steps use various machine vision algorithms to accomplish the task.

11.1 Preprocessing

X-Ray images are gray scale images. Since normally there are no preprocessing steps needed for inspection the preprocessing step for X-Ray is defaulted to NONE.

NONE	- No preprocessing (default)
Red Filter	- Pass the image through red color filter.
Green Filter	- Pass the image through green color filter.
Blue Filter	- Pass the image through blue color filter.
Binarize	- Binarize the image into two gray levels, black and white.

11.2 Lead Bank Inspection

Edit Lead Params..
BGA Group Params..
Align..
Train Solder
Move/Resize
Break into Sectors
Delete
Update

Test

Lead Bank inspection of X-Ray images checks for bridges between BGA balls, missing balls, and ball off-position cases. The default algorithm for BGA lead bank inspection is BGA Group. Currently this is the only algorithm for BGA lead inspection. After a lead bank inspection box is created, users can display the Lead Bank pop up menu by clicking the right mouse button while pointing at the inspection box.

Edit Lead Params.   -Launch the Lead Parameters dialog.

On this dialog the user sets the pitch of the BGA balls, the number of balls in the BGA lead bank**,** the direction**,** the view**,** the lighting and the algorithm selection.

BGA lead banks will always have more than one **Row Count,** which is different from normal IC components.

The **Camera View** for X-Ray images is always set to X-ray.

The **Lighting** for X-Ray images is always set to Side.

The **X-Ray Power Level** lists the power level number for the current lead bank.

The **Preprocess** for BGA lead bank is always set to NONE and the **Decision** is always set to BGA Group.

It is somewhat tricky if you want to change the FOV of an X-ray inspection (e.g. from 1" FOV to 0.5" FOV). Here is the steps to do so: First use the Move Z dialog to move the Z stage to the desire FOV, point the mouse to the Region of Interest (ROI), and open the "Edit Lead Bank Parameters" dialog. Press the X-ray button (the button is already depressed) in the Camera View group again, and then press OK to close the dialog. Double click near the video cross hair to

85

refresh the screen display, you will see the ROI box change from blue to green indicating the FOV has changed.

BGA Group Analysis Params.   -Launch the BGA Group Parameters dialog
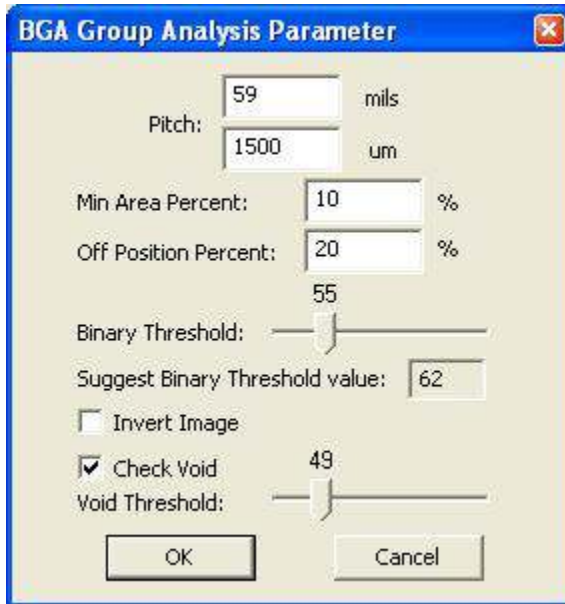
Pitch is the distance between each BGA balls, either in row or column. It can be in mils or microns. (Typical values, 1500 um, 1270 um**)**

Min Area Percent sets up the threshold for detecting a BGA ball missing case. A BGA ball with its area less than the minimum area will be caught as a missing ball. A value of 25% is typical for this parameter. It can range from 5 to 40%.

Off Position Percent combined with pitch, defines the maximum distance (in the percentage of pitch) that one BGA ball could be off from its original position. Set this parameter to detect off-position solder balls. A value of 20% is typical for this parameter. It can range from 0 to 40%.

Binary Threshold sets the binary threshold value which is used to convert gray scale images into binary images. A good binary threshold value separates the majority of BGA balls from their background and results in good measurement values. The **Suggest Binary Threshold Value** is the pre-calculated value based on the current image. When the dialog is first launched, the binary threshold value will be set equal to the suggested binary threshold value. Later on users can select a different binary threshold value by moving the slider bar.

Invert Image check box if checked will invert the pixel value of the image before performing the analysis.

Check Void check box if checked will calculate a void percentage for each BGA ball.

Void Threshold sets the binary threshold value which is used to convert gray scale images into binary images and perform void calculations. Moving the slider bar will change the threshold value and display a binary image instead of the original gray scale image.

It addition to **BGA Group** another algorithm for BGA inspection would be **Image Subtraction.** This algorithm do not calculate numerical parameters of the BGA, instead it uses a simple image comparison principle. A reference image take from a good part is subtracted from the test image. The difference is threshold to determine a pass or fail status.

Different Image = | Test Image – Reference Image |

Image Subtraction Params.. Launches the dialog for setting Image Subtraction parameters
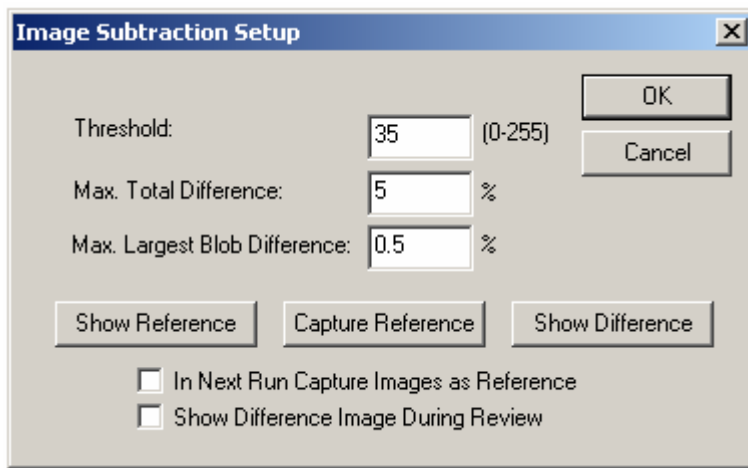
The **Threshold** is the gray level difference between the corresponding pixels of the two images. Pixels gray level difference below the threshold will be considered the same.

The **Max. Total Difference** is the maximum number of pixels that is different from the reference image to be considered PASS, expressed in percentage. The **Max. Largest Blob Difference** is the maximum numbers of pixels in the largest blob of the different image to be considered PASS.

The **Show Reference** button displays the reference image, the **Capture Reference** Button capture the reference image from the camera. The **Show Difference** button displays the Difference Image.

Because of the perspective distortion which is common in the X-ray images, the Reference Image has to be captured exactly where the part is to be inspected. In other words, if the part is to be tested near the top left corner of the screen, then the Reference Image should be captured at that screen location. The check box **In Next Run Capture Images as Reference** switch on the reference capture mode, in capture mode in the next inspection run the software will capture reference images for all test boxes using image subtraction algorithm. User should make sure a good board is put in before the inspection run. The check box will be turned off at the end of the inspection run, normal image subtraction will resume.

During review process the software always displays the Reference image; user can optionally select to have the different image also displayed. To select the option check the **Show Difference Image During Review** check box.

11.3 Solder Inspection

Solder inspection for BGA balls is designed to verify the solder ball quality on each individual ball of a BGA device. The default inspection uses a BGA Analysis algorithm to detect insufficient solder, bad shape, gray defects and void defects. Since this algorithm also utilizes measurements from the BGA Group algorithms, users need to make sure that solder inspections run after lead bank inspections..

| Edit Solder Params.. |
| BGA Ball Params.. |
| Align.. |
| Move/Resize |
| Delete |
| Update |
| Test |

After the solder inspection box is created, users can display the solder pop up menu by pressing the right mouse button while pointing inside the solder inspection box.

Edit Solder Params. – Launch the Solder Parameters dialog

On this dialog users can enter the current solders pin number in the **Pin Num** field.
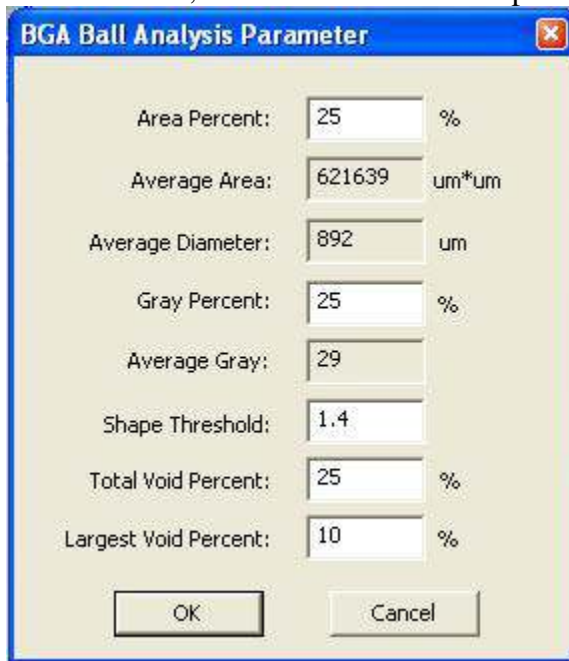
The rest of the buttons on the dialog set the **Direction**, **Camera View**, **Lighting** and **X-Ray Power Level** for the inspection. For X-Ray inspection the Camera View is always set as X-ray and the X-Ray Power Level needs to be specified in the corresponding field.
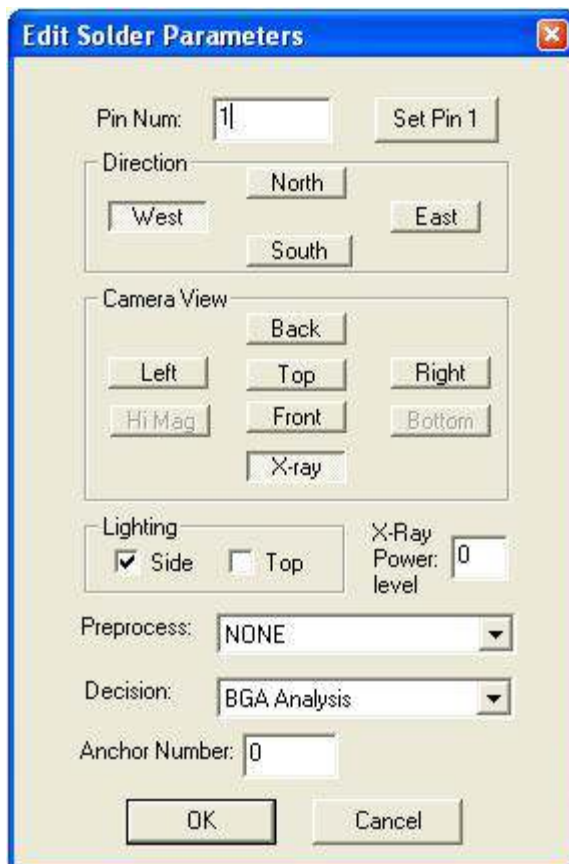
For X-Ray inspection of BGA solder, there is no specific preprocessing algorithm and the decision algorithm is always set as **BGA Analysis**.

BGA Ball Analysis Setup – Launch the BGA Ball Analysis Parameters dialog.

This setup dialog box provides information about **Average Area, Average Diameter** and **Average Gray** of all BGA solders belonging to the same lead bank. Based on these measurements, users can define two percentage thresholds: **Area Percent** and **Gray Percent**. Area defect classifies any BGA solder with too much or too little area, compared to the average area of all the balls in the group. Gray defect identifies any BGA solder with too low or too high of a gray level.

The shape score of BGA solder indicates the roundness of the solder ball. The perfect round shape ball will have a shape score of 1.0. In reality all balls will have a score above 1. The higher the score is, the more irregular shape the ball has. Users can setup the **Shape Threshold** to pick up those balls with bad shape.

The **Total Void Percent** and **Largest Void Percent** threshold needs to be set by the user to pick up void defects. Any BGA solder ball with a higher total void percentage value or a higher largest void percentage value (compared to these two threshold values) is considered to have a void defect. The default values for these two parameters are 25 and 10, respectfully.

11.4 Steps to Create a New BGA Package

There are times when users may need to create a new BGA package from scratch. Creating new packages for different BGA sizes is not difficult. Here are the steps:

1. Create the part body in vision view; enter the Reference ID, part number and package.
2. Turn on the X-ray and switch to X-ray view, experiment with different FOVs and Power levels to find out the desirable FOV and power level. Make the selection in your mind; you will need to enter them later.
3. Move to a large field of view and try to have the entire BGA in one view. Count the number of balls by row and column. You will need this information later.
4. For full array BGA train a lead bank that includes all the balls. For perimeter array BGA train a lead bank that includes all the balls for one direction.

5. Enter the correct parameters for the lead bank; this includes the pitch, the total number of leads, and the row count.
6. From the Lead bank pop-up menu, select **Train Solders**.
7. From the Solder pop-up menu, select **Align**, and line up the solder inspection boxes.
8. Hide the solder inspection boxes by pressing the button on the tool bar.
9. From the Lead bank menu, select **Break into Sectors**, to break the lead inspection box into sectors that will fit into the FOV selected in step #2. The FOVs are rectangular; you want to break the Lead bank into small enough sectors that will fit in the smaller dimension (Y dimension) of the desired FOV. This way the package will work even if it needs to be rotated 90 degree.
10. Move the Z axis into the selected FOV. Switch the FOV of the Lead bank to the selected FOV. Setup other lead parameters.
11. Setup BGA Group parameters, then update the parameters into other lead sectors.
12. Un-hide the Solder inspection box by pressing the again. Display the solder pop-up menu and setup the solder inspection parameters.
13. Setup the BGA ball parameters then update the parameters to other solder inspection boxes.
14. For perimeter array the user needs to repeat step 3 to 13 for lead banks in the other directions.

12 Part List and Part Libraries

Components on the circuit board such as resistors, capacitors, and ICs are collectively called parts. The inspection recipe organizes information based on the concept of parts. Because of the one to one correspondence with the parts and the "parts" on the circuit board it is an easy concept to understand. A part can have any number of the three types of inspection: Mark, Lead Bank and Solder.

In the recipe parts are grouped together to form lists and libraries which are described in the section below.

12.1 Part List

The part list page lists the reference ID for all the parts to be inspected on the board. The **Part List** page in the **List View** shows the reference IDs in alphabetical order.

Double clicking the mouse on any of these parts will move the camera to that part on the board. Right clicking the mouse in this view will pop up a menu.
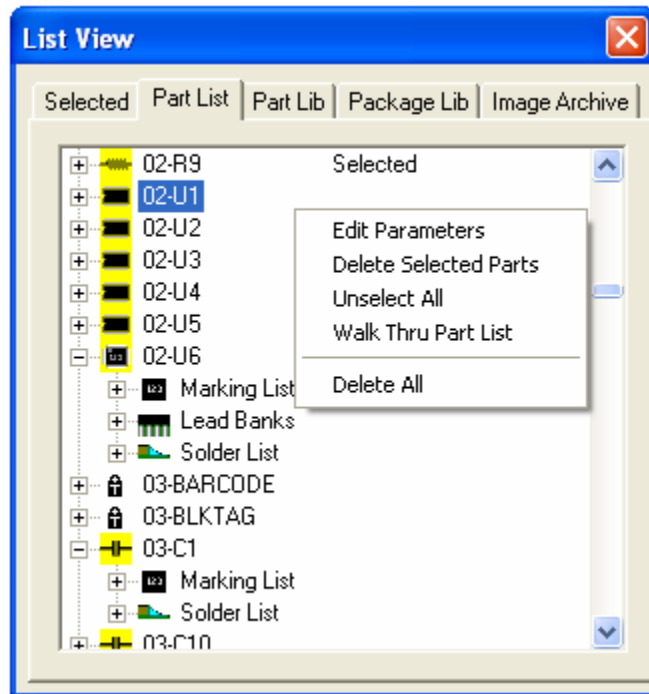
On the **Part List** page it is possible to select multiple parts using a combination of the mouse and the Shift- Ctrl keys.

12.2 Selected Part List

The **Selected** window under the list view is a dynamically generated subset of the **Part List.** At the end of the normal inspection process the **Selected** page displays a list of the parts that failed inspection. The list is used in the defect review process. During the **Walk**
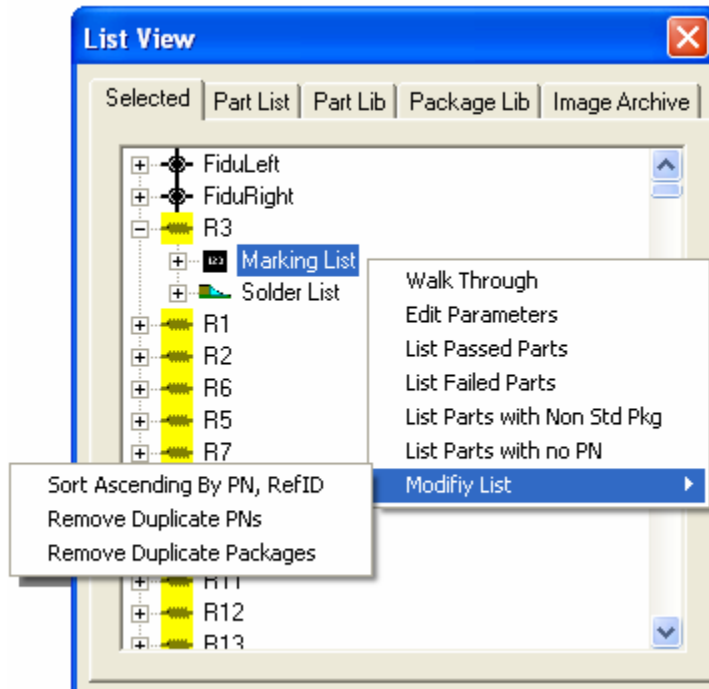
Through process the list displays the parts to be walked through. The local pop up menu selection of the **Selected** page selects parts that meet certain criteria.

12.3 Part Number Library

In addition to its Reference ID a part usually has a part number. Part numbers identify unique parts. For example, a part number may identify a 100 Ohm 0603 resistor. The resistors are used in multiple locations (e.g. R1, R13, R27, etc) on the board but they are all 100 Ohm 0603 resistors. The **Part Lib** page lists the unique part numbers in the recipe.

Part marking templates are unique per part number. Whenever, a part number is selected in the **Part Lib** page its marking templates will be displayed.
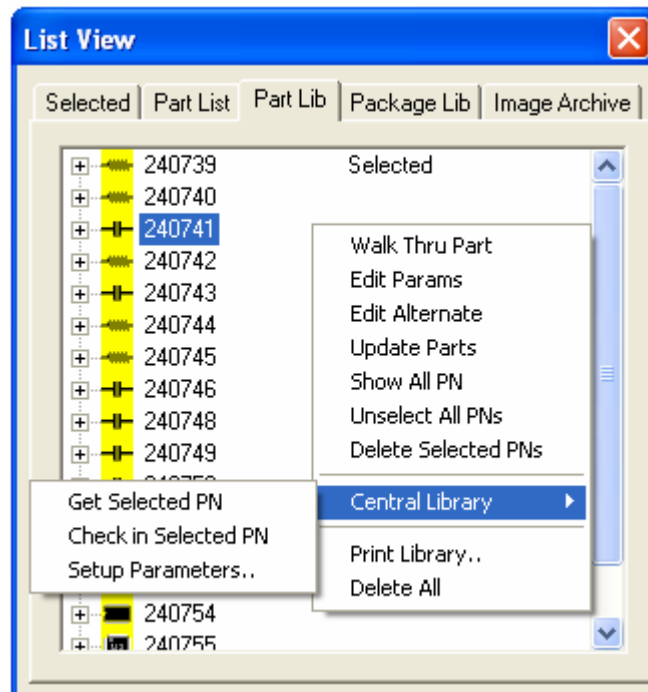
On the **Part Lib** page it is possible to select multiple part numbers using a combination of the mouse and the Shift- Ctrl keys.

The **Part Lib** page also has its own local pop up menu. Compared to the part list, the part library is always a smaller list for any given board. However, it is possible to have a part library that is shared between many boards. This can allow the part library to grow quite large. The menu selection **Show All PN** toggles between showing only the part numbers used by the current recipe and all the part numbers in the library.

12.4 Central Library

The central library allows part inspection parameters to be shared across inspection recipes of different board assemblies and across multiple AOI machines. Each inspection recipe can have a central library in addition to its "local" part library. A central part library serves as a backup information repository for inspection recipes. The central library is accessed only when the requested information is not found in the local library. For example during CAD import when a part needs to be added, the software first searches the local library for the part's information, if the part is not found the software will then search the corresponding central library, if the information is found it will be copied from the central library to the recipe's local library. With the central library connected, the software will only prompt the user to train a new part if the part cannot be found in neither local nor central library.
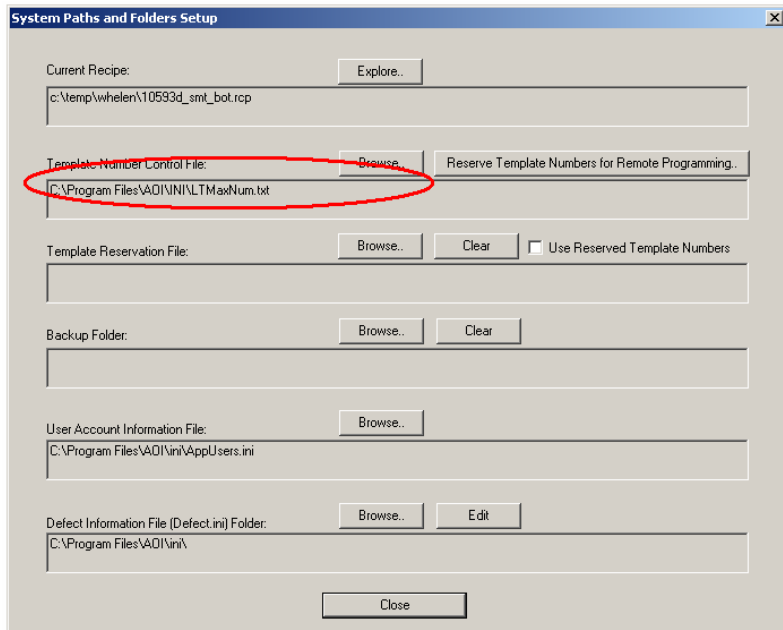
Before using the central library it is important to setup the "logical template number control file". A logical template number uniquely identifies a template in an AOI network. On an AOI network with multiple AOI machines and offline programming stations it is important to ensure the logical template number be unique and never repeat regardless of its origin. The YesTech AOI uses a file named **LTMaxNum.txt** for the purpose of controlling the logical template number. There can be only one **LTMaxNum.txt** file on any AOI network. For example if there are 2 AOI machines, 1 offline programming station and two offline review stations on an AOI network that share inspection recipes, all the stations have to share one **LTMaxNum.txt** file. The **LTMaxNum.txt** file is setup from System Options dialog as shown on the left. **LTMaxNum.txt** file controls templates in both local and central libraries.

To use the central library, in addition to controlling the logical template number, the user must also make sure the part rotation information is consistent across the entire environment. Failure to do so may cause recipe corruption when the part data is merged from the central library to the recipe.

Here are the two simple steps to setup a new Central library:
1. Create a folder for the central library e.g. Central Lib#1.
2. In the YesVision™ software set the central library path to the folder just created by selecting **Central Library, Setup Parameters** from the Part library popup menu.
   (Central library path can also be setup from the **New Recipe** dialog, or using the YCD file header)
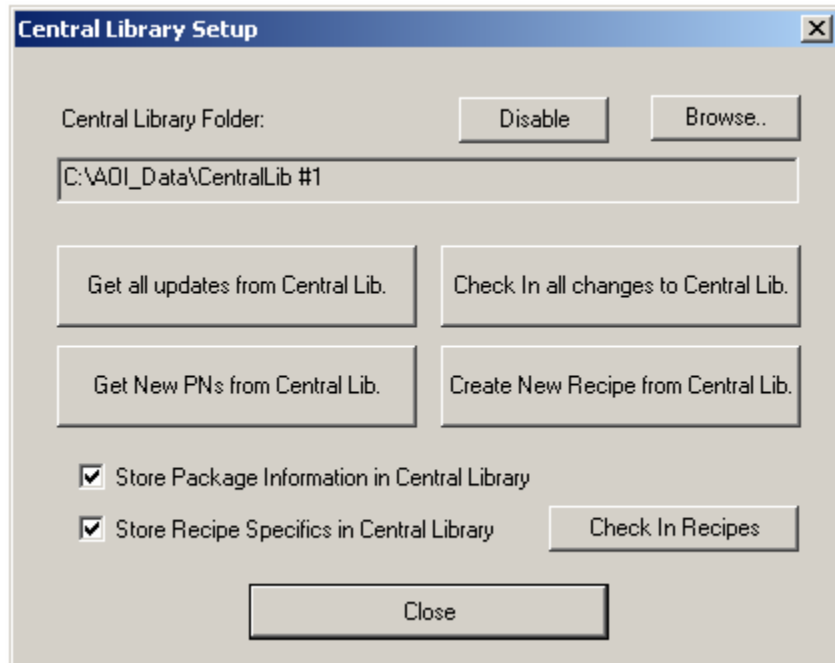
After setting up the central library folder, the user can save and retrieve part information with the central library. The operation that retrieves part data from central library is called "Get" and the operation that saves part data to the central library is called "Check In". Part data is time stamped whenever a modification is made to the part. Both "Get" and "Check In" operations rely on the time stamp to ensure no inadvertent data overwrite.

The central library usually contains many more part numbers than the local library. During the CAD import process new part numbers are pulled from the central library on an as needed basis. User can pull in additional part number using the **Get New PNs from Central Lib** button. Pressing the button launches a dialog that list all the part number in the central library that are not in the local library. Selecting the part number or numbers and press the **Add** button will pull those part definitions from the central and copy them into the local library.
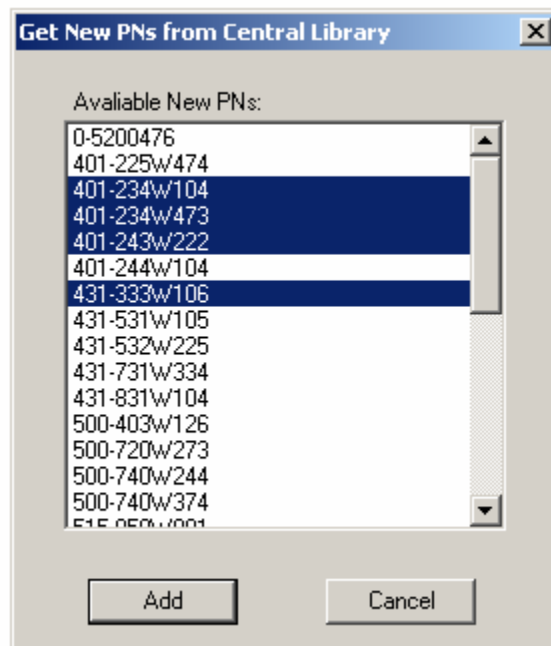
Users can optionally store part package information in the central library; it is like having a central package library. To enable the option the user needs to check the **Store Package Information in Central Library** check box in the **Central Library**

Setup dialog. With this option enabled it is even more critical that the part rotation is consistent across all recipes. Establishing a rotation convention is highly recommended. User can use **Appendix 28.3 Part Rotation Worksheet** to help establish the convention.

Users can also optionally store recipe specifics in the central library. This includes information such as the part lists, recipe notes, local part information and map view backgrounds. User can enable this feature by checking the **Store Recipe Specifics in Central Library** check box. With this option enabled user can check in the "recipe specifics" of the existing recipes into the central library. Pressing the **Check In Recipes** button launches a dialog that lists the recipes that can be checked into the current central library. User can check in one or several recipes at a time. With recipes' specifics stored in the central library, it is also possible to create new recipes from solely the information stored in the central library. This feature is useful when user need to propagate a group of recipes onto a new AOI machine. The **Create New Recipe from Central Lib.** Button when pressed will launch a dialog listing the available recipe stored on the central library. From the dialog user can select one or more recipes to create.

Inside the central library folder part data is saved in a text file with the .part extension. Appendix 28.2 shows a sample .part file.

Recipes with both local and central libraries have the best of both worlds; the flexibility offered by the local library plus the convenience offered by the central library.

12.4.1 YesCLM

Central Library is a very popular feature on YesTech's AOI machines. It is extremely useful in a high-mix production environment where many AOI recipes need to be created and managed. YesCLM is the secondary central library management software for YesTech's AOI machines. Central libraries can be managed using the YesVision software, so YesCLM is not absolutely needed for using the central library feature. However, YesCLM makes the managing of central libraries a lot easier. This is especially true for environments with multiple AOI machines sharing multiple central libraries. Starting from YesVision version 2.6, the YesCLM software is provided to all YesTech's AOI customers at no additional charge. Please refer to the document on YesCLM (YesCLM.doc) in the document folder on the release CD.

12.5 Package Library

The package of a part contains attributes such as part size, number of leads, lead pitch, etc. For example 0805 and 0402 are common packages for chip parts, QFP100 and SOIC16 are common packages for ICs. In YesVision™ software predefined packages include Solder and Lead inspection only. The user must define the part marking.

On the package lib page it is possible to select multiple packages using a combination of the mouse and the Shift- Ctrl keys.
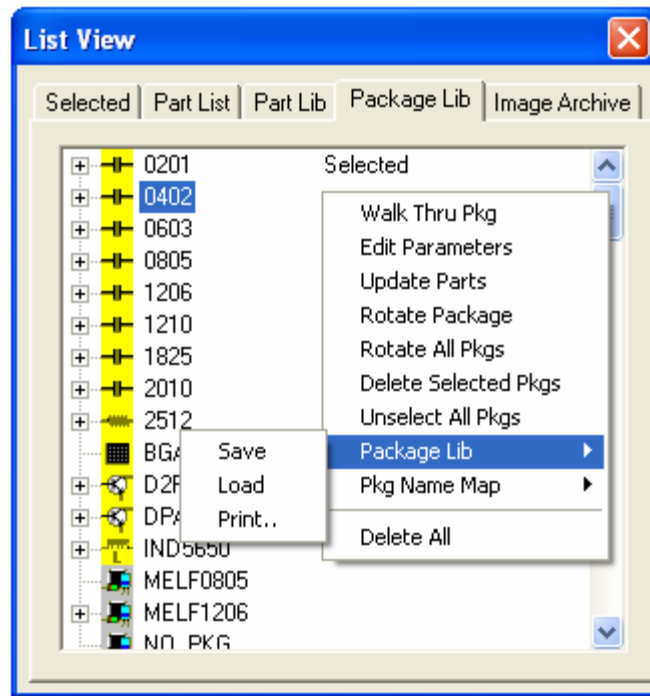
The YesVision™ software ships with Standard Package Libraries that contain all the common packages used in industry. Having the standard package library speeds up the setup of solder and lead inspection tremendously. Several standard package libraries come with the YesVision™ software. **StdPkg_Post.pkg** is for post reflow inspection. **StdPkg_Pre.pkg** is for pre-reflow inspection. Lastly, **StdPkg_Paste.pkg** is for solder paste inspection. There are two more libraries for recipe using the RGB lighting. **StdPkg_RGB.pkg** is for recipe using RGB light exclusively for all inspection, and **StdPkg_WhiteRGB.pkg** is for recipe using a combination of RGB light and White light.

13 Advance Inspection Features

The YesVision software is designed for ease-of-use; it hides the underlying computation complexity away from the normal users. However, to get the optimal performance for inspecting complex boards with small components, a working knowledge of the underlying theory is helpful.

13.1 Mathematics of Fiducial Alignment

By default the YesVision software uses two alignment marks to correct for placement differences between boards. Alignment marks have fixed XY locations. The software uses the fixed XY locations as a reference to determine what compensation is needed for a particular board under inspection. There are two kinds of positional compensations; one is translational and the other is rotational. The software uses the left alignment mark to calculate translational compensation. For example, the left mark has a defined position of (10, 10), and the software finds it to be at (12, 11) . This means in order to compensate the coordinates system needs to shift 2 units to the right in the X axis and 1 unit up in the Y axis.

After the software compensates translationally, it proceeds to find the right alignment mark and calculates the rotational compensation using software theta. The software compensation works best if the fiducials are located on the bottom left and the bottom right corner of the board. It is recommended that the user select the left alignment mark close to the bottom left corner of the board and the right alignment mark close to the bottom right corner of the board whenever possible.

Software theta is a technique that mathematically rotates the user coordinate system to compensate for the mis-alignment of the PCB. For example, there is a 2 degree offset in theta for the PCB. The user wants to go to (1000, 1000) on the PCB to inspect a component. The software calculates the corresponding camera coordinates using the following algorithm:

$$X' = X \cos (A) + Y \sin(A)$$
$$Y' = -X \sin (A) + Y \cos(A)$$

In this case

$$X' = 1000*\cos(2) + 1000 * \sin(2)$$
$$Y' = -1000*\sin(2) + 1000 * \cos(2)$$

$$X' = 1034.29$$
$$Y' = 964.49$$

The software then commands the camera to go to (1034.29, 964.49). This is the same place at (1000, 1000) on the PCB. The process is completely transparent to the user. The reverse calculation is performed when displaying coordinates. The Status bar will show (1000, 1000).

The YesVision software uses a multi-layer scheme to handle coordinates. The top layer is the user coordinates (the board or PCB coordinates). This is how the positions of parts on the board are defined. This is the only coordinate the user will deal with directly. The bottom layer is the physical coordinate where positions are defined by motor steps and encoder counts. The middle layers include scaling, software theta, linear error compensation and error mapping. The layering scheme allows the YesVision to have transferable Inspection Recipes without requiring the machines to be built identically.

In general the 2 fiducials alignment works well, assuming the locations of the left and right fiducials do not change relative to the board's origin. This assumption holds true in most cases, except when the dimensions of the boards change due to temperature or other factors. For example on a 8" by 10" PCB, if a higher temperature makes the board expand by 1/1000 then the right fiducial would be off by 10 mil. In this case using the 2 fiducials alignment method some part on the board would be off by 10 mils. For high precision inspection the software also provides a 3 fiducial alignment method. In addition to providing translational and rotational compensation, the three fiducials alignment method compensates for expansion and contraction of the PCB.

The 2 fiducial alignment technique is the default technique for board alignment; to use the 3 fiducial alignment technique users have to enable it in the **System Default dialog**. To launch the dialog select from the main menu **System, Default Parameters.** After the feature is enabled if the user re-defines the alignment marks the software will prompt to train 3 alignment marks.
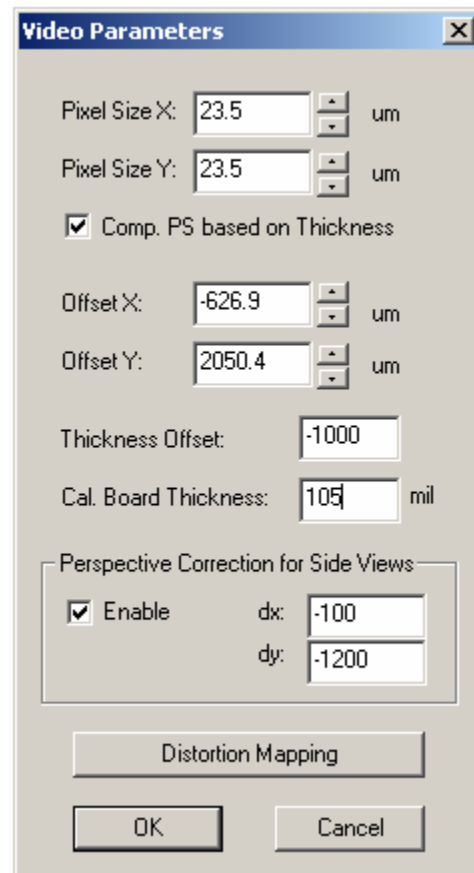
13.2 Understanding the Video Parameter

Fiducial alignment only ensures that the camera moves to the correct location, which means the position of the cross hair is where it is supposed to be at as defined in the program. However, inspections take place in the entire field of view not just where the cross hair is at. The video parameters ensure all the pixels in the field of view are at their correct locations.

During system calibration all the video parameters are adjusted and their values verified against the specification. One critical parameter is the Pixel Size. An accurate Pixel Size parameter allows the software to determine the accurate position of each and every pixel in the field of view. Because of the accumulative effect, Pixel Size Parameter adjustments are the most critical for pixels located at the perimeter of the field of view. One way to verify the Pixel Size Parameter accuracy is to view the overlaid inspection boxes. If an inspection box lines up well with a part in the middle of the screen but appeared off when the part is moved to the edge of the field of view it is an indication that the Pixel size parameter is inaccurate.

Another important parameter is the Camera offset. It precisely records the relative position of each camera. It is especially important for systems with the Hi-Mag camera option or slave camera option (e.g. YTV-2080). One way to verify the calibration of camera offset is to line the cross hair on a clear feature on the board (e.g. silk screen lines) and switch cameras to see if the cross hair remains on the same board feature. If not please adjust the Offsets in the **Video Parameters** dialog to make it do so. It is common that the video parameters need to be tweaked after the machine is moved or its leveling pad adjusted.

13.3 Part Walk Through Process

Walk through is the process of stepping through a list of parts one by one. The process is similar to the defect review process. The Walk through parts process can be started from a number of places based on different part selection criteria. You can walk through all the locations of the particular part number; you can walk through all the parts with a particular package, etc. The Walk Through dialog shown on the left selects the walk through options:

The position group selects which inspection area on the part the walk through will initially go to. The **RefID Prefix** allows the user to select a sub-set of the part in the list to walk through. For example if the RefID Prefix is "R" only the parts with reference ID starting with "R" will be visited. The **Enable Arrow keys Position Adjust** check box if checked will allow arrow keys on the keyboard to adjust part's position during walk through.

The walk through dialog is similar to the review dialog.
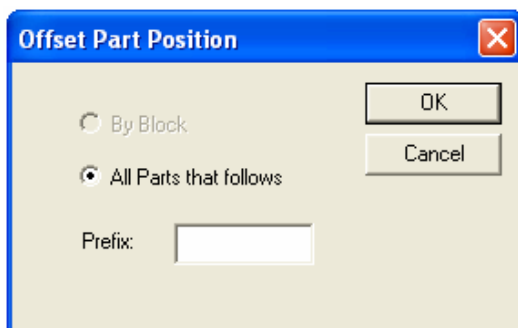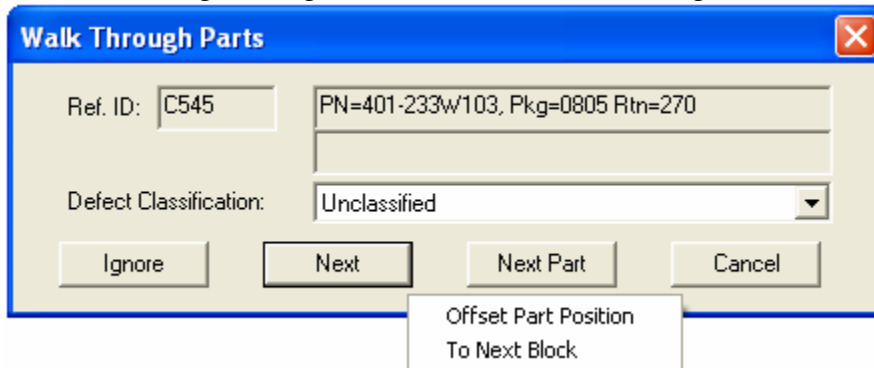
The local pop up menu on the Walk Through dialog has two selections **Offset Part Position** and **To Next Block**. The Offset Part Position allows users to move a group of parts by the same amount that the current part is moved. This movement is accomplished by use of the arrow keys. The **To Next Block** selection skips the parts that belong to the same block number and moves to the first part of a different block number.

100

13.4 Anchor Block Fiducial and Local Fiducial

Anchor, Block fiducial and local fiducial are run-time position compensation features operate based on similar principles. They utilize the position measurement capability of the marking inspection to compensate for positional offset of other inspection boxes and parts. Utilizing them user can achieve inspection precision higher than the mechanical accuracy and repeatability of the XY stage.

Anchor, Block fiducial and local fiducial have different scope of effectiveness. Mark anchor has the shortest scope; it adjusts positions of inspection boxes within a part. For example users can use it to have the solder inspection boxes (and/or lead inspection boxes) to follow the marking inspection boxes. This is useful to inspect solder for parts that are allowed to shift within certain range. Multiple anchors can be deployed within one part. **Anchor Number** parameter is used to differentiate the anchors.

Here is a description for anchor number:

    0   – Means anchor feature is disabled
    1-8   - Used for part anchors.
    9   - Used for block fiducials and local fiducials

Block Fiducial adjusts position for all parts of the block. That can be exactly one block fiducial per block. To create a block fiducial, create a part with reference ID **BLKFIDU** and add a marking inspection block for it. You can use the **Update Block** feature to populate the Block fiducial to all blocks. It is possible to have 2 block fiducial for each block if we also want to compensate for rotational discrepancy from block to block. The second block fiducial must have a Reference ID of **BLKFID2.** A line draw from BLKFIDU to BLKFID2 should pass close to the center of the block area. Block fiducials work best for recipes with small numerous blocks, for recipe with 2 or 3 large blocks it may be better to use another feature called "Per Block Alignment Marks".

Local fiducial adjust parts' positions in nearby inspection frames after the frame containing the local fiducial. Its effective range is around 50 mm. The range of multiple
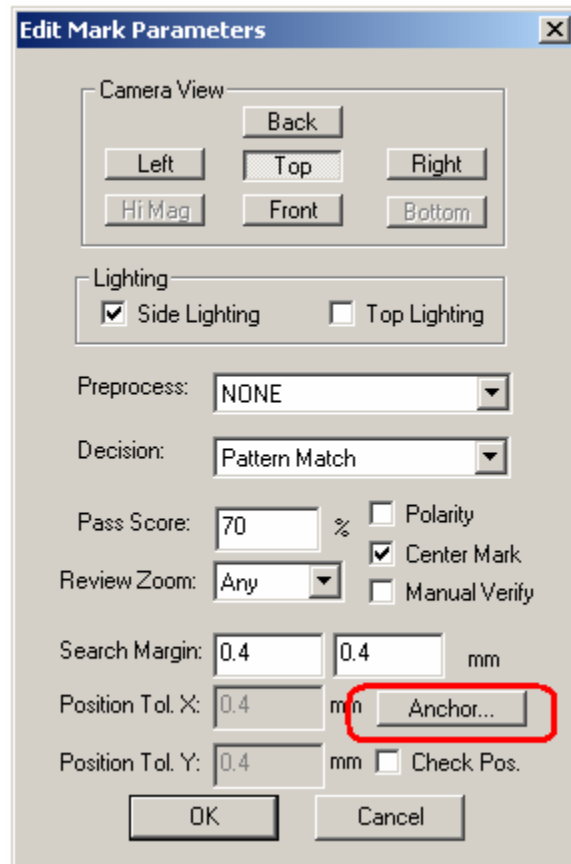
fiducial can overlap. To create a local fiducial create a part and give it a reference ID like **LOCALFIDUx** where x can be a number to identify multiple local fiducials.

All the fiducial's effectiveness can be interactively verified by doing a **Test** for the marking inspection. The affected inspection boxes and parts will move to adjusted positions. To reset the anchor effect user can press the **Reset Pos.** button on the anchor dialog. The **Is Anchor** check mark in the **Anchor Setup** dialog helps distinguish an anchor inspection box from an inspection box being anchored. With it you can setup a marking box to anchor another marking box.

Anchors are normally Mark inspection boxes. As most users knows the changes in the Mark inspection boxes propagate via part number during library update. Sometimes it is advantageous to have anchor functions propagate via package as oppose to part number. The version 2.7 of the YesVision software allows solder inspection boxes to also be used as an anchor. To do so user need to select **Pattern Matching** as the decision algorithm for the inspection box and select direction **N** in the **Edit Solder Parameters** dialog. Also in the Pattern Matching Parameters dialog user need to select **Is Anchor.**

102
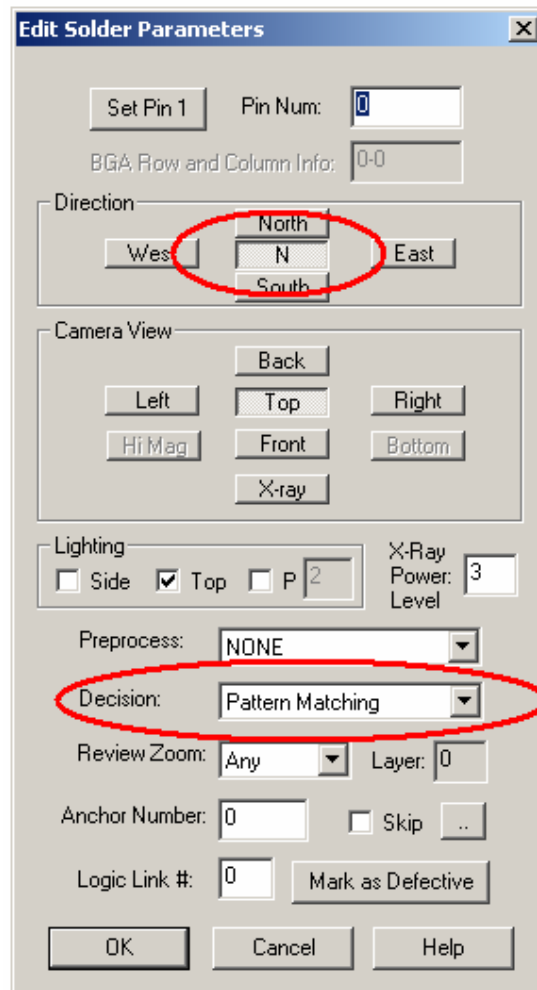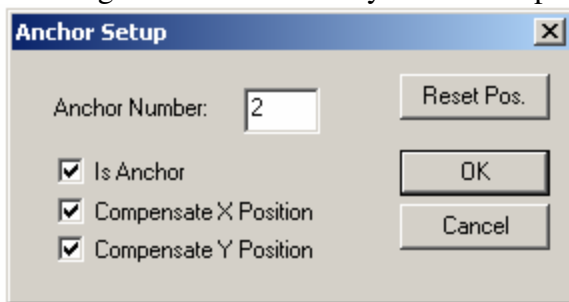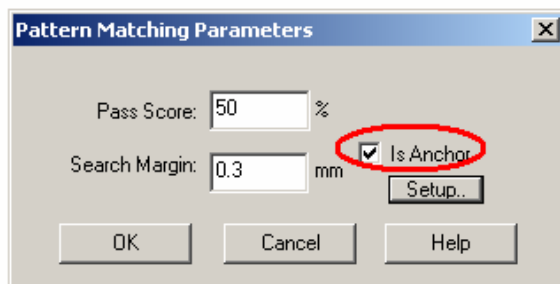
13.5 Layers

Layers are for application where user wants to inspect the same area (e.g. same solder joint) with multiple inspection boxes. The individual layer can have different lighting and uses different inspection algorithms. All the inspection boxes have layer parameter, by default they all set to layer zero. The software maintains a current display layer, when YesVision starts the display layer is set to zero. To change the display layer setting user can select **Set Layer** from the video pop-up menu. Selecting **Set Layer** will launch the **Set Display Layer** dialog.
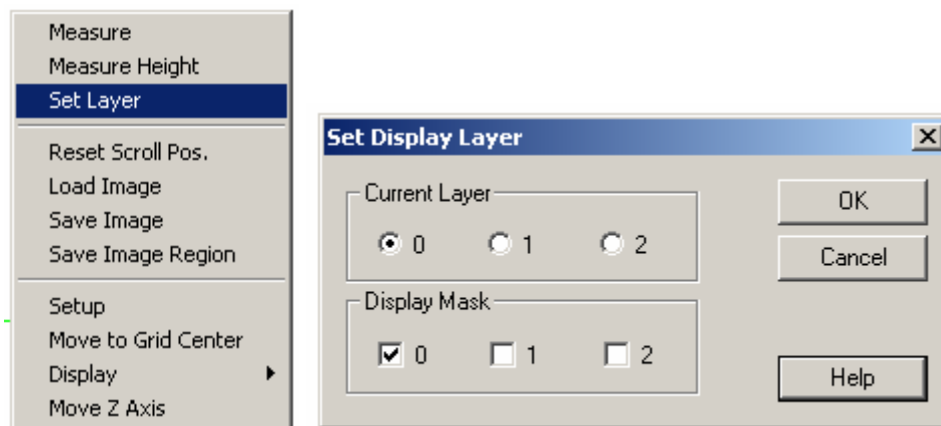
Only the inspection boxes with layer matches that of the display layer will be displayed. Newly created inspection boxes will have layer parameter set to current display layer.

13.6 Reducing Inspection and Review Time for Non First Article Inspection

The very first board come off from a freshly setup line is considered the first article board. A first article board requires the most stringent inspection because of the large possibility of setup errors. This includes but not limited to:

- Incorrect material reel put on the placement machine
- Incorrect programming of the placement machine
- Incorrect version of the program loaded on the placement machine
- Problem with the solder paste stencil screen
- Problem with oven profile
- Etc..

It is usually a standard practice to verify the correctness of the first article board before the rest of the boards are allowed to be built. If the first article board's correctness is verified the subsequent boards would have a much smaller possibility of defects. The defects on the subsequent boards are usually machine related such as part dropped by a placement head of a pick-and-place machine, a blocked stencil aperture result in an open solder, etc.

Based on this nature of the assembly process, the YesVision software has a feature to speed up the inspection and the review process of the non-first article boards. Here is the theory of its operation:

1. For first article board inspect everything, if there are defects have the operator review every instances.
2. For non first article board if one instances of a part number (PN) is verified correct (present, correct orientation and correct component), then the other instances of that PN needs to verify only present (and/or polarity if applicable).
3. If all instances of a PN failed, then during the review process. If the operator OKed one instance, then any instance of that PN which present had been verified will be taken off the review list.

13.6.1 Modifying Recipe to Utilize the Feature

There are 3 modifications users need to perform on a recipe in order to use this feature:

1. Modify the recipe to include inspections for nomenclature in one layer and present/absent in another layer.
2. Enable the feature in Recipe Option
3. In the Run dialog indicate to the software if the inspection is for a first article board or not.

The first step is the most time consuming. For each part number 2 sets of markings need to be trained, one for verifying nomenclature the other for verifying present or absent. Here are some suggestions of the templates:
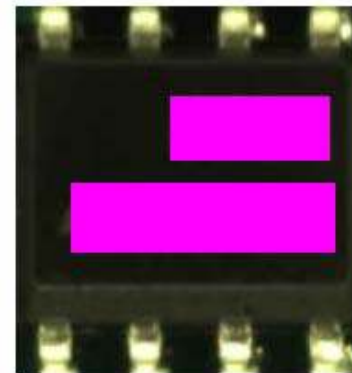
For the templates to detect present or absent of the component don't-care-masks are used to mask out the regions of the nomenclatures. The don't mask is setup using the **Edit Alternate** dialog from the marking pop-up menu.
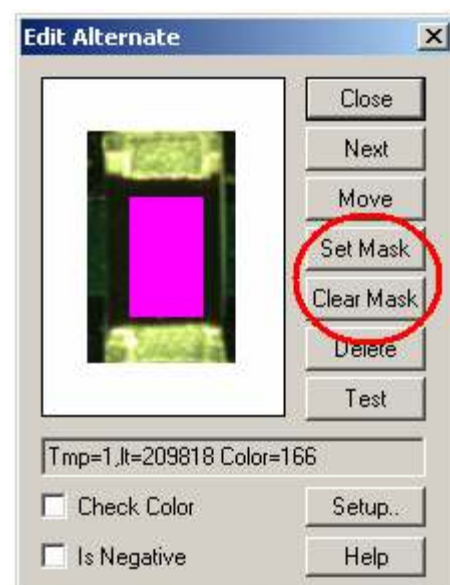
Users are not limited to using template matching algorithm for detection. For example, for axial resistor, the Resistor Color Band algorithm in layer 0 can be used to verify correct value and two marking boxes using template matching can be used in layer 1 to detect present or absent.

It is not necessary to add the 2 layer inspection onto every part number. Any part number with only one layer will be inspected the same way first article or not. User should first focus on adding the 2 layer inspection onto the most abundant part numbers. That will achieve the most time saving.

The second step is to enable the feature in recipe option. The recipe option dialog can be launched from programmer mode's main menu, **Vision, Recipe Option**. One page **Extended Options 2**, check **Logic OR layers for Non-1st Article Inspection** to enable the feature for this recipe.

The last step for utilizing the feature is to indicate to the software whether the board being inspected is a first article board or not. This is done on the Run dialog.
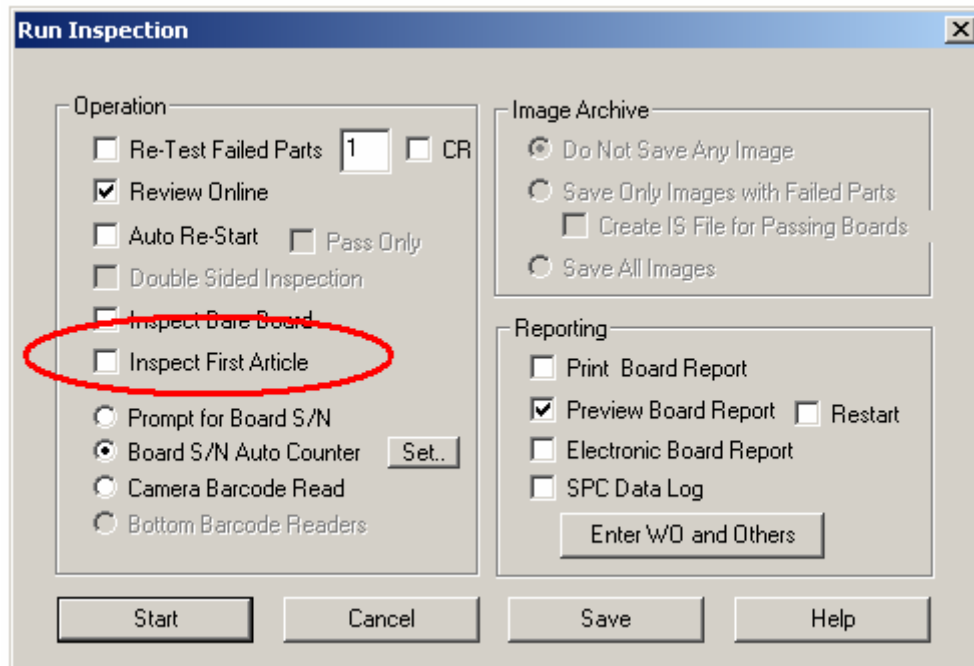
For non first article board, the Inspect First Article should be un-checked.

13.7 Part Measurement Feature

Introduction

Starting from version 2.6.4 the YesVision software added the feature to measure part position relative to one or two reference points. Consider the following application where a target part positions needs to be determined relative to two reference marks.

| Reference 1 | Target Part | Reference 2 |
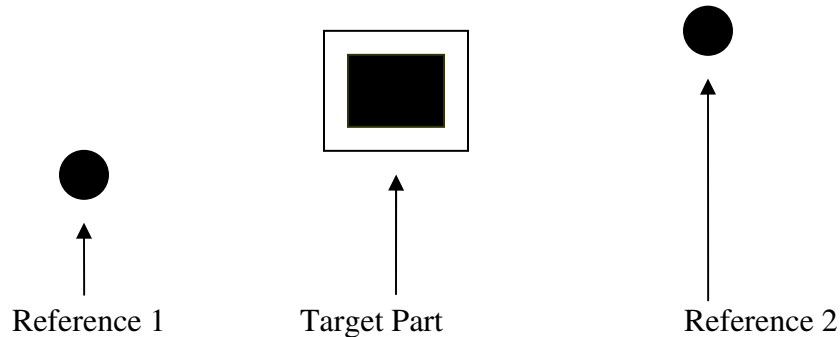
The new software can determine the relative position from Reference 1 to Target part and Reference 2 to target part. Then compares the relative distances with preset distances. If the difference between the measured distance and the preset distance exceed a predefined tolerance a fail status will be assigned to the target part; otherwise it is assigned a pass status.

The three parts in this measurement group (Reference 1, Target part, Reference 2) do not need to be in the same field of view. However, any one of the part will need to be small enough to fit into 1 field of view. Because recipe creation on the YesVision is based on sample boards, to create a recipe for precise measurement user will need to precisely measure a sample board using other technique then use the board as a calibration board in the recipe setup process.

Setup for Measurement

To setup a recipe for measuring target part position as described above, user need to train 3 separate parts and add them into the recipe. For example if the target part has a reference designator as U1.

Target Part   -U1
Reference 1   -U1_REF1
Reference 2   -U1_REF2

For each part train a Marking inspection box that will locate the position of the part. The decision algorithm can either be Pattern Match or Edge Locator. Pattern match is easy to setup but is less accurate (about 1 pixel). Edge locator is more accurate (about ¼ pixel) but will require two inspection box to locator both horizontal and vertical edges.

For each part edit the part's parameter and check the "Is Measurement Part" check box.

For U1_REF1 and U1_REF2 press the Setup button on the right and launch the **Set Measurement Parameters** dialog box. On this dialog setup the nominal distance from the reference point to the part, and establish an allowable tolerance for each distance.
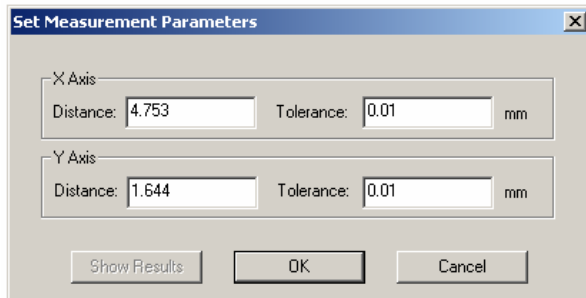
On the **Set Measurement Parameters** dialog for U1 pressing the Show Results button will display the last measured distance for the part.
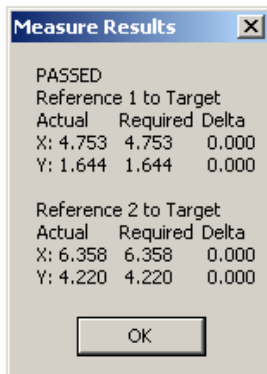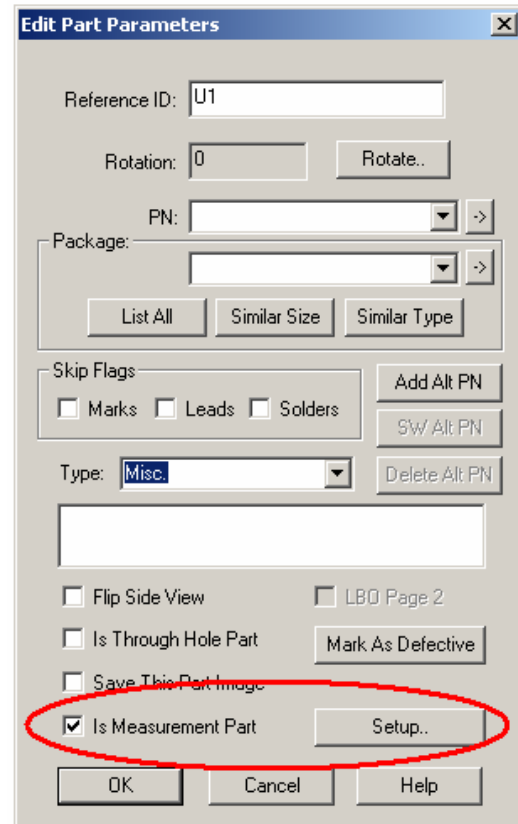
Running the Inspection Recipe

The measurement feature can be mixed with other inspection features in one recipe. An out of tolerance measurement will result in the target part being flagged as fail and be added to the review list to be reviewed by the operator just as any other part that failed the inspection.

Measurement Data Logging

When "Track XY Position into ODBC database table" is enabled in the recipe option dialog box, during inspection with measurement the software will generate a text file logging the measured distance for each inspection. The log file name is

"MeasurePartPos.txt" it is create in folder C:\Aoi_Data\SPC_Datalog be default. The following is a fragment of the log file.

```
ETB001      Test  REF1 4753 1644    REF2 6358 4220
ETB002      Test  REF1 4753 1644    REF2 6358 4220
ETB003      Test  REF1 4753 1644    REF2 6358 4220
ETB004      Test  REF1 4753 1644    REF2 6358 4220
ETB005      Test  REF1 4753 1644    REF2 6358 4220
```

The unit used in the text file is micron or um.

13.8 Logic Operation

There are usually more than one inspection box used for inspecting any one part. With the Layer feature user can even inspect the same area of the part with more than one inspection boxes. By default for the part to pass inspection all the inspection boxes associated with it has to pass. In other words, there is a logic AND relationship between the individual test results and the overall test result. In some particular instances user may want to use an OR relation between two or more inspection boxes to achieve the desired inspection results. The **Logic Link#** feature allows users to have that capability. The logic link# is a number user can assign to any inspection boxes (Marking, Lead or Solder), a number 0 disables the feature, any number from 1 to 9 establish an OR link between the boxes with the same number. For example in the inspection of a part user decided to use 3 marking boxes (M1, M2 and M3) and 2 lead boxes (L1 and L2) and 16 solder boxes (S1..S16). For the 3 marking boxes, M 1 has Link#0, and M 2 and 3 has link# 1. Then the part inspection result will equal to:

Result = M1 AND (M2 OR M3) AND L1 AND L2 AND S1 AND S2 AND…

13.9 Alternate Part Numbers

Alternate Part number feature is very different from the alternate template feature that users are very familiar with. The alternate template is for dealing with parts of the same part number but have different marking on them. Alternate part number is used when certain location (reference designer) of a board that allows more than one part numbers. For example for a particular board assembly a location allows a 100 Ohm 5%, 0805 resistor may also allow 101 Ohm, 1%, 0805 resistor. If only local libraries are used it is possible (but not strictly correct) to handle the situation using alternate template. However, if central library is being used than using alternate templates can create serious problem because such substitution may not be allowed on other assembly or location. There is when the Alternate Part Number feature becomes useful.

To add an alternate part number to a location move so that the location appear in the video window then open the **Edit Part Parameters** dialog. Press the **Add Alt PN** button allows users to select from a list of PNs. The alternate PN must exist in the part library before adding to a location. The **SW Alt PN** button switches between the alternate part numbers. Only one PN amongst the alternates can be the current PN. The **Delete Alt PN** button deletes the current PN from the list of alternates.

Unlike the alternate template feature where the software switch them automatically to find the best match. Switching between alternate part numbers is a completely manual affair. However, operators are reminded the present
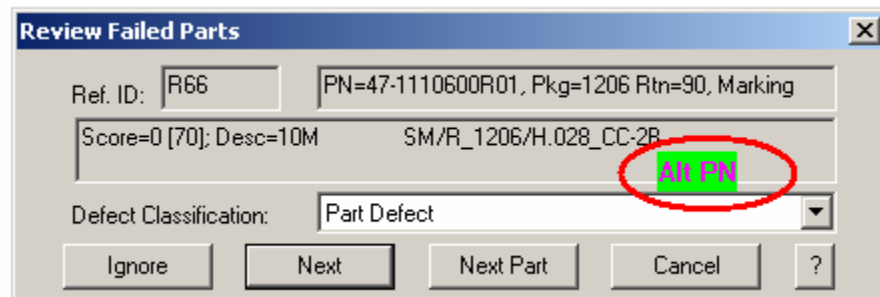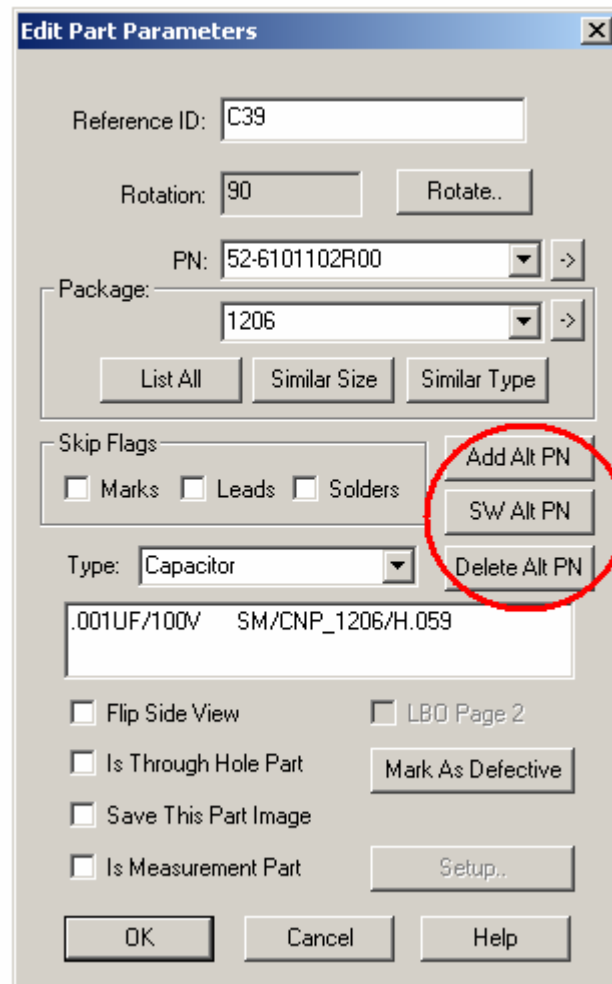
of alternate part number with and icon on the Review Failed Parts dialog when the location is under review. Moreover, switching between alternate part numbers can be initiated in both operator and recipe programmer mode.

14   SPC Data Logging

14.1 Inspection Data

AOI is the best tool to gather product quality data. It is a powerful process control tool. YesVision™ software can log inspection data into a database via ODBC (Open Database Connectivity). Two main tables and a few supporting tables are created. The two main tables are: **SPC_Data**, and **Defect List**. The data **Defect List** data comes from the **defect.ini** file which list all the defects.

In the **SPC_Data** table the following fields are logged:

SystemID	-AOI machine that did the inspection.
Inspector	-The log-in user name.
Assy	-Inspection Recipe. Usually the assembly name.
WO	-Work order number.
IDate	-Date and time of the inspection
SN	-Serial Number of the board.
RefID	-Reference ID
Ref2	-Additional reference information.
DefectCode	-Defect Code
PartTotal	-Total number of parts inspected.
MarkTotal	-Total number of markings inspected
LeadTotal	-Total number of lead banks inspected
SolderTotal	-Total number of solders inspected
BrdCount	-Board Count (0 or 1)
PartFail	-Part failed (0 or 1)
MarkFail	-Mark failed (0 or 1)
LeadFail	-Lead failed (0 or 1)
SolderFail	-Solder failed (0 or 1)
IspTime	-Time in seconds spent during inspection
RDate	-The date and time of the defect review. (Can be different from **IDate** if reviewed offline.)
ReviewTime	-Time in seconds spent during the review
Reviewer	-The log-in user that did the defect review. (Can be different from **Inspector** if reviewed offline.)
Custom1	-User defined custom field 1.
Custom2	-User defined custom field 2.
RecType	-Record type: I-Inspect, R-Review, W-Rework, IR –Inspect and Review.
Side	-T for Top side, B for bottom side
FC	-False Call, 1 or 0
Reworked	-Rework completed, 1 or 0
PN	-Part number
Pkg	-Package

BrdFail   -Board failed (0 or 1)

All the inspection recipes from all the AOI machines in the facility report to a single SPC_Data table. One record represents one defect. A board with 5 defects on 3 parts will have 5 records with identical **SystemID, Inspector, Recipe, WO and IDate** fields. A board with no defects will still have one record with the **RefID and DefectCode** fields blank. The fields which hold 0 or 1 are summed to make up the final reports. A board that has 5 failures will have one record with **BrdCount** equal to 1 and the rest with BrdCount equal to 0. This way the 5 failures will only be accredited to one board.

The SN field records the serial number of the board. In the case of a panelized recipe, if the user chose to have one serial number per panel (Block Skip Enabled but Block SN disabled) then the SN would be a concatenation of the panels' serial number and the Block ID. For example the serial number is Board-001, the SN for the master block would be Board-001-0, the SN for the second block would be Board-001-2, etc. If each block has a unique barcode (and Block SN is enabled) then the SN field will contain the serial number (Barcode) for each block.

By default the software creates the database files in MS Access 2000 format in the name of **YesDB.mdb**, in the folder **C:\AOI_Data\SPC_DataLog\.** When there is more than one station generating SPC data it would be advantageous to use a single database, and have all stations send data to it. To do so the user will need to use the ODBC data source administrator. The ODBC data source administrator can be accessed via **Control Panel\Administrative Tools\Data Source (ODBC).**
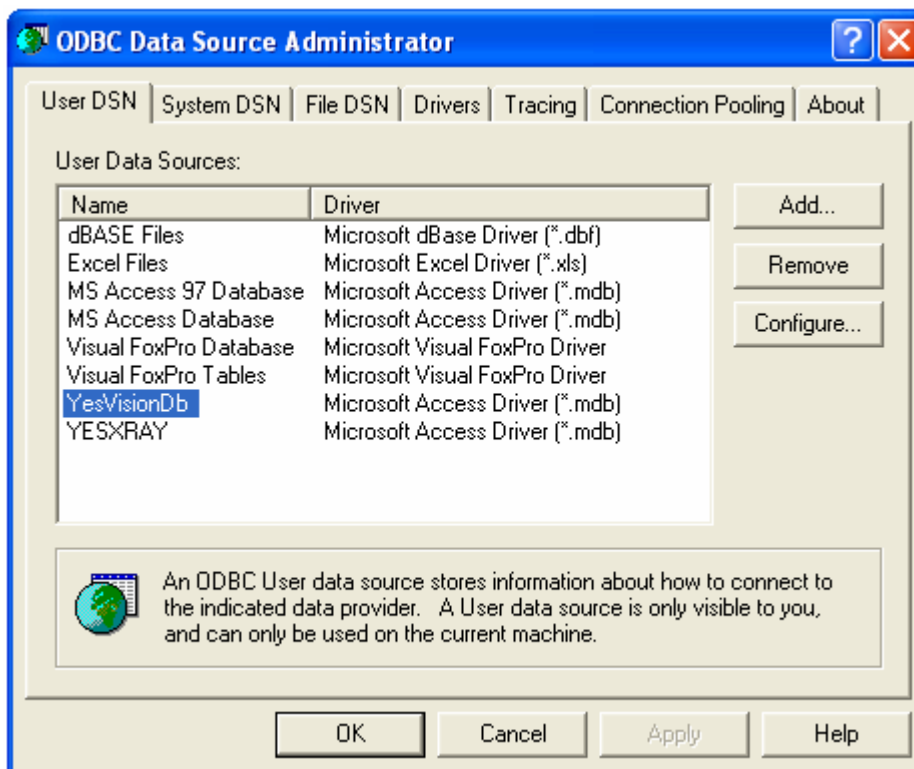
YESTech Inc provides a sample MS Access file, **SPCReportSample.mdb,** to illustrate the type of information AOI users can extract from the data generated by the AOI machines. All YESTech AOI machine users may use the sample database as the starting point to develop their own custom reporting system. The sample database carries no copyright and is distributed in open source form. YESTech's AOI users can copy from it without additional authorization from YESTech Inc. The Sample database plus a write-up describing its usage can be found on the Installation CD in the document folder under the name **SPCReportSample2.zip**.

In addition to logging data into a MS Access database, user can also send the SPC data into an ASCII text file/files. To turn on the feature user can edit the YesVision.ini file and change:

[ODBC_Report]
..
TextOut=1 or 2
TextFolder=C:\Aoi_Data\SPC_DataLog   ;folder for the text files
..

For TextOut=1 the software put the exact content of SPC_Data table into one file called SPC_Data.txt. For TextOut=2 the software output SPC data for each recipe (assembly) into two text files, one for the inspection data the other contains the defect statistics. Format 2 is a format used by old CR Technology AOI machines.

14.2 Using MS SQL Server

For user who prefer to use MS SQL Server instead of MS Access for database management. There are some parameters needed to change in the YesVision.ini file, [ODBC_Report] section.

```
..
UseSQLServer=1
Server=YTV-6000
Address=YTV-6000
UID=sa
PWD=yes
WinNTMode=0
UseNamedPipe=1
..
```

With **UseSQLServer** set to 1 to enable software to write data to SQL Server instead of MS Access. Before start dumping data to SQL server, the user need to set up SQL Server correctly, either locally or on remote machine. The default SQL database name is "YesDb". If software cannot connect to the specified SQL Server, it will automatically switch back to Access database. **Server** is the name of SQL Server. For local server, the default value is "(local)". **Address** is the computer name of SQL Server.

UID is the user id of SQL Server. **PWD** is the password for current UID. **WinNTMode**: set to 1 when use windows authentication mode for login validation. Under this mode the user don't need to set the value of UID and PWD. If set WinNTMode to 0, connection will use SQL Server mode, then the user need to set up both UID and PWD. **UseNamedPipe**: set to 1 when use Win32 named pipes, set to 0 when use Win32 Winsock TCP/IP.

With the parameters set accordingly starting the YesVision software will cause the creation of YesDb database in the MS SQL server folder. (By default the full path is: C:\Program Files\Microsoft SQL Server\MSSQL\Data). It is important to let the software to create the YesDb database automatically. Do NOT try to manually create the database or try to import the database using YesDb.mdb file created by the MS Access software. Doing so could prevent the YesVision software from correctly communicating with the SQL server.

14.3 XY Position Tracking

Introduction
YesVision software can be used to track the XY position of parts on PCBs. The feature is implemented as an extension to the Marking inspection feature of the AOI. Marking inspection is able to verify placement of any markings or parts using the template matching. The feature compares the "found" position with the "trained" position and if the difference is greater than a preset tolerance the software will fail the inspection. To track the XY position the software can be instructed to log all the "found" positions on the selected parts.

The position tracking is OFF by default to turn it on the user needs to go to **Vision, Recipe Option** to pull up the menu on the left below.
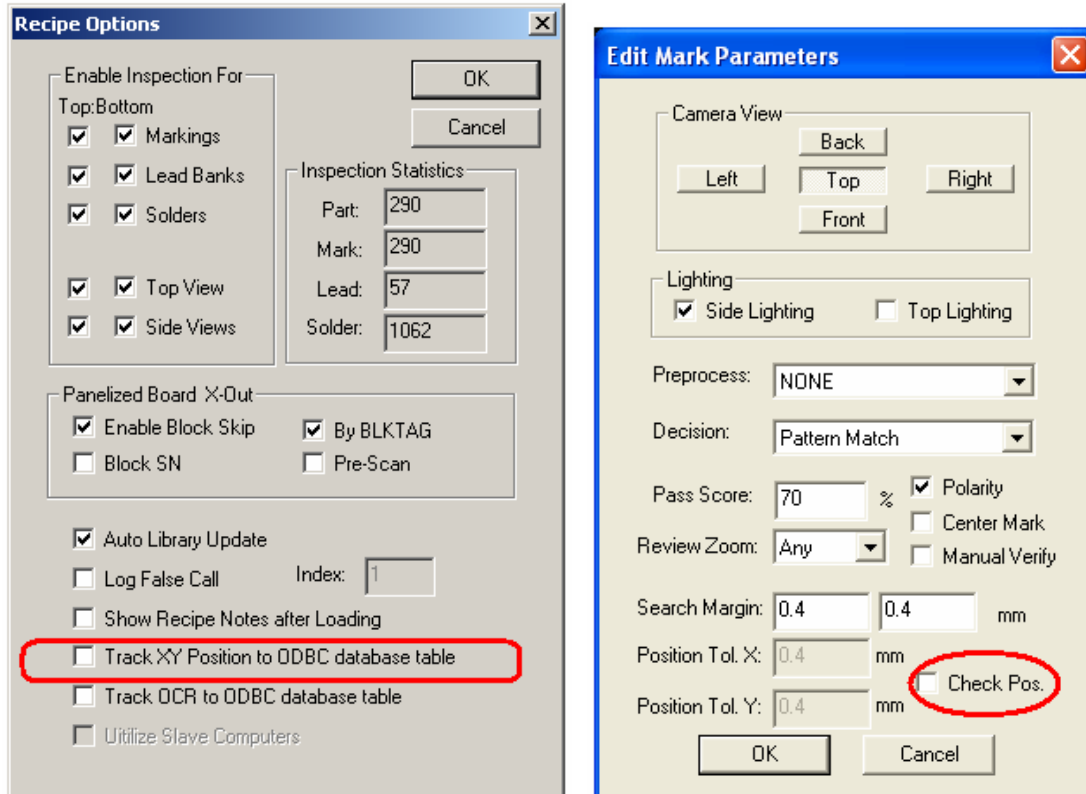
In the Mark parameters dialog only templates with "Check Pos." turned on will have their XY position tracked.

Sample Data Output
The XY Positions is sent via the ODBC to a separate table named **XYPosTrack**. The table has the following fields:

Assy   -Recipe Name
IDate   -Inspection date and time stamp.
SN   -Serial number of the board inspected.
RefID. -Reference designator for the part
X1   -X reference position for the first mark
Y1   -Y reference position for the first mark
DX1   -X Offset position for the first mark
DX2   -Y Offset position for the first mark
X2   -X reference position for the second mark of the same part
Y2   -Y reference position for the second mark.
DX2   -X Offset position for the second mark.
DY2   -Y Offset position for the second mark.
WO   -WorkOrder

Notes: All positioning units are in microns.

Here is a sample output.

Assy	IDate	SN	RefID	X1	Y1	DX1	DY1	X2	Y2	DX2	DY2	WO
DEMO_1	4/2/2004 2:14:34 PM	Board-002	U18	55978	59603	194	-251	0	0	0	0	E1234
DEMO_1	4/2/2004 2:14:34 PM	Board-002	U24	30592	34592	1152	103	0	0	0	0	E1234
DEMO_1	4/2/2004 2:14:34 PM	Board-002	U25	30853	22459	886	169	0	0	0	0	E1234
DEMO_1	4/2/2004 2:14:34 PM	Board-002	U34	30928	10410	806	151	0	0	0	0	E1234
DEMO_1	4/2/2004 2:15:00 PM	Board-003	U18	56004	59603	168	-251	0	0	0	0	E1234
DEMO_1	4/2/2004 2:15:00 PM	Board-003	U24	30592	34592	1152	103	0	0	0	0	E1234
DEMO_1	4/2/2004 2:15:00 PM	Board-003	U25	30853	22459	886	169	0	0	0	0	E1234
DEMO_1	4/2/2004 2:15:00 PM	Board-003	U34	30928	10410	806	151	0	0	0	0	E1234

Operational Details

Marking inspection uses a search algorithm called Normalized Grayscale Correlation or in layman terms "template matching". All successful template matches generate an XY position of the successful match. We call this XY position the "Found" position. A deviation is calculated by subtracting the trained position from this found position. It is this deviation that gets stored into the database as X and Y.

Each part can have one or more mark inspection box. If the part has only one mark inspection box only X1 and Y1 fields in the database table will be filled. X2 and Y2 are for the second mark inspection box. Having a pair of XY data points allows for the calculation of the rotational deviation of a placement.

Mark1   Mark2
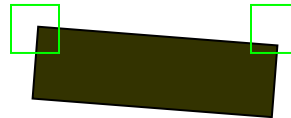
Using Edge Locators for Position Tracking

In addition to using pattern matching user can also use Edge Locator algorithm for position tracking. Edge locator provide more accurate position tracking on targets with clear and well defined horizontal and vertical edges. To use Edge locator for position tracking user need to train two marks both using Edge Locator algorithm, the first mark should be trained to locate a vertical edge or strip and the second mark should be trained to locate an horizontal edge or strip. The first mark will provide the X position plus the angle data and the second mark provides the Y position data to the database.

14.4 OCR Track

The OCR feature can be used to track the date code or lot code of selected components. It will track the code in the ODBC database table named **OCR_Track**. The feature is enabled/disabled in the **Recipe Option** dialog.

The OCR_Table has the follow fields:

1. Assy   -Assembly
2. IDate   -Inspection date and time.
3. SN   -Serial Number of the board.
4. RefID   -Reference ID
5. OCR1   -First OCR string.
6. OCR2   -Second OCR string.
7. WO   -Work Order

The following is a sample database output from OCR tracking.

Assy	IDate	SN	RefID	OCR1	OCR2	WO
DEMO_OCR	3/25/2004 10:36:52 AM	Board-000	U26	8834	-12	E4
DEMO_OCR	3/25/2004 10:36:52 AM	Board-000	U29	3456		E4
DEMO_OCR	3/25/2004 10:37:32 AM	Board-001	U26	8835	-12	E4
DEMO_OCR	3/25/2004 10:37:32 AM	Board-001	U29	3478		E4
DEMO_OCR	3/31/2004 9:10:46 AM	Board-002	U26	8837	-12	E1
DEMO_OCR	3/31/2004 9:10:46 AM	Board-002	U29	3467		E1
DEMO_OCR	3/31/2004 9:16:00 AM	Board-003	U26	8824	-12	E1
DEMO_OCR	3/31/2004 9:16:00 AM	Board-003	U29	3432		E1

If the TextOut feature is enabled, the OCR data log will create a text file named OCR_Track.txt containing the OCR results. The text file will be in a folder specified by the TextFolder parameter in the YesVision.ini file.

14.5 Robust Mode for Data Logging

In normal operating mode for data logging the software opens a link to the database during software start up and assumes the link to be there for all the subsequent data logging operations. This mode of operation works well for most of the network environment. In environment where the network traffic is heavy and prolong connection to one computer cannot be guarantied, the YesVision software offer a more robust mode of data logging. In the Robust mode the software tests the database connection before each batch of data logging operations. It is slightly slower but far mode reliable. To enable Robust Mode edit the YesVision.ini file:

[ODBC_Report]
..
RobustMode=1

14.6 Process Alarm

YesVision allows users to setup various trigger conditions to raise process alarms. There are currently two types of alarms, rate alarms and defect alarms. The rate alarm triggers when the defect rate or the false call rate exceeds a preset level. The defect alarm triggers when a user specified defect condition has been reached.

14.6.1 Rate Alarms

The rate alarms trigger when the defect rate or false call rate exceeds the preset level. The defect rate is measured as PPMO (Part Per Million Opportunities) it is calculated as:

$$\frac{\text{Defects}}{\text{Opportunity for Defect}} * 1{,}000{,}000$$

The opportunity for defects is the total number of tests performed. It is usually the sum of Marking, Lead Bank, and Solder inspections.

The false call rate is also measured as PPMO and is calculated as:

$$\frac{\text{False Call Count}}{\text{Opportunity for False Call}} * 1{,}000{,}000$$

On a board with no real defects, the opportunity for false calls is the same as the opportunity for defects. To simplify the calculation we assume the opportunity for false call also as sum of Marking, Lead Bank, and Solder inspections.

A high defect rate would indicate problems upstream, a high false call rate may indicate the inspection recipe should get additional tweaking.

14.6.2 Defect Alarms

The defect alarms trigger when the user specified defect conditions have been exceeded. There are 10 defect alarms. You can set one defect alarm to trigger when more than 3 part defects in the last 5 runs of board. You can set another defect alarm to trigger when there are more than 10 solder defects in the last 3 run of boards.

The first step to setup a defect alarm is to group the defects into classes. This is done by editing the **defect.ini** file. Use the @C# notation to assign a class to each defect. The class number starts with 1 and ends with 9. Defects with no class assignment default to class 0. Here is a sample defect.ini file with the class assignment.

```
[01]  Unclassified
[02]  Missing Part@S@C2
[03]  Wrong Part@S@C1
[04]  Tombstone Part@S@C4
[05]  BillBoard Part@S@C2
[06]  Skew Part@C2
[07]  Wrong Polarity@S@C3
[08]  Lead Solder Bridge@C4
[09]  Bend Lead@C4
[10]  Insufficient Solder@C4
[11]  Solder defects@C4
[12]  False Call
```

After setting the defect classes the user can setup the trigger condition by selecting **Process Alarm..** from the **System** menu. The **Process Alarm Setup** dialog will display.

14.7 External DLL Interface

YesVision's extension DLL (Dynamic Link Library) interface is a custom API (application program interface) designed to interface various shop floor management systems or WIP (work-in-progress) tracking systems. For various data logging events, the YesVision software calls functions in the extension DLL (**DataLogExt.DLL**). Users can implement these functions in the DLL to link with their specific data collection system. Programming skill from the user will be required to implement these interfaces.

Please refer to the **ExtDLL.zip** file in the Document folder on the YesVision release CD (Version 2.5 or higher) for sample code and a write-up about the interface.

15 Panelized Board Inspection

For assembling small circuit boards it is practical to combine them into repeating panels. A 4-up array has 4 panels of identical circuitry on one large board. There is software features designed specifically for inspection of panelized boards.

15.1 Block Copy and Paste

The block manipulation features are found in the **Edit** menu. You copy the block from the Video View or Map View provided you can enclose the entire block with the selection tool. Most likely you will have to use the Map View. To copy a block, first select the **Map View** by left clicking the mouse in the Map View window once. Then select **Copy Block** from the **Edit** menu. A region of interest selection tool will appear in the Map View window which allows the user to select the block to be copied. It is alright to have the selection box much bigger than the block area you want to copy, because the software will automatically trim down the area to fit around the parts. After enclosing all the parts you want to copy click Ok on the Roi box.
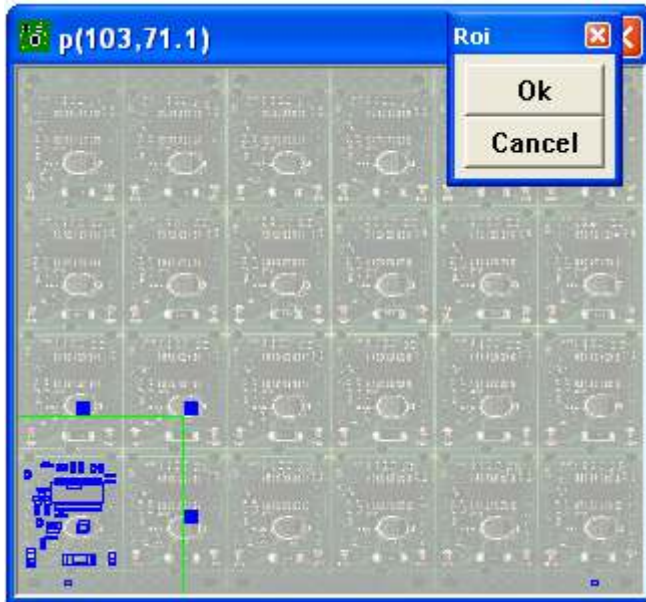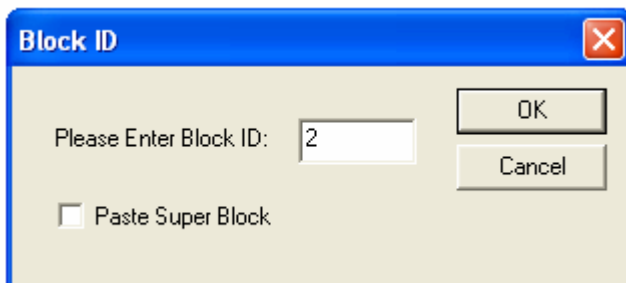
The **Paste Block** selection in the **Edit** menu would be grayed out until a block is copied. To paste a block first move the camera so that the top left corner of the destination block is in the field of view, then select **Paste Block** from the **Edit** menu. The dialog on the left will appear to prompt the user for a block ID. The block ID should start from 2 because the master block is block 1. The **Paste Super Block** checkbox should be checked if the block you are going to paste contains more than one block. In other words, the definition for a Super block is a
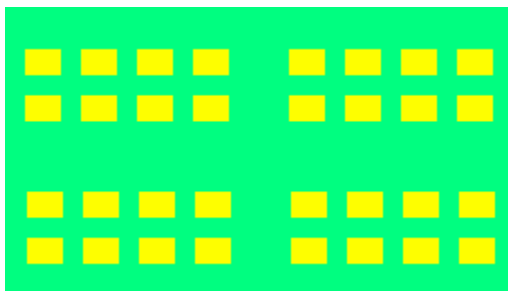
124
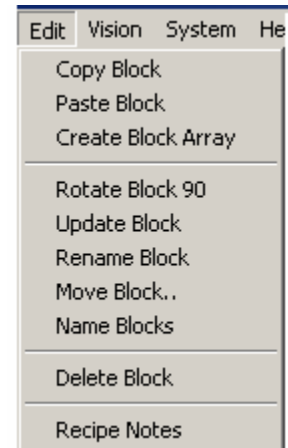
block that contains more than one smaller block. The super block feature is very useful for creating board recipes for boards with small blocks clustered into several regions (see illustration on the left). On this board the user may use the block array feature to create the first 8 blocks, then copy and paste a super block to create the other 24 blocks.

After pressing Ok on the **Block ID** dialog position the overlay to match the destination block circuitry then press **Ok** on the **Roi** box.
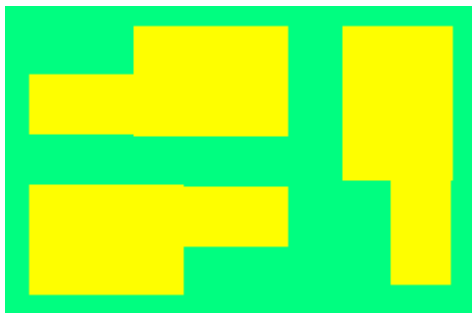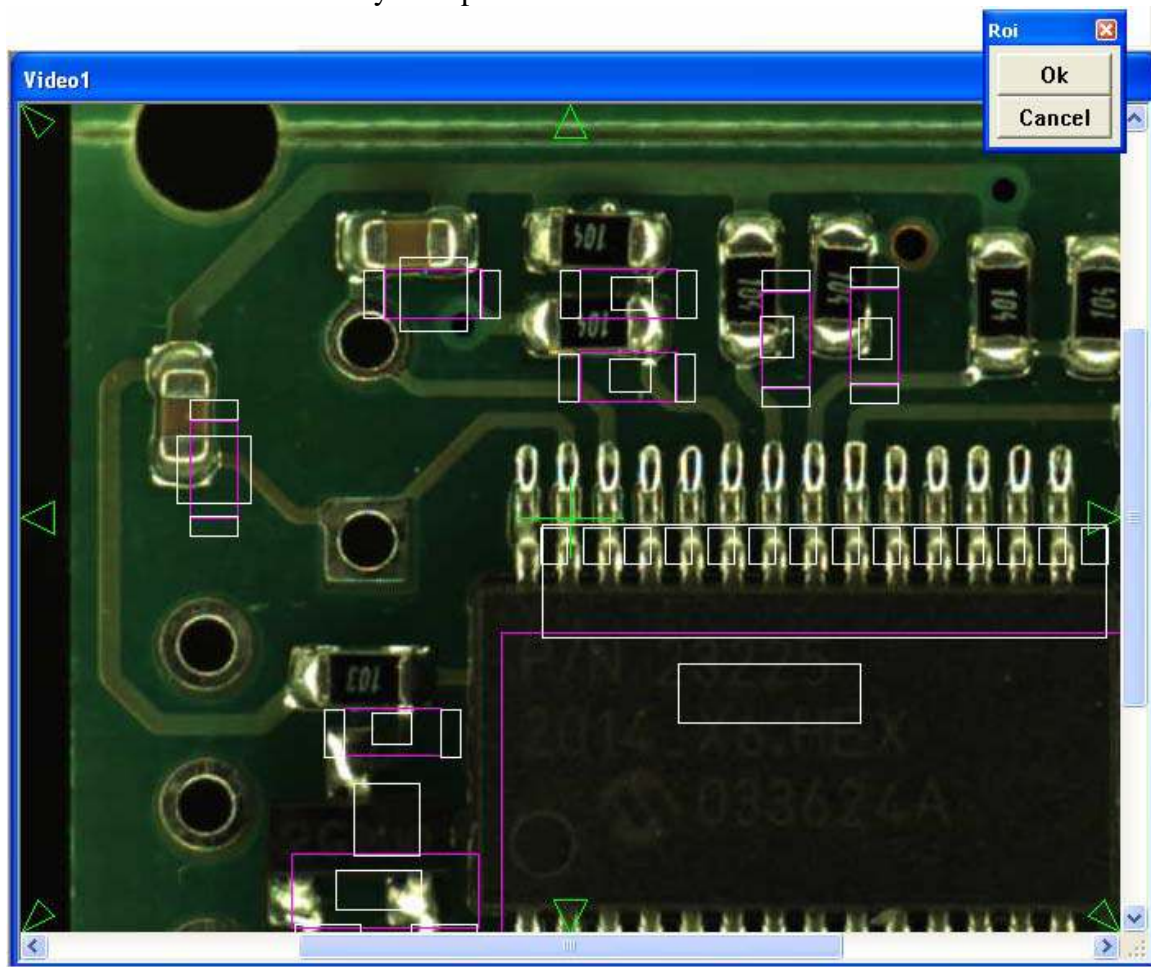
The YesVision software also handles rotated blocks, as long as they are rotated in 90 degree increments. Thus the user can have 90, 180, and 270 degree rotated blocks. To paste a rotated board, copy the block and rotate it (if you need to rotate 180 select **Rotate Block 90** twice), then paste it.

The **Update Block** command propagates any changes made to the master block through the rest of the blocks.

The **Rename Block** renames the block ID. If you need to swap the position of block 2 and 3, you can:

1. Rename block 2 to 99.
2. Rename block 3 to 2.
3. Rename block 99 to 3.

The **Flip Block Name in Block Array** function renames all the blocks on the selected side of the recipe. It can be use to rename the block IDs for the bottom side of a board to match that of the top side.
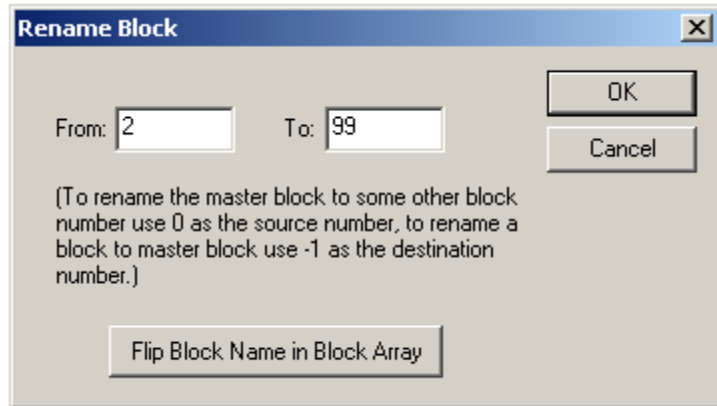
The **Move Block** function allow user to move one block at a time to fine adjust the positions.

The **Name Block** function allow user to assign alphanumerical names to each block; rather than block 1,2,3,4 user could have block names such as A,B,C,D. The block name affects the SPC data log names. The intended usage for this function is to allow user to rename the blocks to match their specific naming convention.
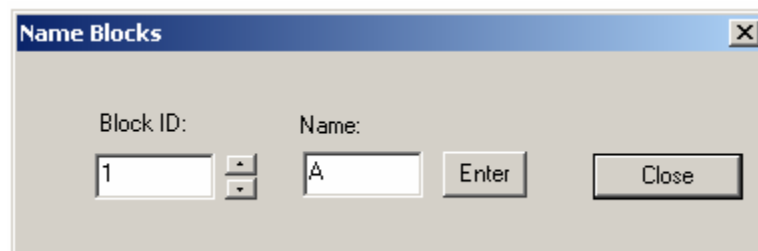
The **Delete Block** function can delete any region on the board. This function will operate on either the Map View or Video View, depending on which is currently in the active state.

15.2 Block Array

The copy and paste procedure described in the previous section works well for large blocks, but for boards with large numbers of small panels, it may be too time consuming to carry out. For a board with a 6 by 6 array of small panels the **Block Array** feature is ideal for creating the inspection recipe. To use the block array feature first copy the block, then select **Create Block Array** from the edit menu. The dialog on the right will appear, enter the array size and press OK. The software prompts the user to move to the "reference position" on the bottom left block. After accepting the position, the software will prompt the user to move to the same position on the bottom right block. After accepting the bottom right block position, the software prompts the user to move to the same position on the top left block. With the three positions the software deduces the X and Y offset for the block and creates the 36 blocks in a 6 by 6 array.
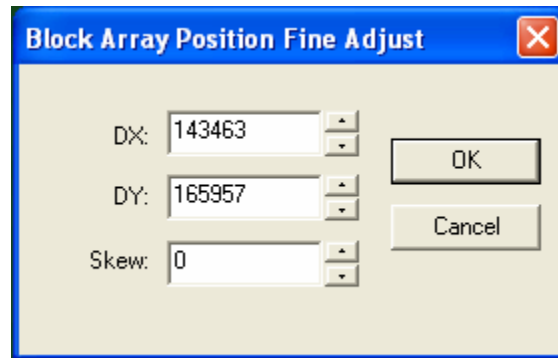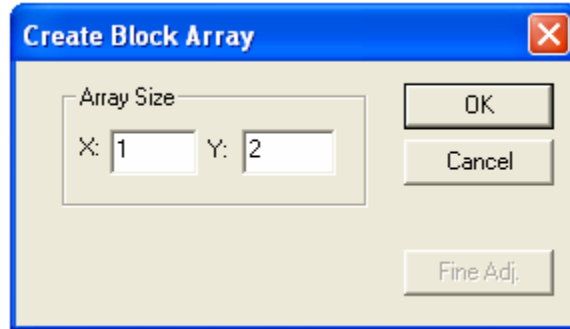
After the block array is created the user can fine-tune the positions of the X, Y and Skew offset by pressing the **Find Adj** button on the Create Block Array block.

Users can also use the Walk Through process (refer to section 13.3) to fine-tune the position for each block.

15.3   BLKTAG and X-out

In a panelized board one or more panels may be unpopulated (X Out).   The **Enable Block Skip** option enables the system to skip the unpopulated areas.

With the **By BLKTAG** disabled the user is allowed to interactively select the block or blocks needed to be skipped from the map view every time a new board is loaded in. If **By BLKTAG** is enabled the system will search for a marker for the block. If the marker is there, the block will be inspected. A block marker can be trained by training a part with a **Ref.ID** of **xx-BLKTAG**.   For example, the block label for block 1 would be **01-BLKTAG**. To skip a block the user may place a label to cover its block marker.

With **By BLKTAG** selected the user can select two modes for the machine to read the **BLKTAGs**: Pre-Scan or No Pre-Scan. If Pre-Scan is selected the system will read all the **BLKTAG's** before inspecting any part. This is good for large blocks and small numbers of blocks. (e.g. 4 up). If the board consists of a large number of very small blocks (e.g. 10x10 array) it would take a long time for the machine to read all the block tags. In this case it would be wise to not select Pre-Scan. In this case, the machine will inspect all parts and the block tags together. And based on the presence or absence of the block tags the inspection results are adjusted. For example if **02-BLKTAG** is not found, block 02 is considered "skip" then the defective parts from block 02 will be removed from the defect report.

15.4 Block Fiducials

For panelized boards it is a standard practice to route or score the boundaries of the circuits to facilitate their eventual separation. The separation process is called de-panelizing. The routing and score weaken the integrity of the PCB causing the circuits to shift relative to each other during the reflow process. To compensate this block to block positional inaccuracy is to use the block fiduicals. A block fiducial is a mark on the block which can be used as positional reference for all other parts on the block.

To use block fiducial, first made sure all part overlays on the master block are well align with the parts. Then selects a positional reference mark on the master block train a part and set its reference ID to **BLKFIDU**. Train a mark inspection box on the reference mark. It is recommended for you to give the part a PN to help later parameter updates. Duplicates the BLKFIDU to all other blocks by selecting **Update Block** from the **Edit** menu.

If you use one block fiducial (BLKFIDU) for each block, you will compensate for XY positional inaccuracy for the block, which is usually efficient for most panelized board designs. Optionally you can use 2 block fiducials (BLKFIDU and BLKFID2) for each block. With 2 block fiduicals you can also compensate for rotational inaccuracy. When you use 2 block fiducials, BLKFIDU has to be to the left of BLKFID2, and for best result the middle point on a line draw from BLKFIDU to BLKFID2 should be close to the center of the block.

15.5 Alternate Reference ID Format

For YesVision the default Reference ID format for panelized board use a leading 2 or 3 digit number and a dash to present the block number. For example if the master block reference ID is **R1** and the corresponding reference ID for block 2 would be **02-R1**. This default format has a format number of 0. YesVision also allows two alternate formats, format 1 which uses a trailing alphabet to represent the block ID. For example the master block reference ID is **R1_A** and the corresponding reference ID for block 2 would be **R1_B**. Format 2 uses a trailing number to represent the block ID. For example the master block reference ID is **R1_1** and the corresponding reference ID for block 2 would be **R1_2**.

16 Double Sided Board Inspection

16.1 Overview

YesVision™ inspection recipes can contain inspection lists for both top and bottom sides of a double-sided board. With double-sided inspection recipes users can choose to inspect one side at a time, like the single side inspection, or the top and bottom side together. If **Double Sided Inspection** is selected from the **Run Inspection** dialog, the software will inspect the first side (top or bottom), eject the board, then prompt the user to flip the board and it will inspect the other side.
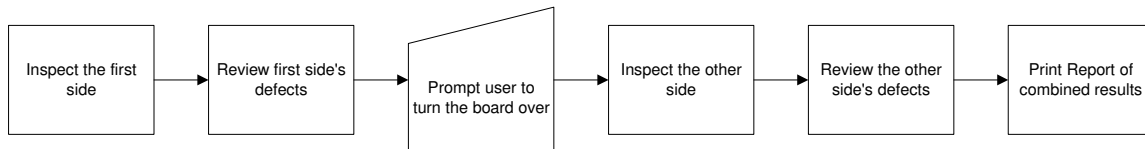
In double-sided inspection the defect report and the SPC data log combine the results of both the top and the bottom sides. For a recipe with serialized barcode, users should inspect the side with the barcode first. This way the defect report will have the correct Serial Number for the board.
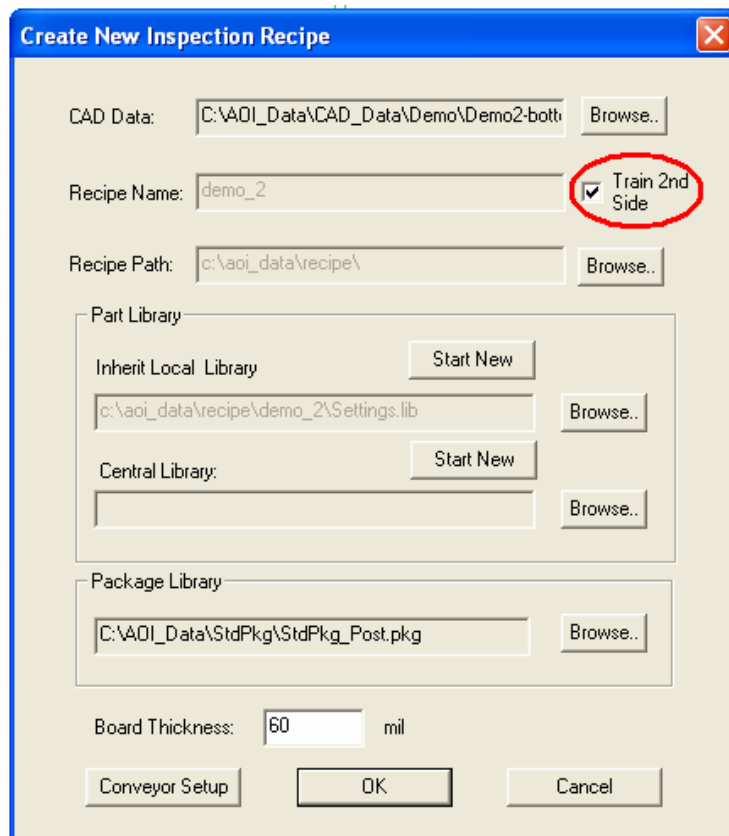
To create a double sided recipe the user needs to prepare two YCD files, one contains top side parts data and the other contains bottom side part data. The **IsTopSide** line in the header section of the YCD file must be set accordingly; for the top side **IsTopSide=1** and for the bottom side **IsTopSide=0.**

The procedure of training the second side of a recipe is similar to that of training a new board. Users first select the proper board side using the button and then put the board into the machine. Next the user selects **File, New Recipe** from the main menu. On the **Create New Inspection Recipe** dialog, the

user can browse and select the YCD file of the second side of the board. With the **Train 2nd Side** check box. Press OK to begin the CAD import process.

In the YesVision software the inspection recipes contains inspection parameters for both side of the board. It is up to the user to decide whether to run the inspection one side at a time or both side together. The **Double Sided Inspection** check box in the **Run dialog** selects the operation mode.

16.2 Reading Board Serial Number

If double sided inspection has camera barcode read feature enabled, it is important to start with the side with the barcode. This way the barcode will be used as the board serial number for both sides of the inspection data.

For inspection large board array with many boards and each board require individual barcode. User can create a double sided inspection recipe with the back side contains the barcodes only. This way during inspection put the board in barcode side first to have the software read all the barcodes, then turn it over for inspection of components on the second side. The trick to make this application work is to have the block ID to be corresponding from the top side to the bottom side. The special feature in Rename Block dialog helps user to create Block ID that mirror that of the other side.
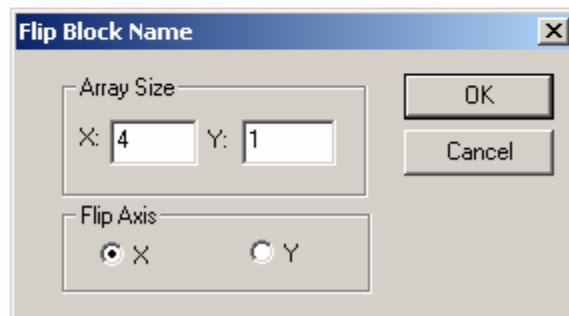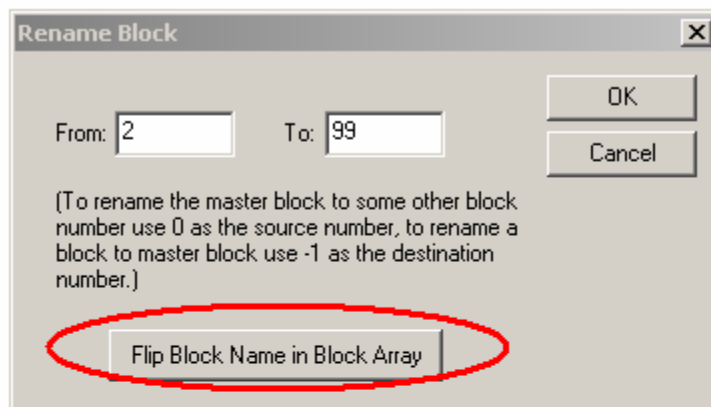
16.3 *Transferring Block SN Read to the Opposite Side*

As described in the last section the YesVision software can transfer the Block SN from one side of the board to the other side during a double sided inspection. However, it is not always practical to do double sided inspection. For inline operation boards will have to be inspected one side at a time. Sometimes two AOI machines would be linked with a board flipper in the middle and each AOI inspect one side of the board. In other cases the same AOI machine will inspect both side of the same board but each side at a different time. These are the scenarios for the new software features that transfer Block SN read from one side to the other side.

Reading barcodes using camera is a standard feature on all YES Tech's AOI machines. This feature work great as long as the barcodes are on the top side of the board. Reading barcode from the bottom side of the board will require optional hardware. There are two options that can be used to read barcodes from the bottom side of the board.

1.) Bottom Camera Option
2.) Bottom Barcode Reader Option

The bottom barcode reader option (with one read-head) cost about the same as the bottom camera option. The bottom camera option is easier to setup and use, but because of its size you can only have one bottom camera per system. That mean it has a limitation; it can only read one barcode from the bottom side of the board. Conversely speaking, the main advantage of the bottom barcode reader option is that you can daisy-chain multiple read heads to read multiple barcodes. Without considering the ease-of-use factor the bottom barcode reader option is more capable, and in some application they are the only option that will work; application such as single sided, panelized board with multiple barcodes on the bottom side.

For most applications both options will work. This document explains the software features that utilize the bottom camera to track serial numbers (barcodes) on double sided, panelized board assemblies regardless of where the barcodes are placed.

Software Feature

The "Block SN" function is extended to allow better barcode tracking. Two new features are added. They are **Transfer SNs to the Other Side of the Recipe** and **Omni-rotational Block Arrangement.**
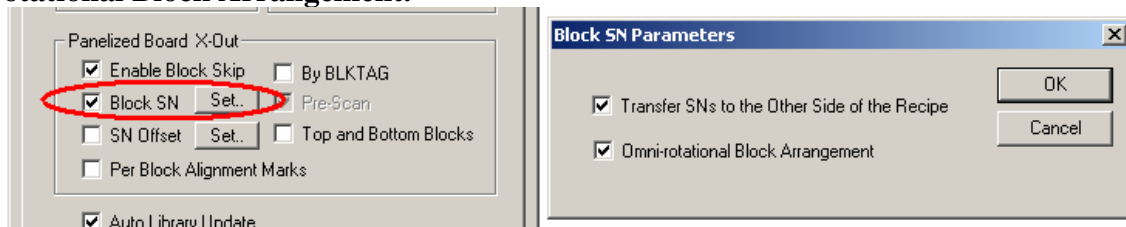
a.) Transfer SNs to the Other Side of the Recipe

To track both side's inspection results to the correct barcode the software transfer the barcode information from the top side and pass it down to the bottom side. For example in a 4 up board assembly where barcodes are on the top side, during the top side inspection the following 4 barcodes are read by the camera:

1. AAAA   for Block 1 (Master Block)
2. BBBB   for Block 2
3. CCCC   for Block 3
4. DDDD   for Block 4

The barcodes are stored in a database. And during bottom side inspection the bottom barcode reader read AAAA. The software then queries the database and retrieves the data to populate   Block 2 to 4's barcode.

If inspection happens with bottom side first then the initial barcodes with be:

1. AAAA   for Block 1 (Master Block)
2. AAAA-2   for Block 2
3. AAAA-3   for Block 3
4. AAAA-4   for Block 4

This barcodes are temporary, as soon as the top side of the board is inspected and the barcodes read the software will substitute the SN entries with the correct barcodes. The substitution happens both in the SPC data database and the Image Set .IS files. This will ensure both the SPC calculations (yield, defect rate, etc) and well as the offline review and rework operation are based on the correct barcodes.

Because an ODBC database is used to track the temporary barcodes, the feature is independent of the starting and closing of the YesVision software neither the turning on and off of the AOI computers. The bottom side of a board may be inspected several days after its top side had been inspected; as long as the barcodes matches, the substitution process will execute correctly.

However, discretions should be exercised if the board is inspected more than one time. The rule is if you inspect the top side twice you should inspect the bottom side 2 times as well for the feature to work correctly. If the top side and the bottom side are inspected different number of time then the barcode information may not be correct.

Also during programming user must number the blocks of the bottom side to match that of the top side block number. We also recommend user to standardize the flipping of the double-sided board to always flip along the X-axis. This way the master block is always on the bottom left on the top side and to left on the bottom side.

b.) Omni-Rotational Block Arrangement

To facilitate board handling during the manufacturing process sometime a panelized board is designed in such as way that is will look the same when it is rotated 180 degree. We call this type of arrangement "Omni-Rotational Block Arrangement". The follow picture show one of such arrangement.
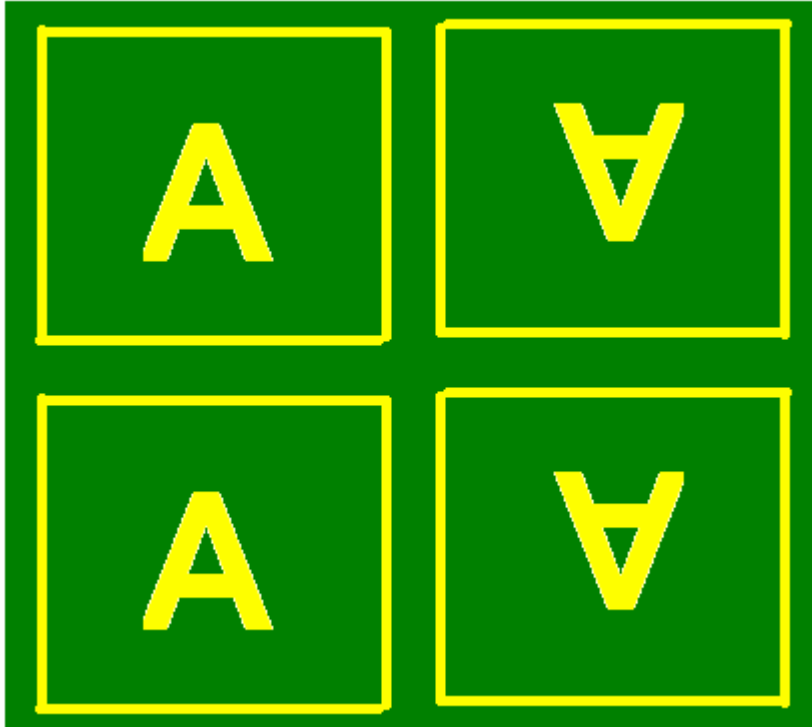
With the feature enabled the software will detect the condition when the top side is inspected at 180 degree board rotation off from the current inspection and rename the barcode correctly.

For example, in a 4 up board assembly where barcodes are on the top side, during the top side inspection the following 4 barcodes are read by the camera:

1. AAAA   for Block 1 (Master Block)
2. BBBB   for Block 2
3. CCCC   for Block 3
4. DDDD   for Block 4

During the bottom side inspection instead of AAAA the barcode DDDD is read in. Because the barcode match not the first block barcode but the last block barcode, from this the software determines that the bottom side of the board is 180 degree different from when its top side was inspected. Arm with that information the software will then assign the SNs to the bottom side block as:

1. DDDD
2. CCCC

3. BBBB
4. AAAA

For this feature to work all the barcode numbers has to be unique and never repeat. The bottom camera has to be placed at a place where the barcode for the master block will normally appear when the board is flipped over but not rotated 180 degree.

17 SmartStart™

17.1 Introduction

SmartStart is a feature that select inspection recipes based on printed circuit board's serial number (SN from barcode) or appearance. With the help of a customized extension DLL (DataLogExt.DLL) it integrates with the WIP (Work in Process) tracking host system via TCP/IP or other interfaces.

17.2 System Part List
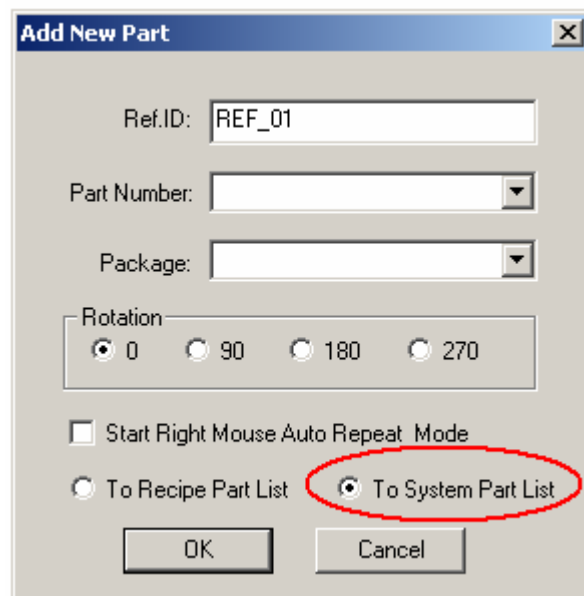
On the YesVision software similar to the part list for each board, there is also a system part list, which is common across all recipes. This system part list is used by SmartStart to automate the process of selecting and loading inspection recipes. Adding a part to system part is similar to that of board part list. It starts by pressing the Add

Part button [icon] on the toolbar. In the **Add New Part** dialog user needs to select the radio button **To System Part List**.

SmartStart uses 4 different methods to select recipes.

- Hand Held Barcode Read Barcode
- Camera Barcode Read
- Board's Appearance
- Bottom Side barcode Reader

For the method "Camera Barcode Read" user must have at least one part in the System Part list that setup to read barcode. For the methods "Board's Appearance" user must train one part per recipe in the set of recipes to be loaded automatically. Each part should have trained a marking that uniquely identifies that particular board assembly. The other two methods, Hand Held Barcode Read, and Bottom Side barcode reader read do NOT require any part in the system part list.

17.3 SmartStart Setup Parameters

SmartStart is launched by selecting **File, SmartStart** from the menu. The following dialog will display:
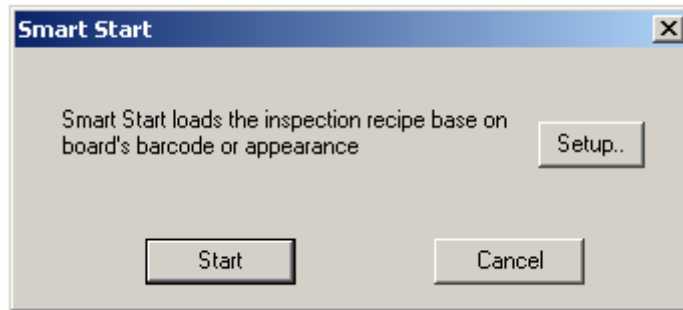
From this dialog pressing Start will start the inspection process, pressing Setup launch the SmartStart Setup dialog:
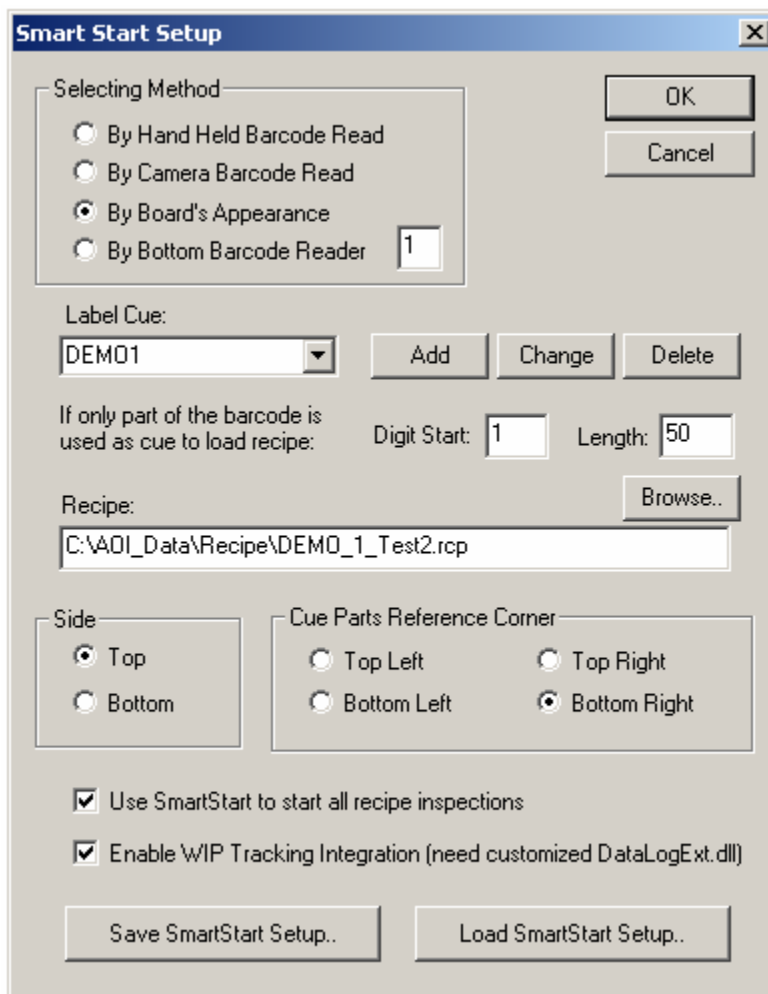
From this dialog users setup the parameters for SmartSart. In the Selecting Method group user chose one of the four methods to select recipe. The user defines the link between the "Cue" and the recipes being loaded. For the methods that involve barcode, part or all of the barcode is a cue. For Board Appearance method the Reference ID of the corresponding part is the cue. If only a portion of the barcode is used as cue (e.g. from digit 2 to digit 6), then user needs to specify that accordingly.

Inspection recipes on YesVision can be double sided. User should specify the desire side to load in the **Side** group of the dialog. The **Cue Parts Reference Corner** group set the reference corner for all the reference parts in the system part list. It is only important if the boards in the selection set are of different sizes.

The check box **Use SmartStart to start all recipe inspections** if checked will force the software to use SmartStart to start all inspection. When it is checked the **Run Recipe** button in the toolbar ▶ will use SmartStart instead of the Load Board dialog.

With the help of a custom **DataLogExt.DLL** the **Enable WIP Tracking Integration** check box, if checked allows the YesVision software to integrate with any WIP (Work in Process) tracking system via TCP/IP or other interfaces. The message formats are defined in **DataLogExt.DLL**. User can customize the DataLogExt.DLL for their internal needs.

Finally all the setup parameters for SmartStart, together with the corresponding system part list, can be saved into disk files for later retrieval. This allows multiple groups of recipes to be SmartStarted. The SmartStart setups are saved in files with extension **.sss**. The **.sss** files can only be located in the INI folder of the YesVision software.

18 Defect and Board Documentation

18.1 Screen Image

In addition to inspecting for defects, because of its camera based operation, the AOI machine is also a wonderful tool to help document a defect found. User may use the machine to capture pictures of the defects and the board to create rework documents. Several features in the software are designed for such applications.

Save Image and **Save Image Region** from the Video View menu saves the image or image region in a file in a user selectable format (bitmap, tiff, JPEG, etc.). The software also prompts the user for the file path/name to save to.
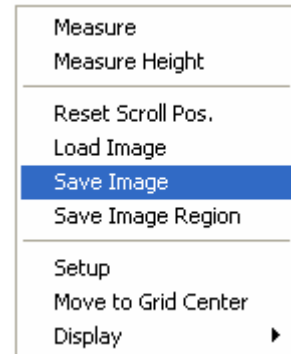
One of the very powerful but often forgotten features in Windows XP is the plain old **Print-Screen** function. It is a wonderful tool for documentation. To use the feature just press the Print Screen key combination (Shift-Prt Sc or Fn-Prt Sc) on the key board, launch the Microsoft **Paint** program and select **Edit, Paste**. Using Paint you can do all sorts of editing for the screen image before saving it to file. In fact, most of the images of the software in this manual are created using this method.

18.2 Part Image

For PCBs used in products require total traceability (medical products, safety devices) YesVision software can be used to capture image of specified parts. The part images are stored in PartImage sub folder under the recipe folder. It is saved in JPEG format. Part Images are stitched from inspection images. If the part is inspected in multiple views, there will be multiple images for that part. The part image file name composes of the board's serial board, part's reference ID and the view that capture the image: BoardSN_RefID_View.jpg

139
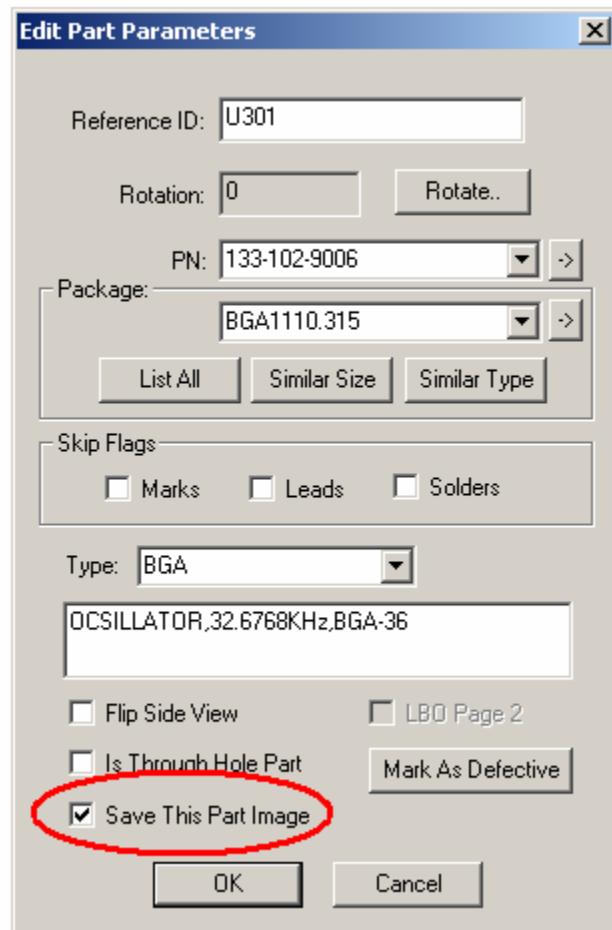
To specify a part for part image save, check the "Save This Part Image" check box in its Parameter dialog. Here is some sample part images:

H1419FC_U27_Top.jpg
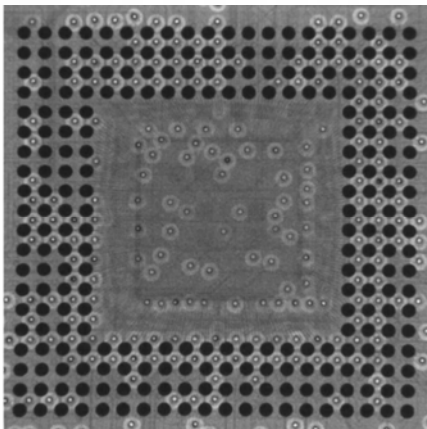
H1419FC_U27_X1.jpg

18.3 Board Image

Stitch Board Image from the Map View menu creates a complete board image by stitching up the individual frames from an Image Set. Users can select the size and the format of this board image, as well as the destination file name.
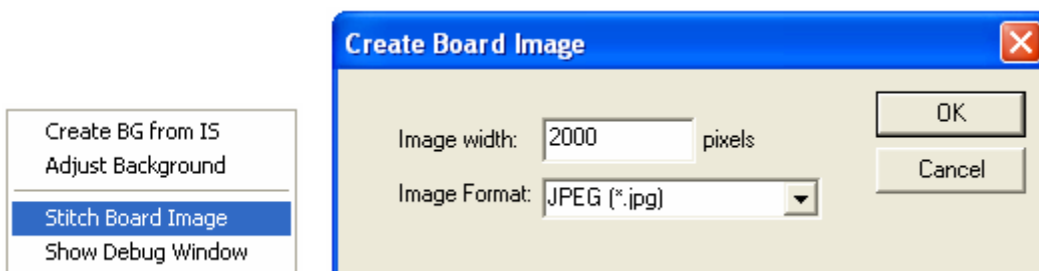
On the YTX-6000 it is possible to stitch together a complete X-ray image of the board from an X-ray Image Set in Grid format. To do so load the Image Set, then switch the camera to X-ray view, then select **Stitch Board Image** from the Map View.
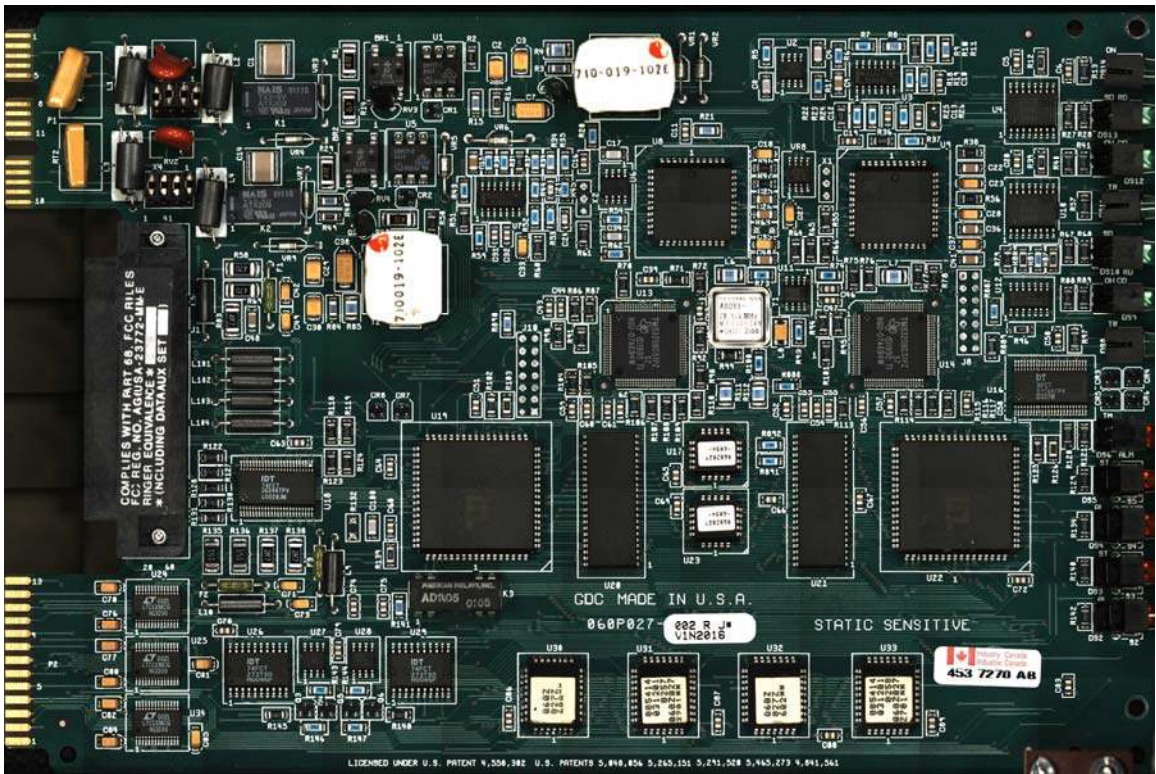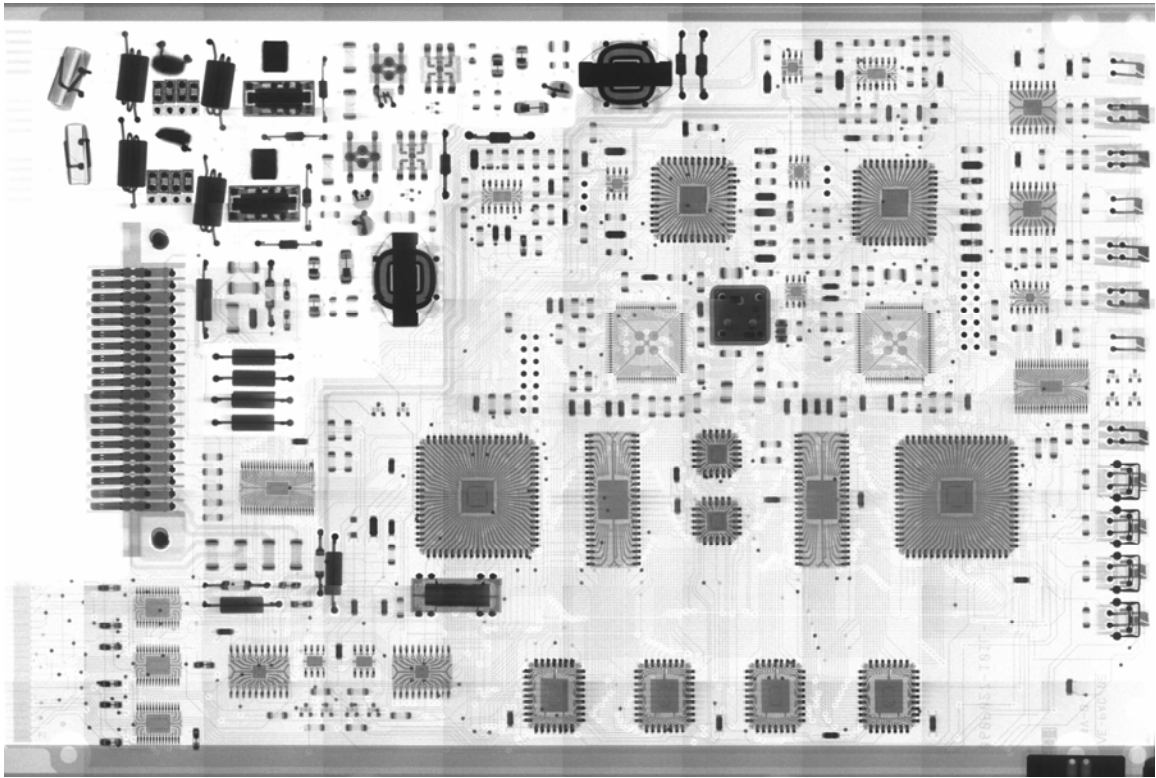
19   Optional Accessories

To satisfy the needs of different customers YesTech offers optional accessories that users can purchase to enhance the capabilities of the inspection machines. After installing such an option, the user need to enable the software interface from the **System Options** dialog accessible by selecting **System, Options** from the main menu in the Recipe Programmer mode.
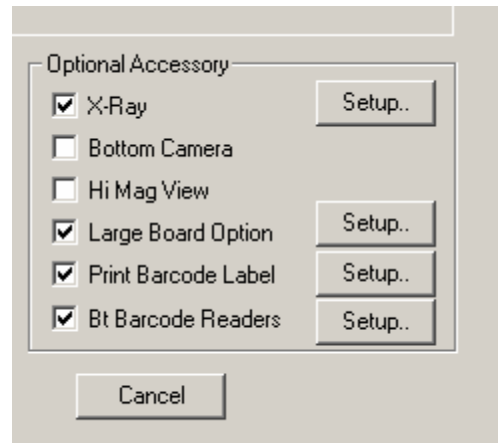
19.1 X-Ray

The X-ray option is only available on the YTX-6000 machine. It can NOT be added to any of the AOI machines.

19.2 Bottom Camera

The bottom camera option can be added to YTV-F1, M1 series AOI machines and the YTX-6000 machine. It can be used to read the board's SN via barcode or OCR. In the case of YTX-6000 it can also do limited bottom side AOI inspection.

19.3 The Hi Mag. View

The High Mag view option can be added to the YTV-F1 series AOI machines and YTX-6000 machines to enhance inspection capabilities on 0201 and smaller components.

19.4 Large Board Option

The large board option for the YTV-F1 series AOI machine increases the board inspection area for the machine from 22"x 18" (Width x Height) to 34" x 18". The additional inspection width is achieved by having one additional set of hard stops mounted to the right of the existing hard stops. Machines with this option would have two sets of hard stops. Board inspection is accomplished in two sections the right half of the board area is inspected with the board against the middle hard stop, and the left half of the board is inspected with the middle hard stop down and the board shifted to the right against the second set of hard stops.

With the appropriate hardware installed, the option can be enable in the System Option dialog. This option add a new icon on the button bar . Pressing the button

142

toggle the board position from 1st stop (Normal board hard stop) to the 2nd stop (the additional hard stop).

To create recipe for large board user must first select the **Board Longer than 20"** check box in the **Create New Inspection Recipe** dialog.

The basic sequence of steps is:

1. Prepare CAD data as usual. There is no format different between the YCD file for large board and normal board.
2. Place the board on the conveyor at the 1st stop.
3. Launch the **Create New Inspection Recipe** dialog, and select **Board Longer than 20"** check box.
4. Follow the prompts to define board side. In this step the software will automatically move the board between the hard-stops to allow user to reach the 3 corners of the board to define board side.
5. The software will capture image set a create background.

6. Software will prompt user to define fiducials for board at the 2nd hard stop. It is recommended to use 3 fiduicals for large board recipe.
7. Import CAD data for the right half of the board.
8. User press the button to move the board on to the 1st stop.
9. From the **Vision** menu, select **Define Align Marks** to define the fiducials for the 1st half (left half)of the board.
10. From **File** menu select **CAD Data, Import CAD Data** to train the left side of the board.

The inspection and review processes for large board recipes are the same as that or regular boards. The software will automatically shuttle the board between the 2 hard-stops. However, user is must start the inspection only with the large board on the 1st stop. If user mistakenly starts the inspection with the board at the 2nd hard-stop only half of the board will be inspected.

To capture grid Image Set for large boards, user must only start the process with the large board on the 2nd hard-stop.

19.5 Print Barcode Label (YESTrack)
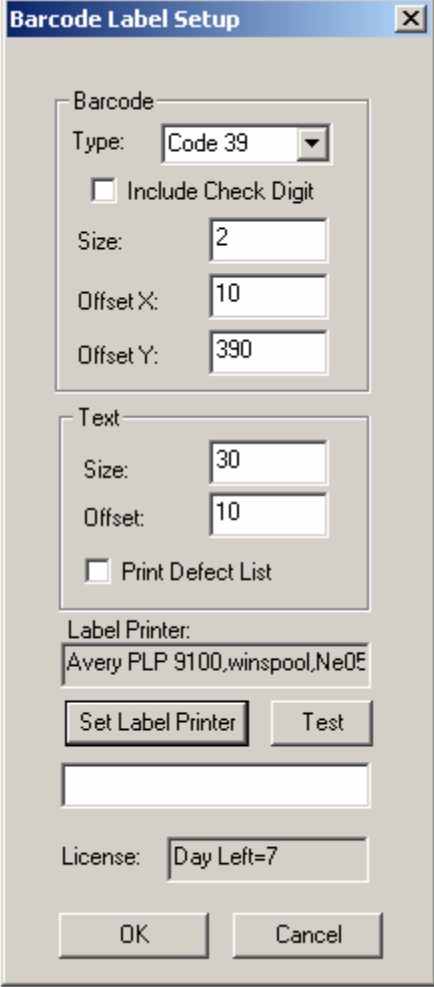
For users who do not serialize their boards with barcode, but still want to utilize the offline line review and rework features of the YesVision, they can purchase the YES Track option. This option prints out the board's serial number on a barcode label. User can put this label on the defective boards. On the rework station the operator can just scan the barcode to pull up the record for this board to perform rework.

When user purchases this option YES Tech will supply an Avery Person label printer for users to start with. This software option can work with any Windows XP compatible label printer that may be purchased separately.

Pressing the **Setup** button from the **System Option** dialog will launch the dialog shown right. Users will need to adjust the parameters based on individual requirement.

Because the normal report and the barcode labels use different printers, the user needs to use the following steps to set the printer selection:

1. With the YesVision software not running, make sure both the normal report printer and the label printer are connected and functional.
2. From Windows XP, control panel, **Printers and Faxes** icon, select the normal report printer as the default printer.
3. Starts the YesVision software. (During starts up the software records the default printer at the time as the printer for normal report.)
4. From **System Options**, press the **Setup** button on the right of the **Print Barcode Label** option to display the **Barcode Label Setup** dialog.
5. From Windows XP, control panel, **Printers and Faxes** icon, select the barcode label printer as the default printer.
6. Press the **Set Label Printer** button on the **Barcode Label Setup** dialog. (Pressing the **Set Label Printer** button causes the software to record the default printer at the time as the barcode label printer.) Press the **Test** button to verify barcode printing.
7. Press OK to close the dialog.

This option requires a license code to activate. The very first time user enable this option a dialog will be displayed showing a system code and prompt for a license code. Users need to call YES Tech's technical support to obtain a license code.
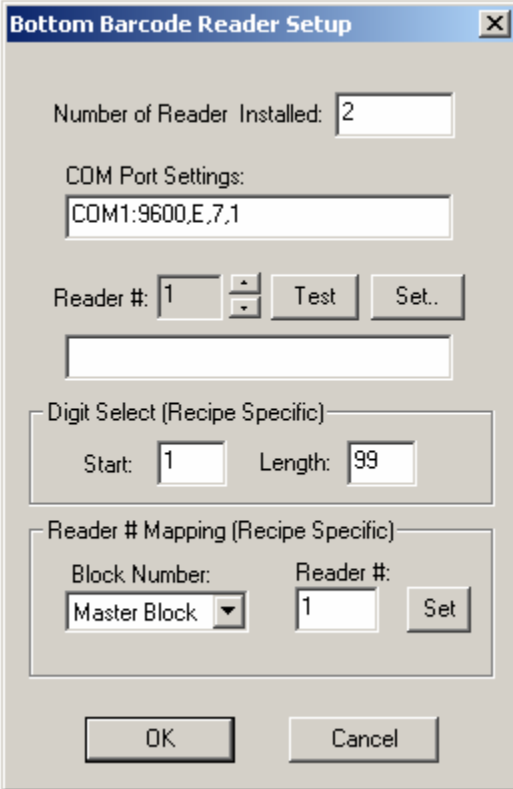
19.6 Bottom Barcode Readers

Both the bottom camera and the bottom barcode reader option can read barcodes placed on the bottom side of the PCB. The bottom camera has the advantage to also perform OCR. It is also generally easier to setup the bottom camera for barcode reading, because it has the same barcode reading capability as the top camera.

The Bottom Barcode Reader option has the advantage of using multiple read heads to read multiple barcodes from a panelized board. It is generally more difficult to setup the bottom barcode reader because it is hard to see where the head is reading. The Bottom Barcode Reader is recommended for high volume applications where the barcodes are machine placed. In addition it is also for applications where non sequential barcodes are used on panelized boards.

Pressing the **Setup** button on the **System Options** dialog displays the Bottom Barcode Reader Setup dialog. The multiple read heads are daisy chained together and interfaced with the PC via the RS232 (Serial) Port.

Bottom barcode readers are typically used in a high volume line where change over is infrequent. Recipe change-over usually involve repositioning the read heads that can be time-consuming. The **Reader # Mapping** feature helps some change-over situation by allow different recipe to use different reader head to read the barcodes. This way physically repositioning the head may be avoided.

19.7 Audible Alarm

It is possible to connect an audible alarm onto the AOI systems to alert the operators when the machine requires human intervention in order to continue with the inspection process. Users can purchase an optional audible alarm from YesTech or, much

more economically, connect their own alarm hardware onto the AOI system. Compatible alarms must operate from 24V DC power supply and have a continuous tone.

To connect the alarm, user need to locate the IOB (Assy#10072) from the back of the machine. IOB is a square PCB about 5" by 6" in size with screw terminal connectors on the top. Connects the negative terminal of the alarm to pin 11 or 12 (Ground) on the ST2 screw terminal connector, and connect the positive terminal to pin 6 of ST2 (OUT2-), then use a jumper cable to connect pin 5 (OUT2+) to pin 1 or 2 (+24V). User may find wires that are already connected on pin 1,2,11 or 12 (Signal Ground or +24V). The alarm wire can share terminal with existing wires.

There are entries in the YesVision.ini file that user can use to customize alarm settings:

```
[AudiAlarm]
DelayTime=10000
OnTime=300
OffTime=300
```

The **DelayTime** is the time in mini seconds that the alarm will sound after user intervention is requested by the software. If the operator responses within the delay time limit then no alarm will sound. Once the alarm begins to sound it oscillates on and off, the **OnTime** and **OffTime** set the duration of it's on and off time.

Audible alarm option is NOT compatible with the Large Board Option. The two options cannot be installed together.

20   User Administration

To provide inspection traceability the software tracks all users of the software. The login user name is on every defect report and SPC data record. A user can have one or more of the 5 types of privileges: **Operate, Build, QA, Program** and **Admin.** The first 4 types of privileges correspond to the 4 activity modes of the software. For example users with **Operate** privileges can operate the machine in **Operator** mode, users with **Program** privileges can create and modify inspection recipes, etc. The **Admin** privilege is for users who are given the right to administer other users.

Admin users can launch the **User Administration** dialog (shown below) from the Switch mode dialog. A valid user has a name and a password. A valid user name contains between 1 and 15 alphanumeric characters without spaces. A valid password contains between 0 and 15 alphanumeric characters, therefore a blank password is allowed.
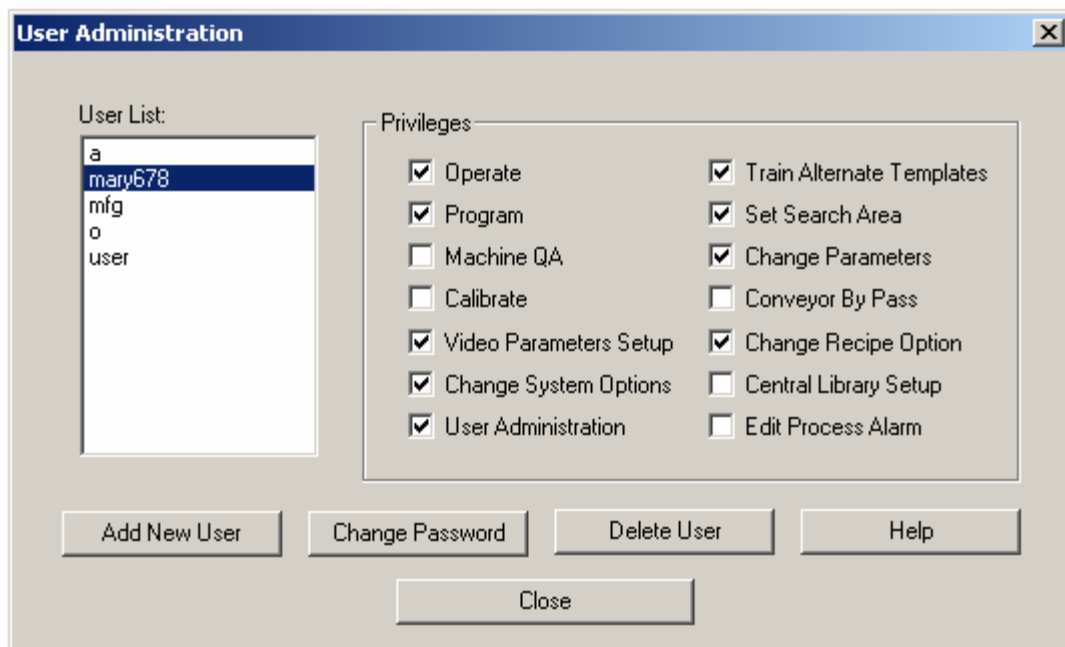
Amongst the 4 activity modes, Operator and Recipe Programmer mode can have additional selectable privileges. The following privileges can be added to operator mode: **Train Alternate Templates, Set Search Area, Change Parameters, Conveyor By Pass** and **Change Recipe Options**. The following privileges can be added to the Programmer mode: **Video Parameters Setup, Change System Options, Central Library Setup** and **Edit Process Alarm**.

21   Image Set and Image Archive

The **Image Set** is a collection of images captured from one particular board. It is like an electronic copy of the board. The software can run an inspection on the **Image Set** of the board as if it were running a live mode inspection. The **Image Archive** is a collection of Image Sets organized according to the inspection recipe. Offline programming and offline defect review features are made possible by the implementation of Image Sets.

YesVision™ supports five image formats for an **Image Set**: TIFF, bitmap, JPEG, JPEG 2000 and Raw Bayer. An **Image Set** can be captured in 2 ways; grid or inspection paths. The Grid Image Set is captured by moving the camera in a grid pattern over the board. Inspection path Image Set is captured during board inspection by selecting one of the Image Archive options in the Run Inspection dialog. Comparatively, the Grid Image set captures more information of the board and it can be captured before the creation of the inspection recipe. The disadvantage of the Grid Image Set is that it is larger and takes more time to capture.
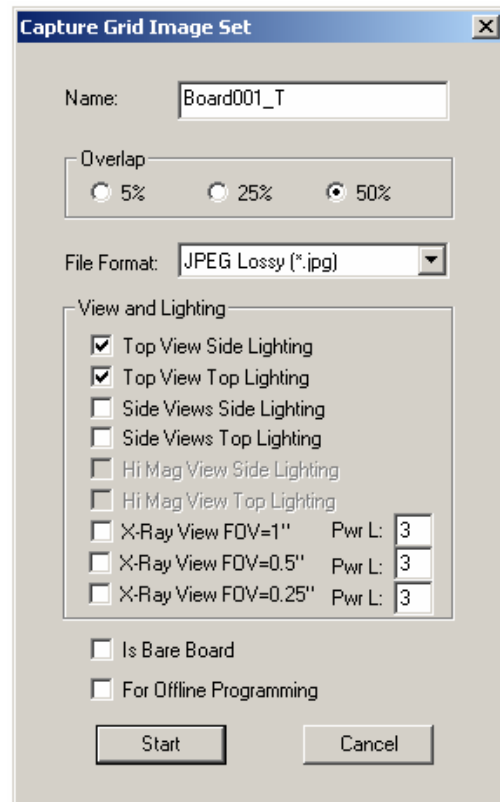
To capture the Grid Image Set select **Image Set -> Capture Image Set** from the File menu. The dialog on the right will appear. On this dialog the user selects an overlap value, image file format, camera view and lighting for the Image Set to be captured.

When an inspection recipe is loaded its associated Image Set is listed in the **Image Archive** window of the **List View.** On this tab the name of the Image Set is listed on the left, followed by **IS Flag. IS Flag** may be one or more of the following letters**:**

I – Inspection Path Image Set
G-Grid Image Set
A-Full Image Set
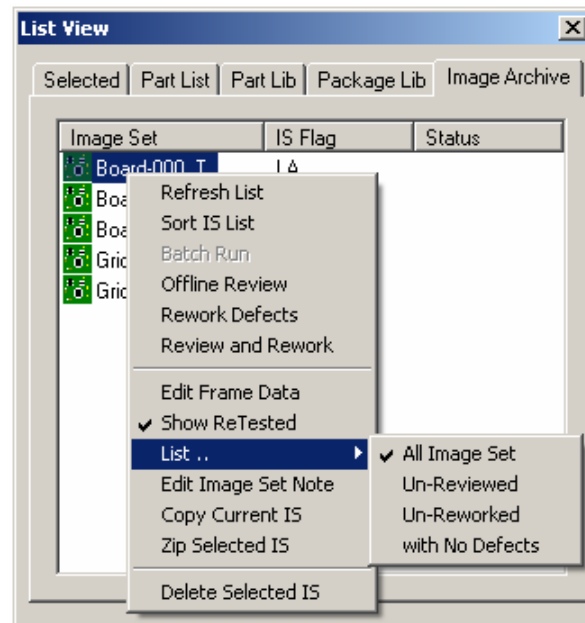
D-Defect Only Image Set
RV – The Image Set had been reviewed.
RW –The Image Set had been reworked.
RD – The Image Set had been reviewed and a real defect is found on it.

Double clicking on the selected **Image Set** will load it into program memory.

This page also has a pop up menu which will display when the user clicks the right mouse button inside the **Image Archive** window.

21.1 Offline Programming

The offline software (PN: YTV-OLS) is a software option that AOI users can purchase separately at an additional cost. The software can perform three main functions: offline programming (i.e. offline inspection recipe creation), offline defect review, and defective board rework. YTV-OLS is a piece of software that users can install on any computer running Windows 2000 or XP. This section describes the offline programming feature. Offline review and rework is documented in the next section.

With the offline software users can create inspection recipes offline from an Image set captured on a YTV AOI system. Programming offline allows the AOI machine to continue with inspection work, which eliminates delay in the manufacturing process. It also allows the user to create inspection recipes in the comfort of his or her office.

Installing the offline software:
1. Install the Rainbow key driver.
   The setup program can be found in the **Rainbow** folder on the YesVision™ delivery CD. The name of the setup program is **SSD5411-32bits.exe**
2. Install Matrox Imaging library.
   The setup program (**install.bat**) can be found in the **Matrox** folder on the YesVision™ delivery CD.
3. Install the YesVision™ software.
   The setup program can be found in the **YesVision Vx.x Setup** folder on the YesVision™ delivery CD.
4. Plug the software protection key into a free USB port.
5. Rename the file **Offline.ini** to **YesVision.ini,** found in the folder C:\Program Files\Aoi\ini. (There may be a **YesVision.ini** already in the folder, please overwrite it.)

Setup the network environment:
Offline software must be connected to the host AOI machine via a fast Ethernet connection (100 base T is the minimal requirement). The **AOI_Data** folder on the AOI machine and the offline computer should be shared as **AOI_Data** and allow full access between them. All AOI machines and offline computers on the network should share a single **LTMaxNum.txt** file. This file regulates the template number for all stations that prevent cross contamination of templates.

Offline Programming process:

The process of creating inspection recipes offline starts on the AOI machine just like normal (online) recipe creation. The user selects **File, New Recipe** from the main menu to launch the **Create New Inspection Recipe** dialog and may carry out the steps for defining board size. When it comes to capturing the image set, the user must click the **For Offline Programming** check box on the dialog.

The second part of the offline programming process involves the offline software. On the offline computer's YesVision™ software select **File, Load Recipe** then browse the network and open the empty recipe created on the AOI machine. The Image Set should load automatically. If not the user can double click and load it from the Image Archive. After the image is loaded the user will need to define alignment marks, unless the fiducial are included in the CAD data, by selecting **Vision, Define Alignment Marks** from the main menu. Press the Align button once to make sure the image set can align properly, then from the main menu select **File, Import CAD** to create the recipe.

21.2 Offline Review

Defect review and classification can be time consuming. Reviewing online ties up valuable machine time that can be used for continual automated inspection. Offline software allows the defect review to be carried out on another computer either downstream to the AOI machine or completely offline (provided the board is serialized). Before using the offline review and rework feature, the user must make sure the defect classification code is the same for all machines and offline stations. This means the **Defect.ini** file must be the same on all the stations. The **Defect.ini** file can be found in the folder **C:\Program Files\AOI\ini**.

The offline review process starts by loading the recipe from the AOI machine. From the Image Archive the user selects the first board to review and double clicks it to load the Image Set. After the selected image set is loaded, from the Image Archive's pop up menu select **Offline Review**. Offline review is very similar to online review where users can review and classify defects. Upon completion of the review a defect report will display and can be printed if desired. After closing the defect report the result dialog will appear, clicking **Next** will repeat the review process for the next board.

Offline Review requires users to serialize the boards being reviewed with barcodes, **downstream review** does not have that restriction. In Downstream review the review station is immediately downstream to the AOI machine. The review station is connected to the AOI machine via a computer network (LAN). The user reviews the boards in the same sequence as the AOI machine inspects them. To setup a computer for downstream review user needs to select the **Is DownStream Review Station** checkbox in the System Option dialog. On the AOI machine's YesVision software the **Has Downstream Review Station** checkbox need to be checked in its System Option dialog.
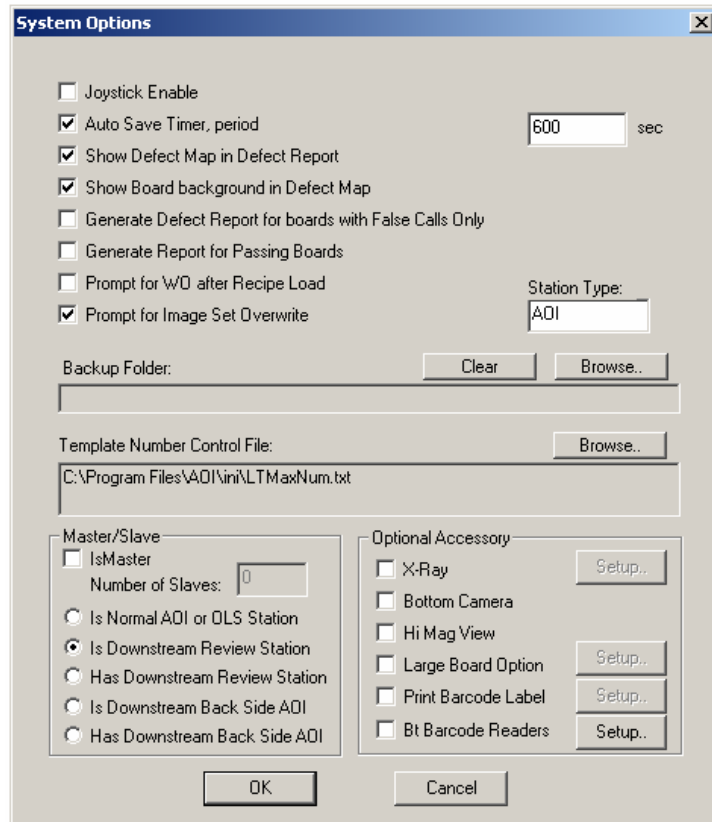
During software startup the down stream review station needs to connect to the AOI machine up stream. It will prompt the user for the computer name of the AOI machine up stream. Once the connection is established the AOI machine will pass board information to the review station in real time.

21.3 Rework Defects

A "touch up" person will need to rework the defective boards. The offline software will assist this person in identifying the defects on the board. The process is called offline rework. To start the process the user on the offline computer station loads the inspection recipe from the AOI machine. Then from the Image Archive menu the user selects **Rework Defects**. The following dialog will appear where the user can enter the board's serial number to rework. If the board is bar-coded the user can scan in the barcode using this dialog box.

On the dialog the **Double Sided Rework** check box enables the double sided rework mode. In this mode the software will automatically switch to the side that the defect is on, and guide the rework process. If there are defects on both side of the board then top side rework will be followed by bottom side rework processes. In this mode all the rework operator needs to do is to scan the barcode for the board to be reworked. The software will identify which side of the board the defect is located and its position.

The **Use Smart Start** check box enables the SmartStart feature for rework. The SmartStart feature loads the recipe based on the barcode of the board and start the rework process. **Post De-Panelized Rework** check box indicates to the software that the rework (or Review/Rework) is performed after the circuit had been separated in the depanelizing process. The software will only show the defects associated with the barcode enter, even though the original board inspected by the AOI is a multi-up board with multiple barcodes. The **Preview Report** and **Electronic Report** controls the report generation after the Review/Rework. The **Digit Select** is used when a barcode reader is used for data entry but not all characters of the barcode are the serial number. The Digit Select allow user to select a segment of the code as the board's serial number. The **Refresh IS List** button refresh the image set list to include the latest image set created.

The SPC data logging function for offline station is controlled from the **System Options** dialog.

After finish reworking the board, the user can press the **Next** button on the result dialog to repeat the rework process for another board.

21.4 Review and Rework

For environments where the False Call rate is very low, such as a high volume OEM manufacturing environment, it would make sense to do the defect review and rework together.

21.5 Board Comparator

Before the invention of AOI people use comparator system to improve the effectiveness of human inspection. The comparator system alternating the displays of a reference board and the board under inspection, the operator pick out the defect on the board by comparing image of the reference board to the board under inspection. The YesVision can also provide this capability for users who want to do a quick comparison of any boards without recreating a recipe for it.

To use the feature user need to capture a grid image set of the reference board, put a board into the system, load the grid image set into the software then select **Compare Board** from the Image Archive Popup menu. The following dialog will appear to guide the user.
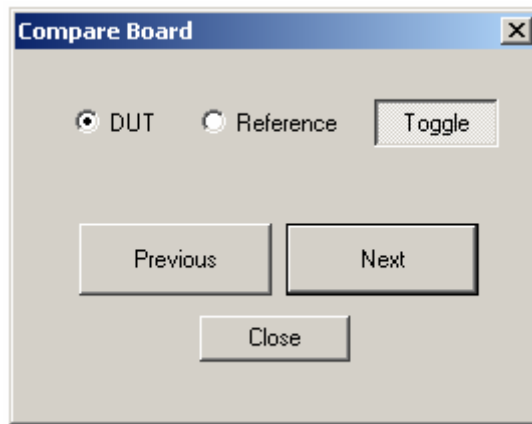
Using the **Previous** and **Next** button user can move across the board. If a defect is spotted on the video window, user can press the right mouse button to pull down a menu, select **Draw Defect** and draw on the video window for the defect location. If a defect is drawn at the end of the inspection a defect report will display.

21.6 Popup Menu for Image Archive

Refresh List- Checks the recipe's folder to ensure newly created Image Sets are listed in this page.

Sort IS List- Sorts the Image Set list in ascending chronological order.

Batch Run RQV Launch a dialog to setup or start the Recipe Quality Validation process.

Offline Review – Starts the offline review process.

Rework Defect- Starts the defect rework process.

Review and Rework Starts the Review and Rework process.

Compare Board Starts the board comparator feature.

Edit Frame Data Launches a dialog on the currently loaded frame.

Setup IS Options.. Launches a dialog to setup the period for auto delete and other Image Set options.
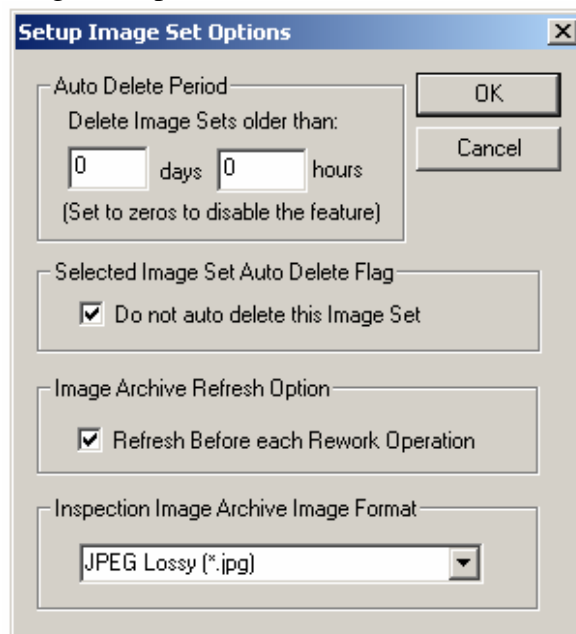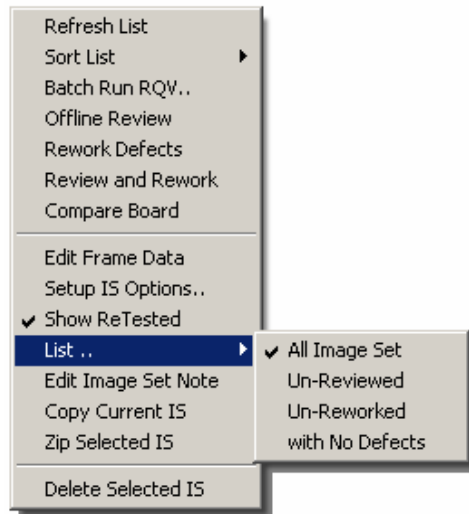
User can also mark selected Image Set to be excluded them from the Auto Delete function. The marked Image Set will not be auto deleted regardless their time of creation. The **Refresh Before each rework Operation** check box if enable will automatically refresh the Image Set list before the starting of each Rework to ensure the list is always up-to-date. The **Inspection Image Archive Image Format** drop down list box selects the image formats for the Image Set save during inspection.

Show ReTested   If the Retest Failed Part option is turned on the software will retest all the parts that failed. The image frame from the original test and the re-test will both be captured. This menu selects which of the frames to display.

List

      All Image Set

          Lists all image sets.

      Un-Reviewed

          Lists only the image set that has not been reviewed.

      Un-Reworked

          Lists only the image set that has not been reworked.

      With No Defects

          Lists only the image set that has been reviewed and has no defects.

Edit Image Set Note

      The **Image Set Note** is a text file that is attached to an image set. Users at the rework station can use it to record information such as any special comments or notes, who performed the rework at what time, etc.

Copy Current IS   It is possible to load an Image Set from a different recipe using the File menu. This menu selection copies the loaded Image Set into the current recipe.

Zip Selected IS   This menu selection launches the following dialog.
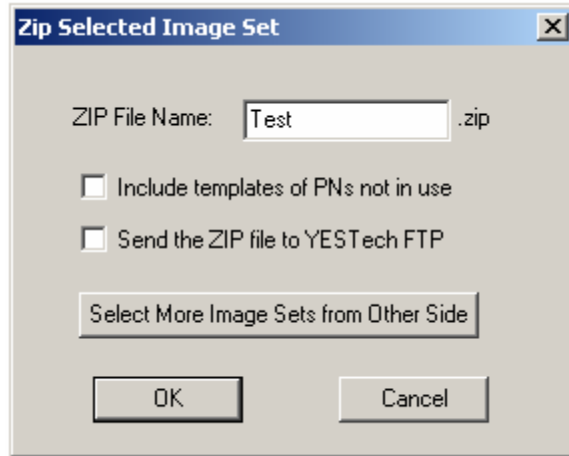
This feature will automatically ZIP up the recipe plus the selected Image Set (or Image Sets) into one single file and place it in C:\Aoi_Data\Zip folder. If **Send the ZIP file to YESTech FTP** is checked the software will also automatically upload the file to YESTech's FTP site. For a double sided recipe sometime users need to zip image sets from both sides onto a single file. The button **Select More Image Sets from Other Side** help user to achieve this.

Delete Selected IS   Deletes one or more selected Image Sets.

21.7 YesIAM

YesTech Image Archive Manager (YesIAM) software is separate software utility that manage image sets and archives for AOI machines. It can be use to delete and/or archive image sets on user specified schedule. Per refer to **YesIAM.doc** in the documents folder on the software installation CD for details of its usage.
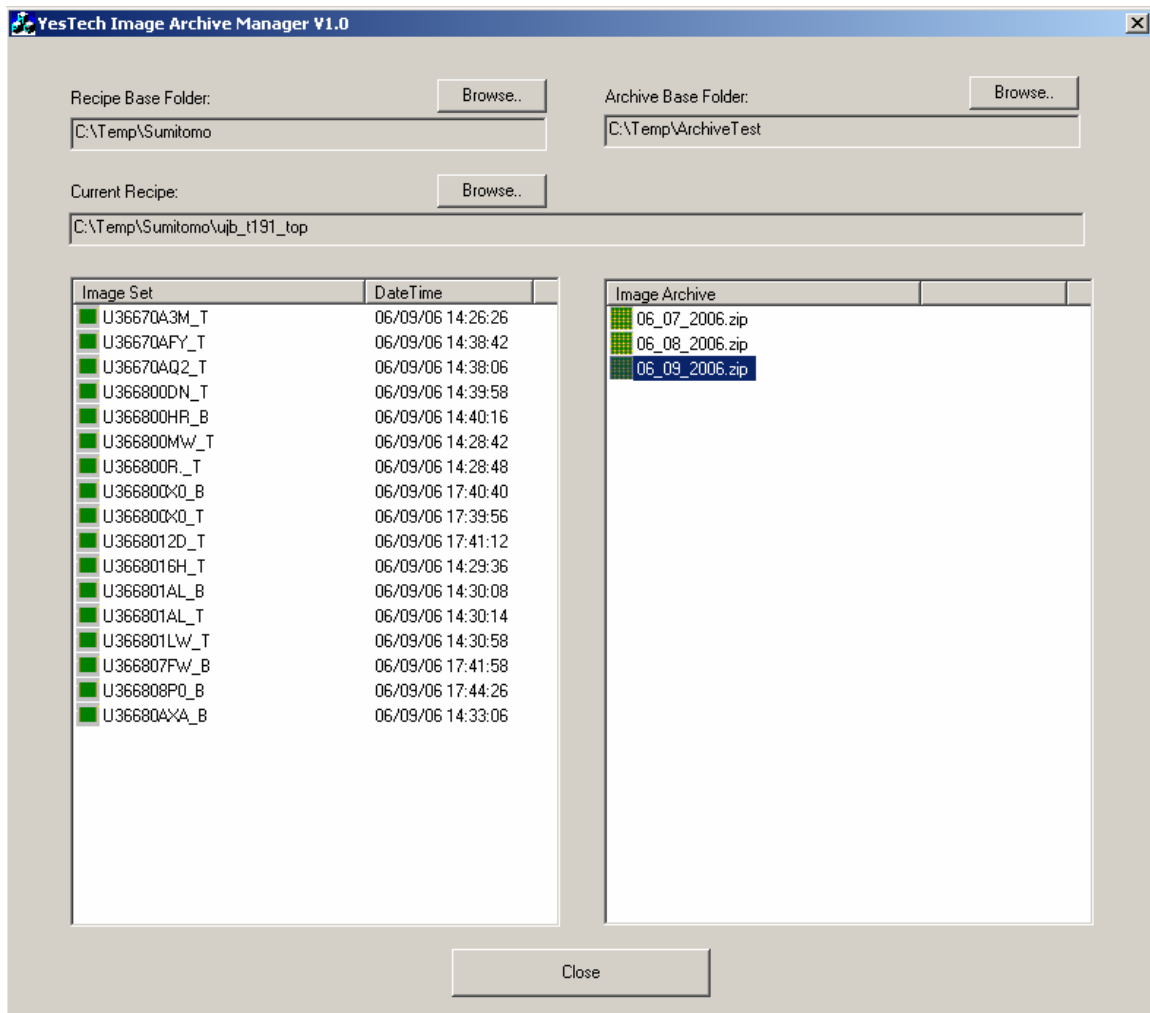
21.8 Recipe Quality Validator (RQV)

The effectiveness of an AOI machine depends heavily on the quality of its inspection recipes. To maintain the effectiveness of the inspection it is a good practice to routinely validate the quality of the inspection recipes, to make sure the defect detection level is acceptable. Some companies achieve this by having a set of boards with known defects on them. They would run the boards at the start of every shift to make sure all the

defects on them are correctly detected before a new batch of the boards are allowed to run through the AOI. This is a very good procedure but require great effort to have it implemented and maintained.

The YesVision software automates this process by using Image Sets. Using Image Set of a defect board is far more convenient than having real defect boards, it also allow the process to be completely automated. To use the feature user need to collect Image Set of boards with real defect, create an Expected Defect List for each board, then run the RQV on them from time to time (e.g. at the start of each shift).

RQV is a complex feature it is just in its infancy stage when version 2.7.0 is first released. It is expected to be further refined in the next several releases. Its setup dialog can be launched by selecting **Batch Run RQV** menu selection from the Image Archive popup menu.
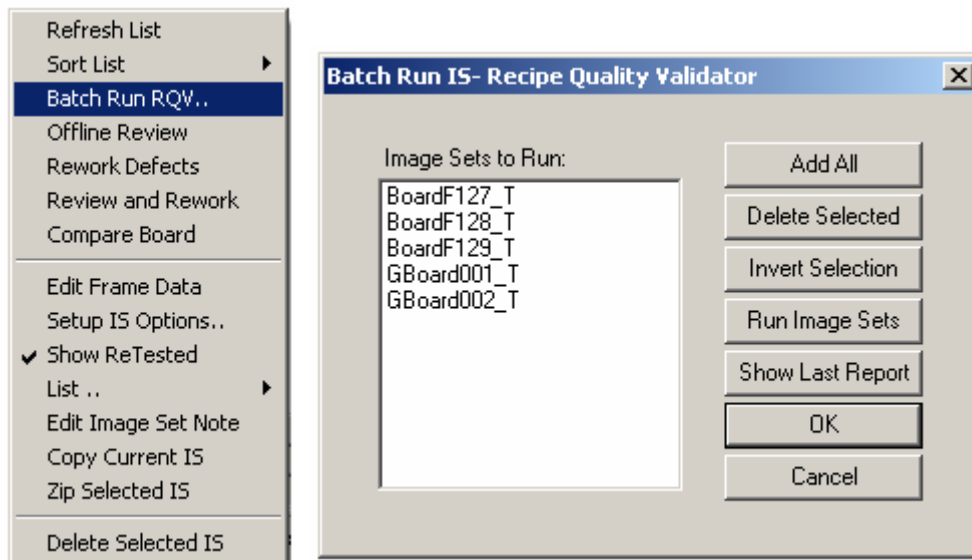
In the Selected Page pop-up menu a sub menu is added to handle the Expected Defect List of the RQV feature.

159
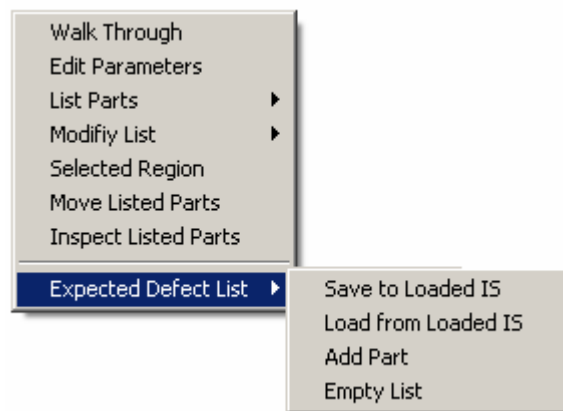
22 Recipe Data Storage

22.1 Folder Structure

By default inspection recipes are stored in the folder **C:\AOI_Data**. In the **AOI_Data** folder there are 4 sub-folders: **CAD_Data, Recipe**, **StdPkg** and **SPC_DataLog.**

The **CAD_Data** folder stores all the YCD files. The **StdPkg** folder stores the three standard package libraries. The **Recipe** folder is more complex since it is the top-level folder for storing all the inspection recipes.

An inspection recipe contains one text file with the extension **.RCP** plus a sub folder. The sub folder contains three part lists and one or two bitmap files. The three part lists are part list, part library and package library; the two bitmap files are the map view background for the top and bottom side of the board. The sub folder also contains two of its own sub folders, **Template** and **Image Set**. The template folder stores all the template files and the Image Set folder stores all the Image Set files (*.IS) and the Image Set sub folders. For recipe ABC.RCP the folder structure would be as follows:

C:\AOI_Data\Recipe
   \ABC.RCP   ;Recipe text files
   \xxxx.RCP   ;Other Recipe text files
…

C:\AOI_Data\Recipe\ABC
   \Settings.pls   ;Top Side part list
   \Settings.plb   ;Bottom Side part list
   \Settings.lib   ;Part Number library
   \Settings.pkg   ;Package library
   \MapBG_Top.bmp   ;Map background for top side
   \MapBG_Bot.bmp   ;Map background for bottom side
   \Template\T000001.tpt **;**A template file
   \Template\T000001.mim ;An image file for the template file
   \Template\Txxxxxx.tpt
   \Template\Txxxxxx.mim

      ..
   \ImageSet\Board-001_T.IS **;**Image Set file for Board-001_T
      \..   **;**Other image set text file
      \Board-001_T*.*   **;**Sub folder for Image Set Board-001_T
      \..
   \Reports\xxx.jpg   ;Electronic defect report
      \..
   \PartImage\xxx.jpg   **;**Part Images

22.2 Data Backup

We recommend that the users of the AOI machine backup the **AOI_Data** folder periodically to prevent data lost in the unlikely event of a computer failure. In addition to the AOI_Data folder the user may also want to backup the folder **C:\Program Files\AOI\INI** folder. This folder contains the calibration information for the machine.

22.2.1 YesBackup

YesBackup is software utility that backup the inspection recipes and software programs and configurations from a YesTech AOI machine. It is provided free of charge to all YesTech's customers. The software "crawl" the folders and backup any new contains.
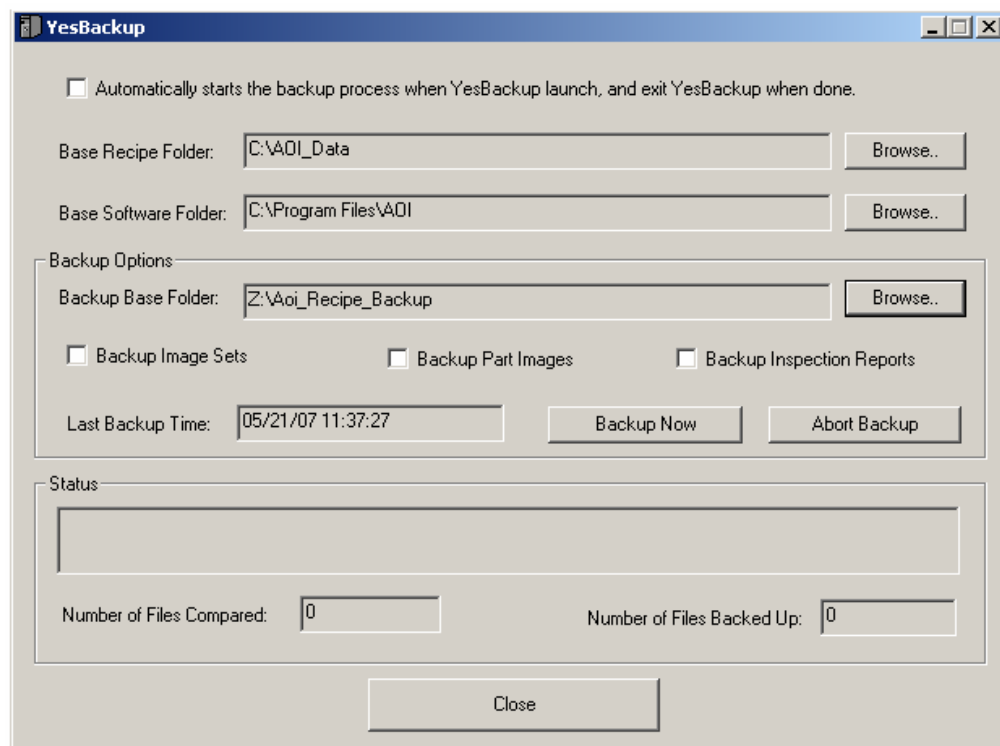
The software user interface is self explanatory. The check mark on the top:

"Automatically starts the backup process when YesBackup launch, and exit when done."

With this check box checked user can use Windows' scheduler to launch this program to perform periodic backup.

22.2.2 Internal Backup Feature

The YesBackup that described in the earlier section is the recommended backup mechanism for all YesVision users. The description for the internal backup feature here is only for the purpose of backward compatibility.

To facilitate the backup activity the software offers a feature to automatically create a backup copy of the recipe at a user specified location most likely on the network. To enable this feature all the user needs to do is open the System Options dialog and specify the folder location to save the backups in. To back up any previously created recipes the user can copy all the contents of the **C:\Aoi_data\Recipe** folder and paste it on the network backup location.

With the Backup Folder specified, every time the software saves the recipe it will save in both locations.
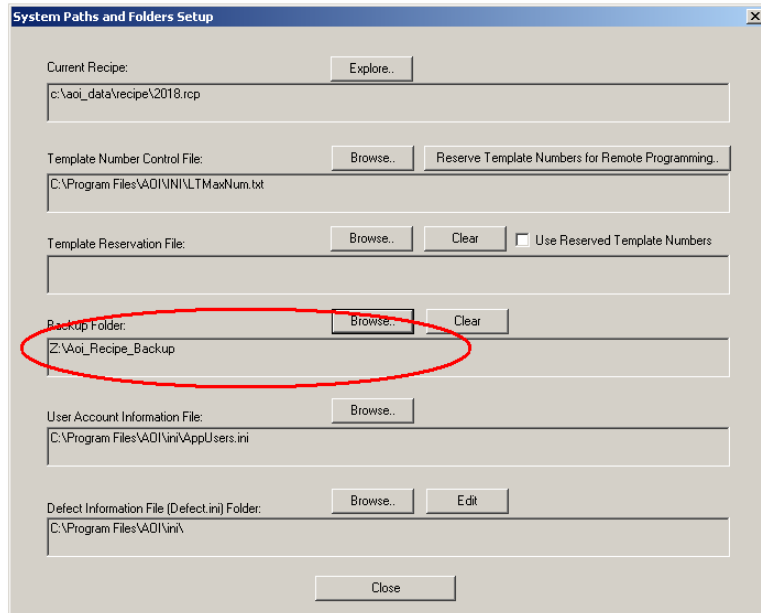
23 Master/Slave Architecture

23.1 Introduction

On AOI systems with multiple computers e.g. YTV-2080 the computers are arranged in a Master/Slave architecture. The computers exchange data and images via a localized network. In normal operation the master computer is the only computer that the user would interact with. Slave computers are "behind the scene" imaging processing engines that work in parallel with the master computer to speed up the inspection tasks. The same YesVision software runs on both the master and the slave computers. A master or slave identity is determined by its configuration.

23.2 Network Configuration

On an YTV-2080 master and slave computers communicate via a local area network. The master computer has two network cards. One for connecting the slaves and the other connects to the outside world. With two network cards the master computer can see both the slaves and the outside network. The slave computers can see only the master and each other. We want the internal work to be isolated with the outside world, and since there is no DHCP server on this network, its TCP/IP configuration is static.

For the internal network it should be setup as following:

Master
IP Address: 10.1.1.1
Sub Net Mask: 255.255.255.248

Slave 1
IP Address: 10.1.1.2
Sub Net Mask: 255.255.255.248

Slave 2
IP Address: 10.1.1.3
Sub Net Mask: 255.255.255.248

Slave 3
IP Address: 10.1.1.4
Sub Net Mask: 255.255.255.248

The configuration for the network card that interfaces with the outside world should be set up according to the network requirement of the user site.

23.3 Software Configuration

During configuration it is necessary to interact with each computer individually. The monitor, keyboard and the mouse ports for all the computers are connected to a 4 port KVM switch. The KVM switch allows the user to interact with any of the computers using the system keyboard, mouse and monitor. To switch to the master computer:

1. Press and release the **Shift-Ctrl-Alt** keys. (The three keys have to be on the same side of the keyboard.)
2. Press and release the number **1** key
3. Press and release the **Enter** key.

To switch to slave number 1:

1. Press and release the **Shift-Ctrl-Alt** keys. (The three keys have to be on the same side of the keyboard.)
2. Press and release the number **2** key
3. Press and release the **Enter** key.
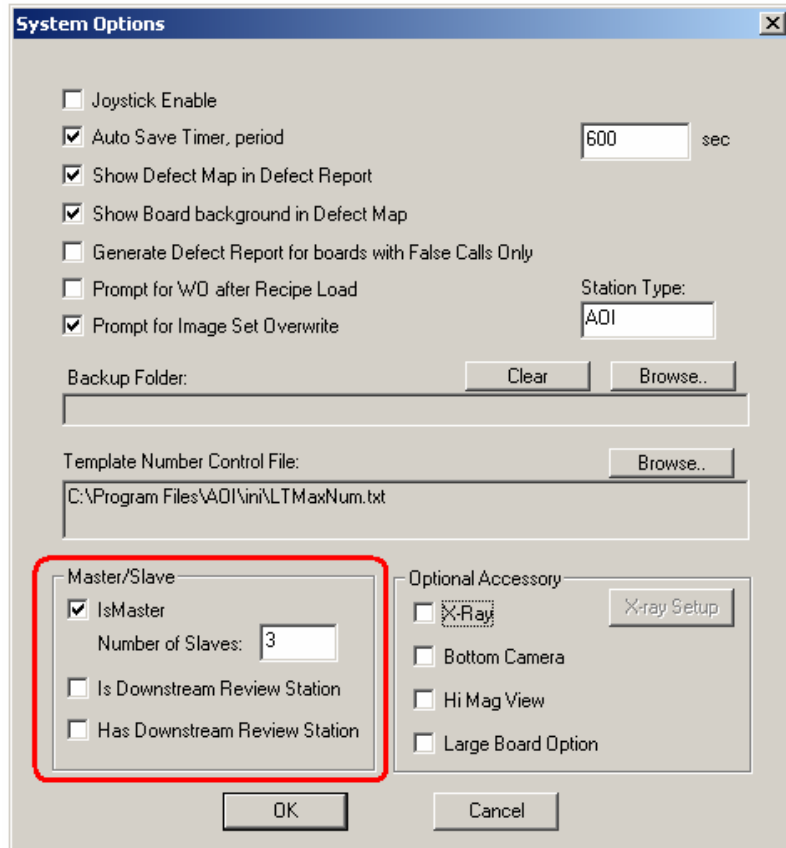
Configuration for the master consists of setting up the total number slaves the master will be communicating with. This can be done via the System Options dialog. The changes made to the master/slave configuration will only take effect after the software restarts.

Configuration for the slave is done using the same dialog. To setup a slave computer, the user should leave both the **IsMaster** and the **Is Downstream Review Station** checkboxes uncheck. Again the changes made to the master/slave configuration will only take effect after the software restarts.

Per the network configuration, the **C:\AOI_DATA** folder on the master computer must be shared to the slaves as **AOI_DATA**. This is because all slaves load the recipe files from the master's **AOI_DATA** folder.

When the YesVision software is in slave configuration, it will try to connect to the master during startup. It will display the following dialog when it is trying to connect to the master.
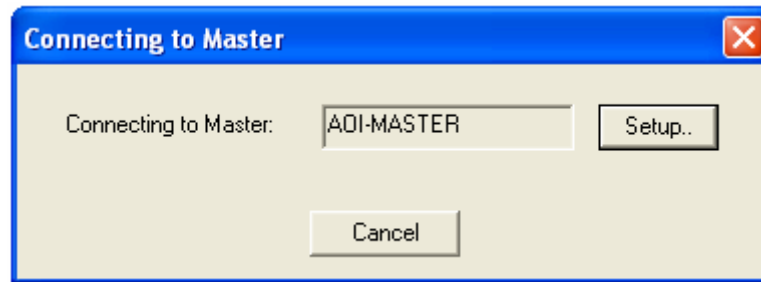
The slave software needs the master computer's network name to connect to it. The Setup button launches the Setup dialog for the user to enter the computer name and Slave ID.
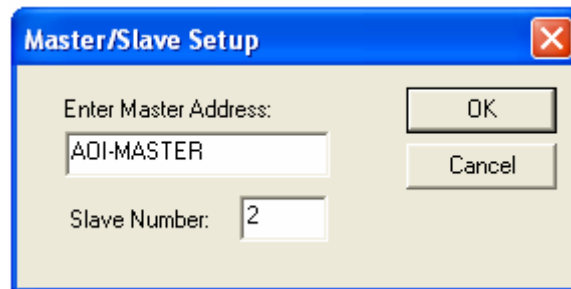
There can be up to 3 slaves numbered 1, 2 and 3. Slave ID 4 is reserved for a downstream review station. The Connecting to Master dialog will disappear automatically after the connection to the master is successfully established.

After configuration additional buttons will appear on the YesVision tool bar of the master computer. These represent the slave camera views. They will be grayed out until the corresponding slave has successfully connected to the master.

23.4 Operations

On a master/slave configuration inspection tasks are divided amongst the master and the slave computers. The division of labor is by no means even. The master does a lot more than a slave. On a YTV-2080 AOI system the master computer controls the following hardware:

- One top camera
- 4 side cameras
- The XY table
- The conveyor
- I/O board (Interlock and the lighting)

On the same system each slave controls only one top camera. Some tasks involve only the master computer. These tasks are:

- Recipe creation including CAD import.
- Recipe and template storage
- Motion control
- I/O control
- Side camera inspection
- SPC data logging
- Entire User Interface

The tasks that the master and slave perform cooperatively are:

- Calibration and Self-Test
- Inspect
- Defect Review

During calibration the slave is involved when calibrating the camera controlled by the slave. Since calibration is not a time-critical operation, during calibration the images captured by the slave cameras are passed to the master via the network for processing. All the image processing and the calculations are done by the master. The slave is like a remote network camera for the master.

Inspection is a time critical operation. During inspection no image is passed from slave to master. Images captured by the slave camera are processed by the slave computer and the inspection results are passed to the master. The master combines the inspection results from all slaves and generates a single report.

Defect review involves the slave because we want the user to review the defect using the same camera that detected the defect in the first place. But since the user interacts with the master computer only, while reviewing defects images from the slave camera are sent via the network to display on the screen of the master computer.

23.5 Inspection Path and Frames

For single computer systems the inspection path is always calculated automatically by the software. For multi-computer systems the user has a choice to run a recipe in single or multi-computer mode. The selection is made in the **Recipe Options** dialog as Utilize Slave Computers.

To run in multi-computer mode, additional efforts are needed to define the inspection frame path. The software provides tools to help the user interactively define the inspection path. To do so select the **Adjust Inspection Frames** item from the **Vision** menu. The **Frame Position Adjust** dialog (shown below) will appear:
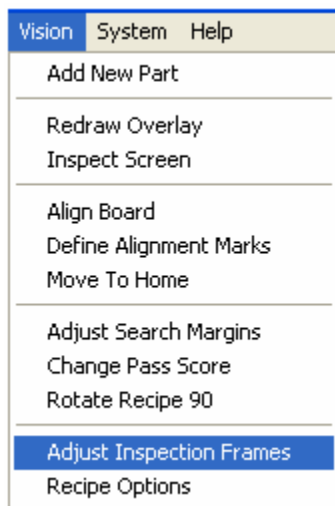
On the **Frame Position Adjust** dialog the **Move** buttons moves one or a group of frames specified by the **Frame #** list box certain distances specified by the **Step Size.**
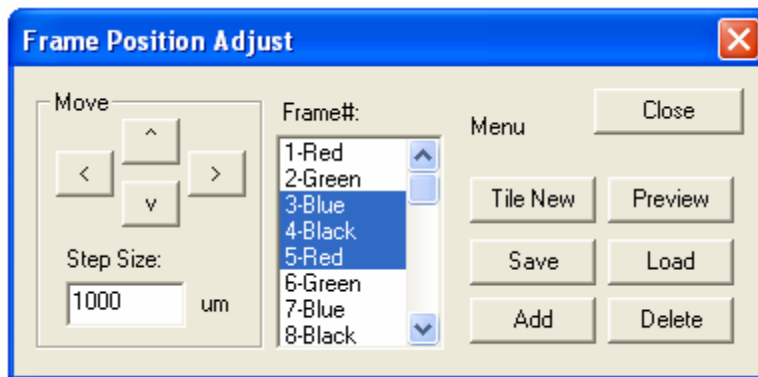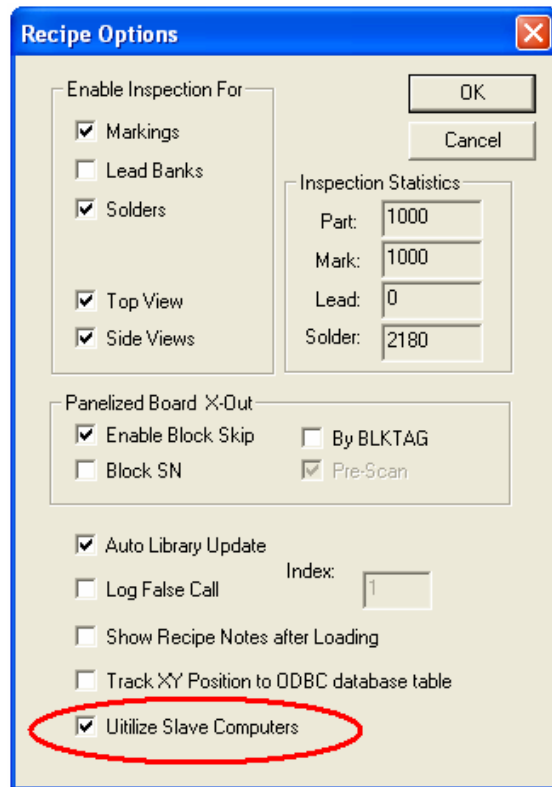
The **Preview** button previews the frame position graphically. The **Save** and **Load** buttons save and load the frame position to and from the **FramePresetTop.txt** or FramePresetBottom.txt files located in the recipe folder.

The **Add** button adds a frame and the **Delete** button deletes the specified frame (highlighted in the Frame# list box).

The **Tile New** button creates a new set of frame positions. It will display a prompt dialog shown to the right.

On the 2080 because of the relative position of the 4 cameras, each frame will look like the following with each square representing the field of view of one camera.
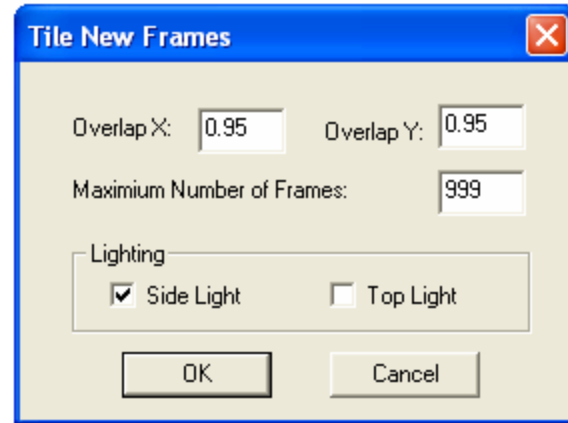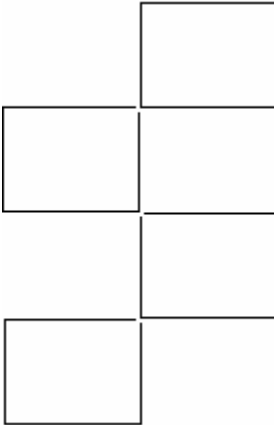
The Frame Position Adjust dialog will stay on top of the preview screen. So it is possible to make the adjustment interactively using the preview screen to provide immediate feedback:
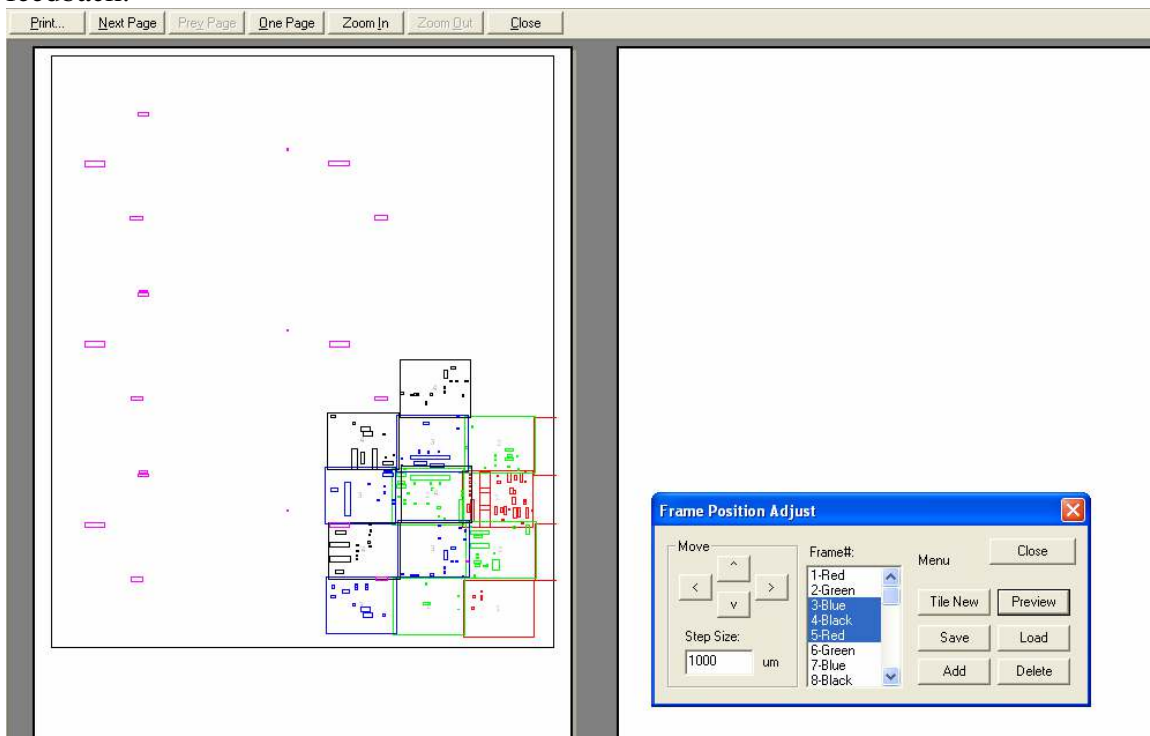
If a box is colored purple, it means that the inspection box is not included in any of the frame area. The objective of the frame adjustment is to use a minimum number frames which include all the inspection boxes.

The size of the inspection boxes has a big effect on the efficiency of the inspection frame. To have high inspection speeds the user should avoid larger inspection boxes. Breaking up long lead banks into several segments and breaking up long markings into smaller marks will increase frame efficiency and therefore increase the inspection speed.

There is a pop up menu on the **Frame Position Adjust** dialog that will appear by pointing the mouse inside the dialog and right clicking.
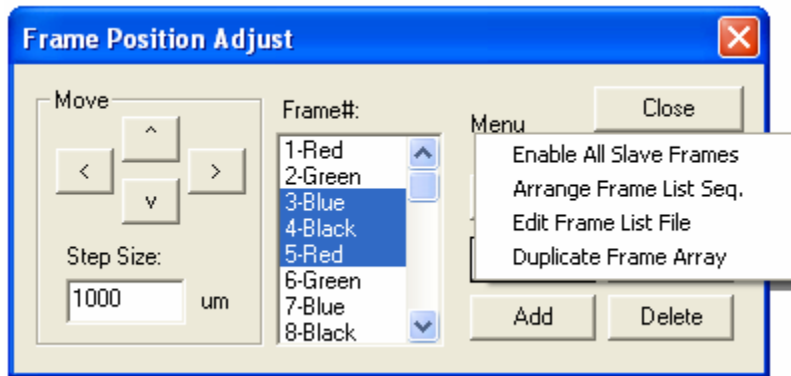
There are 4 selections in the menu:

Enable All Slave Frames   -Enables all slave frames for inspection.

Arrange Frame List Seq.   -Automatically re-arranges the frame list sequence to minimize the inspection travel distance.

Edit Frame List File   -Opens NotePad.exe to manually edit the frame list file.

Duplicate Frame Array   -Copy and Paste a group of frames. This is used in programming multi-panel boards. The following dialog will display:
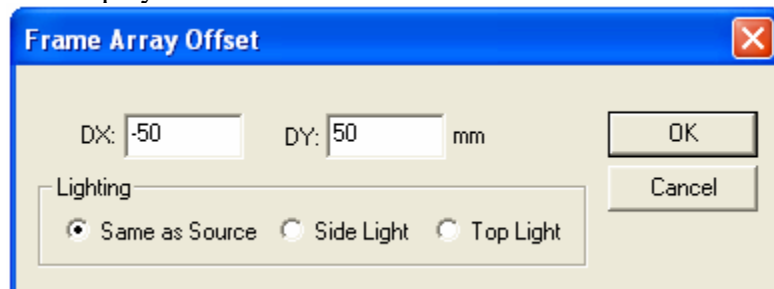
The frame list text files (**FramePresetTop.txt and FramePresetBottom.txt**) have the following format:

Frame Number	-The Frame Number ranging from 1 to the total number of frames listed in the sequence of the inspection.
Lighting setting	-1 for side light, 2 for top light
X Position	-X Position in microns
Y Position	-Y Position in microns
Slave 1 Enable	-1 for Enabled, 0 for Disabled
Slave 2 Enable	-1 for Enabled, 0 for Disabled
Slave 3 Enable	-1 for Enabled, 0 for Disabled

The user can use any text editor to edit the file and fine-tune the frame parameters. Here is a sample of the frame list file.

```
[StartFramePreset]
1 1 220000 19000 0 1 0
2 1 189193 15128 1 1 0
3 1 159172 19128 0 1 0
4 1 126000 19128 1 1 0
5 1 93500 20000 1 1 0
6 1 62800 21100 1 1 0
7 1 36500 17500 1 1 0
8 1 32500 33500 1 0 0
9 1 44500 48500 0 0 0
10 1 218000 91000 0 1 0
11 1 181000 90100 1 1 0
12 1 152172 86328 1 1 0
13 1 121097 83628 1 1 0
14 1 126097 93628 1 0 0
15 1 89443.8 87000 1 1 0
16 1 61552.7 94000 1 1 0
17 1 65552.7 119000 1 0 0
18 2 65552.7 119000 1 0 0
19 2 218000 91000 0 1 0
20 2 180750 90100 1 1 0
21 2 152172 86328 1 1 0
22 2 126097 93628 1 0 0
23 2 122597 83628 1 1 0
24 2 90443.8 87000 1 0 0
25 2 61552.7 91000 1 1 0
26 2 50500 48500 1 1 0
27 2 220500 19500 0 1 0
28 2 187193 15128 1 1 0
29 2 159172 19128 1 1 0
30 2 126000 19128 1 1 0
31 2 93500 20000 1 1 0
32 2 63300 16100 1 1 0
33 2 33000 33500 0 0 0
34 2 34500 16500 1 1 0
[EndFramePreset]
```

24 Customer Support

YesTech is committed to providing excellent customer support after the product is sold. In addition to phone support and visits, we also utilize Internet Technology to help us keep better contact with our customers.

24.1 Automated Software Upgrade

YesTech AOI machines can upgrade to the newest software revisions automatically via the Internet. To use this feature the user can select **About YesVision** from the **Help** menu. The following dialog will display.
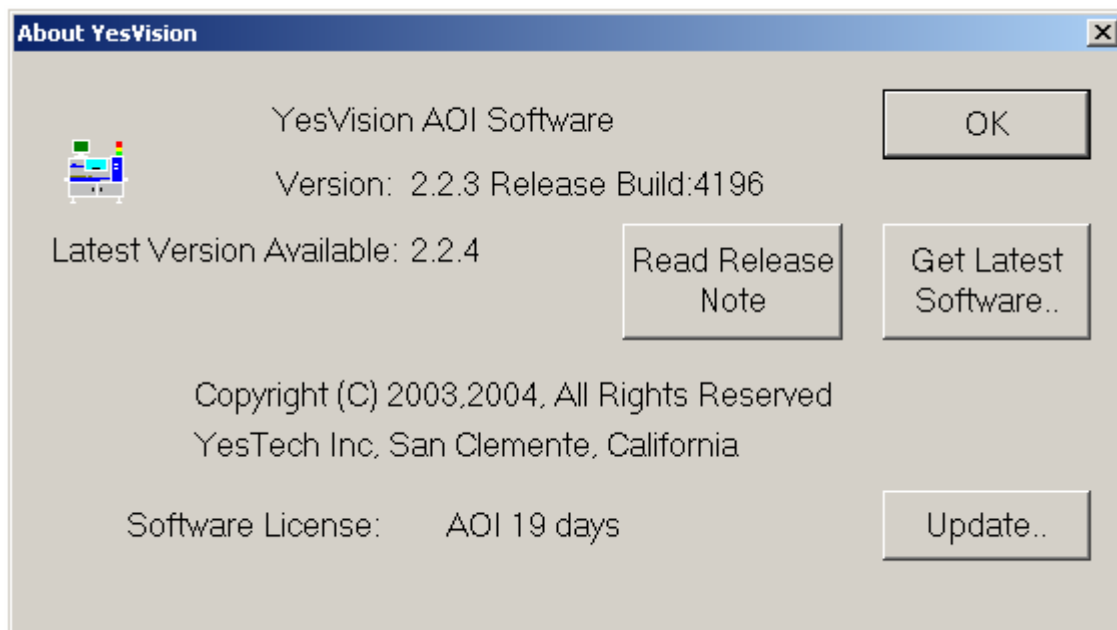
During the initial launch of this dialog the software searches the Web for the latest version of the YesVision software. If the latest version is higher than the current version the two buttons **Read Release Note** and **Get Latest Software** would be enabled. The **Read Release Note** button retrieves the latest release note from the Web and displays it. It is always a good idea to read the release note before upgrading the software. If the user decides to upgrade, pressing the **Get Latest Software** button will launch the upgrade wizard. It will guide the user through the steps of upgrading the YesVision software. The following is a screen shot of the Upgrade Wizard Software.
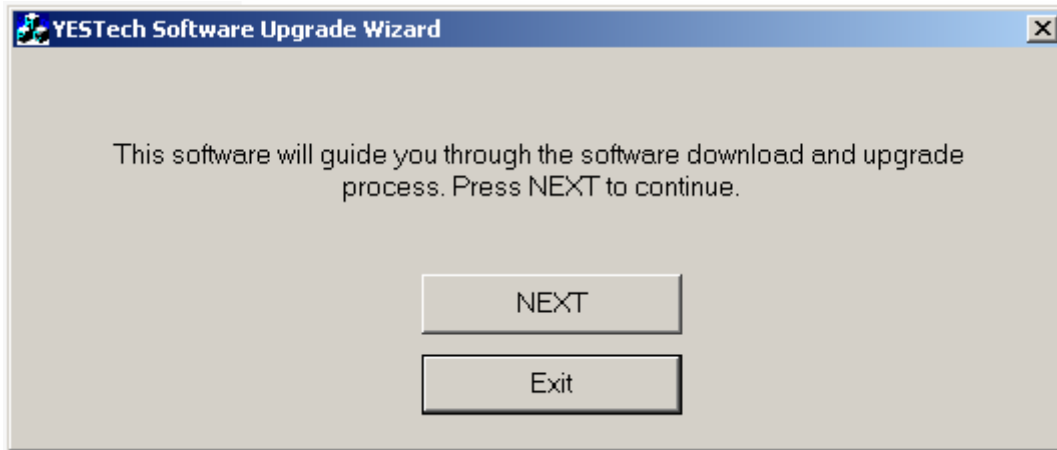
The Upgrade Wizard will always rename the old executable before downloading the newest executable from the web. This allows users to roll-back to a previous version in case the new version is not satisfactory.

24.2 FTP Site

In addition to the automatic software upgrade, an FTP site is setup to exchange information with the customers. The address of the FTP site is:

Address: **ftp://update.yestechinc.com**
User Name: **dev03**
Password: **sea07**

Note: The user name and password may change without notice. Contact YesTech for the current user name and password.

24.3 WebEx

WebEx is the leading web conference service provider. YesTech uses WebEx service to provided world class technical support service to its customers. WebEx allows tech-support experts at YesTech's main office or any regional offices to remotely control the customer's AOI machines via the Internet. It is like having an AOI expert in front of the machine. This feature is especially useful in situations where details or lengthy instructions are required to reproduce or resolve the problems. To use this feature the machine's computer must have Internet access.

Typically a customer who has a problem or a question on the AOI machine will first call YesTech for tech-support. Base on the nature of problem, the tech-support expert at YesTech may suggest the use of WebEx and provides a "meeting number" to the customer. At this point, the customer needs to go to the web address **http://yestechinc.webex.com** and entering the meeting number. The customer can

also go to the web address by selecting **WebEx YesTech** from YesVision's **Help** menu.
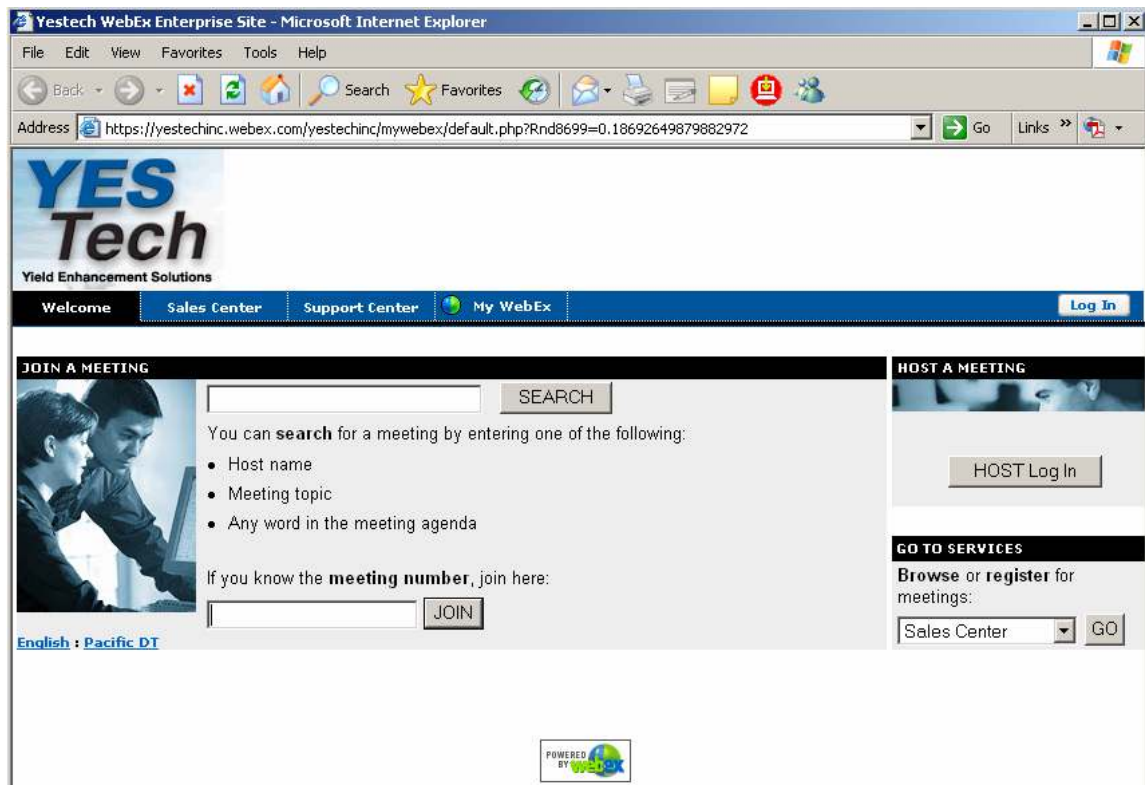
24.4 Remote Assistance

In addition to WebEx YesVision™ software also integrates with the "**Remote Assistance**" feature of Windows XP to provide customer support. Remote Assistance provides the same service as WebEx. Compare to WebEx it is more difficult for customer to setup and use, and have more limitations.

24.5 MS Messenger Service

To get **Remote Assistance** the user needs to sign up with the MS Messenger Service. A special account is setup for the user who may need remote assistance. It is:

User Name: **HappyUser123@hotmail.com**
Password: **yestech**

Another account is for the tech-support experts at Yes Tech:

User Name: **HappyAssistant@hotmail.com**
Password: **yestech**

Before the computer can be remotely controlled the user must first sign up with the MS Messenger Service. Here are the steps:

1. Click on the MS Messenger Icon on the lower right right hand corner of the screen.

2. Click the **Next** button and the following screen will appear.
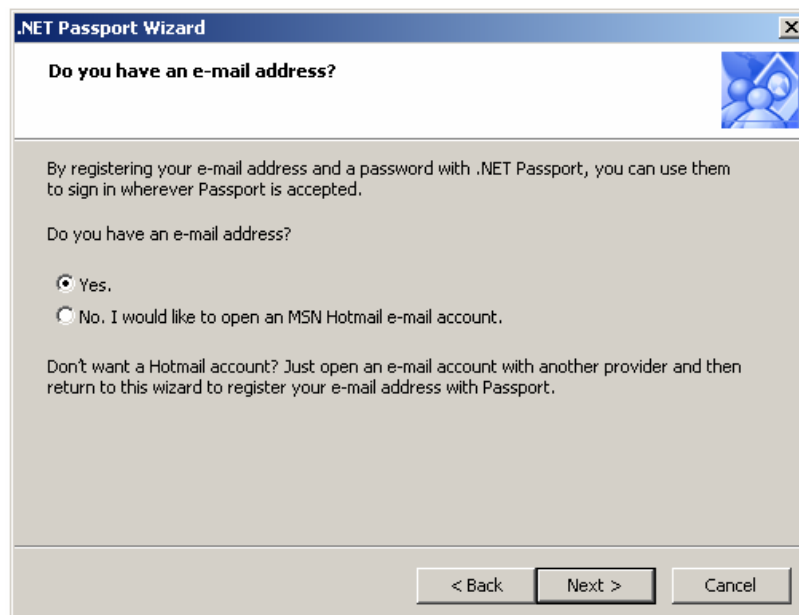
3. Select **Yes** and then the **Next** button.
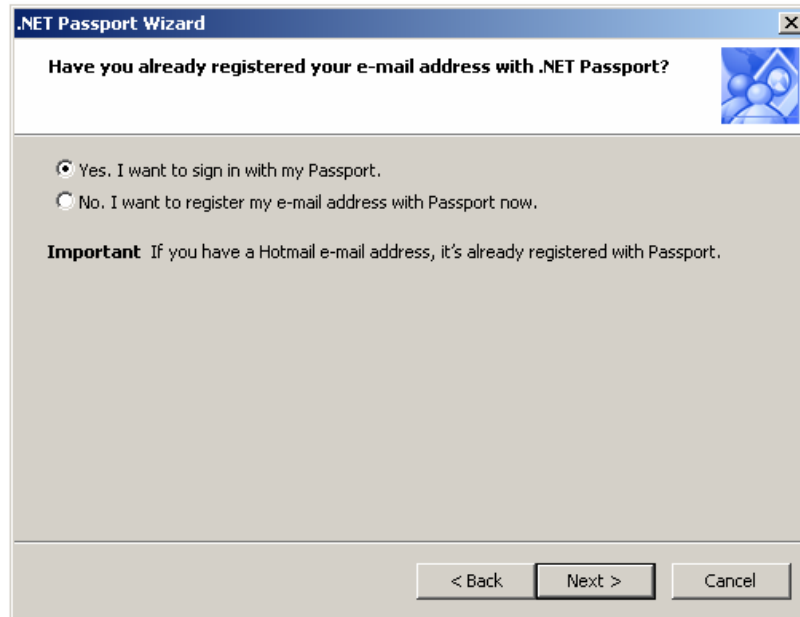
4. Select "Yes. I want to sign in with my Passport."
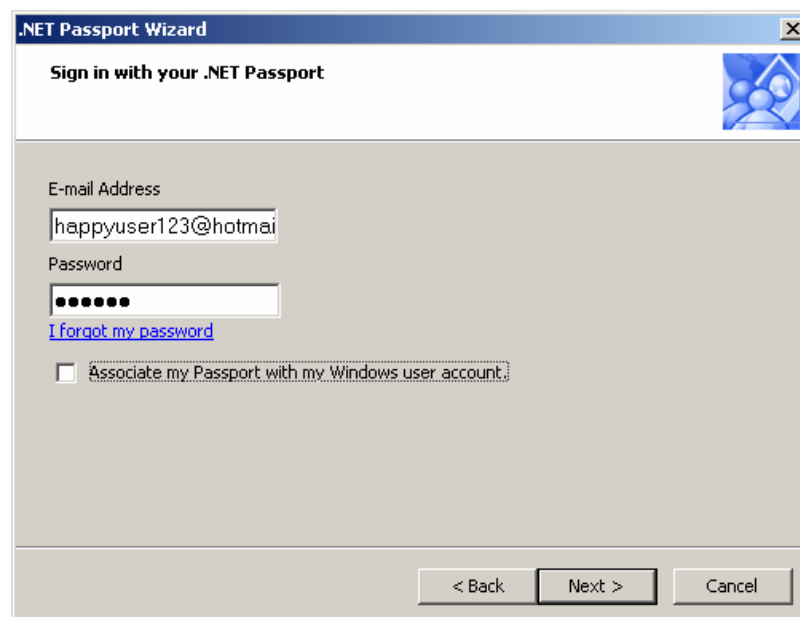
5. Because the happyuser123 account is shared between all YesTech customers, the user should leave "**Associate my Passport with my Windows user account**" UNCHECKED. After pressing the Next button the following screen will appear.

6. After pressing Finish, click on the MS Messenger icon on the bottom right corner of the screen again. Click "Click here to sign in." On the sign in screen it is important **NOT** to select "Sign me in automatically"; because the above account is for all the YesTech customers. Customers should sign in only when they need help from a YesTech tech support expert.
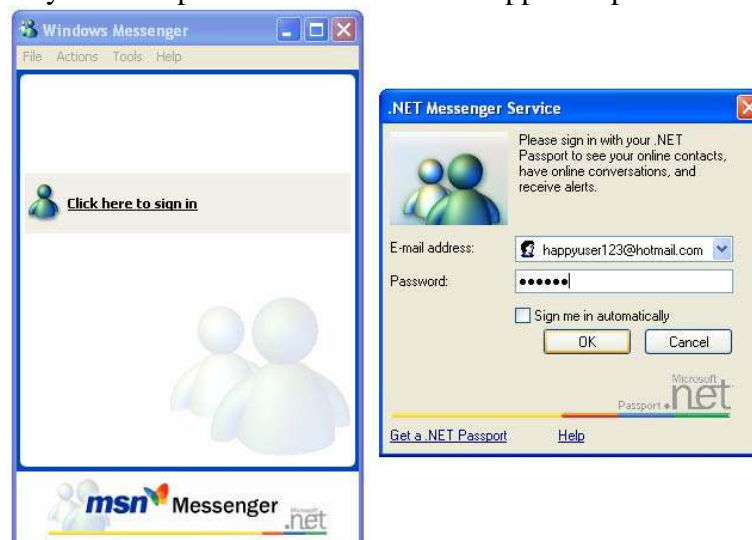
7. After pressing **OK** on the .NET Messenger Service dialog the user needs to add a contact to its contact list.

8. After pressing **Next** on the **Add a Contact** dialog the following screen will display:
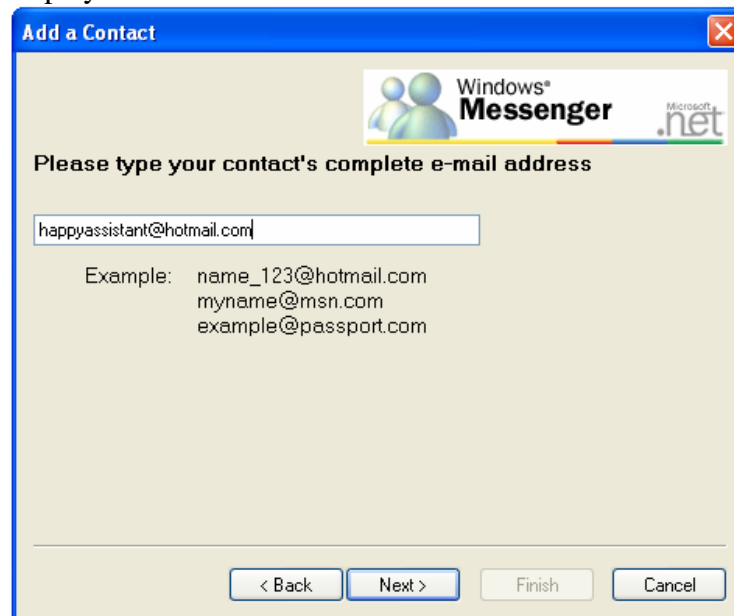
9. Enter **happyAssistant@hotmail.com** as the contact then press **Next** then **Finish.**

24.6 Requesting Remote Assistance

Before initiating Remote Assistance the user should call YesTech so that the tech support expert can prepare for the help session. Moreover, it is better to have simultaneous voice and computer communication during the help session. So please call YesTech tech support while you are in front of the system computer.

Remote Assistance can be initiated by selecting **Remote Assistance…** from the **Help** menu of the YesVision™ software. It is also possible to initiate the **Remote Assistance** from the Windows XP Start menu. Either way will lead to the **Help and Support Center** screen.
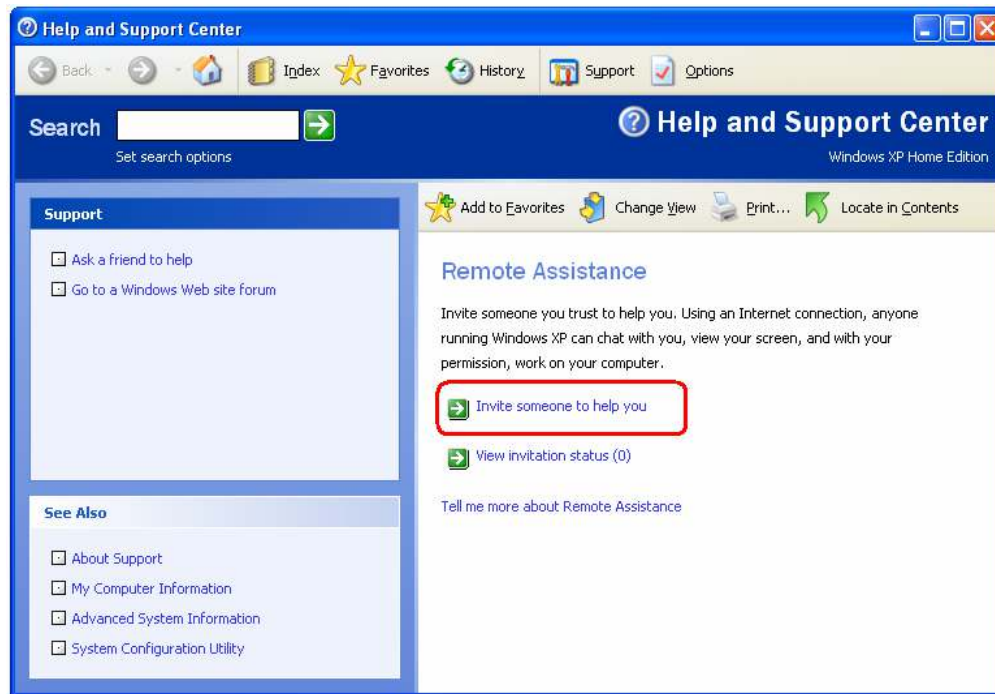
From this screen the user should select "**Invite someone to help you**". After the selection, the following screen will appear.
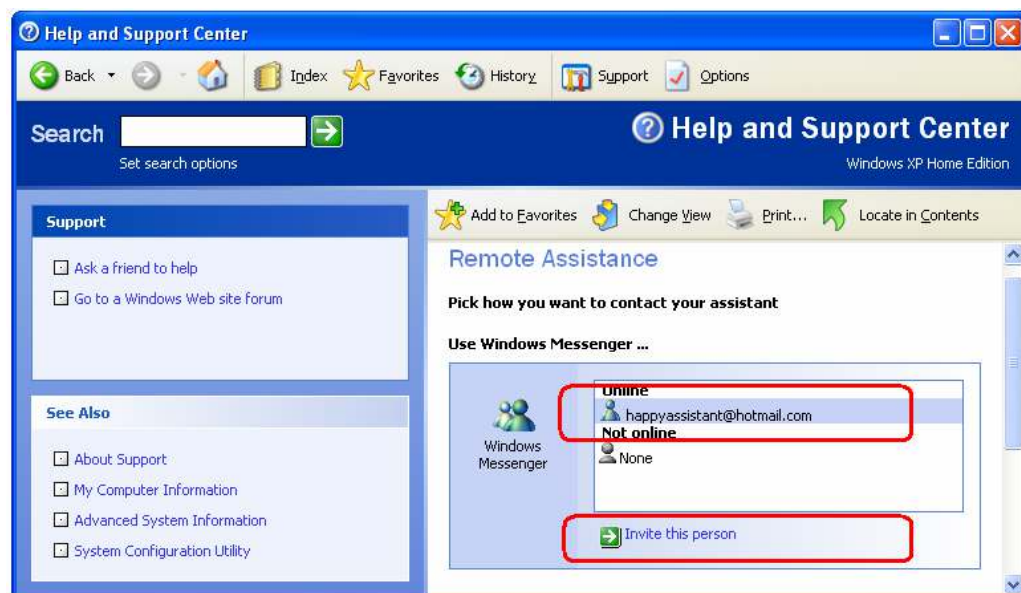
Select **happyassistant@hotmail.com**, and then click on **Invite this person.** At this point an invitation is sent over the Internet to the YesTech tech support desk. Before tech support responds the following dialog will be shown.
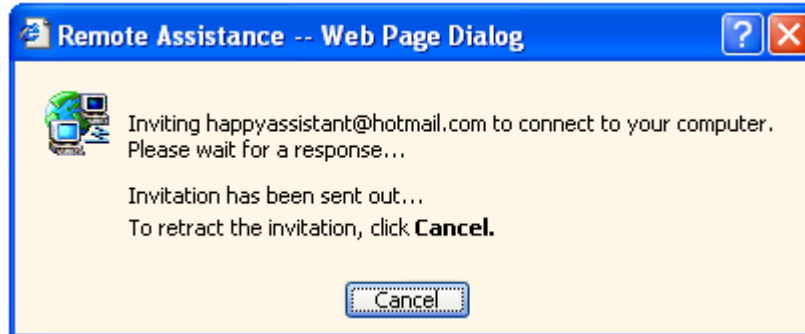
After tech support accepts the invitation the user will get the following acknowledgement message.
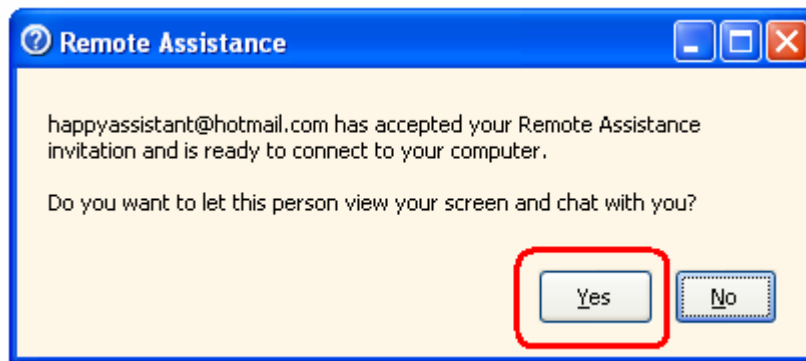
The user should press **Yes** to allow the two way communication. Eventually tech support will want to remotely control the user system. When this happens the user will see the following request prompt.
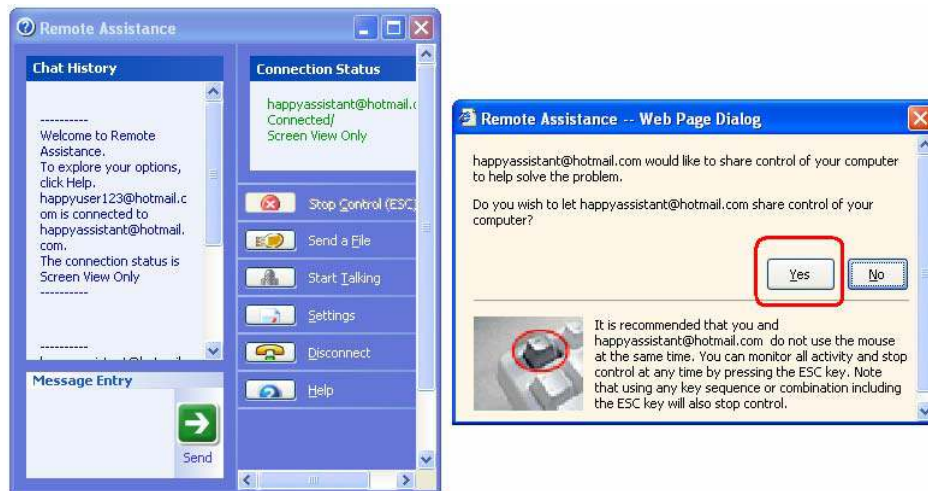
The user should press **Yes** to allow the remote control.

The same **Remote Assistance** feature can also be a useful tool internally for the company. For example a line operator sees a possible defect and wants to consult with a QA manager in the office. Remote Assistance would be the idea tool for the situation, because it allows the QA manager to see the same computer screen that the operator is looking at. This is assuming the QA manager's computer is also running Windows XP. When using the feature for internal support please create separate User and Assistant accounts. Please do NOT use the YesTech accounts for internal support.

25 Hard Disk Crash Recovery

If you've used computers long enough, you may have experienced the disastrous situation of a hard disk crash. A situation when the computer could not boot up at all and you lost all your data on it. Computer viruses can cause a hard disk to die, as well as improper installation of a software program such as computer games. And of course any hard disk is susceptible to physical damage as well.

Rather than praying for good luck users should prepare for the worse case scenario. Yes Tech's machines are "imaged" using the **Disk Image** Utility from **PowerQuest** Corporation before it leaves the factory. The disk images are stored on the computer's hard disk in a Backup partition. The disk image (*.pqi) is spilt into 640Mbytes chunks to allow backup to CD-Rs. Users are highly encouraged to copy those files to other media for safe keeping.

There are two floppy disks labeled "Hard Disk Recovery" which are shipped with each system. The floppy can be used to boot up the system and restore the hard disk data in an event of a hard disk crash. This should be considered as last resort when other recovery methods have failed [e.g. Windows XP's recovery console]. The

program on the floppy disk also allows the user to make backup disk images of the current state of the computer.

26 Calibration and Verification

The software provides a comprehensive set of guided calibration procedures. Each procedure is prompted by a dialog message that gives the instructions for the adjustment and lists the current and the target values.

All the calibration procedures are launched from the **Calibrate** menu in the **Builder mode**.

The specialized calibration board (P/N 10665) is required for all calibrations and verifications. The board must be properly aligned before any calibration begins. The first item on the calibrate menu "Align Calibration Board" is the procedure that guides the user through aligning the board in the system. Upon starting the procedure the software will open the conveyor to the width of the calibration board (approximately 559 mm wide). The user may need to do some minor adjustment (1 or 2 mm) to the conveyor width for the calibration board to fit in. After the conveyor is opened to the correct width the user can place the calibration board on the conveyor from the left opening, manually push the board towards the center of the machine. Then, open the front door of the machine, reach in with your hand and pull the calibration further to the right so that it is over the hard stops. The right edge of the calibration should align approximately with the right limit sensor of the X axis.

26.1 Calibrate XY Skew

This calibration adjusts the perpendicularity of the XY stage. The calibration involves removing the top and side cover and the use of a special adjustment jig. This is a one time adjustment. The procedure is performed in the factory as part of the standard calibration procedure.

26.2 Align Conveyor Rail

This calibration aligns the conveyor rail with the X axis. The software moves between two points along the X axis, one on the left and the other on the right.

26.3 Calibrate Stage Linear Comp

The YesVision™ software compensates for mechanical imperfections of the XY camera transport mechanism. The software employs three scaling factors for compensation: X, Y, and Skew. The X factor compensates for any linear error on the X axis that may be caused by inaccuracies of the X leadscrew. The Y factor compensates for linear error on the Y axis and the skew factor compensates for imperfect XY orthogonality. This calibration calibrates these 3 compensation factors.

26.4 Error Map XY Stage

To compensate for non-linear distortion of the XY stage, the software extends the error compensation features to include error mapping. The linear error compensation mentioned earlier uses 3 scale factors to compensate for linear errors commonly found on an XY stage. Error mapping compensates for all remaining errors by mapping it. Typically, error mapping, when performed correctly can increase stage accuracy by a factor of three.

Error mapping employs a grid (for example 27 x 24) of error correction factors. It maps the distortion of the positioning system. The error correction of any given point is determined by using a piece-wise linear formula with the data from the 3 closest correction factors.

26.5 Calibrate Camera Angle

This calibration calibrates the angle of the top camera to have it aligned with the X axis. During the procedure the stage moves left and right to have the target cross on the calibration board appear on the left and then right side of the field of view. If the camera angle is correct the video cross hair should align with the target cross in both positions. To adjust for camera angle, loosen the three small mounting screws (5/64 button head) that hold the camera PCB to the mounting bar and rotate the camera PCB.

26.6 Calibrate Camera Pixel Size

This procedure calibrates the pixel size of the top camera. The XY stage encoder is used as a ruler. The pixel size is determined using the following formula:

$$\text{Pixel Size in um} \quad = \quad \frac{\text{Stage movement delta in um}}{\text{Pixel delta in count}}$$

To adjust the camera pixel size we raise or lower the camera. We do so by putting washers in the camera mount. Raising the camera increases the pixel size.

26.7 Calibrate Camera Offset

For systems with multiple cameras, it is important when switching cameras that the field of view remains the same. This is why camera offset needs to be calibrated. The procedure cycles through all camera views and asks the user to align their center with the same cross hair on the calibration board.

26.8 Set Lens Focus

The area on the calibration board with a dense pattern of vertical lines is for the software to determine camera focus. The software determines the best focus based on image contrast. To assist the user in adjusting the focus the software produces a

"focus quality number." The larger the focus numbers the better the focus. The User should adjust the focus ring of the camera to achieve maximum reading.

26.9 Calibrate Light Uniformity

A uniform gray area on the calibration board is for calibrating light uniformity. The test is currently used to calibrate the brightness of the top light (red LED light). A trim potentiometer on the top light PCB is for controlling the top light brightness.

26.10 Planarize Conveyor

The conveyor that holds the circuit boards for inspection needs to be planarized so that any spot on the board is the same distance to the camera as any other spot on the board.. Perfect planarization is extremely important for side view inspection.

26.11 Calibrate Dewarp Params

Images captured by the side angle camera have distortion due to the viewing perspective. The YesVision software compensates for the distortion by warping the images. This calibration step calibrates the parameters for the warping operation. Before starting the calibration move the stage to the middle of the calibration board so that the camera is viewing the small grid pattern. Warping is used only in side angle camera, therefore the user should switch to a side angle camera before selecting **Calibrate Dewarp Params** from the **Calibrate** menu.
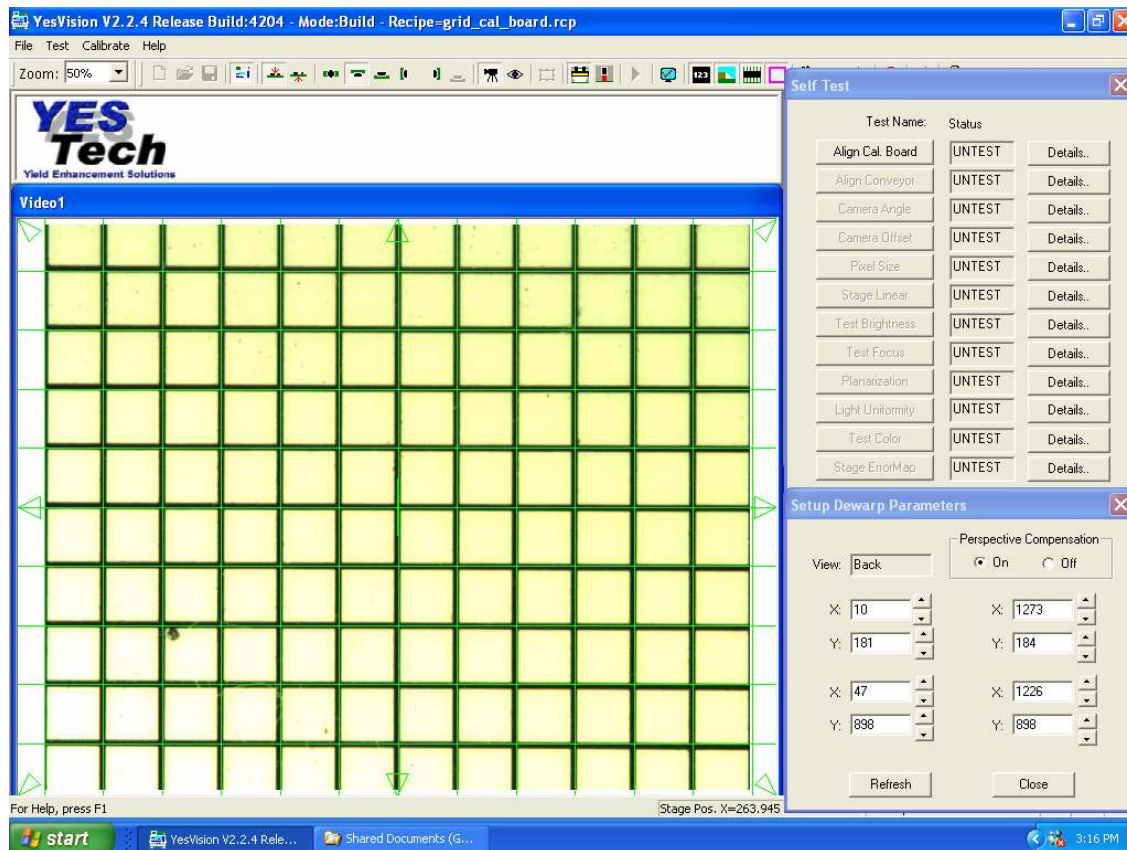
On the **Setup Dewarp Parameters** dialog users can toggle the **On** and **Off** button to see the effect of the compensation. With the compensation turned on the 4 pairs of XY coordinates define the compensation value for the 4 corners of the image. Users need to adjust their value so that the image grid is lined up exactly with the overlay green grid. After making any adjustments to those XY values, the user needs to press the **Refresh** button to have changes applied to the image.

The procedure needs to be repeated for each of the four side angle cameras.

26.12 Calibrate Fusion Lighting

The light intensity of each LED segment on a Fusion Lighting needs to be calibrated in order to maintain machine to machine recipe transferability. We control the intensity of the LED light by controlling its driving current. The white LED segments are factory set to 90 mA. The **F1 Top** intensity is adjusted in the Light Uniformity calibration process. In this calibration process the rest of the LEDs segment's current are adjusted to produce the correct color balance on the video image.

To starts the calibration process, put the calibration board in the machine, move the camera so that a white square is in the middle of the field of view. From the Video View's popup menu selection **Setup** to launch the **Video Parameters** dialog, then press **Fusion Light** button to launch the **Fusion Light Setup** dialog.
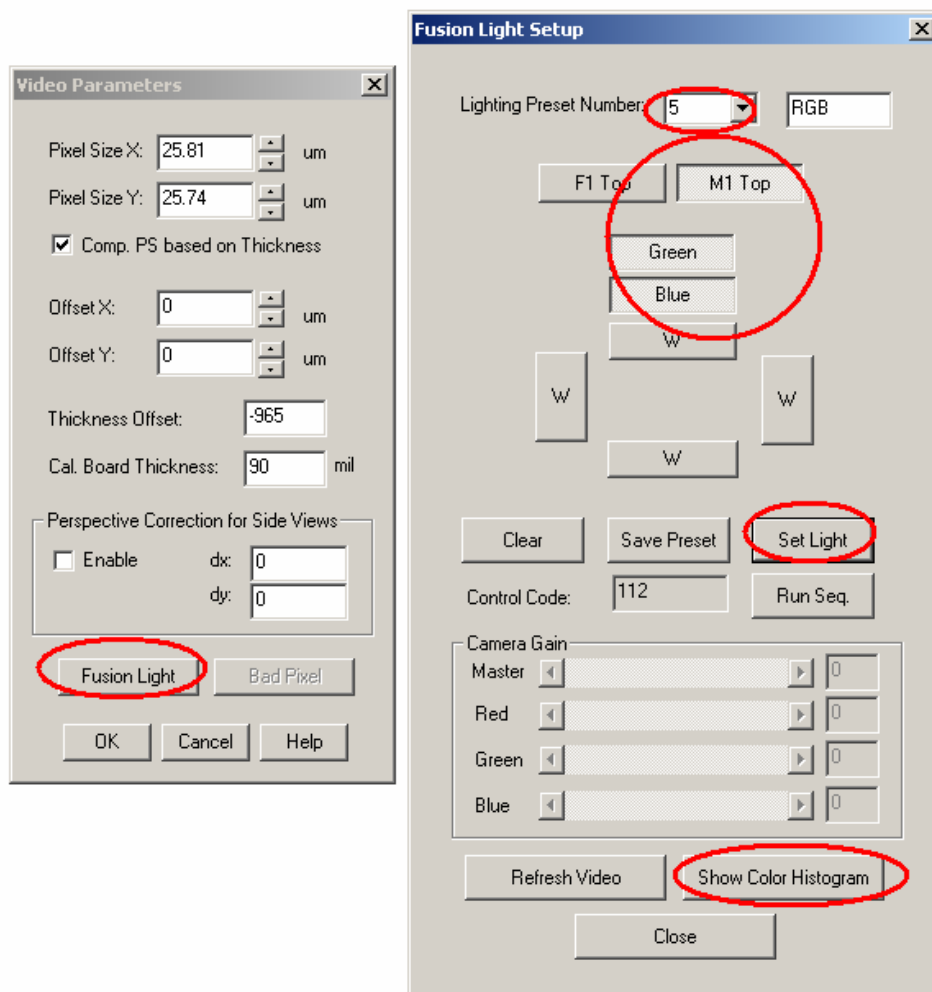
On the **Fusion Light Setup** dialog, select light preset 5 the RGB light, then press **Set Light** button to set the light. Press **Show Color Histogram** button to display the color histogram window.

Close the **Fusion Light Setup** and **Video Parameters** dialogs, then switch to Live view on the video window. Adjust the ROI handles so that the selection box is just within one blank box on the calibration box as shown below. Adjust the appropriate potentiometers on the Fusion Light control board (shown below) while observing the changes on the histogram display to achieve specified peak location for red, green and blue.

Fusion Light Control Board
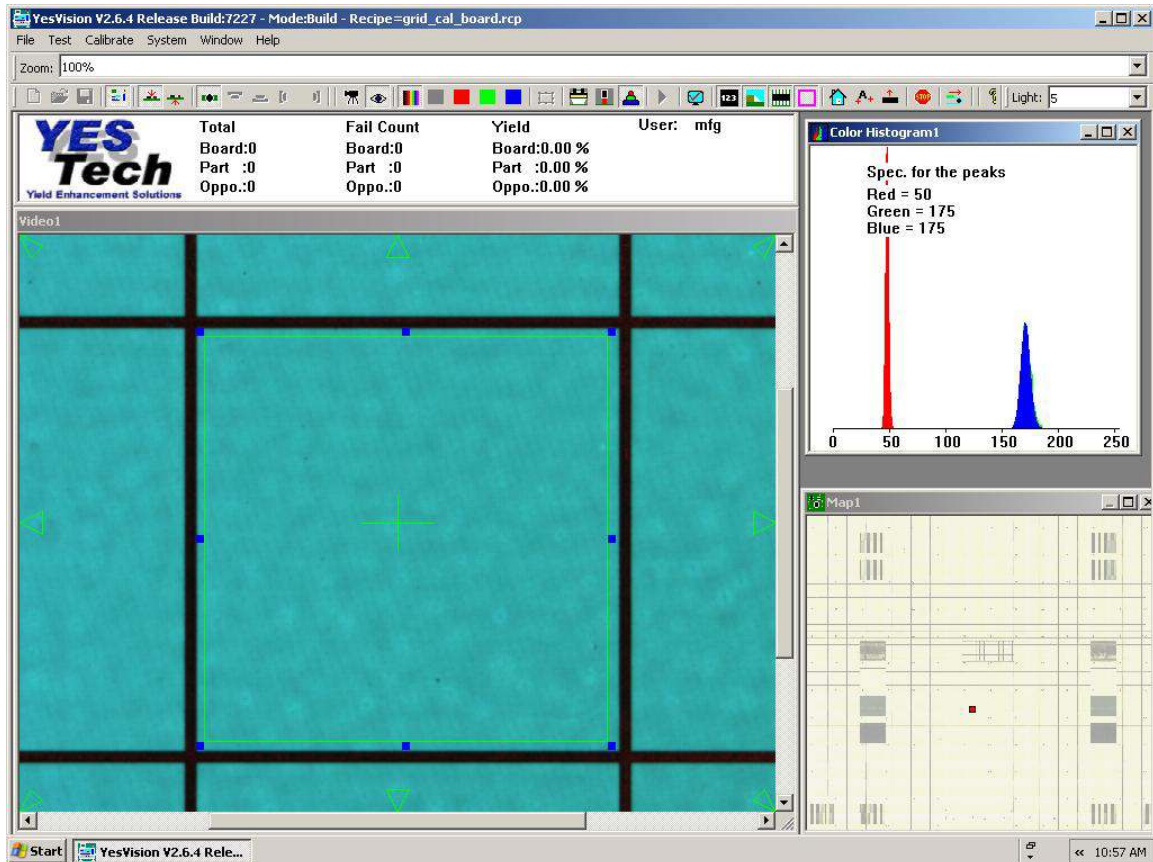
26.13 Self Test

The software provides a comprehensive set of self-testing features that automatically verifies all the essential calibration parameters. The self-test determines the current values of the calibration items then compare them with the corresponding specification values in the **SysSpec.dat** file to generate a Pass or Fail status for each of the items. This feature takes the guesswork out of the calibration.

The self-test requires the specialized calibration board (P/N 10665) in the system. The board must be properly aligned before any test can be preformed. The first item on the Self-Test dialog "Align Cal. Board" tests the alignment of the calibration board. The rest of the tests will be enabled only if this test passes.
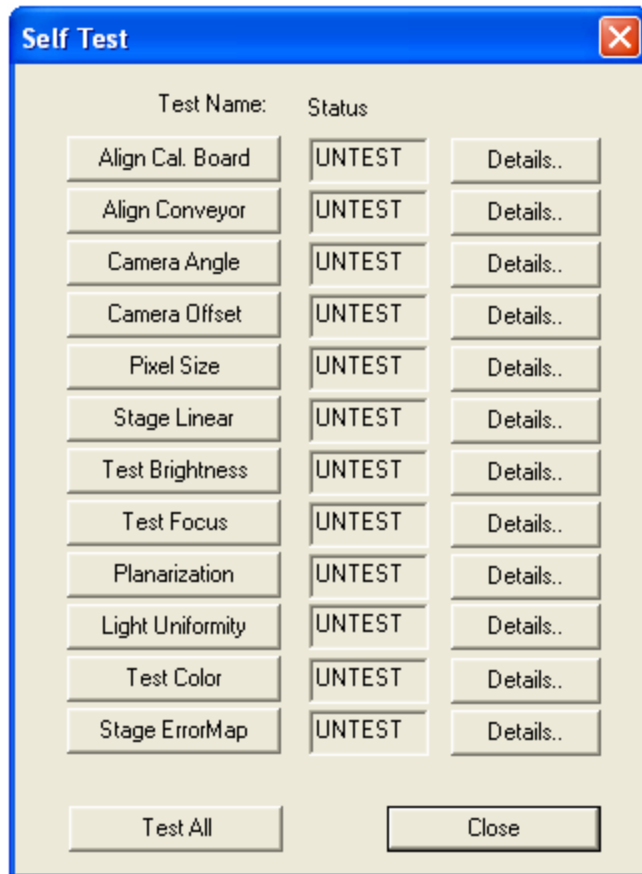
All the calibration procedures outlined in the previous section are performed in the factory as part of the quality assurance program. It is unlikely for a machine to get out of calibration so bad that it would require a complete re-calibration. The self test procedures that verify and correct the system parameters are much more likely to be used by users or a field service engineer to bring a machine back into specification.

The self test dialog lists a total of 12 tests. On the left is the action button for the test. Clicking it starts the automated test procedure. The middle box shows the status of the test. It can be UNTEST, PASS or FAIL. The right buttons when clicked launch detailed dialogs that list the test results. In many cases they also provide a means for the user to tweak the parameters to bring them back into specification.

26.14 Calibrate X-ray

The YTX-6000 has additional calibration and verification functions to calibrate and verify the functionalities of the X-ray imaging system. An additional calibration board is needed to complete the tasks.

26.14.1 Align Source to II

This step aligns the X-ray source mount on the Z-axis with the X-ray Image Intensifier (II). It ensure that doing a zooming operation, when the X-ray source move up and down on the Z axis, the center of the view does not shift.

The alignment procedure is guided step by step by message prompt dialogs. The Z axis is mounted in such a way there are 3 points in contact with the base. There are push-pull mechanisms on the two front screws; adjusting them can achieve proper alignment.

26.14.2 Calibrate Offset

This step calibrates the offset from the vision camera to the X-ray camera. Because the offset could be slightly different at different Z levels, this step only serves to achieve rough offset. Users should then use the Self-Test fine adjust feature in the Self-Test X-ray dialog to finish the calibration of the offset.

26.14.3 Calibrate Uniformity

Since X-ray is a point source, the image intensity may not be even across the entire field of view. This step tries to calibrate out those variations.

26.14.4 Run Self-Test X-ray

This is the same as the vision calibration; in X-ray calibration the software provides a comprehensive set of self-testing features that automatically verify all essential calibration parameters.

The self test X-ray dialog lists a total of 7 tests. On the left is the action button for the test. Clicking it starts the automated test procedure. The middle box shows the status of the test. It can be UNTEST, PASS or FAIL. The right buttons, when clicked, launch detailed dialogs that list the test results. In many cases they also provide a means for the user to tweak the parameters to bring them back into specification.
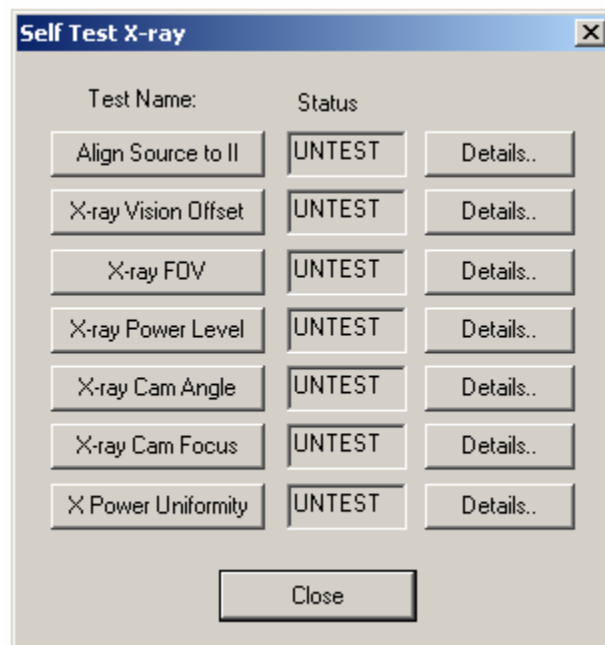
26.14.5 Align Conveyor Loading Positions

The YTX-6000 machine has the conveyor carried by the XY stage. User will need to set the left and right loading position for the conveyor to match the position of the shutter doors and the position of the incoming and outgoing conveyors. A special dialog is designed to facilitate the adjustment, to launch the dialog select **Set Position** from the **Test** menu, press the **Set YTX-6000 Loading Positions** button.
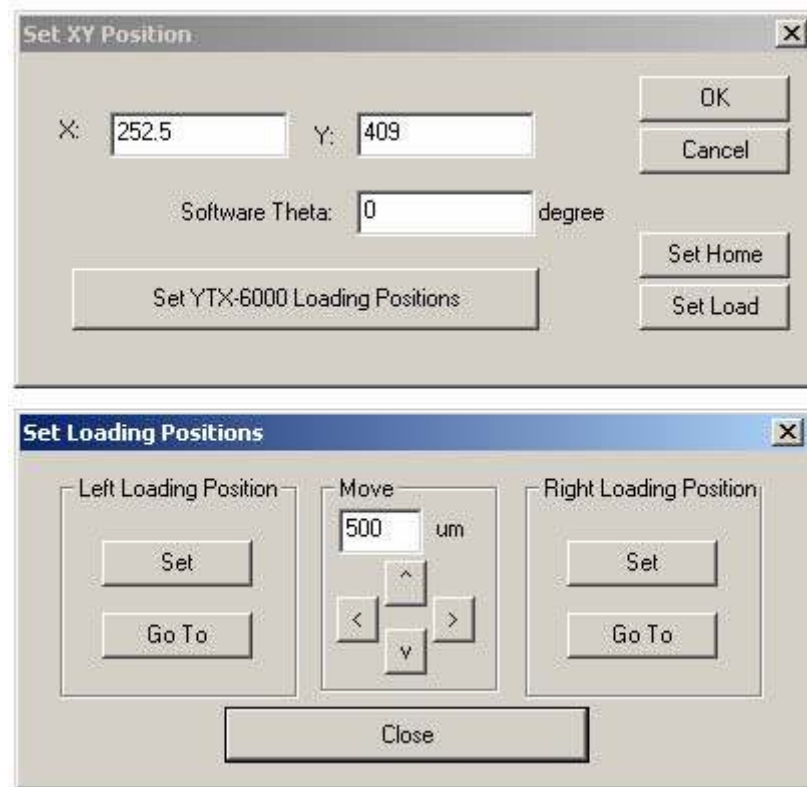
This dialog allow user to verify and set the loading positions. The Set button set the current position as the corresponding loading position. The arrow buttons in the middle jog the XY stage in small increment to facilitate fine adjustments.

27 Design for Manufacturing

Initialize XY Stage
Find Travel Limits
Move Stage
Jog Stage
Set Position

Conveyor Setup

Test TTL I/O

Setup Thin Camera
Set TC Gain/Offset
Setup EPB

YesTech AOI machines have been designed with ease of manufacturing and maintenance in mind. The software contributes to this goal by providing low-level control functions. These functions allows machine builders or maintenance personnel to exercise particular hardware modules so that any problem can quickly be isolated.

The low-level test functions can be found in the Test menu in builder mode (shown left).

27.1 Initialize XY Stage

The XY stage will initialize (or home) if the software is being started for the first time since the servo controller is powered on. During initialization the stage travels to the front left position then returns to the middle of the track. This menu selection forces the software to start the initialization routine regardless of the servo control status. It is useful when adjusting the front and left limit switch positions.

27.2 Find Travel Limits

In addition to having hard stop bumpers and limit switches at the ends of the stage travel, the software also has the so called "**Soft Limits**". With the soft limits properly set up the software will truncate any out of bound moves. The Find Travel Limits feature finds the travel limit for the soft limit function to work. It also tests the back and right limit switches and hard stop positions.

27.3 Move Stage

This menu selection launches the **Move To** dialog to move to an absolute stage position.
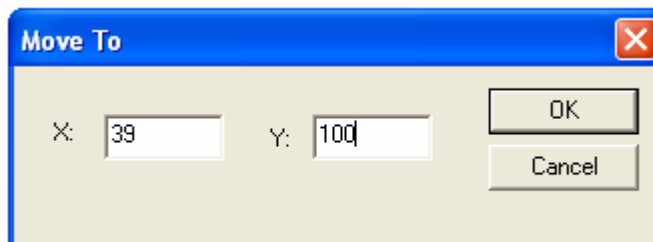
27.4 Jog Stage

This menu selection launches the utility program **ControlPoint** to exercise the XY Stage.

27.5 Set Position

Sets stage position to the specified values.
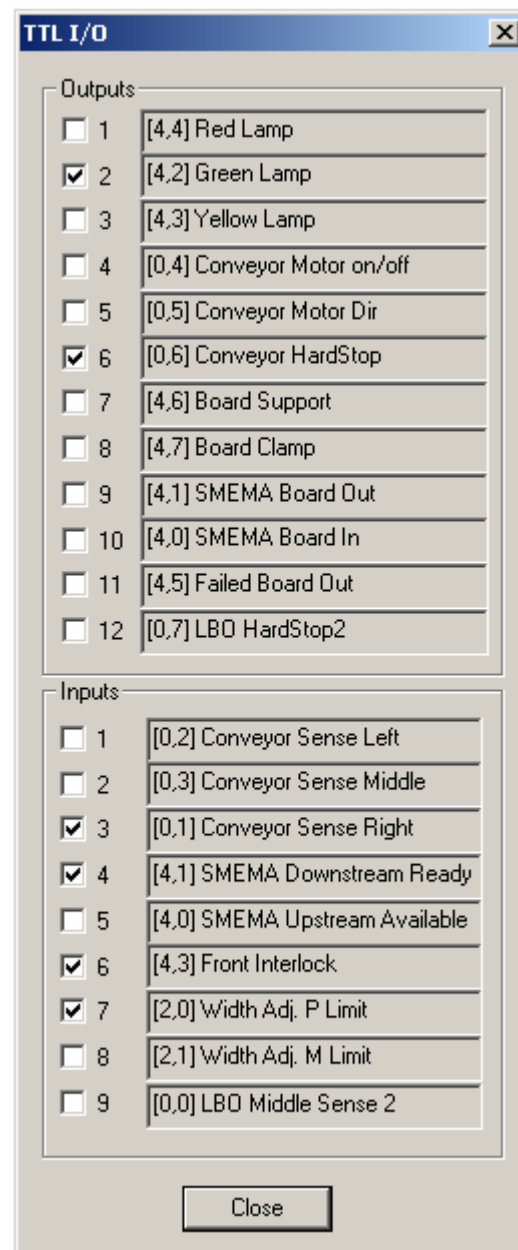
The user can also use this dialog to set the Home and Load position. The Home position should always be the bottom right corner of the PCB being inspected. The Home position is recipe dependent. The Load position is not recipe dependent. It is the position the stage moves to when loading or unloading a PCB. If the lighting fixture is close to the conveyor middle sensor, pressing the **Feed Board** button will cause it to move to the load position set by this dialog.

27.6 Disable Motor

This menu selection would disable the holding torque on the servo motors so that the user can push the stage to a desired position. The next move command will automatically enable the motor.
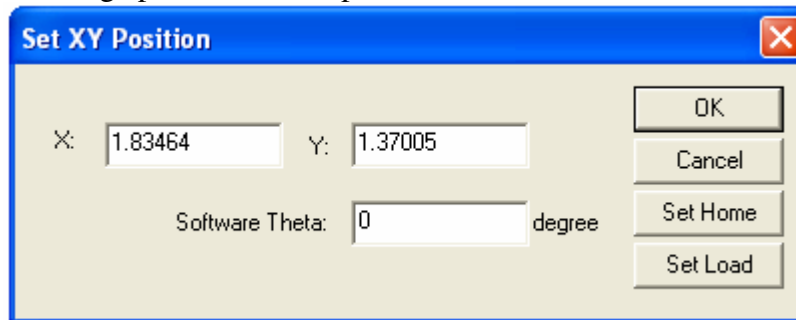
27.7 Conveyor Setup

This menu selection launches the conveyor setup dialog. Refer to section 9 "SMEMA Conveyor Setup" for details.

TTL I/O

Outputs

☐	1	[4,4] Red Lamp
☑	2	[4,2] Green Lamp
☐	3	[4,3] Yellow Lamp
☐	4	[0,4] Conveyor Motor on/off
☐	5	[0,5] Conveyor Motor Dir
☑	6	[0,6] Conveyor HardStop
☐	7	[4,6] Board Support
☐	8	[4,7] Board Clamp
☐	9	[4,1] SMEMA Board Out
☐	10	[4,0] SMEMA Board In
☐	11	[4,5] Failed Board Out
☐	12	[0,7] LBO HardStop2

Inputs

☐	1	[0,2] Conveyor Sense Left
☐	2	[0,3] Conveyor Sense Middle
☑	3	[0,1] Conveyor Sense Right
☑	4	[4,1] SMEMA Downstream Ready
☐	5	[4,0] SMEMA Upstream Available
☑	6	[4,3] Front Interlock
☑	7	[2,0] Width Adj. P Limit
☐	8	[2,1] Width Adj. M Limit
☐	9	[0,0] LBO Middle Sense 2

Close

193

27.8 Test TTL I/O Board 1& 2
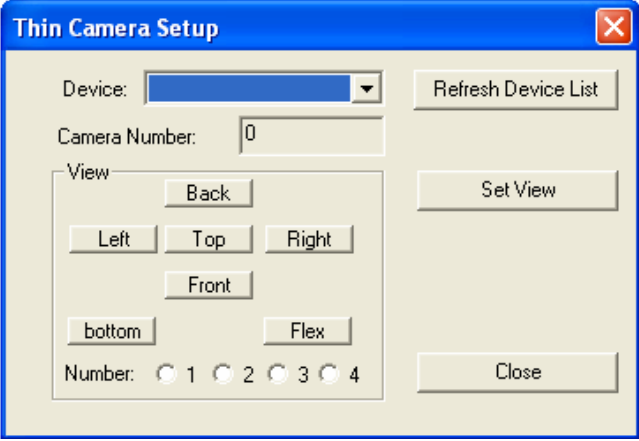
This menu selection launches the utility dialog shown at the right to allow toggling individual TTL outputs and watching the state of individual TTL inputs.

27.9 Setup Thin Camera

Thin cameras store a unique identifier to identify its view in its non-volatile memory.

This dialog allows users to set or change this identifier number.

It may used by a technician who needs to replace or reconfigure a thin camera. A thin camera fresh from the factory may not have its identification number initialized (equal to 255). The technician will need to set it based on the view the camera is used for. Also, if the technician needs to move a camera originally used as a side view to a top view he/she will also need to reconfigure its identifier.

27.10 Set TC Gain/Offset
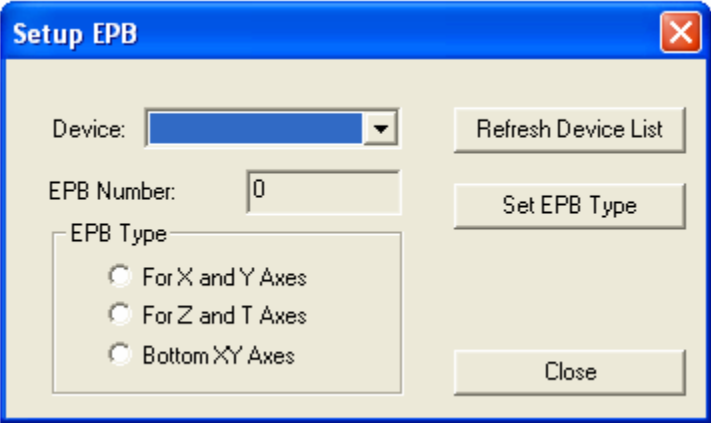
The gain and offset values for each camera are adjusted to match a standard so that all cameras produce images of consistent brightness and color. This dialog allows the user to adjust the gain and offset values. Users may need to use this dialog to adjust gain and offset in order for the machine to pass the **Brightness** and **Color** sections of the **Self Test**.

27.11 Setup EPB

The Embedded Processor Board (EPB) is the microprocessor control board for the AOI machine. The EPB stores an identifier to

signify its functionality which can be set or changed using the dialog to the right The EPB is used for controlling other YesTech products, so for AOI the EPB should be set to **For X and Y axes**.

28 Trouble Shooting

28.1 During Startup

The software performs a self checking routine during startup. If a problem is detected the following error messages may be displayed.

Error Message: License Key not Found or Expired

The YesVision™ software is protected by a software license key also known as a dongle. A proper dongle on a USB port is required for the software to run. There are two types of dongles: time limited and permanent, a time limited dongle will expire after a period of time usually 30 days. Time limited dongles can be extended or changed into a permanent one by a matching its locking string with a licensing string. When a time limited dongle is within 10 days of its expiration. The dialog on the right will display during software start up. Users should contact YesTech and provide YesTech with the 20 character locking string and the License type. YesTech engineers will use the locking string to generate a license string (26 characters. With the licensing string the user can update their software license.
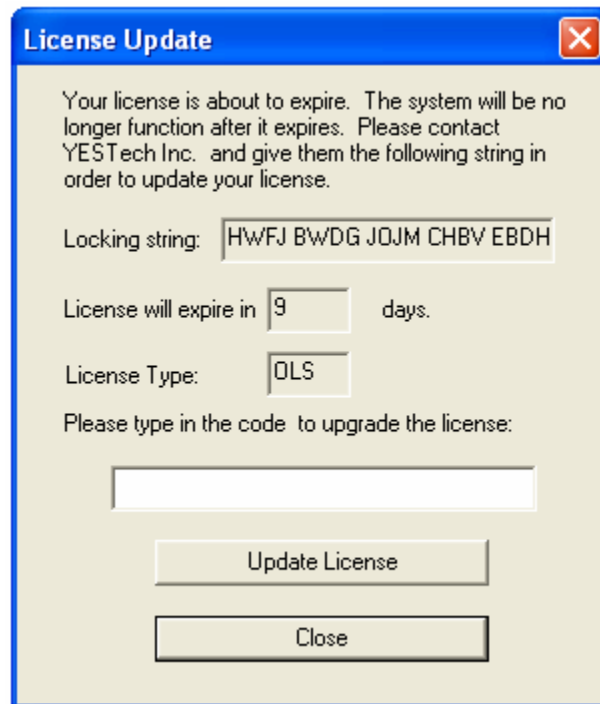
It is a YesTech company policy to supply new users with a time limited dongle until the system is paid for.

Error Message: Unable to communicate with the Teknic Servo Controller.

The XY stage of the AOI system is driven by closed loop servo motors. Teknic is the vendor who supplies YesTech the servo motor system. The computer communicates with the servo controller via its parallel port. This error message will display if the computer is unable to establish communication with the servo controller.

There can be a number of reasons for this to happen:

1. The power to the servo controller is not turned on. Check to make sure the power key switch is in the ON position.

2. The servo controller is not yet ready. After power is applied to the servo controller, it will take about 30 seconds before it is ready to communicate.

3. The computer's parallel port is not set to EPP. The servo controller requires the computer's parallel port to be in EPP mode. The user may need to enter the BIOS setup of the computer to change the settings.

Error Message: Cannot find EPB or TTL I/O & Cannot find EPB for XY Motor Control

The EPB (Embedded Processor Board) is a small (credit card size) circuit that controls the TTL input/output (tower light, interlock) of the AOI system. The same board also controls conveyor functionalities. The EPB communicates with the computer via the USB port. The above error message would display if the computer is unable to communicate with the EPB.

There can be a number of reasons for that to happen:

1. The USB cable to the EPB is not connected.

2. The device driver for the EPB is not properly setup. When the EPB is working properly its status LED would blink about once a second. Like a heart beat it indicates a healthy EPB in operation. If the status LED is not blinking it could mean either a bad driver setup or a damaged EPB board.

Error Message: No Top View Camera

Different models of AOI systems can have different numbers of cameras; however, all AOI systems must have at least one top view camera. This error message will appear if the computer is unable to communicate with the top view camera. Cameras communicate with the computer via the USB ports. There can be a number of reasons why this may happen:

1. The cable to the camera is not connected.

2. The device driver for the camera is not properly setup. Like the EPB board the thin camera boards also have a status LED that blinks like a heart beat when the camera is functioning properly.

3. The camera identifier is not properly setup. Refer to section 27.8 "Setup Thin Camera" for setting the camera identifier.

Error Message: Execute SQL..

During software start the software will try to connect to an ODBC database for storing the SPC data. If it cannot connect to a database it will try to create a new one in the default location **C:\AOI_Data\SPC_DataLog**. The software will display the above

error if it cannot create the database. To resolve this problem user need to make sure the ODBC connection is good (section 14.1), if it is make sure the **SPC_DataLog** folder exist in the right place.

28.2 During Recipe Loading

Error Message: Unable to own LTMaxNum.txt

The **LTMaxNum.txt** file is for controlling the logical template number, to make sure it does not duplicate. Refer to section 12.4 "Central Library" for an explanation of the **LTMaxNum.txt** file. All software stations (on and offline) need to have full access (read/write) to the **LTMaxNum.txt** file in order to train new templates. This error message indicates the system was not able to have full access to the **LTMaxNum.txt.** Seeing this error means that the user must investigate and resolve the problem before training any new template.

Error Message: Unable to take Ownership

When a new recipe is loaded the software will try to determine if it can write to the part list and the local part library files. The software then claims ownership of those files by writing its computer ID into the **Owner.txt** file, located in the recipe's folder. The above error will display if the software is unable to write to the owner.txt file. There could be two reasons for the error message:

1. The software does not have full access to the recipe's folder.
2. Other AOI software is claiming control of the recipe. (e.g. when the recipe is opened on an AOI machine, an offline programming station trying to load the recipe will get the above error message.)

Conveyor Does not open to the Right Width

When a recipe is loaded the software will automatically try to adjust the conveyor width according to the width specified in the recipe. Width adjust will be deferred to a later time if there is a board on the conveyor during recipe loading. In this case, the width adjusts will

happen as soon as the board is removed. If the conveyor adjusts to a width that is not the correct width for the board, the user should perfrom the following steps:

1. Home the conveyor.
2. Adjust the conveyor to the right width for the board.
3. Check "**Allow Width to be Saved in Recipe**"
4. Save the recipe.

To verify whether the problem is fixed the user should:

1. Feed out and remove the board that was on the conveyor.
2. Adjust conveyor width using the **Conveyor Setup** dialog to any width other than the width for the board.
3. Load the Recipe.

If the conveyor adjusts to the right width the problem is fixed. If not there may be a hardware problem with the conveyor adjustment mechanism.

28.3 Trying to Run a Recipe

Error Message: Unable to fit the ROI of xxx in Inspection Frame

When the user tries to run a recipe by pressing the **Run** button the software first executes the alignment routine. After that the software will create a camera move path for inspecting all the regions of interest (ROI) in the recipe. The process of creating the inspection path involves trying to fit all the ROIs into a minimum number of camera frames. This error message will display if one of the ROIs cannot fit into any frame. If there is more then one ROI that can't fit into a frame only the ROI first encountered will be identified in the error message. The user must fix the problem before inspection begins.

A lead bank longer than the field of view of the camera will generate this error. To fix the problem the user can break the lead bank into smaller sectors.

Error Message: XMax (YMax) Soft Limit Exceeded

In addition to hard stops (rubber bumpers) and hardware limit switches (optical sensors), the AOI system also has software limits for XY stage travel. Software limits when triggered will not allow any attempted move that is outside the travel limits. Hardware limit switches will cause the stage to stop abruptly at the limit, soft limits on the other hand will have the stage smoothly decelerate to the limit position. The above error message will display to inform the user that the software limit has been reached and the move has not been completed.

For soft limits to work properly travel ranges must be determined. If the above error message is displayed when the stage is not at the limit, then it is possible that the stage

travel range is incorrectly set. To set up travel range, the user can enter the builder mode of the software. From the **Test** menu, select **Initialize XY Stage**. The stage will move to the front left position then return to the middle position. Initializing the XY stage establishes the front left limit positions. To determine travel range we also need the back right positions. This is done by selecting **Find Travel Limits** from the **Test** menu.

28.4 While Running a Recipe

An error messages during inspection is caused by the software having problems with the current inspection box. The error messages may be "Cannot load template #xx" or "MbufCopyColor…" etc. Identifying the inspection box giving the error message is the first step towards fixing the problem. The software has a feature to help the user identify the troublesome inspection box. The feature is called "Show Last Inspected" and is located in the Help menu.
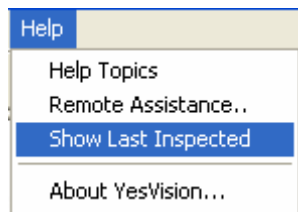
28.5 At the End of a Inspection

Displaying Defect Report
There are several things the software must do at the end of an inspection. One of that is to display a defect report for user to preview. The preview function requires a Printer Driver to be correctly installed. If user only needs to use the preview function and never need to print out a hardcopy of a defect report, then a printer is NOT needed. Even without the printer user must make sure a printer drivers is properly installed for the preview function to work.

Software hang-up may occur at the end of inspection, if on the AOI computer the default printer is setup as a network printer, and that printer became un-available.

SPC Data Logging
At the end of an inspection, the software may need to send inspection data to a database. The error message on the right may be displayed if one or more field of data is too long. The field can be the Serial number of the board (Max: 30 characters) the Work Order Number (Max: 20),
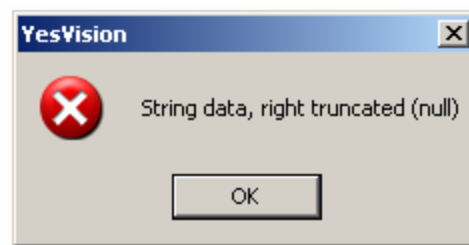
reference ID (Max: 20), PN (Max: 30) and Package Name (Max: 30). To resolve the problem, user to try to locate the extra long character field and then truncate it.

29 Appendices

29.1 Sample YCD File Fragment

```
.YESTECH_CAD
[Header]
Version=              1
RecipeName=           ASSY-533373-REV-B
ScaleFactor=          25.4
InvertXPos=           0
InvertYPos=           0
RotationDir=          -1
RotationOffset=       270
PNLib=
IsSharedPNLib=        0
PkgLib=               C:\AOI_Data\StdPkg\StdPkg_Post.pkg
PkgNameMap=
IsTopSide=            1
[PartList]
Ref.ID Name          X        Y       Rot'Pkg     Extension
FL1    ----          -62.5    2787.5  270 ----
L120   ----          -1299.5  5700    270 ----
R18    ----          -75      505     0   ----
R19    ----          325      505     0   ----
R21    ----          -1000    505     0   ----
R22    ----          -2125    505     0   ----
R23    ----          -1725    505     0   ----
R24    ----          -1400    505     0   ----
R208   14C-00102J-00 -5400    5595    270 0805    RES  1K 1/8W 5%   KOA # RM73B2AT102J
R275   14C-00102J-00 -5587.5  6132.5  270 0805    RES  1K 1/8W 5%   KOA # RM73B2AT102J
R190   14C-00103J-00 -5687.5  3295    0   0805    RES  10K 1/8W 5% 200pp KOA # RM73B2AT103J
R307   14C-00105J-00 -5681.3  5181.2  270 0805    RES  1M 5% 1/8   ROHM # MCR10EZHJ105
R278   14C-00220J-00 12.5     5295    0   0805    RES  22 OHM 1/8W 5%   ROHM MCR10EZHJ220
R293   14C-00220J-00 -75      5295    0   0805    RES  22 OHM 1/8W 5%   ROHM MCR10EZHJ220
R305   14C-00243J-00 -5350    837.5   270 0805    RES  24K 1/8W 5%   ROHM # MCR10EZHJ243
R301   14C-00330J-00 -1725    1906.2  270 0805    RES  33 OHM 1/8W 5%   ROHM # MCR10EZHJ330
R302   14C-00330J-00 -1975    2618.7  0   0805    RES  33 OHM 1/8W 5%   ROHM # MCR10EZHJ330
R314   14C-00471J-00 -2125    5443.7  0   0805    RES  470 OHM 1/8W 5%   KOA # RM73B2AT471J
R316   14C-00471J-00 -168.8   787.5   0   0805    RES  470 OHM 1/8W 5%   KOA # RM73B2AT471J
R205   14C-00473J-00 -5462.5  1757.5  270 0805    RES  47K 5% 1/8W   ROHM # MCR10EZHJ473
R262   14C-01003B-00 -5150    5570    0   0805    RES  100K 1/8W 0.1%   KOA # RN73T2AT1003B
R209   14C-01003F-00 -4850    5607.5  270 0805    RES  100K 1/8W 1%   KOA # RK73H2AT1003F
R231   14C-01003F-00 -5762.5  3295    0   0805    RES  100K 1/8W 1%   KOA # RK73H2AT1003F
R264   14C-01003F-00 -5137.5  6120    270 0805    RES  100K 1/8W 1%   KOA # RK73H2AT1003F
R273   14C-01003F-00 -5412.5  6107.5  0   0805    RES  100K 1/8W 1%   KOA # RK73H2AT1003F
R277   14C-01003F-00 -5400    5520    270 0805    RES  100K 1/8W 1%   KOA # RK73H2AT1003F
R241   14C-04992B-00 -5900    4057.5  0   0805    RES  49.9K 0.1% 1/8W   THIN FILM TECH #
C1     24C-C104KP-75 387.5    2820    270 0805    CAP  0.1UF 10% 50V   ROHM # MCH215C104KP
C2     24C-C104KP-75 387.5    2732.5  270 0805    CAP  0.1UF 10% 50V   ROHM # MCH215C104KP
C31    24C-C104KP-75 -2250    3095    270 0805    CAP  0.1UF 10% 50V   ROHM # MCH215C104KP
C140   24C-C104KP-75 -3762.5  3532.5  0   0805    CAP  0.1UF 10% 50V   ROHM # MCH215C104KP
C145   24C-C104KP-75 -3887.5  2620    0   0805    CAP  0.1UF 10% 50V   ROHM # MCH215C104KP
C164   24C-C104KP-75 -3712.5  4970    270 0805    CAP  0.1UF 10% 50V   ROHM # MCH215C104KP
C180   24C-C104KP-75 -5825    4057.5  0   0805    CAP  0.1UF 10% 50V   ROHM # MCH215C104KP
C208   24C-C104KP-75 -5862.5  1670    270 0805    CAP  0.1UF 10% 50V   ROHM # MCH215C104KP
C226   24C-C104KP-75 -5600    5595    270 0805    CAP  0.1UF 10% 50V   ROHM # MCH215C104KP
C230   24C-C104KP-75 -4437.5  5470    0   0805    CAP  0.1UF 10% 50V   ROHM # MCH215C104KP
C232   24C-C104KP-75 -5750    4057.5  0   0805    CAP  0.1UF 10% 50V   ROHM # MCH215C104KP
C233   24C-C104KP-75 -5612.5  3295    0   0805    CAP  0.1UF 10% 50V   ROHM # MCH215C104KP
C238   24C-C104KP-75 -5837.5  3295    0   0805    CAP  0.1UF 10% 50V   ROHM # MCH215C104KP
C244   24C-C104KP-75 -5675    2395    270 0805    CAP  0.1UF 10% 50V   ROHM # MCH215C104KP
C275   24C-C104KP-75 -87.5    3187.5  0   0805    CAP  0.1UF 10% 50V   ROHM # MCH215C104KP
C299   24C-C104KP-75 -37.5    6750    0   0805    CAP  0.1UF 10% 50V   ROHM # MCH215C104KP
C300   24C-C104KP-75 -287.5   6750    0   0805    CAP  0.1UF 10% 50V   ROHM # MCH215C104KP
C295   24C-VIH102-96 -5681.3  5343.7  270 0805    CAP  1000pF 50V 5% NPO   PANASONIC # ECU-
U5     380-3223EC-89 -40.2    5672.5  90  SO20    IC   MAX3223ECAP SO20 MAXIM # MAX3223ECAP
U139   380-4011BC-FC -5550    5857.5  180 SO14    IC   GATE QUAD SO14N FAIRCHILD # CD4011BCM
U140   380-4013BC-FC -5125    5857.5  0   SO14    IC   DUAL FLIP-FLOP SO14N FAIRCHILD #
U123   380-4242EU-89 -5700    3495.2  180 ----    IC   S08-FINE PITCH MAXIM # MAX4242EUA
```

```
U135    380-4242EU-89 -5712.5 1869.8 0   ----   IC   S08-FINE PITCH MAXIM # MAX4242EUA
U150    380-426525-7M -887.8  1500.8 270 ----   IC   16Kx18 FIFO CYPRESS # CY7C4265V-25ASC
U159    380-520925-EF 162.5   3150   270 ----   IC   2.5VOLT LDO REGULATOR MICREL #
U13     380-74CT14-86 -1312.5 5313.5 270 ----   IC HCT INVERTER TI#SN74HCT14D MARK: HCT14
U9      380-D7243B-66 -2450   4989   90  SO16W  IC   12-BIT SERIAL SO16W AD # AD7243BR
U149    380-LP339M-39 -4437.5 5857.5 180 SO14   IC   QUAD COMP SO14 NSC # LP339M
U154    380-MAX823-89 -100    3487.5 180 ----   IC   VOLTAGE MONITOR MAXIM # MAX823SEUK
U114    380-MAX887-89 -3600   3770   180 SO8    IC   REGULATOR PWM SO8N MAXIM # MAX887HESA
U115    380-MAX887-89 -3675   2645   180 SO8    IC   REGULATOR PWM SO8N MAXIM # MAX887HESA
U118    380-MAX887-89 -3450   5082.5 180 SO8    IC   REGULATOR PWM SO8N MAXIM # MAX887HESA
U10     390-AT1710-4X -1745   1420   90  ----   IC   AT17LV010A-10JC ATMEL # AT17LV010-
JP15    400-SSM105-79 287.5   4482.5 0   ----   CONN  5x2 HEADER SAMTEC # SSM-105-S-DV
JP16    400-SSM105-79 -2175   2120   270 ----   CONN  5x2 HEADER SAMTEC # SSM-105-S-DV
JP17    400-SSM105-79 287.5   5120   180 ----   CONN  5x2 HEADER SAMTEC # SSM-105-S-DV
JP19    400-SSM105-79 -2400   4420   0   ----   CONN  5x2 HEADER SAMTEC # SSM-105-S-DV
T3      500-970233-00 -4975.5 2220   0   ----   TRANSFORMER  XFMR8x8PIN+24V DT MAGNETICS
T1      500-970234-00 -4938   4157.5 0   ----   TRANSFMR  XFMR-8x8PIN +12V DT MAGNETICS
CB4     550-PFMC11-6C -5537.5 1607.5 270 ----   FUSE  1At FUSE-PFMC SCHURTER # PFMC.110.2
D128    640-M140T3-38 -3862.5 2383.5 180 SOT23  DIODE  SCHOTTKY 40V 1A MOTOROLA #
Q123    740-SI4562-00 -4262.5 5220   270 SO8N   TRANSISTOR  SI4562DY SO8N
Q124    740-SI4562-00 -4762.5 5932.5 0   SO8N   TRANSISTOR  SI4562DY SO8N
Q143    740-SI4562-00 -375    5680.5 270 SO8N   TRANSISTOR  SI4562DY SO8N
Y3      750-FPX060-26 -464.5  5207   90  ----   CRYSTAL  6Mhz OSC-FPX FOX # FPX060-B-A-E
..
..

[PartListEnd]
```

29.2 Sample Central Library .part file

```
[Header]
Owner=NONE
Version=1
TimeStamp=1062867360

<PART>
  Pkg= 1206
  Type= 0
  Desc=
  <IB>
    CP= 0 0
    SIZE= 3040 1640
    Dir= 0
    VID= 7
    Layer= 0
    Light= 1
    PreP= 0
    Algo= -1
    Param0= -842150451
    Param1= -842150451
    Param2= -842150451
    Param3= -842150451
  <\IB>
  <MARK>
    SM= 400
    PS= 70
    IF= -12851
    MF= 8
    PX= 400
    PY= 400
    <IB>
      CP= 0 0
      SIZE= 1757 904
      Dir= 0
      VID= 0
      Layer= 0
```

```
      Light= 1
      PreP= 0
      Algo= -1
      Param0= -842150451
      Param1= -842150451
      Param2= -842150451
      Param3= -842150451
    <\IB>
    <TMP>
      Num= 1051
      CP= 0 0
      SIZE= 1757.8 904.4
    <\TMP>
  <\MARK>
  <SOLDER>
    Pin= 0
    <IB>
      CP= 1805 0
      SIZE= 766 1532
      Dir= 3
      VID= 0
      Layer= 0
      Light= 2
      PreP= 0
      Algo= 1
      Param0= 128
      Param1= 12800
      Param2= 0
      Param3= 0
    <\IB>
  <\SOLDER>
  <SOLDER>
    Pin= 0
    <IB>
      CP= -1805 0
      SIZE= 766 1532
      Dir= 1
      VID= 0
      Layer= 0
      Light= 2
      PreP= 0
      Algo= 1
      Param0= 128
      Param1= 12800
      Param2= 0
      Param3= 0
    <\IB>
  <\SOLDER>
<\PART>
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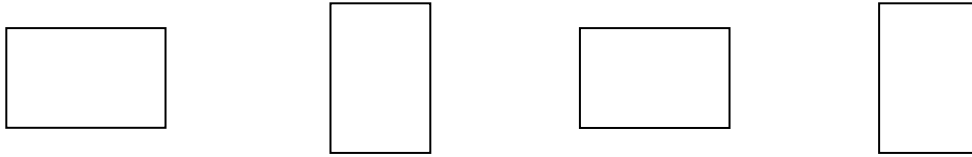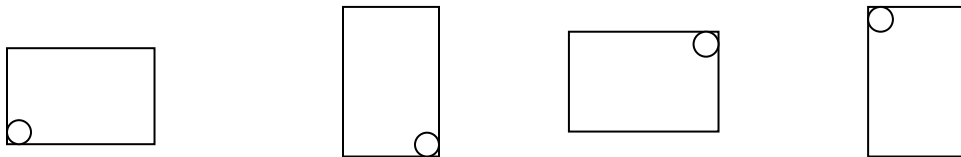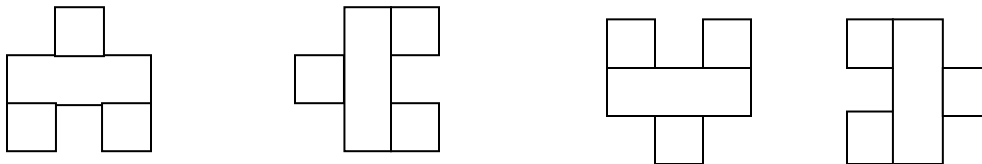
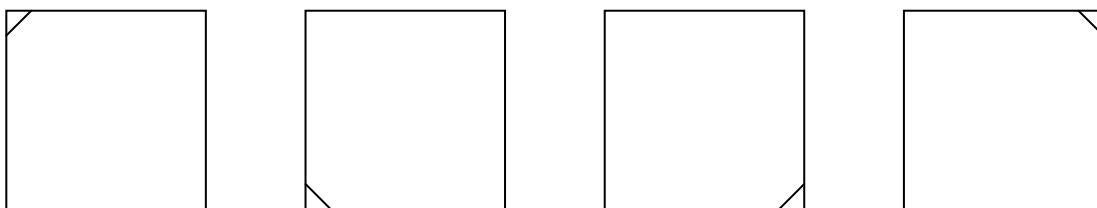## 29.3 Part Rotation Worksheet

Chip resistors and Caps.

Polarized Cap or Diode

SOIC/TSOP/DIP

SOT/DPAK

QFP/BGA

29.4 Sample Defect Reports

```
YESTECH Defect Report – c:\aoi_data\recipe\gdc-060p027002rev_k.rcp
Board S/N:Board-01  DateTime:Thu Jun 26 15:41:03 2003•  User:a
  Machine:AOI-PROTO
Summary Statistics:         Mark      Lead Bank  Solder    Total
 Inspection Counts:         293       44         1066      1403
       Fail Counts:         2         1          5         8
           Yields:         99.32 %   97.73 %    99.53 %   99.43 %
Defect List:-
         R11   Solder Insufficient Solder
         C5   Solder Insufficient Solder
         R4   Mark  Wrong Part
         R85   Mark  Wrong Part
         U14   Lead South Solder Bridge
         U14   Solder Pin=10 Insufficient Solder
         U14   Solder Pin=98 Insufficient Solder
         U14   Solder Pin=95 Insufficient Solder
```
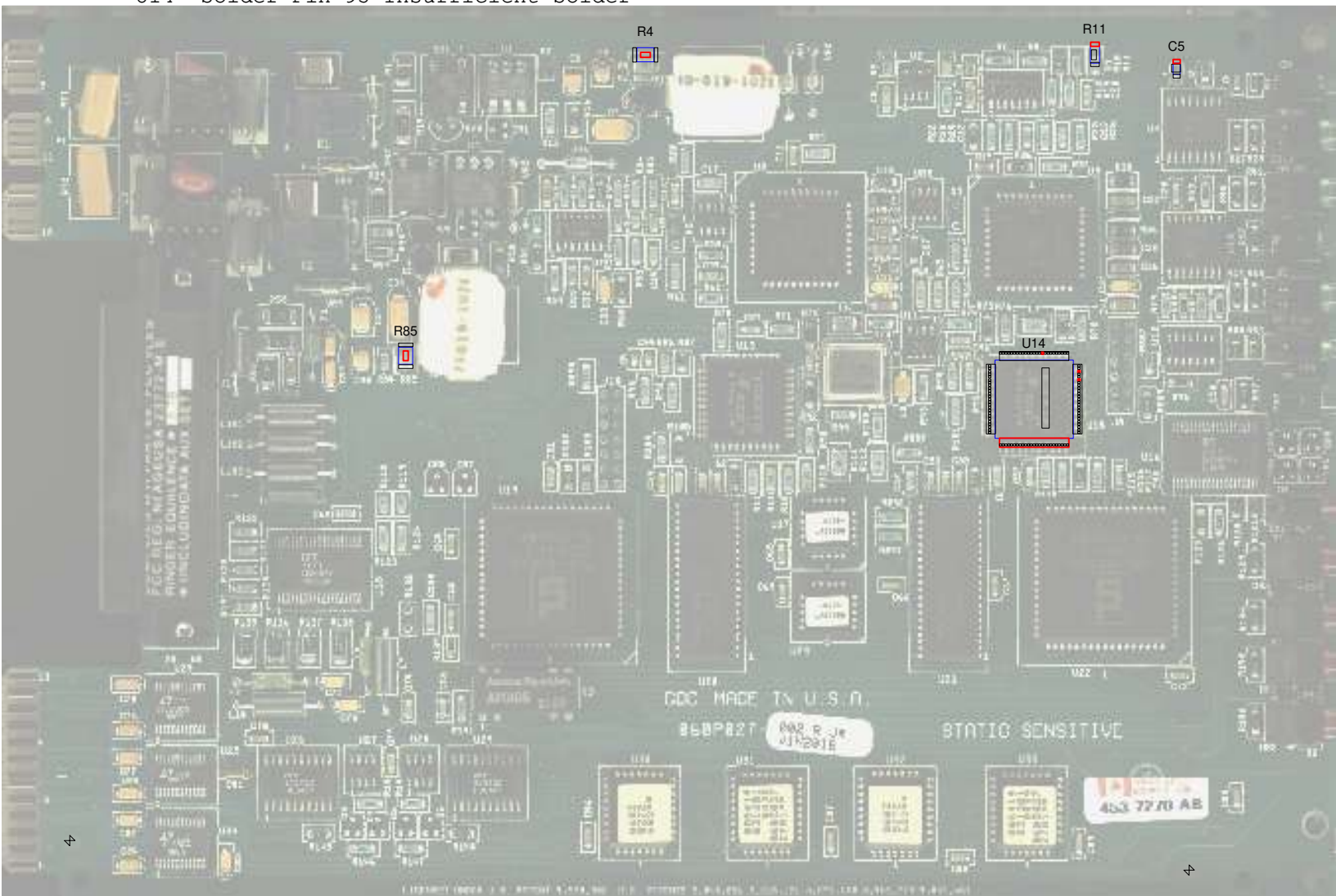
```
YESTECH Defect Report – c:\aoi_data\recipe\gdc-060p012-009-rev_ap.rcp
Board S/N:Board-01  DateTime:Thu Jun 26 08:37:15 2003•  User:Mary
   Machine:AOI-PROTO
Summary Statistics:          Mark      Lead Bank Solder     Total
 Inspection Counts:          228       56        899        1183
       Fail Counts:          2         1         0          3
            Yields:          99.12 %   98.21 %   100.00%    99.75 %
Defect List Top Side:-
         U535  Lead South Solder Bridge
         U34   Mark  Wrong Part
         U13   Mark  Wrong Polarity
Defect List Bottom Side:-
```