Madell Automatic Pick and Place Machines
User's Manual

Madell Technology Corporation

http://www.madelltech.com

This user's manual covers all of Madell single-head automatic pick and place machines, including and not limited to the following models:

SX1010, MCN-2012, DP2006-2, DP2006-3, MINI-X, Lab-X1, etc.

The Madell series pick and place machines are low-cost fully automatic SMT assembly systems. They can handle various SMT components. Most of our machines can place 0402 and bigger components, some can work with 0201 parts. We have different machines to wide range of customer requirements: from lab prototype use to batch production. After more than 10 years research and development, our pick and place software is feature packed, easy to use and powerful.

Specifications:

- Speed (parts per hour):
  Please see individual machine specifications
  Actual speed varies depending on feeders selected, components to be placed, PCB, and components arrangements
- Maximum PCB panel sizes:
  Please see individual machine specifications
- Placement of 0402 and up standard
- Fully programmable digital z-axis and θ rotation angles
- x- and y-axis 0.0005" resolution, 0.001" positioning
- Computer vision automatic part alignment system (comes with one up-looking camera and one teaching camera)
- Automatic PCB board position correction with fiducial recognition
- Pick and place CAD file conversion function
- Maximum feeder capacity (8mm feeders; bigger feeders take more space)
  Please see individual machine specifications
- 12 month full factory warranty - parts & labor
- Easy to use software for quick programming. Programming can be done manually with video camera or with PCB CAD file conversion
- 110 VAC 60 Hz, or 220 VAC 50 Hz
- 65 psi compressed air or vacuum pump selectable
- RS232 communication between the machine and computer

Options:

- Additional up looking video camera*
- Fly vision for faster small parts placement
- Upgraded CCD camera and light for up looking video
- Multiple pick and place heads
- Vacuum sensor
- Auto nozzle changer
- Vibratory feeder
- 8mm, 12mm, 16mm, 24mm, 32mm, or 44mm feeders
- Bulk feeders for cut tapes
- Low cost SX-2 feeders
- PCB conveyor system
- External enclosure
- Solder paste dispensing
- Computer(XP with RS232 port or Win 7 32-bit), at least 1G RAM
- Vacuum pump

The computer vision performs these important functions:

1. Acquiring accurate machine calibration positions.
2. Placing fine pitch IC's and BGA's.
3. Aligning the picked parts before placed on PCB.

Article I. NOTES and WARNINGS

1) Turn on the machine before starting the software.
2) All units displayed in the software are stepper motor steps, not measured distance.
3) Do not put any item on the machine platform which may block the movement of the vacuum nozzle.
4) Immediately press down the red emergency button or turn off the machine power if the machine is not working properly.
5) The machine will not work if the emergency button is in the pressed down position.
6) Never leave machine unattended while running
7) Never plug or unplug feeders while machine power is on

* Fixed-zoom lens are used on the machine. If the view field of a lens is good for large IC's, pictures of small parts like resistors and capacitors will be too small. Also, it saves machine travel time and improves performance if the up-looking cameras are placed close to feeders at different locations.

8) Do not install any unauthorized software or alter any of the configuration settings on the computer, without prior approval from a factory engineer
9) Please save the custom shipping crate for warranty returns.

***Note:** When the machine hits something, or when it stops abnormally, press the red Emergency button, close the software and turn off the machine immediately. Locate and revolve the problem before starting the machine again.

Machine speed and acceleration have to be changed at the same time. Suggested values:

Speed (steps per second)	Acceleration
50,000	165,000
60,000	255,000
70,000	270,000
80,000	295,000
90,000	320,000

1. Set up Instructions

1. Set up the pick and place machine and controller box on a flat and stable table. Please note that the table has to be strong enough to support the weight and movement of the machine. Set up the computer on a convenient location close to the machine.
2. Connect the RS232 cable from the computer to the connector on control box.
3. Connect the air hose from an air compressor or a vacuum pump to the inlet of the pick and place machine.
4. A filter is highly recommended between the compressor and the control box inlet.
5. Connect the computer vision cable from the computer to the different video sources.

2. Pick and Place Step-by-Step operations

(Refer to section 7 for dispensing operations)

Note: From here on, "angle" will be shortened to "A" instead of "*θ*."

1. Turn on the machine using the power switch on the control box. Double-click the software icon to start.

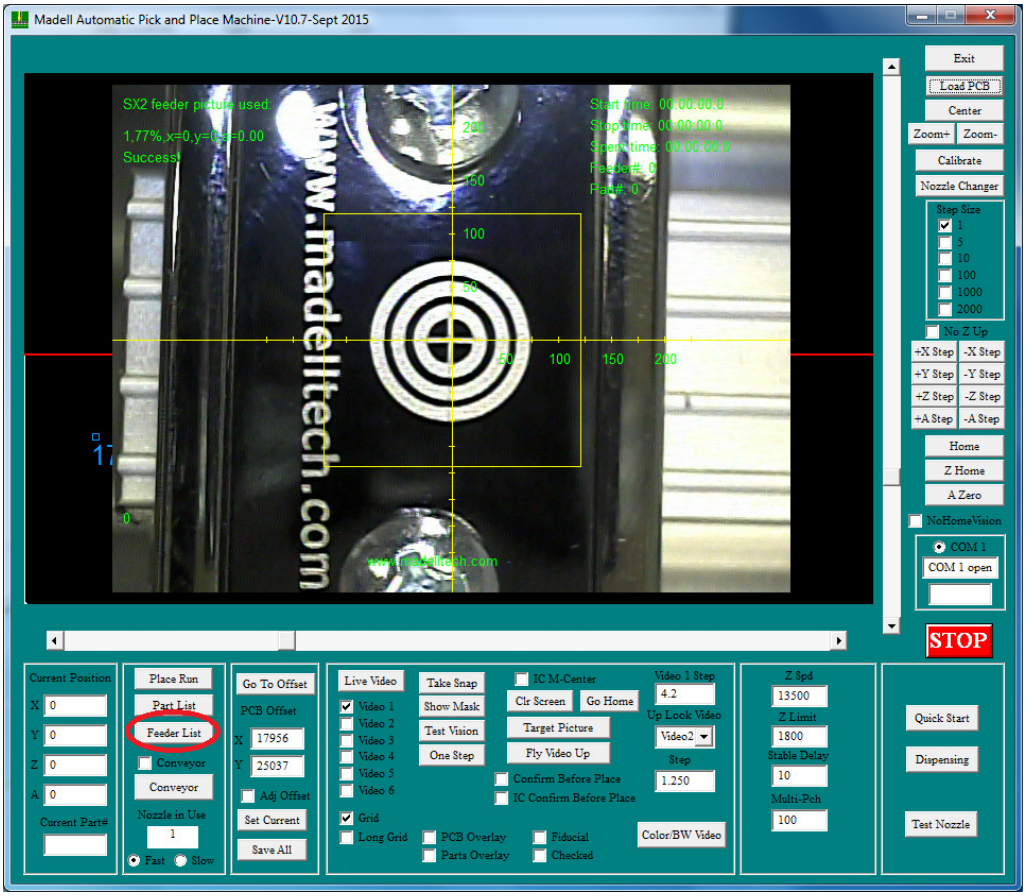
2. The software starts by doing a self-calibration based on the optical home mark.
   If the machine has not been configured in advance, please refer to the following steps:
   - Set the *Main Home* location inside the Calibrate window.
     Use steps to move to the home marks. Click on *Set to Current* to set its position. Take

a snapshot of the home mark and name it as home.tif. Click on *Home* on the main software interface to let the machine do another self calibration.

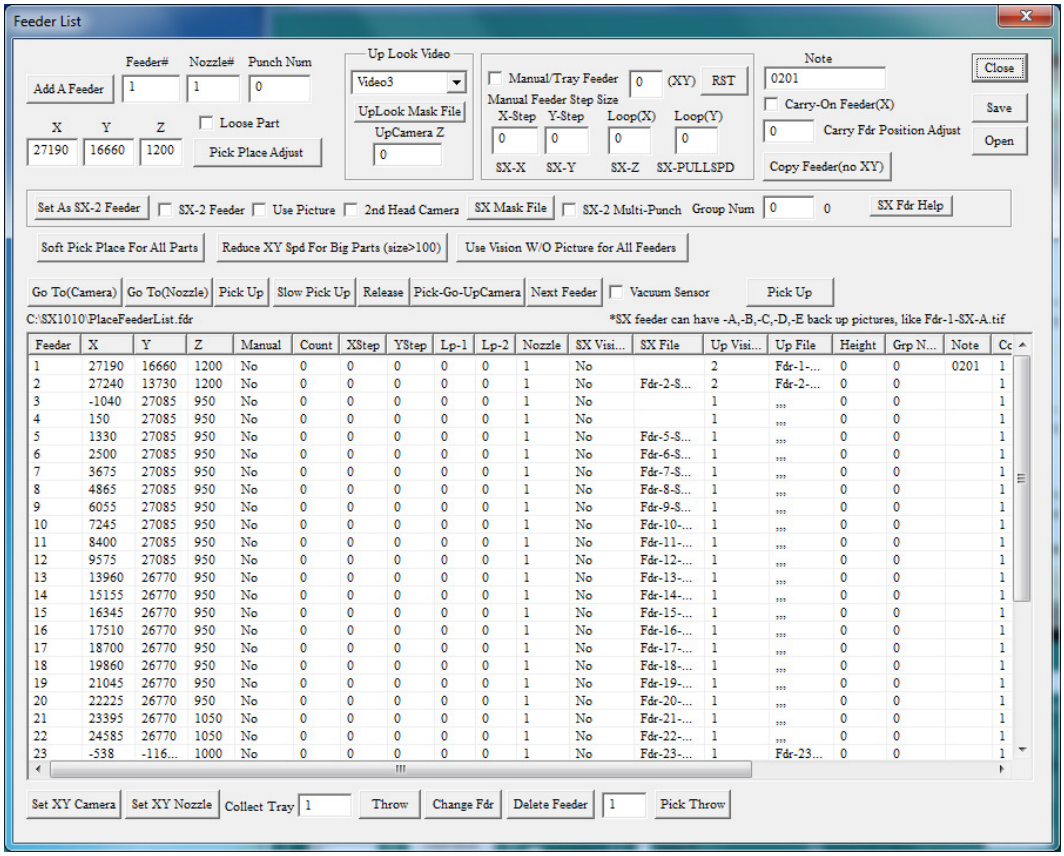
- Camera-Nozzle offset: Open the Calibrate window. The simplest way to find the correct camera offset is to find a mark on a circuit board. Click on *Try Offset*, and lower the nozzle. Check if the nozzle aligns with the mark. If not, modify the camera offset X and Y values and try again. You may need to do this a few times to get the optimal offset. Once the optimal offset is reached, save its X and Y values for your record. You can also make a copy of the PX3000A.ini file and save it to another folder.
- Set the up-looking camera locations: move the machine head to the up-looking camera until the nozzle is at the center of the camera. Click on *Set Cur.* to set the camera location. You may need to set each camera location if your machine is equipped with more than one up-looking camera.
- Set the Collect Tray and Nozzle Hub inside the Calibrate window at convenient locations.

3. Set up the feeders:

- Open the Feeder List window:

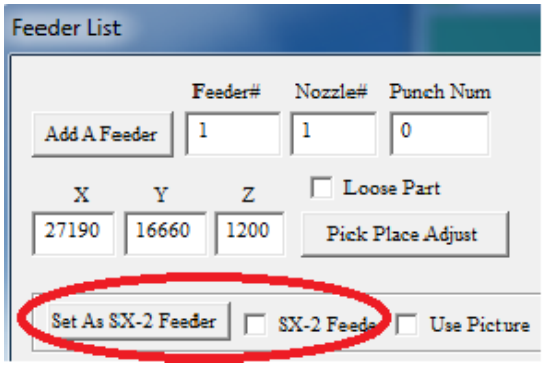


The feeder list opens as below:



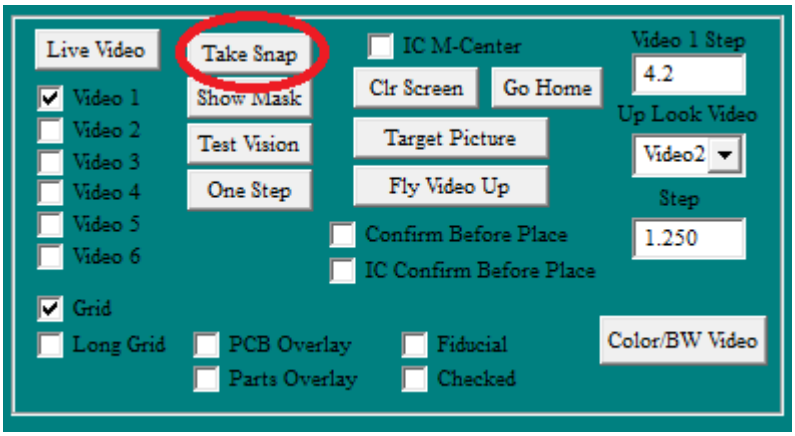
- Aim the camera center to the location where the part will be picked up.
- SX-3 feeders are similar to PX feeders that they both have fixed steps, i.e., the tape is advanced in fixed distances.
- For PX pneumatic feeders, the part to be picked up should be covered by the feeder before the feeder puncher is activated. This prevents the part pops out before being picked up.

To specify that the part will be picked up from an SX feeder, click on the button Set as SX-2 Feeder or check the box labeled as SX-2 Feeder:

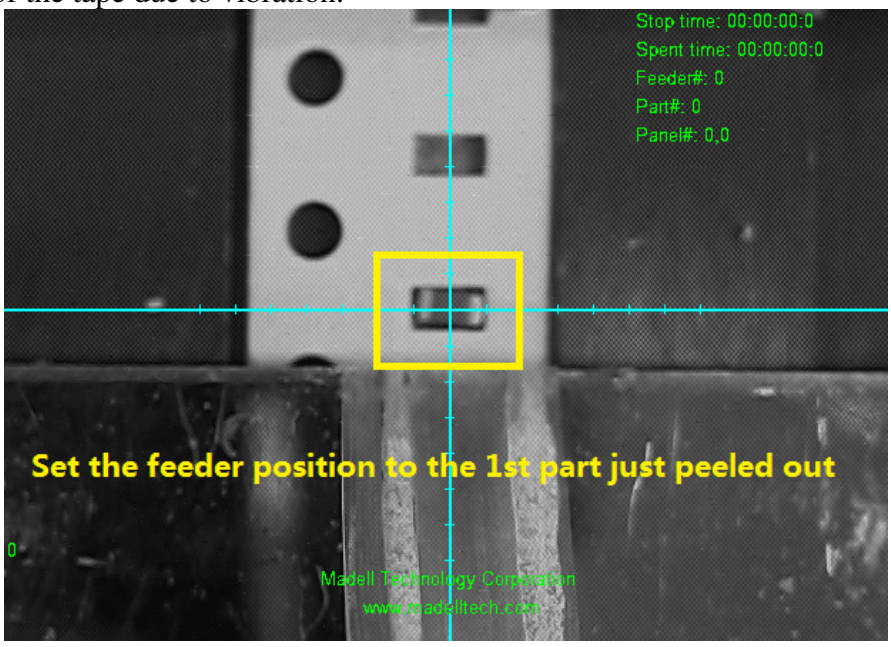


- If the Set as SX-2 Feeder button is pressed, the software uses the current location as the feeder address and takes a picture of the part on the tape and insert into the feeder list automatically.

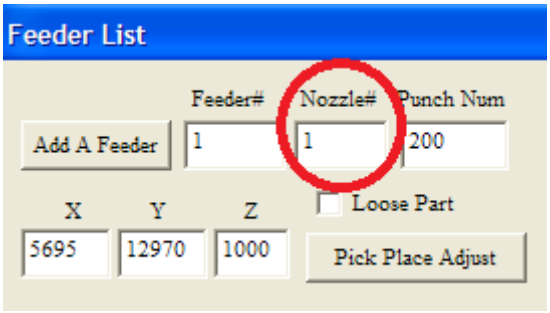
- Supply a down-looking camera picture (part inside the tape pocket) if the SX Feeder box is checked. If you do not have a picture, simply go back to the main interface, click *Take Snap*, name the file, and you can use this as your SX feeder picture.



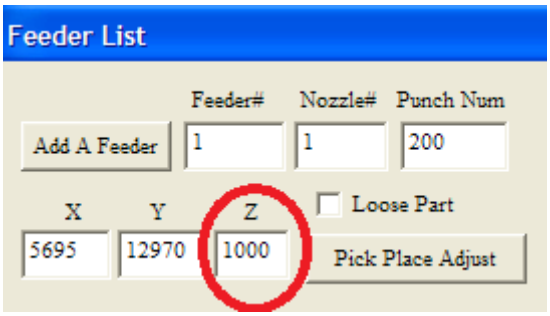
The SX-2 feeder position should be set at the center of the part on tape and as close to where the part is just peel out as possible. This can prevent part popping out of the tape due to vibration.



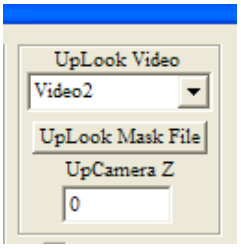
- Select a suitable sized nozzle for the part, and enter its number inside the Nozzle# field. Nozzle numbers can be set from 1 (smallest) to 5 (largest).



- Set the proper height for the feeder in the Z field. The height should be set such that the nozzle barely touches the part in the tape without applying too much force. Move the nozzle down manually with Z steps until it touches the part on the tape if you are not sure about the height, and read the Z current value at the lower left corner of the main screen.

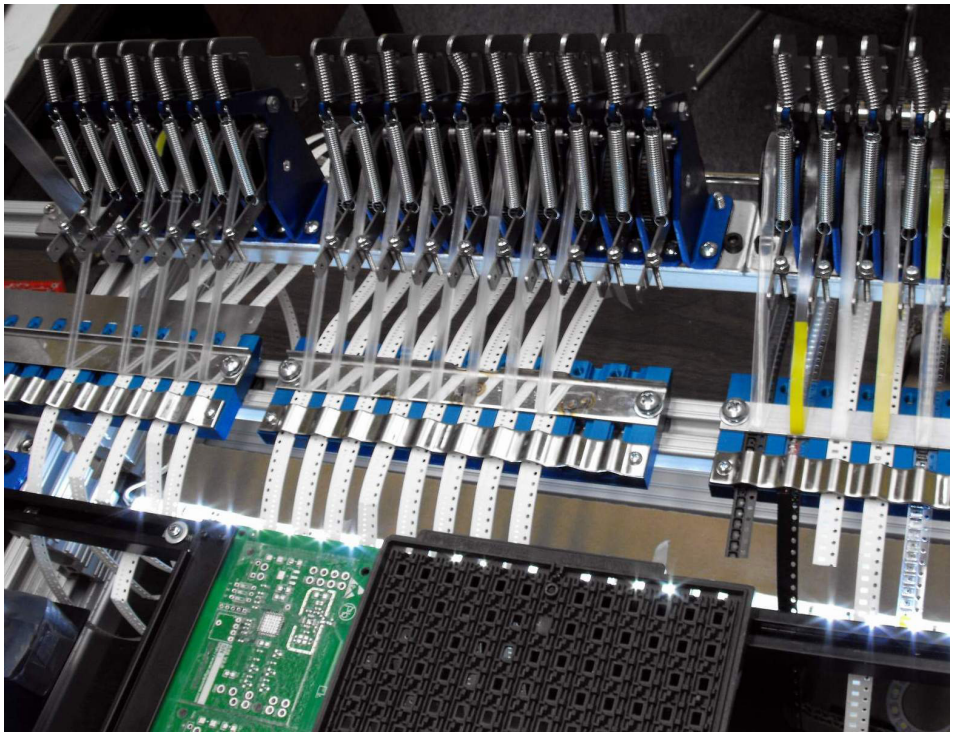


- If the up-looking camera is going to be used to align the picked part, select the camera in the UpLook Video pull-down menu. For each camera, you can select either Full Alignment or Non-Stop. The Non-Stop is faster than but not as precise as the full aglinment. Do not use Non-Stop for IC's. The up looking video mask pictures can be changed by clicking on the "UpLook Mask File" button. The nozzle can be set to go down (a value>0) or up (a value <0) when it is above the up looking camera.

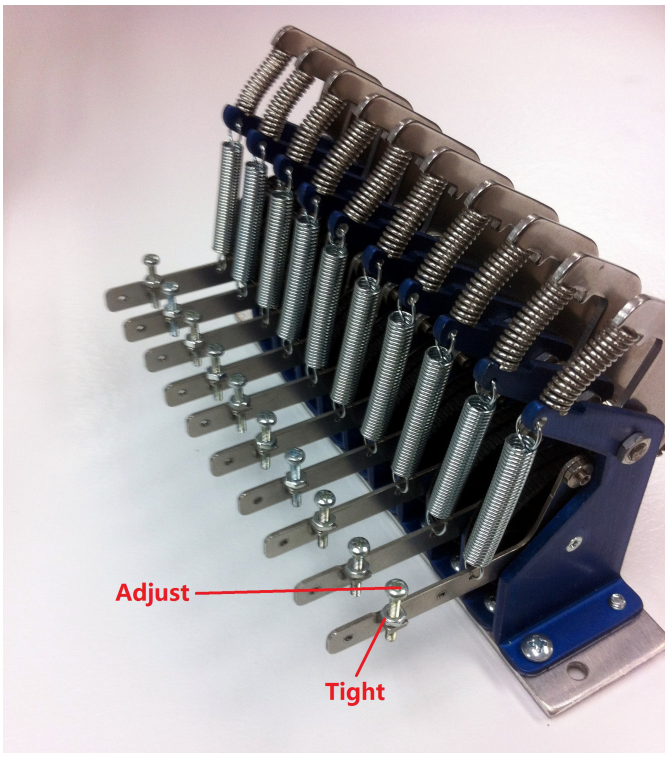


- Try to pick up a part by clicking the *Pick Up* or *Pick-Go-UpCamera* buttons. Check if the part is picked up at the center. Adjust Noz Tip Pick Up Correction X and Y values inside the calibration window to pick up the part at the center.

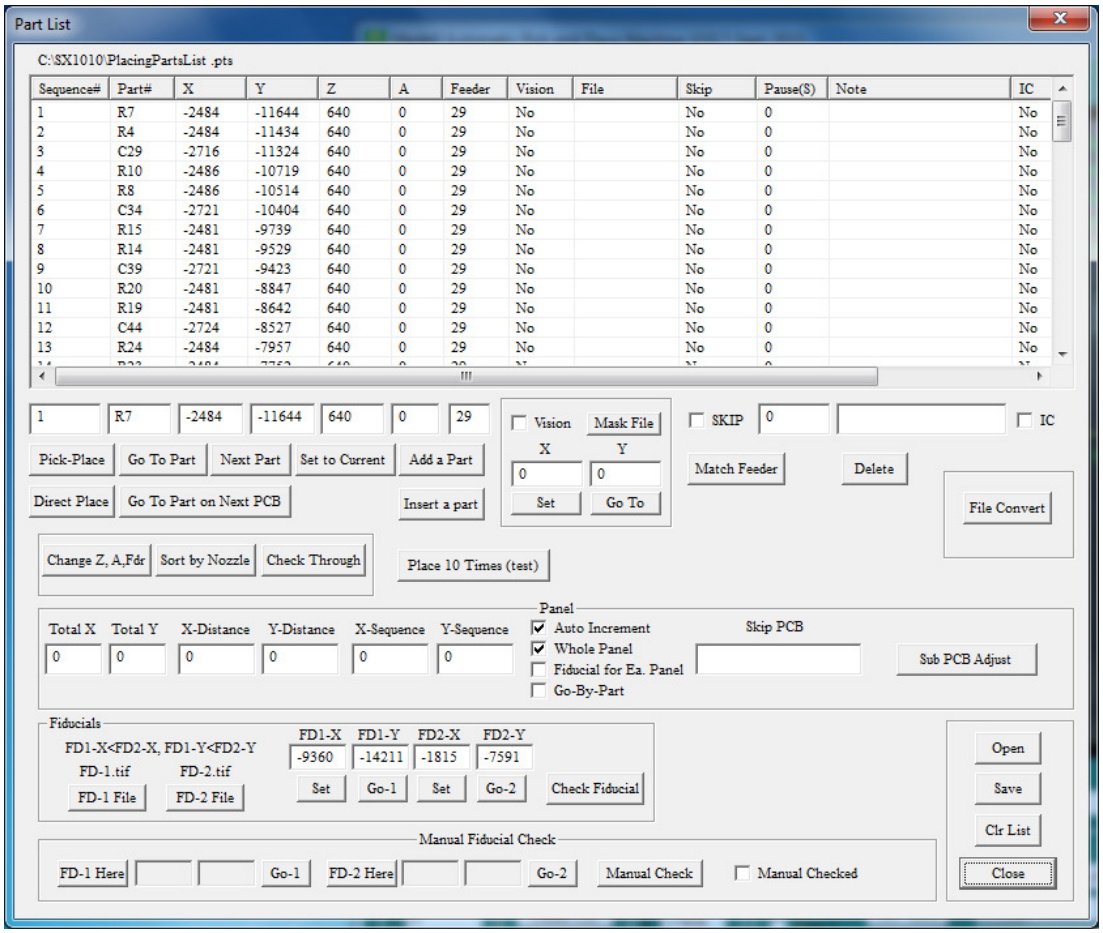
- Take snapshots while the part is above the up-looking camera. You may want to take multiple pictures at 0°, 90°, 180° and 270° rotations. For most parts, 0° and 180° (or 90° and 270°) can use the same picture. Select the picture area just surrounding the part. The smaller the picture, the faster the computer vision process runs.



- Adjust the screw on the SX-2 feeder lever so that when a part is picked up, the next part is advanced to the same position on the tape.



4. Set up the part list:



Open the Part List window. You can manually set up the part list with the down-looking camera by clicking on the Add a Part button, or use the PCB file conversion function inside the Part List window.

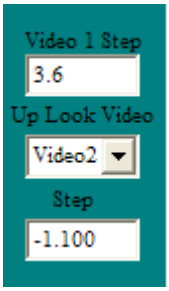
To set up the part list manually:

- Move the down-looking camera to the location where the part will be placed. Aim the camera to the center of the location. Click on the *Add a Part* button. The Add Part window should pop up. Type in a part name (i.e. R1 or C1), and specify the feeder that the part will be picked up from, the height (Z value), and the part's rotation. The Z-height can also be changed conveniently in the part list window with the button *Change Z*. The Z-height should be set so that the part is securely placed on the PCB with little force. The software changes every 90° rotation to 2000 machine rotation steps automatically. The rotation is relative to the part on the tape
- Repeat the above process for all the parts to be placed.
- Modify the *A*-step values to place the part in other rotation angles (not 0°,90°,180° and 270°) if needed.

5. Place the Parts:
   After the part list is built, you can place the parts with the following steps:

- Inside the Part List window, click on *Pick-Place* button to place a single selected part. Single or double-click on the part list to select the part to be placed.
- To place the parts continuously, click on the *Place Run* button on the main screen. The pop up window shows the start and stop sequence of the part list. You can modify them to suit your needs. It also gives you the choice to place the parts one by one or to place all parts without stop.

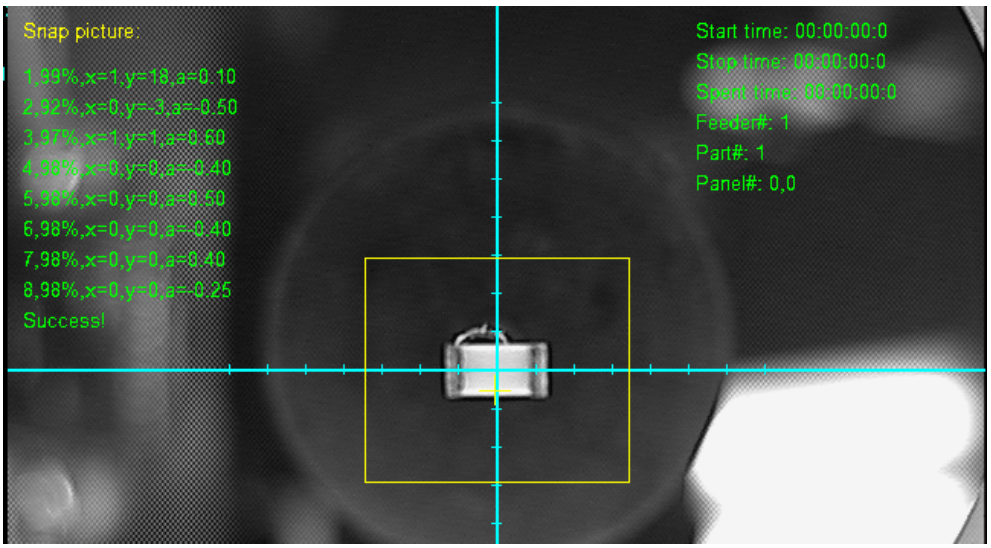
6. Adjustments:
   Make the following adjustments if the part is not placed exactly at the designated position:
   - To align the part before it is being placed, select the up-looking camera from inside the Feeder List window.
   - Inside the Calibrate window, check the Adj. Calibration box, and use XY steps to move the cross hair of Video 1 to the center of the placed part. You can see that the Up Camera Calibration X and Y values are being changed while you move with steps. Uncheck the Adj. Calibration box after you are done with this adjustment. Try to place some parts to check the new values. Each up-looking camera has different calibration values.
   - Make sure that the nozzle height is set properly so that the part is being placed on the PCB securely, not dropped from mid air.
   - Select proper nozzles. Bigger nozzles should be selected for heavier parts for stronger vacuum.
   - Specify the part as an IC inside the part list window if it is a big or fine pitch part.
   - Adjust the up looking video steps on the main screen.
     The Step values covert screen pixel distances to machine moving distances.



     The video steps should be adjusted to prevent the vision matching process jumping back and forth repeatedly while at the same time reaching the best matching score with the least iterations. Too big or too small video steps will cause failures in computer vision matching and the part being dropped into the collect tray.

   - Pay attention to the display numbers on the live video after a computer vision operation. The score number shows how much the item captured by the computer vision matches with the selected mask picture. The best score is 100. You should use pictures that can achieve matching scores above 80. Retake the picture if the matching score is too low. The matching score number is displayed in red color if it is less than

80. The x and y values reflect the vision alignment adjustment in x and y directions, while the a value indicates the rotation adjustments.



Refer to section 4, Operations Details, for a more detailed description of the pick and place process.

3. Computer Software Installations and Interface

The Madell pick and place machine software was developed and tested on Windows XP and Windows 7 32 bit systems. The computer vision option does not work on Windows Vista and 64 bit systems. The software should be installed on a computer which does not have other applications that may interfere with the operation of the pick and place machine. Auto-backup or updates should be disabled or scheduled to not overlay in time with the pick and place machine software. Network connection is not recommended, and connect the network cable only when needed.

Installing the software:
Refer to the installation instruction file that comes with your new machine.

1) Create a new folder on your computer; name it to whatever you like. Please note that this folder has to be under the C drive. It cannot be on the computer desktop.
   a) Copy the xxx.exe (names may change) program to this folder.
   b) Copy any *.dll files to either this folder or the C:/winnt/system32 folder
   c) There are some other vision configuration files that should be copied to the current folder. Check the installation instructions that come with the machine

2) Create two subfolders: "config" and "Parts."
   The machine configuration file PX3000A.ini is under the "config" folder. Make a copy of this file and save it at another location. All the machine configurations are saved in this file.
   All the computer vision pictures are under the Parts folder.
3) Copy feeder list files and placing list files to the working folder.

Article II. PX3000A.ini file contents

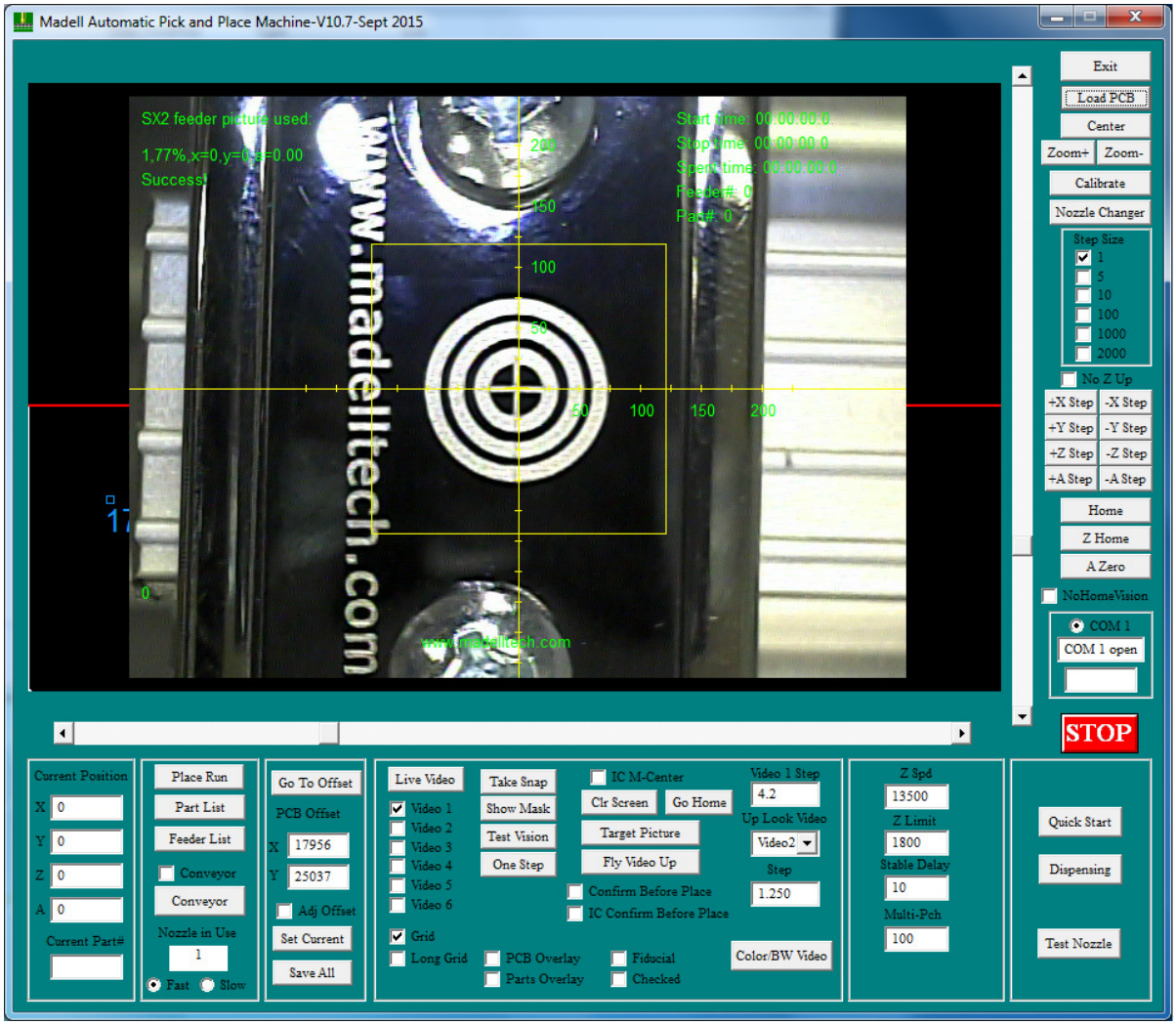
1. XOffet, YOffset, ZDown, ZUp
2. PCB offset-X
3. PCB offset-Y
4. Vision Search (0=fast, 1=medium, 2=fine), check home 2 (0=yes, 1=no), 90 degrees (0=no, 1=yes)
5. PCB Scale
6. Main home X
7. Main home Y
8. Camera offset X
9. Camera offset Y
10. Com port, up look camera, parallel port address (hex format, no 0X at front)
11. 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, 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

12. Home2 X, Home2 Y, not used, not used, mirror center X(screen), mirror center Y(screen), mirror front stride, mirror back stride
13. Nozzle hub X, use mark (0=no, 1=yes), mark shift value, check mark time, mark mask file
14. Nozzle hub Y
15. Current nozzle on head, nozzle changer position (0=front, 1=left)
16. Change nozzle (0=no, 1=yes)
17. Vision max iteration, video1 search area, video2 search area
18. Collect tray X
19. Collect tray Y
20. Use fiducial (0=no, 1=yes)
21. Video1 step size
22. Video2 step size, video4 step size, video5 step size, video6 step size, video3 step size
23. Rotation factor
24. Not used, camera delay, frame delay
25. 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
26. Actuator delay, blow delay, pick delay, multi-punch delay
27. X limit, Y limit, Z limit
28. 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
29. Tip height, tip speed
30. Paste dispenser, needle down, needle up, start delay, stop delay, line speed, dot delay, camera offset X, camera offset Y, camera Z, past list overlay (0=no, 1=yes)
31. Feeders file
32. Parts file

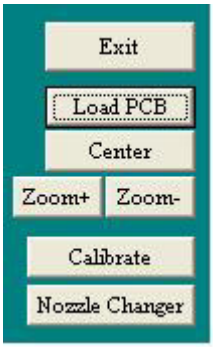
The PX3000A.ini file can only be modified when the software is not running. Otherwise it will be overwritten by the software. It is not recommended to change this file if you are not familiar with the machine.

Computer Interface:

The following is the software's main interface:



Controls:



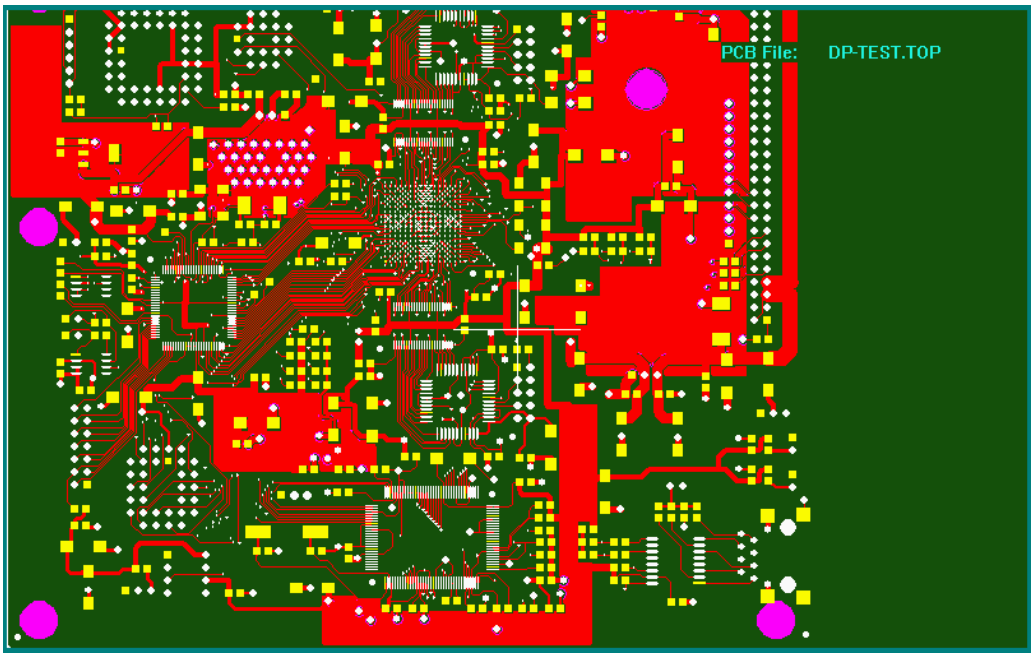
Please note: the Gerber viewing function is for convenience only. It does not have any pick and place functions. We have stopped updating this function.

1) *LoadPCB*: This button loads a PCB file in Gerber format. The file can be any of the various layers: top, bottom, ground, power, silkscreen, paste, solder mask, drill draw, etc. Some files take less time to be opened and displayed, while others may take more.
   Note: The software as of now works only on positive coordinates, where the origin of the PCB design has to be set at the lower left corner.
   The software supports RS-274X format Gerber files. Although we have tested with Gerber files generated by a few commercial software packages, it is not guaranteed to be compatible with all versions. Please let us know if there is a problem with opening a Gerber file.

2) *Center*: If a PCB file is loaded into the program, clicking this scales the display to fit in the center of the display window. If a placing list is loaded, it centers the X and Y sliding bars. It does nothing if neither PCB nor placing list files are loaded.

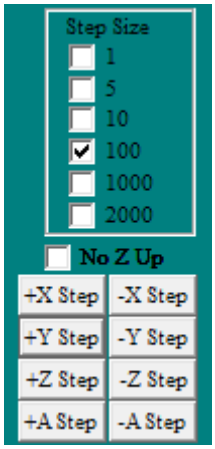
3) *Zoom+*: Zooms in the display. Zooming is based on the center of the display window.

4) *Zoom-*: Zooms out the display. Zooming is based on the center of the display window.



5) *Calibrate*: This windows holds a lot of the machine configuration parameters: like the machine home position(s), video camera offsets, etc. The machine position is based on the main home position(s). The home position(s) has to be correct at all times. The camera/nozzle offset refers to the offset from the down-looking video camera to the pick-up vacuum nozzle.

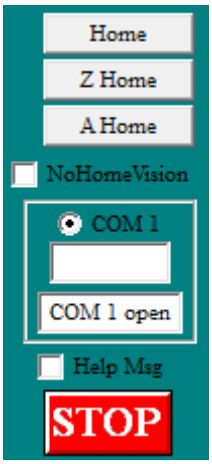
6) *Nozzle changer*: Goes to the automatic nozzle changer configuration window



7) Step Size: Specifies the length of each step movement

8) No Z Up: Check this to ensure that the nozzle does not return to Z-home when moving in the X or Y coordinates. It is recommended to leave this unchecked for precautionary purposes.

9) *+X, -X, +Y, -Y, +Z, -Z, +A, -A Step*: Click on any of these buttons to move the placing head in positive or negative directions in steps, with the length specified in the above Step Size field.



10) *Home*: Machine automatic calibration. If this button is clicked, the machine first moves to Z home sensor, then Y home sensor and X home sensor. After all the home sensors are found, the machine moves to the optical home mark and automatically aligns with it.
It is recommended to check and adjust home positions every time the machine is turned on or whenever necessary. Sometimes the machine may lose position if it hits something while moving or if the set speed is too high and it suddenly stops. Click the *Home button* in such cases to recover the correct position.

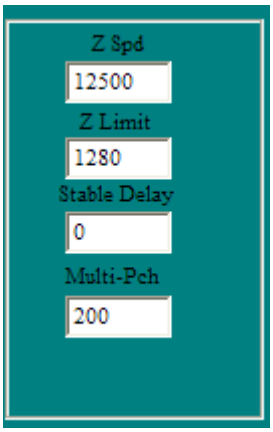
11) *Z Home*: Moves the placing head to the Z-home position without changing the X or Y locations, or the A rotation

12) *A Zero*: Reset the current A value to zero without changing the X, Y, or Z locations

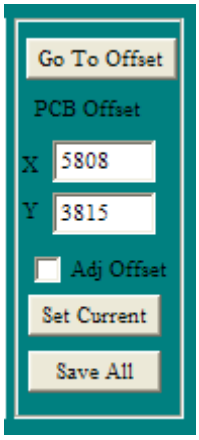
13) NoHomeVision: Checking this will prevent the machine from adjusting the home position using computer vision at start up. Check this box if automatic start up calibration fails. Make sure the screen cross hair is aligned with the optical home mark

14) COM1: RS232 communication port status. The program uses COM1 by default. It can be changed by typing in a different port number if a USB-RS232 adaptor is used.

15) **Stop**: Clicking this stops the current operation. As a software emergency stop, its response is not as fast as the hardware emergency stop button, stopping the machine only after a movement is finished. Hence, using the hardware emergency stop button or the power button is a better choice in case of true emergencies.



16) All of the following speed parameters can be changed by directly typing in a value (unit in steps per second).
- Z Spd – Maximum Z speed
- Z Limit – The maximum depth the Z-axis can move down. Note that this software limit is limited by the mechanical Z-axis limit.
- Stable Delay – This delay is effective when the machine moves to the uplooking camera, and to the place where the part is placed. The purpose of this delay is to let the machine stabilize after long movements.
- Multi-Pch Delay – This is a delay when the tape needs to be advanced more than one times



17) PCB Offset:
- The X and Y values show the current offset from the machine home position.
- *Go To Offset* – Click on this button to move the placing head to the position specified by the offset values in the text box fields.
- Adj. Offset – Check this box and click +X, –X, +Y and –Y to adjust the offset and move all the parts in the part list.
- *Set Current* – Click this button to set the offset values in the text box field to the current X-Y position.
- Save All: this has nothing to do with PCB offset. Click on this button to save the machine configuration values, feeder list, part list and nozzle changer locations.

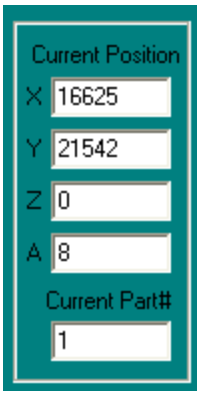
All the part locations (X and Y values) in the part list are relative to the PCB offset. Changing the offset values will change all of the parts' locations. A convenient way to move all of the parts is to change the PCB offset values.

How to match the actual PCB with a converted pick and place file data:
Please use the following procedures if the part locations in the converted pick and place file do not match the actual PCB:

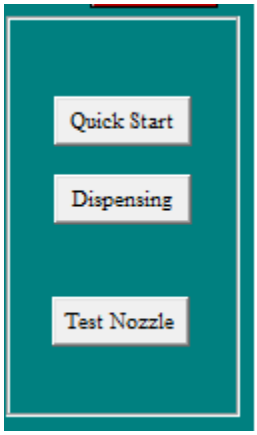
1. Type "0" in both PCB offset X and Y fields. This will give you a new start point
2. In the part list, click on "Go To Part" for a part you know the position. Most probably, the down-looking camera will go to a very different position
3. Check the "Adj. Offset" box, using X and Y steps to move the blue cross on the screen to the center of the know part. As you use steps to move, you can see that the PCB offset values are changing.
4. Uncheck the "Adj. Offset" box after you are done.

18) Pick and Place Controls:

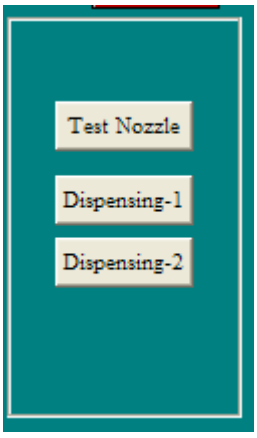
- *Place Run* – If the dispensing window is not open, this runs the current parts list by selecting the start item, end item, and the number of parts between each stop. If the dispensing window is open, this runs the dispensing list.
- Conveyor check box – Checking this specifies that the PCB conveyor is used.
- *Conveyor button* – set up the PCB conveyor.
- *Part List* – Click this button to open the part list window.
- *Feeder List* – Displays and sets feeders.
- Nozzle in Use – Shows the current nozzle on the head. Make sure the displayed nozzle number matches the nozzle changer.
- Fast or slow – Specifies if the machine should work in normal speed (Fast), or slow speed. The slow speed setting can be used to get familiar with the machine.



19) Current Position: shows the current placing head's X-Y-Z-A positions. It also shows the sequence number of the current part being placed.



or



20) The last group contains some additional features:

- Quick Start – Introduces major functions of the pick and place machine
- Test Nozzle – A simple procedure to check if the nozzle has enough vacuum suction
- *Dispensing* -1 and -2– Opens the first and second paste dispensing control windows.

The standard software has only one dispensing control window. Machines with purchased option of two dispensers will get the software with two dispensing controls. See section 7 for details.

4. Operations Details

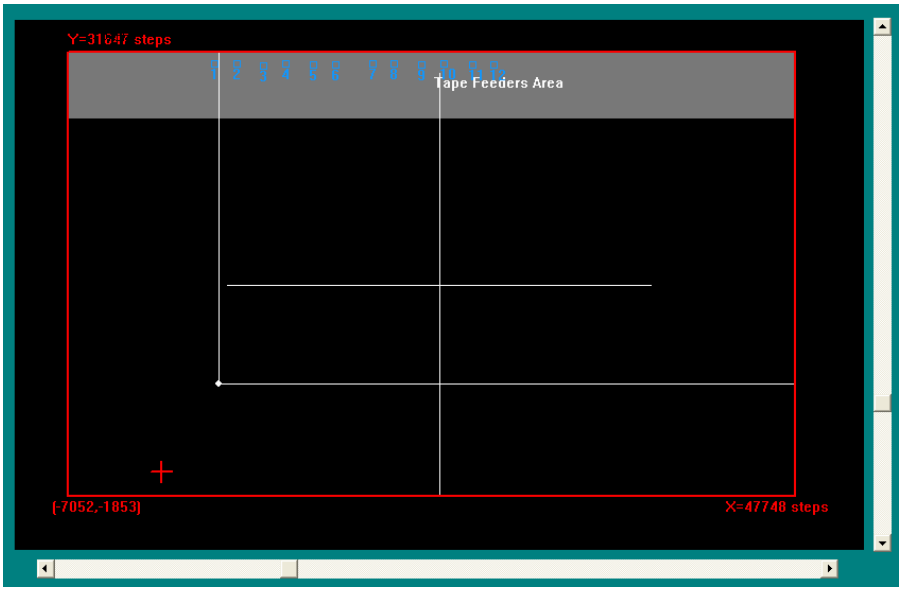
1. Turn on the pick and place machine power. The power switch should be on the control box, or on the main control panel if the machine is a floor model.

2. Start the Pick and Place software. The machine should perform a homing operation. It will issue a "Serial port COM 1 not initialized" error message if the RS232 cable is not plugged in or if the machine is not powered on.

   Click on Live Video button and *Zoom-* button several times, a red rectangle will show up, signifying the valid machine working area. The numbers show the X and Y limits in machine steps. The machine home position is displayed as a red cross. A white dot inside the working area shows the PCB Offset point. This normally is the lower left corner of the PCB board.

   Two white lines reaching to the X and Y limits specify the position that a rectangular PCB board can be placed on the platform. The machine's physical working surface area is the summation of the absolute values of the X and Y limits and the mechanical home position values (where the X and Y home switches are located).

   In the following graph below, the physical working surface area is 47748+7052=54800 steps in X direction, and 31647+1853=33500 steps in Y direction.

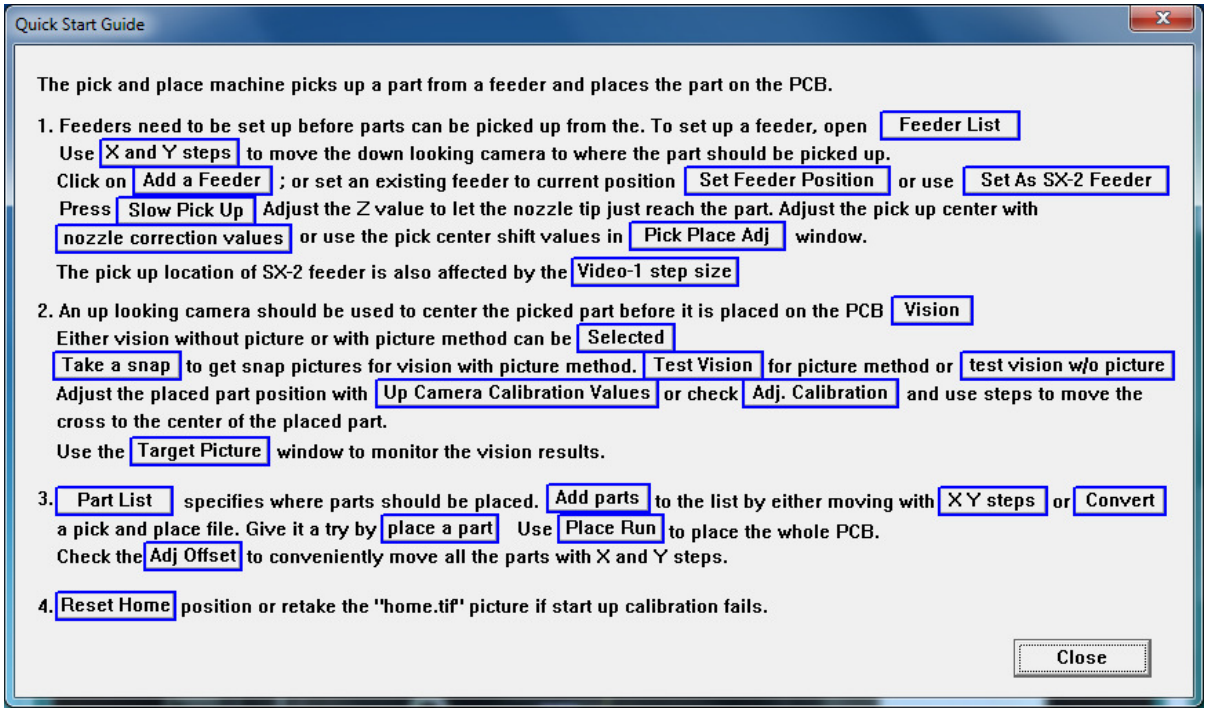


   An accurate home position is very crucial for the accuracy of the machine. The machine uses computer vision to find the correct optical home position, and makes adjustments if

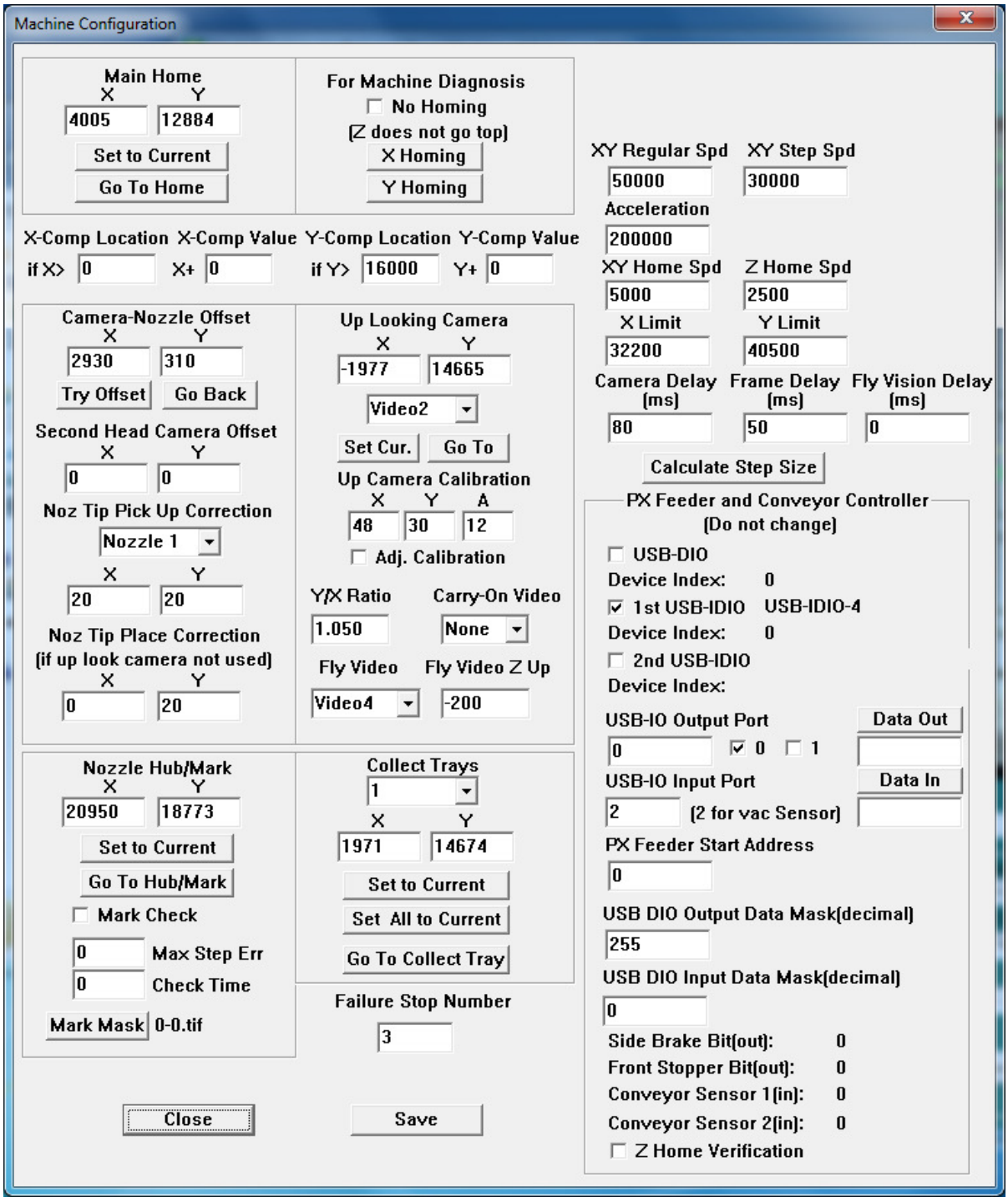
necessary. On the PX3700 machines, there is a 2nd home position on the left side of the working surface. The machine also searches for it when it starts. The second home position guarantees that the two Y-axes are parallel.

Quick Start:

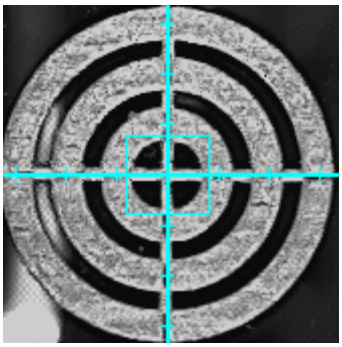
Click on the Quick Start button on the main screen to bring up the Quick Start window. Goes through it if you are not familiar with the machine software. This page covers most of the pick place machine functions. Click on the text with blue boxes to bring up the related windows or functions.



Calibrate window: Machine settings can be viewed and changed inside here:



- Main Home: when the machine starts, it first tries to find the optical home mark. The machine will automatically adjust the home X and Y values in the calibration process. All the positions, including parts, feeders, etc, are based on the main home address. Make sure that the machine stops at the main home mark after the calibration process. Do not change the main home mark location, unless it is absolutely necessary.



optical home mark

Snap picture of the home mark, saved under /Parts folder as home.tif

- *Set to Current*: click this button to set the current position to the corresponding item.
- The Camera-Nozzle Offset values specify the distance from the center of the down-looking camera (Video 1) to the pick-up nozzle. These values have to be carefully calibrated before the machine can be used.
  - *Try offset*: click this button to try the camera offset value.
  - *Go Back*: click this button to reverse the movement of the camera offset.
- Nozzle Tip Pick Up Correction: Select from nozzle 1 to 5 and specify the correction values to compensate for tips that are off center. These values are only used at picking up.
- Nozzle Tip Place Correction: these values are used at placing the part if no up looking camera is used.
- The machine diagnosis group disables machine start up self-calibration; X and Y can go to home sensors separately.
- The Up-Looking Camera values specify the location of the up-looking cameras (camera though Video 2, 4, 5, 6, or mirror, selected by the drop down menu).
- The Up Camera Calibration values compensate the selected up-looking cameras to achieve accurate placement. To adjust these values, check the "Adj. Calibration" box and then use +X, –X, +Y or –Y steps to move the intersection of the onscreen crosshairs to the center of the placed part.
- Y/X ratio: this ratio number calibrates Y axis movement in regards to X movement.
- Carry-On Video: enable or disables carry-on up looking camera.
- Fly Video: enables or disables fly video; specifies the camera used for fly vision. Please note that to use this function, the machine has to be equipped with fly vision.
- Fly Video Z Up: specifies the Z level for the fly video if equipped. This should be a negative number.
- Nozzle hub/Mark: specifies a convenient location that the pick-up head should move to for the operator to change nozzles manually. It can be anywhere the machine can reach. This function is disabled when the automatic nozzle changer is enabled.
- Mark Check: The mark check function shares the same location with the nozzle hub. Its purpose is to repeatedly check this location to make sure that the machine runs

normally. A mark label should be placed on this location with its picture taken. The Threshold value specifies a machine step number which the software will declare a machine position loss when the computer vision finds the X or Y offsets are over this threshold. The Check Time specifies the frequency the machine checks the mark label. Click the *Mark Mask* button to load the mark's snapshot file.

- Collect Trays: specify locations to drop components that the computer vision fails to recognize. The software supports up to a total of ten collect trays.
- Failure Stop Number: specifies the number of failed trials to pick from a feeder or vision alignment before the machine stops.
- XY Regular Speed: XY movement speed at steps/second when performing pick and place operations.
- XY Step Speed: speed at which the machine moves when a step button is pressed.
- Acceleration: this value should be a few times bigger than the XY Regular Speed. The machine will clash or jump in the middle of a movement if the acceleration value is too small; or the machine will shake or suddenly stop if this value is too big.
- XY Home Speed, Z Home Speed: homing speed.
- X Limit, Y Limit: machine working area software limits.
- Camera Delay(ms): this delay is the time after the machine reaches an up looking camera and before starts a vision alignment.
- Frame Delay(ms): a delay between vision alignment iterations.
- Calculate Step Size: automatically calculates video camera step size. Please note sometimes this procedure may fail.
- PX Feeder and Conveyor Controller: configures PX feeder support and PCB conveyor. Do not change the values in this group.

Note about Camera-Nozzle Offset:
The smallest pick-up nozzle can be used to calibrate the camera offset. For the calibrating procedure:

- Move the pick-up head to a mark or a part, aiming the down-looking video camera to the center of the mark.
- Click the Try Offset button, and use +Z Step to lower the nozzle down.
- Check how far the nozzle is away from the intended position.
- If necessary, click the Go Back button, adjust the offset values manually by directly typing in new values, and perform the above steps again until the correct offset values are reached.

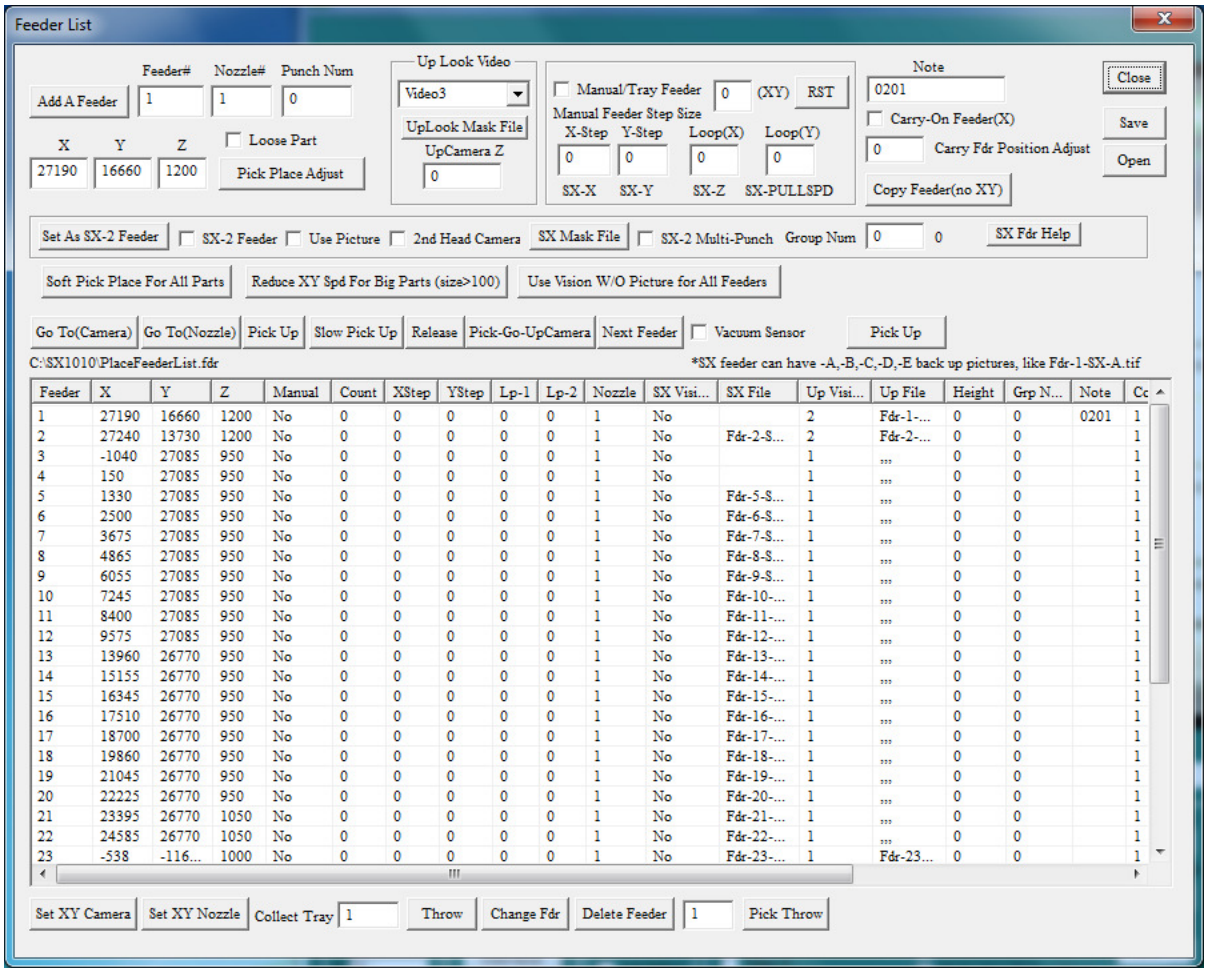
After the calibration, the nozzle should point to where the down-looking camera looks at.

The following steps do not need to be performed in sequence:

3. Load a PCB Gerber file by clicking on *Load PCB*. The display window shows the PCB design after it is loaded. The origin of the X and Y coordinate plane is set at the lower left corner. Click on *Center* if the PCB is shown as being too big or too small inside the display window, or use *Zoom+* or *Zoom-* to check details and use horizontal and vertical sliding bars to adjust the view area.

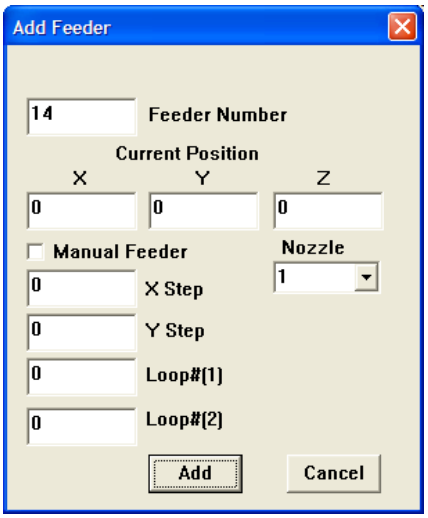
Different colors in the PCB graph do not have actual physical meanings. They just help show different shapes, like circles, rectangles, round cornered rectangles, lines, texts, etc.

4. **Feeder list:**
   The Feeder list window shows the feeder's list. There are 12 example feeders hardcoded in the program. Make necessary changes and save for your own application. The X-Y-Z positions have to be specified for each feeder. The X-Y-Z positions are motor steps, not physical measurements. They can be changed directly in the X, Y, and Z editing boxes. Use only valid values for them (smaller than the X or Y limits). The X-Y values of a feeder can also be specified by finding the location first with video 1, then clicking the *Set XY Camera* button.

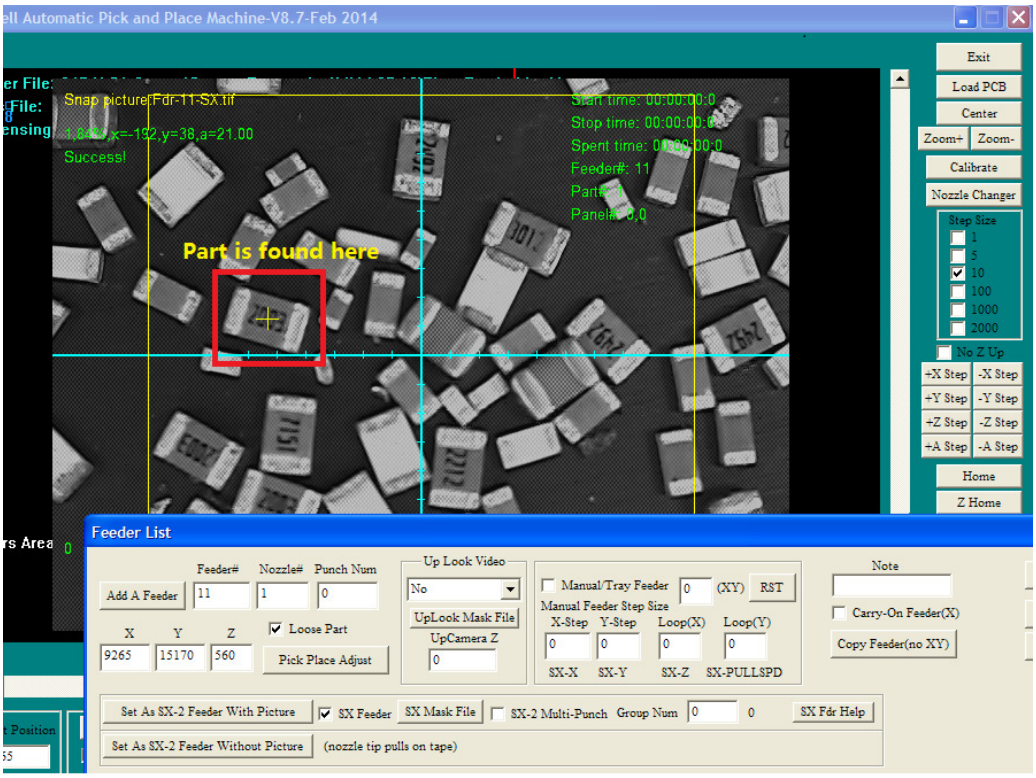


Feeder	X	Y	Z	Manual	Count	XStep	YStep	Lp-1	Lp-2	Nozzle	SX Visi...	SX File	Up Visi...	Up File	Height	Grp N...	Note	Cc
1	27190	16660	1200	No	0	0	0	0	0	1	No		2	Fdr-1-...	0	0	0201	1
2	27240	13730	1200	No	0	0	0	0	0	1	No	Fdr-2-S...	2	Fdr-2-...	0	0		1
3	-1040	27085	950	No	0	0	0	0	0	1	No		1	,,,	0	0		1
4	150	27085	950	No	0	0	0	0	0	1	No		1	,,,	0	0		1
5	1330	27085	950	No	0	0	0	0	0	1	No	Fdr-5-S...	1	,,,	0	0		1
6	2500	27085	950	No	0	0	0	0	0	1	No	Fdr-6-S...	1	,,,	0	0		1
7	3675	27085	950	No	0	0	0	0	0	1	No	Fdr-7-S...	1	,,,	0	0		1
8	4865	27085	950	No	0	0	0	0	0	1	No	Fdr-8-S...	1	,,,	0	0		1
9	6055	27085	950	No	0	0	0	0	0	1	No	Fdr-9-S...	1	,,,	0	0		1
10	7245	27085	950	No	0	0	0	0	0	1	No	Fdr-10-...	1	,,,	0	0		1
11	8400	27085	950	No	0	0	0	0	0	1	No	Fdr-11-...	1	,,,	0	0		1
12	9575	27085	950	No	0	0	0	0	0	1	No	Fdr-12-...	1	,,,	0	0		1
13	13960	26770	950	No	0	0	0	0	0	1	No	Fdr-13-...	1	,,,	0	0		1
14	15155	26770	950	No	0	0	0	0	0	1	No	Fdr-14-...	1	,,,	0	0		1
15	16345	26770	950	No	0	0	0	0	0	1	No	Fdr-15-...	1	,,,	0	0		1
16	17510	26770	950	No	0	0	0	0	0	1	No	Fdr-16-...	1	,,,	0	0		1
17	18700	26770	950	No	0	0	0	0	0	1	No	Fdr-17-...	1	,,,	0	0		1
18	19860	26770	950	No	0	0	0	0	0	1	No	Fdr-18-...	1	,,,	0	0		1
19	21045	26770	950	No	0	0	0	0	0	1	No	Fdr-19-...	1	,,,	0	0		1
20	22225	26770	950	No	0	0	0	0	0	1	No	Fdr-20-...	1	,,,	0	0		1
21	23395	26770	1050	No	0	0	0	0	0	1	No	Fdr-21-...	1	,,,	0	0		1
22	24585	26770	1050	No	0	0	0	0	0	1	No	Fdr-22-...	1	,,,	0	0		1
23	-538	-116...	1000	No	0	0	0	0	0	1	No	Fdr-23-...	1	Fdr-23...	0	0		1

- *Add A Feeder*: Click this button to add a new feeder. The Add Feeder window pops up at this time. The feeder sequence number is automatically incremented. The X and Y positions shown in the window represent the current head position. Leave Z to be 0, or enter an estimated value. Other values are self-explanatory.



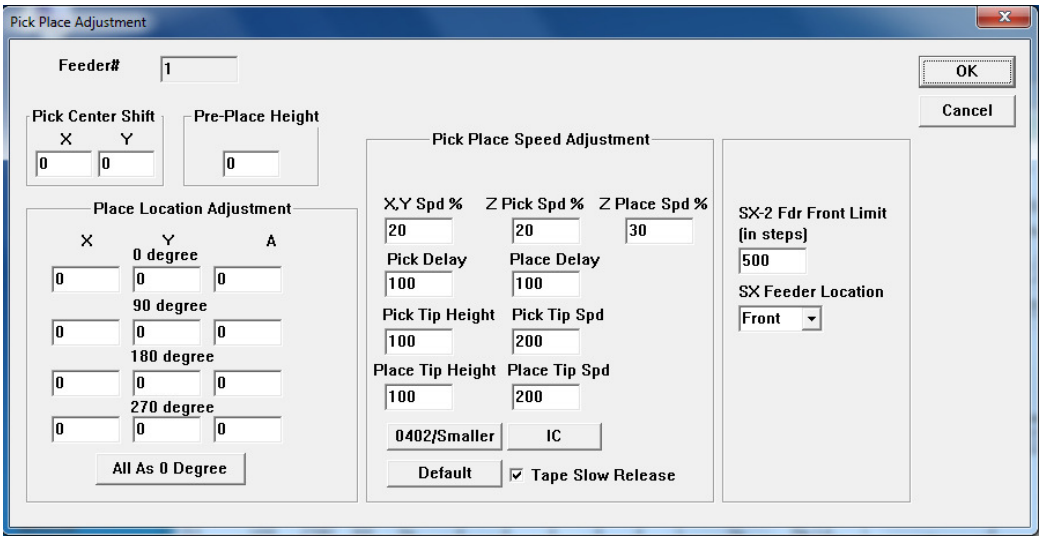
- The Feeder# value shows the current feeder. Type in a different feeder number or click on a row in the feeders table to change it.
- The Nozzle# shows the nozzle this feeder should use. The machine will change nozzle if the automatic nozzle changer is equipped or it moves to the nozzle hub location, waiting for the operator to change the nozzle.
- The Punch Num value specifies how many times the actuator should press the feeder lever to move the part forward, or how far the tape should be pulled forward if the SX-2 no picture method is selected.
- Loose Part: indicates this feeder is for loose parts; loose parts are parts that are not on a tape or a tray but randomly spread in a small area. The SX Feeder box should be checked also. Two snap pictures of the part should be supplied: one picture is when the part is at 0 degree, can be named to anything, like Fdr1.tif; the second picture is the same part that is rotated 90 degrees and should be named same as the first picture with a "+" at the end, like Fdr1+.tif. The software first searches parts with the 1st picture at ±45°; if a part is not found, the software searches at ±45° with the 2nd picture.
  Adjust the Pick Tip Height and Pick Tip Spd values in the Pick and Place Adjustment window to make the pick up very gentle when the nozzle tip reaches the part. This is to prevent vibrations that will cause other parts jumping around because the loose parts do not have tapes to cover them.



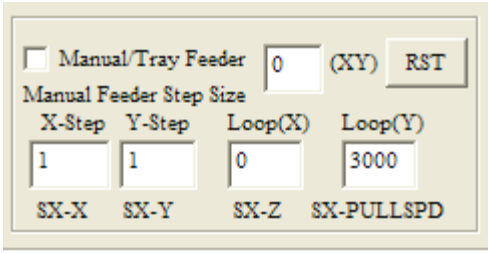
Example of Loose Part

- Pick Place Adjust: more adjustment for picking up the part or placing the part can be applied in this window. Most items are self-explaining.

  (a) Pre-Place Height: the nozzle goes down to this level before the part is placed. The purpose of this function is to reduce the Z travel distance but it is a little danger of hitting something. Use this function with caution.
  (b) Slow Release: the part is picked up slowly. This is useful for big IC's or to prevent parts pop out of tape pocket. It uses the Pick Tip Height as the travel range of the slow movement, and Pick Tip Speed as the slow moving speed.
  (c) SX-2 Fdr Front Limit: if the feeder is an SX-2 feeder and if the part is found 500 steps beyond the specified location, do not pick up this part.



- The Manual/Tray Feeder group specifies whether the selected feeder is a manual or tray feeder.

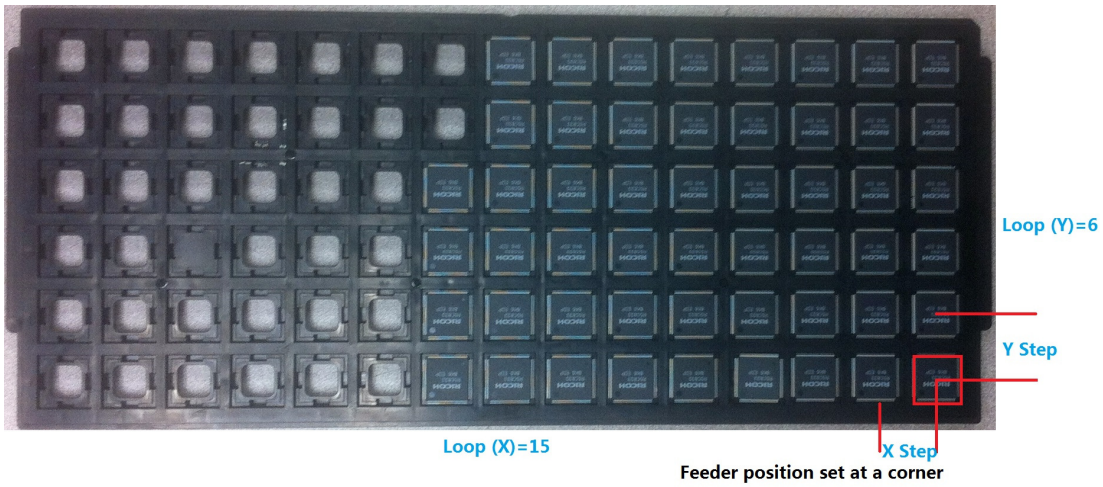


To use a manual or tray feeder, check the Manual/Tray Feeder box, set the feeder position at the first part in one of the four corners of the tray, and specify the following parameters:

- X-Step – Distance in the X direction between adjacent parts
- Y-Step – Distance in the Y direction between adjacent parts
- Loop (X) – Total number of parts the machine will pick up sequentially in X direction before it stops for manual forwarding of the tape or replacing the tray.
- Loop (Y) – Total number of parts the machine will pick up sequentially in Y direction before it stops for manual forwarding of the tape or replacing the tray.
- RST – Count reset.
- For tape feeders, only specify the X-Step or Y-Step values, each depending on whether the feeder is mounted in the X or Y direction respectively.
- For tray feeders, the machine always goes through the X direction first.

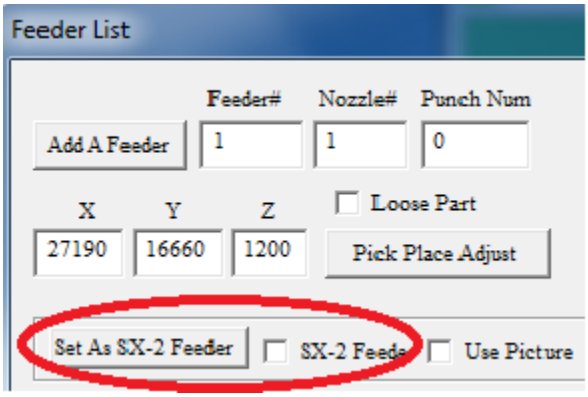
Note that a number can be directly typed into the counter box

See the following example to set up a tray feeder. Also, the manual/tray feeder group is used to set up bulk feeders as a one dimensional tray feeder.



The manual/tray feeder position should be set when the index counter is at zero.

Some of the parameters in the manual/tray feeder group are shared with SX feeders. These parameters have different meanings when they are used for SX feeders. See SX feeder help section.



SX-2 Feeder Set Up

- Set as SX-2 Feeder: this is one of two ways to use the SX-2 feeder. When this button is pressed, the software sets the current location as the feeder address, takes a picture at the center of video-1, and checks the SX-2 Feeder box.

  The snap pictures are not necessary for parts on paper tapes. They should be used for black plastic or bigger than 8mm tapes. Please check the "Use Picture" box for these tapes and make sure to supply the snap pictures.

  The machine first uses video 1 to find a part on the tape, then picks it up.

  The automatic generated snap picture may not work for some parts, like 0201 or big parts. Please manually take snap pictures at this situation.

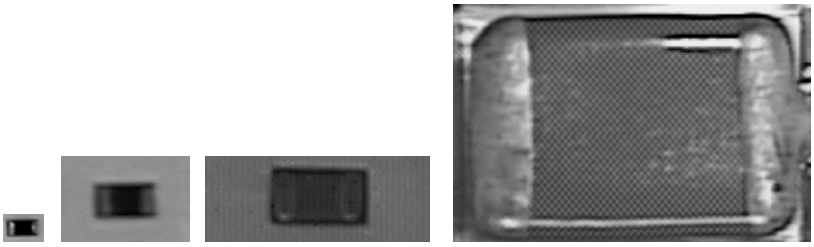
The snap picture size should be bigger than the part in the tape socket. The purpose of the bigger picture is to average out some details of the parts in the tape pockets.

Also, more than one snap pictures can be supplied to the same feeder. The additional pictures should be named the same as the first picture with -A,-B,-C,-D, and –E at the ending. If the first picture name is Fdr-1-SX.tif, the additional picture names should be Fdr-1-SX-A.tif, Fdr-1-SX-B.tip,…etc.

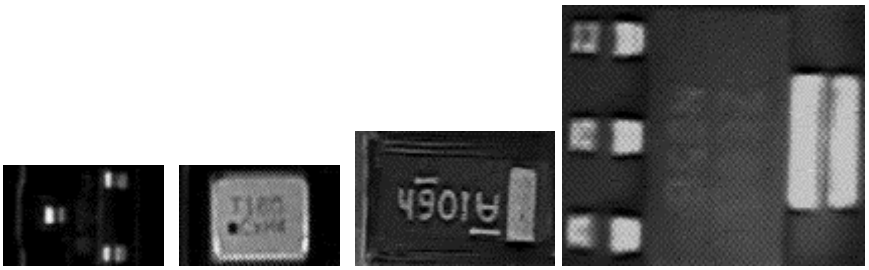
Example snap pictures can be found under the /Parts folder at the supplied software.

The position of the SX-2 feeder, no matter with or without picture, should be set at the first part that is peeled from the tape, like this picture shows. The software uses the snap picture to find where the part is before picking up.

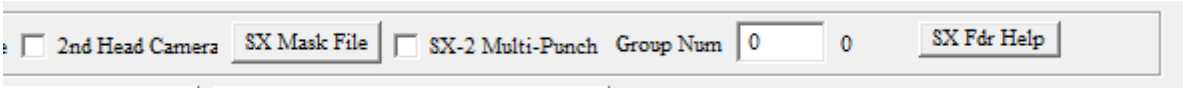
- The SX-2 Feeder check box specifies if it is a SX-2 feeder. When this box is checked, an Open File window pops up. Browse and find the necessary snapshot file for the specific feeder.



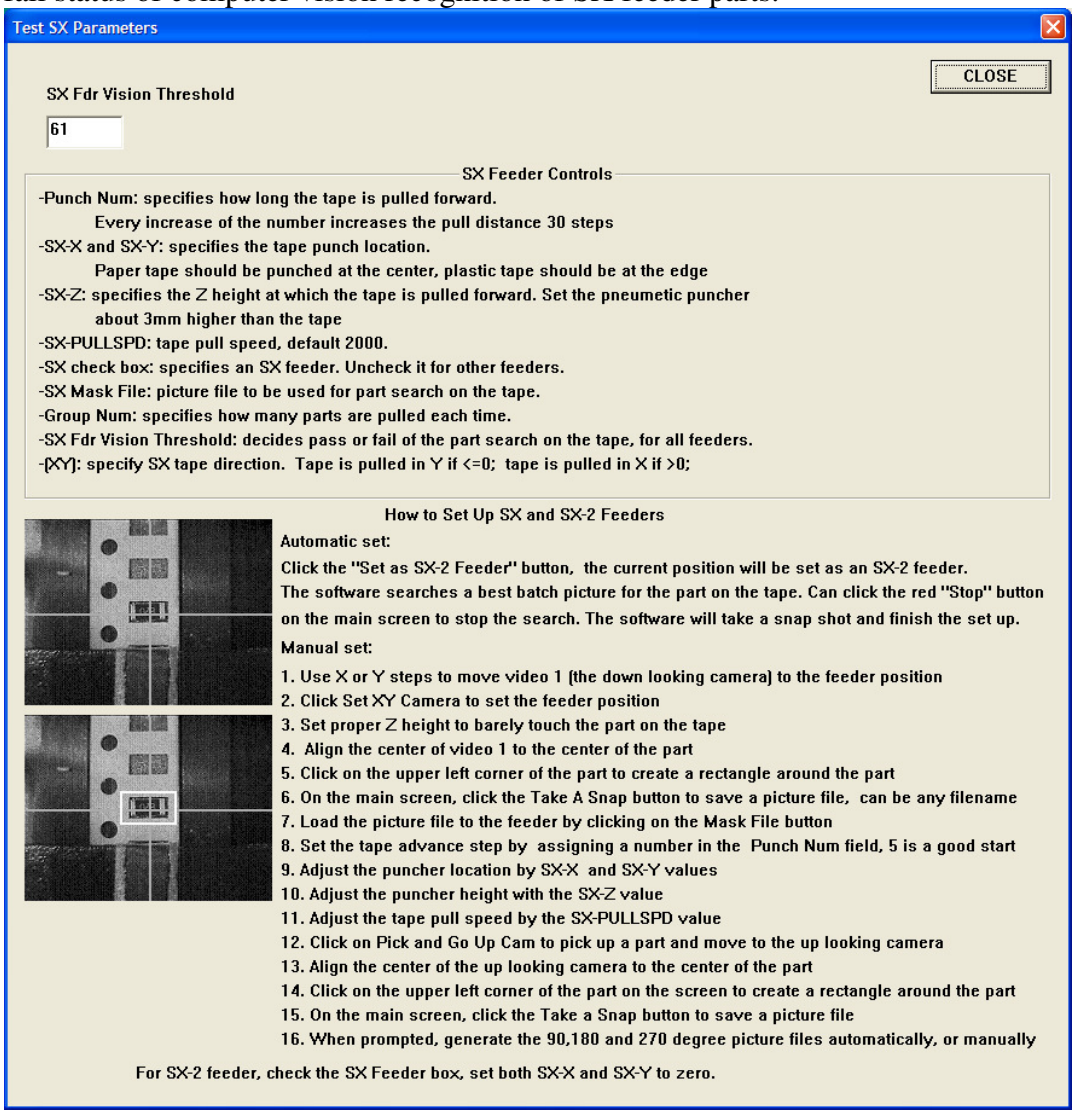
If the "Use Picture" box is checked, snapshots are needed for the machine to find parts on the tape. Take pictures with enough surrounding area to average out some details (highlights, part orientation, etc.) that varies from part to part on the same tape.



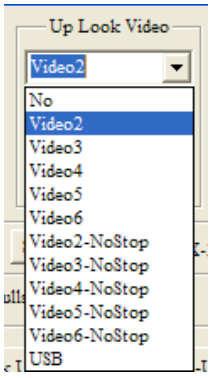
More examples of snap pictures on the tape for SX-2 feeders



- *2nd Head Camera:* some machines are equipped with two down looking video cameras. Use this check box to select to use the 2nd camera.
- *SX Mask File* provides the snapshot file for the current SX feeder.
- *SX-2 Multi-Punch:* 12mm or bigger tapes may need to advance more than one time to get a part. Check this box and enter the number of advances in the Punch Num field. The tape advance distance can be adjusted by entering a number in the "SX-Z" field. A default value is used if this field is left with zero.
- Group Numb: Specifies the number of parts which are picked up from the SX-2 feeder before video 1 is used again to find the part location on the tape. Default value is zero and can be left as zero at most situations. But if the part is relatively big (0805 or bigger), this number can be used to improve the pick up speed.
- *SX Fdr Help*: Contains instructions for setting up the SX feeder. Also contains box for setting the SX feeder vision threshold. The threshold is used to determine pass or fail status of computer vision recognition of SX feeder parts.



- The UpLook Video dropdown menu specifies whether the up-looking camera should be used to align the picked parts for position and angle correction, which up-looking camera it should go to, and also whether it should perform a complete position correction or just take a snapshot and adjust the position while it moves to the placing position.

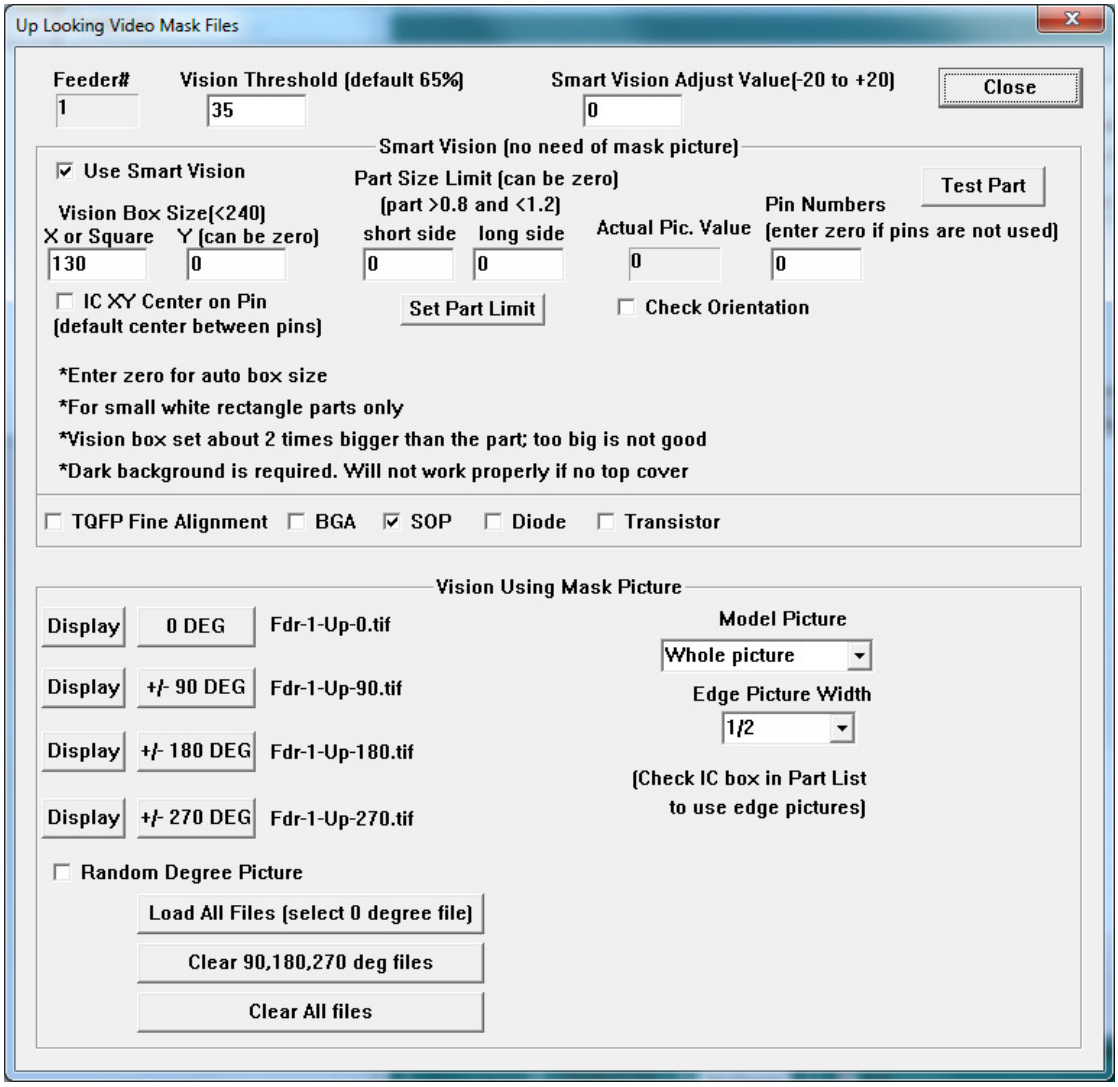


Choices:

1) No: No vision position correction performed for parts picked up from this feeder
2) Video2 ~ Video6: Vision position correction performed with the selected up-looking camera.
3) Video2-NoStop ~ Video6-NoStop: The part will go through the selected up-looking camera to take a snapshot but vision correction is performed while the part is being moved to the placement location. This is much faster and more effective than the above 2) option for small parts (i.e. resistors, capacitors, and small IC's). Please note that the up-looking camera steps have to be optimized first so that the X, Y, and rotation correction can be achieved in one iteration.
4) USB: support of USB video cameras (in development)

- *UpLook Mask File* selects which vision method to be used and provides snapshot files for the up-looking video. Corresponding files should be provided according to the rotation of the part after being picked up.

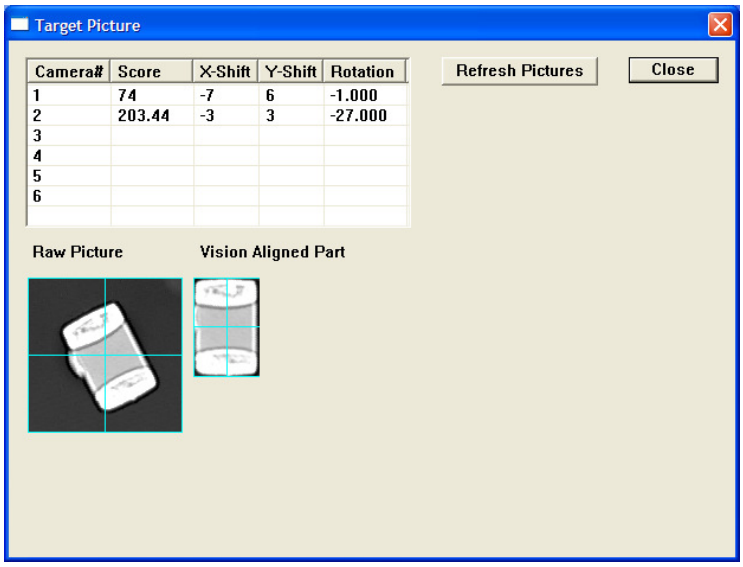
  Smart Vision (visio without mark picture) or with mask picture can be selected in this window.



(1) . **Smart Vision** (**Vision without mask picture):** this is a new vision alignment method we developed. It is easy to use, faster and time saving.

No mask picture is required with smart vision. Instead, a search box area centered at the nozzle is specified. The search box should be big enough to cover the part. Strong contrast between the part and background is required to get good results.

Please note that this method works only for 0,90,180,270 degree rotated parts. It does not work for randomly rotated parts. It always tries to align the part to either horizontal or vertical directions. Also, it works only for rectangle shaped or symmetrical parts. Even with these limitations, the smart vision is easy to use, faster and pass rate is higher than the vision with picture method. Also it is not as light sensitive. The smart vision can also be used for IC's with good results.



vision alignment without using a mask picture

The Test button can be used to test the smart vision alignment when the nozzle with a part is above the up looking camera. Test to see if the part can be moved to the center of the screen with the angle corrected.

Enter a value in the Y box field if a rectangle box is needed.

The Part Size limit tells the software that only parts within the specified range can pass. It is useful to prevent parts being picked up stand up on the nozzle. The values can be set by clicking on the Set Part Limit button after a good vision alignment.

The Smart Vision Adjust value is used to adjust the part cut off edge. It can be left as zero at most times. Enter a positive value if the vision results have extra areas surrounding the part. Or a negative value if some areas on the part is cut off.

The Actual Pic. Value is an image gray level indicator. Set the Vision Threshold value below the Actual Pic Value, but above the actual picture value when the nozzle has no part. For example:

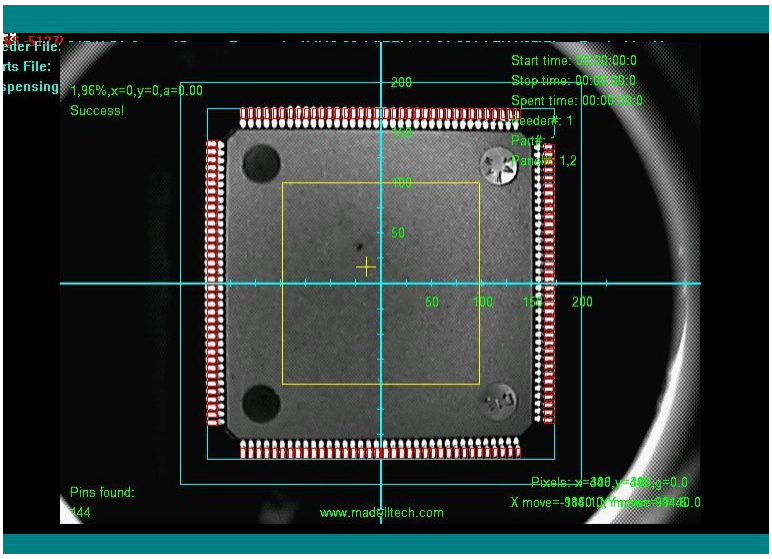
Actual Pic. Value=253 when the nozzle has a part on it;
Actual Pic. Value=90 when the nozzle has no part;
The threshold can be set to 150.

The software will know that a part is not on the nozzle and need to pick up another part when the actual picture value is below the set threshold.

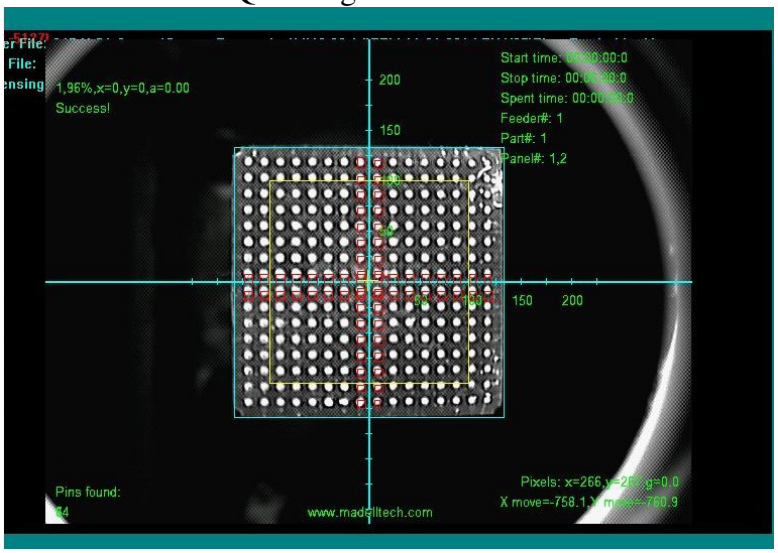
Pin Numbers: IC pins can be used to align the part. Specify the number of pins or ½ of the number of pins in this field. The video image has to be big enough to show the pins clearly.

The Check Orientation box tells the software to check the orientation of a rectangle part and to make sure it is placed in the desired direction.

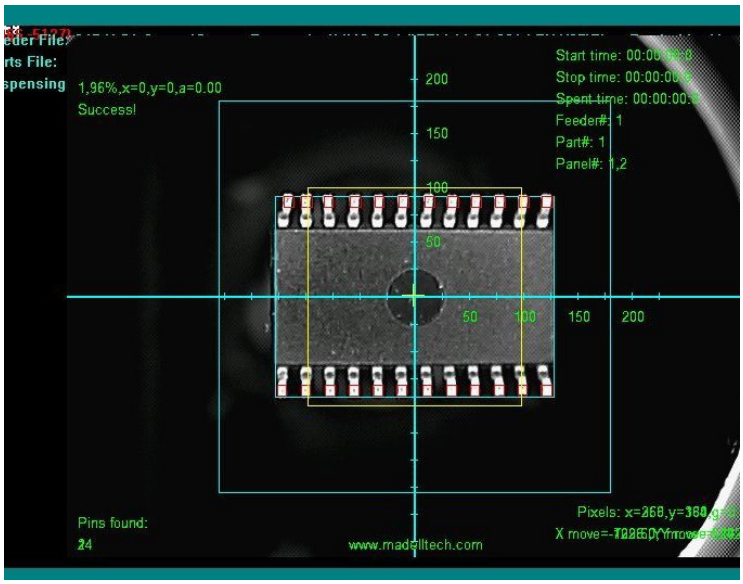
The Smart Vision can further find pins on the IC and align the part based on the pin positions if the TQFT, BGA, or SOP boxes are selected. Try to check the Diode and Transistor boxes if the vision with picture method does not work well.



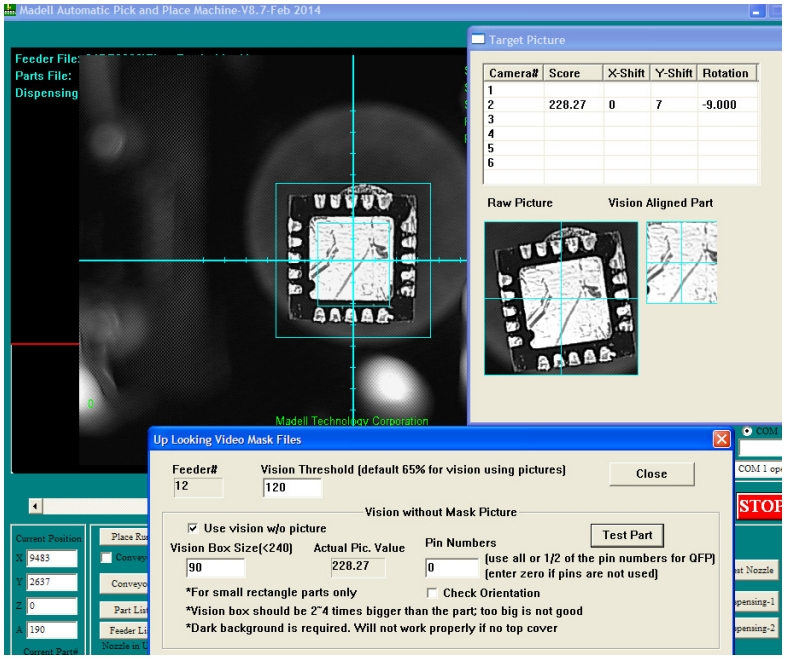
TQFP Alignment with Pins

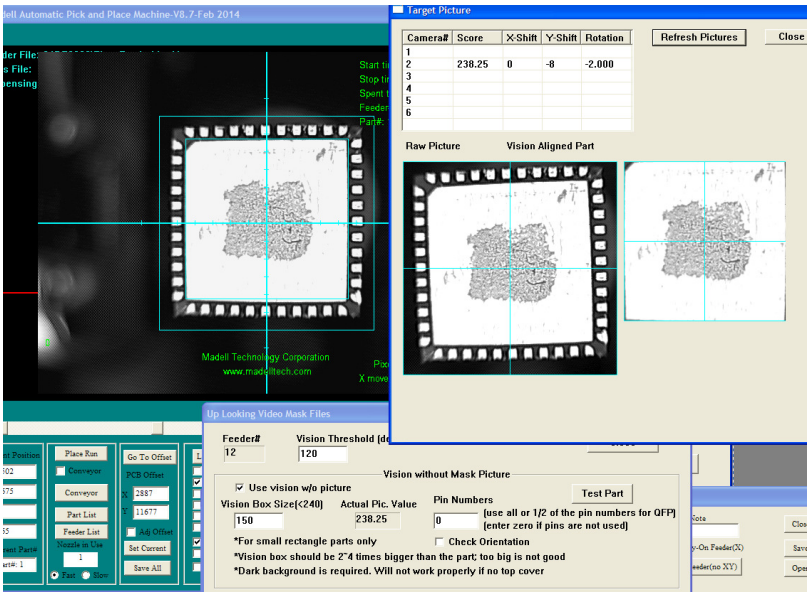


BGA Alignment with Pins



Following are two more examples of using smart vision to align IC's. Note that the vision box are set to different sizes.
The part can be set as IC inside the part list to tell the software to align it more precisely.



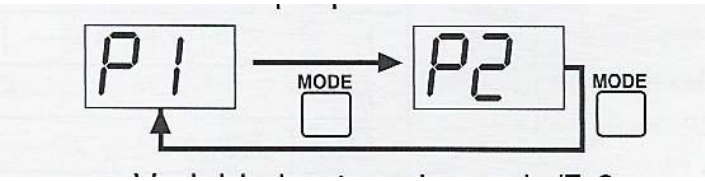


(2). Vision alignment with mask picture: the software will use this method if the "Use Smart Vision" box is not checked. Mask picture files should be provided to use this method. At least the 0 degree picture should be available. The software will use the 0 degree picture if other degree pictures are not provided. This method should be used if the smart vision fails, or need to do random degree pick and place.

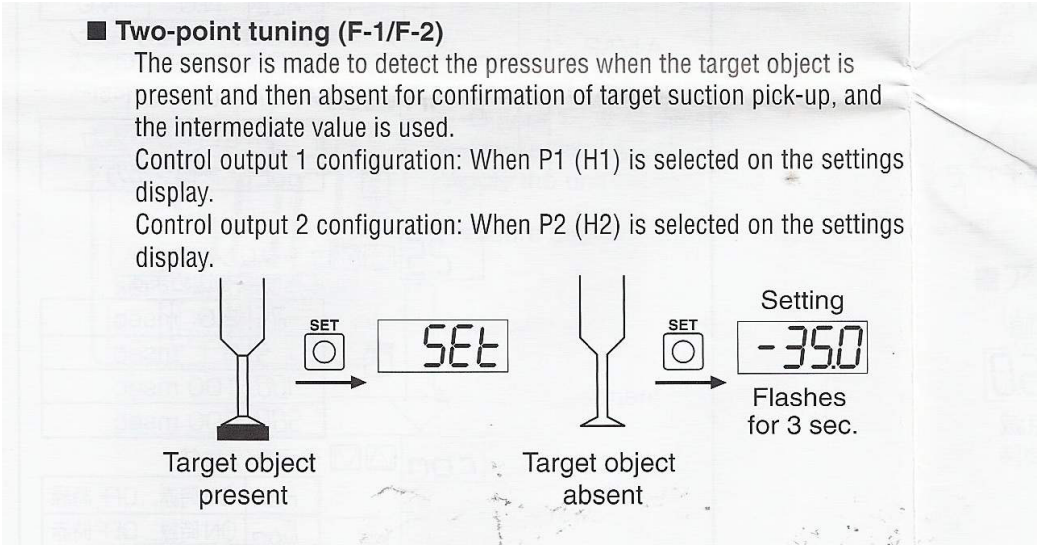
- UpCamera Z specifies the Z position of the nozzle at the up-looking camera. Moving down the nozzle will allow a bigger picture to be taken
- Note: customer notes
- Copy Feeder (no XY): Selecting this will allow the user to copy all specifications from another feeder except its current X and Y position
- Go To (Camera): Moves the video camera to the current feeder.
- Go To (Nozzle): Moves the pick-up nozzle to the current feeder.
- Pick Up: Picks up a part from the current feeder.
- Slow Pick Up: slowly pick up a part from the current feeder. The Z speed is very slow to let the operator see the action more clearly.
- Release: Release the part on the nozzle at the current position immediately.
- Pick-Go-UpCamera: Pick up a part and move to the up-looking camera.
- Next Feeder: Moves the pick and place head to the position of the next feeder.
- Vacuum Sensor: check this box to enable vacuum sensor on this feeder. Vacuum sensor can be used to detect if the part has been picked up. Without the vacuum sensor, the software knows if a part is on the nozzle only after the head moves to the up looking camera.
  The vacuum sensor goes through an I/O board to connect to the computer with a USB cable. There are two outputs from the vacuum sensor. Output 1 is used for nozzle #1 only for small parts; output 2 is shared by nozzles #2 to #5.

Vacuum Sensor

Both of the outputs on the vacuum sensor need to be set up before they can be used correctly.



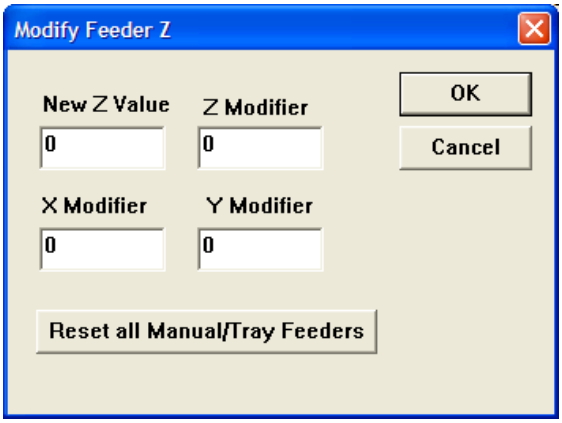
Press the MODE button on the sensor to toggle between output 1 and 2 (P1 and P2).



Set up P1 or P2 vacuum detection threshold: at the desired output, pick up a part, press the SET key on the sensor, then take off the part from the nozzle while the vacuum is still applied, press the SET key again.

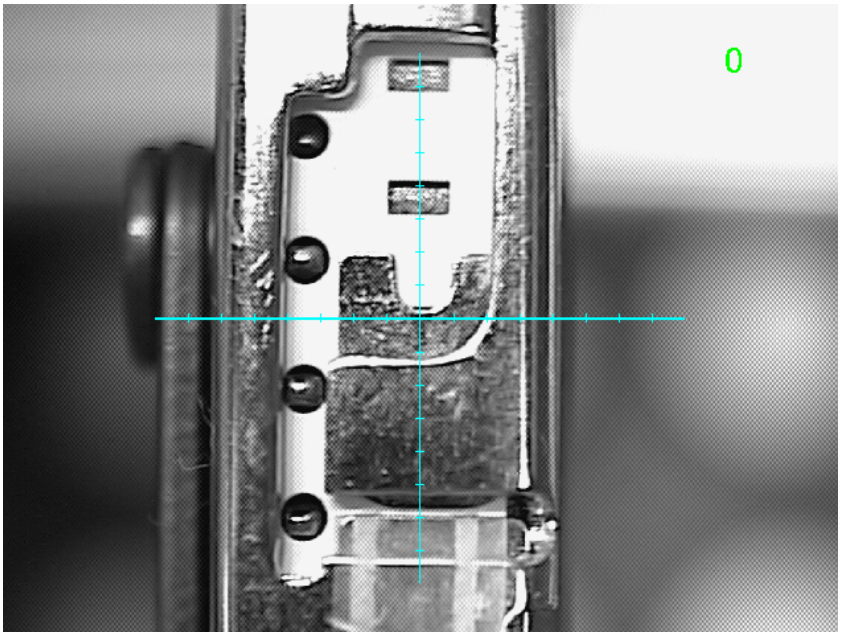
- Set XY Camera: Sets current feeder's X and Y values to the current camera's position.
- Set XY Nozzle: Sets current feeders's X and Y values to the current nozzle position.
- Collect Tray: Specifies the collect tray where feeder parts will be dropped
- Throw: Drops the picked-up part into the collect tray

- Change Fdr: Entering a value in the X, Y, or Z modifier will offset the location of all feeders by that value. Clicking on *Reset all Manual/Tray Feeders* will reset the values of all manual feeders to 0



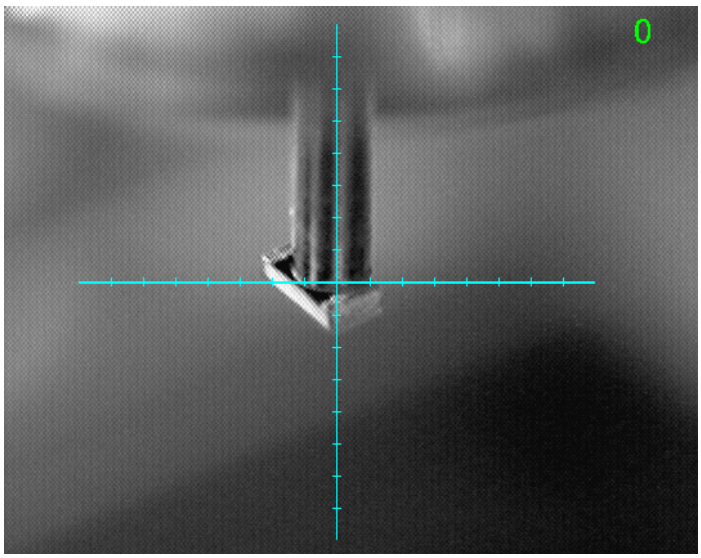
- Delete Feeder: Deletes the current feeder from the list.
- Pick Throw: Picks up a part from the current feeder, moves to the up looking camera and drops in the collect tray. This is repeated the number of times specified in the input field. This function can be used to test the feeder set up.
  .

Feeder position:
Please note that if the feeder in question is a PX tape feeder, the pick-up location should be set to be at the 1st part, which is not exposed until after the air actuator is pressed. This will help to prevent the part from jumping out of its pocket. See the photo below:

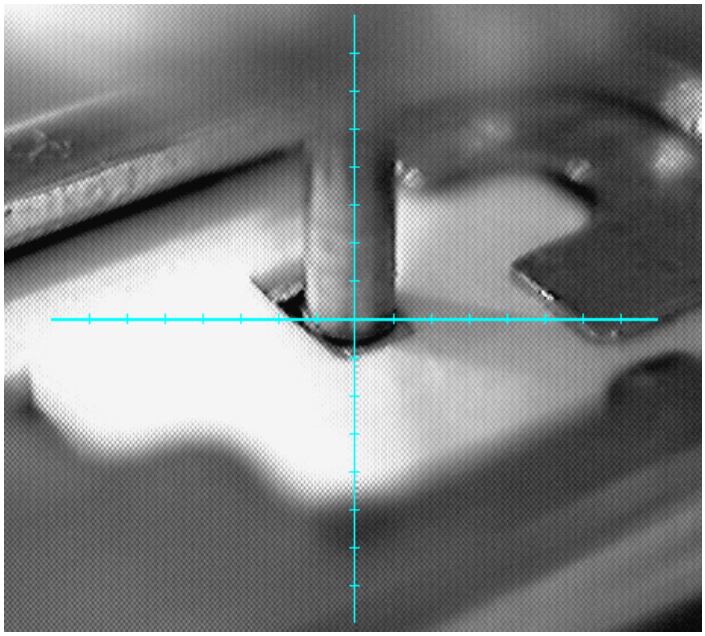


Correct tape feeder pick-up location

Use any of the *Go To* (*Nozzle*), *Pick Up*, *Slow Pick Up or Pick-Go-To-UpCamera* buttons to try to pick up a part, then verify or adjust the pick-up location.



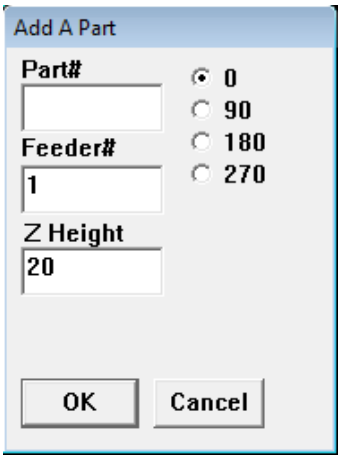
Make sure that the part is picked up at the center.



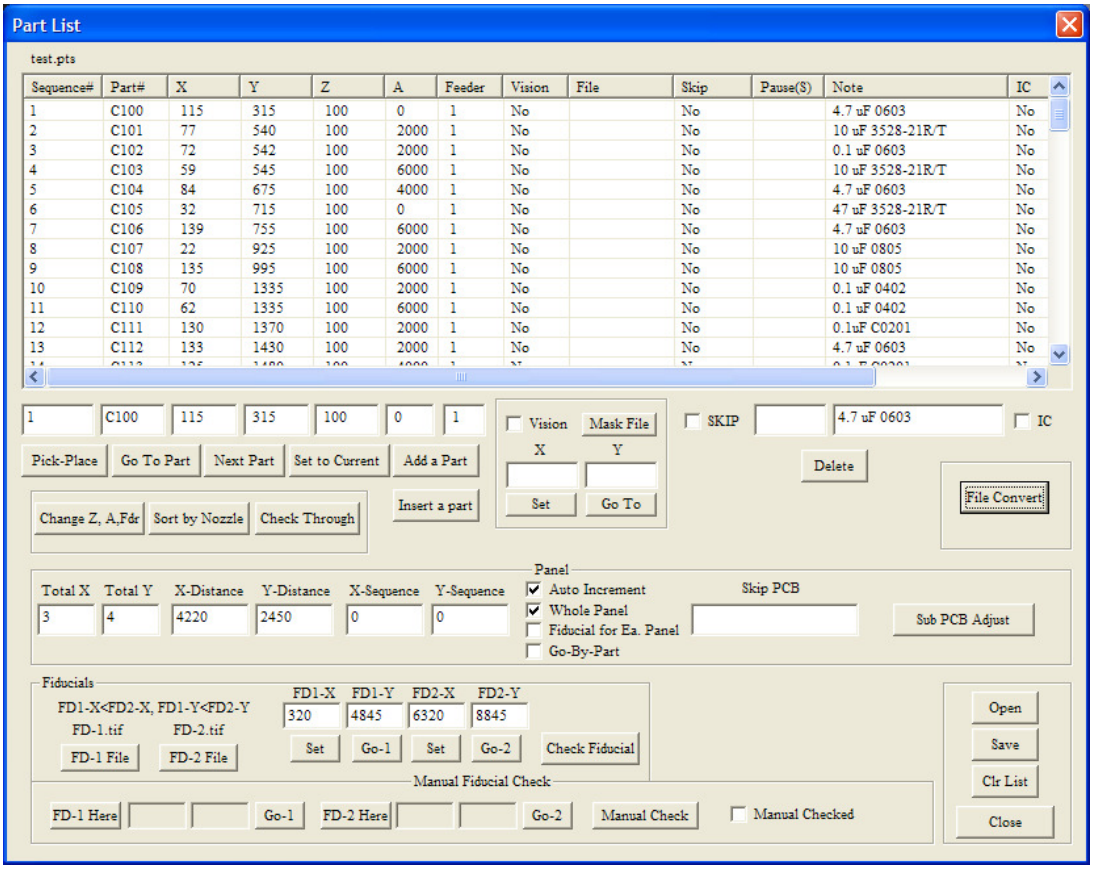
Use the *Go To* (*Nozzle*) function to check the actual pick-up location.

5. **Generating a pick and place part list**

   A pick and place part list can be generated directly by moving the down looking camera (video 1) to the center of a part on the PCB and then right-click on the mouse to bring up the Add A Part window, or to click on the Add a Part button in the Part List window. The Add A Part window is shown in the following picture:



Inside the Add A Part window, enter a label in the Part# box, the feeder number that the part can be picked up, the Z-axis travel distance required to place the part, and the rotation needed. Click on OK to add the part to the part list.



The Part List window shows up after a new part is added to the list. The list can be edited, saved or opened. The list shows the part sequence numbers, labels, X-Y-Z-A locations, feeder numbers, whether computer vision is required or not, etc. The text fields below the list correspond to the highlighted item in the list. Click on an item in the list, or type in the sequence number in the first text box, to highlight and show the data of that item in

the text fields. These values can be changed by directly entering new values in the text fields.

Change the X, Y, and A values accordingly to place the part in the desired location. For the A (rotation) value, every increase in 2000 corresponds to an additional 90-degrees rotation. These values have to be integers within the range from –8000 to 8000.

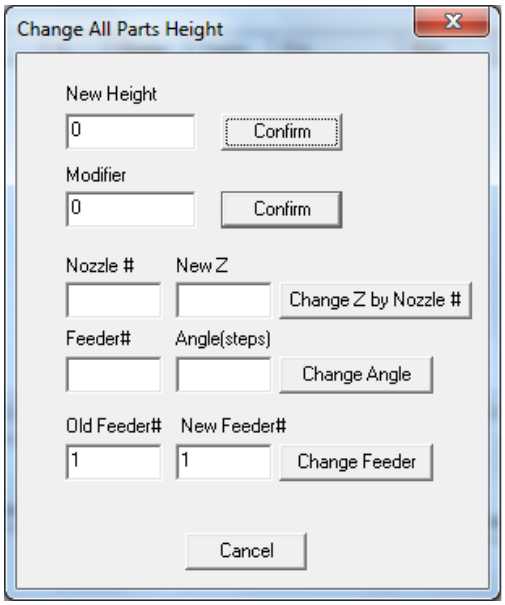
The Vision check box specifies if computer vision is used to find the correct part location. If this box is checked, a picture file has to be supplied. *Mask File* can be used to supply or change the file. The picture maybe a mark, or some item on the PCB that is close to the part to be placed.

If the SKIP check box is checked, the selected part will be omitted from the operation.

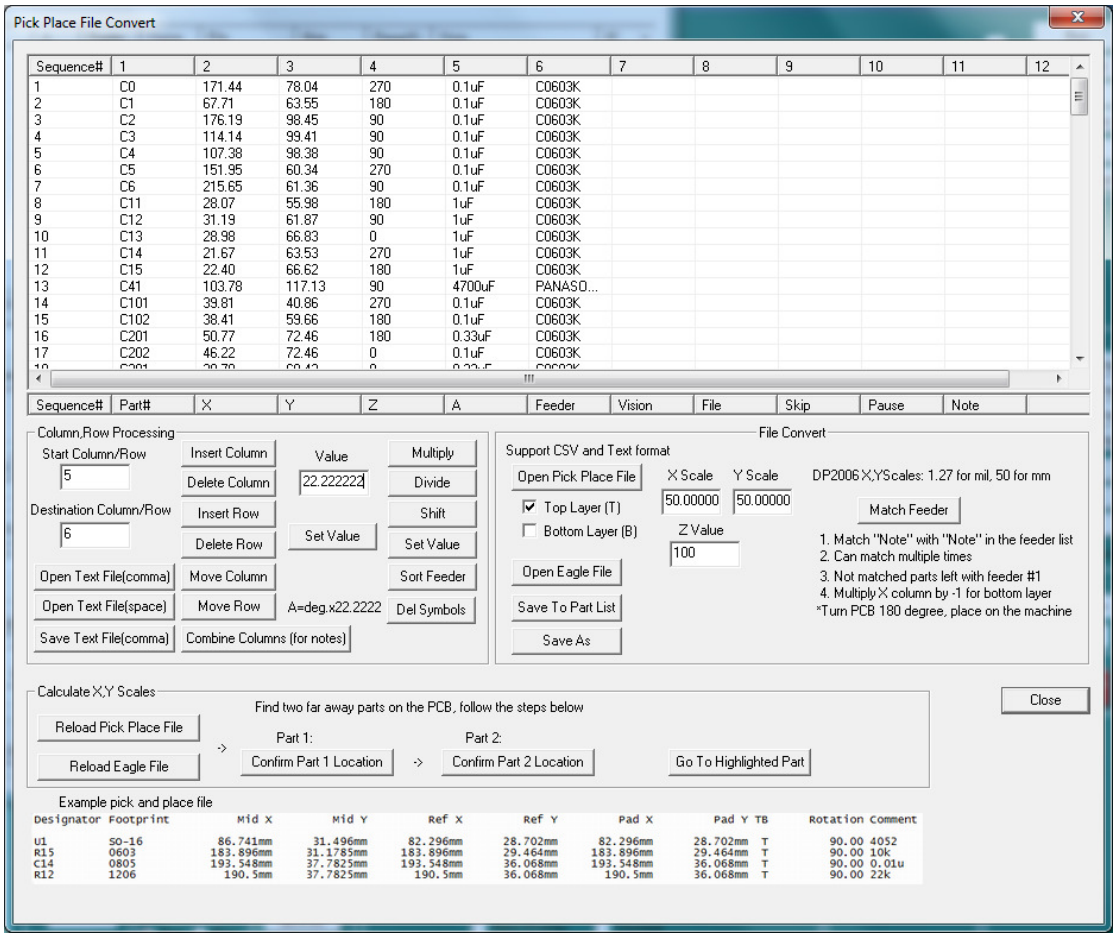
If the IC check box is checked, the up looing camera vision alignment will be processed with more strict XY and rotation thresholds.

Control buttons in the Part List window include:

- *Open*: Opens and loads a saved list.
- *Save*: Saves the current list.
- *Clr List*: Clears the entire list. A previously opened list will not be affected.
- *Pick-Place*: Picks up a part from the specified feeder and places it at the specified location.
- *Go To Part*: Moves the video camera on the pick-up head to the selected part.
- *Next Part*: Moves the pick and place head to the next part on the list.
- *Set to Current*: Sets the part's position to that of the current camera's position.
- *Add a Part*: Adds a new part to the end of the list. The part added will use the current video camera position.
- *Insert a Part*: Adds a new part to the current position on the list. The part added will use the current video camera position.
- *Delete*: Delete a part from the list.
- *Change Z, A,Fdr*: Assigns or modifies the Z, rotation values for all parts. Also can be used to change part rotation and feeders.



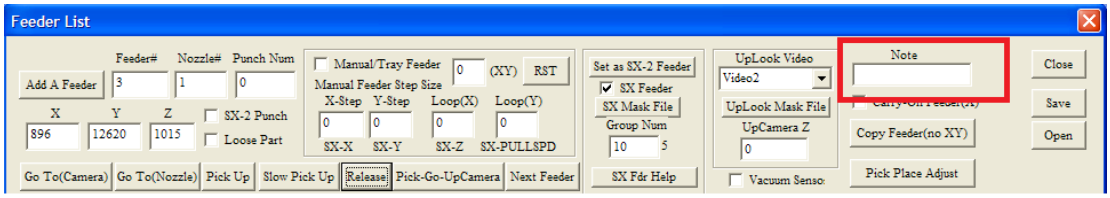
- *Sort by Nozzle*: Sort the part list by nozzles. Note: This action is not reversible.
- *Check Through:* video 1 goes through all parts automatically.
- *File Convert*: A general CAD file conversion interface will be initiated to change a third-party pick and place file to a part list that can be directly used by the machine. The third-party pick and place file can be a standard pick and place file, as shown in the window example; or it can be a Eagle PCB software generated file; or a text file.



- Most PCB design software can generate pick and place files. The generated files may contain more information than needed by the part list. Please compare the pick and place file format from your PCB software with the example. It is looks the same, you can use the "Open Pick place File" button the convert the file. This is a one click convert operation. No more information is needed.
- Feeder information is generally not supplied by the PCB software. Default feeder number 1 is used in the converted file. The correct feeder numbers have to be supplied part by part or obtained with the Match Feeder function.
- The file conversion function converts a pick-place file to a part list file by adding, deleting, modifying, or setting the values of rows or columns.
- Change rotation angle to steps by multiplying by 22.222, due to having a rotation resolution of 8000 steps per 360 degree rotation.

    - Column, Row Processing: general text processing functions.
    - Open Text File: can open comma or space delimited files.
    - Save Text File: saves text in comma delimited format.
    - Open Pick Place File: opens a standard pick and place file. The standard file format should look like the example at the bottom of the window.

- Combine Columns (for notes): some PCB software exported files contain two note fields. They can be combined to one note field if both need to be conserved.
- X Scale, Y Scale: scale values that converts the X and Y values in the pick and place file to the part list.
- Z value: the pick and place file does not provide a Z value. This value is used to fill the Z field space in the part list.
- Match Feeder: matches parts to feeders in the feeder list. The matching is performed by finding the same note text in both the converted part list and the feeder list. Enter the same text in the note field in feeder list and perform the matching process by clicking on the Match Feeder button. Unmatched feeders will be left with the default feeder number of 1.

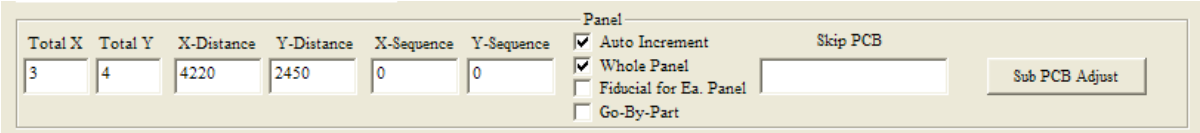


Match parts with feeders using same Note text

- Open Eagle File: Eagle generated file is different from standard pick and place files. Use this button to open an Eagle file.
- Save with Head: use this button to save the converted file to a Part list file which can be used by the pick and place software.

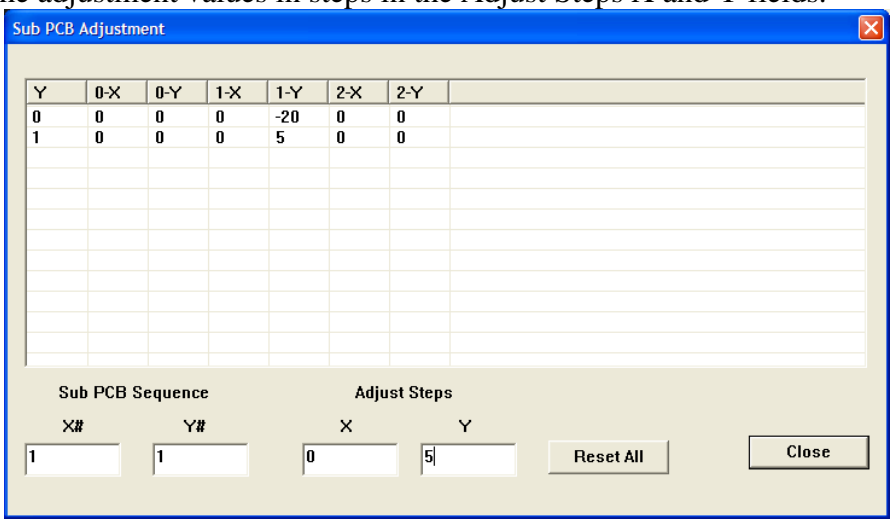
Panel:

The Panel group inside the Part List window can be used to work with panelized PCB boards.

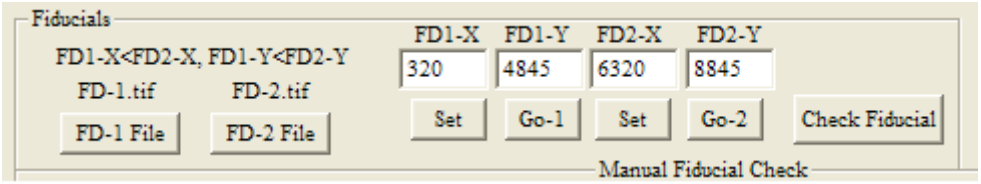


- Total X and Total Y: Specify the total number of circuit boards in the X and Y direction on the panel.
- X-Distance and Y-Distance: Specify the distances in X and Y directions between each circuit board.
- X-Sequence and Y-Sequence: Specify the current circuit board the machine is working with inside the panel. Please note that these numbers start from zero.
- Auto Increment: Specifies if the circuit board sequence should be automatically incremented after one board is finished.
- Whole Panel: Specifies if the machine should work non-stop with the whole panel.
- Fiducial for Ea. Panel: Enables fiducial correction on each circuit board.

- Go-By-Part: If this box is checked, the same part will be placed on all the circuit boards before placing the next part. If fiducial correction is enabled for each panel, it will be performed on all the circuit boards before placing starts.
- Skip PCB: Specifies if one or more circuit boards should be skipped from the panel. Type in the sequence number of the circuit board in this area, counting from 0, 1, 2 (X=0 and Y=0, X=1 and Y=0, X=2 and Y=0), etc. The sequence numbers should be separated by commas (i.e. 0, 5, 12).
- Sub PCB Adjust: sub PCB positions can be adjusted separately within this window. Type in the PCB X and Y sequence number (start with 0) in the X# and Y# fields, and enter the adjustment values in steps in the Adjust Steps X and Y fields.



Fiducials:
This group sets up fiducials on the circuit board.



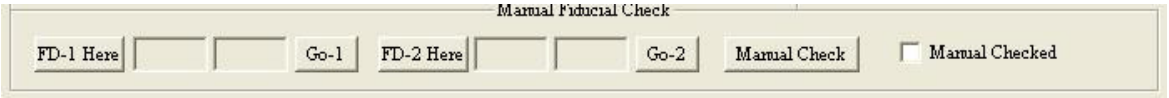
Fiducials can be used to automatically compensate circuit board position shifts and rotation. Fiducials should be set only after a complete part list is compiled. Fiducials are not checked if the Fiducial check box is not marked on the main control window, even if values are specified.

There are two fiducial marks to be specified on a circuit board or on a panel. They can be two fixed position marks on a circuit board with good contrast. Please note that silkscreen layer sometimes has shifts from the trace layer and is not accurate to be used as fiducial marks. It is better to use marks on the trace layers. The fiducial pictures must be sharp and easy for the computer vision to recognize.

Fiducial one should be at the upper right corner of the circuit board, and fiducial two at the lower left corner, if the circuit board is held vertically facing you. In other words, X and Y values of fiducial two should both be greater than X and Y values of fiducial one.

- FD-1 File, FD-2 File: specify the snapshot files of fiducial one and two.
- FD1-X, FD1-Y, FD2-X, FD2-Y shows the X and Y values of the two fiducials.
- Set: set a fiducial position to the current Video 1 position.
- Go-1, Go-2: move the machine head to the fiducial position.
- Check Fiducial: perform a fiducial check.

Manual fiducial can be performed if the automatic fiducial function fails.

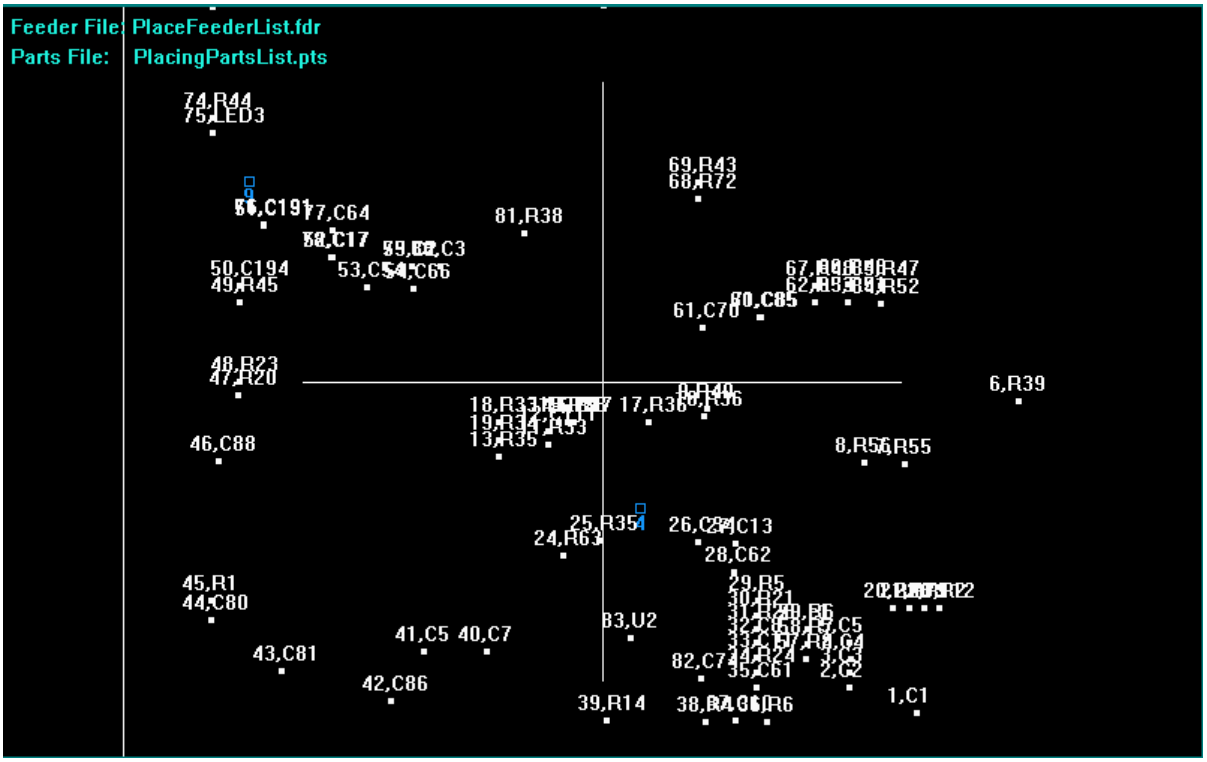


- To specify the fiducial positions: move the down looking camera to fiducial mark 1, click FD-1 Here button; then move to fiducial mark 2 and click FD-2 Here button.
- Click on the Manual Check button to perform the manual fiducial check.

Check the Fiducial box on the main software window to enable the fiducial function.

Part List Display:

The compiled part list can be displayed on the computer screen by checking the Parts Overlay button on the main software window.

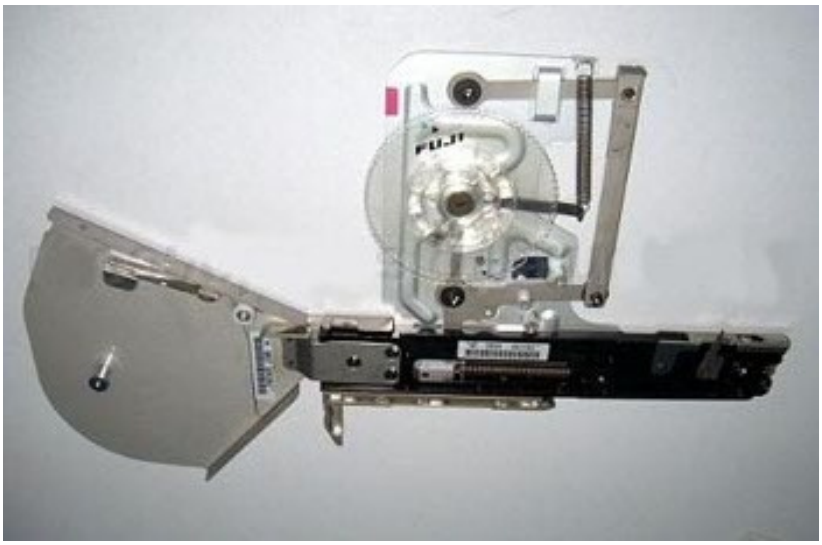


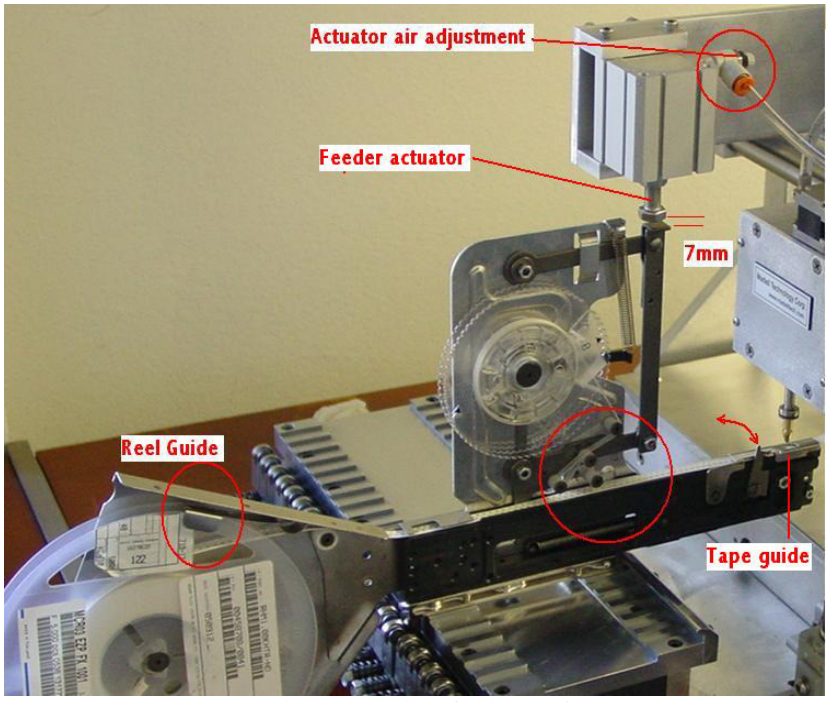
Note:

The Z value (the distance the pick-up nozzle travels) is very important for successfully picking up the part. The part cannot be picked up if the nozzle does not reach it. The part will be pushed into the tape pocket if Z travels too much. Carefully adjust this value when necessary.

Tape feeders:

PX3700 and PX3705 feeders:

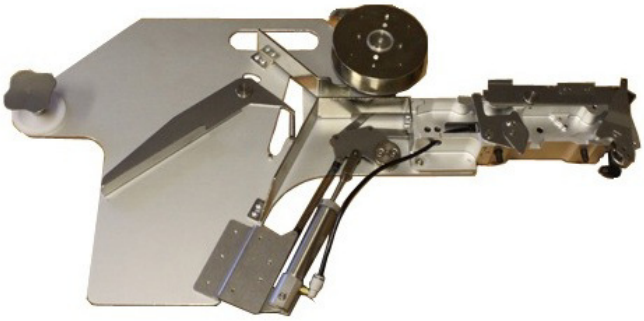


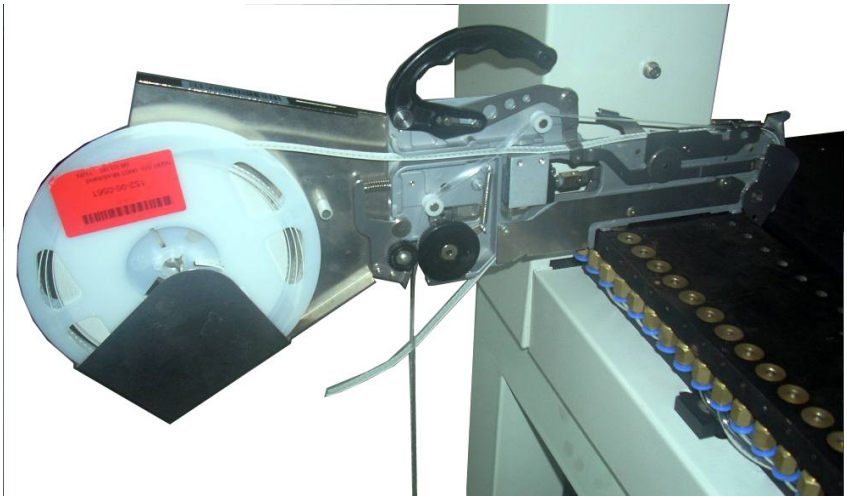


Feeder mounted on feeder carrier

PX feeders:

PX feeders are fixed index pneumatically activated feeders. These feeders are also used on some Yamaha and Philips pick and place machines.



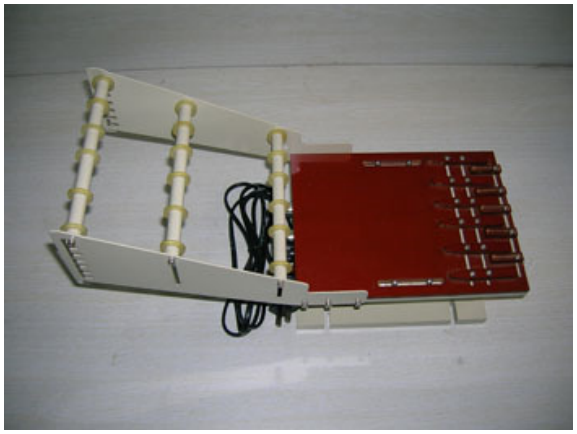


Feeder mounted on feeder carrier

a) Make sure that tape feeders are mounted on the feeder carrier securely.

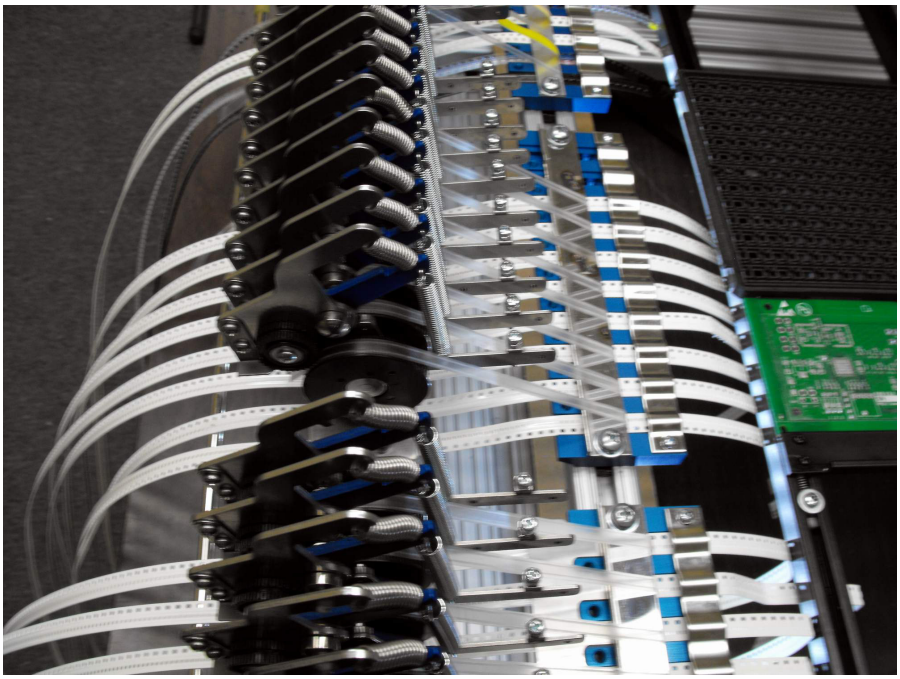
The part to be picked up should be the one covered by the tape guide, not the one already exposed. The actuator pushes the tape guide backwards so that the nozzle can pick the part up.
The tape guide is secured in position by a metal lever. It can be released by moving the lever to the back of the tape.

Adjust the compressed air supply to the actuator so that proper pressure is applied. Too much pressure will cause the feeder to shake. The actuator will not be able to forward the tape if not enough pressure is supplied.



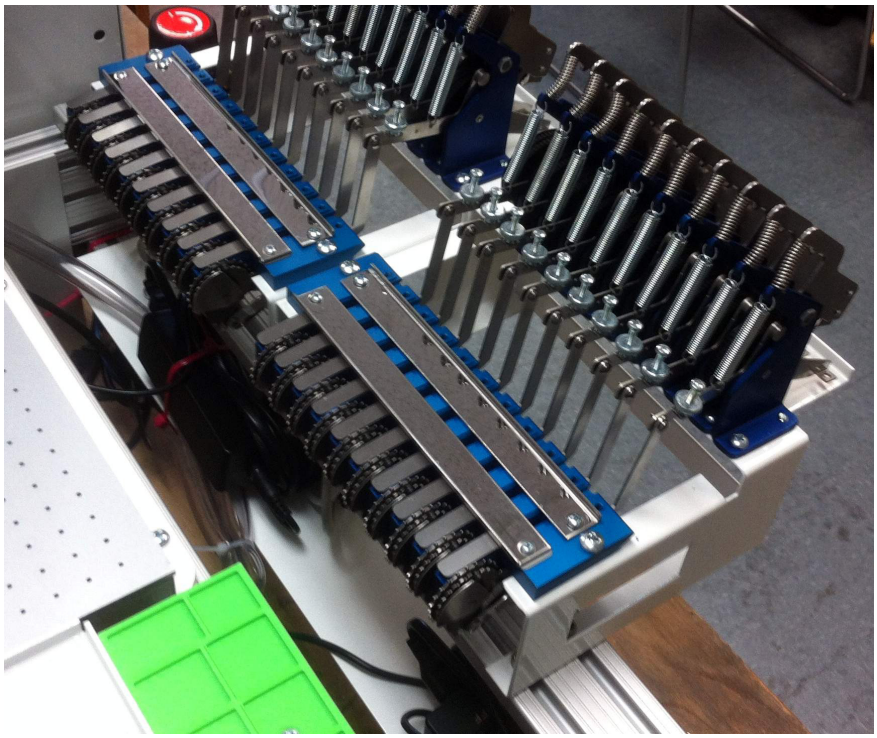
Five channel vibration feeder for parts in tubes

SX-2 Feeders:



The SX-2 feeder is the second generation of our low cost SX feeder family. With the SX-2 feeder, the tape is advanced at the same time that the part is picked up. Video 1 is used to find the part on the tape before it is picked up. The tape is peeled automatically at the pick up time. SX-2 feeders may work better for small parts than PX feeders.

SX-3 Feeders:



Module SX-3 feeders

Individual detachable SX-3 feeders

SX-3 feeders are fixed index feeders. No need to use camera to find parts on the tape before picking up. Select either PX or SX-3 feeders if you want to get a high performance machine.

PX and SX-3 are both fixed index feeders. **Differences of PX and SX-3 feeders:**

1. Price: SX-3 costs less
2. Activation: SX-3 feeder is activated by the machine head; PX feeder is pneumatically activated
3. PX is a little faster than SX-3
4. SX-3 is better for 0402 and 0201 parts; 0402 parts may pop out of the tape on the PX feeder due to the vibration caused by the air actuator. PX feeder will not work for 0201 parts
5. PX is a generic feeder used by several manufacturers: Yamaha, Philips, Madell, and some others; SX-3 is Madell's own design

Bulk Feeders:

Bulk feeders are basically tape channels that hold cut tapes. We have two types of bulk feeders:

1. Adjustable bulk feeders: can be used to hold 8mm, 12mm, 16mm, and other sized tapes. The width of the channels can be adjusted.

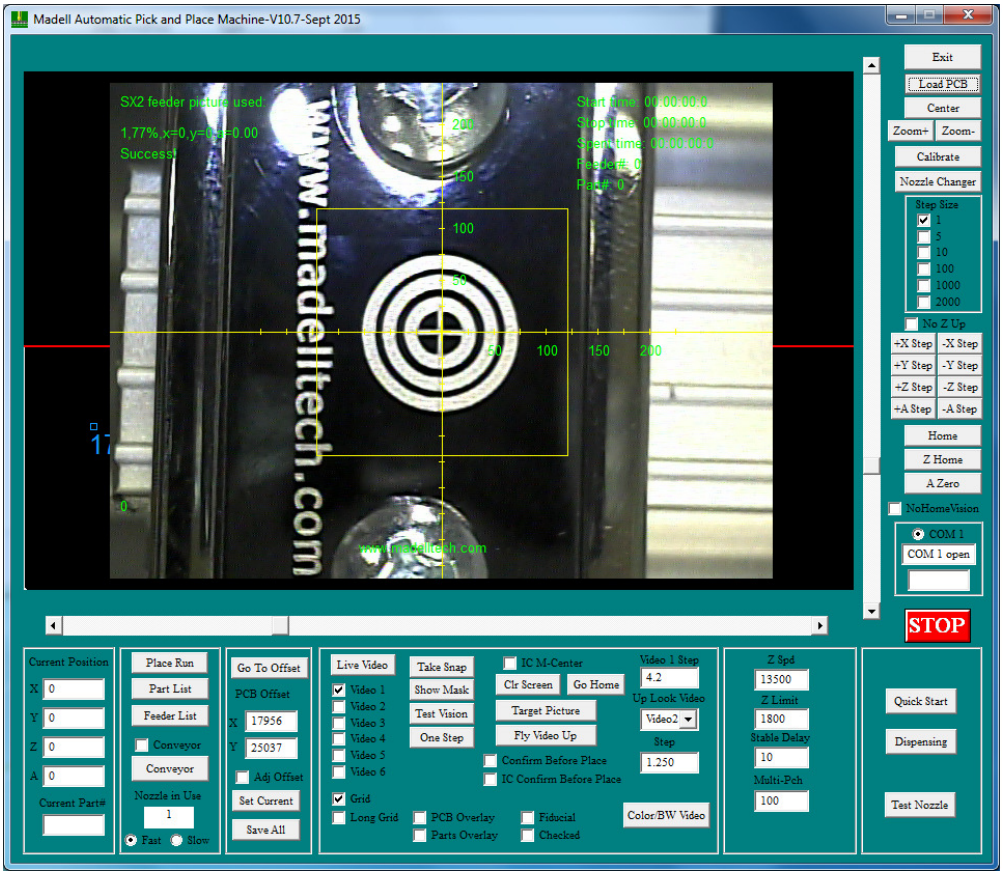
2. Fixed 8mm 5-channels bulk feeders, can be used for paper tapes only.

In the software, bulk feeders can be set up with the Manual/Tray feeder. Set them as a one dimensional manual feeder. The software will remind to replace or forward the tape manually after the specified number of parts has reached.

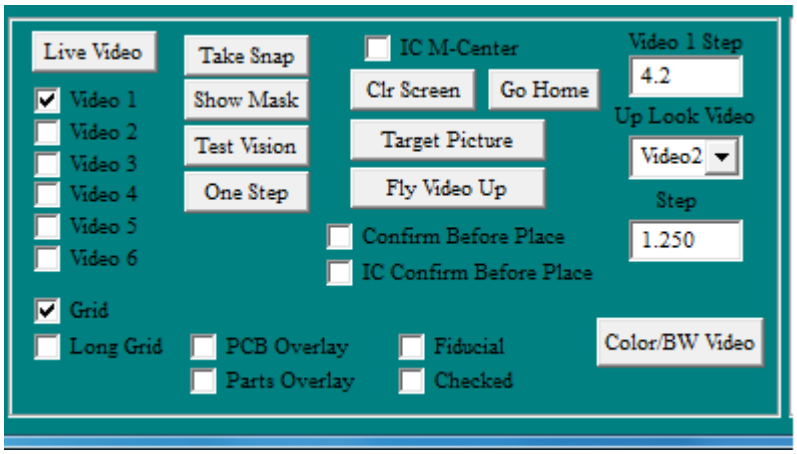
Set proper tip height and tip speed in the Pick Place Adjust window to pick up the part gently from the bulk feeders to prevent parts popping out the tape pocket.

5. Computer Vision

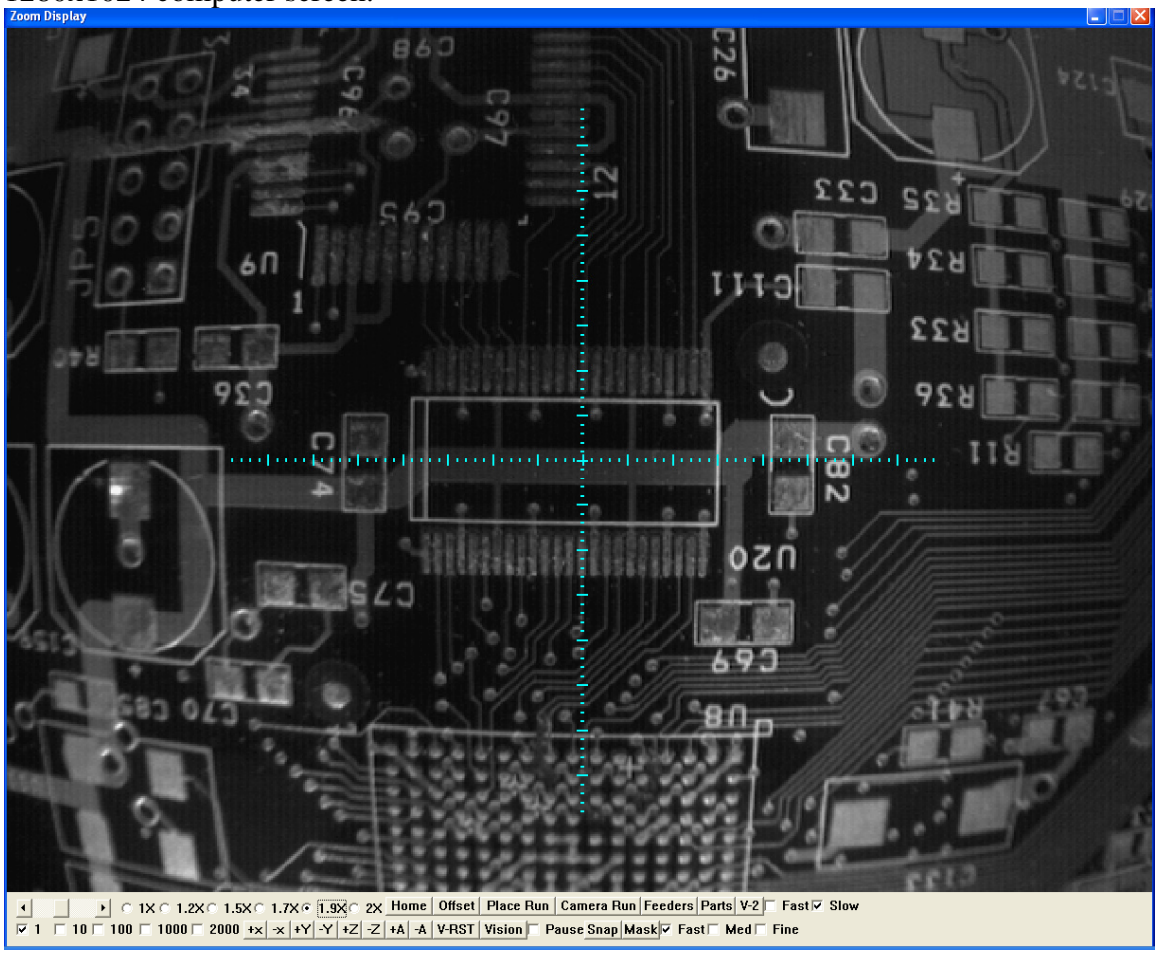
If you purchased a machine with computer vision, the program interface should look like this:



A live video is shown in the center of the display area.
The computer vision configuration and controls are on the main software window:



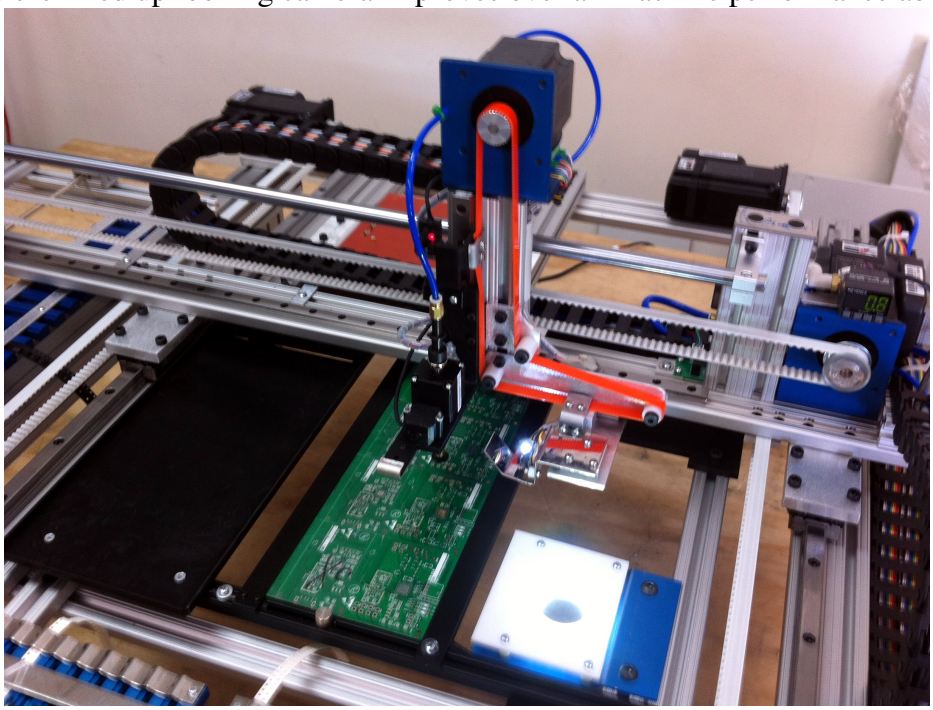
Computer Vision Controls:
Live Video: Turn on/off live video. The live video is on by default.
Video 1 to Video 6: Switches between video cameras. The software switches between them automatically (most of the) at most times.
GRID: Enable or disable the crosshair.
Long Grid: X and Y divisions are extended.
Zoom: New vision card does not support zoom. The zoom function calls the zoom display window and switches the live video to it, as shown below. The zoom display window is helpful in placing fine pitch components. It includes most of the frequently used controls. Close this window to switch the live video back to the main software window. Note that the bigger the zoom scale, the slower of the video refresh rate. Zoom rate 1.9X will fill in a 1280x1024 computer screen.



Take Snap: Take a mask snapshot. The snapped picture is saved in .tif format. All the snapshot picture files are saved under the Parts folder.

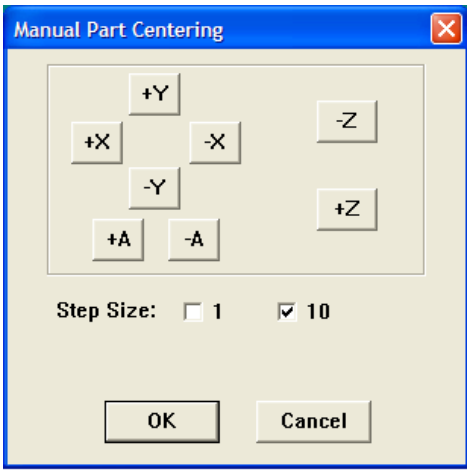
Note:
The smaller the snap picture, the faster the computer vision process. Instead of using the full component picture, a corner or edge of it can be used instead.

Show Mask: Displays a mask picture.
Test Vision: Performs a computer vision operation with the selected mask picture.
One Step: Perform a computer vision operation in one iteration
PCB Overlay: overlay the PCB graph with the semi-live video.
Parts Overlay: overlay the part list with the semi-live video.
IC M-Center: if this box is checked, manually part alignment can be performed if automatic up looking camera vision alignment fails.
Clr Screen: clean the on-screen display generated by the computer vision operation.
Go Home: moves to the optical home mark in regular speed.
Target Picture: opens the target picture window which shows computer vision alignment results.
Fly Video Up: Pick up nozzle goes up a distance as specified in the "Fly Vision Z Up" field inside the Calibration window.
Fly video is a video camera that is mounted on the machine head. The fly video camera checks on the picked part while the machine moves from the tape to the PCB, and correct the X,Y and rotation errors when the part is placed. Using the fly video eliminates of the process of going to the fixed up looking camera improves over all machine performance about 1/3.



DP2006-2 machine equipped with fly video

Confirm Before Place: the nozzle stops 200 steps above the PCB at the place location. The part can be adjusted in X, Y, rotation before placed on the PCB with the Manual Part Centering window. The software changes the part location to the adjusted X and Y values if the OK button is pressed. This is effective to all parts in the part list.



IC Confirm Before Place: similar to Confirm Before Place, but only effective to parts declared as IC in the part list.
Fiducial: check this box to enable the fiducial function.
Checked: show if fiducials have been checked or not. This box can only be unchecked, not checked. The fiducial function will check it automatically.

Video 1 Step: specify the X and Y adjustment factor for video camera 1. Note that the pick up head will jump over the correct position if this step is too big, or it takes too many iterations to get to the correct position if this step is too small. Normal value should be around 2 to 6.

Observe the computer vision displays on the upper left corner of screen. If the X and Y numbers change from positive to negative back and forth, that means the step size is too big. If the numbers keep the same sign for several iterations, that means it is too small. Try to get a step size, which almost reaches the best position in one to two iterations.

Up Look Video and Step: specify the X and Y adjustment factor for the up looking video camera specified with the pull down selection. Normal value should be around 1 to 8, depending on the camera lens.

Note: The up looking video steps can be positive or negative numbers, depending how the video camera is mounted on the machine. If you find the computer vision moves the part to the wrong directions, try to change these numbers from positive to negative, or from negative to positive.

The computer vision is used in these situations:

1. Pick up at a feeder location (camera 1);
2. Correct the part position with the up looking video camera;
3. Place the part on the PCB (camera 1).

The first two situations are specified in the Feeder List window and the last one is specified in the Part List window.

In Feeder List window, check Vision drop down box to specify if computer vision is used for the feeder and select the camera, specify the mask picture file ;

In the Parts List window, check the Vision box to enable computer vision for PCB pads, and select the mask image with the Mask File button.

About up-looking video camera:
The XY positions have to be specified before the up-looking video cameras can be used. Place the camera in a convenient location; make sure its edges are parallel to the PCB edges. Manually move the pick up head to it, switch the live video to Video 2 or another video number. Align the pick up nozzle to the center of Video 2 by watching the cross lines on the computer monitor. Click the *Set to Current* button in the Up-Looking Camera group inside the Calibrate window. This sets the up looking video camera position.

The computer vision process is a pattern matching process.
If the "Use vision w/o picture" box is not checked, a mask image must first be obtained before the pattern matching process is applied. The mask image can be obtained by:

1. Move camera one (on pick up head) to a feeder or PCB location;
2. Or pick up a part and move to the up looking camera.
3. Carefully move the part to the center of the live video picture.
4. Click on a point at the upper left quarter of the live video picture to generate an inclusive rectangle. If this rectangle is too large or small, click on another point to generate another box.
5. Carefully move the component center to the video camera center with fine steps.
6. Click the Take Snap button to save the mask picture. Give it a filename you can remember.
7. The snapshot will be displayed automatically. Close it after viewing.

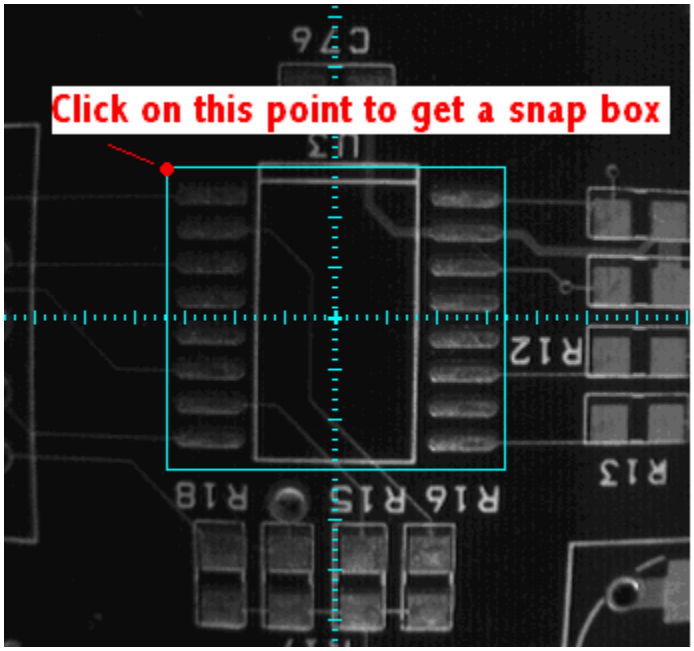
Please note that all of the mask picture files should be saved in the Parts folder under the working directory. All the files should be saved in .tif format.

Two special mask files should already exist in the Parts folder:

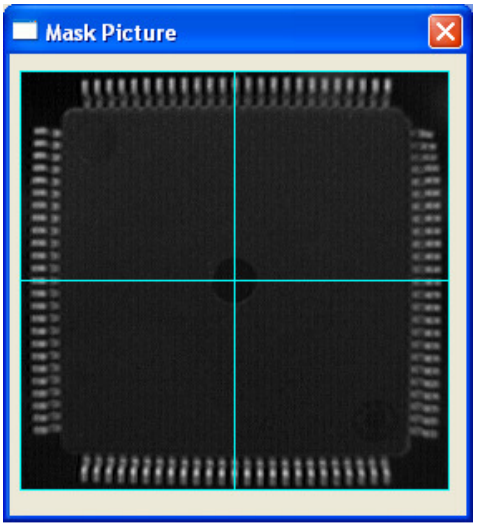
home.tif
home2.tif

The software uses these snap files to find accurate machine home locations.

i) Snapshot Pictures

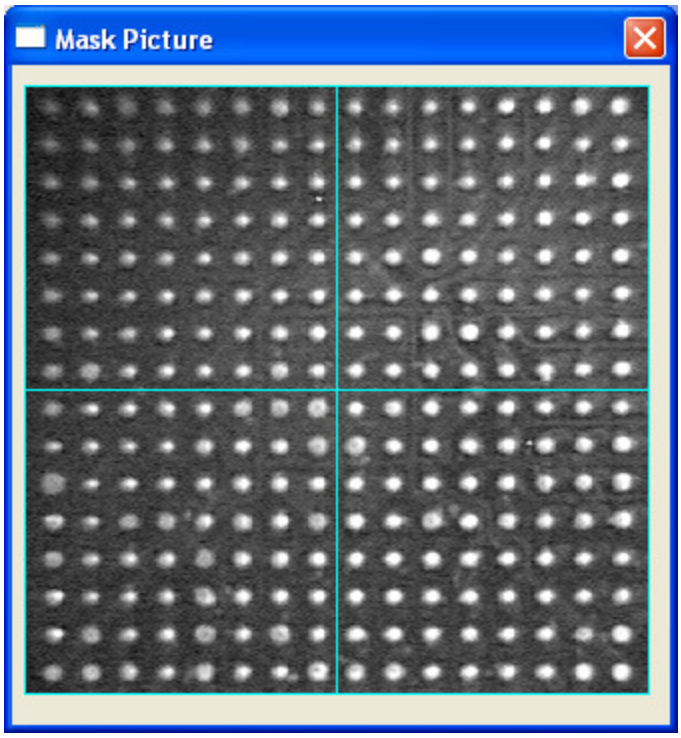


Example of PCB pads on video camera 1



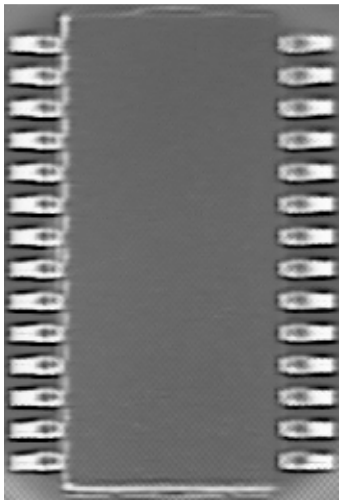
Example of bottom view of a QFP chip on video camera 2

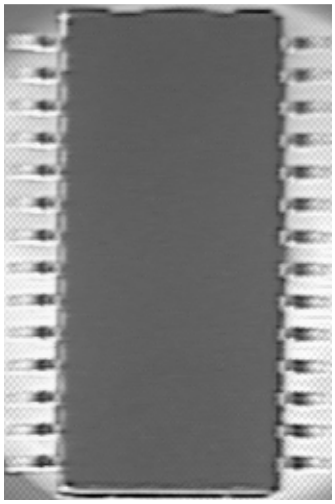

Example of bottom view of a resistor on video camera 2

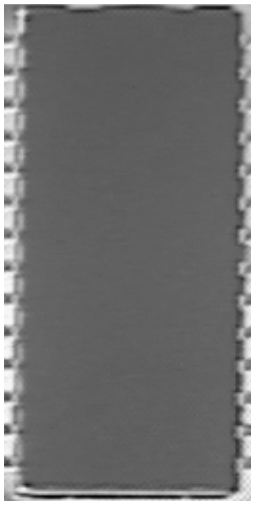


Example of bottom view of a BGA chip on video camera 2

The computer vision operation can be tested on a part by clicking on the *Test Vision* button. The part should be close to the center of the up-looking camera. The part cannot be found if it is too far from the center of the video camera. The computer vision will make X, Y and rotation adjustments (rotation adjustment only available on the up-looking camera) to move the part found to the center of the video screen.


Background mixed with IC


IC body standing out from

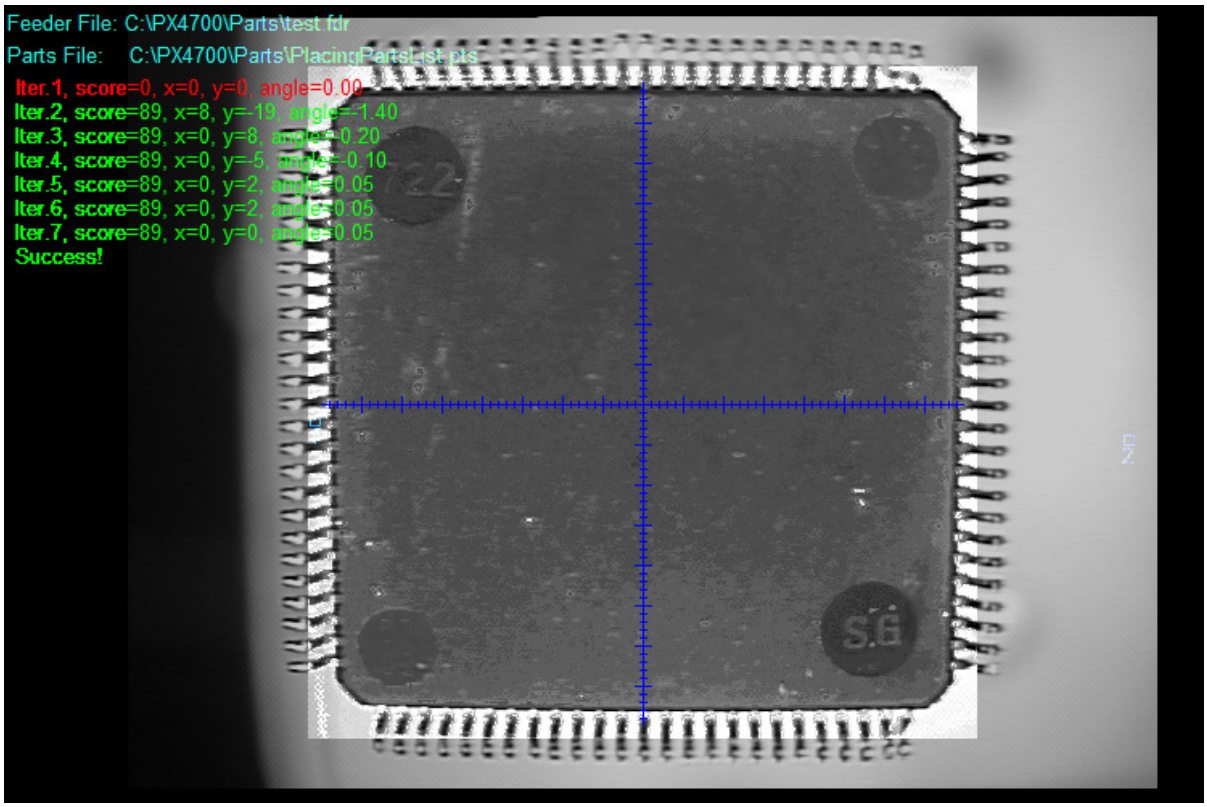

Only IC body without pins, smaller

body; not good background picture

Make sure that the IC body has enough contrast with the background to perform better, as shown in the middle picture above in contrast with the left one. It may help to paint the nozzle disc to white. Also, it is not necessary to include the pins when taking an IC snapshot, and smaller pictures like the one on the right allow for faster calculations.

The lighting condition is extremely important for the success of the computer vision process. The mask pictures should be obtained at the same lighting condition of normal operation. Try to keep the lighting condition constant and stable when working with it.

If the computer vision can not find the correct home position or other parts as required, check the pictures and take new ones if necessary.



The picture of the snapshot is overlay with the real time video. We can see that the part is accurately aligned with the picture after the computer vision correction.

ii) Computer vision displays

The computer vision matching results are displayed over the live video and also in the Target Picture window. Its format is like:

Iter.1, score=96, x=-13, y=112, angle=0.85

Iter.: Iteration sequence number. The computer vision continues until it finds a best match or reaches the pre-set iteration limit.
Score: The matching score of the real time video with the snapshot. The best matching score possible is 100. The color is green if the matching score is greater than 80 and red otherwise. Try to get higher scores by taking various snapshots, adjusting the light and focus.
X: The *x* direction movement in this iteration.
Y: The *y* direction movement in this iteration.
Angle: The rotation in this iteration.

Pay attention to the signs of X and Y values. They reflect the movement of the alignment process. Also you can tell if the vision step values are reasonably set by looking at the X and Y values. If the X or Y values change signs back and forth too frequently, it means that the step size is set too big. If the sign stays the same for a few iterations, it indicates that the step size is too small. Try to adjust the step sizes so that it takes the computer vision the least number of iterations to reach the matched location.

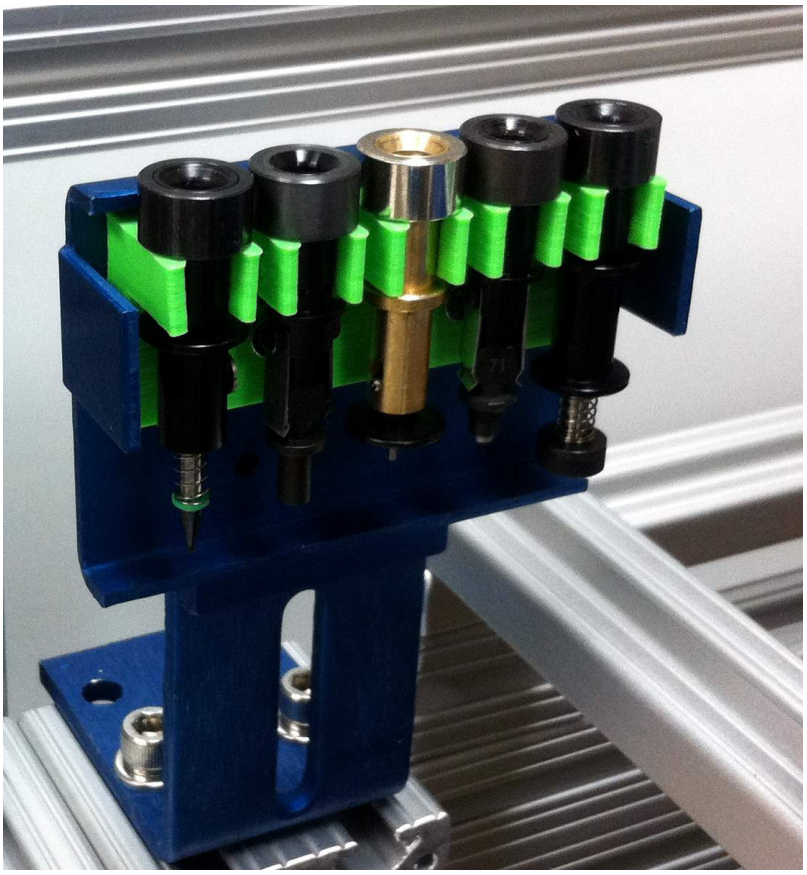
The yellow rectangle shows the computer vision searching area.
The yellow "+" symbol shows the part's center location before computer vision correction.

Click on the *Clr Screen* button to clean the computer vision outputs on the screen.

Recommendations for placing fine pitch components

- Make sure the vacuum is strong enough.
- Use the biggest nozzle possible.
- Make sure the nozzle tip is flat or put a rubber cup over the tip.
- Set the Z value so that the part barely touches the board; do not push on the PCB too much.
- Slow down the Z release speed when troubleshooting.
- If necessary, check the IC checkbox inside the Part list to use the special IC X, Y, Z speeds and blowing delay time.
- Make sure to pick up the part from the center. Otherwise one side of the IC may be higher or lower than the other side, and it may cause a small shift when the part is placed.

6. Auto Nozzle Changer



One version of our automatic nozzle changers is shown in the above picture.

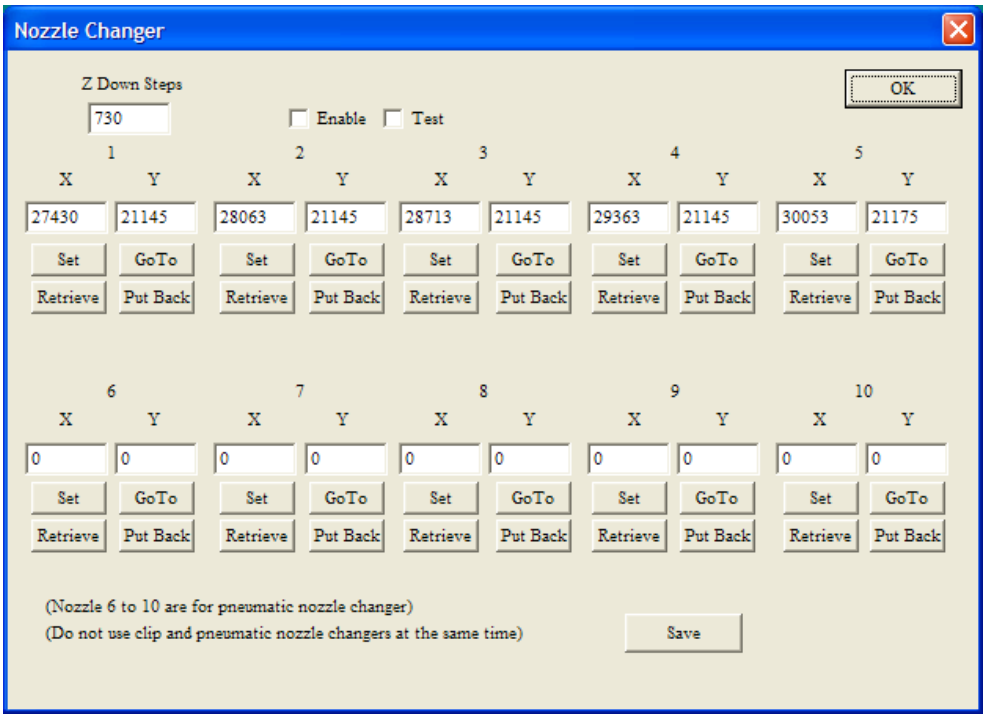
Make sure that the lock pin is in front of the nozzle changer when the nozzle is placed on the changer. The vacuum pipe on the head rotates when a nozzle is being picked up. The side clip blocks the pin while it rotates. This ensures that the nozzle is always at the same angle relative to the head. This is important for consistent performance of the machine.

The automatic nozzle changer can be configured inside the Nozzle Changer window.

Nozzle:

Proper nozzles are extremely important to the final results of a PCB assembling job. Please see available nozzles on our website.

Nozzles should be selected to provide the maximum vacuum for the part. Nozzle qualities vary with the cost of the nozzles. Generally speaking, our clip nozzles are better than the steel pipe nozzles for 0402 and bigger resistors and capacitors. The special one piece IC nozzle should be used for big IC chips. It has better air sealing achieved by the O-ring on the nozzle tip.



A total of ten nozzles are supported by the software. Actual number of nozzles equipped on the machine varies depending on the machine model and customer selections.

Down: Specify how far the Z-axis travels down to change the nozzle.
Up: Specify the nozzle stage height. **This value normally should be zero for our newest design of nozzle changer, and between 200 to 300 steps for old designs.**
Enable: Enable the auto changer. Manual operation will be used if this box is not checked.
Test: Check this box when the auto nozzle changer is being set up. The machine stops several times during either the Retrieve or Put Back process. This gives the chance to back out when the nozzle position is not correct.
X, Y: Specify the nozzle positions.
Set: Set the nozzle holder to the current position.
GoTo: Move the machine head to this nozzle holder position. **Make sure the nozzle is not attached to the machine head. Otherwise it may hit the nozzle changer accidentally.**
Retrieve: Perform a nozzle retrieve operation.
Put Back: Place the current nozzle on the holder.

Note: make sure that the displayed nozzle number in the "Nozzle in Use" field on the main screen matches the nozzle changer. For example, if nozzle #1 is displayed in use, nozzle changer position one should be empty. Otherwise collision will occur and the rotation motor shaft may be bent.

Please be very carefully when the nozzle changer is being set up. Make sure that the Test checkbox is checked. It is better to take off the nozzle from the head and let it sit on the nozzle changer. Aim the vacuum pipe carefully over the nozzle; set the Z-axis values in 100-

step intervals to try several times to see if the pipe can go into the nozzle smoothly. Then uncheck the Test checkbox and try again. Remember to save a copy of the NozzleChanger.ini file, which stores the nozzle changer parameters.

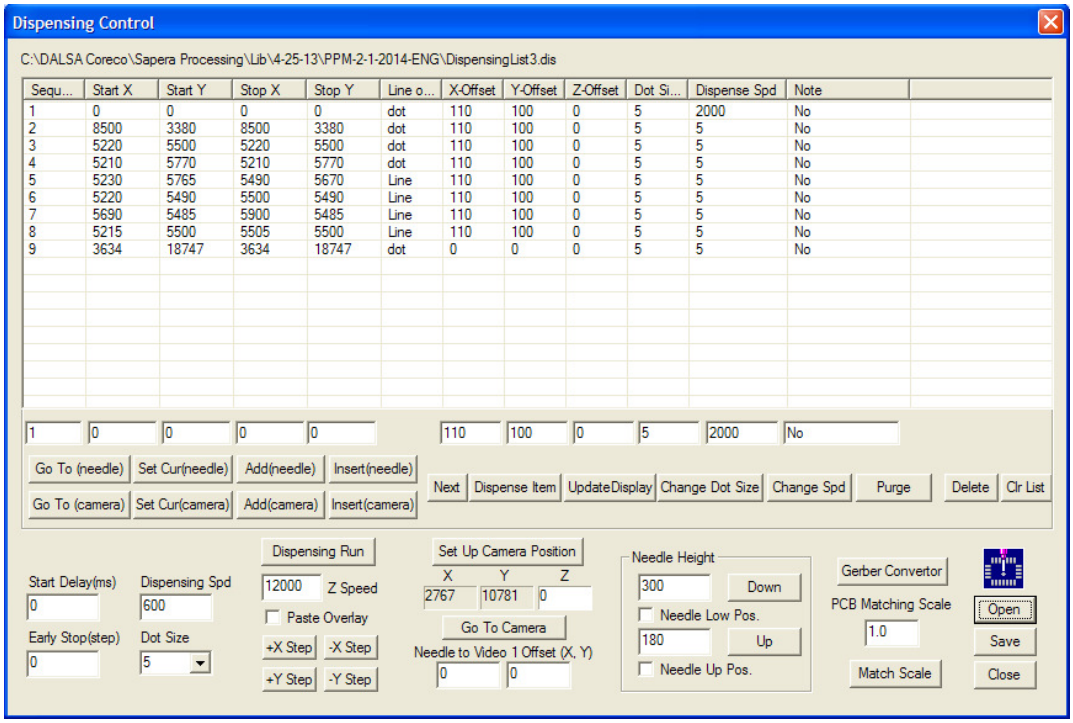
If the automatic nozzle changer is enabled, the machine will automatically change nozzles as specified in the Feeder window. If it is not enabled, the pick-up head will move to nozzle hub position specified inside the Calibrate window and wait for the operator to change nozzles.

7. Paste Dispensing

Read the following section if your machine is equipped with the paste dispensing option. You may purchase one or two dispensers for your machine.
Please note that paste dispensing is much slower and more difficult to achieve fine pitch results than stencil printing. It is not recommended for production.

Note: if this is the first time you use the dispenser, do not mount the solder paste syringe at this time. Get familiar with the software and the machine before doing that.

Open the dispensing control window by clicking on the dispensing button in the main control interface.



Dispensing window

The dispensing table contains the following items:

- The start and stop X and Y locations in machine steps.
- Line or dot.
- X and Y offsets, which shift the dispensing locations.
- Dot size: specify how long the dispensing needle will stay at the position
- Dispense Spd: how fast the needle moves in machine steps
- Note: any text

Controls in the dispensing window:

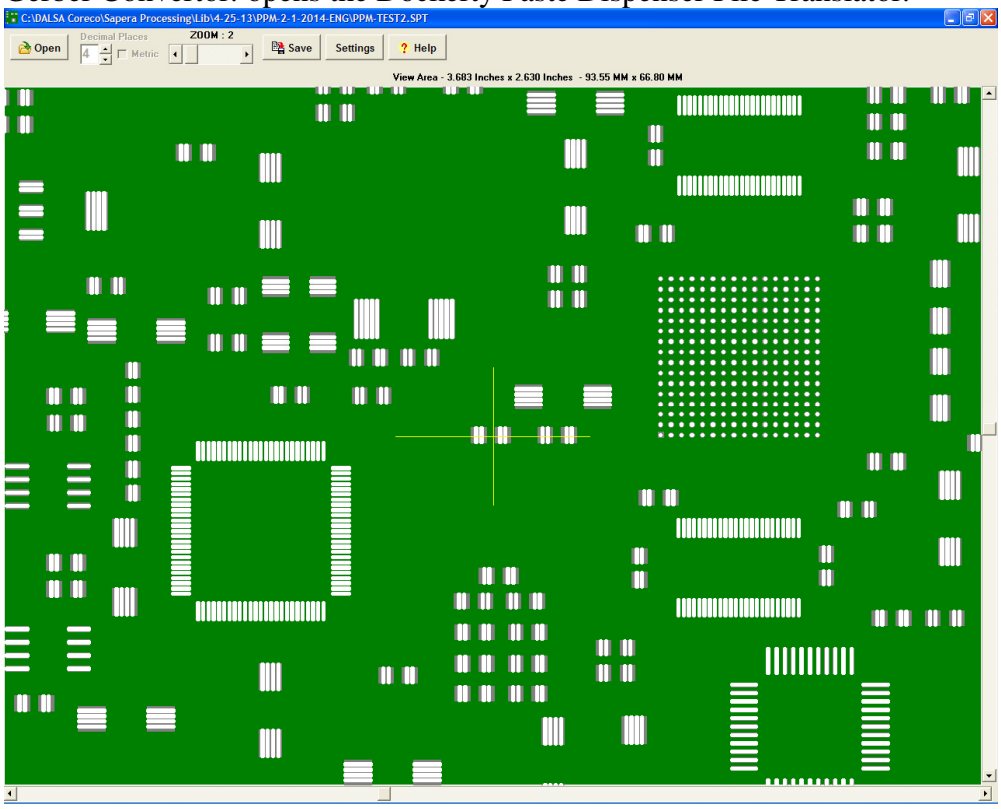
- Go To (needle): moves the dispensing needle to the selected item XY position.
- Set Cur(needle): set the item to the current needle position.
- Add(needle): add a dispensing item at the current needle XY position.
- Go To (camera): moves video 1 to the selected item XY position.
- Set Cur(camera): set the item to the current video 1 position.
- Add(camera): add a dispensing item at the current video 1 XY position.
  (the above camera functions are correct only after the Needle to Video 1 Offset values are set correctly)
- Next: moves to the next dispensing item location
- Dispense Item: performs dispensing for the selected item.
- UpdateDisplay: update the graphics display.
- Change Dot Size: change the dot size of all the items.
- Change Spd: change the dispensing speed of all the items.
- Purge: applies compressed air to the syringe.
- Delete: delete the currently selected item.
- Clr List: clear the entire list. The saved list will not be affected.
- Start Delay(ms): a delay after the needle moves to the down position. This gives the syringe sometime to push the paste out.
- Early Stop(step): the compressed air is cut off so many steps before the movement reaches to the end of the dispensing line.
- Dispensing Spd.: machine moving speed while dispensing. The value is machine steps per second. The smaller of this number, the slower.
- Dot Size: dispensing dot size. The smaller of this number, the smaller of the dot size. This number actually controls how long the needle stays in the down position while the compressed air is applied to the paste syringe.
- Dispensing Run: dispenses the whole list.
- Paste Overlay: displays the list in the graphics window.
- +X, -X, +Y, -Y Steps: modifies the X and Y Offsets. The step size is determined by the step size selection in the main window.
  Use these offset values to align the dispensing list with the PCB.

- Set Up Camera Position: when the needle is above the up looking camera, click this button to set the position. The X, Y and Z values are shown in the corresponding fields.
- Go To Camera: click on this button to move the needle over to the up looking camera.
- Needle to Video 1 Offset (X,Y): offset values from the center of video 1 to the dispensing needle.
- Needle Height:
  The first number shows the set position when the needle travels down. Dispensing is preformed at this level. Clicking the Down button moves the needle to the down position. Check the Needle Low Pos. box and click +Z or –Z to adjust this position.

  The second number shows the up position. This position is useful only when in continuous dispensing mode. The needle rises to this level, instead of going all the way up to the machine up limit. Clicking the Up button moves the needle to the up position. Check the Needle Up Pos. box and click +Z or –Z to adjust this position.

  Note: The software will issue a warning message if the down position is greater than the Z Limit. Fist enter a greater Z Limit value, and then adjust this position.
  Both the Down and Up positions can be changed by directly typing in different values.

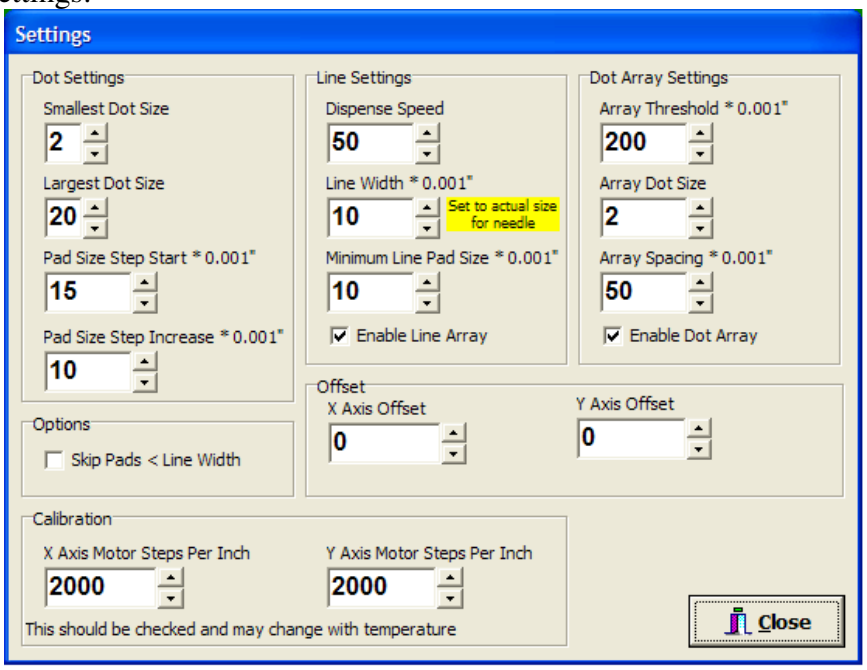
- Gerber Convertor: opens the Dockerty Paste Dispenser File Translator.



This is a 3rd party software that can directly converts your PCB Gerber file to a paste dispensing list.

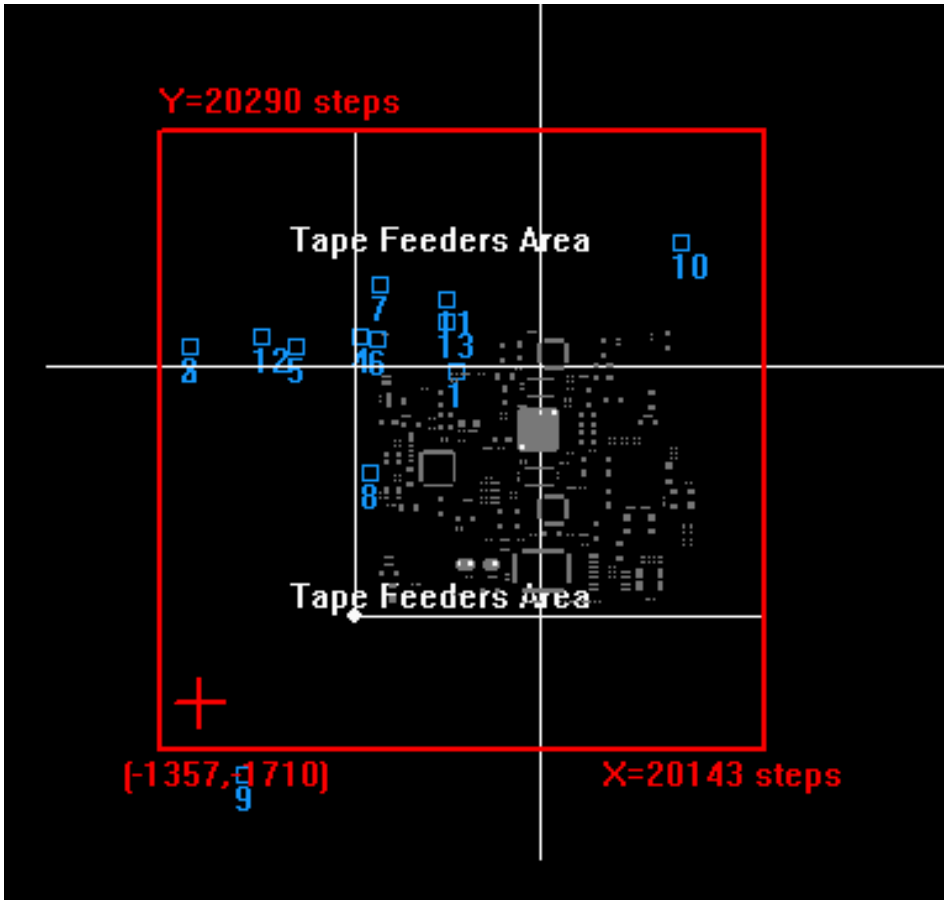
Controls in the paste convertor software:

1. Open: opens a Gerber paste Gerber file
2. Zoom: zooms in or out of the graphics display
3. Save: saves the opened file to a paste list file
4. Settings:



The settings affect dispensing dot sizes and trace width; leave the Calibration to the default values of 2000 steps per inch. These calibration values affect the scaling of the Gerber data to the pick and place machine steps. The scaling can be changed in the paste control window with the PCB Matching Scale value below.

The converted paste list can be loaded to the dispensing control window with the Open button. It can be viewed on the main screen graphics area by check the "Paste Overlay" button. Also the live video needs to be turned off by clicking on the "Live Video" button. The Zoom+ and Zoom- buttons can be used the change the dispensing list graphics viewing fields.

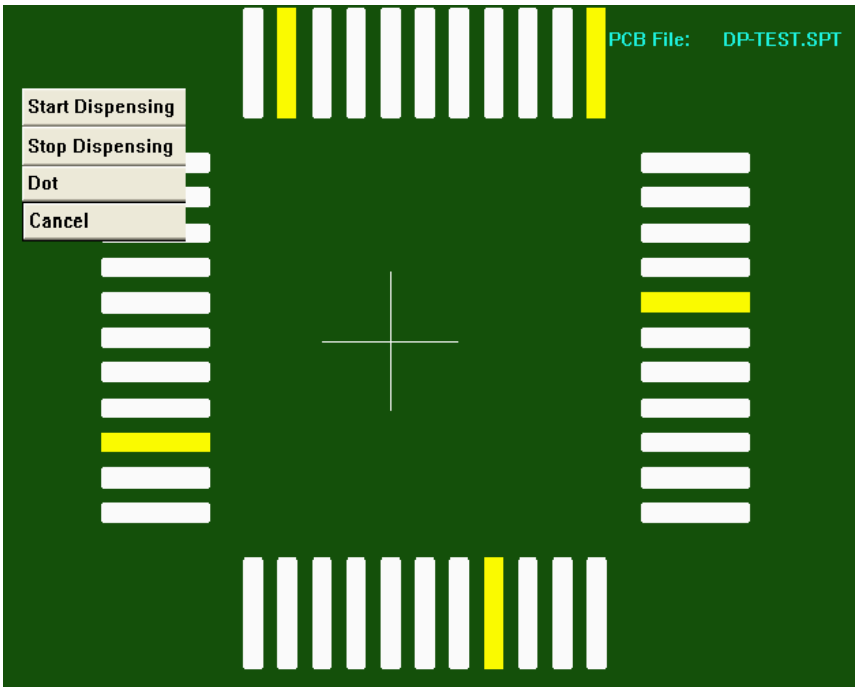


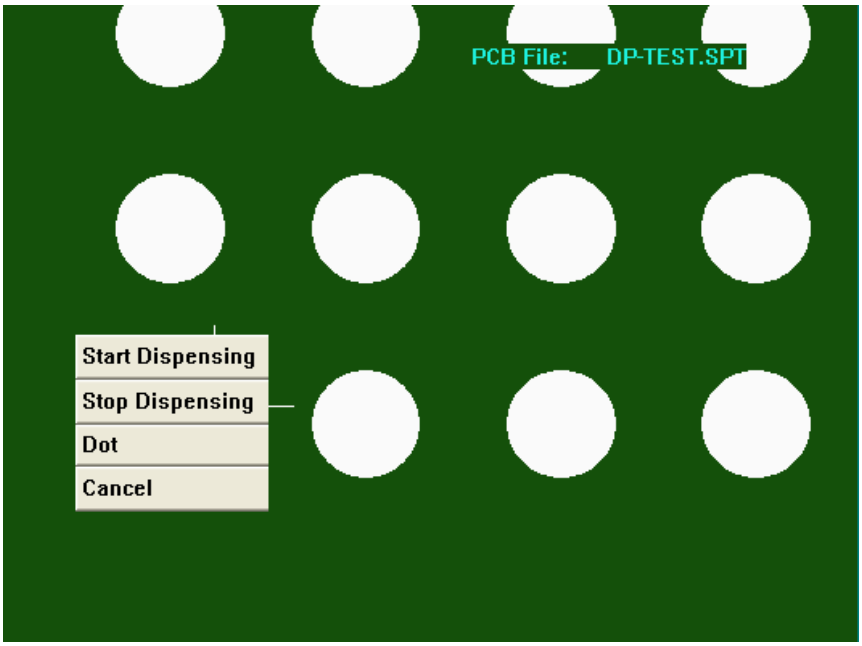
- PCB Matching Scale: this number scales the converted paste list to the actual PCB. The value can be changed directly by typing in a new value.
- Match Scale: click this button to make the new matching scale value effective.
- Open: open a saved list.
- Save: save a list.
- Close: close the dispensing window.

Generating a dispensing list On the Screen

Dispensing list can be generated directly on the PCB design displayed on the computer screen. There are two major types of dispensing items: lines or dots. They are generated similarly.
Click the “Live Video “ button on the main screen to shut off the live video. Click on it again to bring the live video back.

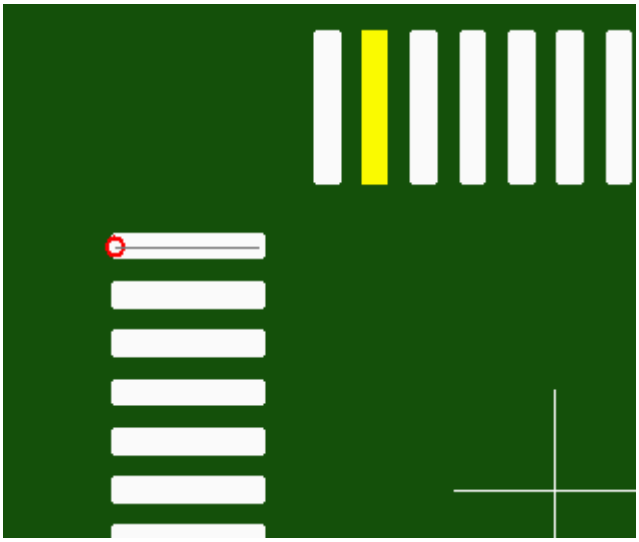
When the dispensing control window is open, click the left mouse button on a point where a dispensing line starts, or a dot needs to be placed, then click on the right mouse button, a selection window shows as the following pictures:



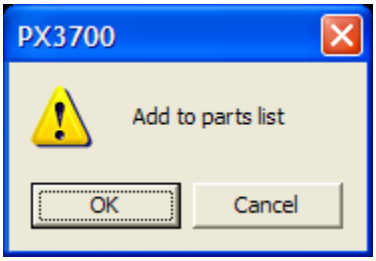


Selecting the Start Dispensing to start a solder paste line, or selection Dot to dispense a dot at the current location.

If the Start Dispensing is selected, a red circle shows at the start location with a gray line connected from the red circle to the current mouse location. The gray lines moves with the mouse.



Click the left mouse button at the dispensing stop location. The selection window shows up again. Selecting the Stop Dispensing option to complete a dispensing line. Another small window pops up:

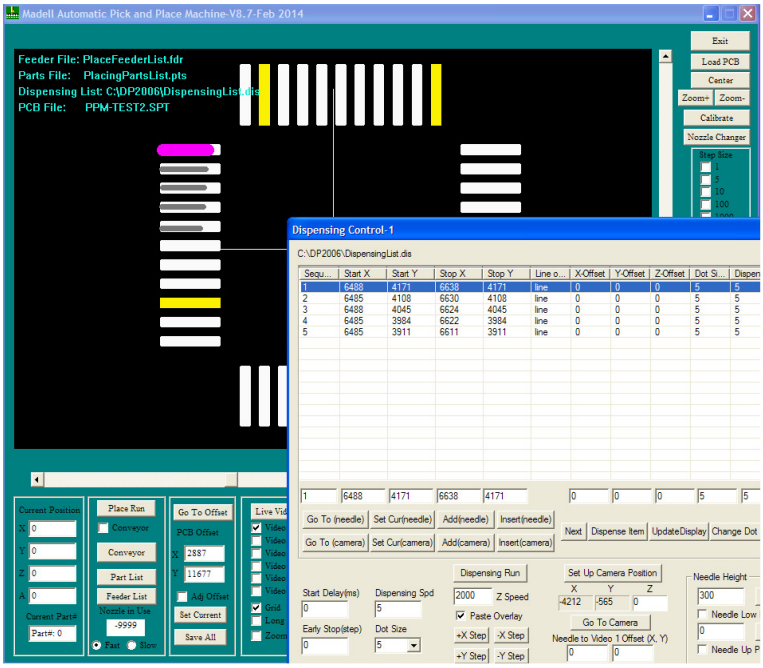


This small window also shows up if Dot is selected at the dispensing start location.

Click Ok to add this new generated dispensing item to the list, or Cancel to discard it.

The dispensing list shows the dispensing start and stop locations, line or dot, dot size, and more information. The edit boxes below the list correspond to the highlighted item in the list. Double click on a dispensing item, or type in the sequence number in the first edit box, to show the data in the edit boxes. The corresponding values can be changed by directly entering new values in the edit boxes.

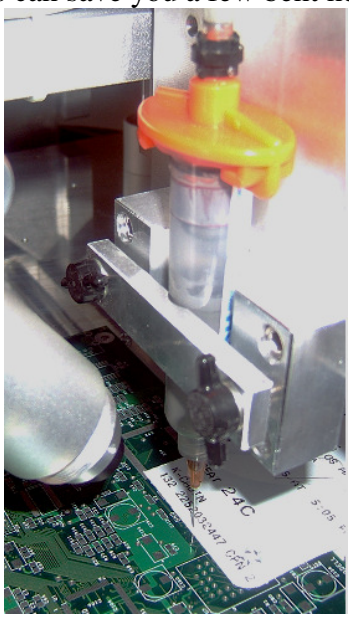
Click on a dispensing item in the list makes the item changes to pink color in the displayed graphics.



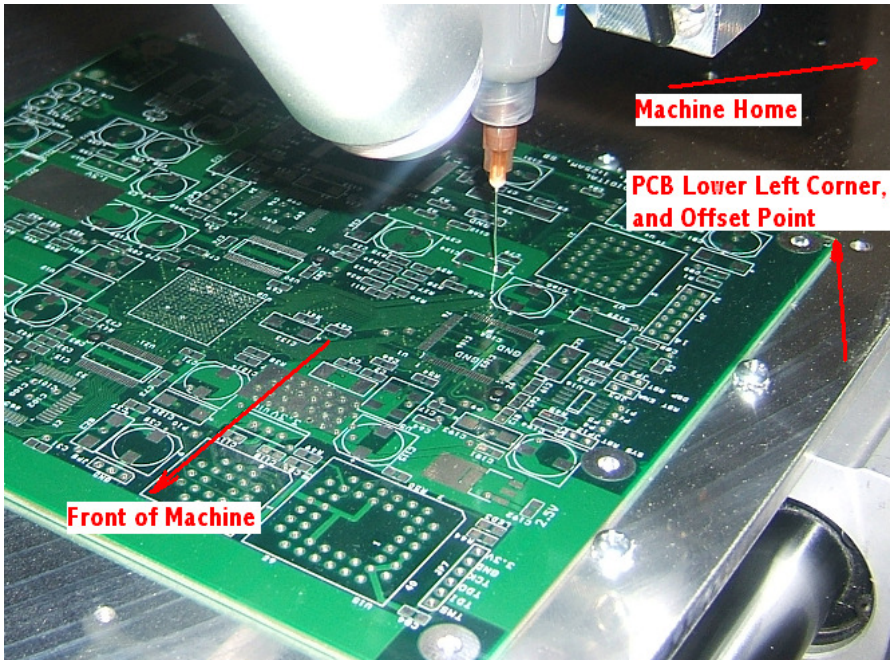
Syringe Mounting

After getting familiar with the machine and software, a syringe can be mounted to do some testing.

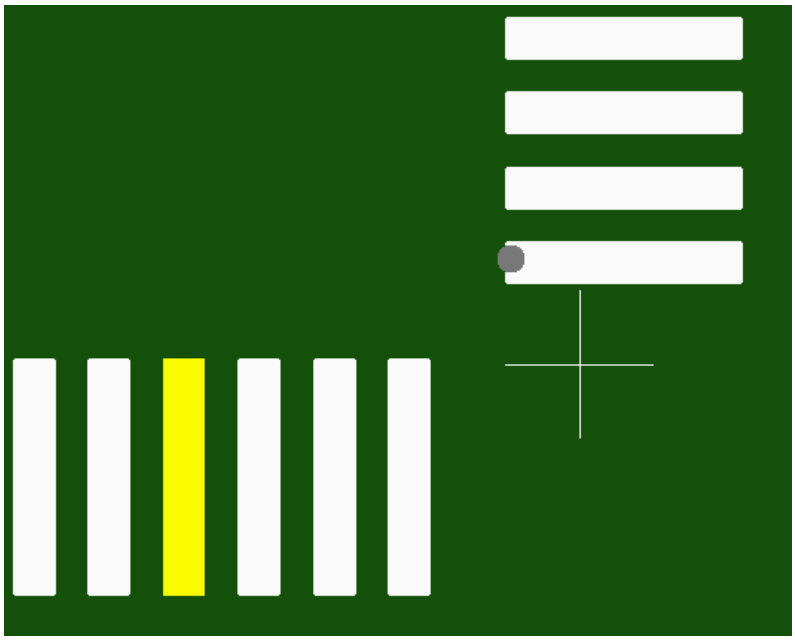
The syringe should be mounted when the Z direction is at the down position. Click the Down button in the needle height group to do this. Find a piece of thick paper or a thin credit card, place it on the circuit board; hold the syringe with the needle to be used on it; tight the screws on the syringe mounting adapter. Do not tight too much. It is better that the syringe can still move up and down in trials. This can save you a few bent needles.



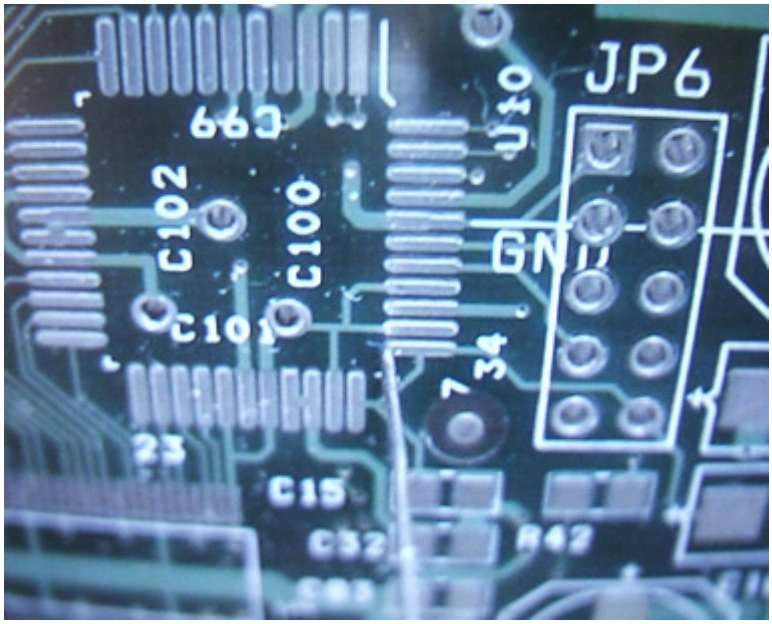
The circuit board should be placed on the platform parallel to both the X and Y axis.



Loading the Gerber file into the program. Click with the left mouse button on some specific points, and check if the needle moves to corresponding positions on the board.



Click on a specific point on the computer display.



Check on the video monitor if the needle moves to the corresponding position on the circuit board. If not, adjust the PCB Offset values with the +X, -X, +Y, or –Y step buttons while the Adj. Offset box is checked. Uncheck the Adj. Offset box after adjusting the offset.

Paste Dispensing Adjustments

1) The following settings will affect dispensing results:
   a) The compressed air regulator setting on your air compressor.
   b) Pressure setting of the dispenser valve that determines the amount of force applied to the paste syringe.
   c) Dispensing speed for lines and dot size, which are set in the software.
   d) Needle size.
   e) Solder paste grade. Solder paste has different ball sizes which can be observed under a microscope. Consult with the paste manufacturer about this.

2) The settings will require some experimentation to arrive at the proper performance, but once found and documented they should be repeatable.
3) The paste syringe should be stored in the refrigerator (not the freezer) if it is not used for a while (days). Place it in vertical direction to prevent air bubbles. Use the supplied cap to seal the front outlet.
4) Use pre-filled syringes only. Self-refilled syringes normally contain air bubbles. They are not recommended for fine pitch applications.

Needle Height Adjustment

Besides air pressure, needle size and needle height are also critical factors in dispensing quality. Generally speaking, the distance from the needle tip to the circuit board should equal

the needle inner diameter. The needle will smear the new dispensed paste if it is too close to the circuit board. The paste will be pulled up if the needle is too far from the circuit board. Paste will not come out if the needle diameter is too small.

Dispensing
There are two choices in the software to dispense paste.
1). Dispense only one item: this is achieved by clicking the Dispense Item button in the Dispensing window. It dispenses only the highlighted item. It may be necessary to re-dispense some points if they are missed in the first time.
2). Dispensing a complete list: this is achieved by clicking the Run Dispensing button on the software.

Trouble shooting in dispensing
No paste coming out of the needle:

a). Check if the needle is clogged.

b). Try a bigger needle.

c). Check air pressure on the air compressor and QK982B dispenser controller. Higher air pressure can be used in the beginning and adjust it smaller once paste comes out smoothly.

8. Machine Maintenance

Lubricate the lead screws and precision slides on all the X, Y and Z axes from time to time with high quality grease.
Check loosed screws and nuts.
Check if the two Y axes are parallel.

Check and tight the X and Y axes lead screw holding nuts periodically if the machine is suspected not accurate. They should be checked when you just received the machine. It may get loose during shipping.

9. Troubleshooting

1. If the machine does not move at all: check RS232 serial cable connection, power supply to the machine control box, stepper motor cables.
Also the RED emergency button (if installed) should be in the UP position. The machine will not move if this button is pushed down.
2. Home positioning problems: check if X, Y and Z home switches are working correctly.
3. Contact us for technical support.

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