User Manual

Automatic Pick and Place Machine

Models QM1000, QM2000 and QM3000

125 Business Center Dr Unit G

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Introduction

Thank you for purchasing a SMT Max Automatic Pick and Place Machine from the QM1000, QM2000, or QM3000 series. The following pages contain an overview of the machine and step-by-step instructions on calibrating its various components, as well as maintenance and troubleshooting details. To make the most use of your machine, please read through this manual carefully before operation.

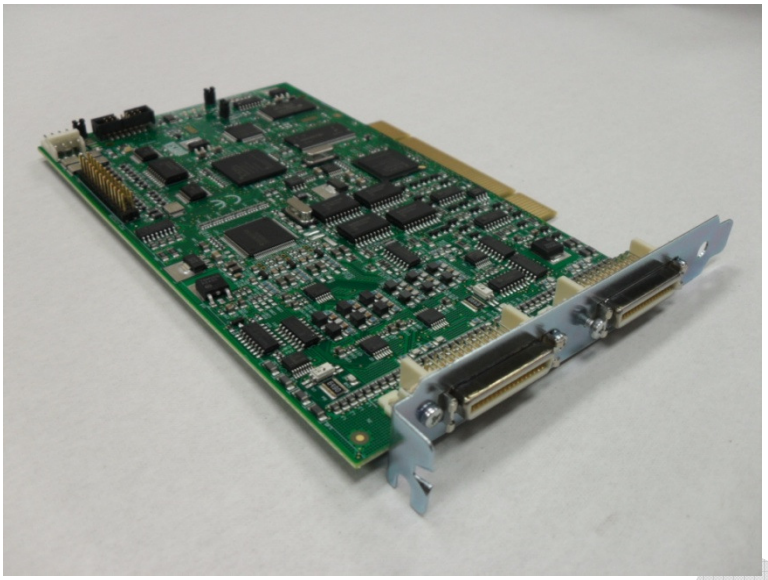
Specifications

In order to verify that all the components have been correctly delivered to you, the following is a components list (options not included) and picture of the complete machine:

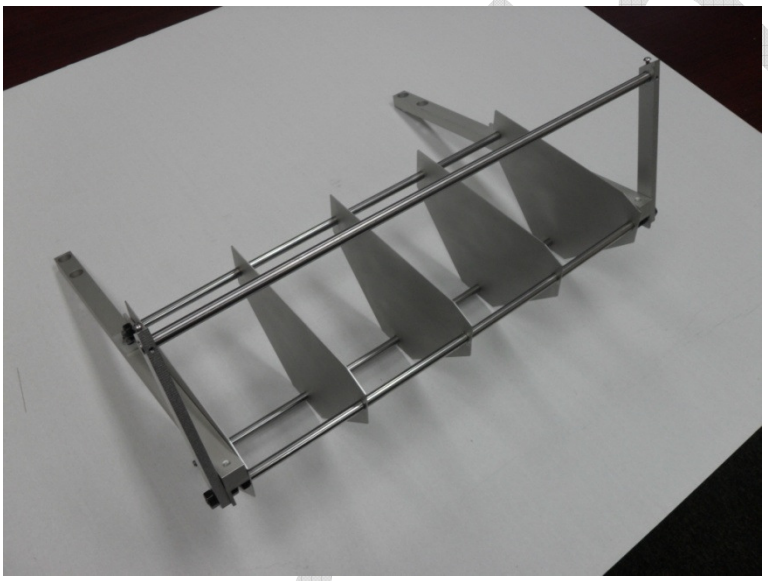
RS-232 Cable x 1

Power Cable for Control Box x 1

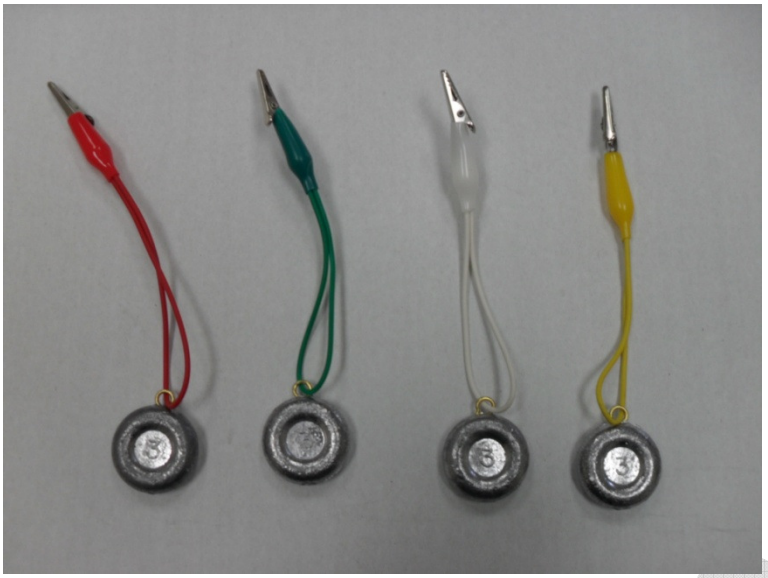
Vision Card x 1



Feeder Basket x 1

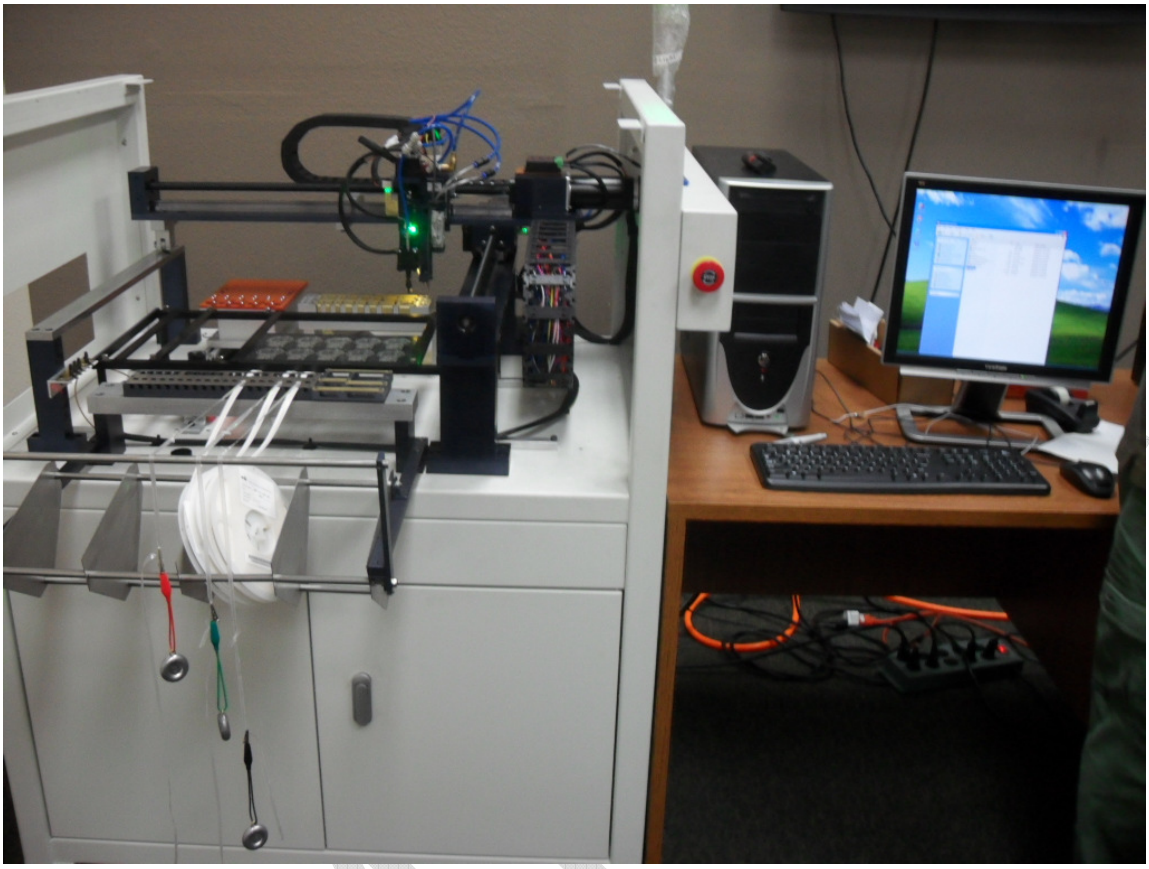


Feeder Weights x 4



Software x 1

Machine x 1 (QM 1000 - your own machine may look somewhat different)



Health Hazards

Please make sure that all operators are aware of the following safety procedures before operating QM Automatic Pick and Place Machines.

Heavy Parts

Depending on the model, the machine could weigh from several hundred to over a thousand pounds. **BECAREFUL** when placing the machine, and make sure that the surface you place it on can support the weight.

Moving Parts

The pickup head, pulling needle, and syringe of the QM Automatic Pick and Place Machines are automatically driven and can cause **BODILY INJURY** if they pinch a part of the human body. To ensure that such an accident does not occur during operation, please **DO NOT INSERT** any part of your body into the operational area above the machine board while the machine is turned on.

Be **AWARE** that the machine will move on its own at startup as it moves to the home position.

Compressed Air

The QM Automatic Pick and Place Machines make use of compressed air through a connected external air compressor of 70 to 120 PSI. Using and manipulating air compressors can be hazardous, and all standard operational safety procedures for air compressors apply.

Electrical Shock

Be careful while handling the electrical cables and wires of the QM Automatic Pick and Place Machine, as electricity up to **220V** may be running through them. Do not store or use the machine in a humid environment. If, for some reason, parts of the machine become wet, **DO NOT OPERATE** it until it has dried.

Installation Requirements

The following external requirements must be met before the machine can be operated. **SMT Max is NOT responsible for damages caused by using equipment that do not fulfill the requirements!**

Electricity Requirements

QM Automatic Pick and Place Machines support power sources of either **110V, 60Hz** or **220V, 50Hz**. The customer should specify in advance which power source format will be used.

Air Compressor Requirements

QM Automatic Pick and Place Machines support air compressors of **70-120 PSI**. Furthermore, the air compressor tank should be above 13 gallons in capacity.

Paste Dispenser Requirements

The same electricity and air compressor requirements are as above.

Chapter1. Quick Start

Make sure that all the components in the components list are present in the correct physical locations on the machine, as shown in Figure 1. To start the machine, follow these steps:

Quick Start: Hardware Setup

1. Place the PICK AND PLACE MACHINE and CONTROL BOX on a flat and stable platform. Make sure that the platform can support the weight and movement of the machine. Set up the COMPUTER on a convenient location close to the machine.

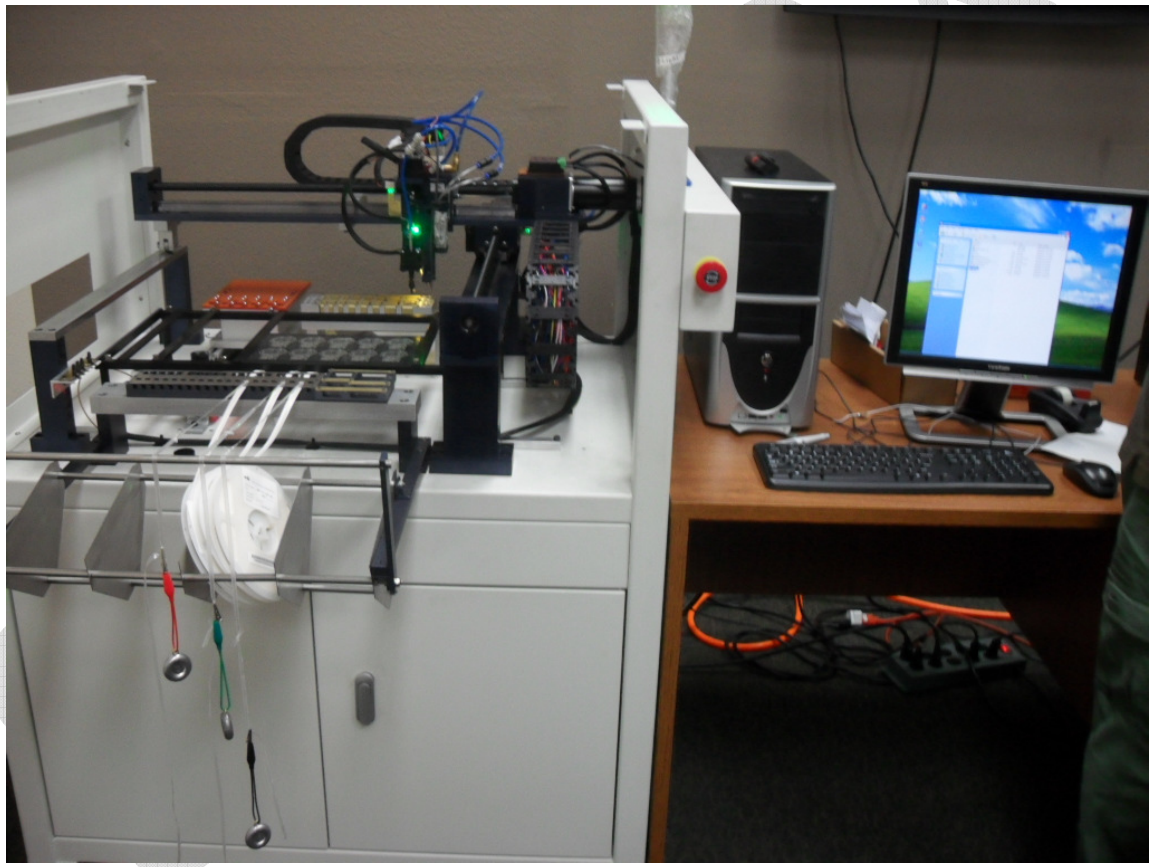


Figure 1.1: A sample machine of type QM2000 with a computer nearby

2. Connect the RS232 CABLE from the COMPUTER to the RS232 CONNECTOR on the back of the CONTROL BOX.

Figure 1.2: RS232 CABLE

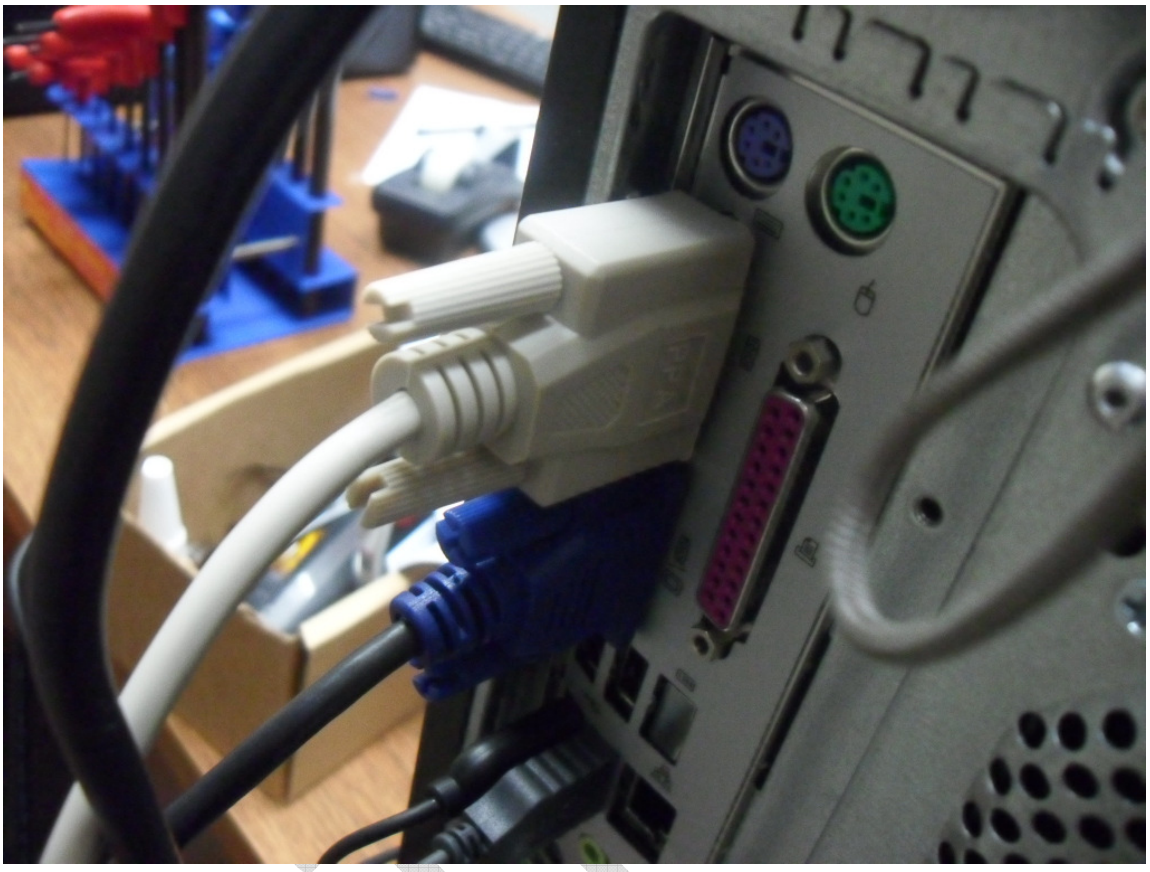


Figure 1.3: RS232 cable connected to the computer

Figure 1.4: RS232 cable connected to the control box

3. Connect the AIR COMPRESSOR HOSES and the 32 PIN CABLE to the corresponding connectors on the back of the CONTROL BOX.

Figure 1.5: The AIR COMPRESSOR HOSES (blue) connected to the control box

Figure 1.6: The 32 PIN cable (green) connected to the control box.

4. Connect the AIR HOSE from an AIR COMPRESSOR to the CONTROL BOX inlet labeled AR-IN**.** Using a filter between the AIR COMPESSOR and the CONTROL BOX inlet is highly recommended.

Figure 1.7: Sample air compressor with orange air hose (purchased separately)

Figure 1.8: Air compressor hose connected to the control box

5. Connect the COMPUTER VISION CABLE to the computer. One side of the cable should already be connected to the machine.

Figure 1.9: Computer vision cable connected to the computer

6. Connect the CONTROL BOX POWER PLUG to a power source.
7. Connect the COMPUTER POWER PLUG to a power source.

Quick Start: Software Setup

1. Make sure the COMPUTER has Microsoft Windows XP installed and has a CD DRIVE.
2. Disable or schedule the COMPUTER's automatic backup/update such that it does not overlay in time with pick and place machine software usage.
3. Disconnect the computer from any **internet connections**.

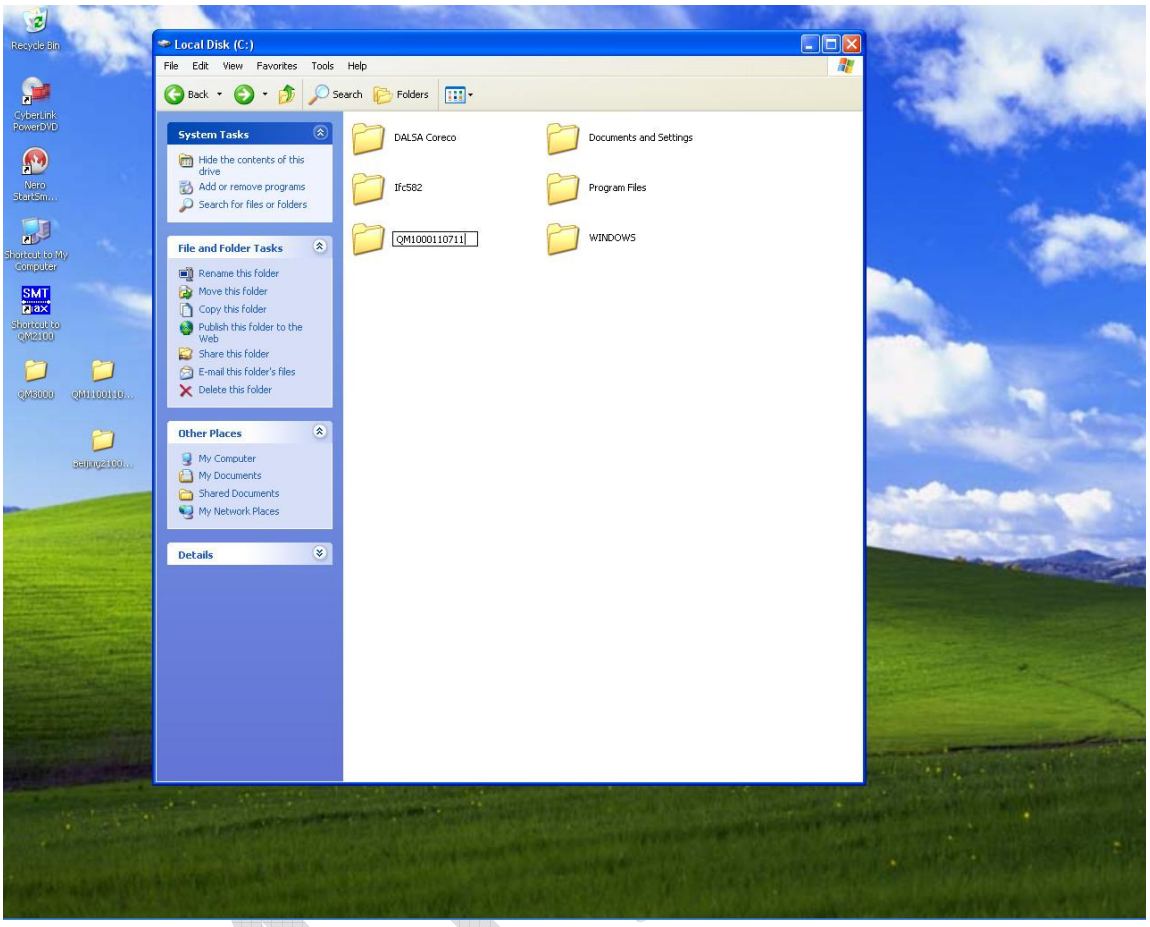


Figure 1.10: Creating a folder for the QM software

4. Place the installation CD into the computer's CD-ROM drive, and then navigate to the folder on the CD labeled by your machine's serial number.
5. Copy the folder to your C:\ drive.
6. Follow the instructions in the Installation.txt on the CD for the setup of the software
7. If you are creating a new folder please make sure to copy the P2VTest.txt to the new folder.
8. Copy the Vision license file to your C:\DALSA Coreco\Sapera Processing\Bin\. Lunch the CProLmgr.exe to load the license. Make sure the board serial number have to match the license number.

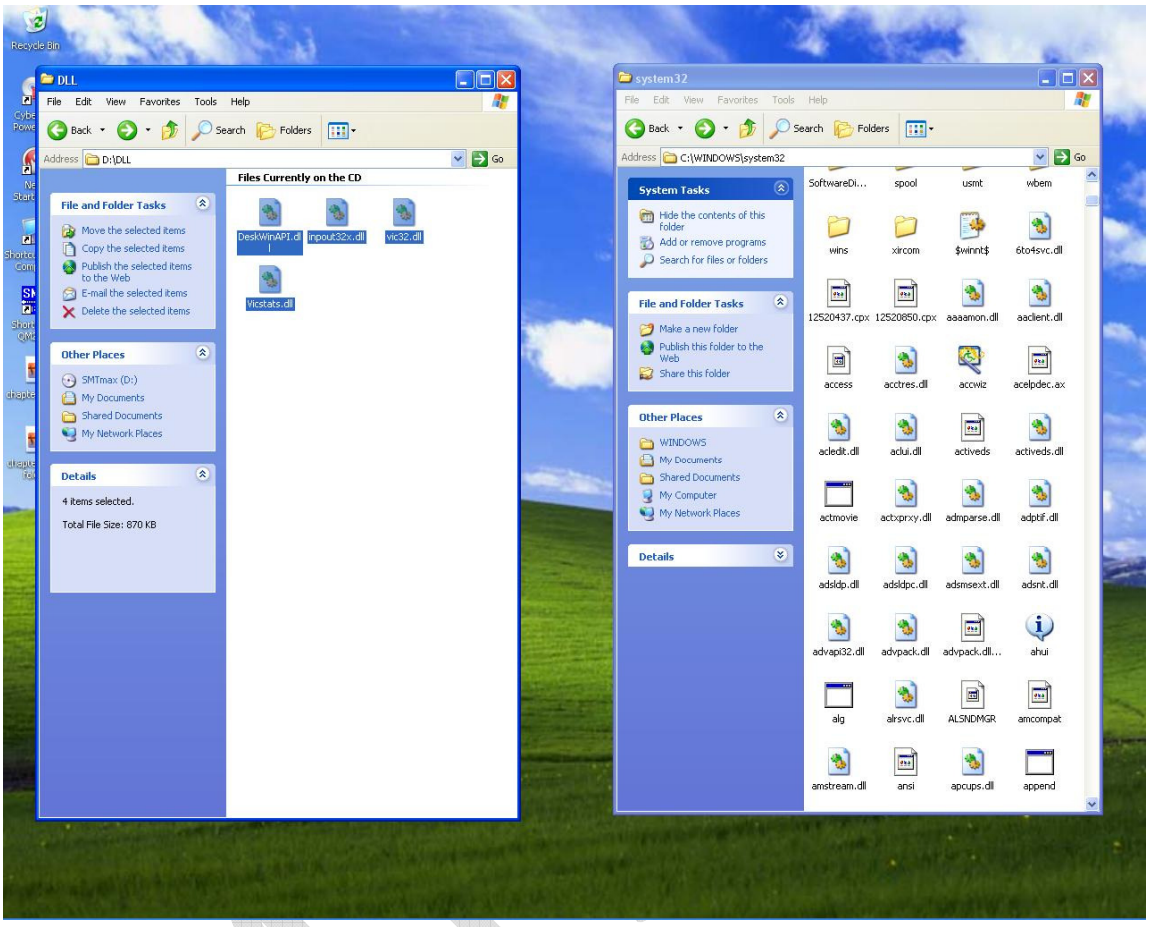


Figure 1.11: DLL files and where they should be moved

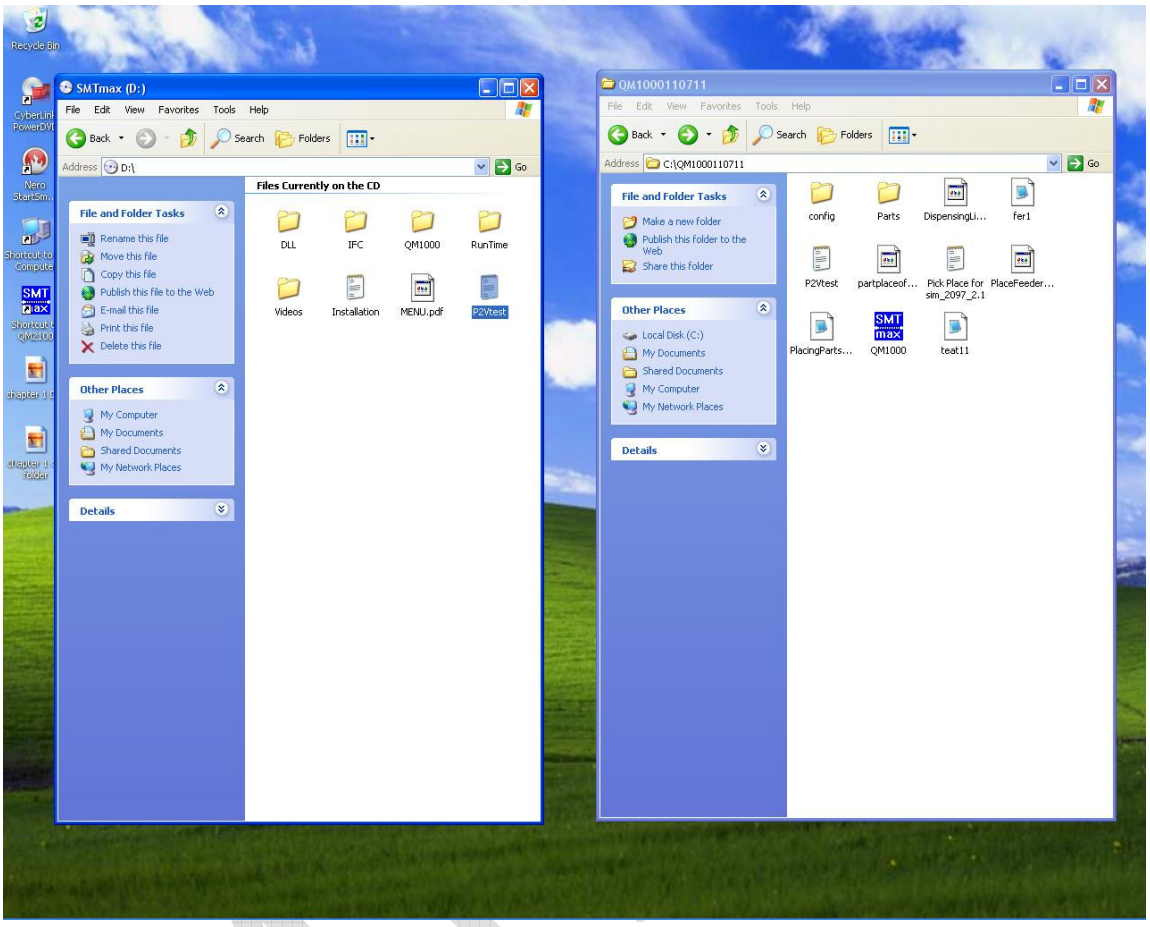


Figure 1.12: P2VTest.txt and where it should be moved

9. Create a SHORTCUT to the executable file QM1000.EXE, QM2000.EXE, or QM3000.EXE by right clicking on it and selecting CREATE SHORTCUT. Move the SHORTCUT to the DESKTOP of the COMPUTER for easy access.

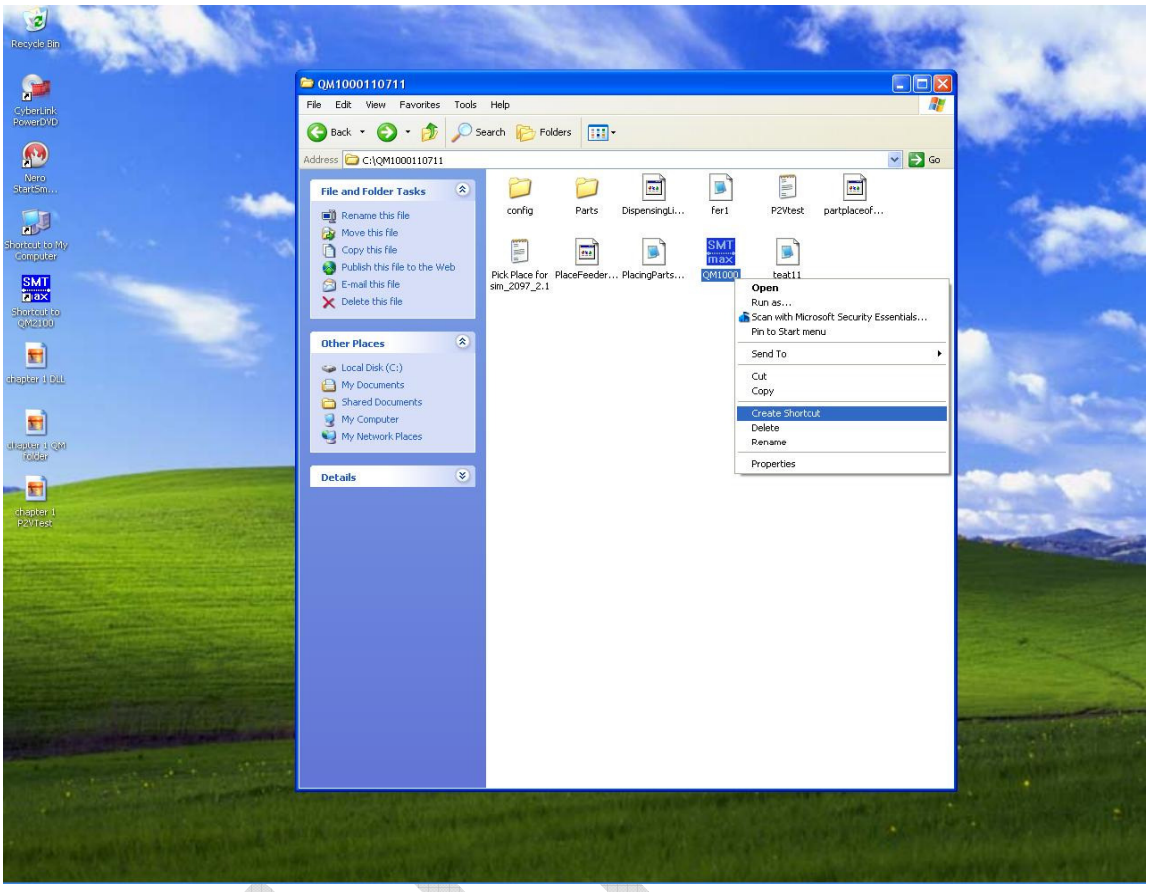


Figure 1.13: Create a shortcut of the QM application and put it on your desktop for easy access

10. Create two SUB FOLDERS in the FOLDER you created, and name them CONFIG and PARTS (if you have copied the folder that is named by your machine's serial number these two folders were pre-created) .

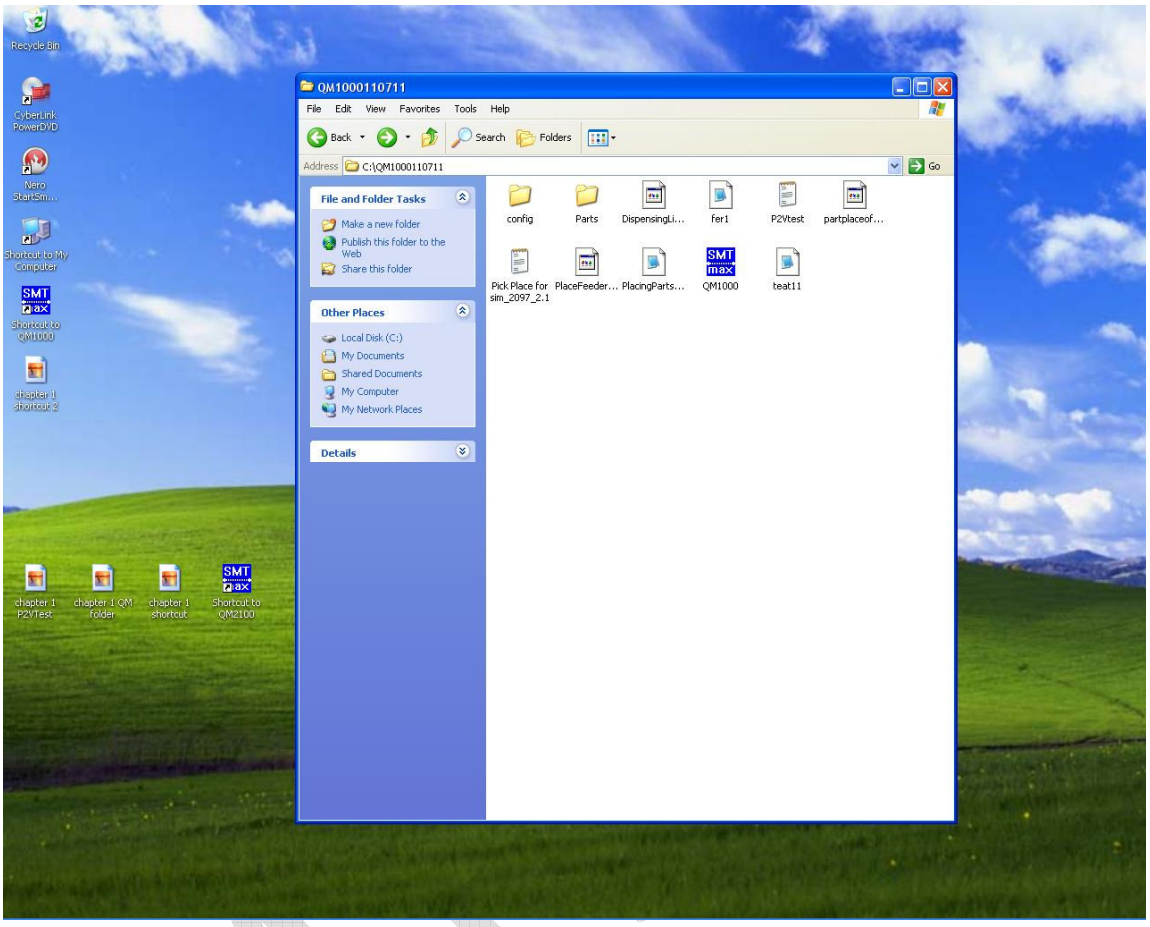


Figure 1.14: Create the CONFIG and PARTS subfolders in the folder you created

11. Copy the MACHINE CONFIGURATION FILE QM2000A.INI from the installation CD to the CONFIG folder you created. All the machine configurations are saved in this file.
The contents of the configuration file are explained in details as the follows:
    1) Xoffset, Yoffset, Zdown, Zup
    2) PCB offset-X
    3) PCB offset-Y
    4) Needle offset X
    5) Needle offset Y
    6) Vision Search (0=fast,1=medium,2=fine), check home 2(0=yes, 1=no), 90 degree(0=no, 1=yes)
    7) PCB Scale
    8) Main Home X
    9) Main Home Y
    10) Camera offset X
    11) Camera offset Y
    12) Com port, up look camera, parallel port address (hex format, no 0X at front)
    13) Video2 X, Video2 Y, Video4 X, Video4 Y, Video5 X, Video5 Y, Video6 X, Video6 Y,

Video2 X shift, Video2 Y shift, Video2 A shift, Video4 X shift, Video4 Y shift, Video4 A shift, Video5 X shift, Video5 Y shift, Video5 A shift, Video6 X shift, Video6 Y shift, Video6 A shift, Mirror X, Mirror Y, Mirror X shift, Mirror Y shift, Mirror A shift

14) Home2 X, Home2 Y, not used, not used, mirror center X(screen), mirror center Y(screen), mirror front stride, mirror back stride
15) Nozzle hub X, use mark (0=no, 1=yes), check mark value, check mark time, mark mask file
16) Nozzle hub Y
17) Current nozzle on head, nozzle changer position(0=front, 1=left)
18) Change nozzle(0=no, 1=yes)
19) Vision max iteration, video1 search area, video2 search area
20) Collect tray X, dumpcanX0, dumpcanY0, dumpcanX1, dumpcanY1, dumpcanX2, dumpcanY2, dumpcanX3, dumpcanY3, dumpcanX4, dumpcanY4, dumpcanX5, dumpcanY5, dumpcanX6, dumpcanY6, dumpcanX7, dumpcanY7, dumpcanX8, dumpcanY8, dumpcanX9, dumpcanY9
21) Qmpull speed, Qmpull return speed, Qmvision threshold
22) Use fiducial (0=no, 1=yes)
23) Video1 step size
24) Video2 step size, video4 step size, video5 step size, video6 step size, video3 step size
25) Rotation factor
26) Not used, camera delay, frame delay
27) XY regular speed, step speed, XY regular acceleration, Max Z speed, Max A speed, XY home speed, Z home speed, Z place speed, Z top, Z release speed
28) Actuator delay, blow delay, pick delay, multi-punch delay
29) X-limit, Y-limit, Z-limit
30) PCB shift X, PCB shift Y, tip-1 shift X, tip-1 shift Y, tip-2 shift X, tip-2 shift Y, tip-3 shift X, tip-3 shift Y, tip-4 shift X, tip-4 shift Y, tip-5 shift X, tip-5 shift Y
31) Tip height, Tip speed
32) Paste dispenser, needle down, needle up, start delay, stop delay, dispencer speed, paste dot size, camera X, camera Y, camera Z, pasteoverlay, camera offset X, camera offset Y
33) Feeders file
34) Parts file
35) Dispensing list
36) Part list offset

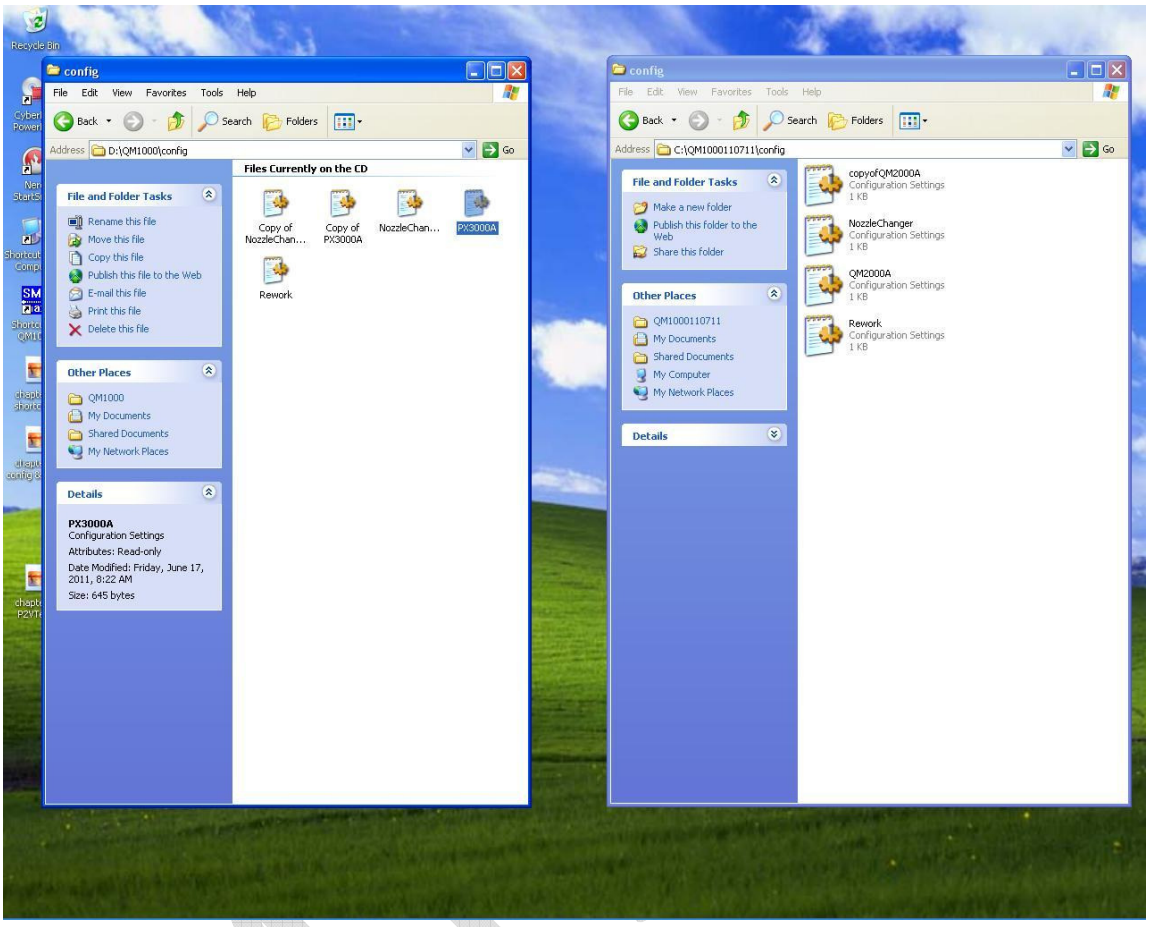


Figure 1.15: Where the QM2000A.ini file is on the CD, and where it should be placed in the QM program folder

Quick Start: Turning On The Machine

1. Start the computer.
2. Turn on the CONTROL BOX with the CONTROL BOX POWER SWITCH.
3. Navigate to the program folder.
4. Start the application labeled QMXXXX (where XXXX is determined by the version of the machine)
5. Five GREEN LED lights should turn on in different parts of the machine, as shown here:

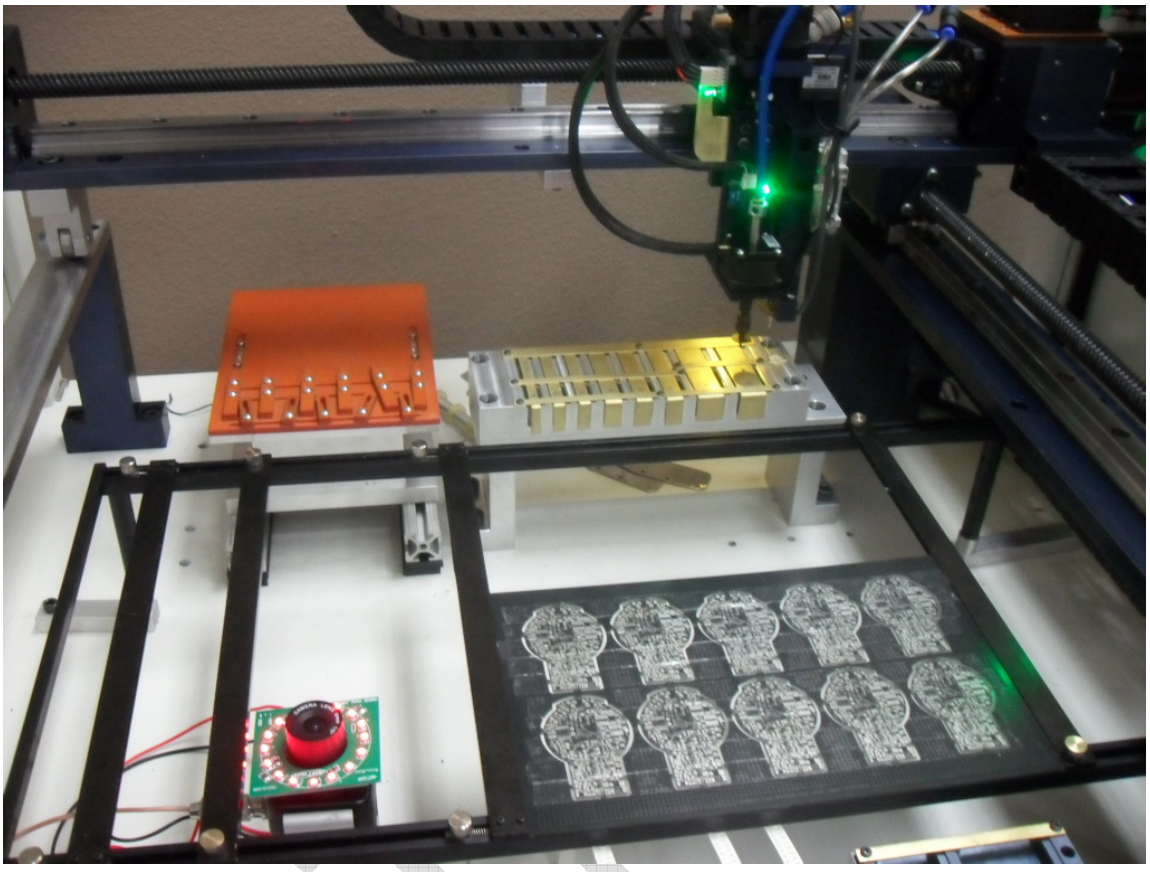


Figure 1.16: Front A rotation and Z Limit switch LED lights (Two)

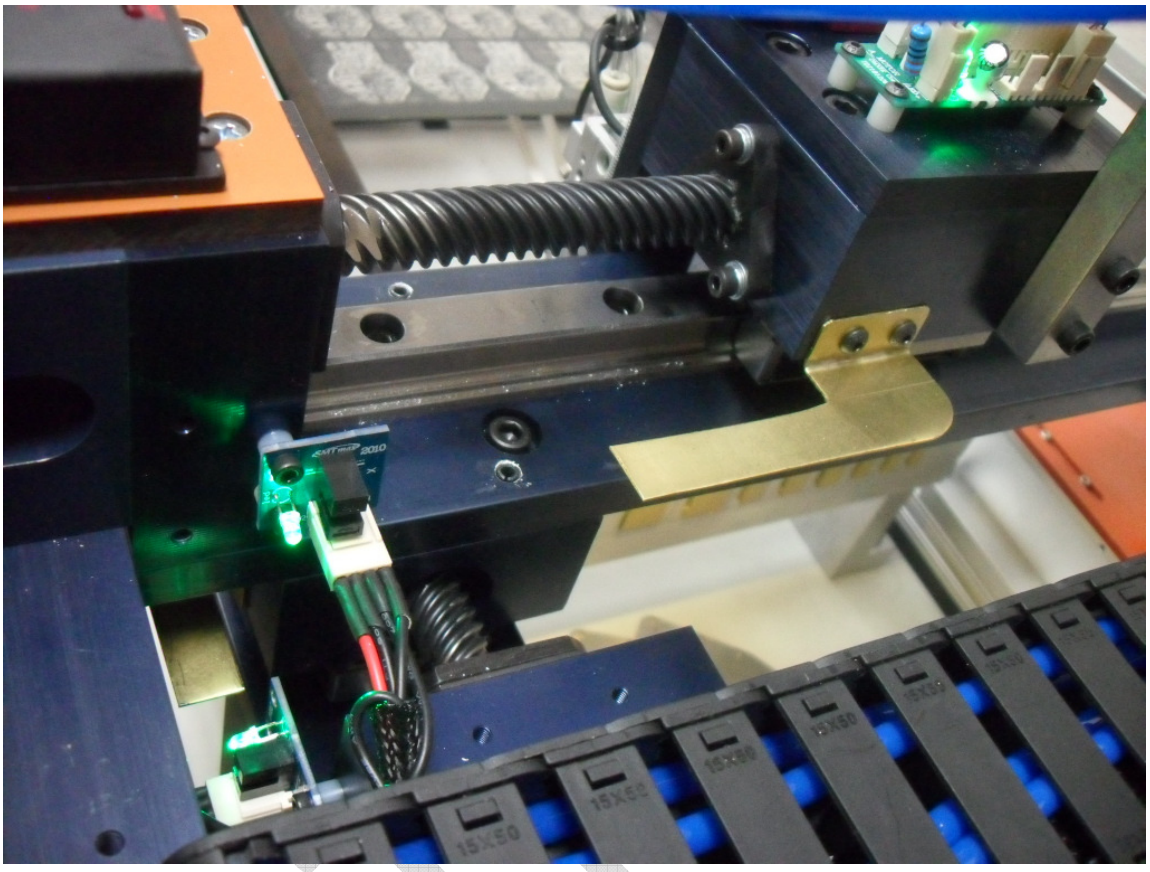


Figure 1.17: X,Y and top of head Limit Switch LED lights (Three)

If some of the lights do not turn on, please refer to the Troubleshooting section for instructions.

The machine is now ready. Before you start using it, however, you should read Chapter 2 for an overview of the operation process. The other chapters provide information and instruction on specific parts of that process.

Chapter2. Home

The QM1000, QM2000, and QM3000 series of Automatic Pick and Place Machines feature two types of home locations, which are used to calibrate the head's precise location during operation so as to reduce errors.

The MECHANICAL HOME, which we will denote H1, is preset to be the physical location where the four switch sensors (one for each of X, Y, Z, and A Rotation) on the machine head are simultaneously intersected by the copper plates shown in Figure 1. All locations in the system are relative to H1, which is defined to be mechanical (0, 0). H1 physical location is not modifiable by the user.

The SOFTWARE HOME, which we will denote H2, is determined by the location of the CALIBRATION ROD. The CALIBRATION ROD is a cylinder with a series of concentric circles painted on its top. The center of the circles represents H2 with respect to the position of the camera implanted in the machine head.

The location of the CALIBRATION ROD is based on user preference and is usually set during the user customization process prior to delivery. By default, H2 should already be set according to the location of the CALIBRATION ROD. However, in the case that it isn't set, or in the case that it's off due to components being shifted during delivery, the following steps may need to be performed.

To locate the existing software home, H2, follow these steps:

Locating Software Home

1. Start up the machine and software as detailed in Chapter 1 above.
2. During software initialization, the machine head should automatically move to H2. If not, click the HOME button at the upper right corner of the MAIN WINDOW.
3. In the MAIN WINDOW, an image should appear corresponding to the display of the DOWNLOOKING CAMERA located on the machine head.
4. When the machine stops moving after software initialization or after clicking the HOME button, the crosshairs of the MAIN WINDOW image should be placed on the CALIBRATION ROD such that the center of the crosshairs is the same as the center of the concentric circles.

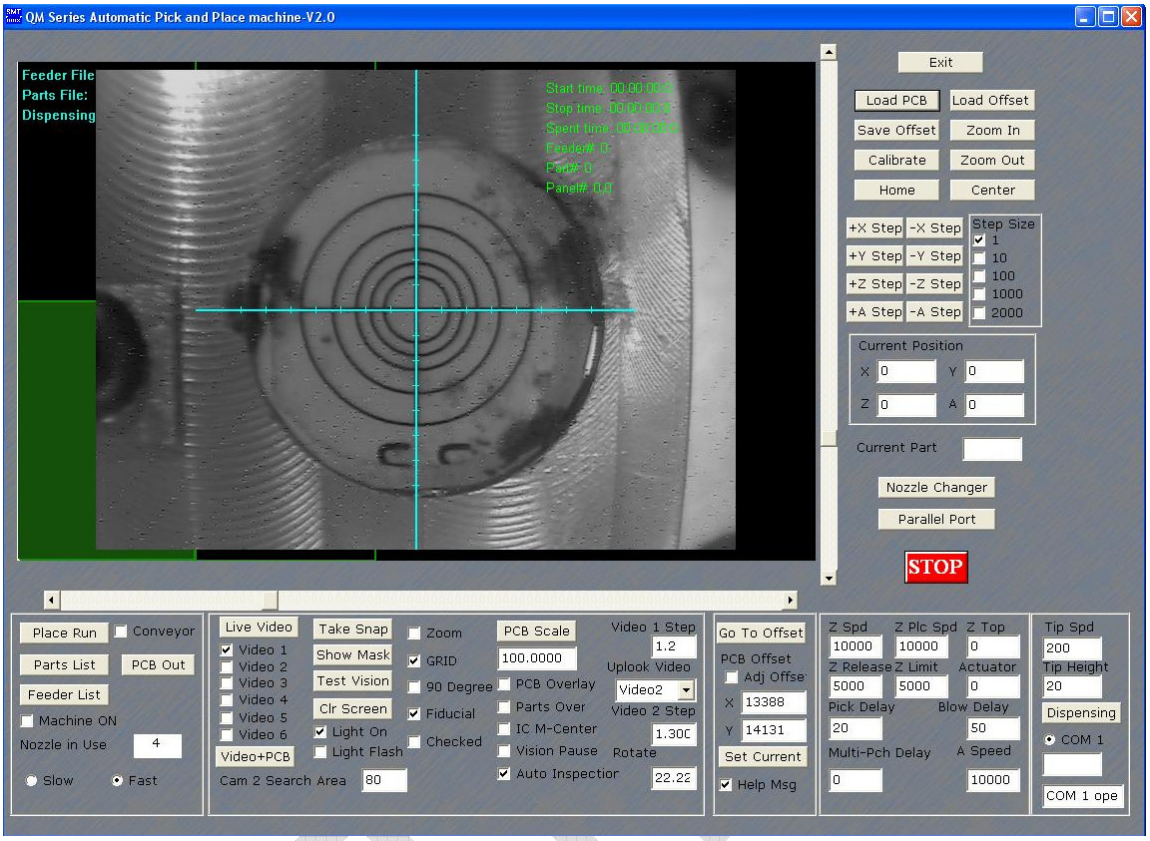


Figure 2.1: MAIN WINDOW crosshairs centered on the middle of the CALIBRATION ROD

5. If the image that appears in the MAIN WINDOW is not what you see above, then H2 needs to be reset.

Software Home Setup

1. Start up the machine and software as detailed in Chapter 1 above.
2. The MAIN WINDOW should pop up on the computer screen following software initialization.

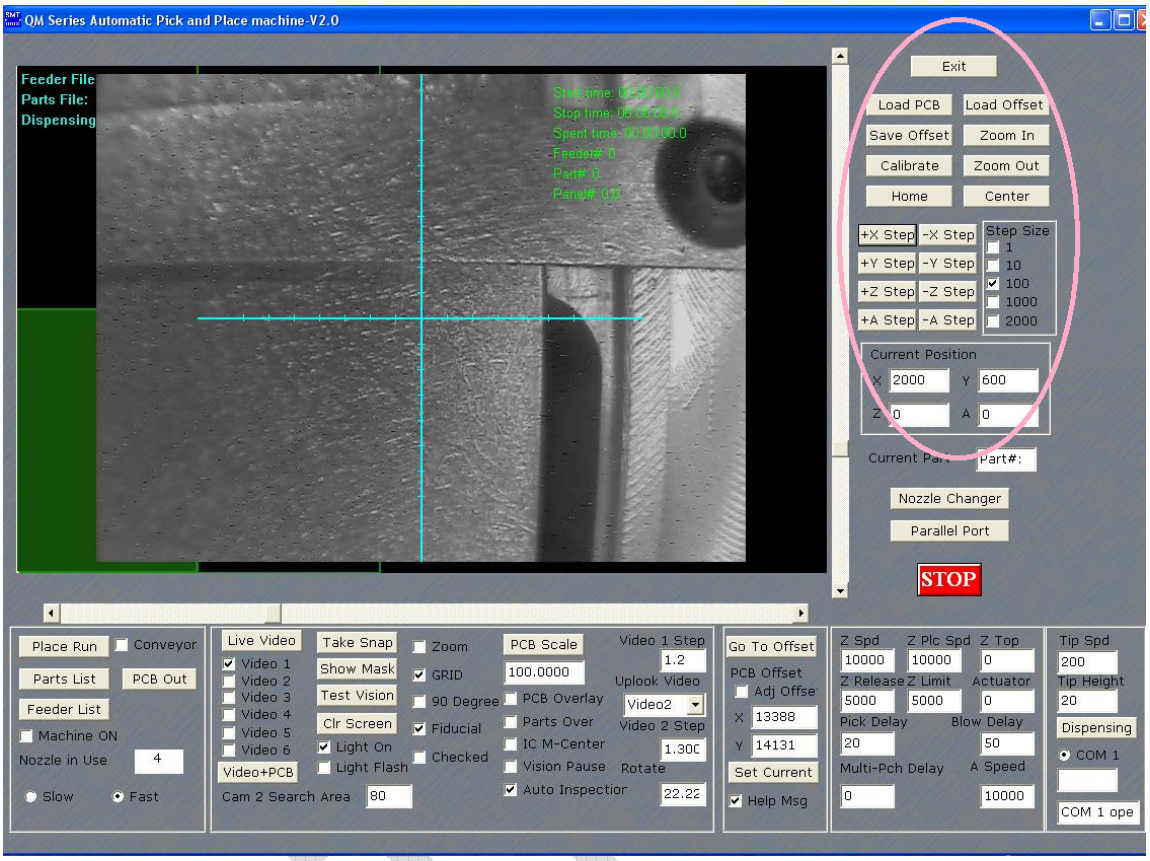


Figure 2.2: The MAIN WINDOW on start up, with NAVIGATION PANEL circled

3. Locate the NAVIGATION PANEL, which is used to navigate the machine head.
4. Under the NAVIGATION PANEL, you should see X and Y adjustment buttons labeled +X STEP, -X STEP, +Y STEP, and -Y STEP. The (+) and (-) are directions relative to H1. Use the buttons to move the machine head until the crosshair shown in the MAIN WINDOW is centered on the CALIBRATION ROD, as shown in Figure 2.1.

   TIP: You may need to change the displacement magnitude of the adjustment buttons to achieve an accurate centering. To do this, use the checkboxes labeled 1, 10, 100, etc. located right under Step Size in the NAVIGATIONAL PANEL shown above. These checkboxes determine the number of units to move per step.

5. Once centering is achieved, click CALIBRATE -> HOME SET TO CURRENT -> OK. The X and Y LOCATION should change to the current location of the machine head (recall that the exact numbers are relative to H1).

6. Using the mouse cursor, select a square area corresponding to the inner four rings of the CALIBRATION ROD (which should have five rings in total) as displayed in the MAIN WINDOW.

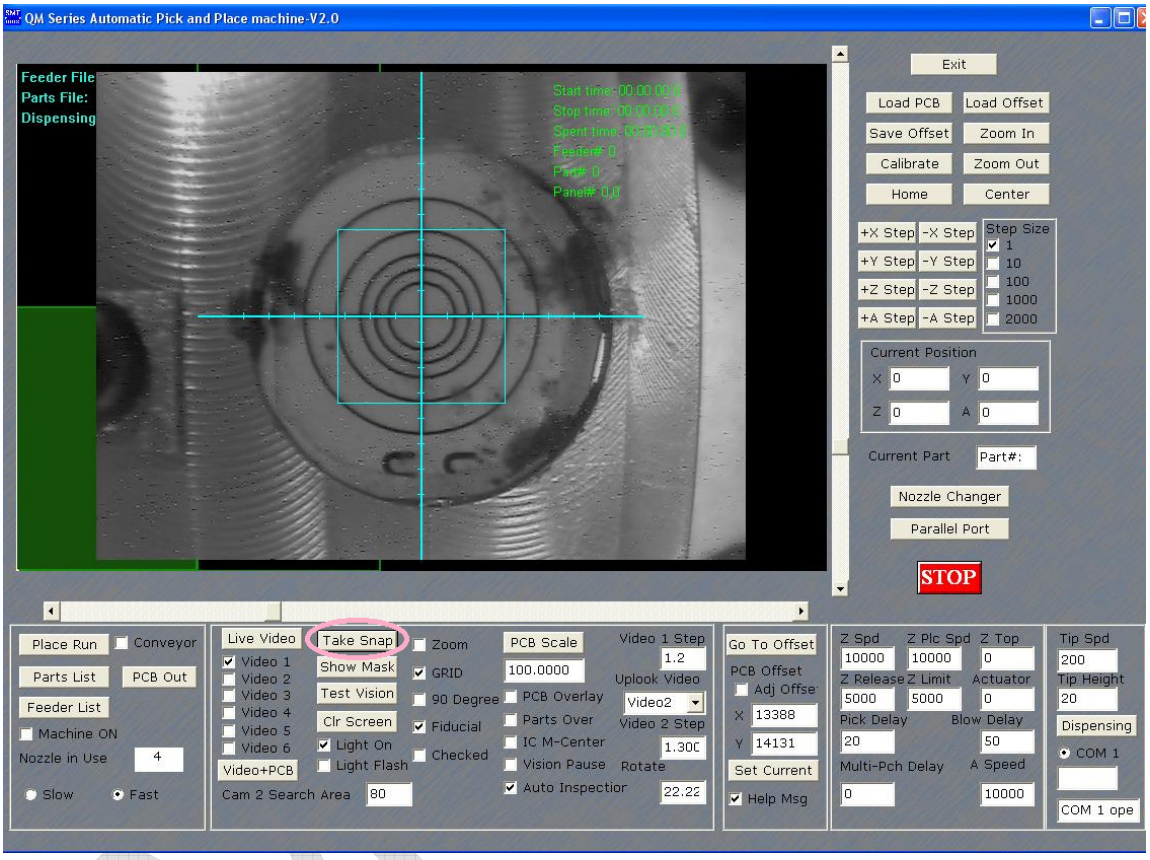


Figure 2.3: MAIN WINDOW crosshairs centered on the middle of the CALIBRATION ROD, with a selection box corresponding to the inner four rings of the CALIBRATION ROD, and the TAKE SNAP button circled

7. Click the TAKE SNAP button, which is located at the bottom panel of the MAIN WINDOW. Save the image as "home.tiff" in the [program location]/parts directory. This is the image that the machine's vision system will use to verify whether it is at H2.

   IMPORTANT: The snap image *must* be named "home.tiff" and *must* be placed in the [program location]/parts directory, as this is what the software will be looking for when it is searching for an image of H2. As such, at any one time, there can only be one image corresponding to H2.

8. To verify the success of this process, click the HOME button in the main window. The machine head, if it isn't already at H2, should move first to H1, and then to H2.

Chapter3. Cameras

The QM1000, QM2000, and QM3000 series of Automatic Pick and Place Machines feature a number of integrated cameras. The cameras are not only used to view the working area, but are critical components of the vision system employed by the QM series of Automatic Pick and Place Machines for error checking and automatic calibration during operation. It is therefore important to setup the cameras before making use of the machine.

Camera System

The exact number of integrated cameras on a particular machine is subject to user customization, but will always include a DOWNLOOKING CAMERA, mounted on the machine head and looking downwards, and at least one UPLOOKING CAMERA, mounted on the base platform and looking upwards.

Downlooking Camera

There are two important offsets associated with the DOWNLOOKING CAMERA that must be set before operation: the NEEDLE-CAMERA OFFSET, for QM feeders, which describes the displacement between the pulling needle and the camera, and the NOZZLE-CAMERA OFFSET, which describes the displacement between the parts nozzle and the camera.

For both of these offsets, we will be providing instructions for setting them via the use of a component reel tape, which is included with reel feeders like the QM feeder.

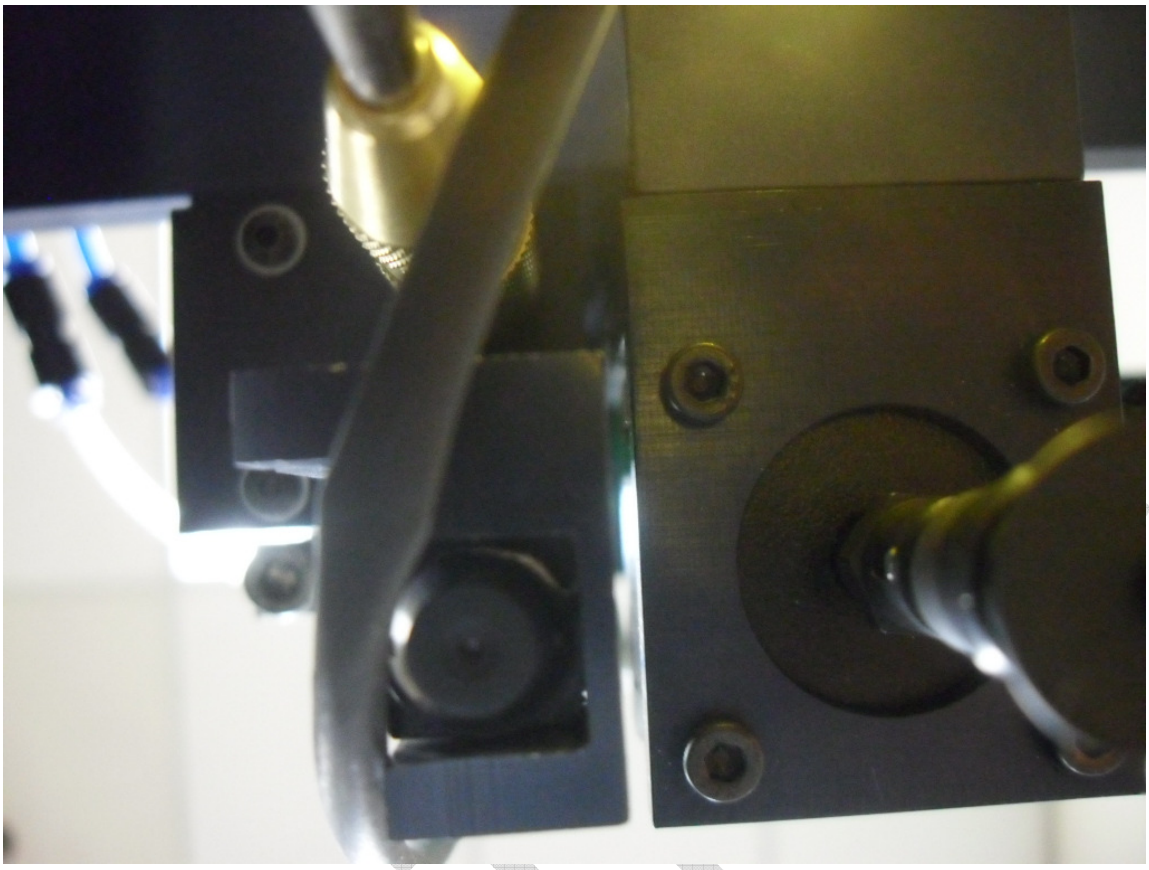


Figure 3.1: Downlooking Camera viewed from below

Needle-Camera Offset Setup for QM feeders

1. Using the NAVIGATION PANEL of the MAIN WINDOW, move the DOWNLOOKING CAMERA until its crosshairs are centered on a needle hole of the component reel tape.

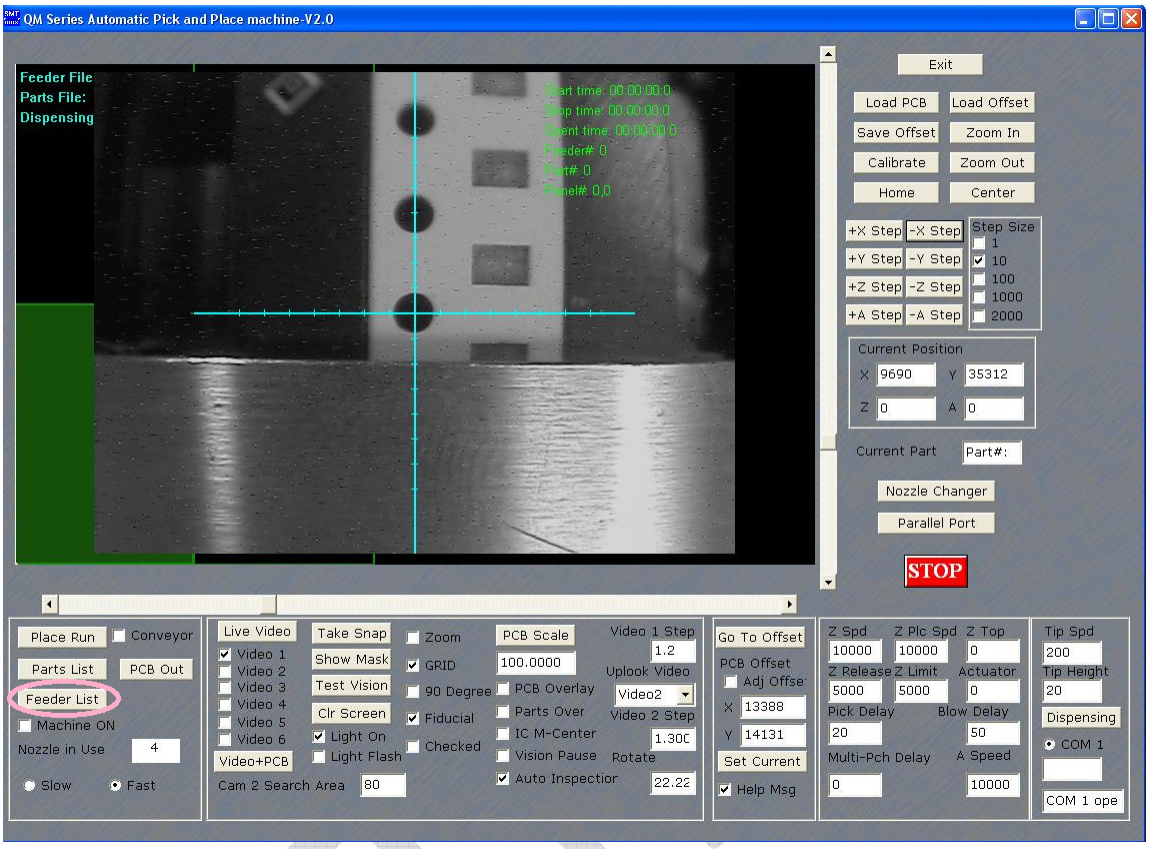


Figure 3.2: Crosshairs of the DOWNLOOKING CAMERA centered on a needle hole of the component reel tape, with FEEDER LIST BUTTON circled

2. Bring up the FEEDER LIST WINDOW by clicking the FEEDER LIST BUTTON in the MAIN WINDOW, and then click the SET CURRENT BUTTON to set the pulling needle position.

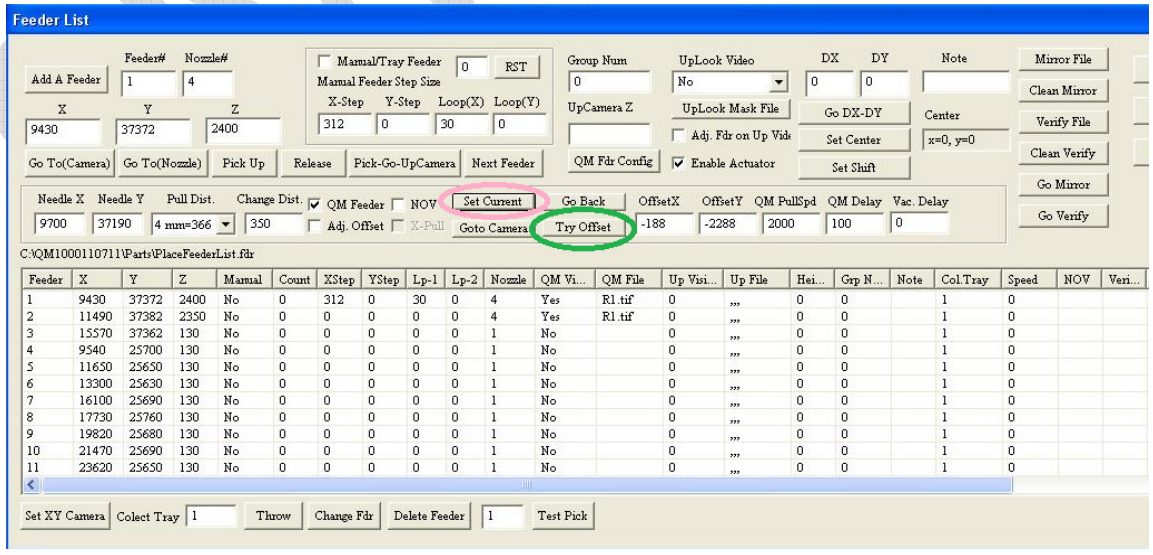


Figure 3.3: FEEDER LIST WINDOW with SET CURRENT BUTTON and TRY OFFSET BUTTON circled

3. Click the TRY OFFSET BUTTON. The pulling needle will move to hover over the needle hole.
4. Manually operate the pulling needle by physically pulling down on the white needle actuator shown here:

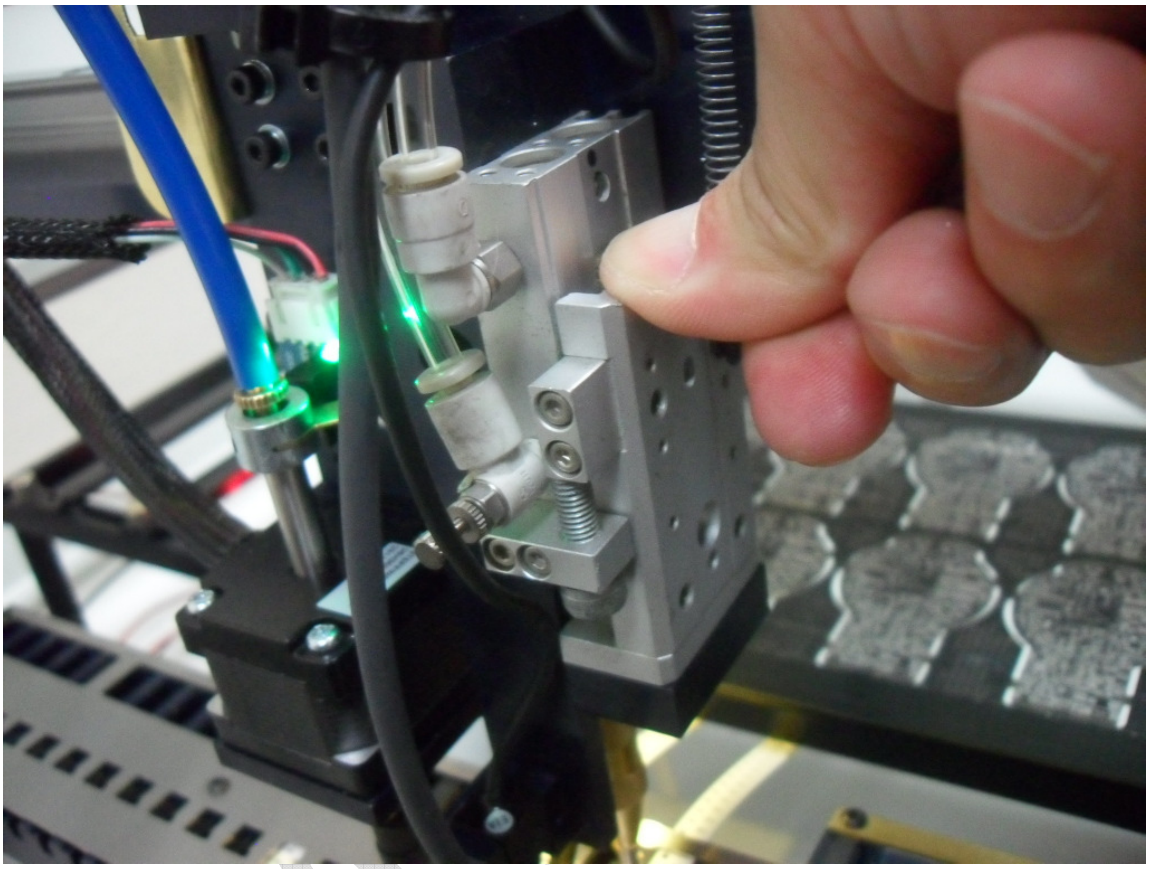


Figure 3.4: Physically pull the white actuator down to move the pulling needle down

5. If the pulling needle accurately enters the center of the needle hole, then STOP, because the needle-camera offset is already correct and nothing more needs to be done. If it doesn't, CONTINUE reading.

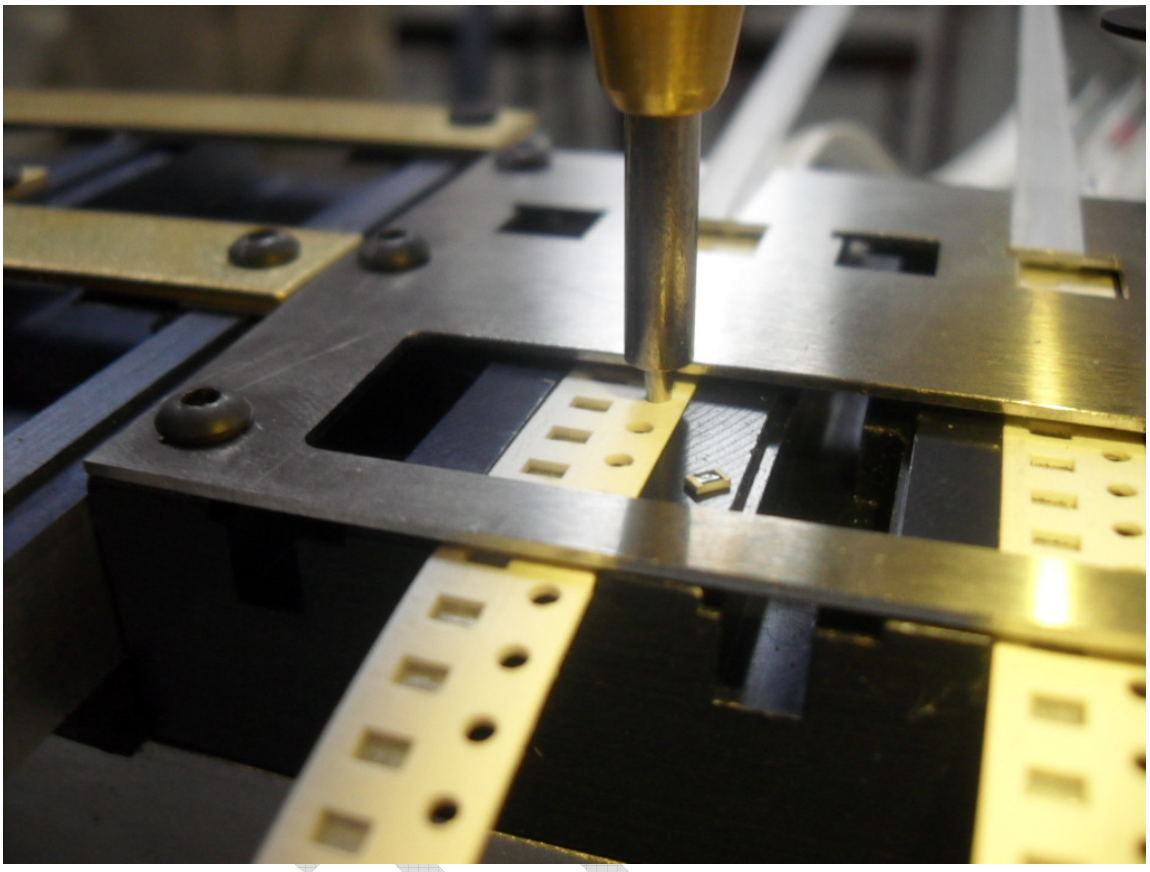


Figure 3.5: The pulling needle (and thus the needle-camera offset) is in the correct position

6. Use the NAVIGATION PANEL of the MAIN WINDOW to move the pulling needle such that it is centered over and accurately enters the needle hole.
7. Click the GO BACK BUTTON in the FEEDER LIST WINDOW. This will move the PICKUP HEAD away by a certain offset.

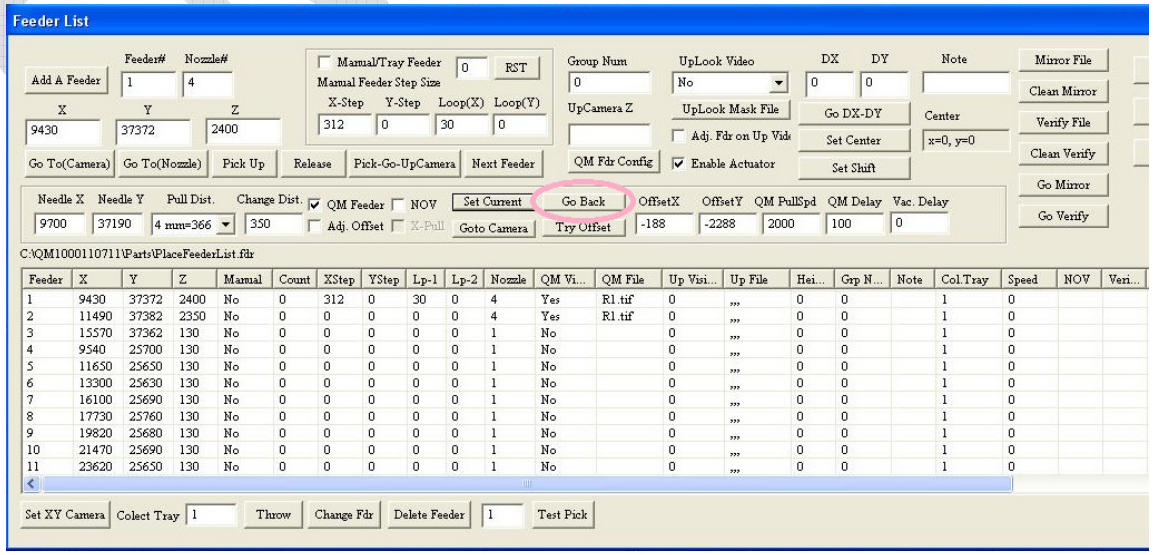


Figure 3.6: FEEDER LIST WINDOW with GO BACK BUTTON circled

8. Under the FEEDER LIST WINDOW, check ADJUST OFFSET. When prompted, click OK.

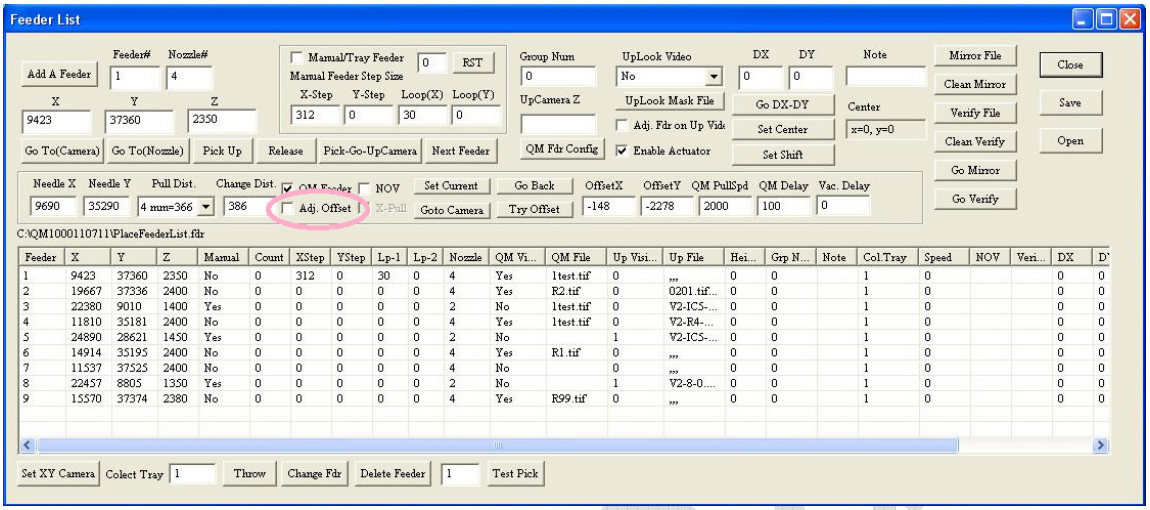


Figure 3.7: FEEDER LIST WINDOW with ADJUST OFFSET CHECKBOX circled

9. Now, using the NAVIGATION PANEL of the MAIN WINDOW, move the PICKUP HEAD such that the camera crosshairs become centered on the needle hole, as in Figure 3.2.
10. Uncheck the ADJUST OFFSET CHECKBOX in the FEEDER LIST WINDOW. The X and Y offset values should have changed.
11. Repeat Steps 1-5 to check that the new offset is correct.

Nozzle-Camera Offset Setup

1. The NOZZLE-CAMERA offset is calibrated using the component pocket, a rectangular slot used to hold parts located on the component tape. To begin calibrating the offset, click the CALIBRATE button on the MAIN WINDOW.

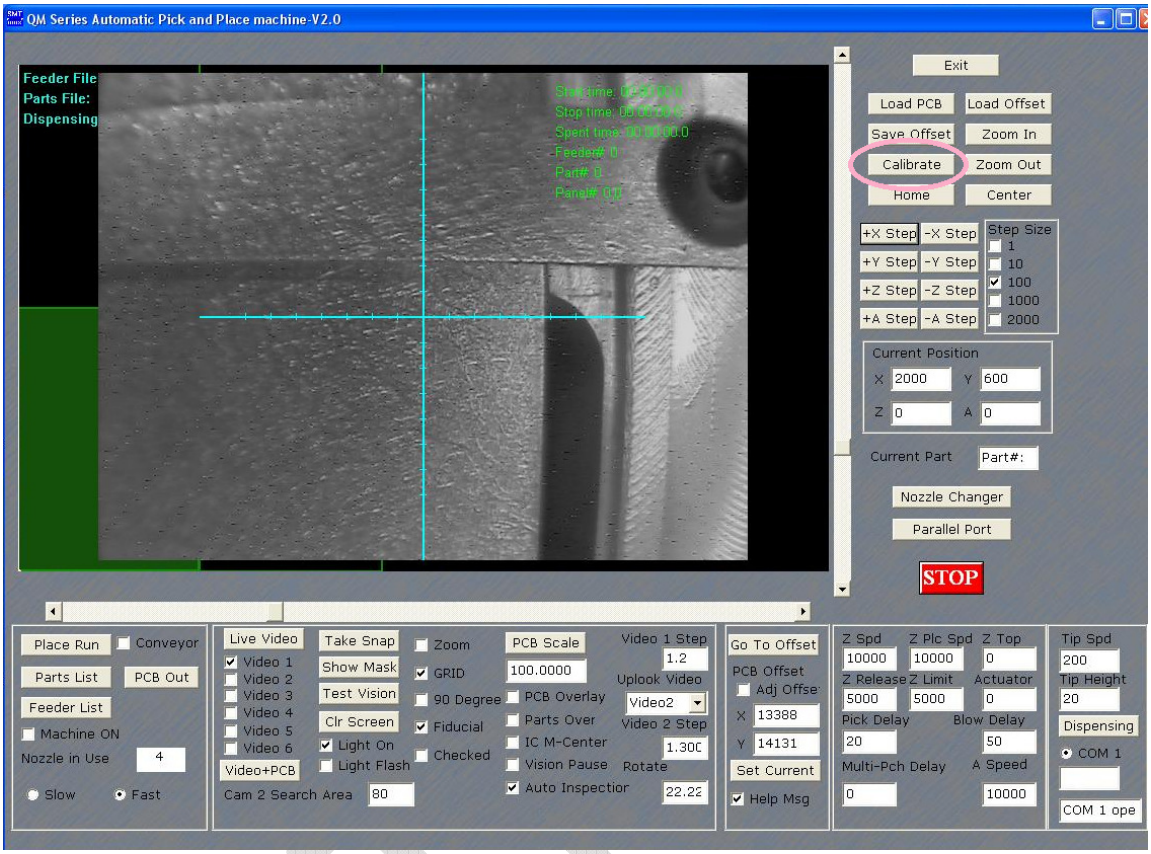


Figure 3.8: MAIN WINDOW with CALIBRATE BUTTON circled

2. Using the NAVIGATION PANEL, move the PICKUP HEAD until the camera crosshairs are centered on the component pocket, like this:

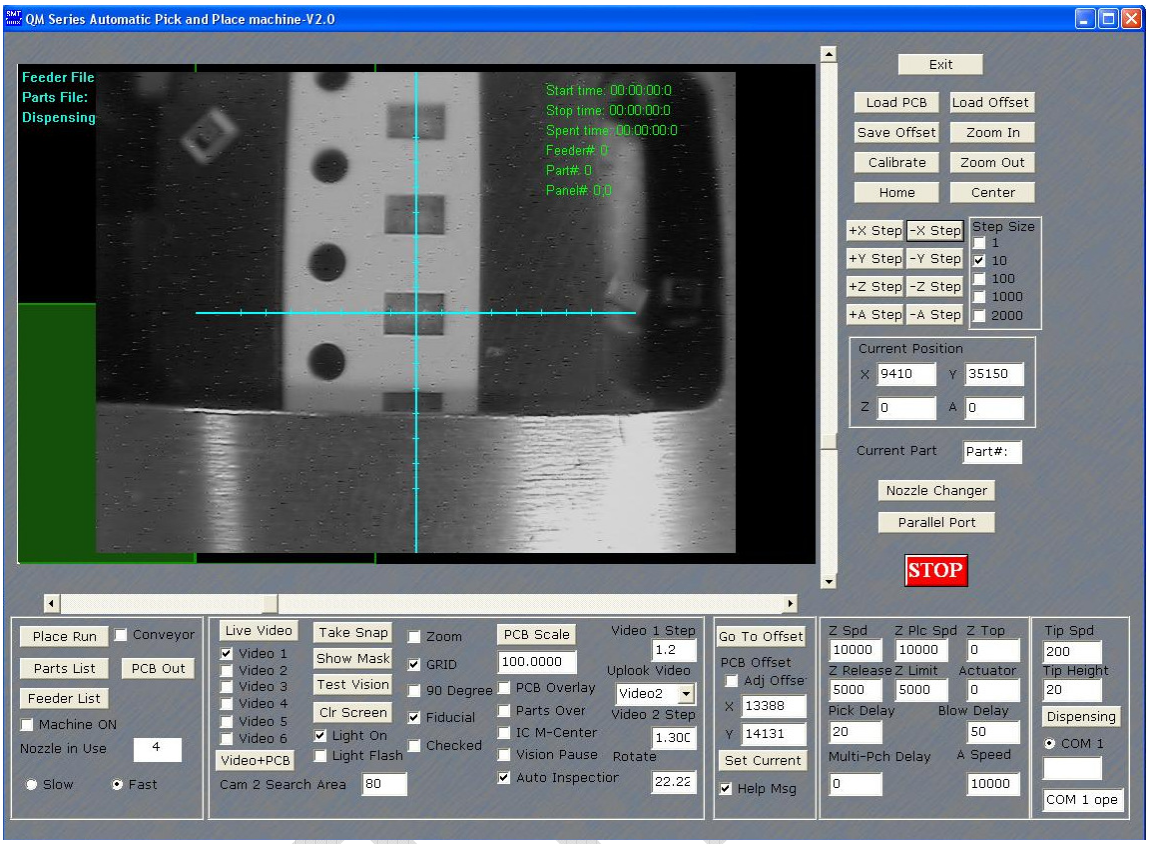


Figure 3.9: : Crosshairs of the DOWNLOOKING CAMERA centered on a component pocket of the component reel tape

3. Click the TRY OFFSET BUTTON in the CALIBRATE WINDOW. The parts nozzle will move to hover above the component pocket.

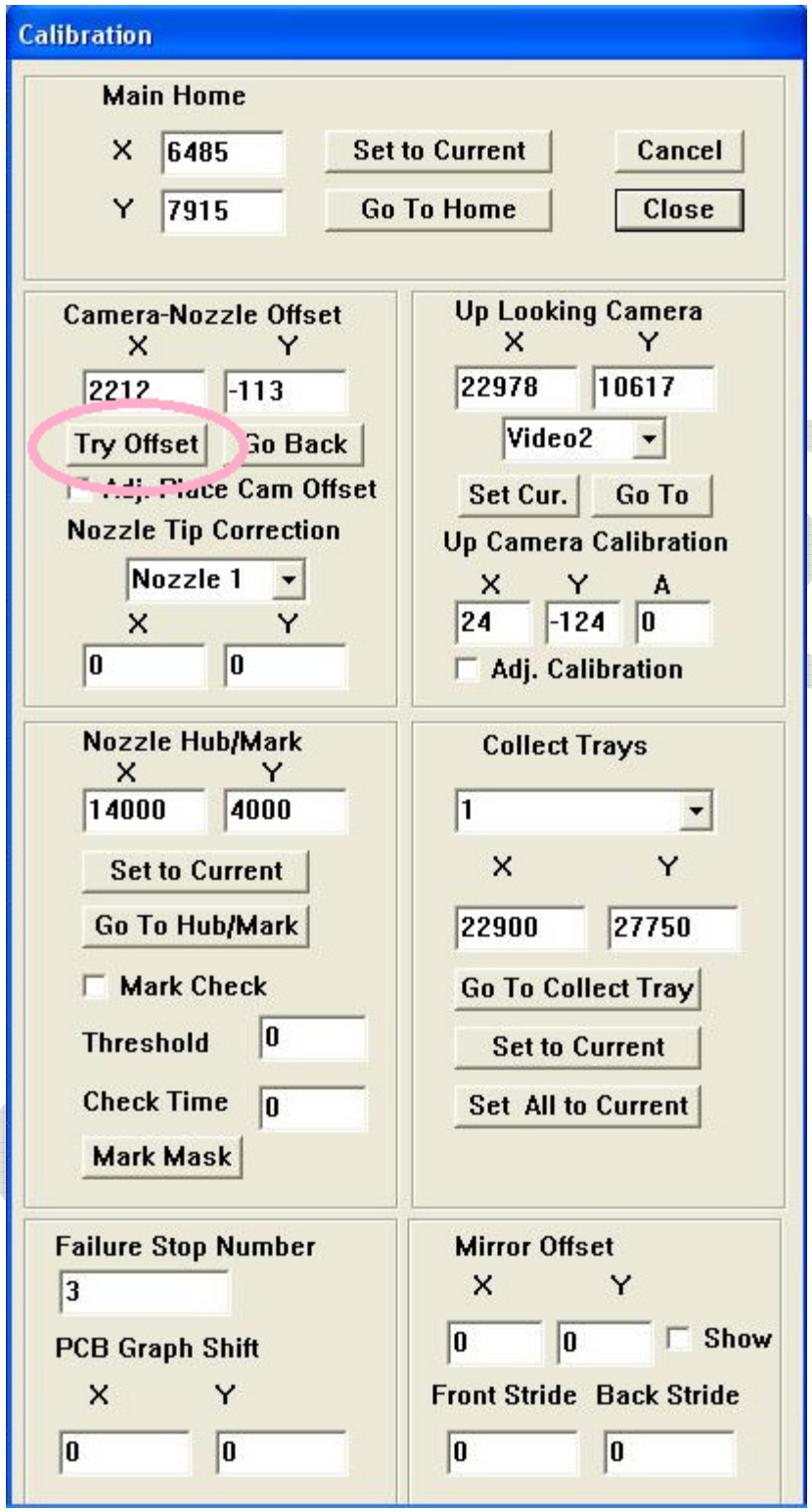


Figure 3.10: CALIBRATE WINDOW with TRY OFFSET BUTTON circled

4. Using the +Z STEP button under the NAVIGATION PANEL of the MAIN WINDOW, move the nozzle down towards the component pocket until you can see whether it is physically at the

center of the component pocket. If so, STOP, because the offset is already correct. If not, CONTINUE reading.

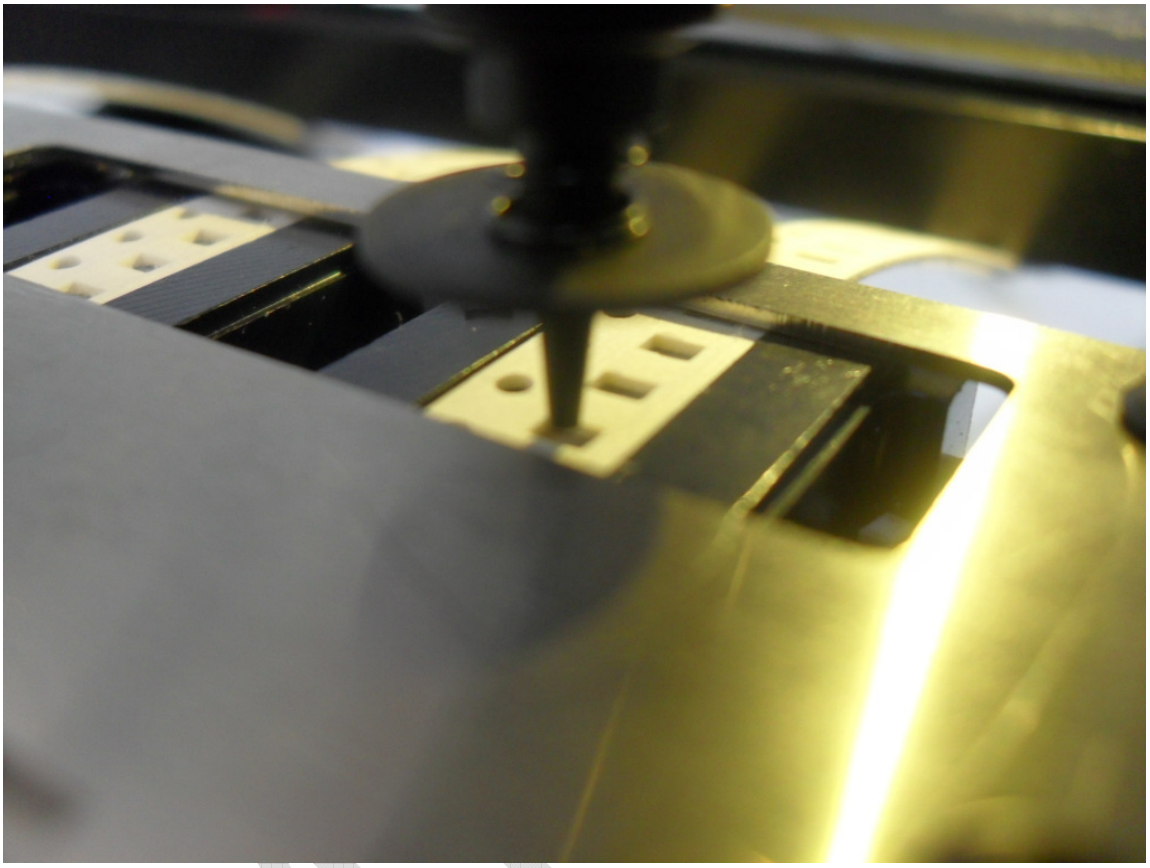


Figure 3.11: Correct nozzle position with respect to component pocket

5. Use the NAVIGATION PANEL of the MAIN WINDOW to move the parts nozzle such that it is physically centered over the component pocket, as in Figure 3.10.
6. Using the -Z STEP button under the NAVIGATION PANEL of the MAIN WINDOW, bring the PICKUP HEAD back to the Z = 0 position, then click the GO BACK BUTTON in the CALIBRATE WINDOW.

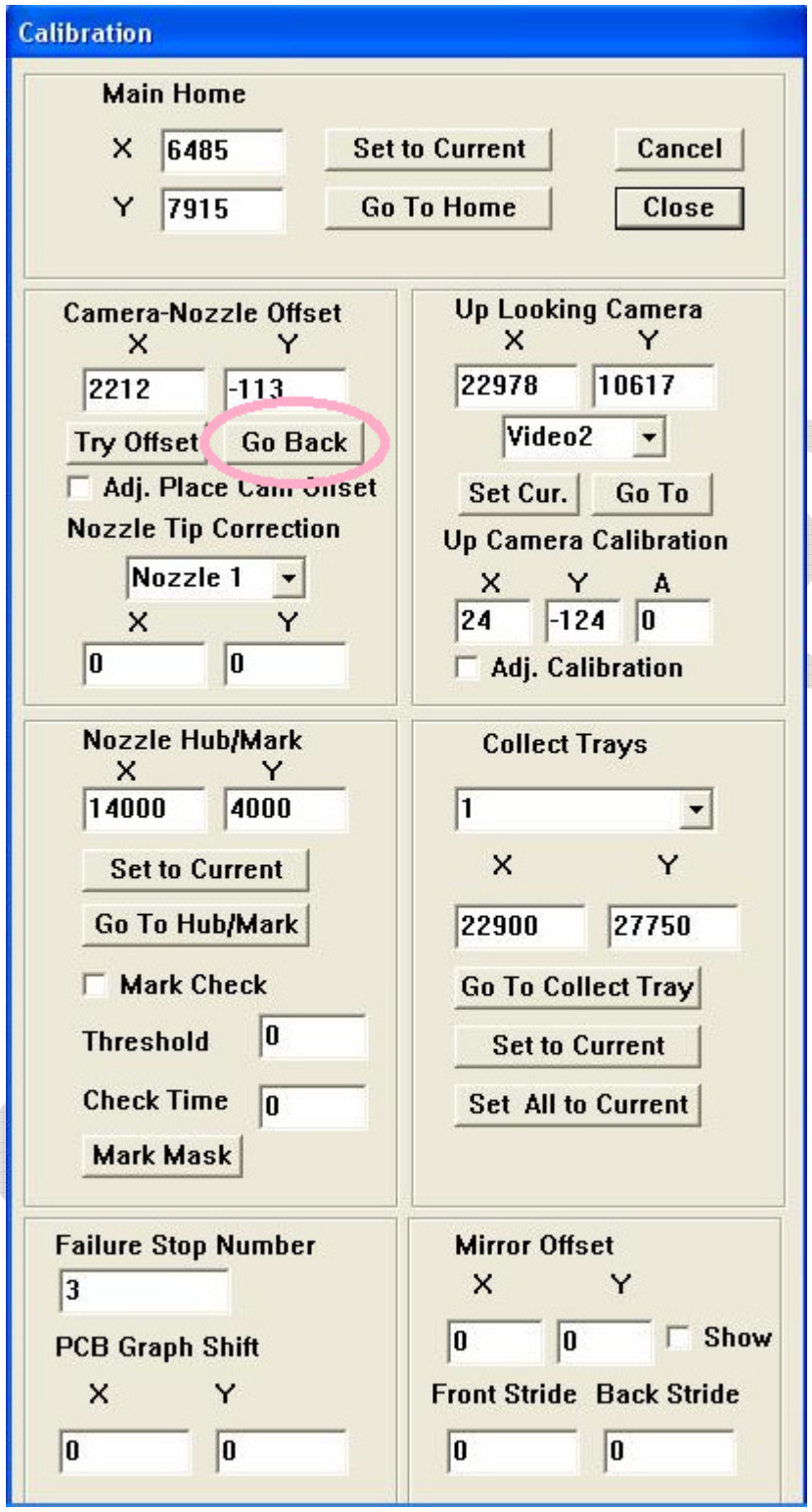


Figure 3.12: CALIBRATE WINDOW with GO BACK BUTTON circled

7. Check the ADJUST CAMERA OFFSET CHECKBOX in the CALIBRATE WINDOW, right below the TRY OFFSET and GO BACK BUTTONS.

8. Move the camera until its crosshairs are centered on the component pocket, as in Figure 3.9.
9. Uncheck the ADJUST CAMERA OFFSET CHECKBOX. The offset values in the boxes under CAMERA-NOZZLE OFFSET should have changed.

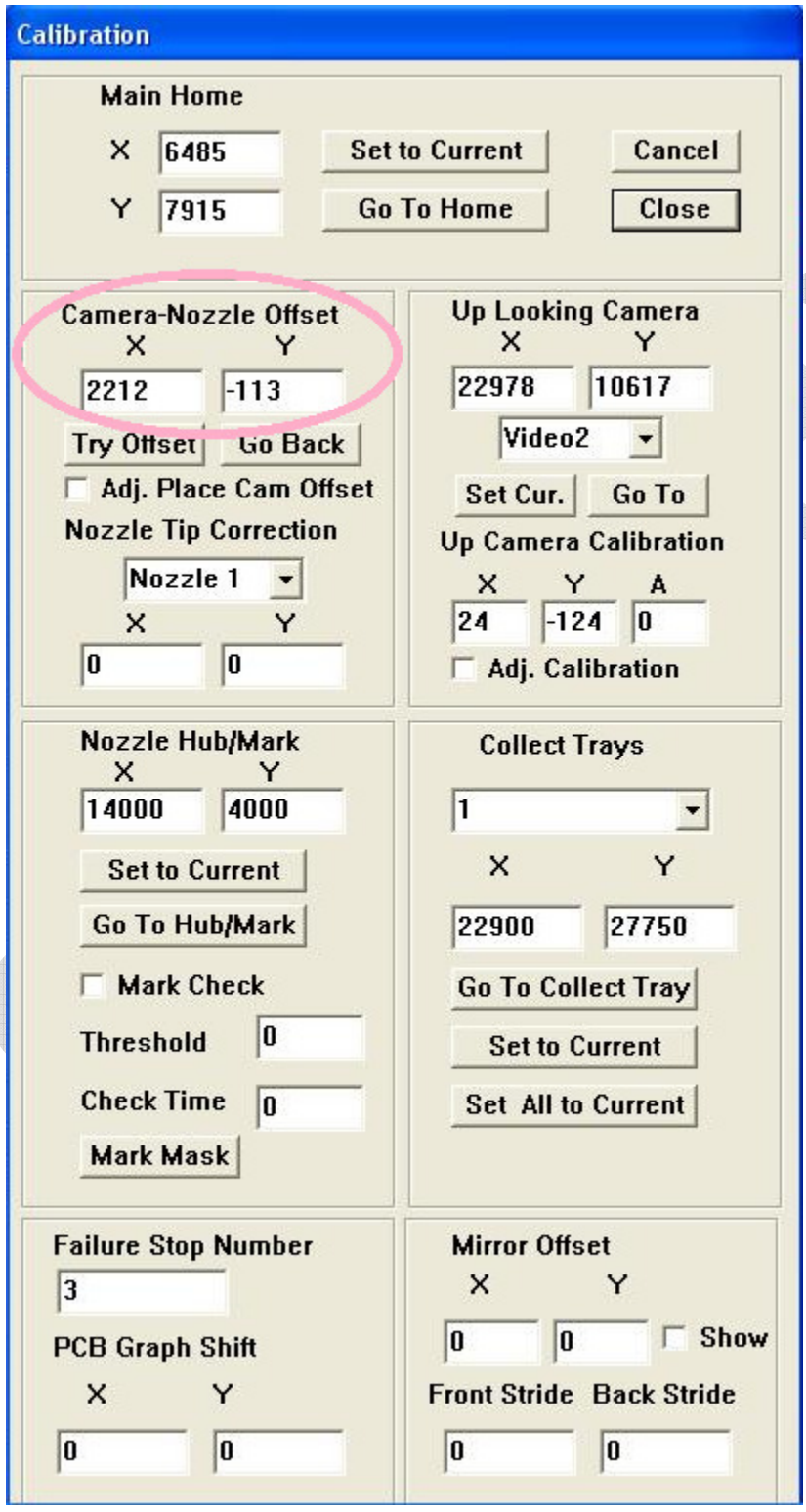


Figure 3.13: The offset values in the boxes right below Camera-Nozzle Offset should have changed after these steps

10. Repeat Steps 1-5 to check that the new offset is correct.

Uplooking Camera

The intended use of an uplooking camera is to examine and validate parts during the pick and place process. A QM pick and place machine comes with at least one uplooking camera, though the option exists, at purchase time, for the addition of a second, high resolution uplooking camera for use with tiny parts that the standard camera is inadequate for. Instructions for setting up the two cameras are mostly the same.

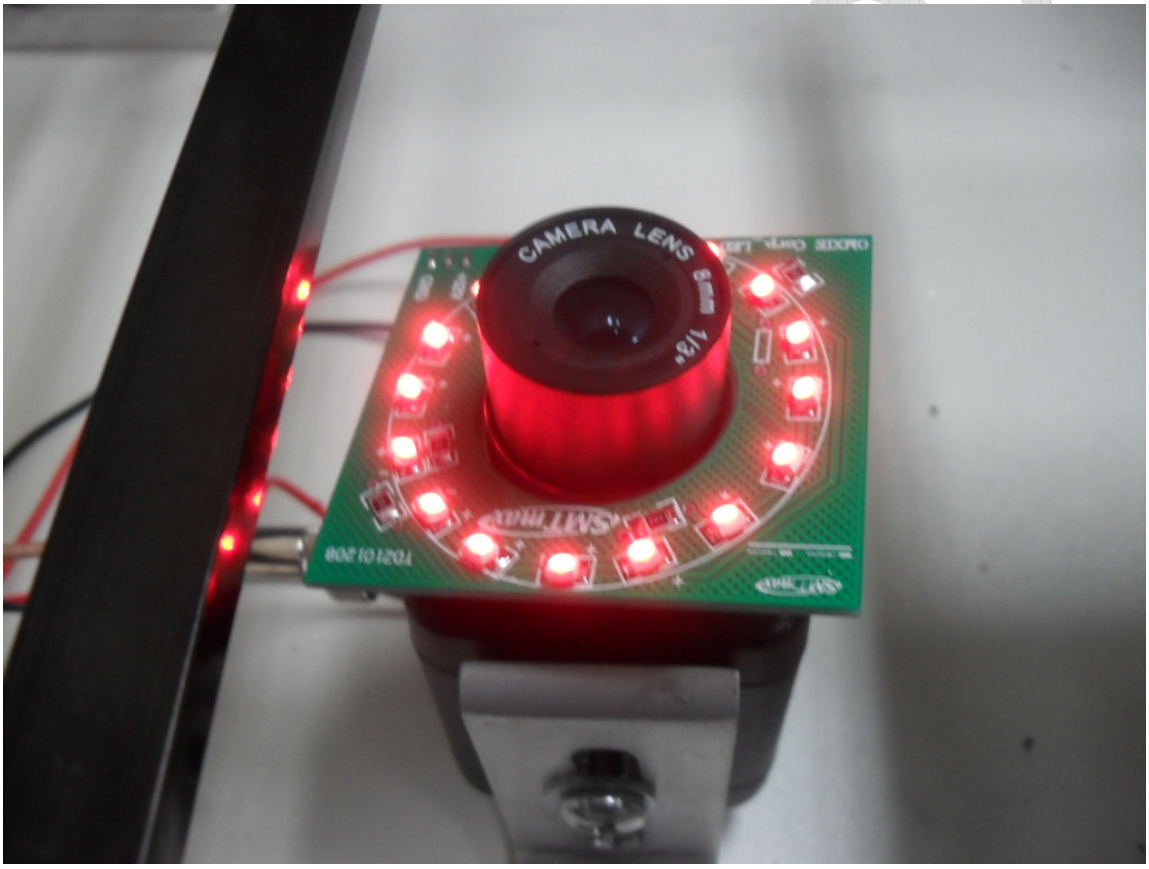


Figure 3.14: Uplooking Camera viewed from top side

Uplooking Camera Setup

1. In the MAIN WINDOW, click CALIBRATE to bring up the CALIBRATION WINDOW.

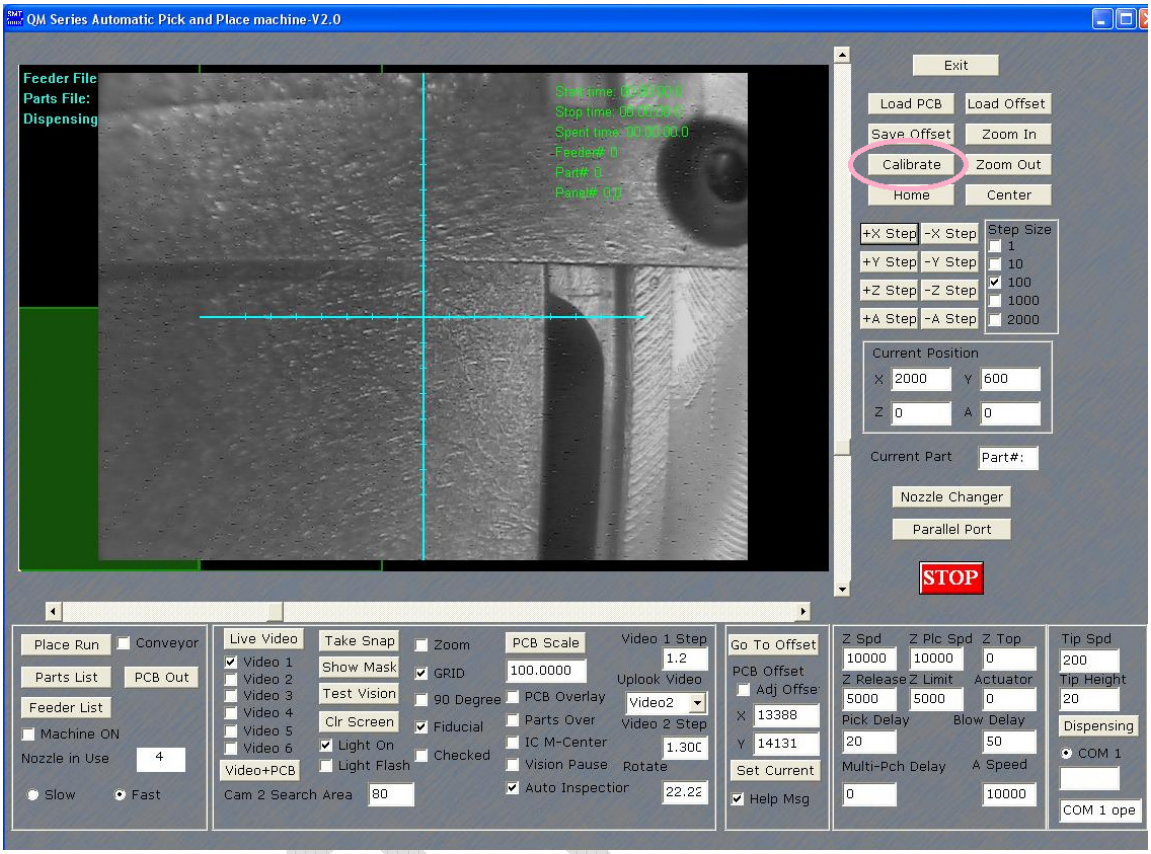


Figure 3.15: MAIN WINDOW with CALIBRATE BUTTON circled

2. Under the section labeled Uplooking Camera, you will see a pull down box with various VIDEO selections. The default uplooking camera is VIDEO 2, and on machines with one uplooking camera this is the only VIDEO you need to worry about. For machines with two uplooking cameras, the second uplooking camera is usually VIDEO 4.

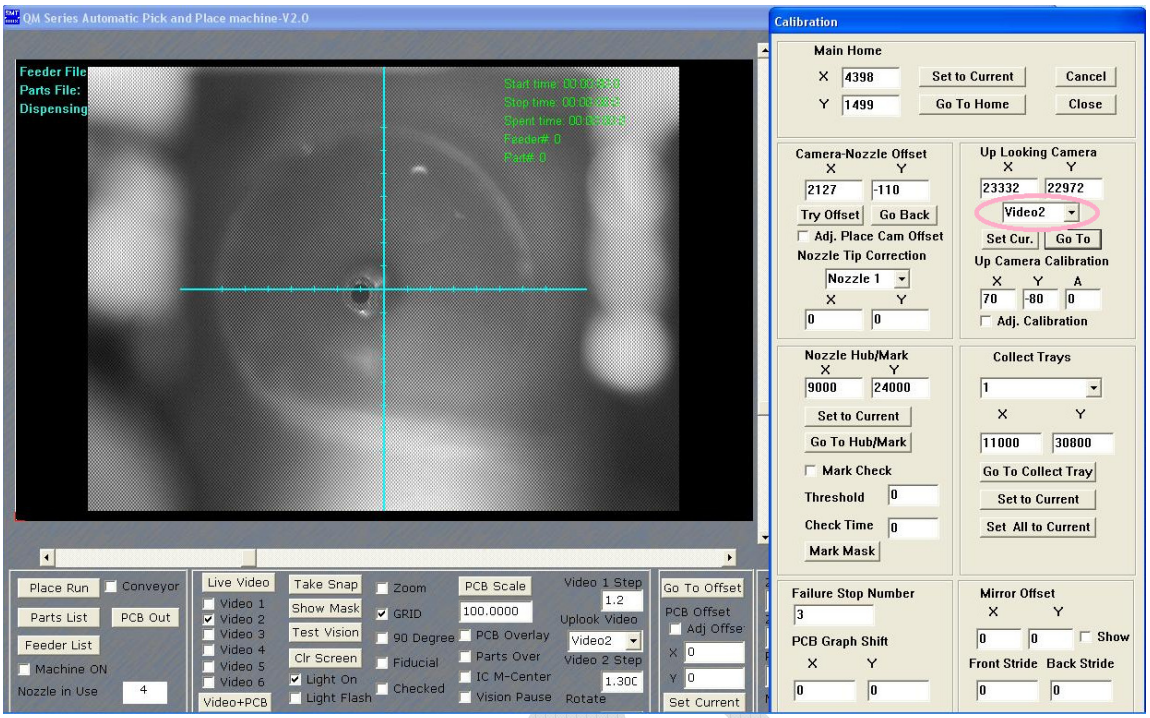


Figure 3.16: CALIBRATION WINDOW with UPLOOKING CAMERA VIDEO circled

3. Select the desired UPLOOKING CAMERA VIDEO and then click the GO TO BUTTON right below it and to the right. This will cause the PICKUP HEAD to move to the UPLOOKING CAMERA and then switch the main screen view to the camera (which defaults to VIDEO 2).
4. What you *should* see on the main screen is a set of crosshairs centered on the NOZZLE, as viewed from below. This is the correct position for the UPLOOKING CAMERA.

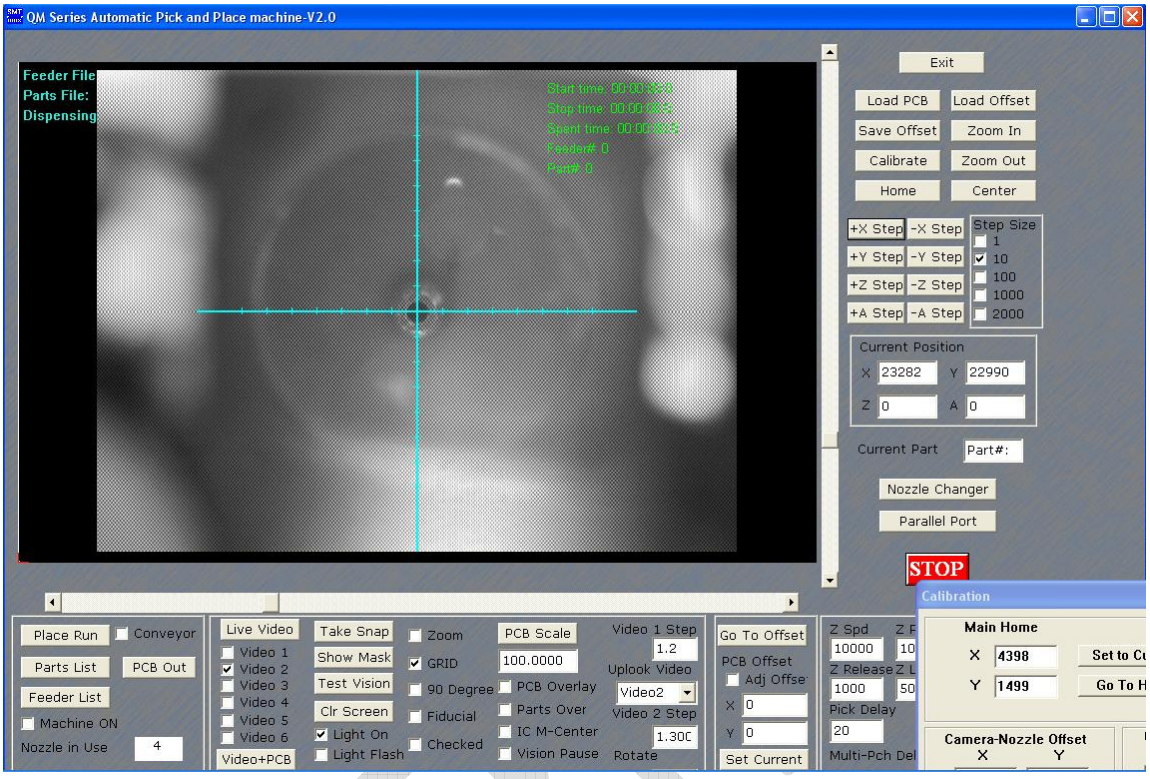


Figure 3.17: Crosshairs of the UPLOOKING CAMERA centered on the nozzle, as viewed from below

5. If the UPLOOKING CAMERA is NOT in this position, as it isn't in Figure 3.14, for example, then it needs to be calibrated.
6. To calibrate the UPLOOKING CAMERA, while the main screen is switched to the UPLOOKING CAMERA view (default VIDEO 2), use the NAVIGATIONAL PANEL to move the PICKUP HEAD until the crosshairs of the UPLOOKIN CAMERA are centered on the nozzle tip, as shown in Figure 3.15.
7. Click the SET CUR. BUTTON in the CALIBRATION WINDOW to set the UPLOOKING CAMERA position to the current position.

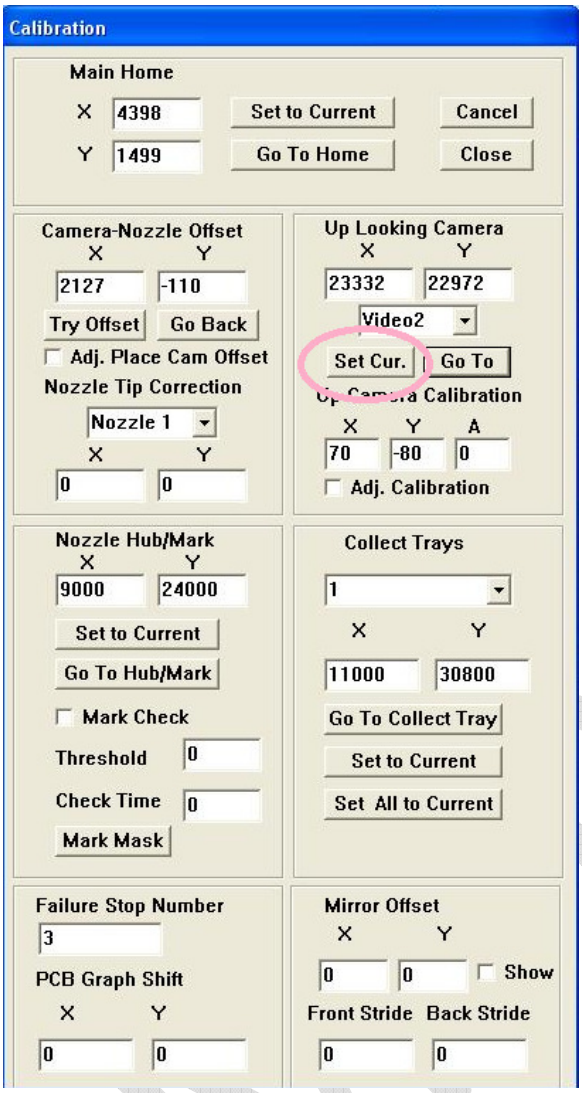


Figure 3.18: CALIBRATION WINDOW with SET CUR. BUTTON circled

8. Zero out the values in the X, Y, and A BOXES under Up-Camera Calibration. These values need to be 0, 0, 0 after calibrating the Up Looking Camera.
9. The position of the UPLOOKING CAMERA should now be correct. Verify that it is by clicking GO TO HOME in the CALIBRATION WINDOW and then GO TO under the Uplooking Camera section. The main screen should display the UPLOOKING CAMERA's vision as a set of crosshairs centered on the NOZZLE as viewed from below, as in Figure 3.15.

Chapter4. Feeders

The QM series of Automatic Pick and Place Machines support several different types of feeders, which are divided into the following categories based on operational requirements.

Automatic Feeders are feeders that make use of the machine needle to pull a component tape forward or which use air pressure to advance through components. Examples are:

- QM Feeder
- Yamaha Feeder

Vibration-Based Feeders are feeders that use mechanical vibration to shake parts down a tube and/or slide. They do not require the machine needle to operate and also do not require manual intervention during operation:

- Vibratory Feeder
- Bowl Feeder

Tray Feeders are feeders in which components are arranged in a matrix, such that each component on the feeder is a regular metric distance away from another component in either the X or Y direction. Operations on tray feeders proceed in a batch format, incrementing a regular number of units in the X or Y direction after each pickup.

- Waffle Tray Feeder

Manual Feeders are feeders that require manual (human) intervention in-between pickups. For example, a manual tape feeder requires an operator to drag the tape forward after a certain number of pickups.

- Loose Part Tray Feeder
- Manual Tape Feeder

The size, number, and types of feeders are usually determined at purchase time and shipped with the machine. In general, SMT Max does not guarantee plug and play capability for feeders that do not come with the machine. User discretion during installation is advised.

QM Feeder

The QM feeder is a SMT proprietary tape-based automatic feeder in which the tape is physically moved by a needle mounted on the pickup head during operation. For QM feeders, every tape corresponds to a particular part. The number and sizes of the feeder slots are based on

customer preference. The QM2100 machine, for example, can support up to 50 simultaneous feeders. Each feeder can be of size 8mm, 12mm, 16mm, 24mm, 32mm, or 44mm.

In order to add a new tape-based feeder, the feeder must first be physically connected to the machine, as follows:

1. Place the QM tape reel on a nearby tray connected to the machine.

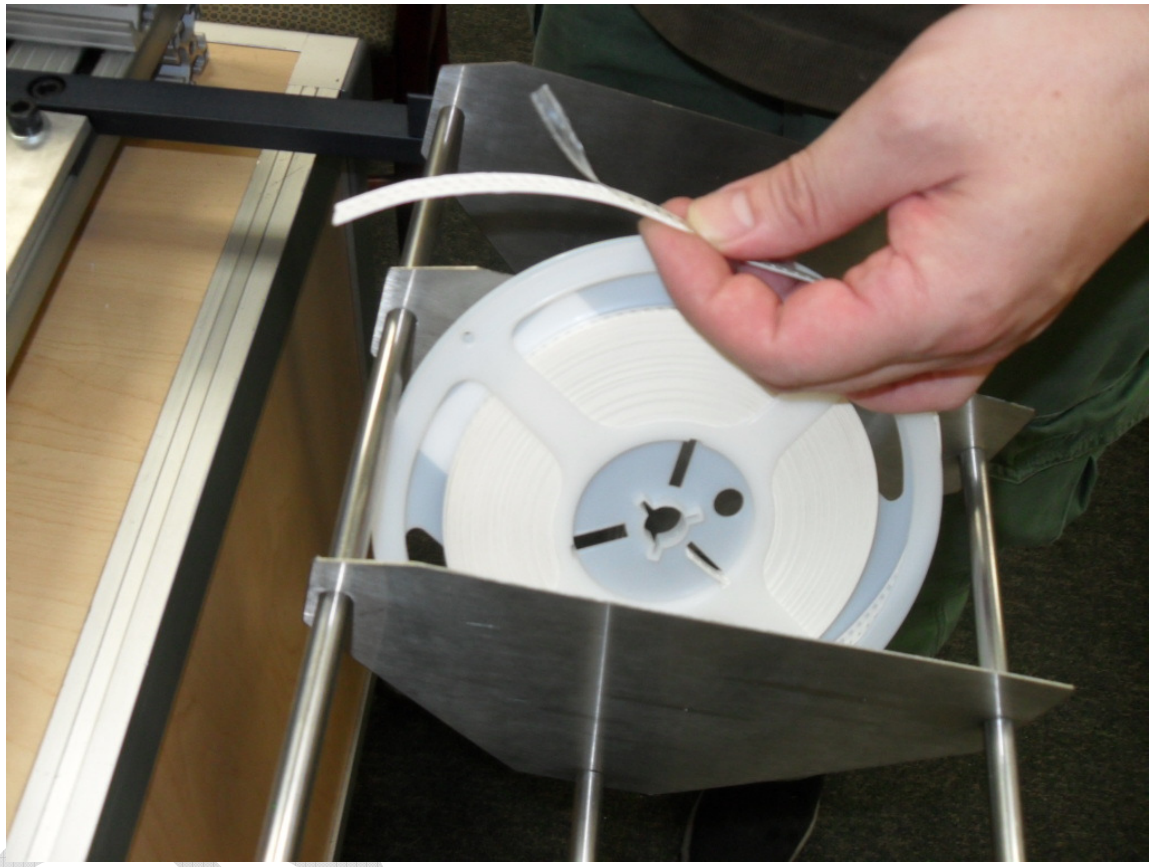


Figure 4.1: The QM tape reel placed on a nearby tray connected to the machine.

2. The QM feeder platform should have come pre-installed with the machine. Drag the tape into one of its open tape slots.

Figure 4.2: The QM reel tape inserted into the feeder platform

3. Carefully drag the QM reel tape through the feeder platform until it reaches the pick-up chute, circled below.

Figure 4.3: QM feeder platform with pick-up chute circled

4. Next, pull the transparent plastic tape covering the parts on the feeder tape out of the pick-up chute.

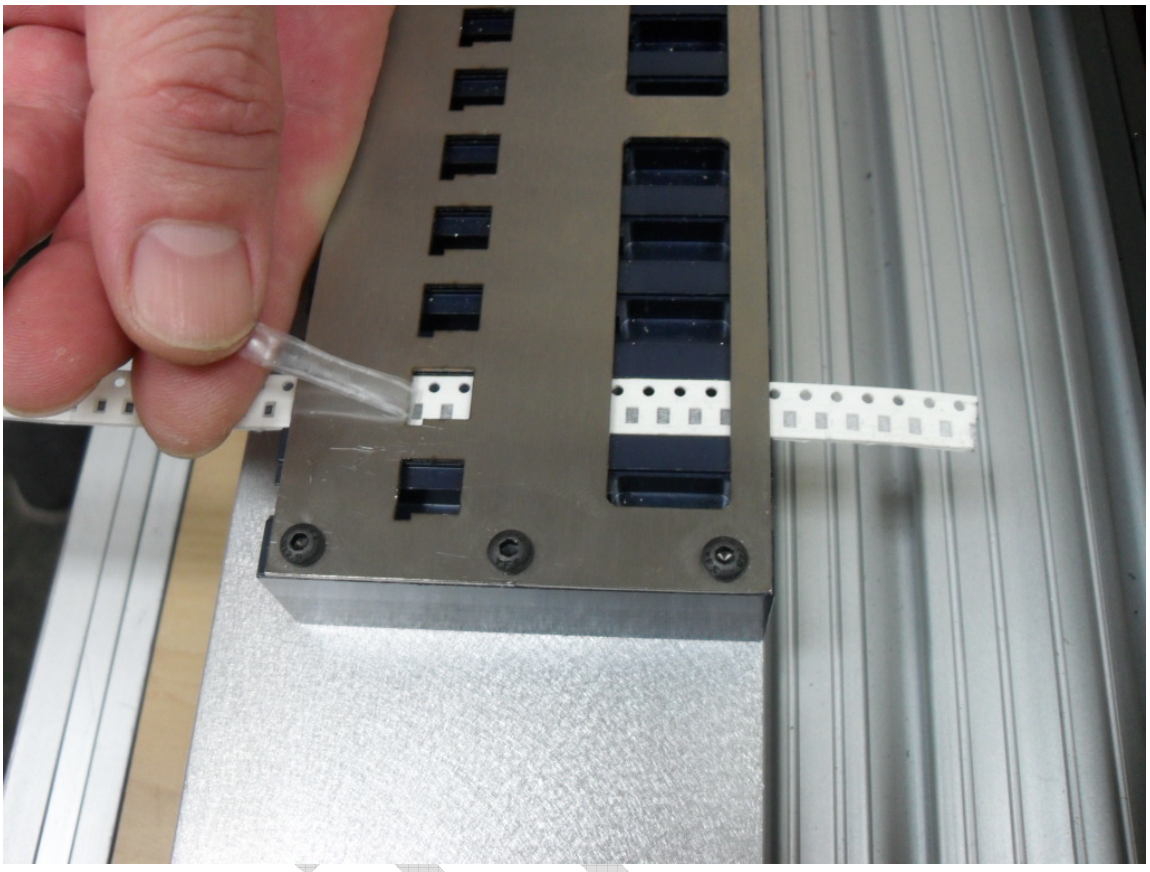


Figure 4.4: The plastic cover tape being pulled out of the pick-up chute.

5. Tie the plastic cover tape to another piece of plastic tape or a string of some kind.

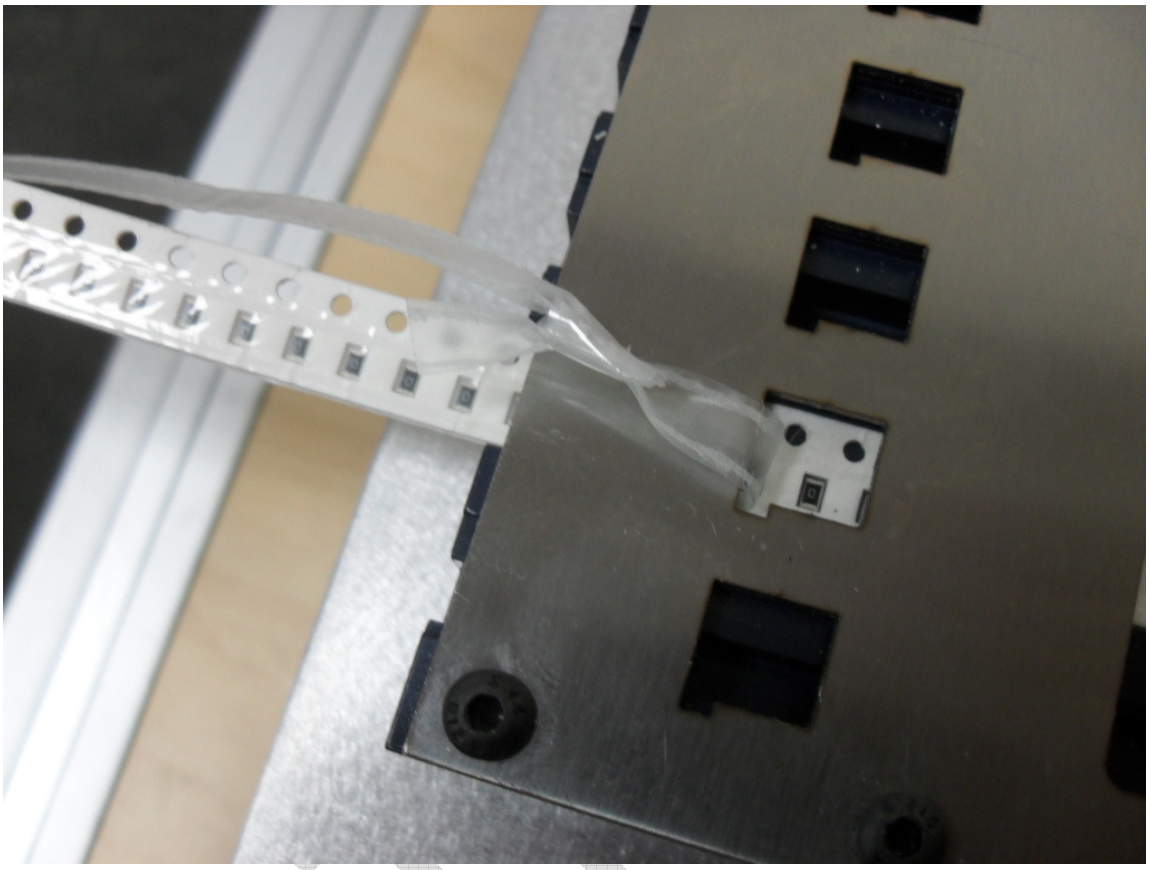


Figure 4.5: The plastic cover tape being tied to another piece of plastic tape

6. Finally, connect the other end of the tape or string you tied to the plastic cover tape to a supplied feeder weight and secure it over the tray.

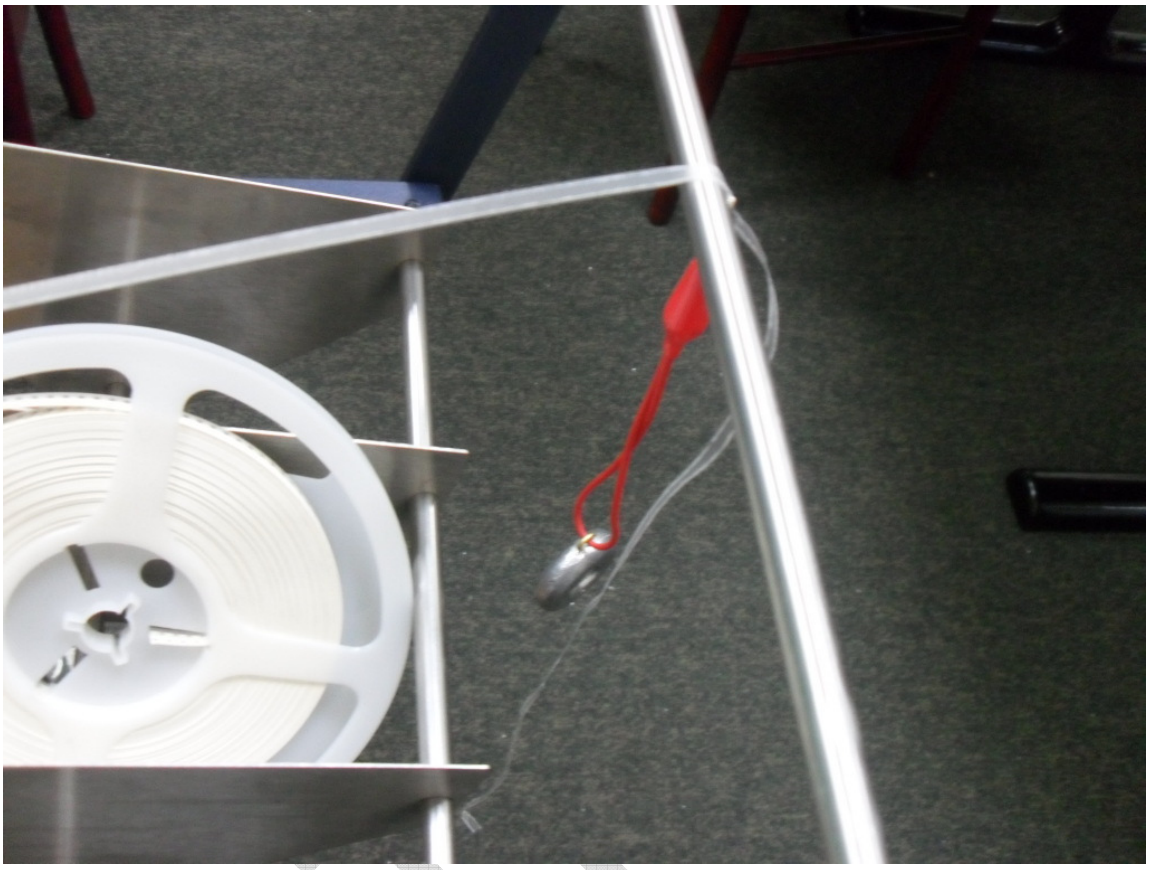


Figure 4.6: The plastic cover tape connected to one of the supplied feeder weights and secured over the tray

Having connected the feeder, we must now setup the software to recognize and use it.

Adding a New Feeder (QM Feeder)

1. In the MAIN WINDOW, click the FEEDER LIST button to bring up the FEEDER LIST WINDOW. This is the window that controls the feeders.

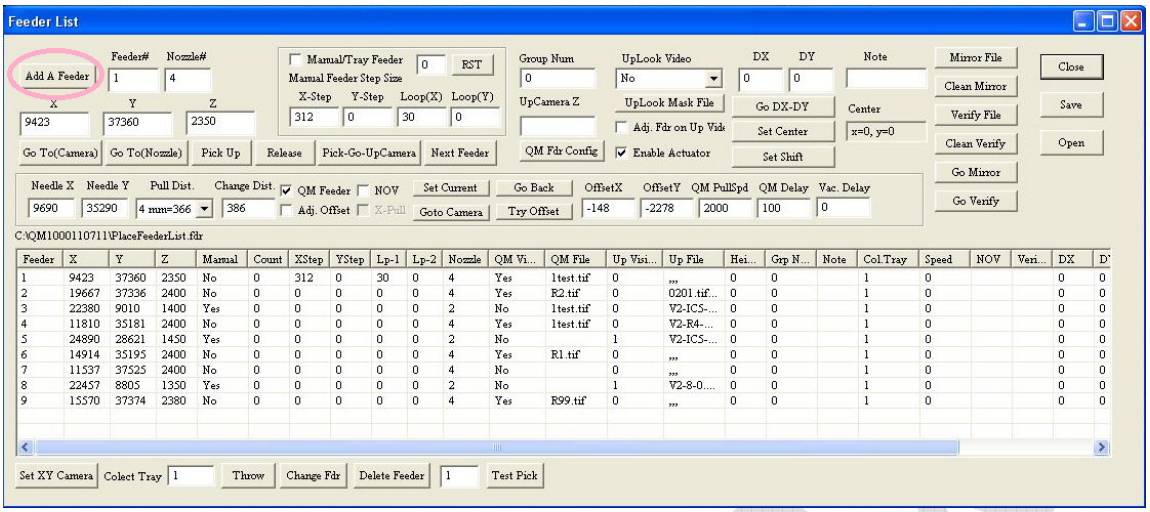


Figure 4.7: The FEEDER LIST WINDOW with the ADD A FEEDER BUTTON circled

2. In the FEEDER LIST WINDOW, click the ADD A FEEDER button to bring up the ADD FEEDER WINDOW.

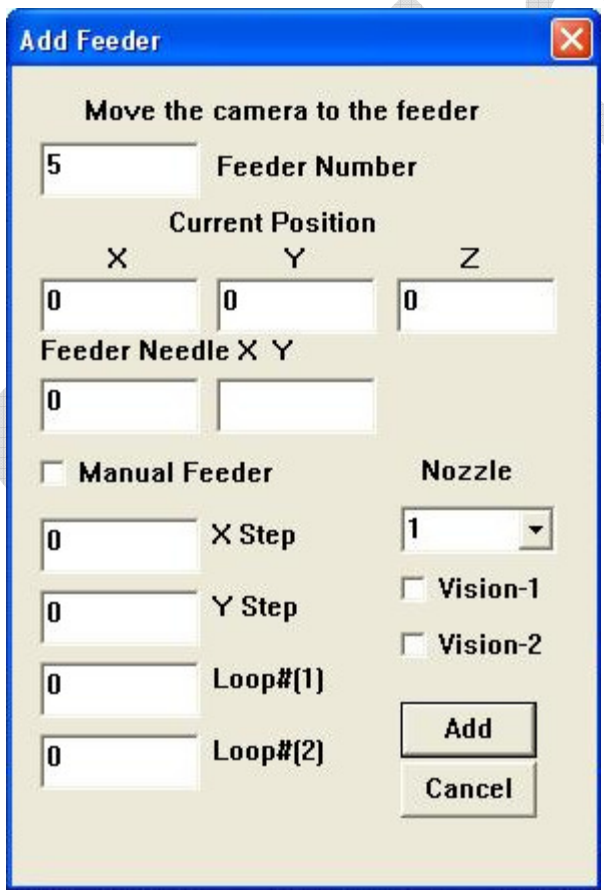


Figure 4.8: The ADD FEEDER Window

3. Leave the various options blank and/or at their default values, for now, and click the ADD BUTTON to add the feeder. You will notice that the FEEDER SEQUENCE NUMBER has been automatically incremented. Each new feeder has a FEEDER SEQUENCE NUMBER one greater than the previous.
4. The new feeder should appear in the FEEDER LIST WINDOW. Select it.

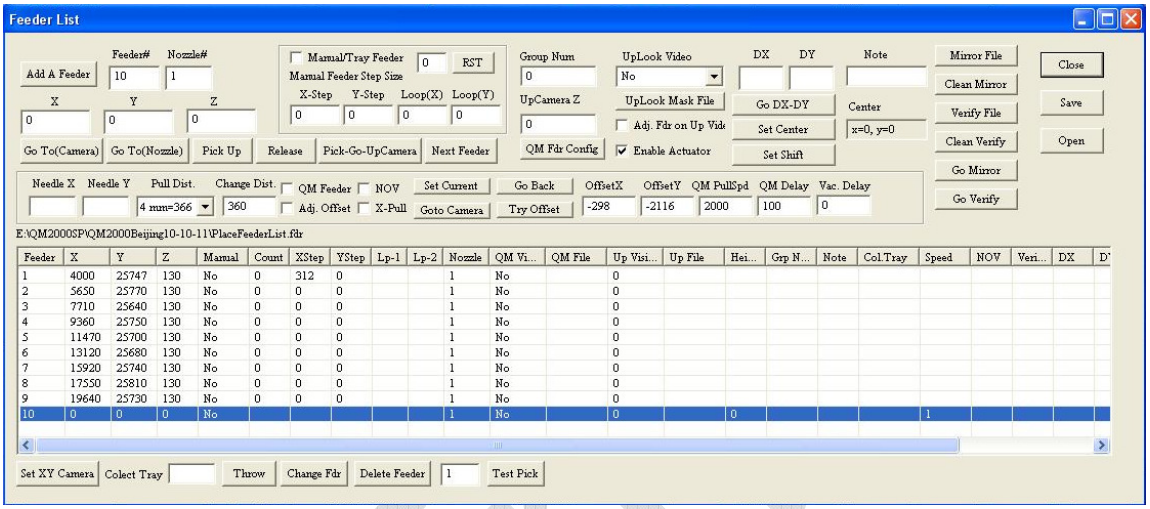


Figure 4.9: New feeder selected in FEEDER LIST WINDOW.

5. Check the QM FEEDER BOX to inform the machine that the feeder being added is a QM FEEDER. This will prompt you for a DOWNLOOKING SNAPSHOT for use with the vision verification system.

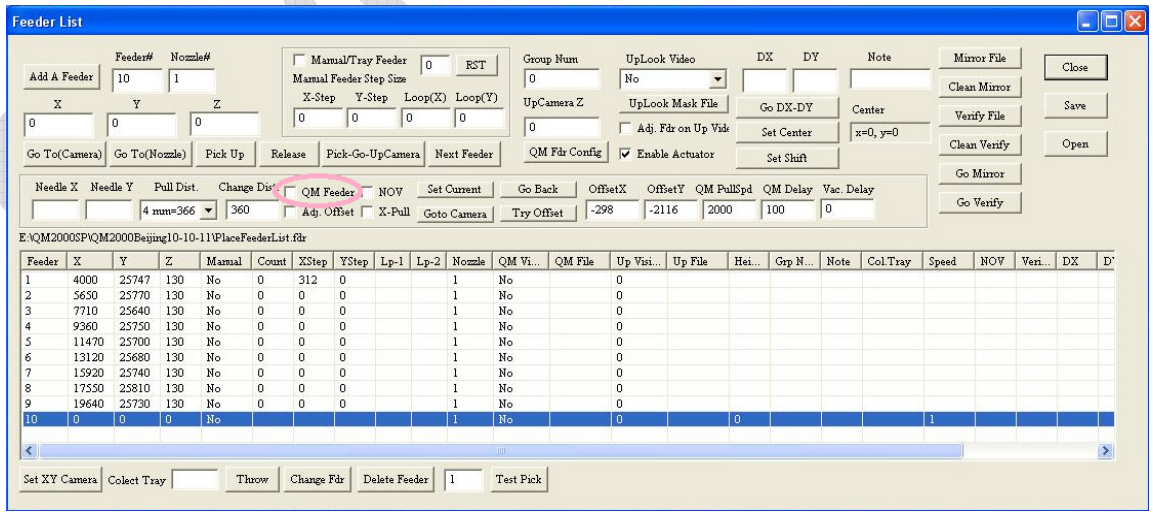


Figure 4.10: The FEEDER LIST WINDOW with the QM FEEDER BOX circled

IMPORTANT: The QM Feeder REQUIRES that you specify a DOWNLOOKING SNAPSHOT. For instructions on producing this picture, please see the Specifying Downlooking Snapshot section below.

6. There are two positions associated with a QM FEEDER, the NOZZLE POSITION and the NEEDLE POSITION. The NOZZLE POSITION is the location where the pickup nozzle will be picking up component parts from the feeder. The NEEDLE POSITION is the location of the needle holes on the feeder tape, which the pickup needle will use to drag the tape forward.
7. To set the NOZZLE POSITION, go back to the MAIN WINDOW and navigate the pickup head to the tape. Then center the DOWNLOOKING CAMERA on the rectangular part slot on the tape, as follows:

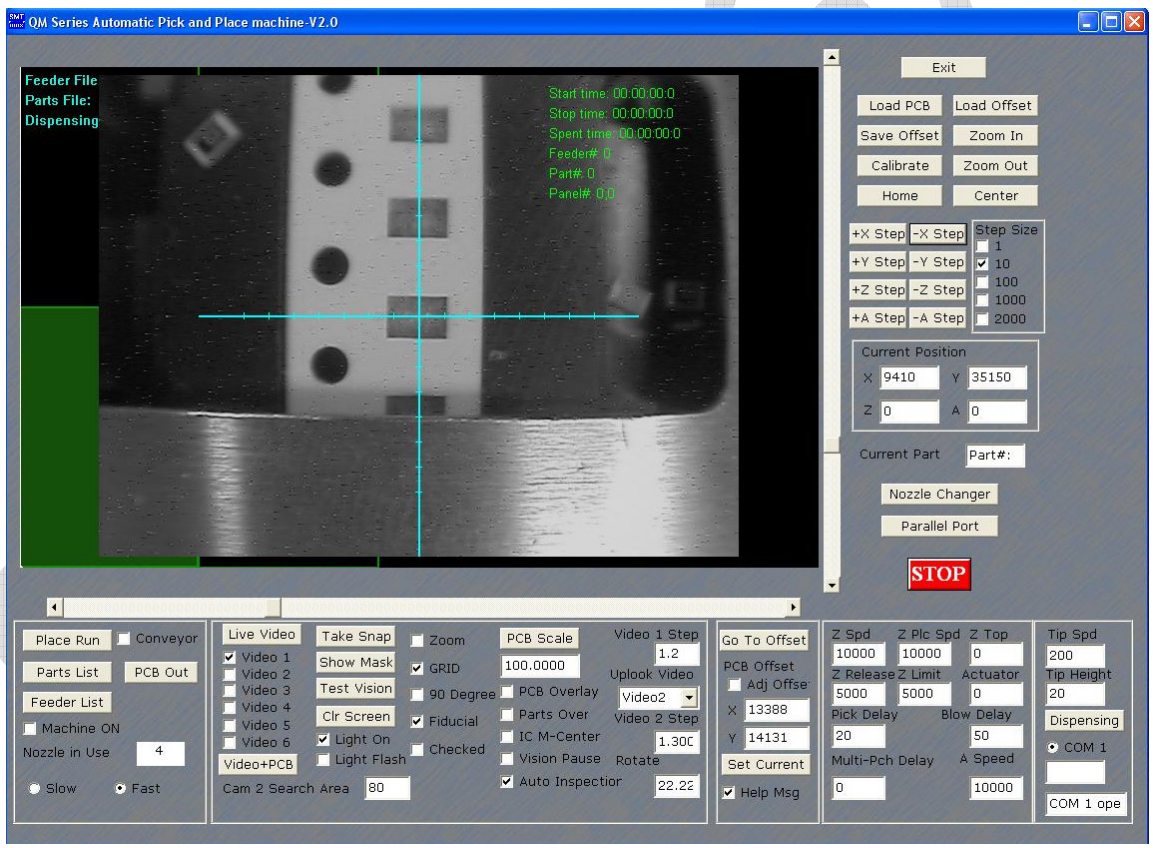


Figure 4.11: Center the crosshairs of the DOWNLOOKING CAMERA on a part slot of the component tape

8. Record the CURRENT POSITION X and Y shown in the MAIN WINDOW as the NOZZLE POSITION X and Y.
9. Next, find NOZZLE POSITION Z by placing a sample component (of the type to be used during operation) on the part slot of the feeder directly below the nozzle and then

manually lowering the nozzle using the NAVIGATION PANEL until it just touches the surface of the component. Once that happens, record the CURRENT POSITION Z as the NOZZLE POSITION Z.

10. Finally, input these values in the following boxes in the FEEDER LIST WINDOW while having the feeder selected:

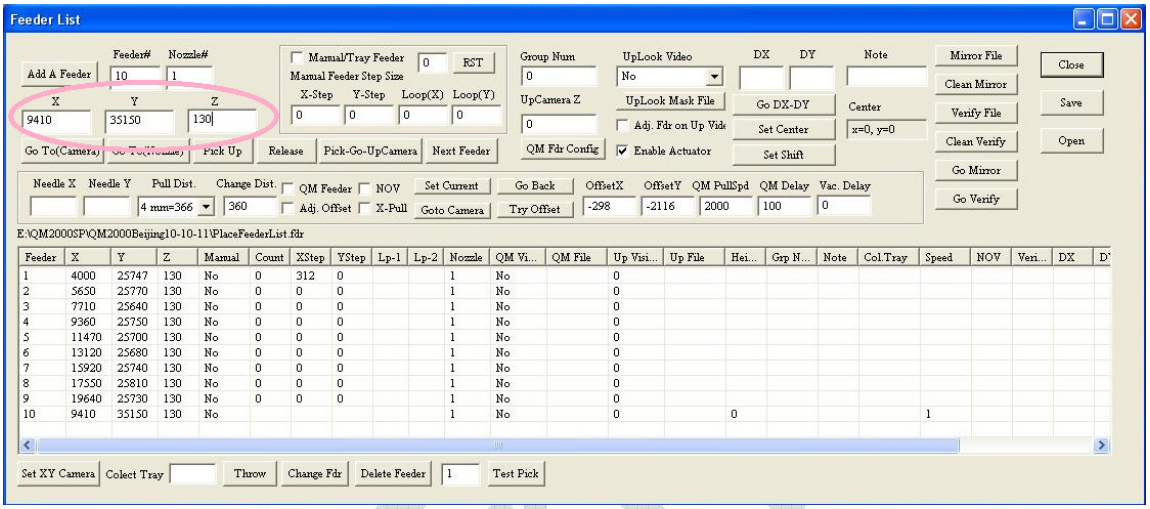


Figure 4.12: FEEDER LIST WINDOW with NOZZLE POSITION boxes selected and filled in

11. To set the NEEDLE POSITION, once again go back to the MAIN WINDOW and navigate the pickup head to the tape. This time, center the DOWNLOOKING CAMERA on the circular needle hole on the tape, as follows:

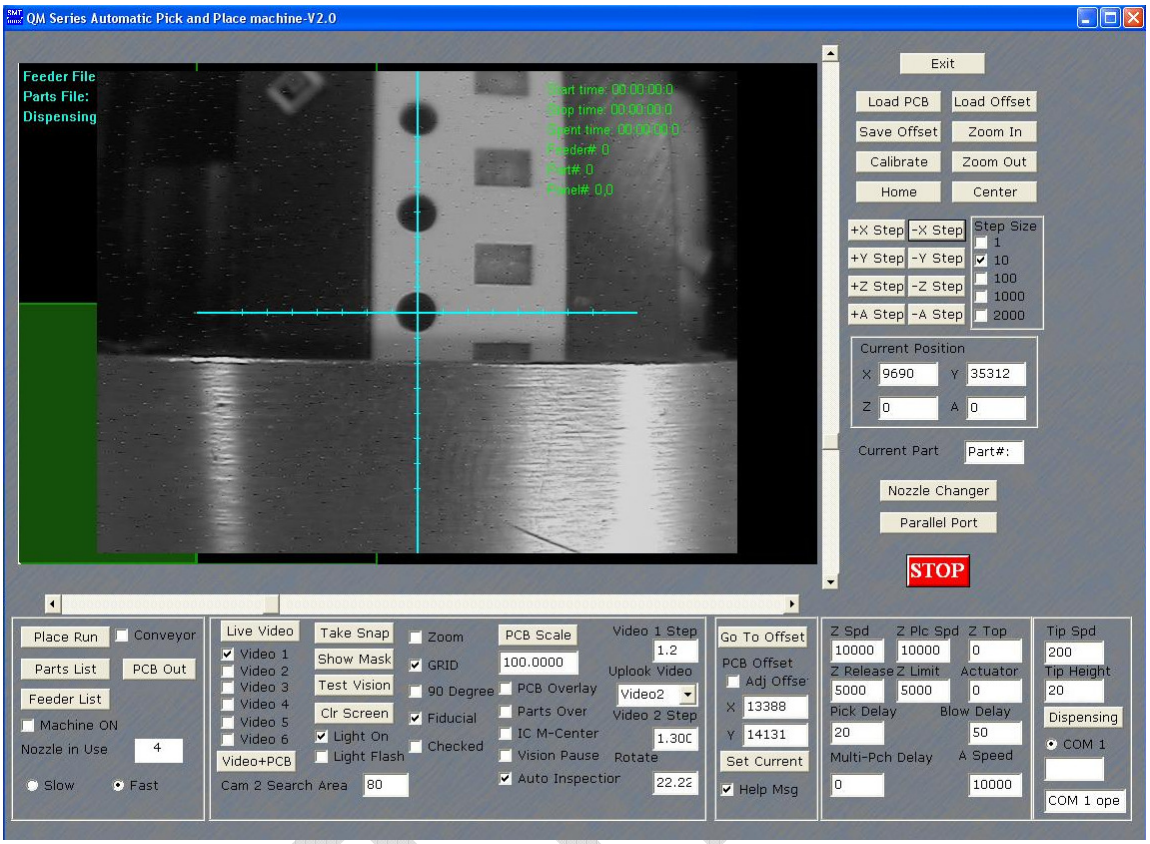


Figure 4.13: Center the crosshairs of the DOWNLOOKING CAMERA on a needle hole of the component tape

12. Record the CURRENT POSITION X and Y coordinates shown in the MAIN WINDOW as the NEEDLE POSITION X and Y, and input them into the following boxes in the FEEDER LIST WINDOW, while having the feeder selected:

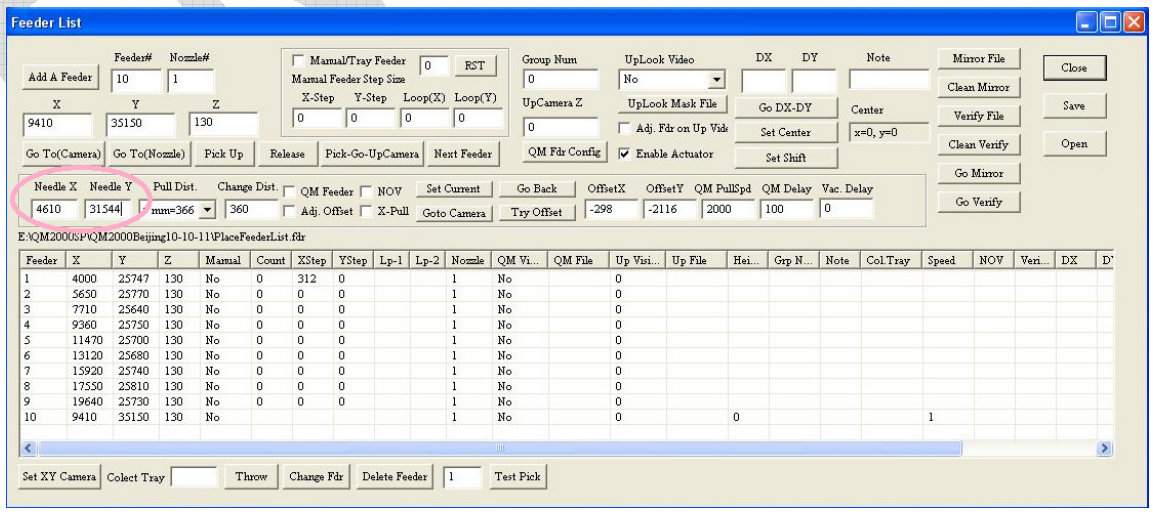


Figure 4.14: FEEDER LIST WINDOW with NEEDLE POSITION boxes selected and filled in

13. Next, you must determine the PULLING DISTANCE for the QM FEEDER. The PULLING DISTANCE represents the center-to-center distance between needle holes on the component tape, and is used by the machine to determine how far it should pull the tape each time. While, in theory, this distance should be standardized, practically speaking there may be slight variations between component tapes, making it important to verify before operation.
14. The easiest way to determine the PULLING DISTANCE is to use the NAVIGATION PANEL. First, switch to the MAIN WINDOW and move the camera view until the crosshairs are centered on a needle hole of the component tape, as in **Figure 4.8**. Record the X and Y coordinates of this position (in this case, X = 9690, Y = 35312).
15. Then, using the NAVIGATION PANEL, move the crosshairs towards the next needle hole (in this case upwards) until it is centered on top of it. The PULLING DISTANCE is the difference between this second position and the first position that you recorded. Or, expressed graphically, it is the length of the yellow line, in number of steps:

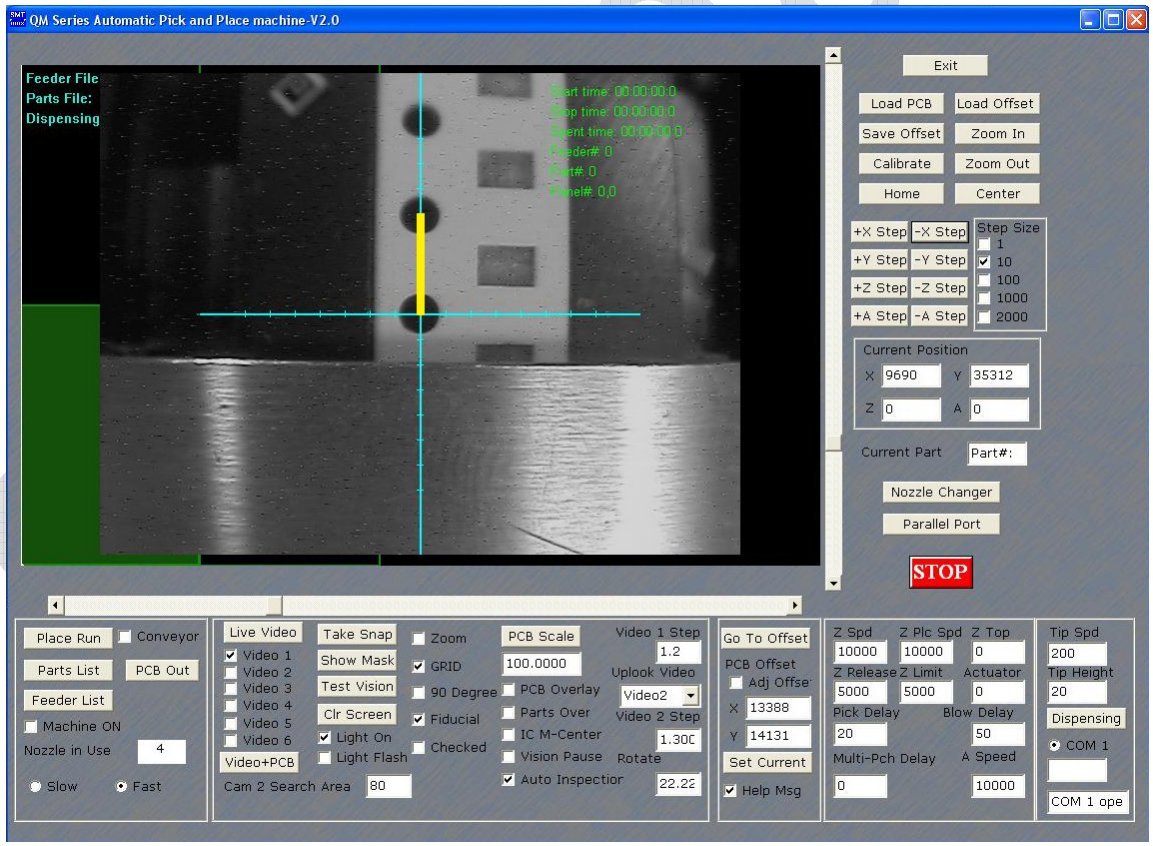


Figure 4.15: The PULLING DISTANCE is the center to center distance between the needle holes on the component tape, expressed graphically in the form of a yellow line

16. Having determined the PULLING DISTANCE, you must now tell the software what it is. To do this, have the feeder selected in the FEEDER LIST WINDOW, and then record the

PULLING DISTANCE value, in number of steps, under the CHANGE DIST. BOX. Make sure that this value change is reflected in the FEEDER LIST under the FEEDER PULL DISTANCE column:

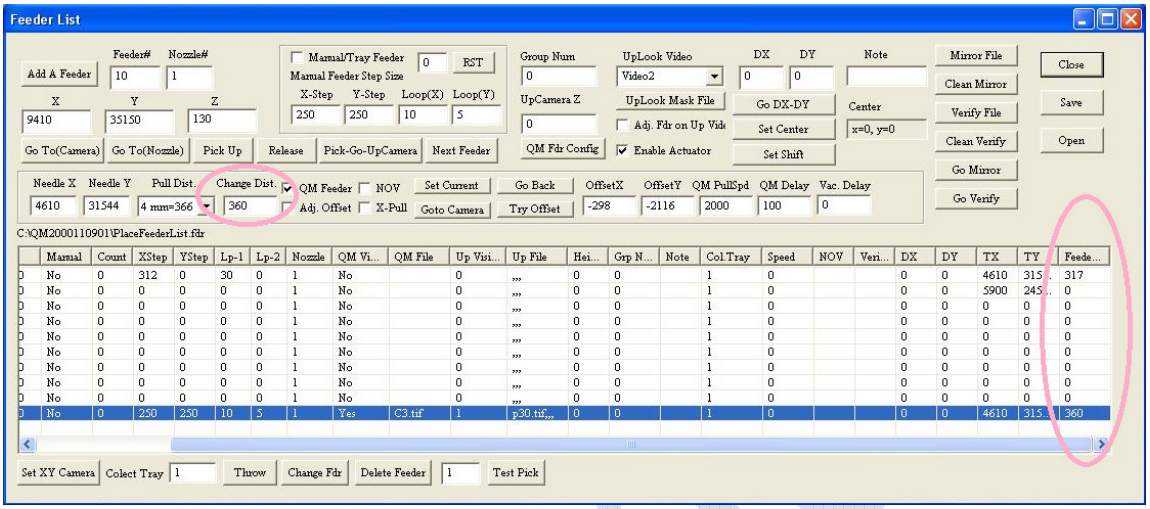


Figure 4.16: FEEDER LIST WINDOW with CHANGE DIST. BOX and FEEDER PULL DISTANCE column circled.

17. The QM FEEDER also has a number of options you should consider setting:

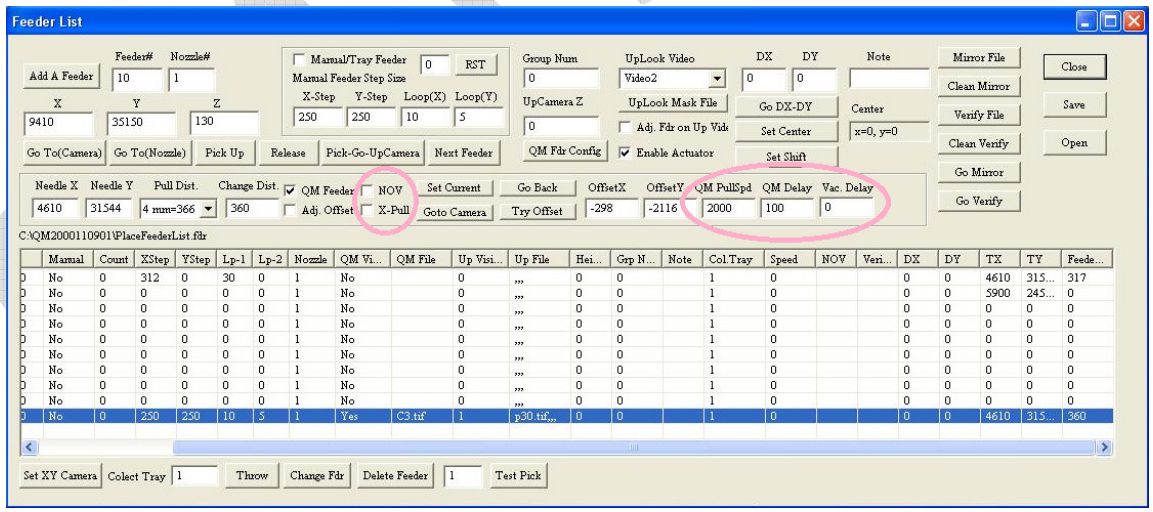


Figure 4.17: FEEDER LIST WINDOW with QM FEEDER options circled.

- **QM Pull Speed:** The speed, in steps/second, at which the NOZZLE pulls the component tape during operation. The default value is 2000. If this speed is too fast for the type of parts you are using (which may manifest itself as parts being shaken out of their pockets), lower it until stability is reached.

- **QM Delay:** The amount of time, in milliseconds, the NOZZLE stops between each pull of the component tape. The default value is 100. As with QM Pull Speed, if this delay is too short for the type of parts you are using (which may manifest itself as parts being shaken out of their pockets), increase it until stability is reached.
- **VAC Delay:** The amount of time, in milliseconds, the NOZZLE stops on top of a part before activating the vacuum. The default value is 0, indicating that the NOZZLE should start the vacuum right before it touches the part. In some cases, parts that are very sensitive to vacuum may require a longer (ie non-zero) delay to ensure stable pickup.
- **NOV:** This option governs whether the vision system HAS to validate a part from the QM FEEDER using the DOWNLOOKING SNAPSHOT before picking it up. Uncheck it if, for some reason, you do not want to use the vision validation system or if the vision validation system has trouble validating the particular part you are using.
- **X-PULL (QM 2000 ONLY):** In QM 2000 machines, the QM FEEDER is often aligned horizontally, rather than vertically, such that the NOZZLE must pull in the X direction instead of the Y direction. Check this option if the NOZZLE must pull in the X direction to advance the component tape. **IMPORTANT:** Setting the X-PULL OPTION incorrectly may BREAK the needle and nozzle! If you are unsure, test first with the needle and nozzle removed!

18. To set these options for a particular feeder, select the feeder and then change the option(s) as desired.

Yamaha Feeder

The Yamaha Feeder is an industry standard tape feeder that uses a

Vibratory Feeder

The vibratory feeder is a simple vibration-based feeder that uses mechanical vibrations to shake parts down a tube and onto a pickup platform. To setup the feeder, follow these steps:

1. The vibratory feeder can be physically installed either on the machine platform, or on a Yamaha feeder platform attached to the machine. Either way, the part slots must be in reach of the NOZZLE.

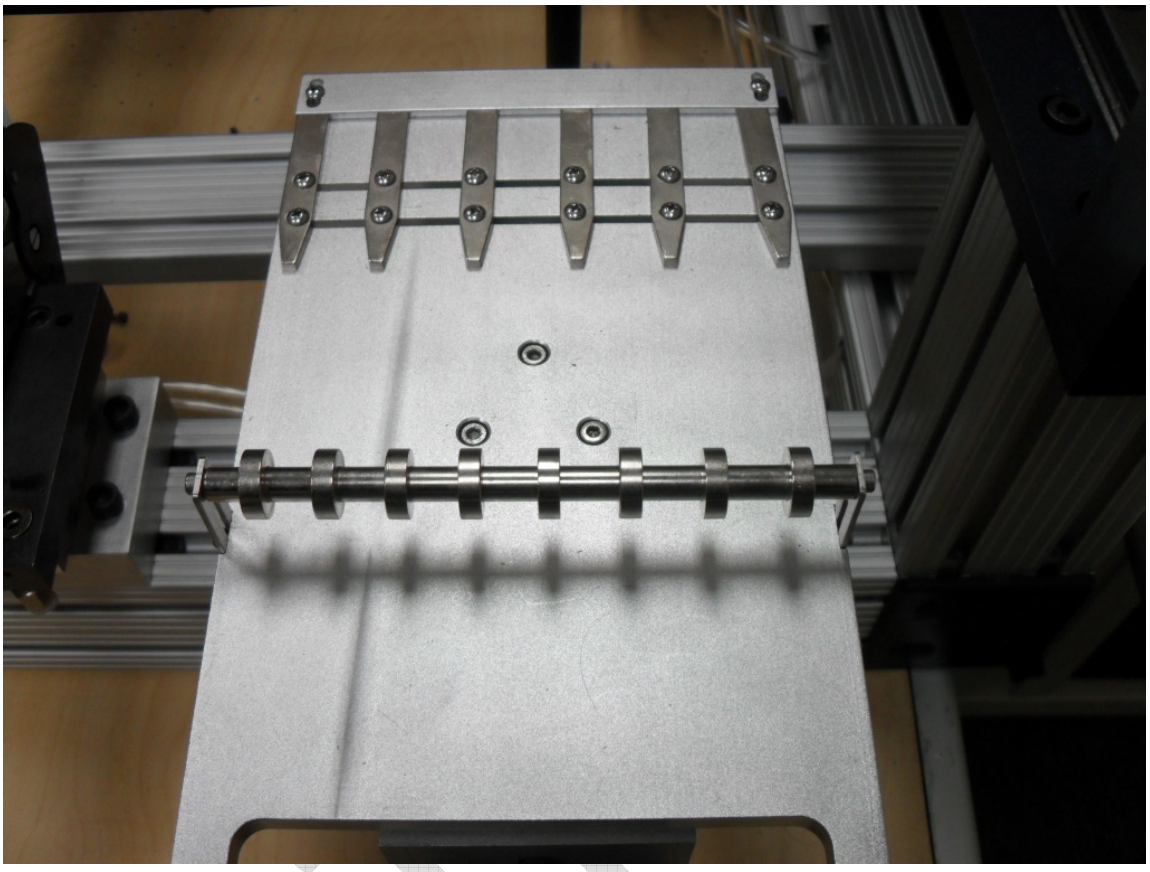


Figure 4.18: Vibratory Feeder installed on the machine platform

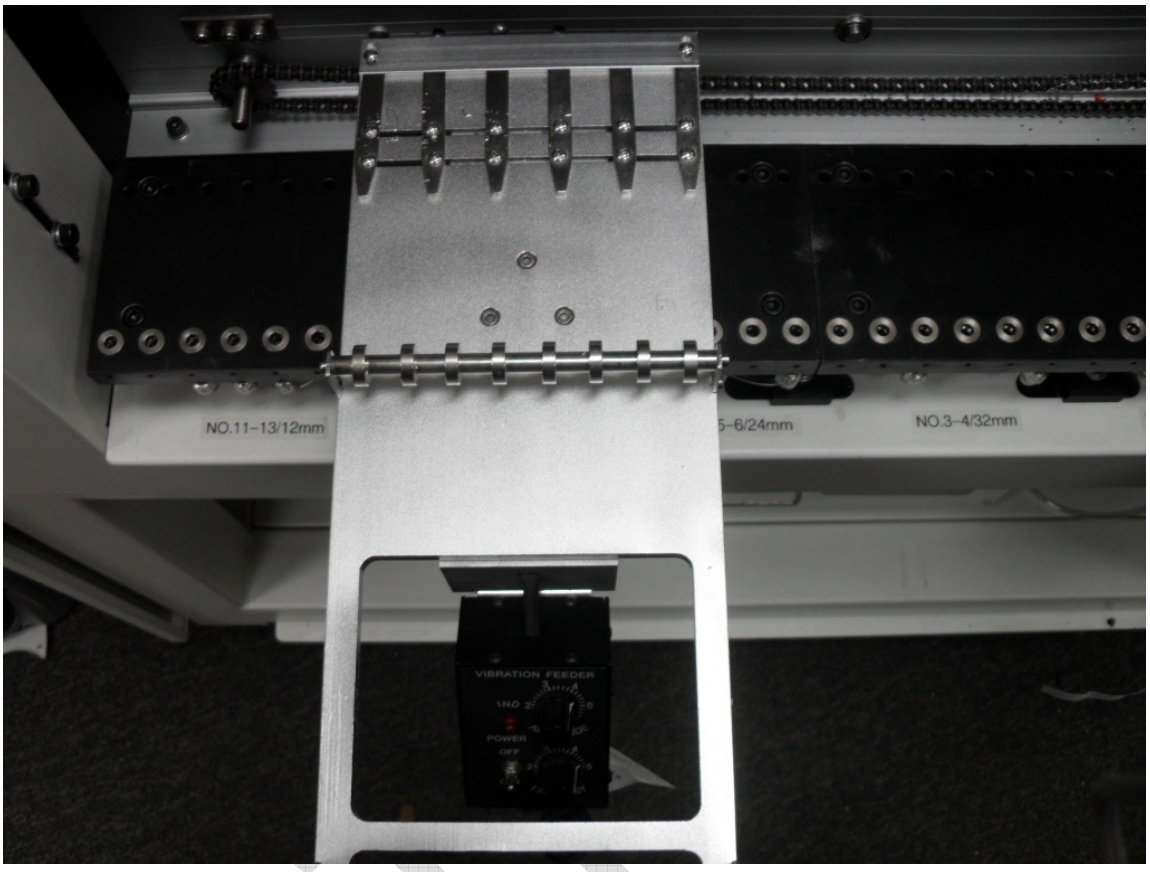


Figure 4.19: Vibratory Feeder installed on a Yamaha feeder platform

2. Set the VIBRATORY TUBES so that components are shaken down to the desired parts slot of the VIBRATORY FEEDER:

Figure 4.20: Vibratory Feeder component tube with chip components

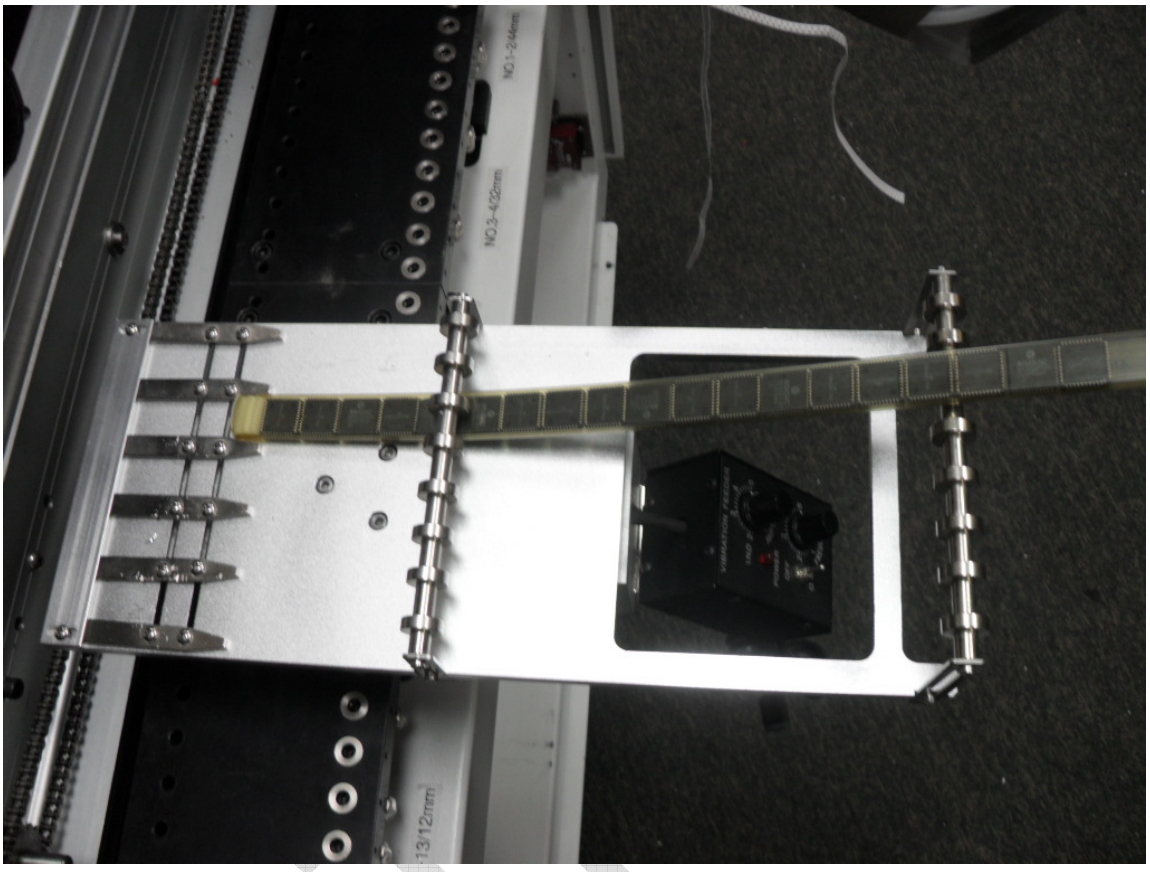


Figure 4.21: Vibratory Feeder component tube installed on the feeder platform

3. Adjust the frequency and amplitude of the VIBRATORY CONTROL BOX so that parts slide correctly down the tube. This may need to be done with trial and error.

Figure 4.22: Vibratory Feeder control box

Adding a New Feeder (Vibratory Feeder)

1. In the MAIN WINDOW, click the FEEDER LIST button to bring up the FEEDER LIST WINDOW. This is the window that controls the feeders.

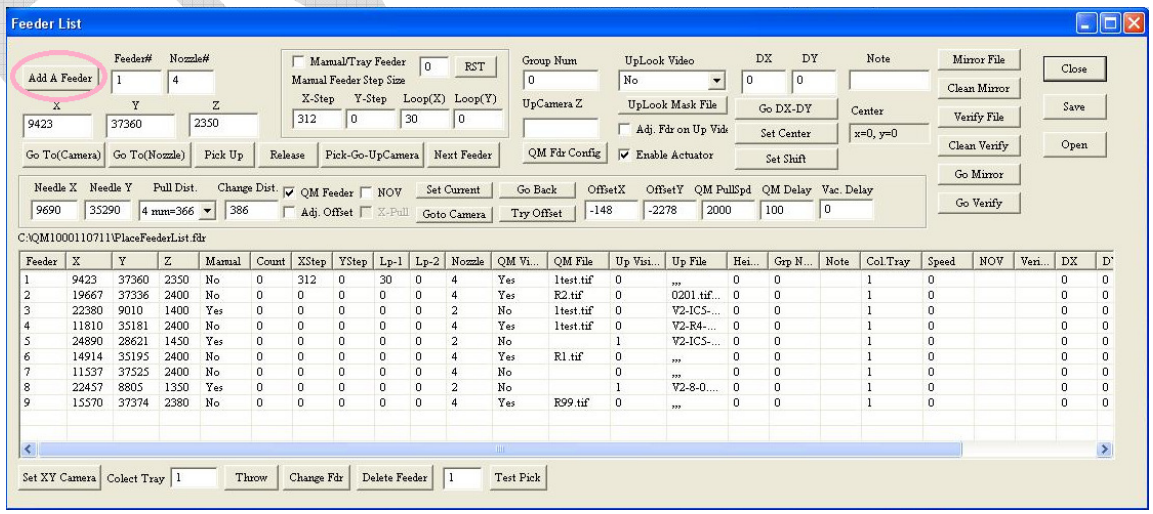


Figure 4.23: FEEDER LIST WINDOW with ADD A FEEDER BUTTON circled

2. In the FEEDER LIST WINDOW, click the ADD A FEEDER button to bring up the ADD FEEDER WINDOW.
3. Leave the various options blank and/or at their default values, for now, and click the ADD BUTTON to add the feeder. You will notice that the FEEDER SEQUENCE NUMBER has been automatically incremented. Each new feeder has a FEEDER SEQUENCE NUMBER one greater than the previous.
4. The new feeder should appear in the FEEDER LIST WINDOW. Select it.

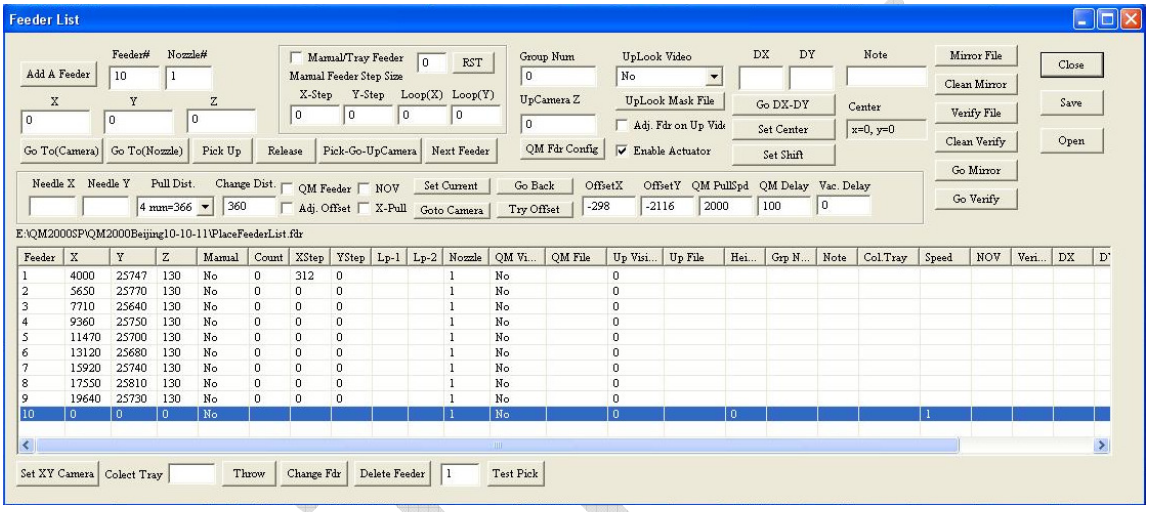


Figure 4.24: New feeder selected in FEEDER LIST WINDOW.

5. There is only one position associated with a VIBRATORY FEEDER, the NOZZLE POSITION, which is the location where the pickup nozzle will be picking up component parts from the feeder.

   IMPORTANT: Do not check the QM FEEDER BOX or fill in the NEEDLE POSITION for a VIBRATORY FEEDER. The machine needle might be damaged, otherwise.

6. To set the NOZZLE POSITION, go back to the MAIN WINDOW and navigate the PICKUP HEAD to the PICKUP PLATFORM. Then center the DOWNLOOKING CAMERA on the area of the platform where parts will be picked up:

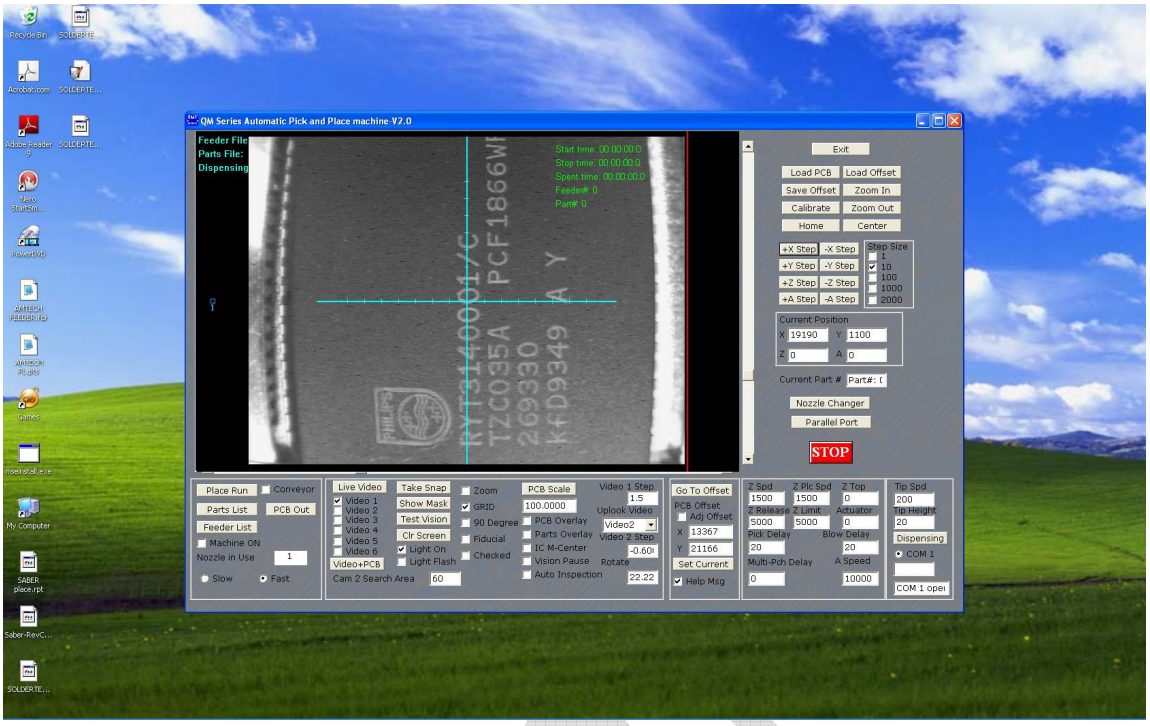


Figure 4.25: Pickup platform with a component inserted

7. Record the CURRENT POSITION X and Y shown in the MAIN WINDOW as the NOZZLE POSITION X and Y.
8. Next, find NOZZLE POSITION Z by placing a sample component (of the type to be used during operation; an example can be seen in Figure 4.19) on the part slot of the feeder directly below the nozzle and then manually lowering the nozzle using the NAVIGATION PANEL until it just touches the surface of the component. Once that happens, record the CURRENT POSITION Z as the NOZZLE POSITION Z.
9. Finally, input these values in the following boxes in the FEEDER LIST WINDOW while having the feeder selected:

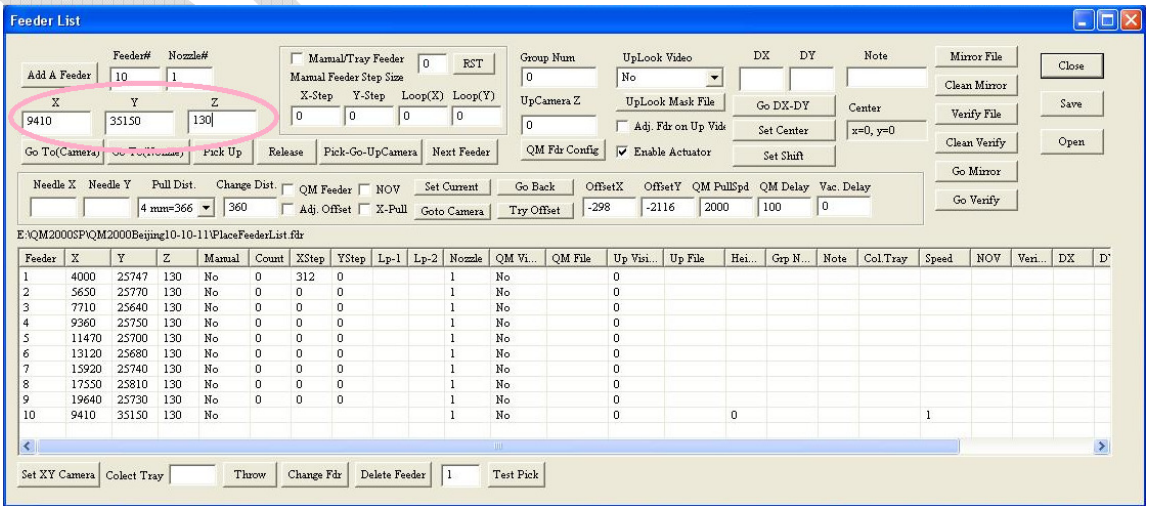


Figure 4.26: FEEDER LIST WINDOW with NOZZLE POSITION boxes selected and filled in

Bowl Feeder

A bowl feeder is a vibration-based feeder that shakes parts down a bowl and onto a pickup platform.

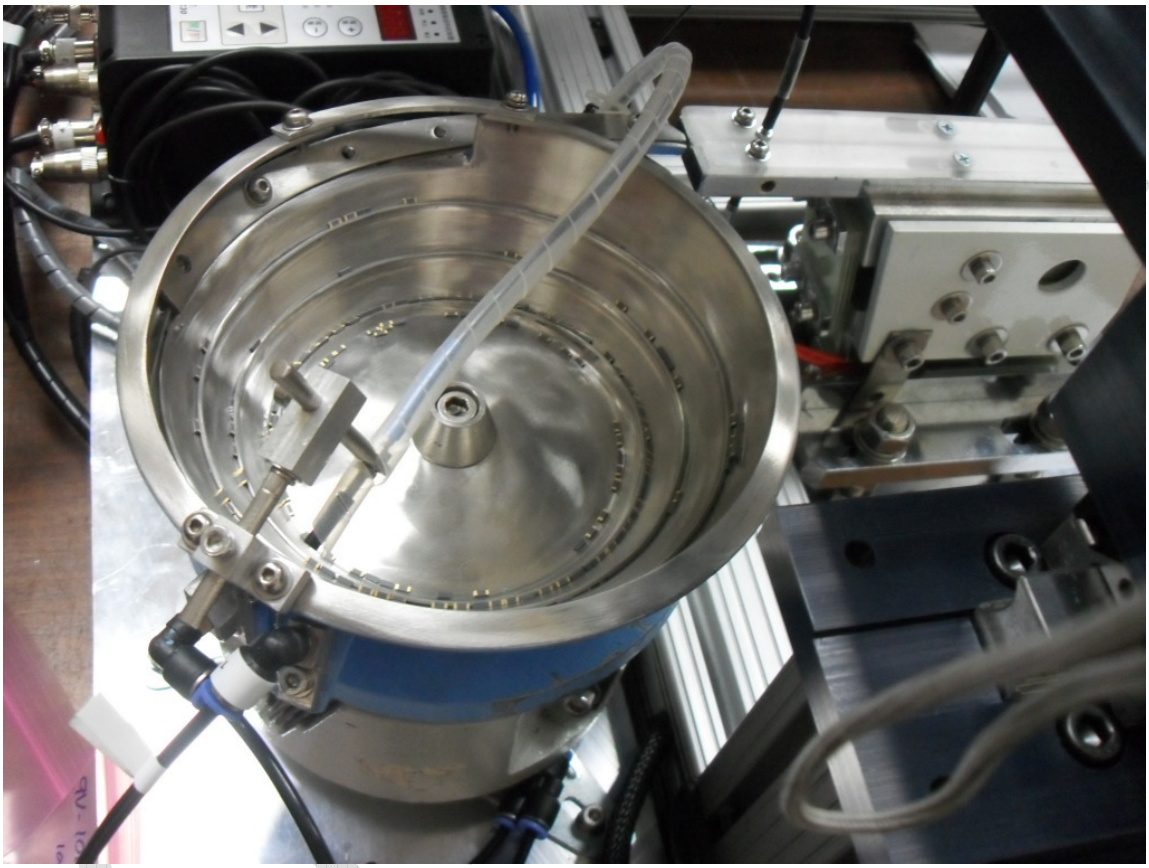


Figure 4.27: A Bowl Feeder with parts lying alone the ridges of the bowl.

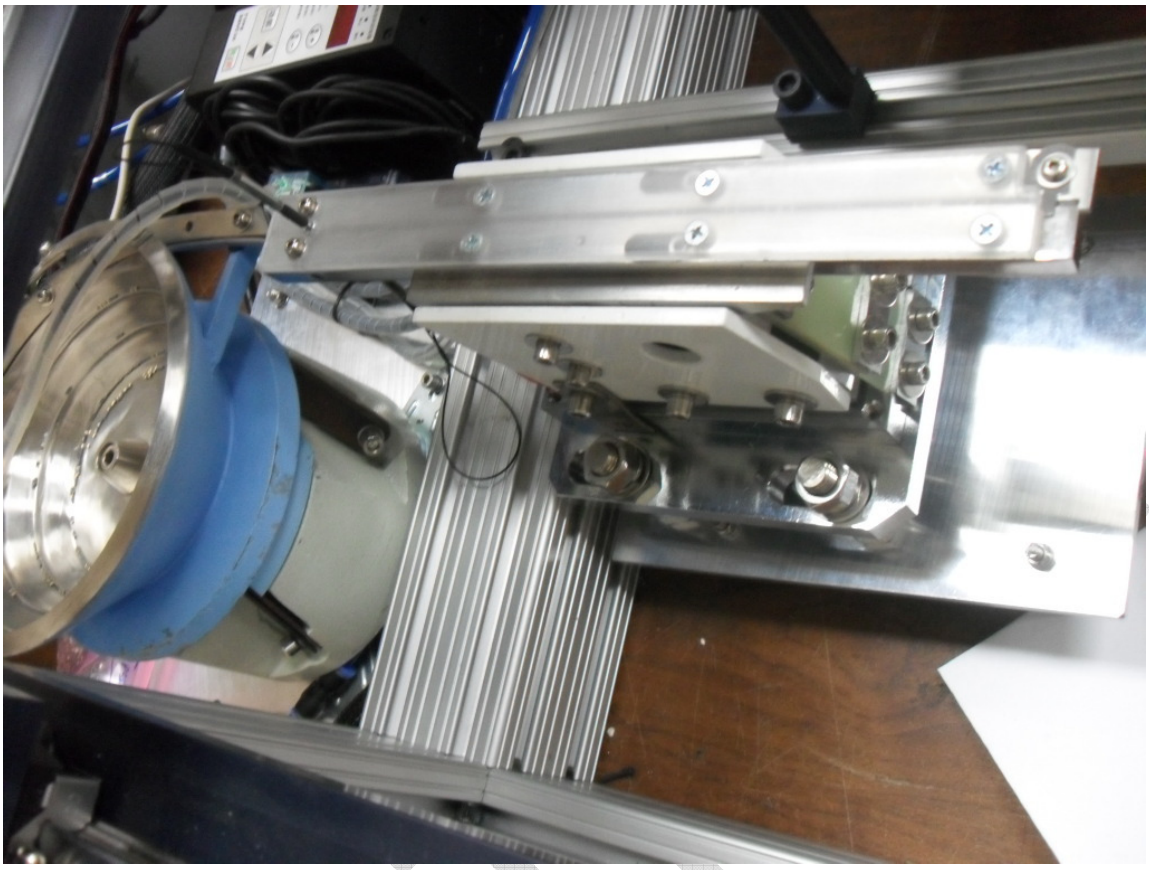


Figure 4.28: A Bowl Feeder's pickup platform

To setup a bowl feeder, place it somewhere convenient, such as shown above, and extend its pickup platform to a place reachable by the nozzle. Then, follow the same Add a New Feeder instructions as for the Vibratory Feeder.

Adding a New Feeder (Bowl Feeder)

Same as VIBRATORY FEEDER.

Waffle Tree Feeder

The waffle tree feeder is a standard tray feeder that looks somewhat like a waffle. To use it, install the feeder at a location such that the entirety of the "waffle" is reachable by the pickup head:

Adding a New Feeder (Waffle Tree Feeder)

1. In the MAIN WINDOW, click the FEEDER LIST button to bring up the FEEDER LIST WINDOW. This is the window that controls the feeders.

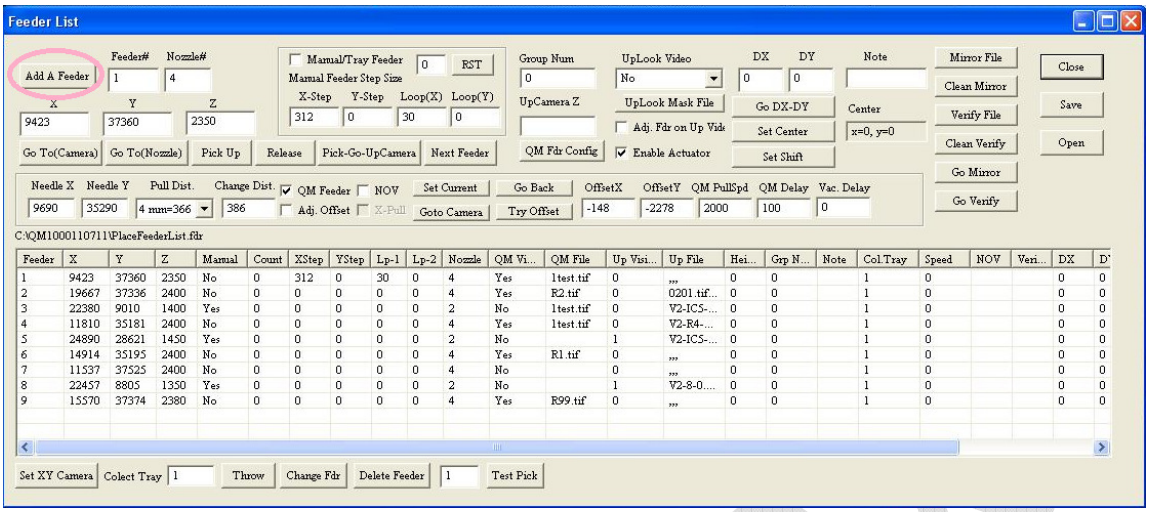


Figure 4.29: FEEDER LIST WINDOW with ADD A FEEDER BUTTON circled

2. In the FEEDER LIST WINDOW, click the ADD NEW FEEDER button to bring up the ADD FEEDER WINDOW.
3. Leave the various options blank and/or at their default values, for now, and click the ADD BUTTON to add the feeder. You will notice that the FEEDER SEQUENCE NUMBER has been automatically incremented. Each new feeder has a FEEDER SEQUENCE NUMBER one greater than the previous.
4. The new feeder should appear in the FEEDER LIST WINDOW. Select it.

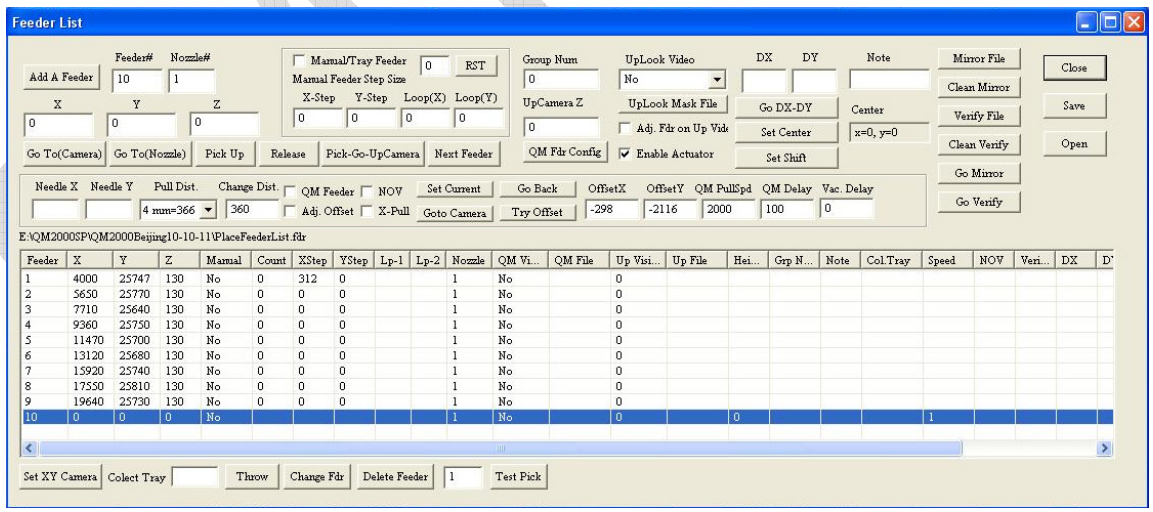


Figure 4.30: New feeder selected in FEEDER LIST WINDOW

5. For the WAFFLE TREE FEEDER, check the MANUAL/TRAY FEEDER BOX and make sure the QM FEEDER BOX is unchecked.

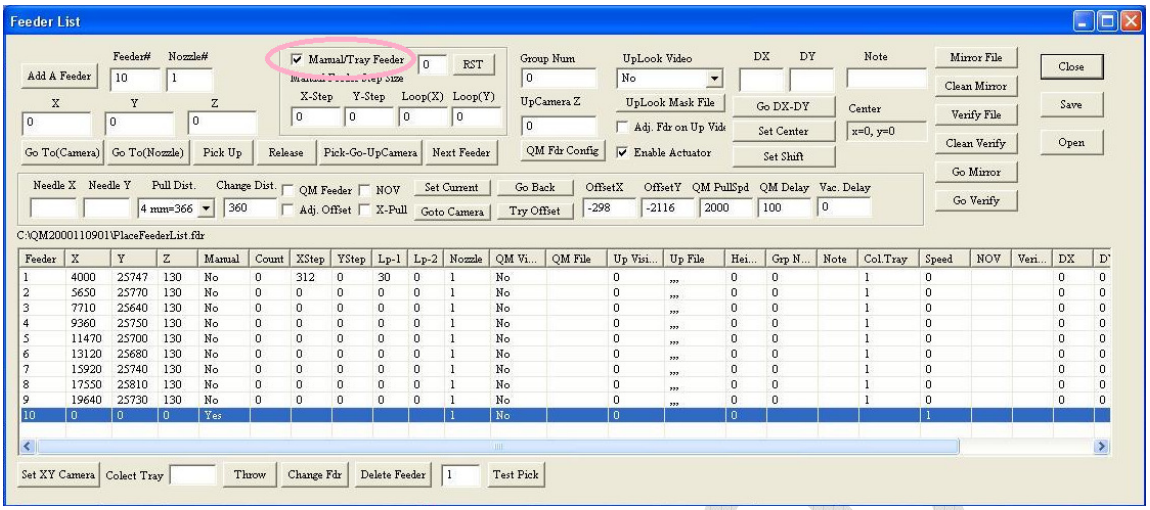


Figure 4.31: FEEDER LIST WINDOW with MANUAL/TRAY FEEDER OPTION circled

IMPORTANT: Do not check the QM FEEDER BOX or fill in the NEEDLE POSITION for a WAFFLE TREE FEEDER. The machine needle might be damaged, otherwise**.**

6. To configure a WAFFLE TREE FEEDER, you must have values for the NOZZLE POSITION, X STEP, Y STEP, X-LOOP, and Y-LOOP. To find the NOZZLE POSITION, go back to the MAIN WINDOW and navigate to the center of a part slot on one of the four CORNERS of the WAFFLE TREE FEEDER. This position will designate where the machine will look for the first part in the feeder.

7. Record the CURRENT POSITION X and Y shown in the MAIN WINDOW as the NOZZLE POSITION X and Y.
8. Next, find NOZZLE POSITION Z by placing a sample component (of the type to be used during operation) on the part slot of the feeder directly below the nozzle and then manually lowering the nozzle using the NAVIGATION PANEL until it just touches the surface of the component. Once that happens, record the CURRENT POSITION Z as the NOZZLE POSITION Z.
9. Finally, input these values in the following boxes in the FEEDER LIST WINDOW while having the feeder selected:

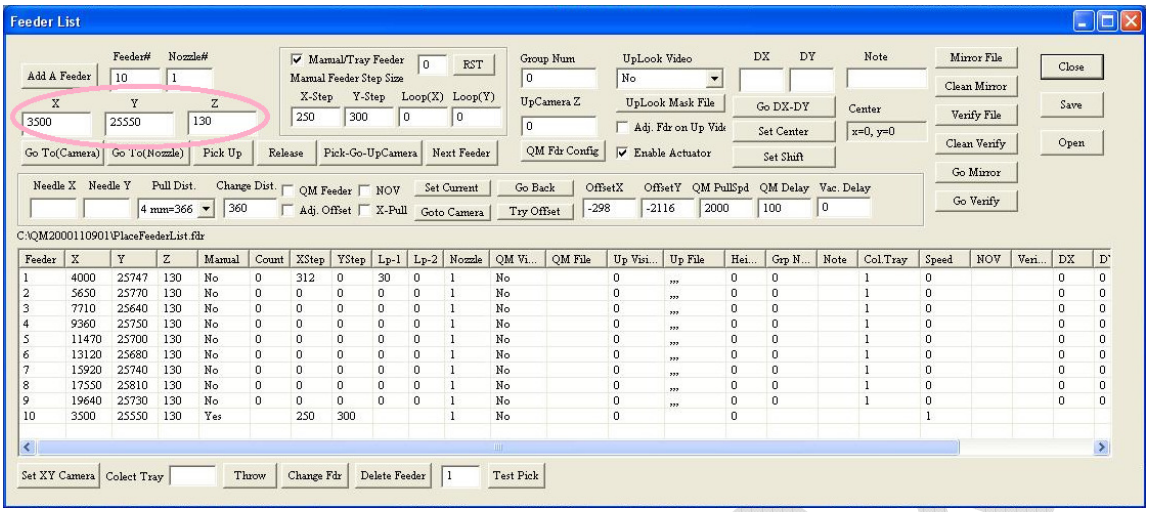


Figure 4.32: FEEDER LIST WINDOW with NOZZLE POSITION boxes selected and filled in

10. Set the X-STEP and Y-STEP, which represent the number of steps in the X and Y direction, respectively, that the machine should travel to look for the next part in the feeder. These steps may be negative, depending on the orientation of the starting corner with respect to the machine, and it is advised that the user uses the NAVIGATION panel of the MAIN WINDOW to test these step sizes before using them.

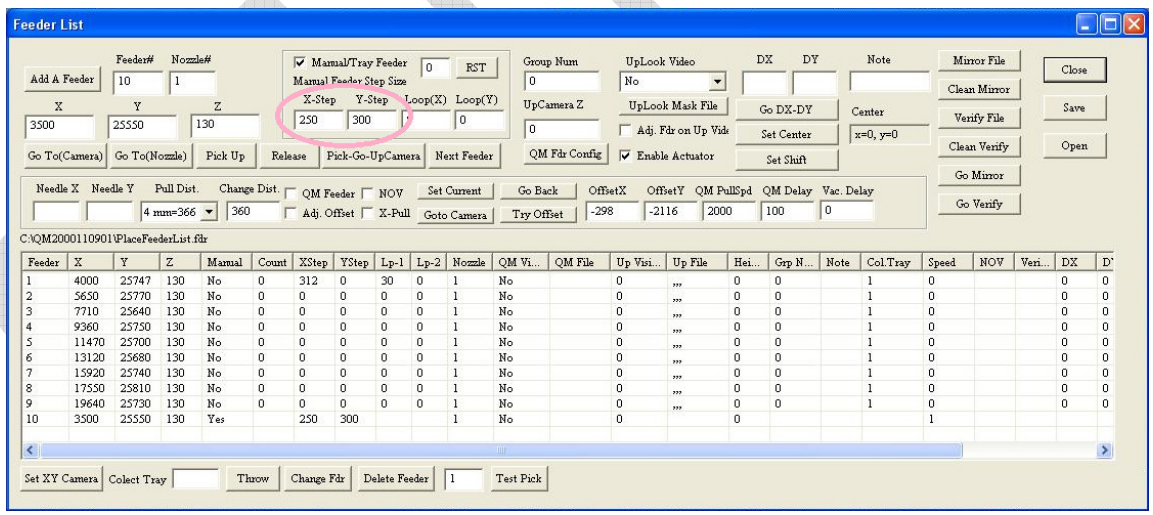


Figure 4.33: FEEDER LIST WINDOW with X-STEP and Y-STEP boxes circled and filled in

11. The X-LOOP and Y-LOOP boxes represent the number of components in each direction from the corner of the WAFFLE TREE FEEDER, and should be filled in accordingly, based on the specific WAFFLE TREE FEEDER being installed.

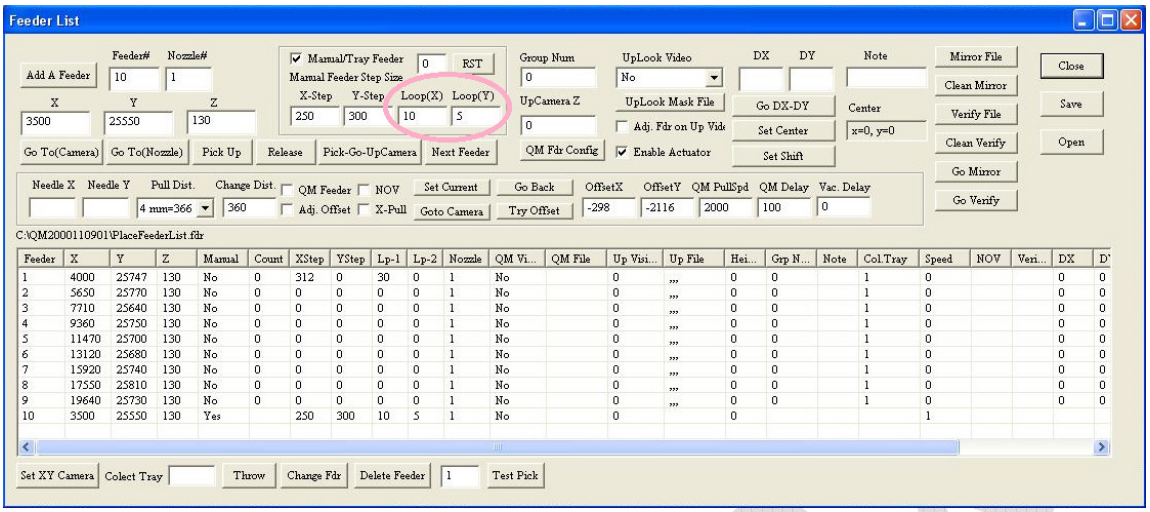


Figure 4.34: FEEDER LIST WINDOW with X-LOOP and Y-LOOP boxes circled and filled in.

Loose Part Tray Feeder

The loose part tray feeder is any tray feeder used to store a single, loose part. For the purpose of the QM series of Automatic Pick and Place Machines, a loose part tray feeder is represented by a single pick-up location.

To install a loose part tray feeder, put its designated pick-up location within reachable distance of the pickup head, then follow these instructions:

Adding a New Feeder (Loose Part Tray Feeder)

Same Add a New Feeder instructions as for a WAFFLE TRAY FEEDER, but for only one component slot. As stated, make sure the QM FEEDER BOX is unchecked and that the MANUAL/TRAY FEEDER option is checked. The X-STEP, Y-STEP, X-LOOP, and Y-LOOP values for a LOOSE PART TRAY FEEDER are 0, 0, 1, and 1, respectively.

Manual Tape Feeder

The manual tape feeder is a special type of tape feeder that advanced by a human operator pulling on the tape, rather than by a pulling needle. The QM series of Automatic Pick and Place Machines support the use of manual tape feeders either as loose part tray feeders or as regular tray feeders. In the former capacity, a single part pickup is followed by a human operator physically advancing on the tape. In the latter capacity, which is more common and expedient, multiple pickups may happen before a human operator needs to advance the tape.

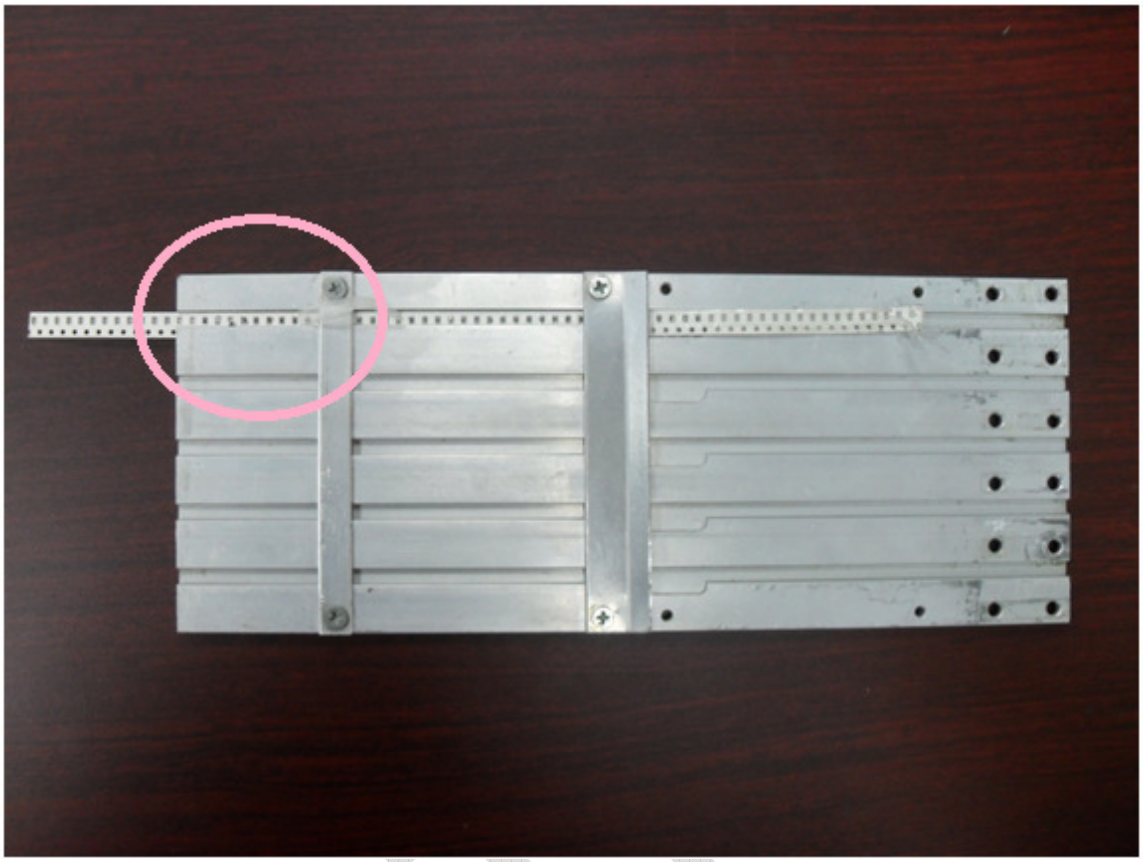


Figure 4.35: Manual Tape Feeder with pickup region circled

To install a manual tape feeder, attach it to the machine platform with the pickup region, circled above, located within reach of the nozzle.

Adding a New Feeder (Manual Feeder)

For the single pickup case, simply follow the same instructions as for a LOOSE TRAY FEEDER.

For the multiple pickups case, follow the instructions for a WAFFLE TREE FEEDER, and use the X-STEP, X-LOOP or the Y-STEP, Y-LOOP (depending on the orientation of the MANUAL TAPE FEEDER) to specify the distance between tape slots and the number of tape slots from which to do pickups before human intervention.

Vision Verification System

During operation, the QM series of Automatic Pick and Place Machines uses a combination of physical coordinates and computer vision to ensure the accuracy of part pickup and placement. Consequently, when adding a new feeder, it is advised to specify both the physical location of

the feeder and snapshots of its component part for vision recognition. However, vision-based correction is not required in all cases for the machine to function. It is simply there to ensure greater accuracy and reliability.

Each feeder supports the use of an UPLOOKING SNAPSHOT for validating the orientation of the part before placement, while the QM FEEDER also REQUIRES a DOWNLOOKING SHAPSHOT for validating the location of the feeder tape before pickup. The vision validations represent an extra layer of stability for the machine, and will stop the machine from picking and placing when the vision matching requirements are not met.

Specifying Downlooking Snapshot (QM Feeder)

1. The DOWNLOOKING SNAPSHOT is a snapshot of the part as it is lying on the QM FEEDER tape as viewed from the DOWNLOOKING CAMERA. This snapshot will be used by the DOWNLOOKING CAMERA to verify that the nozzle is at the correct location and part before pickup.
2. To create this picture, navigate the DOWNLOOKING CAMERA to the feeder tape in the MAIN WINDOW and center the crosshairs of the camera on the part (make sure that the appropriate part for the operation is on the tape), as shown below:

Figure 4.36: DOWNLOOKING CAMERA crosshairs centered on part slot with part

3. Use the mouse and left-click to draw a tight box around the part as follows:

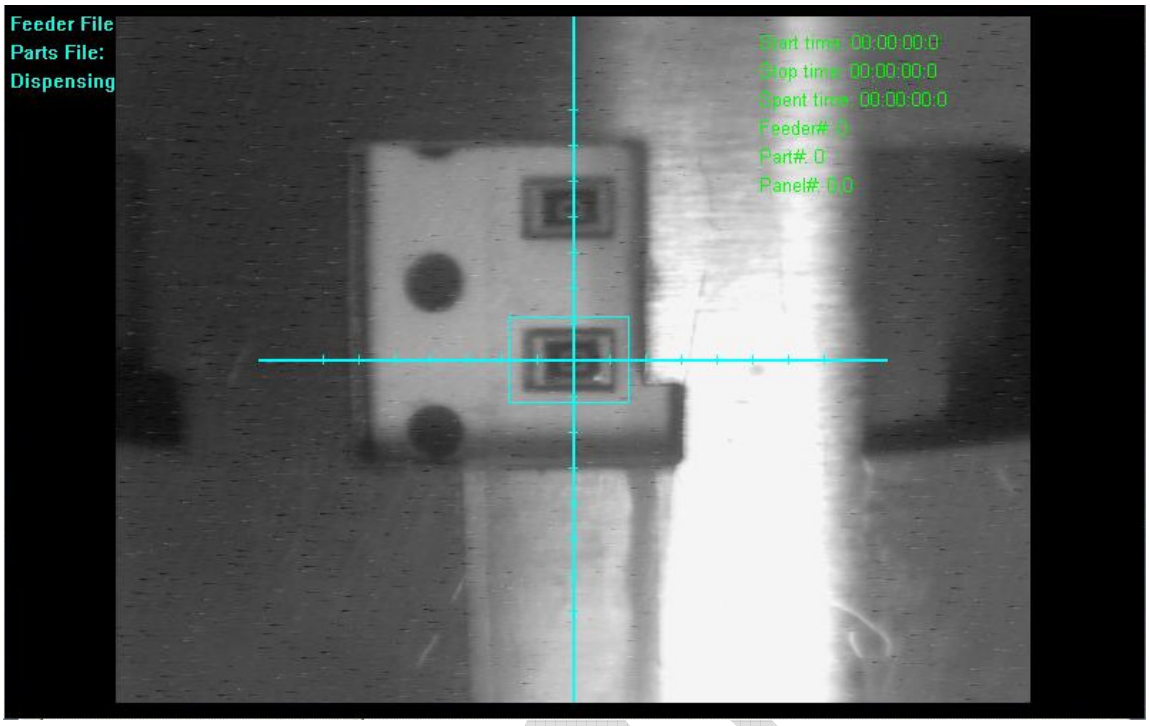


Figure 4.37: A tight bounding box drawn around the part in Figure 4.30.

4. Click the TAKE SNAP button at the bottom left side of the MAIN WINDOW. Give the snapshot a reasonable name, such as partNfeederM.tif, where N is the part number and M is the feeder number, and save it. The vision system will use this snapshot to verify that the part is the correct part during the pickup phase.
5. Associate the snapshot with the feeder's DOWNLOOKING SNAPSHOT by selecting the feeder in the FEEDER LIST and clicking QM FEEDER to bring up the snapshot selection dialogue box.

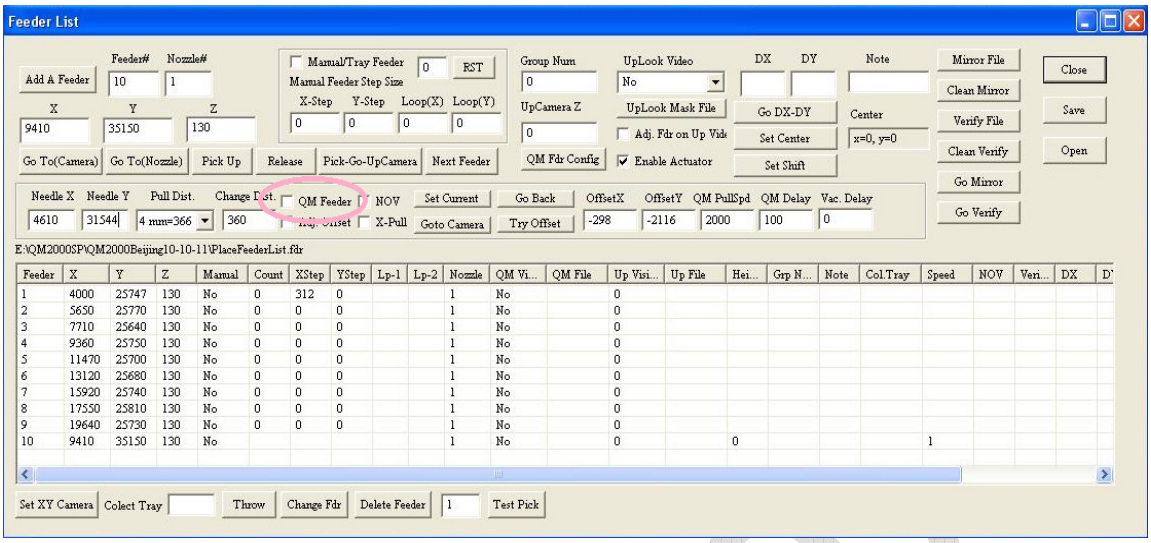


Figure 4.38: Click the QM FEEDER checkbox in the FEEDER LIST WINDOW to bring up the DOWNLOOKING SNAPSHOT file selection dialogue box

6. In the snapshot selection dialogue box, locate the picture file you created in Step 4 and click the OPEN BUTTON to complete the selection.

Specifying Downlooking Snapshot (non-QM Feeders)

Follow the same instructions as in the QM Feeder, except instead of taking a snapshot of the part as it is lying on the component tape, take a snapshot of it lying on its own respective feeder slot before pickup.

Specifying Uplooking Snapshot

1. The UPLOOKING SNAPSHOT is a snapshot of the part held in its correct orientation by the NOZZLE, as viewed from an UPLOOKING CAMERA on the machine. This snapshot will be used by the UPLOOKING CAMERA to verify that the part is in the proper orientation before placement.
2. For this operation, we require that you already have an UPLOOKING CAMERA configured and set to a certain VIDEO (ie VIDEO 2). UPLOOKING CAMERA setup is covered in Chapter 3.
3. We also require that the feeder you are specifying the UPLOOKING SNAPSHOT for already has an appropriate NOZZLE POSITION and NEEDLE POSITION. Instructions for setting these positions are covered in the Adding a New Feeder (QM Feeder) section above.
4. With these requirements met, bring up the FEEDER LIST WINDOW by clicking the FEEDER LIST button at the bottom left of the MAIN WINDOW.
5. Use the UPLOOK VIDEO drop-down box on the FEEDER LIST WINDOW to select VIDEO 2 (or whichever video that UPLOOKING CAMERA is set to).

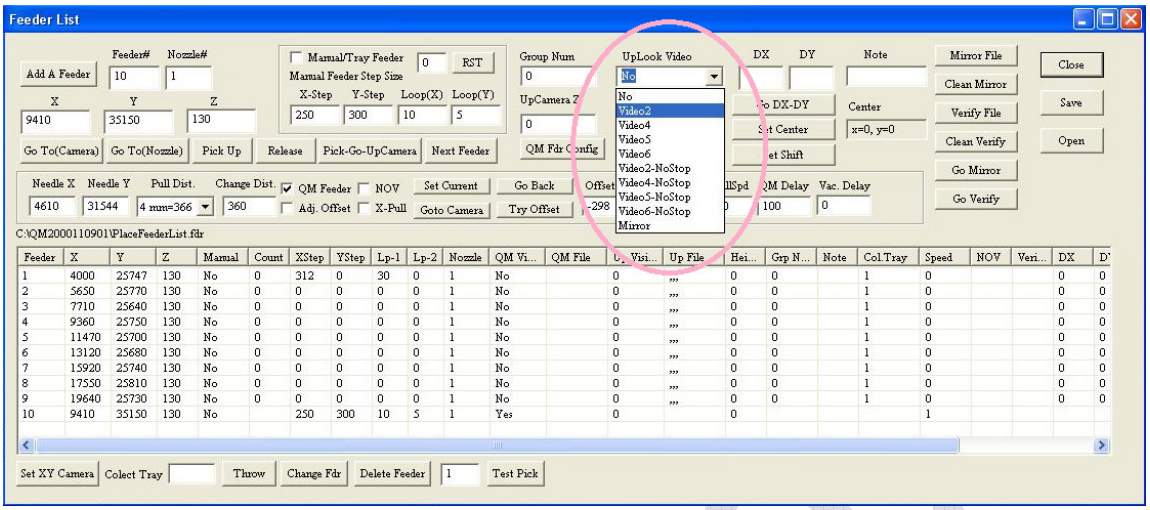


Figure 4.39: FEEDER LIST WINDOW with UPLOOK VIDEO drop-down box being set to Video 2

6. When you select Video2 in the drop-down box, a window will pop up requesting pictures for eight different rotations of the part, one for each 45° increment.

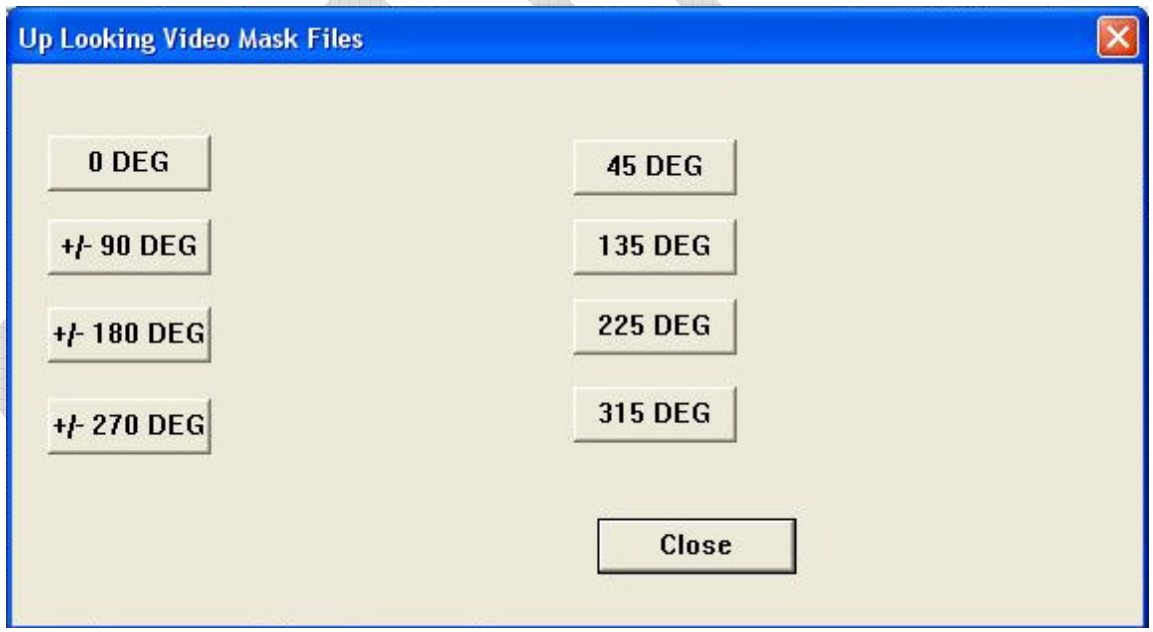


Figure 4.40: The UP LOOKING VIDEO MASK FILES window, which stores UPLOOKING SNAPSHOTS in different orientations for a particular part.

IMPORTANT: These rotations are hard-coded, and represent the rotations for which vision checking currently exists. If you plan to rotate a part to multiples of 45° before

placement, and want to use the vision checking system to validate it, then you should ensure that a picture for each one of those rotations exist.

Since you do not have these pictures yet, click the CLOSE BUTTON for now.

7. Click the PICK-GO-UPCAMERA button on the FEEDER LIST WINDOW. When you click this button, the machine will pick up a part from the feeder tape, move to the UPLOOKING CAMERA designated by UPLOOK VIDEO, and then switch the MAIN WINDOW video to that UPLOOKING CAMERA.

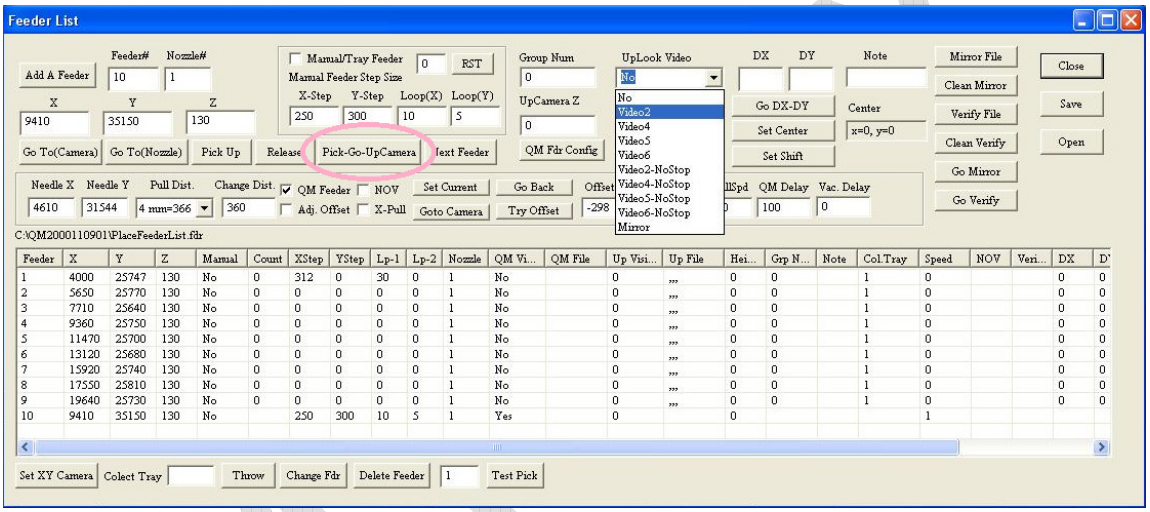


Figure 4.41: FEEDER LIST WINDOW with PICK-GO-UPCAMERA BUTTON circled.

8. Using the MAIN WINDOW view, verify that the part is at the correct position with respect to the UPLOOKING CAMERA's crosshairs, which should be centered on the part as shown below:

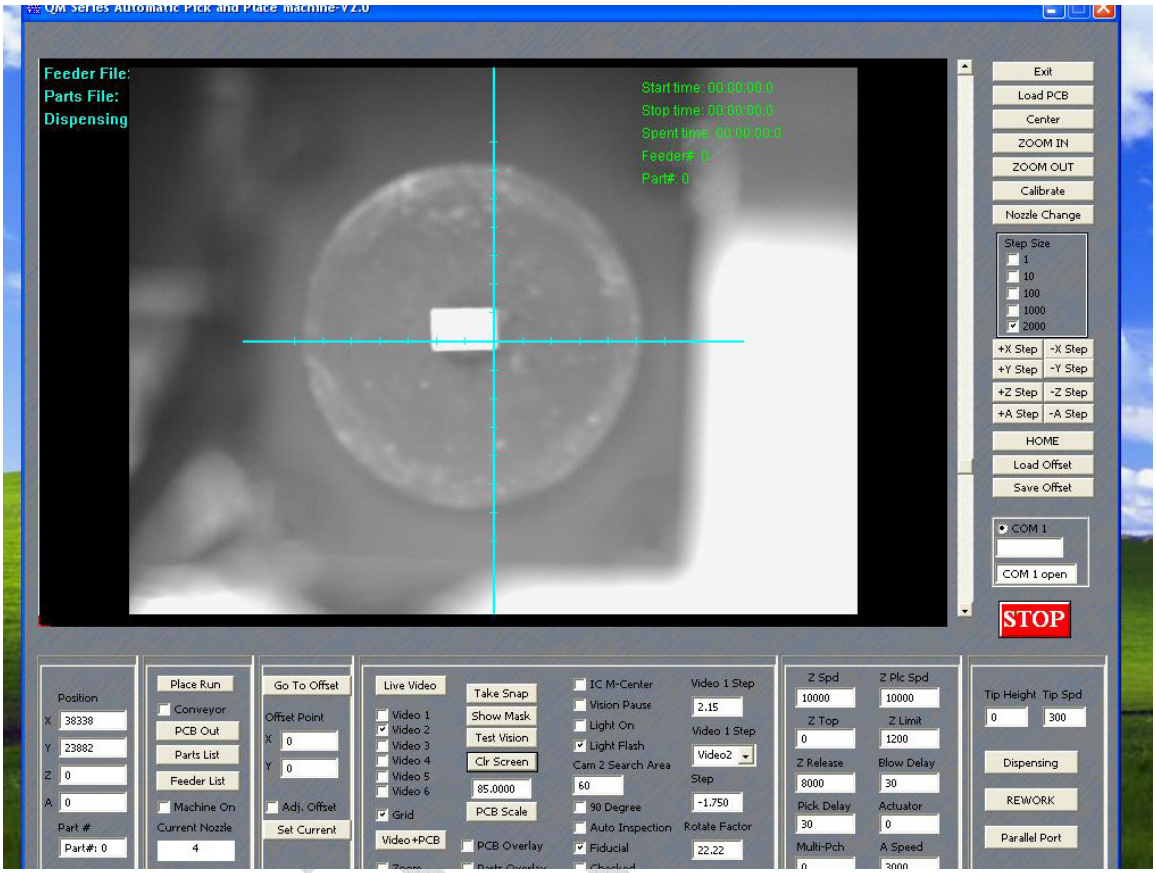


Figure 4.42 Incorrect position of a component displayed by the uplooking camera

9. If the part *isn't* in the correct position, like the part shown in the picture, use the MAIN WINDOW navigation panel to move the part until it is.

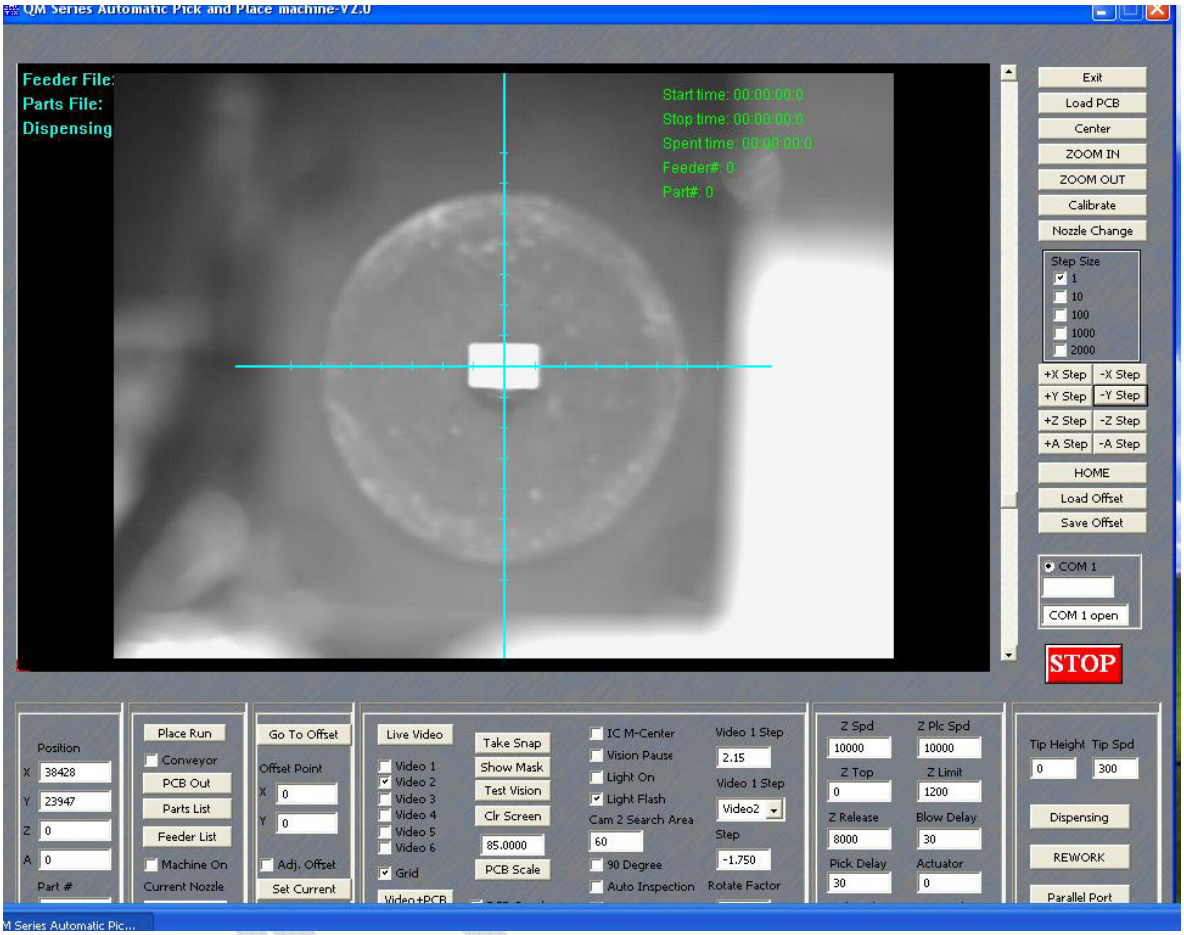


Figure 4.43 Correction of a component by the uplooking camera

10. Next, decide the rotation (0°, 45°, 90°, 135°, 180°, 225°, 270°, or 315°) for which you are creating an UPLOOKING SNAPSHOT, and use the ROTATE function of the NAVIGATION PANEL to rotate the camera until the part is rotated that many degrees on the camera.

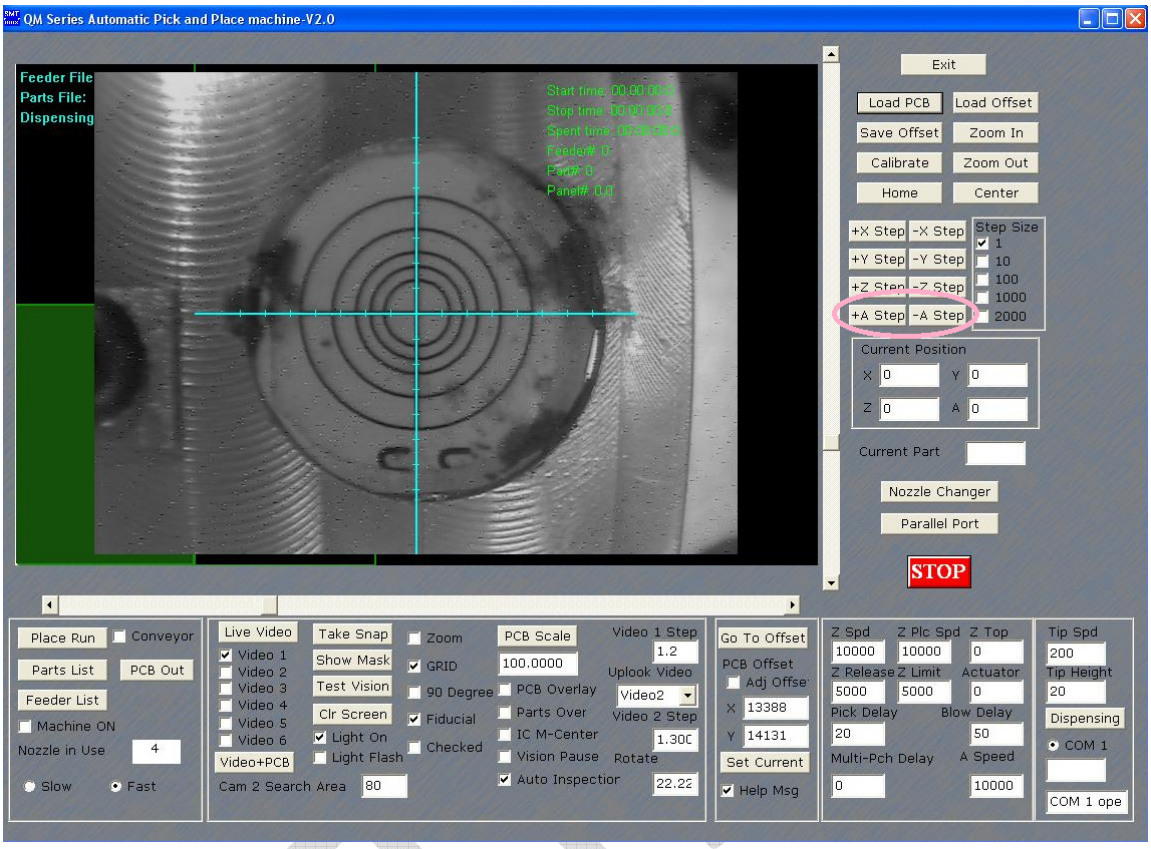


Figure 4.44: Navigation panel with Rotate Buttons circled

11. Once the part has been rotated to the desired rotation, use the mouse and left-click to draw a tight box around the part, as shown here:

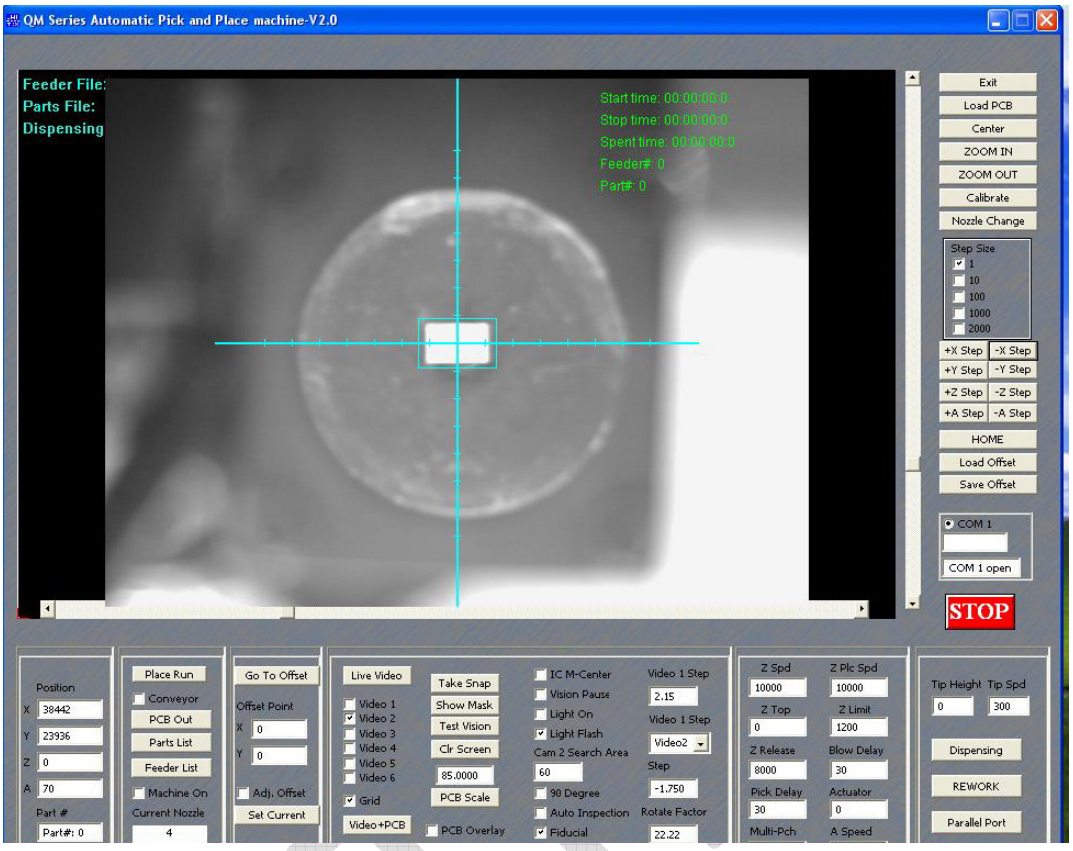


Figure 4.45 Take a snap shot of a component

12. Click the TAKE SNAP button at the bottom left side of the MAIN WINDOW. Give the snapshot a reasonable name, such as pN-DEG.tif, where N is the part number and DEG is the degree of rotation, and save it. The saved image file can be opened to review by click on Show Mask from the MAIN WINDOW.

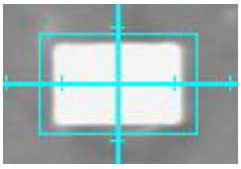


Figure 4.46

13. Now, go back to the FEEDER LIST WINDOW and once again select Video2 from the drop-down under UPLOOK VIDEO to bring up the UP LOOKING VIDEO MASK FILES window. Once there, click the DEG BUTTON corresponding to the rotation of the UPLOOKING SNAPSHOT you just took.

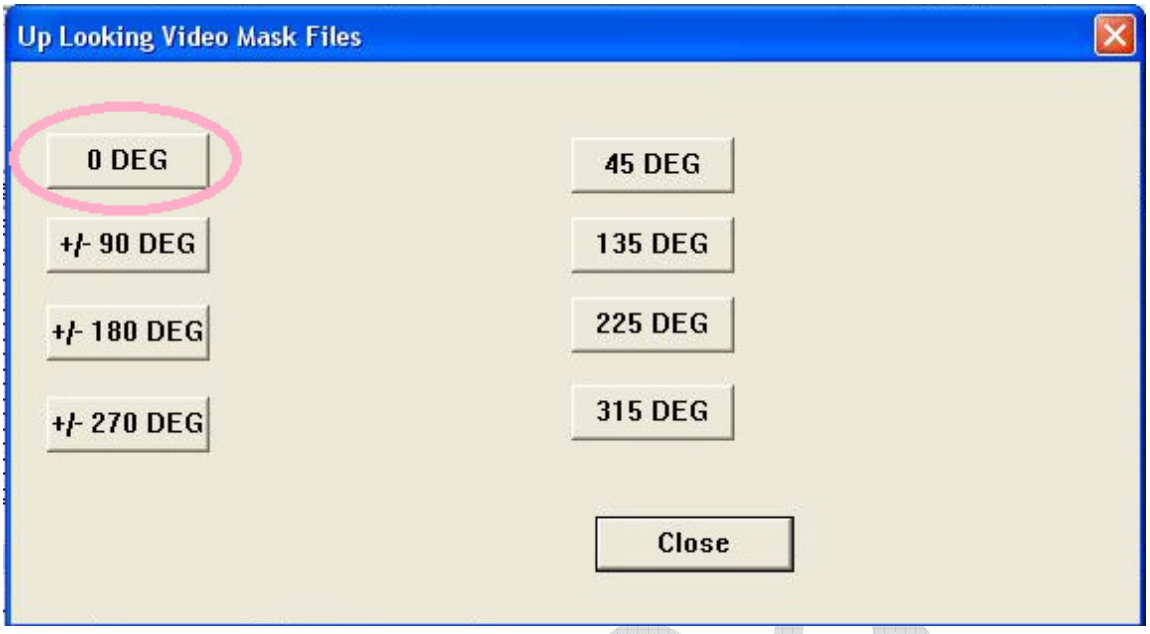


Figure 4.47: Clicking the 0 DEG BUTTON will bring up a dialogue box asking for a picture of the part rotated 0°.

14. Select the picture file you created in Step 12, and click the OPEN BUTTON.

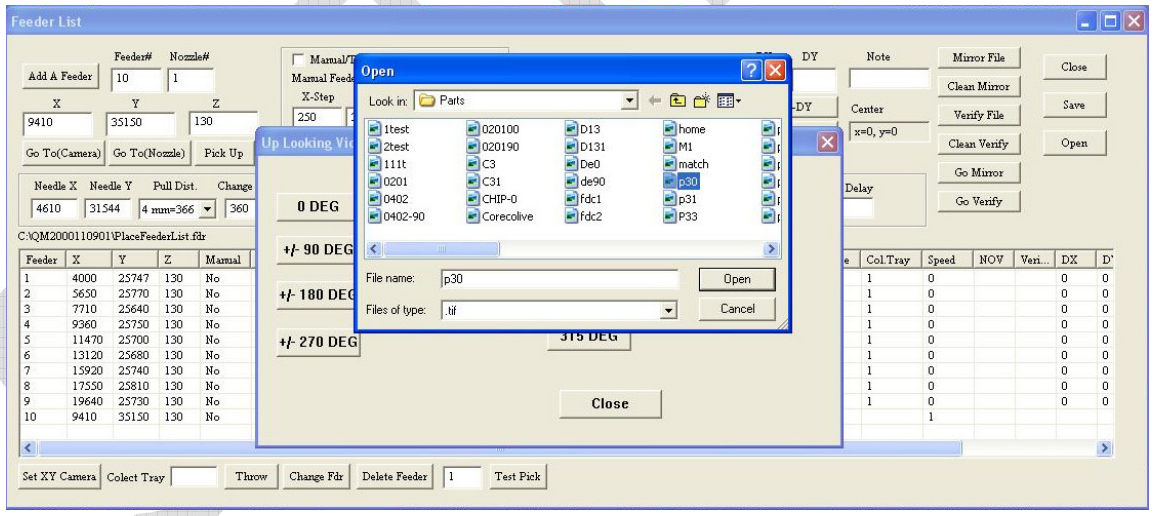


Figure 4.48: Select the picture file you want to link with the DEG BUTTON you pressed.

15. The selected picture file will now be linked with the rotation of the part corresponding to the DEG BUTTON you pressed, and its file name will appear in the UP LOOKING VIDEO MASK FILES WINDOW to the right of that DEG BUTTON.

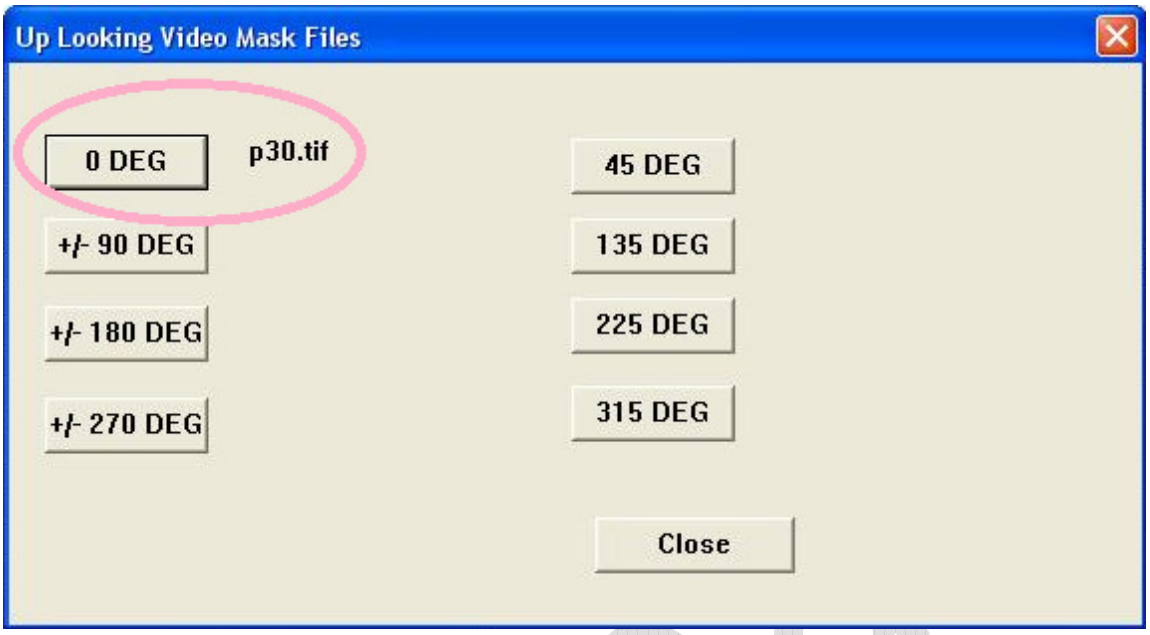


Figure 4.49: The picture file p30.tif is now linked with the part's 0° rotation.

16. Repeat the above steps as necessary to generate a picture file for other rotations of the part.

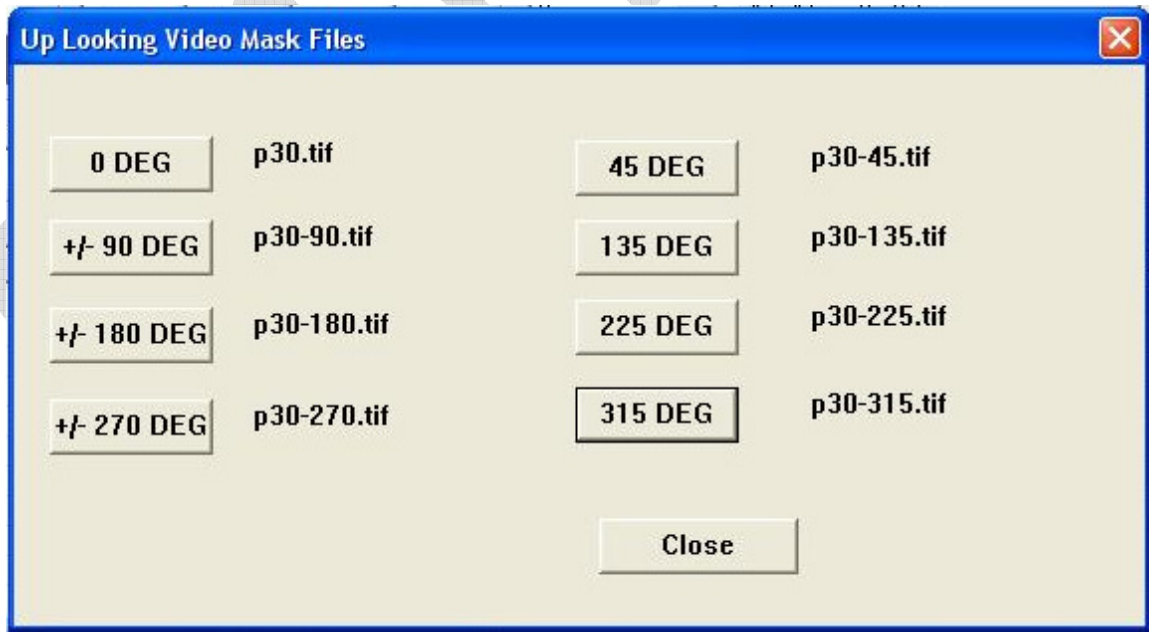


Figure 4.50: An example UP LOOKING VIDEO MASK FILES WINDOW for part 30 with an UPLOOKING SNAPSHOT picture for every rotation (p30.tif, in this case, is p30-0.tif – a picture of the part at 0° rotation).

Chapter5. Parts List

The PARTS LIST WINDOW is used to define where parts are placed during pick and place operation. The QM series of Automatic Pick and Place Machines support both individual and panelized operations.

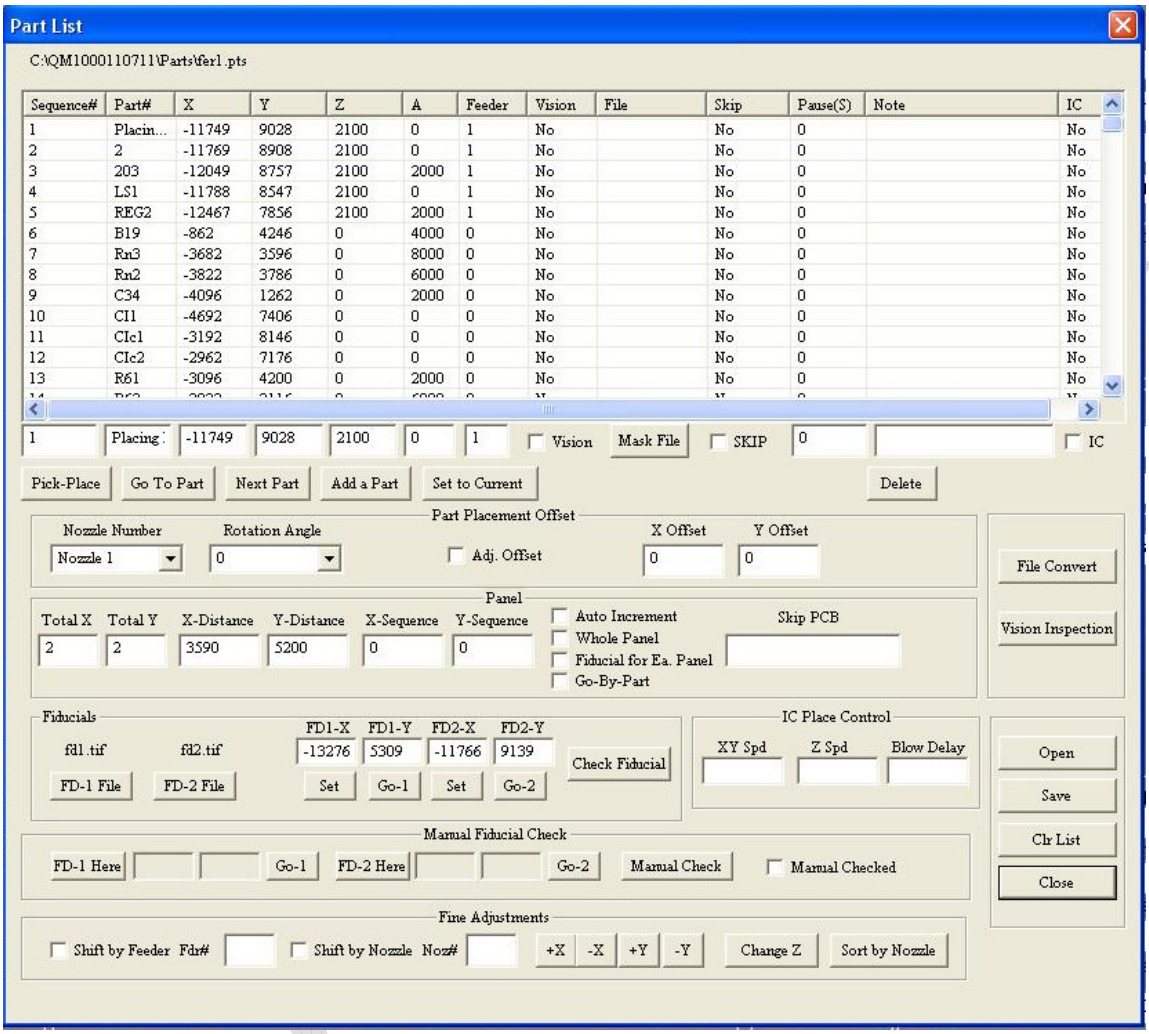


Figure 5.1: The PARTS LIST WINDOW

The user defines parts placements by adding sequences to the parts list. There are two main methods for doing so: CONVERT MODE and TEACHING MODE. In CONVERT MODE, a GERBER file (or any other ECAD format capable of generating a pick and place layer) is used to populate the list. In TEACHING MODE, the user manually adds sequences to the list by specifying their exact parameters.

Before discussing the two modes in more detail, it is necessary to describe the format of the sequences.

Part Sequence Format

Each sequence has a number of features:

- **Sequence**: The sequence number.
- **Part Number:** An unique id used to identify a part type & the feeder containing it.
- **X**: The X position of placement, in machine units.
- **Y**: The Y position of placement, in machine units.
- **Z**: The Z position of placement, in machine units.
- **A**: The rotation of the part upon placement, relative to its pickup rotation, in degrees.
- **Feeder**: The feeder number (id) used to find the part.
- **Vision**: Whether to use the vision system to validate placement, either *yes* or *no*.
- **File**: If Vision is marked *yes*, then this feature selects the reference photo to be used for vision checking.
- **Skip**: Whether the sequence should be performed during operation, either *yes* or *no*.
- **Pause**: How many microseconds to pause when the part is placed.
- **Notes**: Notes for the operator.
- **IC:** Whether to use customized speed control (under the IC panel) instead of the default, either *yes* or *no*. Useful when the default speed might cause the part to slip.
- **Component**: Presently unused.

IMPORTANT: Not all the features must be filled in for a sequence to be executed, but their order must be preserved for a sequence to be recognized by the system. That is to say, the columns of each row in the parts list are treated as features in the order listed above. Thus, for any given sequence, Column 1 represents the sequence number, Column 2 represents the part number, etc.

Given that a list of sequences is what is required by the system, there are two ways to arrive at such a list, as stated above: CONVERT MODE and TEACHING MODE.

Convert Mode

1. Bring up the PARTS LIST WINDOW by clicking the PARTS LIST BUTTON in the MAIN WINDOW.
2. Click the FILE CONVERT BUTTON in the PARTS LIST WINDOW to bring up the FILE CONVERT WINDOW.

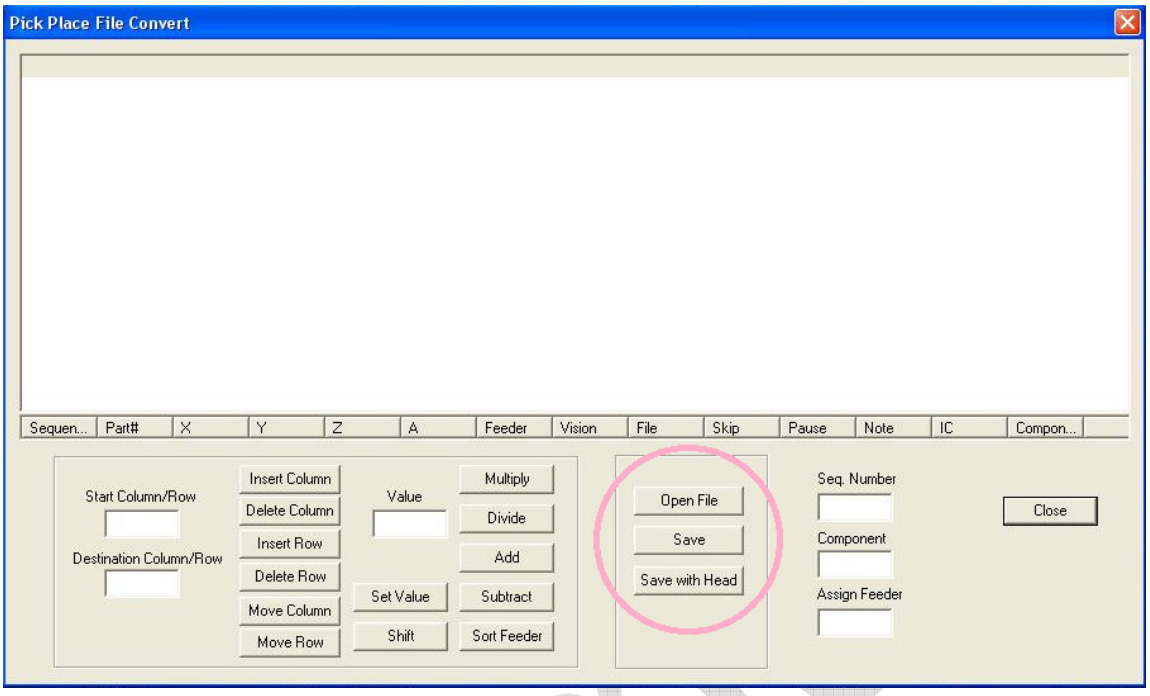


Figure 5.2: The FILE CONVERT WINDOW with OPEN FILE, SAVE, and SAVE WITH HEAD BUTTONS circled

3. Click the OPEN FILE BUTTON, and select a compatible file to convert. Compatible files include any GERBER or ECAD format capable of extracting a TXT pick & place layer.
4. The pick & place layer should describe the relative position of each part's center position with respect to the circuit board's origin (0, 0) position.
5. A number of SEQUENCES should appear on the list. Each SEQUENCE corresponds to a pickup -> place cycle.

   IMPORTANT: Based on the format of your input file, certain columns and rows maybe unnecessary, missing, or in the wrong order. You must edit them to the format described above under Part Sequence Format.

6. To make the changes, a number of tools maybe used:

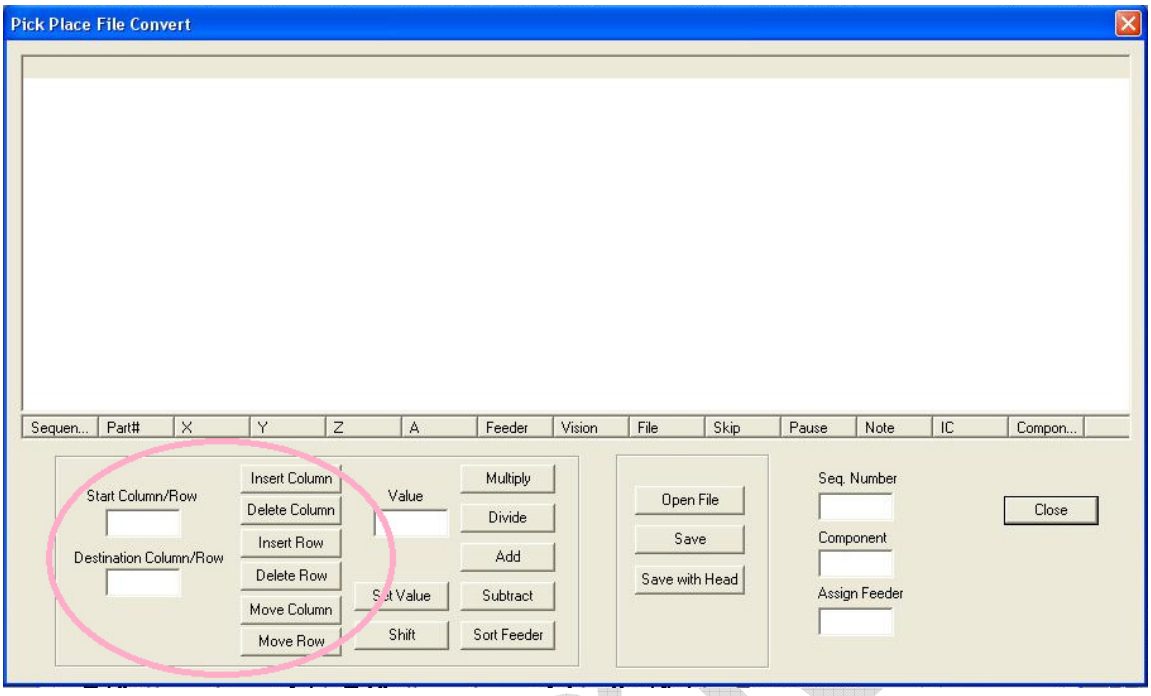


Figure 5.3: The FILE CONVERT WINDOW with Row/Column Editing Tools circled

- **INSERT COLUMN/ROW:** insert a column/row *before* the column/row specified in the START COLUMN/ROW box.
- **DELETE COLUMN/ROW:** delete the column/row specified in the START COLUMN/ROW box.
- **MOVE COLUMN/ROW**: move the column/row specified in the START COLUMN/ROW box to the column/row specified in the DESTINATION COLUMN/ROW, moving everything after it forward.

7. Furthermore, the unit of measurement used by the source format is probably *not* the same as the internal unit step of the QM machines.

   IMPORTANT: The unit of conversion from standard units to QM internal units is as follows:

1 inch	**2000 steps**
90 degrees	**2000 steps**

   To convert these, use the value editing features, which operate on the entire column specified by START COLUMN/ROW:

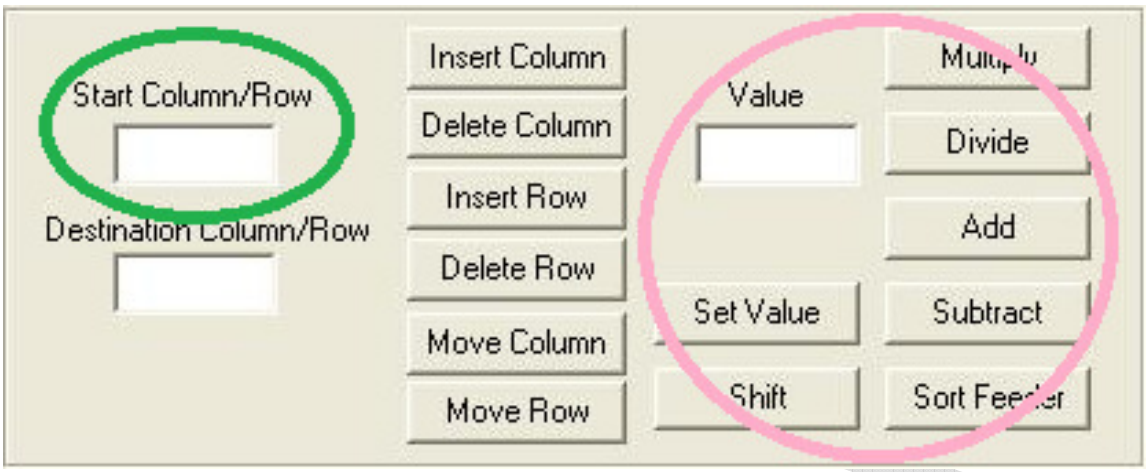


Figure 5.4: The Value Editing Features (pink circle) work on the entire column specified by START COLUMN/ROW (green circle)

- **SET VALUE**: sets the values in the column to the value specified
- **ADD**: adds to the values in the column the value specified
- **SUBTRACT**: subtracts from the values in the column the value specified
- **MULTIPLY**: multiplies the values in the column by the value specified
- **DIVIDE**: divides the values in the column by the value specified
- **SHIFT**: bit shifts (^2) the values in the column by the value specified

8. If desired, use the SORT FEEDER button to sort the sequences in order of their displayed feeder numbers.
9. Once you have made the necessary conversion modifications, click the SAVE BUTTON to save the original file in the new format (**NOTE**: will overwrite the original file), or the SAVE WITH HEAD BUTTON to save as a new file.
10. The resulting parts list file can now be opened using the OPEN BUTTON in the PARTS LIST WINDOW, where it can then be used to operate the machine.

Teaching Mode

1. TEACHING MODE allows for the manual creation of sequences. To make use of this feature, bring up the PARTS LIST WINDOW.
2. To add a part sequence manually, click the ADD A PART BUTTON under the PARTS LIST WINDOW. The system will automatically generate a sequence number and then place the sequence into the parts list.

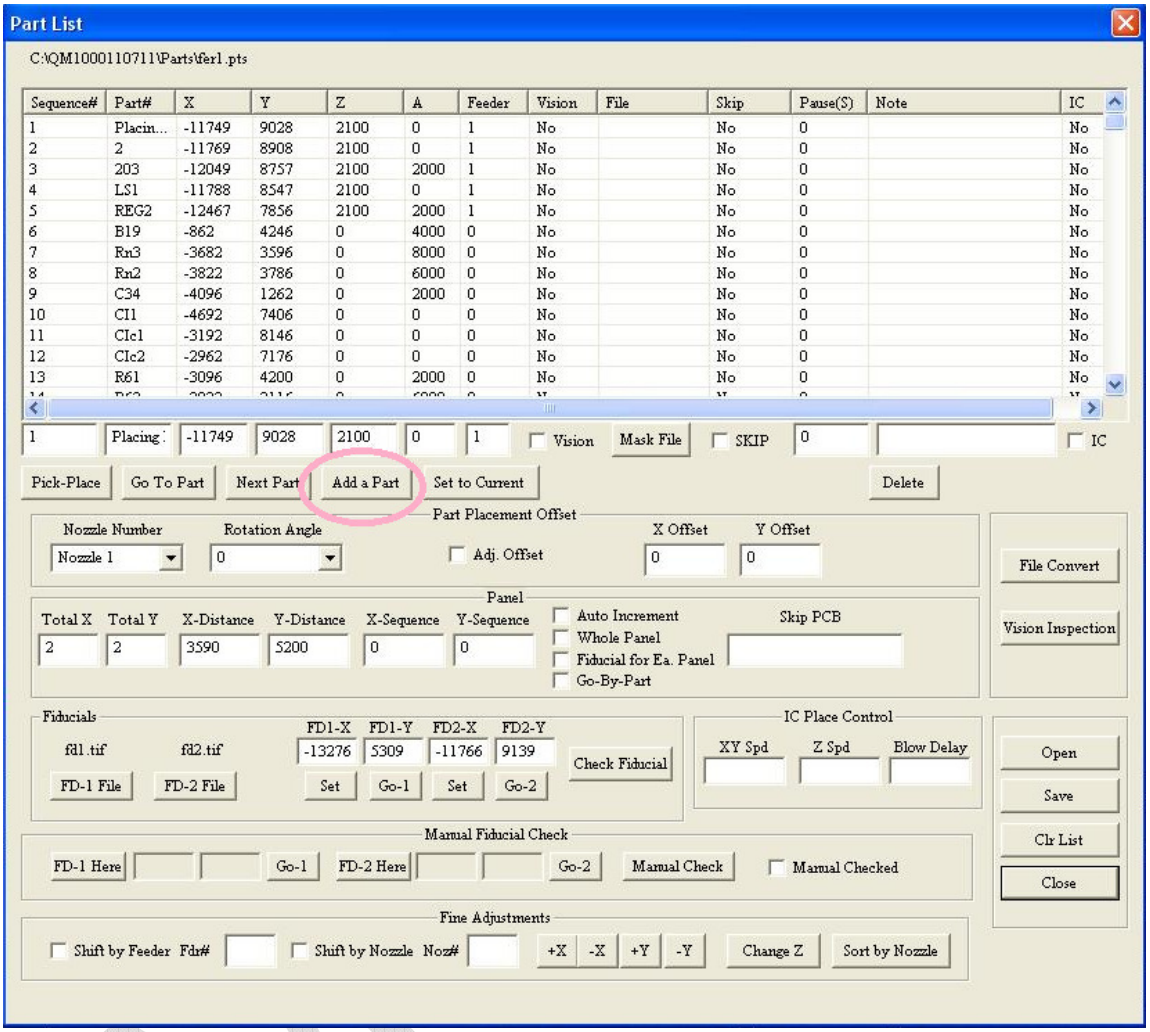


Figure 5.5: The ADD A PART BUTTON in the PARTS LIST WINDOW

3. You will then need to fill in, for the sequence, the information contained in the Part Sequence Format described above. Specifically, you will have to assign values for the following:
    - **Part Number**: An unique id for the part type & feeder containing it
    - **X and Y positions**: the X and Y coordinates representing the part's center of placement. One way to do this is to use the NAVIGATION PANEL of the MAIN WINDOW to locate this position by moving the crosshairs of the camera until they are centered on the desired position, and then clicking the SET TO CURRENT BUTTON to set the selected sequence's X and Y POSITION to the coordinates of that position.
    - **Z position**: the height the PARTS NOZZLE should descend to during placement. This height may vary depending on the part, and will have to be determined manually via testing.
    - **A rotation**: the rotation of the part upon placement relative to the pickup orientation. Again, this may vary depending on the part and feeder placement, and will have to be determined manually via testing.

- **Feeder**: the feeder number (id) used to find the part. Feeders that have been registered with the system should all possess such an id. For information about feeder setup, please see Chapter 4.
- **Vision**: to make use of the vision validation system, you must have this feature marked *yes*, in which case a photo file has to be provided in the **File** slot.
- **File**: the photo used to validate part placement. To create such a reference photo, follow the steps under the Creating a Part Placement Photo section below.
- **Skip**: mark this option *yes* if you want the sequence to be skipped during operation.
- **Pause**: if you want the NOZZLE to pause after placing a part, specify the number of microseconds to pause under this option.
- **Notes**: notes for the operator can be written here.
- **IC:** If you want to customize the speed of the NOZZLE for this part sequence, such as when the default speed might cause the part to slip, mark this option *yes*. Refer to the Customizing Operation Speed section below for information on how to set a custom speed.

4. Once you have added this information, the sequence will be ready for operation. Remember, if necessary, you can tune the parameters of the sequence later by clicking it in the list.

Creating A Part Placement Photo

1. To create a reference photo for a particular part's placement, first place the part in the appropriate position and orientation on the board.
2. Next, using the NAVIGATION PANEL of the MAIN WINDOW, move the crosshairs of the DOWNLOOKING CAMERA until it is at the center of the part you placed.

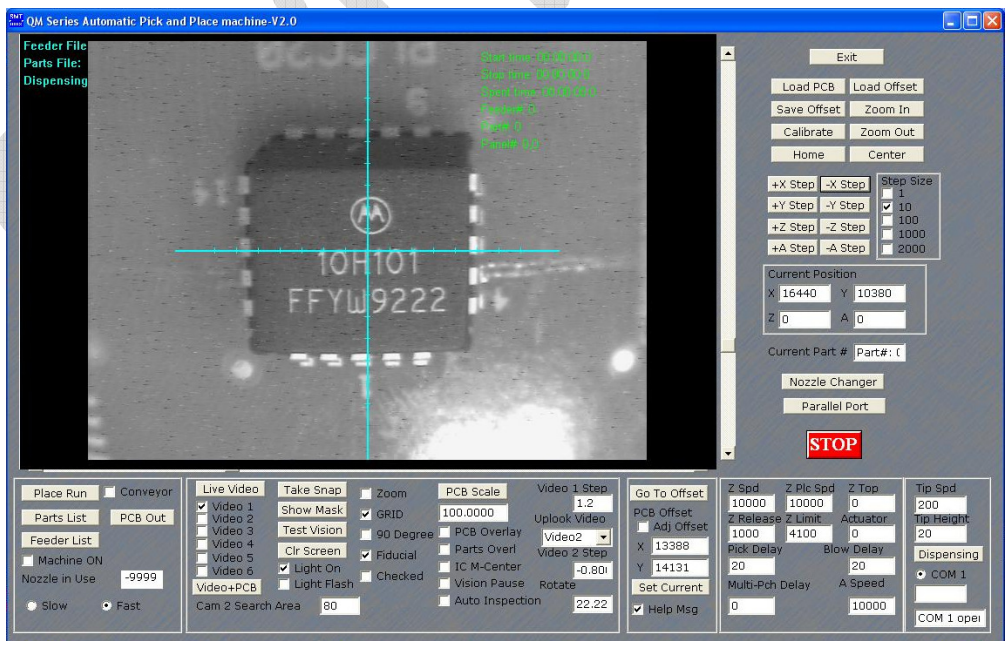


Figure 5.6: Crosshairs of the DOWNLOOKING CAMERA centered on a part placed on the board

3. By left clicking and dragging, draw a tight bounding box around the part.

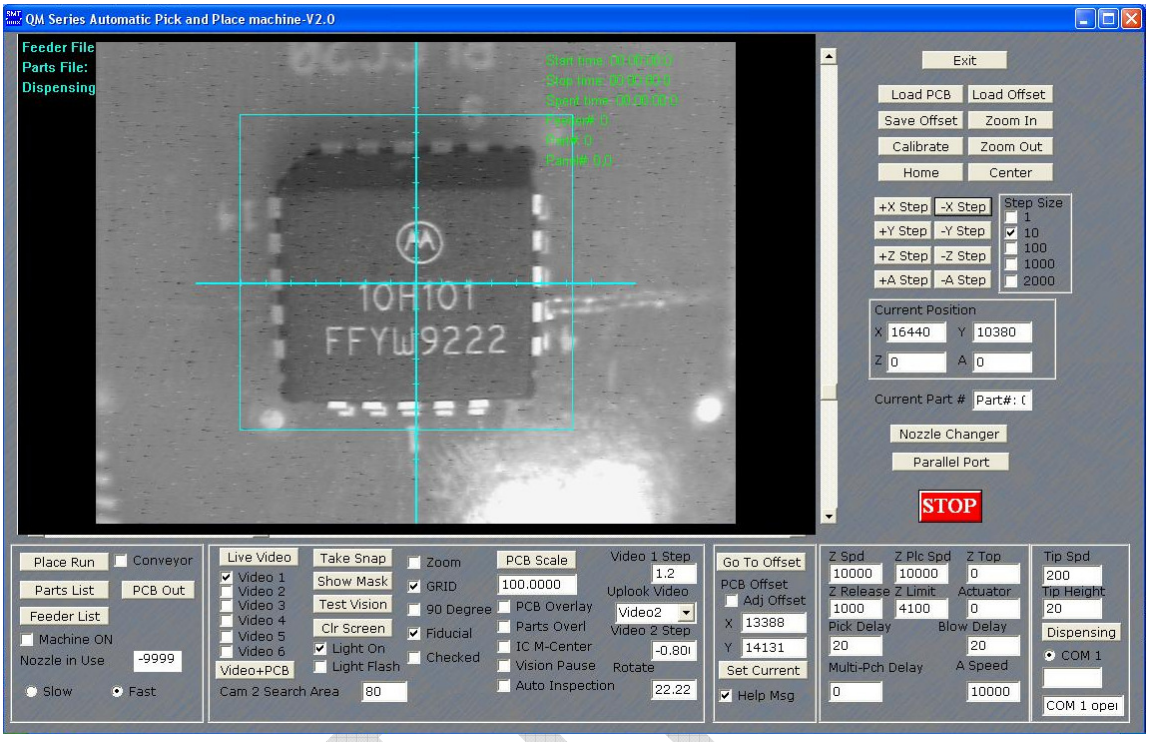


Figure 5.7: A tight bounding box drawn around the part in Figure 5.6

4. Click the TAKE SNAPSHOT BUTTON under the MAIN WINDOW, and specify an appropriate file name when prompted, such as partXplacement.tif.
5. Save the file in a convenient location.
6. Link the file to the part sequence by specifying *yes* in the **Vision** slot of the sequence and then selecting the reference photo file you created in the **File** slot.

Customizing IC Speed

1. Under the IC Place Control of the Parts List Window, there are XY and Z speeds, which can be used to specify custom speeds for the movement of the nozzle during operation, in steps per second.

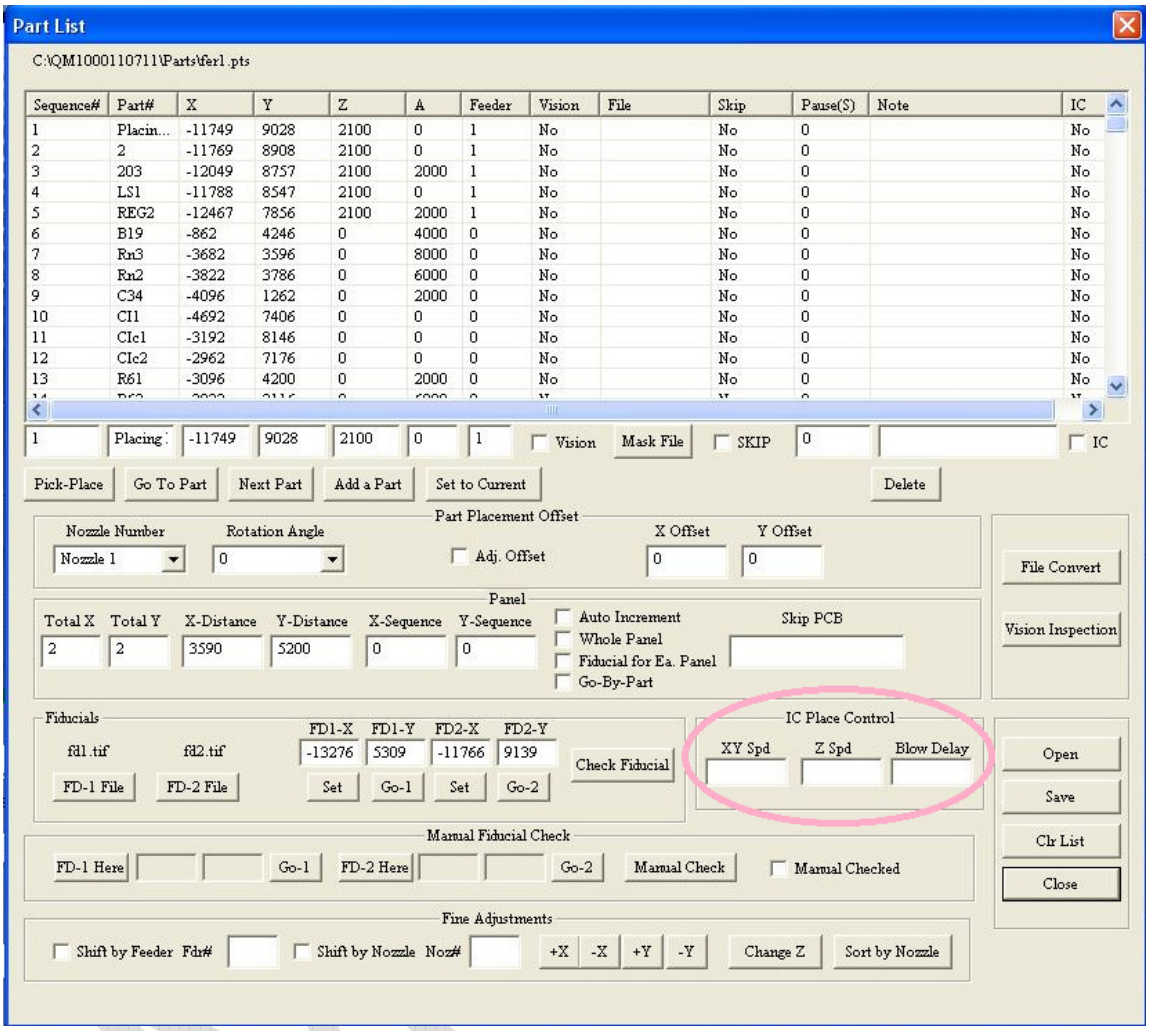


Figure 5.8: The IC Place Control panel allows custom nozzle speeds to be inputted.

2. To enable custom speed for a part, make sure the IC COLUMN for that part is set to YES.

Throughout this chapter, we have discussed parts placement within the context of a single board. For boards with multiple panels, the QM series support automatic panelization. To specify multiple panels, follow the instructions below.

Specifying Multiple Panels

1. Generate the parts list for a single panel by using either the CONVERT or TEACHING MODE described above. This parts list will be repeated for the other panels in the series.
2. Set the TOTAL X and TOTAL Y values in the PARTS LIST WINDOW, which represent the total number of panels in the X and Y directions.

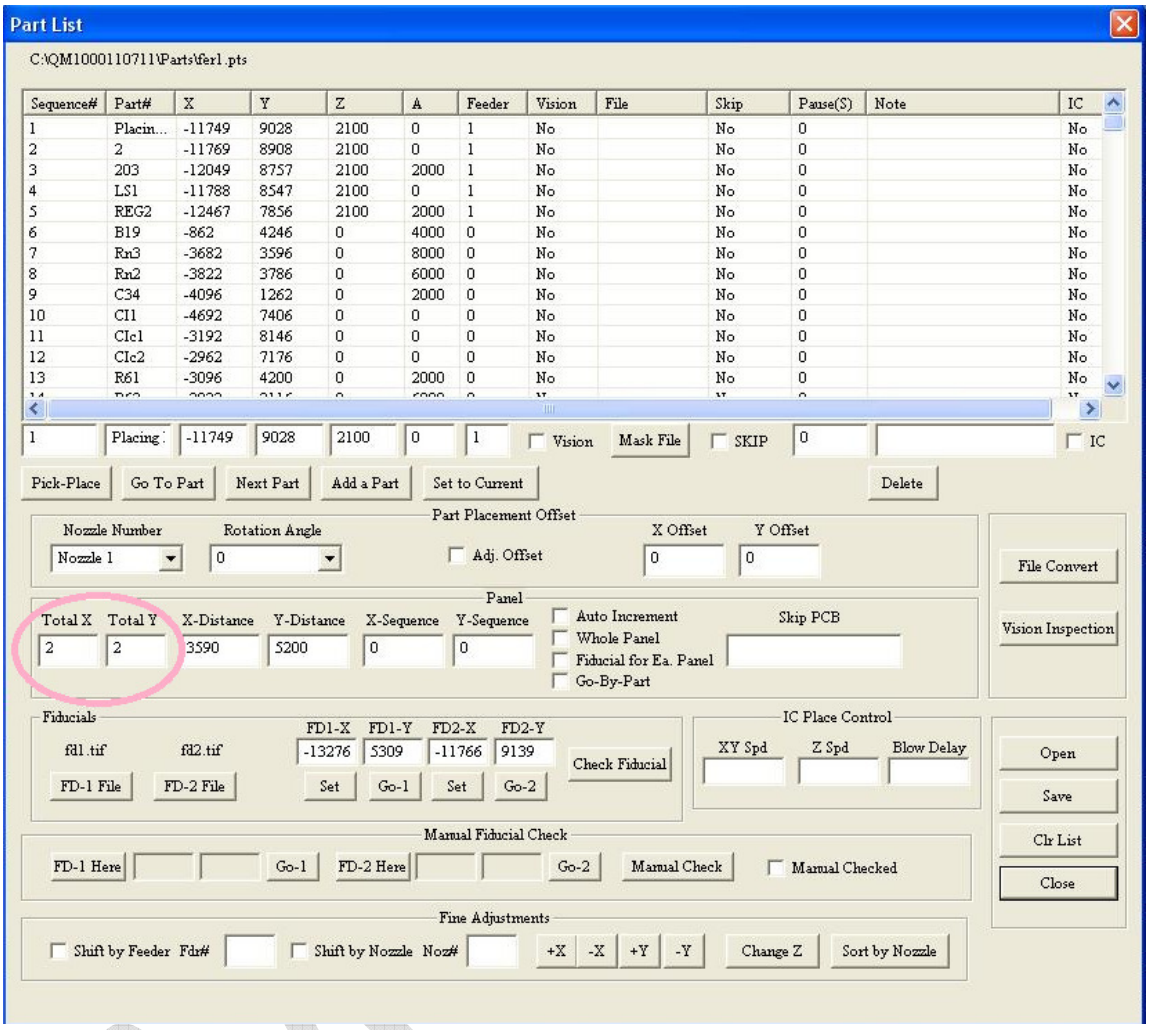


Figure 5.9: The TOTAL X and TOTAL Y boxes represent the number of panels in the X and Y directions. The current values of TOTAL X = 2 and TOTAL Y = 2 represent two panels in each direction, for a total of four.

3. Next, set the distance to skip in-between panels by filling in the X-DISTANCE and Y-DISTANCE boxes. You can determine these values manually using the NAVIGATIONAL PANEL in the MAIN WINDOW.

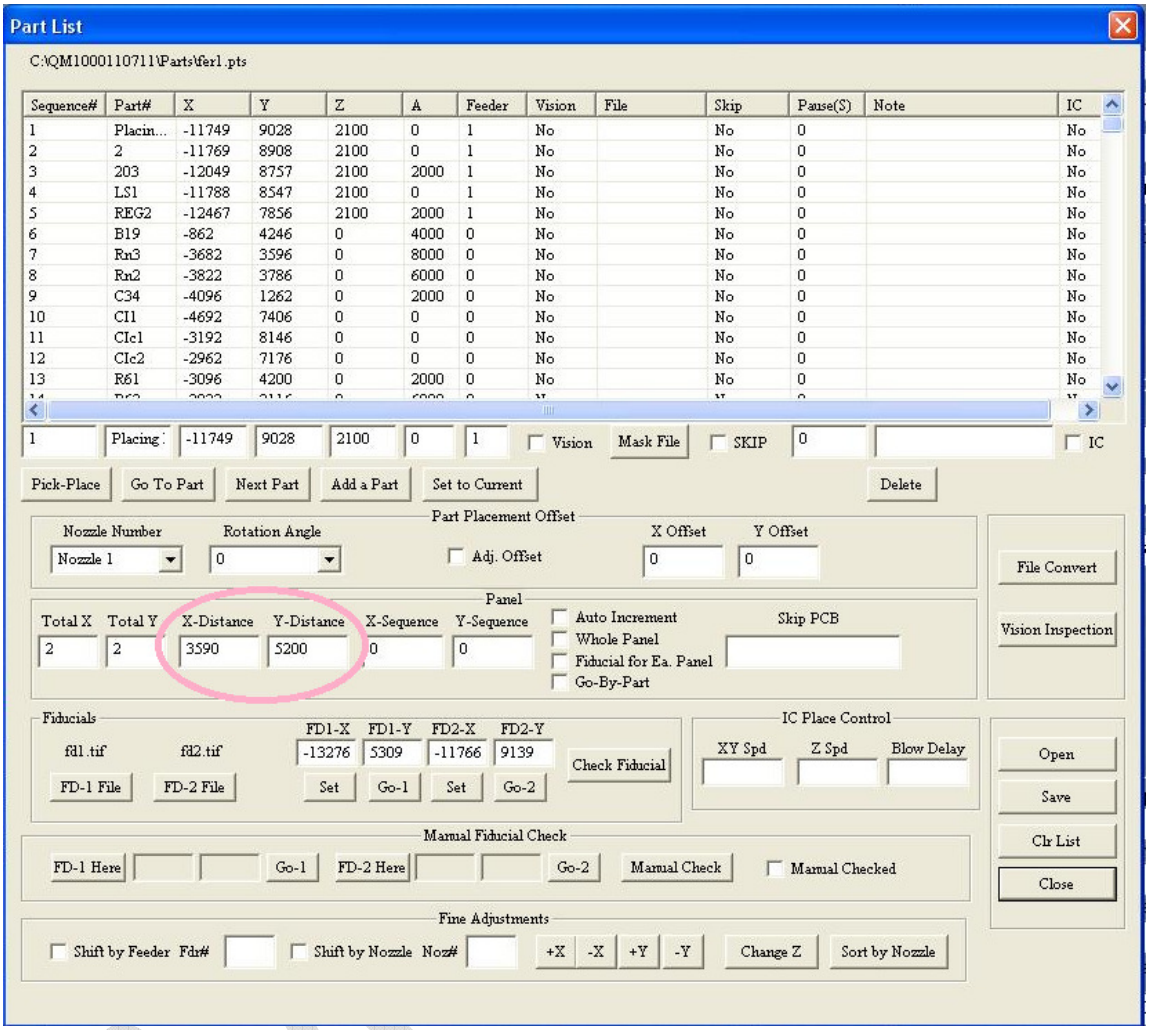


Figure 5.10: The X-DISTANCE and Y-DISTANCE boxes represent the number of machine steps to skip in-between panels while moving in the X and Y direction, respectively. The above values would cause the machine to skip 3590 steps in-between panels in the X direction, and 5200 steps in-between panels in the Y direction.

4. To start the operation process from a particular panel, fill in the X-SEQUENCE and Y-SEQUENCE values, which specify from which panel (in the X and Y direction, respectively) to start picking and placing.

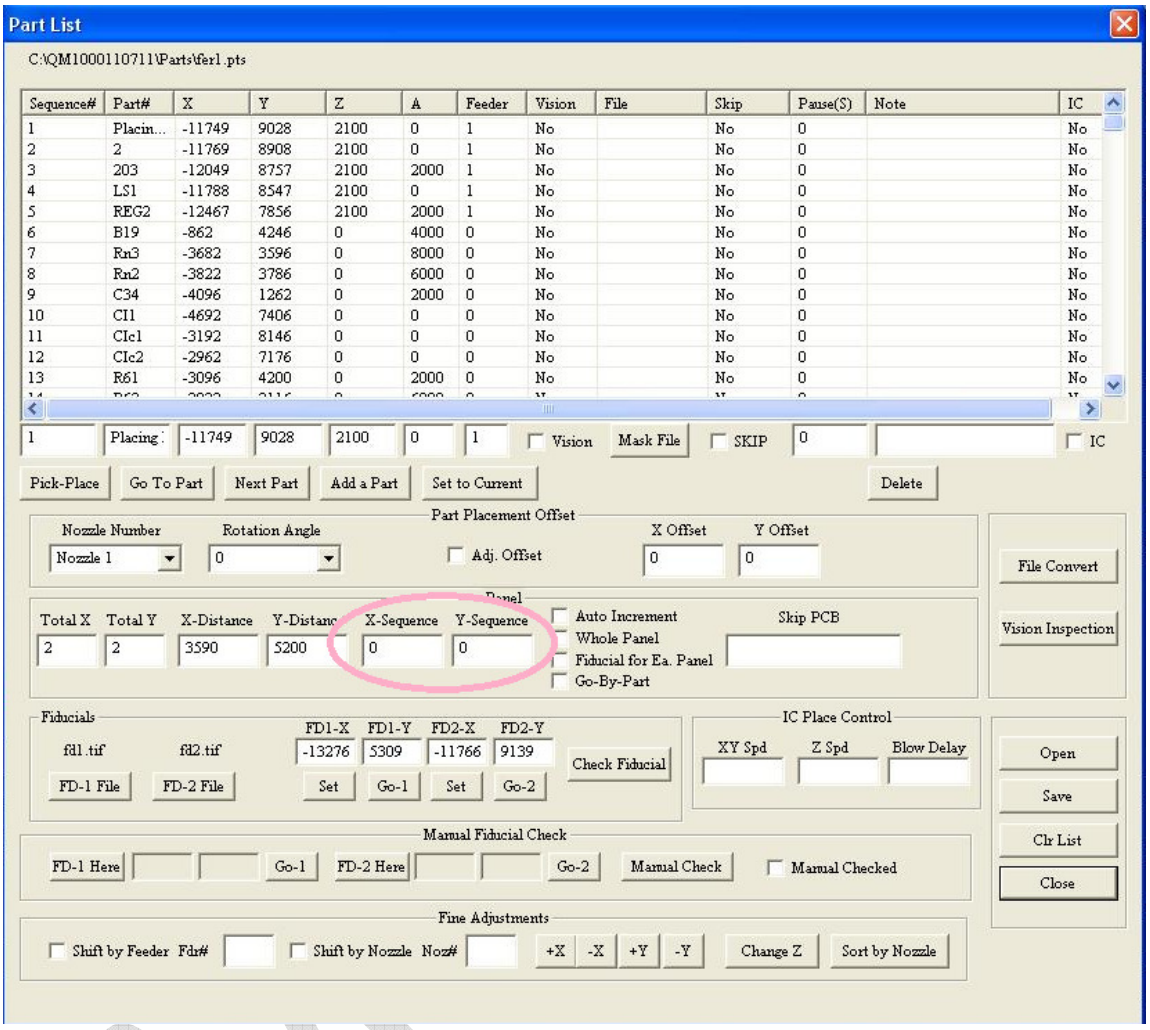


Figure 5.11: The X-SEQUENCE and Y-SEQUENCE boxes represent the panel from which to start picking and placing. The panel count starts from 0, so X-SEQUENCE = 0, Y-SEQUENCE = 0 designates the first panel in the X and Y direction.

5. There are a number of options that you can set for automatic panelization.

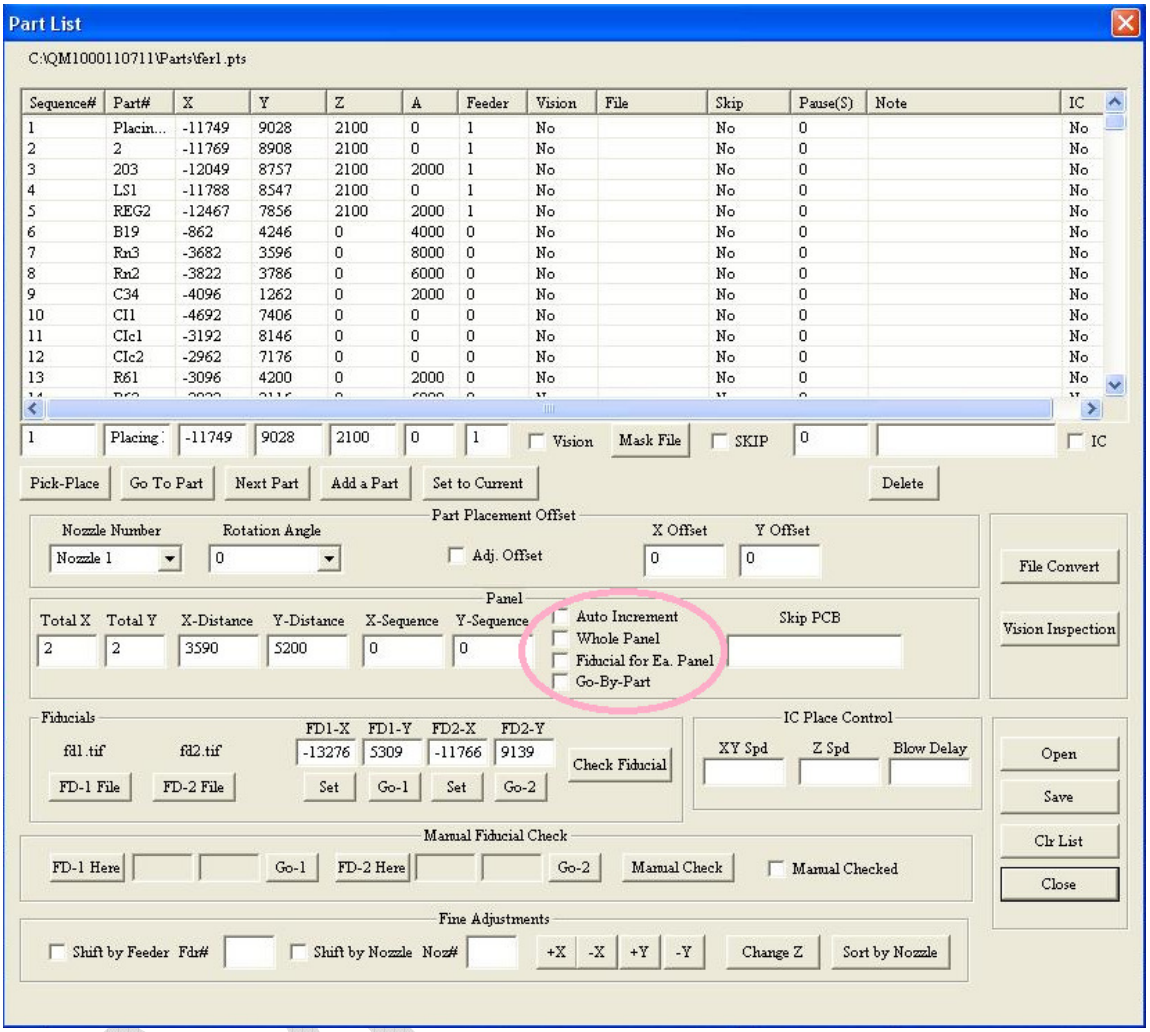


Figure 5.12: Various options for automatic panelization.

6. Set the AUTO INCREMENT option to make the machine automatically repeat the parts list for all panels during picking and placing. If AUTO INCREMENT is not set, the machine will make one panel and then stop.
7. Check the WHOLE PANEL option if you want the machine to complete an entire panel before moving to the next panel.
8. Check the GO-BY PART option if you want the machine to complete one part for all panels before moving to the next part. These two options are mutually exclusive and should never be checked together.
9. Enable fiducial checking for EACH panel before placing parts by checking the FIDUCIAL FOR EACH PANEL option. See the next chapter for further instructions concerning fiducial checking.
10. Lastly, you can use the SKIP PCB box to skip a particular board during picking and placing. The panel number is counted X first, starting from 0, so that X=0,Y=0 is Panel 0, X=1,Y=0 is Panel 1, and X=0,Y=1 is Panel |X|, where |X| designates the number of panels in the X direction.

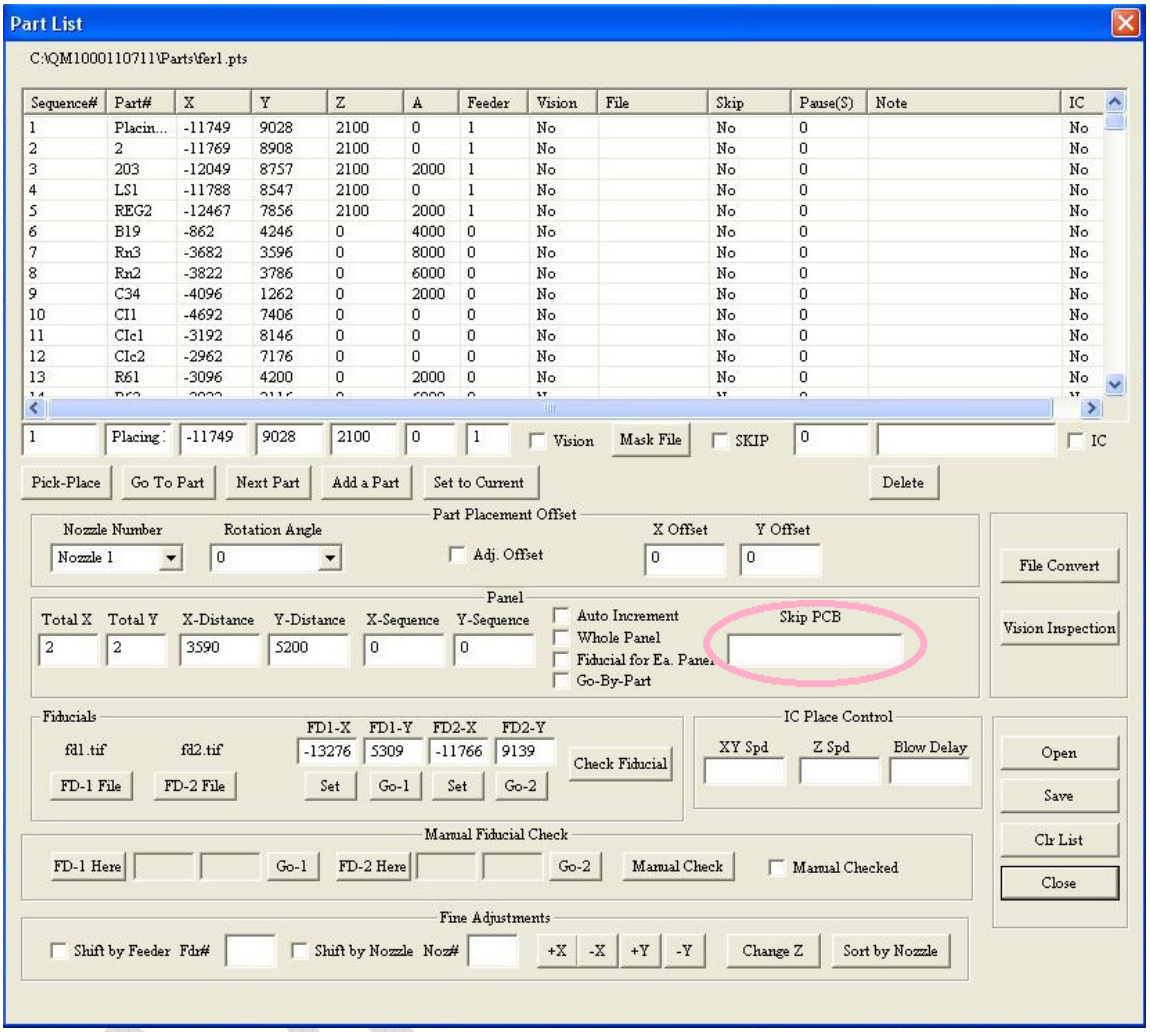


Figure 5.13: The SKIP PCB box can be used to skip a particular board during picking and placing.

Chapter6. Fiducial Checking

Fiducial marks are features built into a circuit board, which maintain the property that between any two circuit boards of the same type, the relative position of each component on the circuit board to the fiducial marks is the same. They are used to auto-correct for minor changes in the physical position and orientation of a circuit board as it lies on the machine, so that accuracy during picking and placing are not subject to such changes.

The QM series supports automatic fiducial checking with two fiducial marks. To use this feature, follow these instructions.

Fiducial Setting

1. Using the NAVIGATION PANEL of the MAIN WINDOW, move the DOWNLOOKING CAMERA such that it is centered on the first fiducial mark. In this case, we will be using the three letters, “QFP,” shown in the following display.

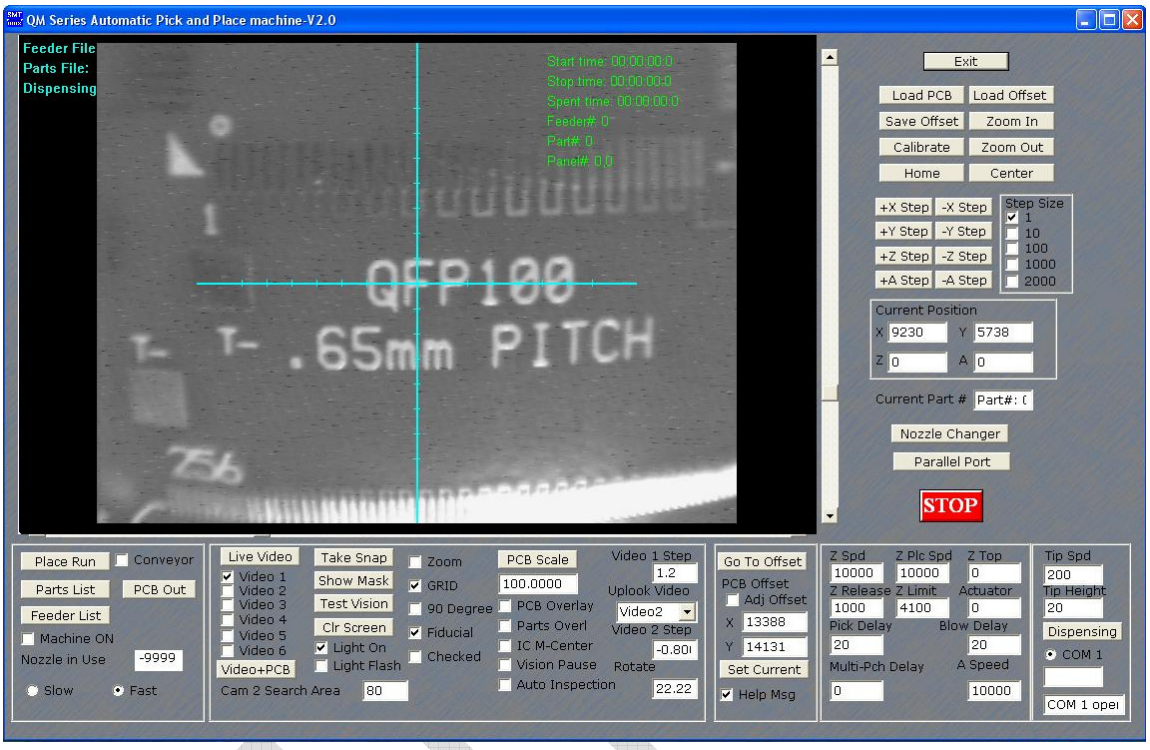


Figure 6.1: Crosshairs of the DOWNLOOKING CAMERA centered on the first fiducial mark, “QFP”

2. Bring up the PARTS LIST WINDOW, and click the SET BUTTON under FD1_X to set FD1_X and FD1_Y to the current center of the DOWNLOOKING CAMERA.

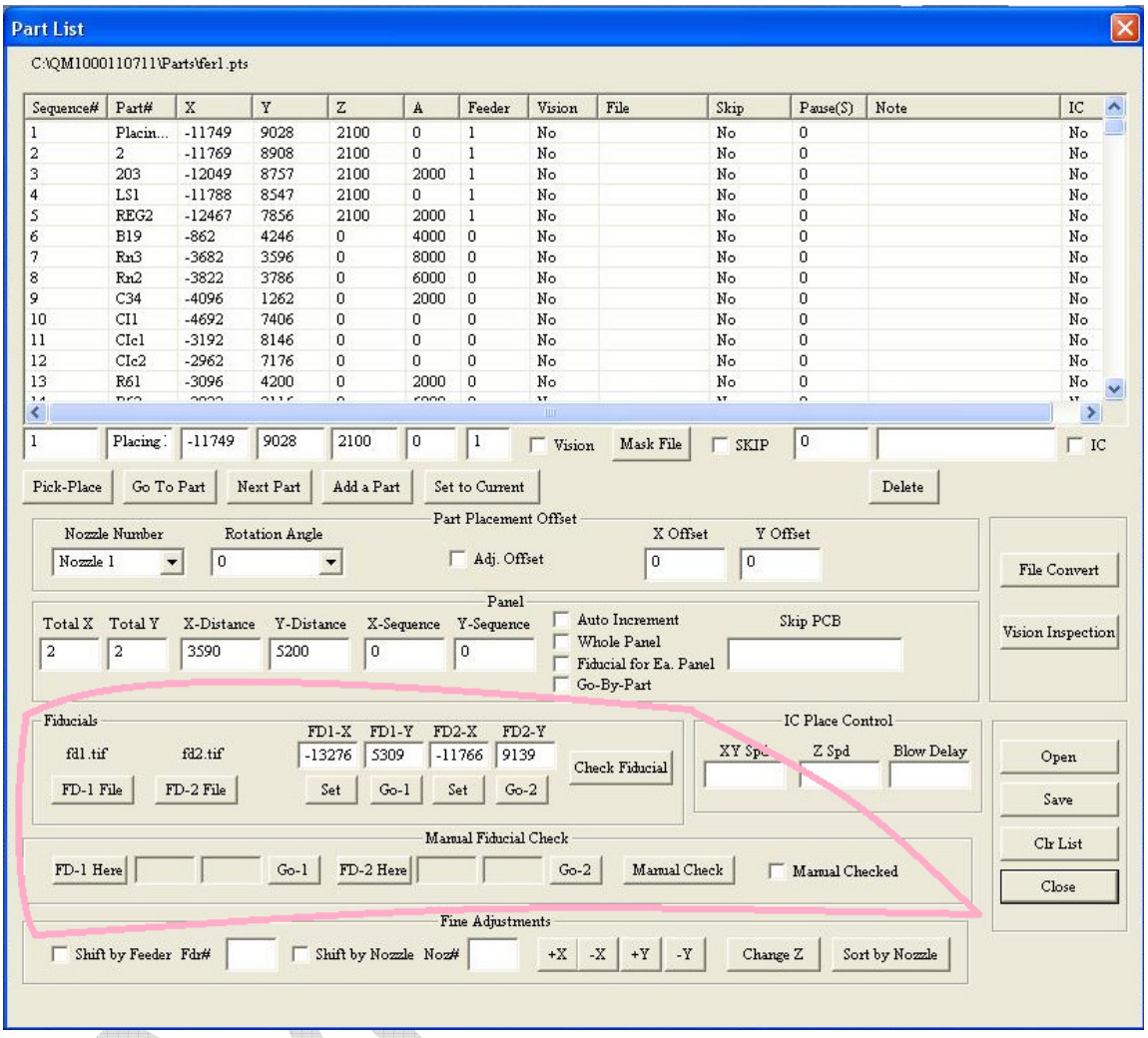


Figure 6.2: The fiducial settings area in the PARTS LIST WINDOW

3. Select a tight box around the fiducial mark and click the TAKE SNAPSHOT button to take a photo. Give it a convenient name, such as fdc1.tif.

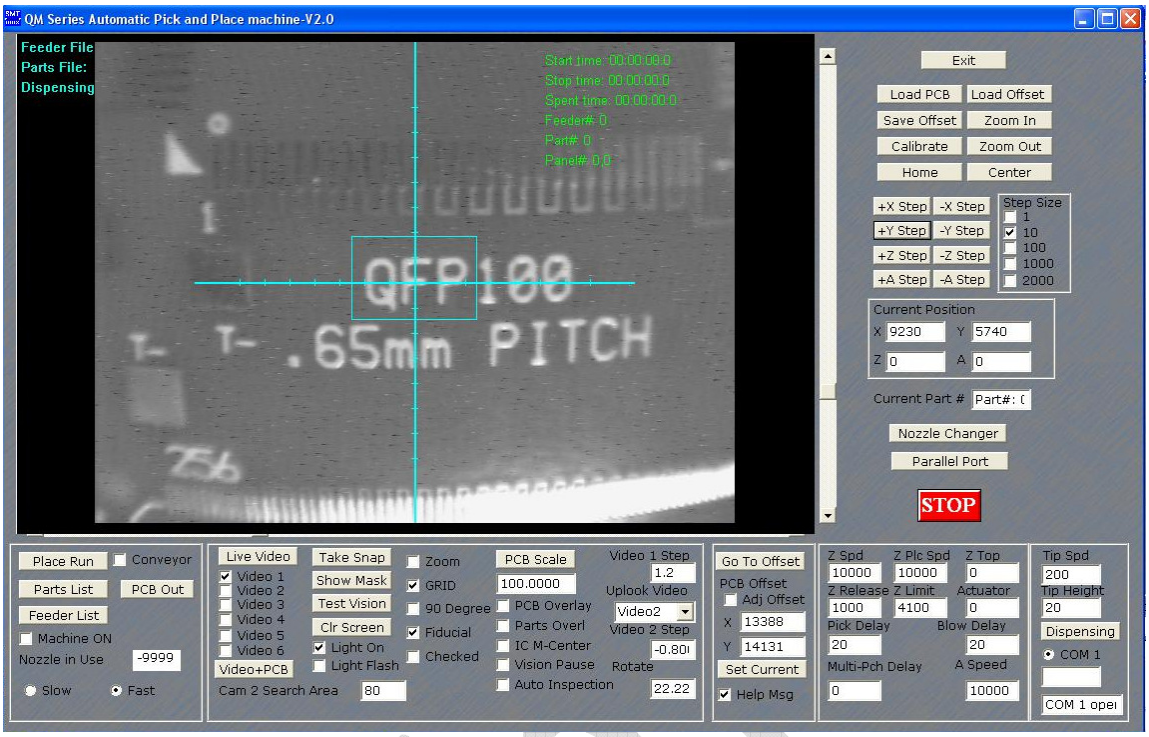


Figure 6.3: A tight bounding box drawn around the first fiducial mark, "QFP"

4. Repeat Steps 1-3 for the second fiducial mark, resulting in a second fiducial photo, fdc2.tif, and values for the FD2_X and FD2_Y boxes.
5. Set the files for FDC1 and FDC2 to the fiducial mark files you created, fdc1.tif and fdc2.tif, respectively, by selecting them with the FD_1 FILE and FD_2 FILE BUTTONS.
6. Enable fiducial checking before placing parts by checking the FIDUCIAL option in the MAIN WINDOW.

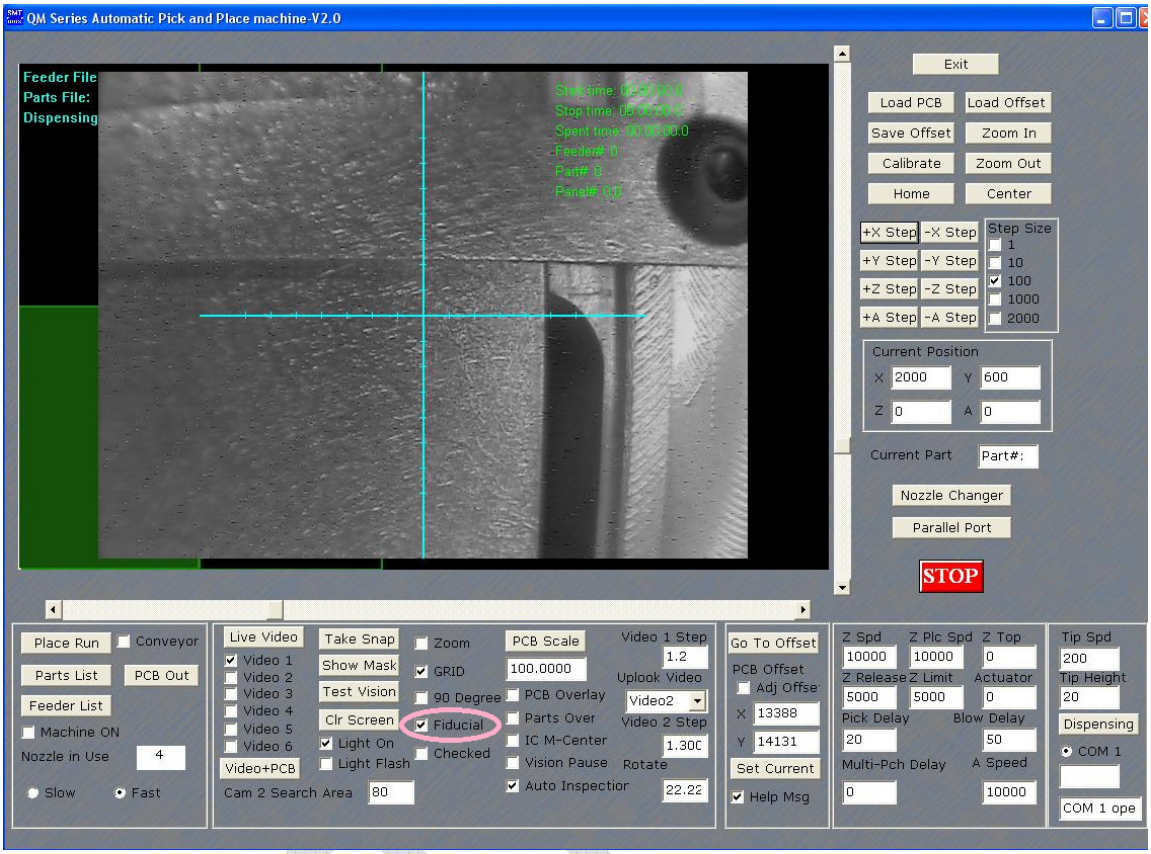


Figure 6.4: Checking the FIDUCIAL option in the MAIN WINDOW enables fiducial checking for parts

Chapter7. Nozzle Changer

The QM series of pick and place machines come equipped with a nozzle hanger that can be used, along with the necessary software control, to automatically switch between nozzles.

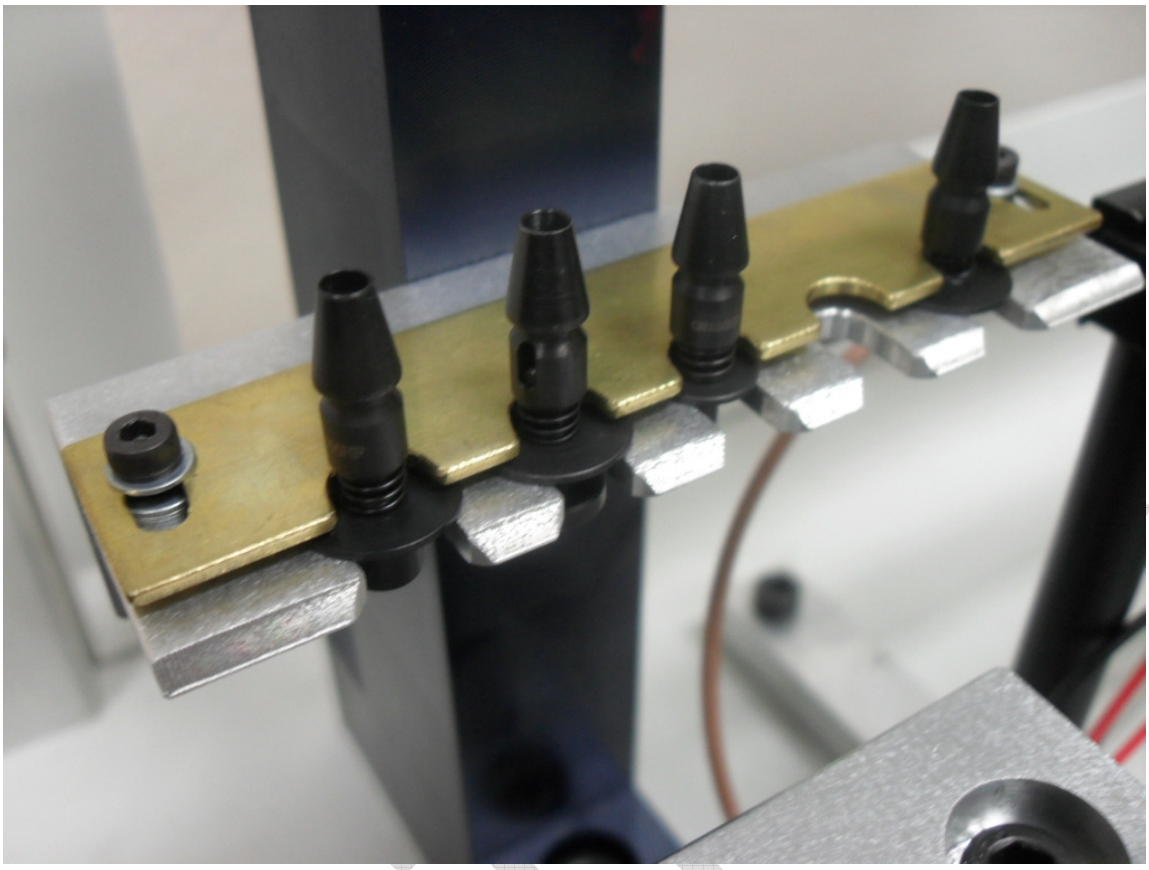


Figure 7.1: The Nozzle Hanger

To use this feature, follow these instructions for each nozzle:

Automatic Nozzle Changer Setup

1. Make sure that the nozzle is installed on the nozzle hanger. This can be done by sliding the nozzle horizontally into the hanger until it securely fastened, with the nozzle disc resting between the two holding plates, as in Figure 7.1.
2. Remove any nozzle currently on the pickup head so that it won't interfere with picking up the newly installed nozzle.
3. Move the pickup head using the NAVIGATION PANEL of the MAIN WINDOW until it is physically positioned right above the nozzle as it rests on the nozzle hanger. This position should be precise enough that the nozzle socket of the pickup head can slide vertically onto the nozzle.

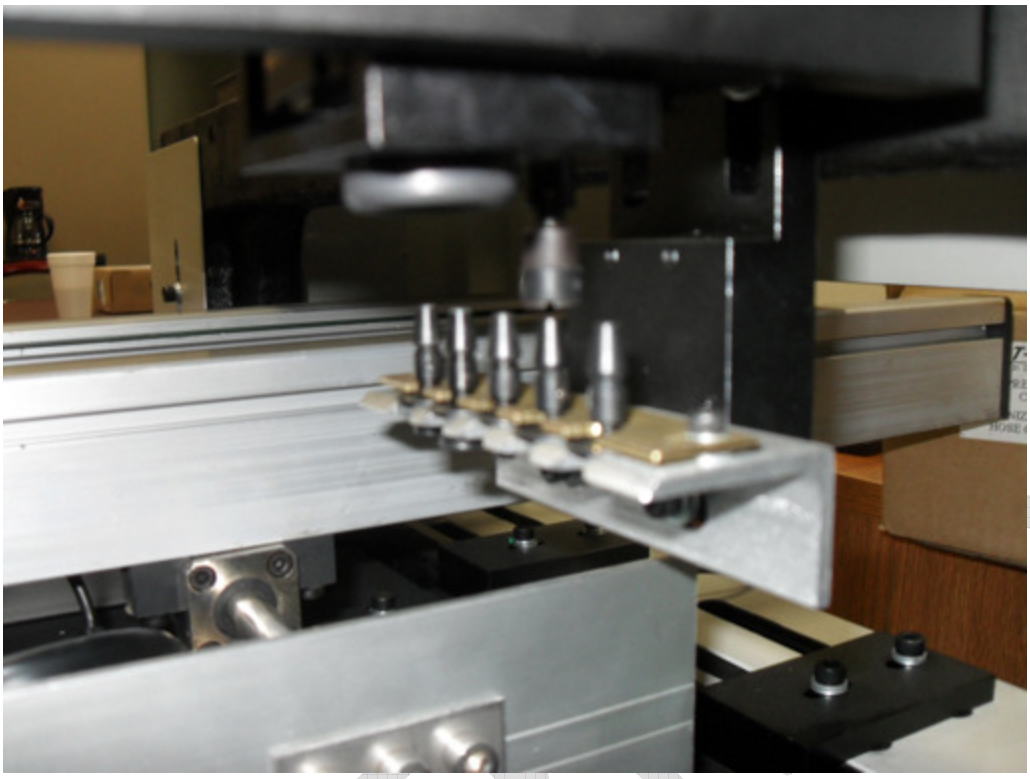


Figure 7.2 Positioning of the nozzle

4. Record the X and Y coordinates shown in the MAIN WINDOW, and then open the NOZZLE CHANGER WINDOW by clicking the NOZZLE CHANGER BUTTON.

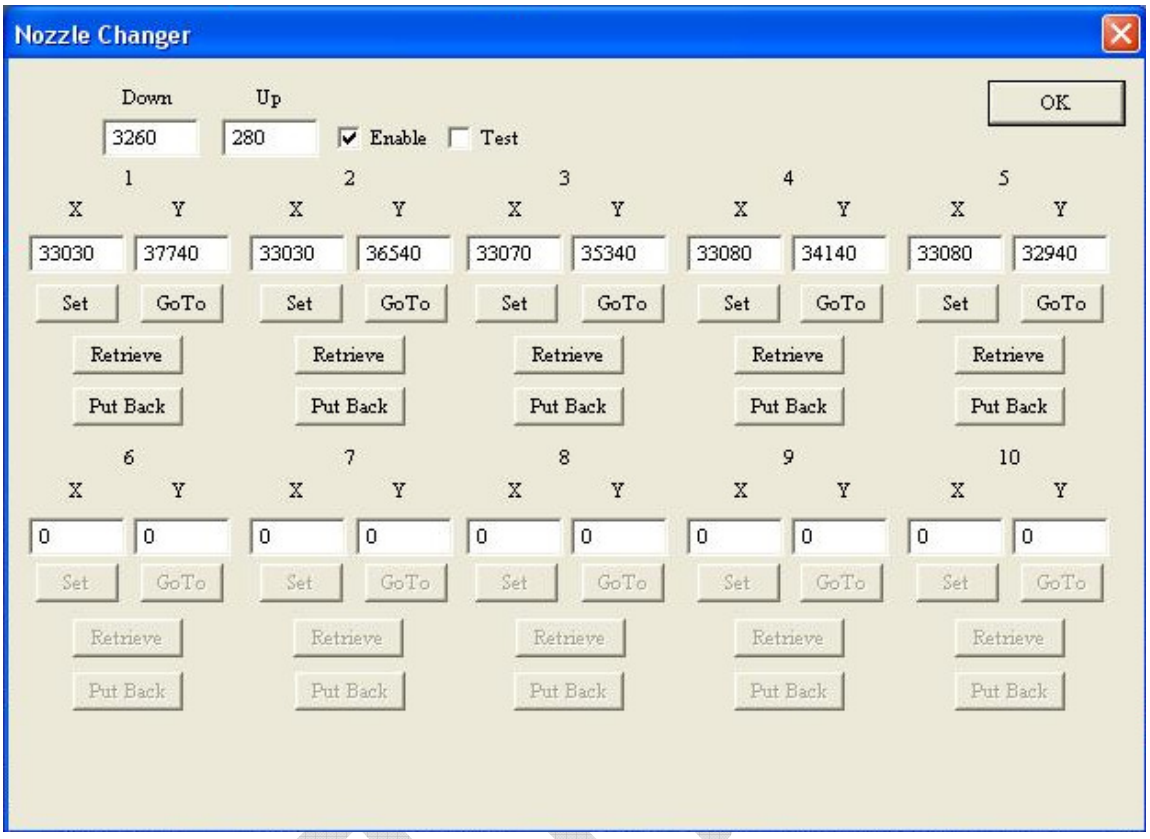


Figure 7.3: The NOZZLE CHANGER WINDOW

5. In the NOZZLE CHANGER WINDOW, you should see a number of nozzle panels, one for each software recognized nozzle (nozzles #6-10 are disabled by default). Select one that is unused or no longer necessary, and enter the X and Y coordinates you recorded into the appropriate boxes under that nozzle's panel.

   IMPORTANT: The X and Y position you inputted will now be linked to this particular nozzle, and future operations involving this nozzle will ASSUME that it is at the same position on the hanger!

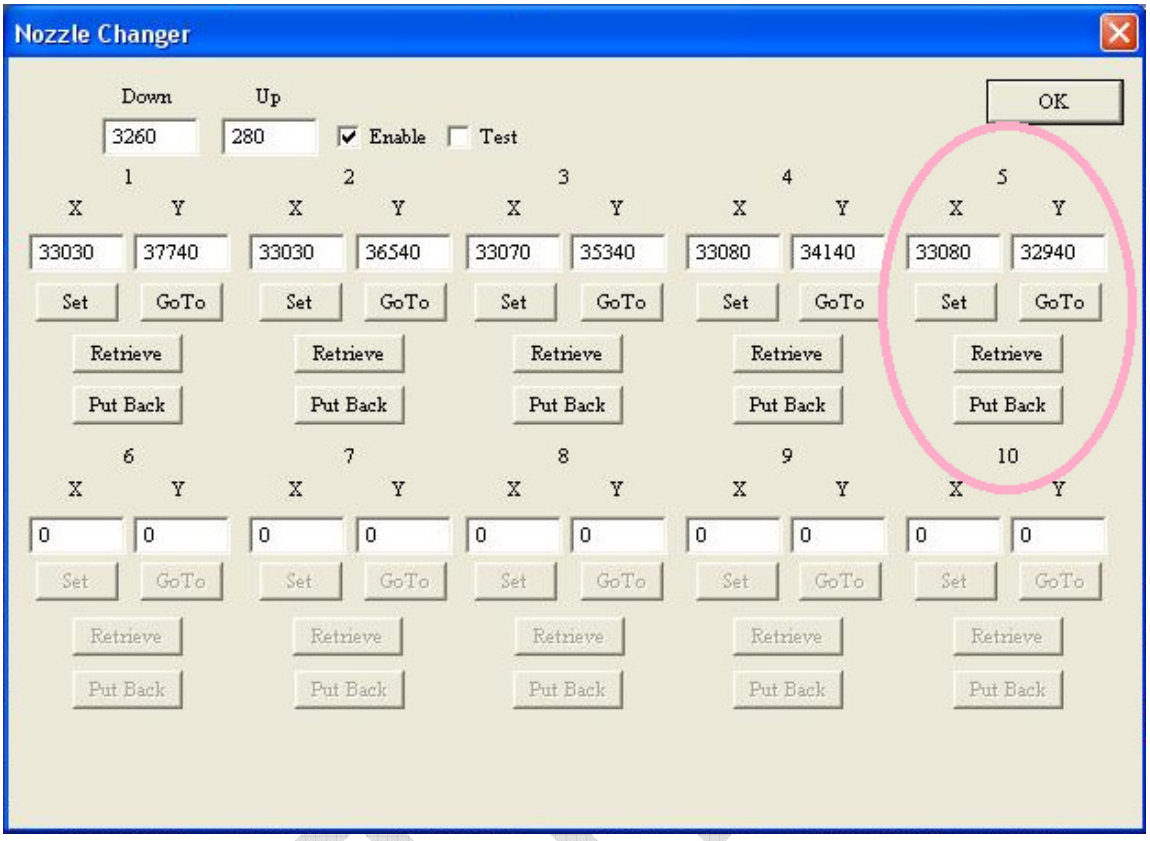


Figure 7.4: NOZZLE CHANGER WINDOW with unused nozzle panel circled. You will want to fill it in with the appropriate x and y coordinates for the nozzle, which you recorded in Step 4.

6. Next, you must determine the Z coordinate corresponding to the depth to which the pickup head must descend in order for the nozzle to "socket" itself into the nozzle socket. This coordinate needs to be determined only ONCE for all nozzles. To find this coordinate, click the TEST checkbox to enable it.

   IMPORTANT: Not enabling TEST MODE when testing coordinates could result in damage to the machine and the nozzles, as the machine will assume that the coordinates are already correct!

   TEST MODE is a "debugging" mode used to prevent damage to the machine and the nozzles while testing coordinates.

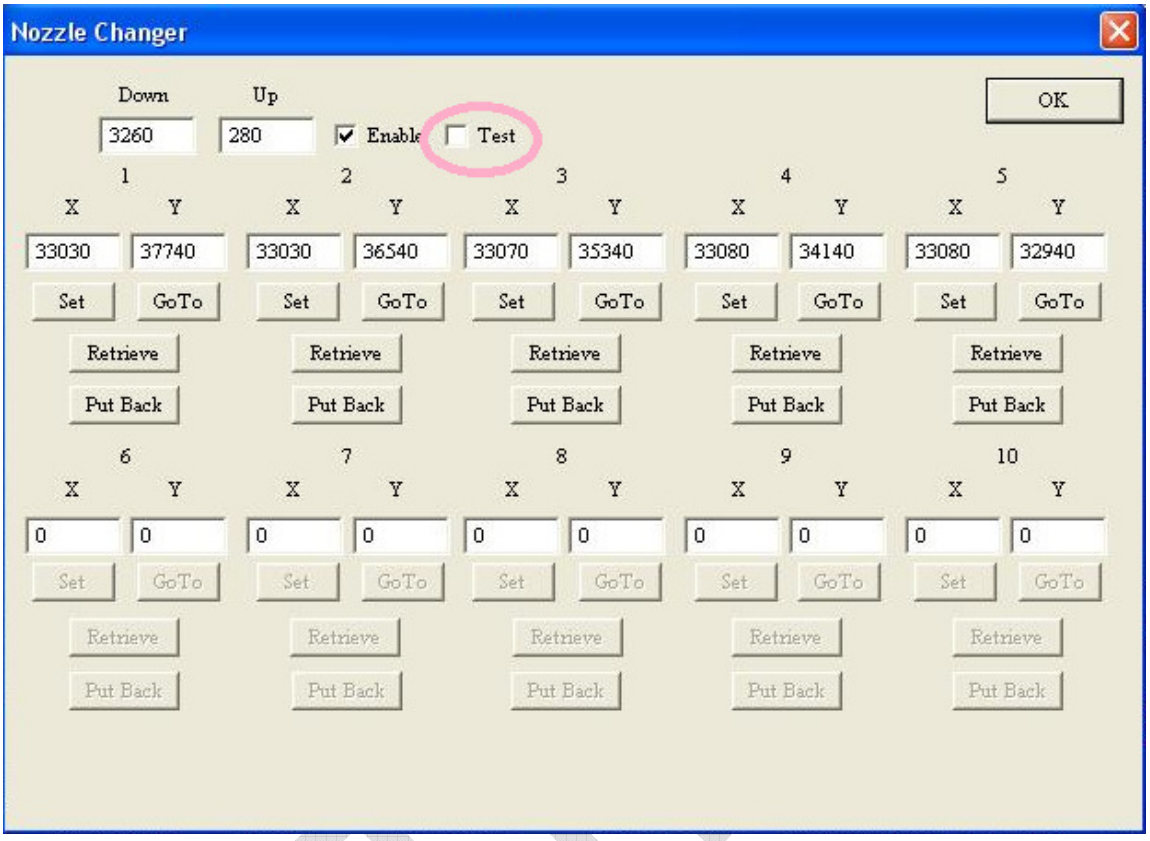


Figure 7.5: The TEST MODE checkbox

7. Click the RETRIEVE BUTTON for the nozzle whose X and Y coordinates you just filled in. The pickup head will move to the designated X and Y position, and then move down about 500 units.

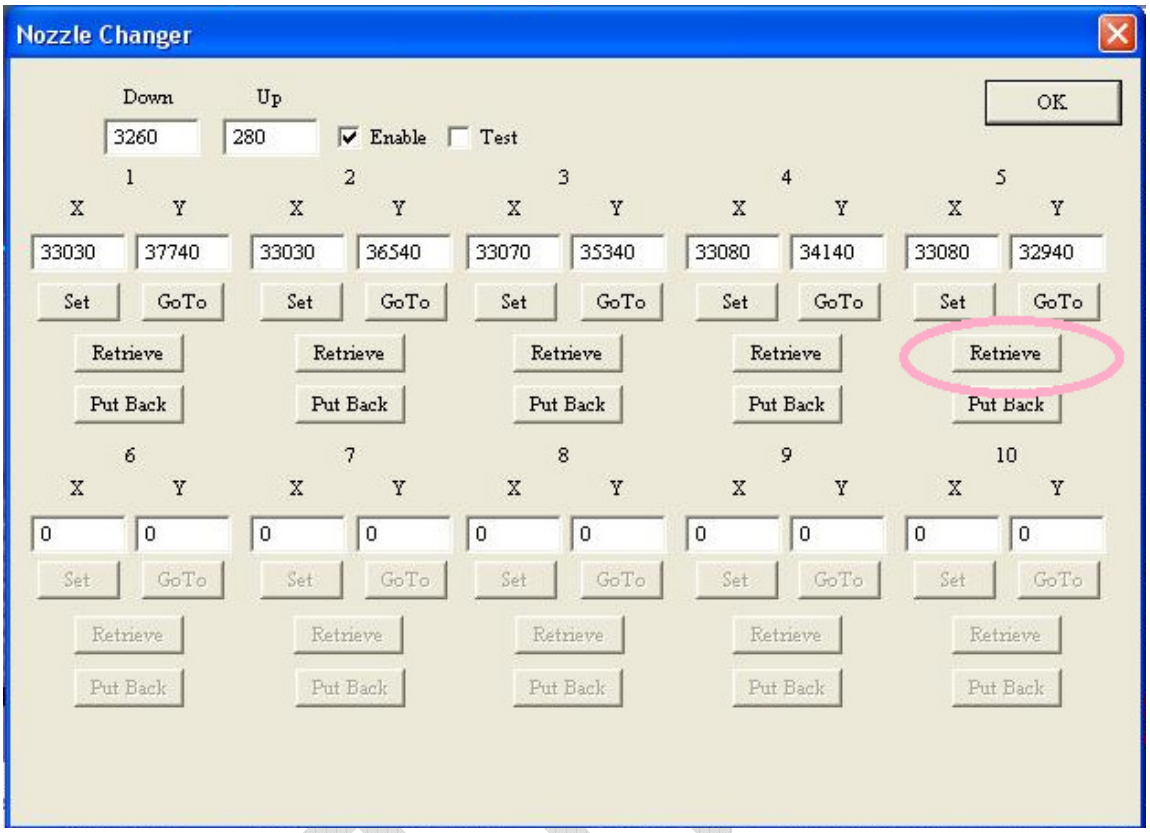


Figure 7.6: NOZZLE CHANGER WINDOW with RETRIEVE BUTTON circled for Nozzle #5

8. Click CANCEL when prompted with a dialogue, then carefully move the pickup head down using the NAVIGATIONAL PANEL of the MAIN WINDOW. You will eventually hear a click and see that the nozzle has snapped into place. Record the Z coordinate of this position as DOWN in the NOZZLE CHANGER WINDOW.
9. Next, you must determine the Z coordinate corresponding to the height to which the pickup head must rise before it can safely slide the nozzle into/out of the hanger. Again, this coordinate needs to be determined only ONCE for all the nozzles. To determine it, first carefully remove the nozzle from the pickup head. Then bring the pickup head back to the Z=0 position.
10. Remove the nozzle you are installing from the hanger, and manually place it on the pickup head. We will be using the PUTBACK feature to determine the UP position.
11. Make sure that TEST MODE is still enabled, and click the PUTBACK BUTTON for the nozzle. The pickup head will move to a distance away from the nozzle hanger and prompt to proceed.

    IMPORTANT: DO NOT click OK to proceed!

    Instead, visually check the vertical position of the nozzle disc. This disc must be exactly in-between the two metal plates of the nozzle hanger in order for the nozzle to slide into/out of the hanger.

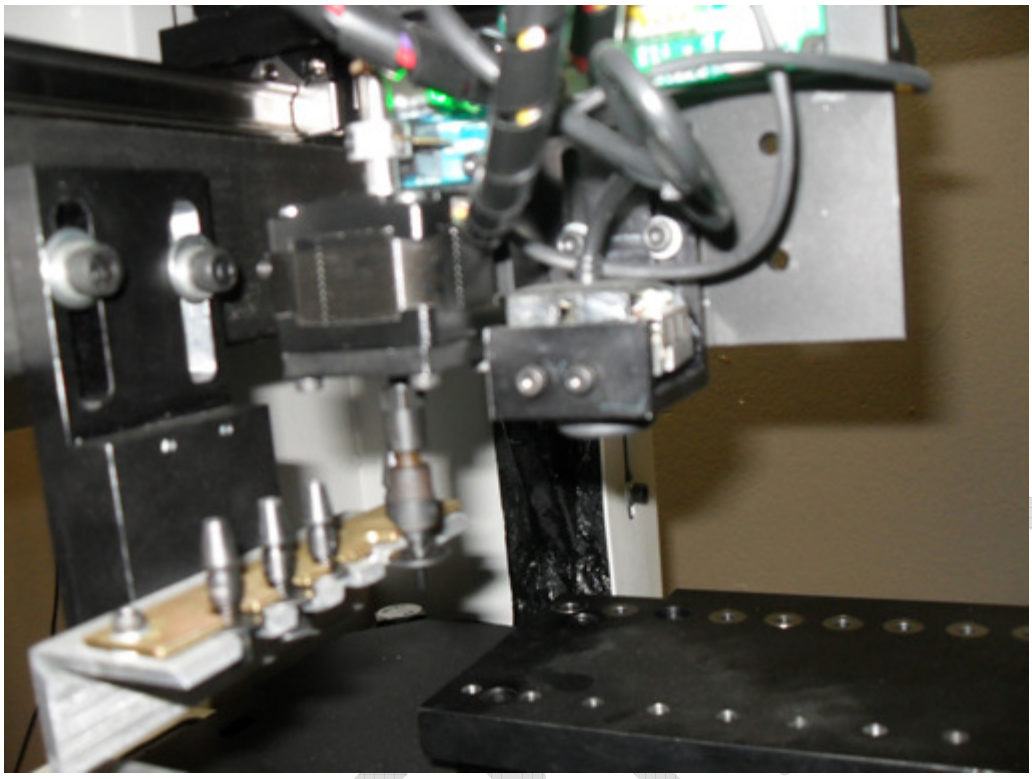


Figure 7.7 The vertical position of the nozzle disc

Carefully adjust the Z position of the pickup head using the NAVIGATION PANEL of the MAIN WINDOW until the above position is achieved. If you need the pickup head to move closer in order to accurately judge the nozzle disc's position, you may click the OK BUTTON *once* on the dialogue box to proceed. This will move the nozzle so that it is right next to the nozzle hanger.

IMPORTANT: DO NOT click OK to proceed again until you have ascertained that the nozzle is in the correct Z position to slide in/out of the hanger or you will DAMAGE the nozzle!

12. Once you have determined that the nozzle is in the correct Z position to slide in/out of the hanger, record this Z position as UP in the NOZZLE CHANGER WINDOW. You should now have coordinates for both the DOWN and UP boxes, as well as the X and Y coordinates filled in for the nozzle you are trying to install.

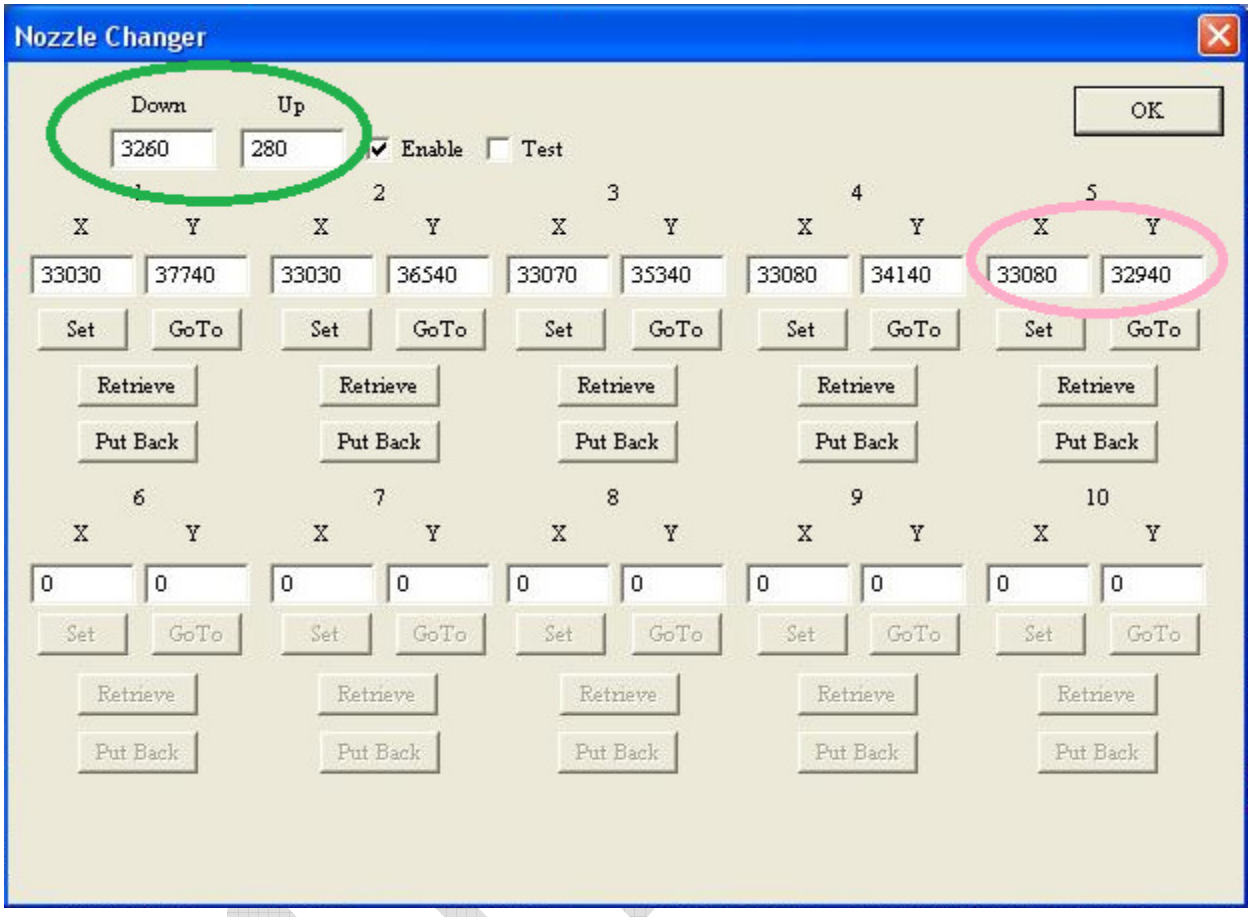


Figure 7.8: A properly installed nozzle in the NOZZLE CHANGER should have values for both the green circled boxes and the pink circled boxes. The green circled boxes are filled in just once for all installed nozzles.

13. At this point, the nozzle has been installed. However, due to the automatic nozzle tracking feature of the system, we must make sure that the system is in the correct state after installation. Find the NOZZLE IN USE BOX at the bottom left of the MAIN WINDOW. The value there should always reflect the current nozzle socketed on the pickup head, or -9999 if no nozzle is socketed on the pickup head. Check to make sure that this is the case.

IMPORTANT: If the NOZZLE IN USE BOX does not have the right value, the system may confuse its present state, in which case the nozzle could be DAMAGED the next time the system is operated!

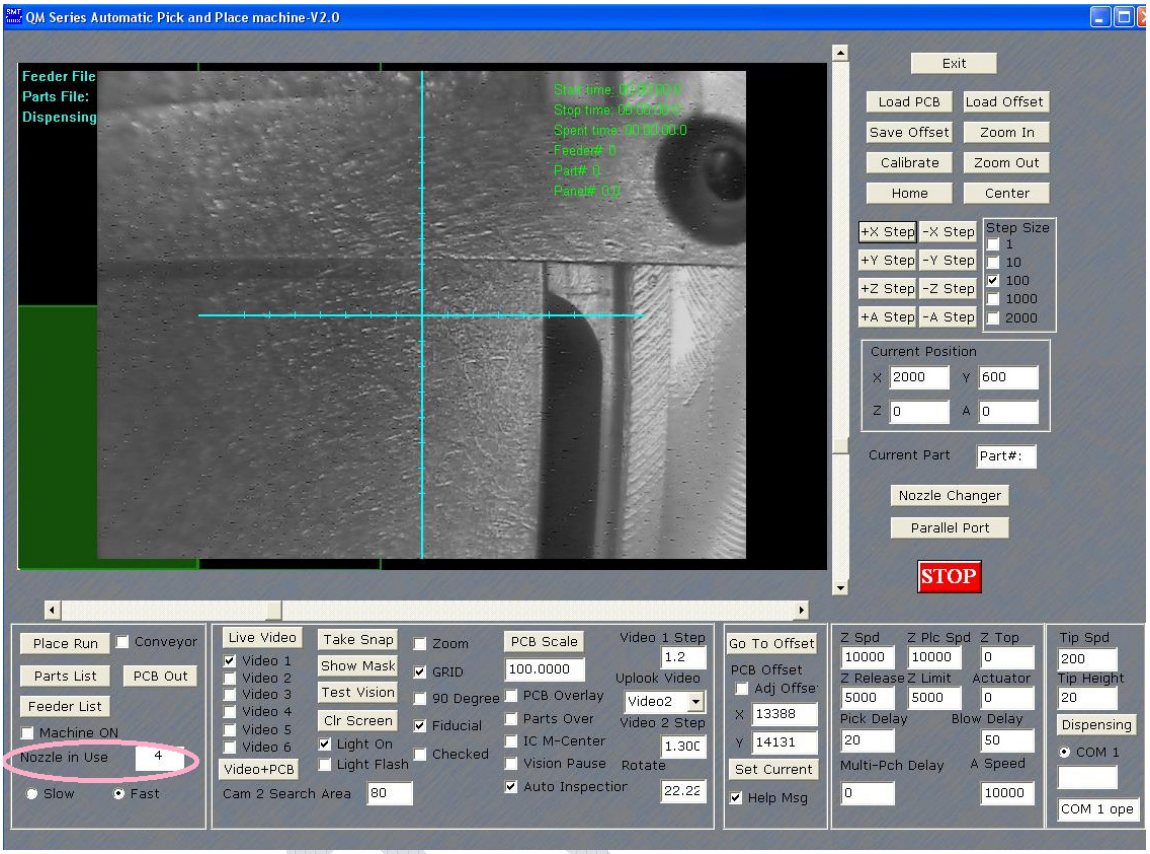


Figure 7.9: NOZZLE IN USE BOX showing that Nozzle #4 is currently in use (socketed on the pickup head)

14. If, for some reason, the NOZZLE IN USE BOX contains the wrong value, manually remove all nozzles from the hanger and from the pickup head, and then execute the PUTBACK operation to reset the NOZZLE IN USE BOX to -9999.
15. You may now use TEST MODE to verify that the RETRIEVE and PUTBACK operations are working.
16. Once you have verified that they are working, check the ENABLE OPTION in the NOZZLE CHANGER WINDOW to turn on the automatic nozzle changer.

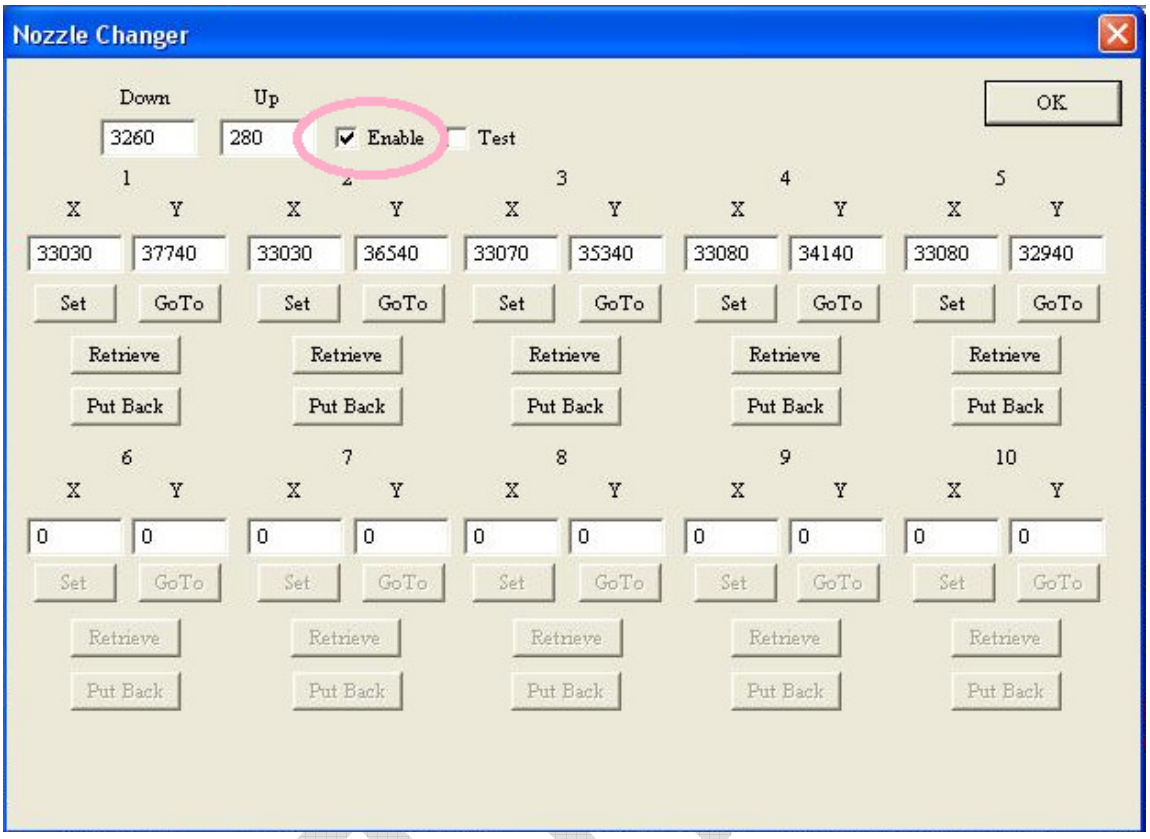


Figure 7.10: Checking the ENABLE OPTION in the NOZZLE CHANGER WINDOW turns on the automatic nozzle changer

Chapter8. Troubleshooting

In Progress.....

Chapter9. Warranty

Non-consumable major parts

1 year warranty

Chapter10. Customer Support

If you have any questions please email us at info@smtmax.com or contact us at 1-951-278-0720.