Automated Production Equipment, Inc.

LIBERTY BANDIT SERIES

SMD-7500 SMT/BGA/Chip Scale
Placement and Rework System

OPERATOR'S MANUAL

Revision 3 November 3rd, 2004

APE.com

IMPORTANT PLEASE READ THE FOLLOWING STATEMENT

The responsible body shall be made aware that if the equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

A.P.E. LIBERTY BANDIT™

OPERATOR'S MANUAL

Contents:

1. INTRODUCTION

The A.P.E. LIBERTY BANDIT™ SMD-7500 combines precision visual alignment with top and bottom preheat (option)/reflow for complete rework processing of SMT, BGA, and Chip-Scale components. The LIBERTY BANDIT is the next, generation of rework systems, designed for the new world of chip-scale packages, as well as traditional fine-pitch SMD components. Its split-vision alignment utilizes the latest technology in optical engineering and alignment design. It provides absolute control in positioning all ultra-fine pitch QFP, CSP, and µBGA components, together with large ceramic or plastic BGA devices. The heart of the vision system is the Dichroic Alignment Beam Image Splitter (DABIS), a contemporary innovative refinement in imaging dual fields to enhance and complement the processed image.

The heating system incorporates the best features of the popular and proven Flo-Master™ high

power/low temperature rework system, providing controllable top and bottom heating (option), and the ability to create, store, and repeatably use thermal Patterns recreating those used in the initial manufacture of the circuit assembly. The LIBERTY BANDIT is a complete, precise, and sophisticated manual alignment and rework system, for BGA/Chip-Scale components.

Using the LIBERTY BANDIT, an operator may remove a defective component, accurately position a replacement component within an accuracy of +/- 0.001", and safely solder attach that new component to the PCB. The ability to preset positioning parameters, as well as to create and store complex thermal Patterns, ensures precise repeatable processing and a robust process, component after component, and board after board.

Therefore the LIBERTY BANDIT brings together two powerful systems - the LIBERTY BANDIT placement unit with its DABIS split imaging optics, and the Flo-Master heating and rework system, to create one complementary synchronous unit - the LIBERTY BANDIT SMD-7500.

This manual is designed and intended for personnel who will use the machine and contains an over view of the system, how to unpack, inspect, assemble, and power up the unit. It also contains a brief overview of the rework process, and how to use the LIBERTY BANDIT to remove and replace defective components, and how to accomplish light assembly. The operator will learn how to create, test, store, retrieve, and modify thermal Patterns for removal, and to program the controller. If you have questions regarding the use of the machine that are not answered in the manual, contact the A.P.E. factory at (305) 451-4722 or email techsupport@ape.com. We would appreciate your comments, and they will help us create a better manual for you, your co-workers, and your colleagues in the field.

Lastly, Please read and review this manual in its entirety before assembling or operating the LIBERTY BANDIT!

The LIBERTY BANDIT is a sophisticated, though user-friendly system; and although the system has been assembled and factory-calibrated, some final light assembly and calibration is necessary before operating the machine. The LIBERTY BANDIT is a highly precise unit, and should be checked and fine-tuned by the operator for his or her own particular application before operating. This manual will tell you how to do it right, in easy-to-follow steps.

2. GETTING ACQUAINTED

Key Operational Features of the LIBERTY BANDIT Vision System:

Superimposed Images: The DABIS system allows the contact array of the component to be viewed from the underside and superimposed over an image of the contact land pattern on the PCB or substrate.

Precision Component Alignment: Precision alignment of the two lead patterns and a Camera focus provides for high magnification positioning.

Manual Positioning: Once registered, the component is positioned by manual control, lifting the

vision system clear of the placement vector and allowing a precise Vertical Placement Drive (VPD) to accurately orient the component to the contact land pattern.

Optional Macro Imager: For large QFP, high pin count components and some large BGA devices, it is necessary to use the Macro Image Scope, a precision mirror Second Stage Splitting Imager, which simply slips into place between the camera and the DABIS allowing only two of the diagonals (four (4) sides) of the component to be brought into view, by adjustment of a precision mirror system.

Stable, Precise Placement: When placing delicate components to fine tolerances, emphasis on stability of engineering is paramount. The reinforced VPD provides a stable final positioning operation.

Final Positioning: A selection of Vacuum Pickup Barbs has been designed to ensure adequate clearance of adjacent components and obstacles around the positioning area. Consequently, the length of each Barb is 0.80" (20.3mm), which should provide sufficient depth of penetration.

Board Holder: The LIBERTY BANDIT includes a standard 8" x 12" (203 x 305mm) frame PCB holder, which quickly glides into position. Precision bearings facilitate adjustment in the X and Y axis, and the Rotary feature of the frame provides Theta (rotational) adjustment.

Template Nest: A template nest aligns the component package within the register and protects the device during the pickup operation.

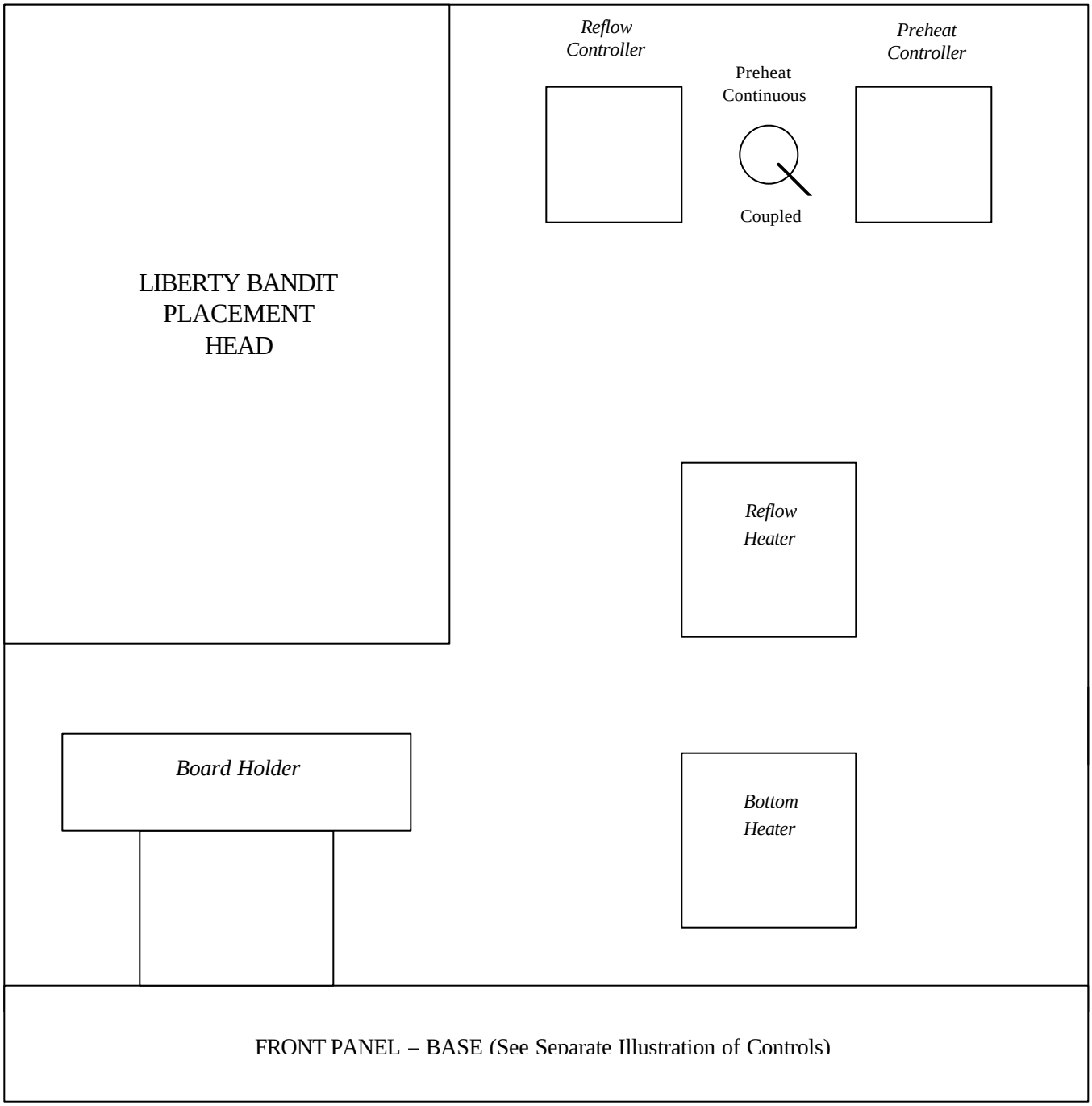
Vacuum Pickup: The Vacuum Pickup Barb supports the component during the registration alignment and releases the component during placement.

Key Operational Features of the LIBERTY BANDIT Rework System:

High Power/Low Temperature Rework: The LIBERTY BANDIT is a fully integrated dual top and bottom (optional) heating system designed to handle all BGA components, military-type boards, and commercial applications requiring an efficient level of power versus temperature.

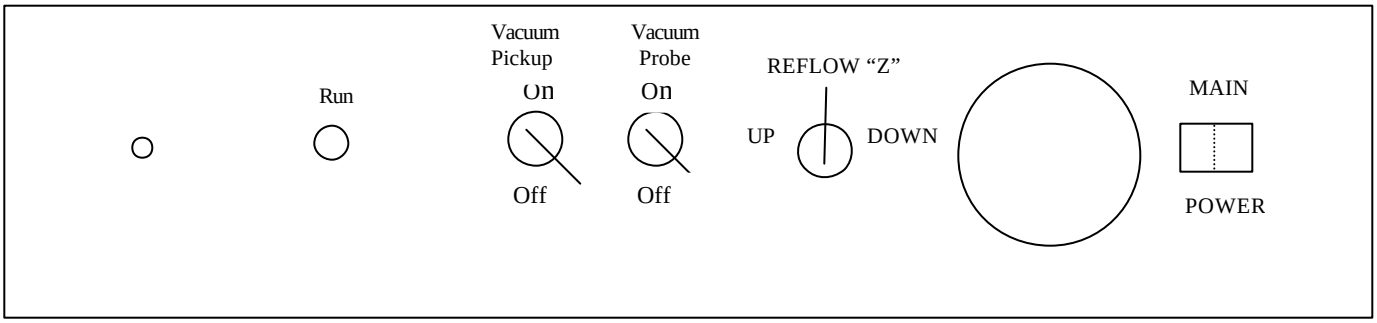
Preheat (optional): A bottom "Preheat" and "In-Process" heat source ensures stability of board temperature, reducing the necessary top reflow temperature, thereby following a more precise Pattern structure for the component undergoing rework.

Independent Preheat Control: The bottom heat source is an independently controlled integral system with its own "Pattern" and "process time" controls. An important feature is the power available, optimizing the energy performance flowing below and into the work piece, preventing unnecessary overheating.



LIBERTY BANDIT (Alignment & Placement) and LIBERTY BANDIT (Heating/Reflow Soldering) Controls: Front View
Figure 1

Figure 2



LIBERTY BANDIT front of base., Reflow"Z" toggle switch moves the Reflow arm of the LIBERTY BANDIT, either up or down to the part, as needed.; "Vacuum Pickup toggle" switches, on or off, the LIBERTY BANDIT component pickup. The "Vacuum Probe" switches, on or off, the Reflow vacuum.

Temperature Patterns: A range of temperature Patterns are installed for bottom and top controllers and each thermal Pattern may be custom programmed enabling different combinations of preheat and removal temperatures to be selected.

Mechanical Control: The LIBERTY BANDIT has been engineered to operate on a standard workbench and includes a Board Holder with built-in X-Y axis for precise alignment.

Linear Air Delivery: The Heat Acceleration Chamber and delivery Nozzle Block are designed to provide maximum air spin of the air flow through the nozzle, ensuring minimal temperature difference.

Using the LIBERTY BANDIT SMD-7500, you can achieve the following:

Remove a defective component

Align, Place and Solder attach a component – either as a replacement for a defective one, or as a single-site post-assembly soldering operation, or prototyping operation

Remove a defective component, clean and prep the site, then Align, Place and Solder attach a replacement component – a complete rework operation.

3. LIBERTY BANDIT Install and Setup:

a. Unpack and check for missing parts or damage.

b. It's important to make sure that a strong, rigid, and stable bench or table supports your LIBERTY BANDIT system. It is also very important that the unit be level.

c. Remove the metal shipping/alignment pin, which secures the Optics Hood, it can be located through the vertical placement assembly. It is very tight and some force is required to remove (pull out).

d. **Do not connect the Power Supply cord from the mains outlet to the rear of the machine at this stage.** Ensure all switches are in OFF position as follows:

E1. Power "OFF" Green Switch

E2. Vacuum Probe Switch to "OFF"

E3. Vacuum Pickup Switch to "OFF"

E4. Preheat "Continuous/Coupled, set to "Coupled"

e. Install camera using the U Mounting Bracket and four (4) shoulder screws provided. Plug in the BNC Coax video cable located at the top of the machine and connect to "Video Out" of the camera. Connect camera power connectors to "12VDC & GND" of the camera.

f. Position Monitor near the machine. Connect 6ft (91.83 millimeters) coax cable from Monitor (Video In) and (Video Out) at rear of Sniper. Connect Monitor power cable to one of the Auxiliary Power Outlets at the rear of the machine.

g. Attach the foot pedal cable to the DIN Connector on back panel (Figure 4). Assemble the Halogen Light (Page 15) and connect to one of the 120V outlets on the bottom rear panel (Page14). Unpack and set up the Frame Boardholder.

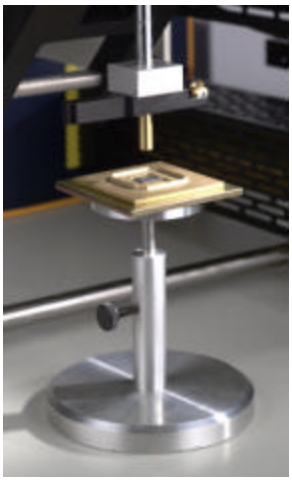
h. Now plug in the power cord provided to a 120v source (120v Machines only) main power connection, uses a "computer" style 3-prong power cord.

i. Turn on the Green Power switch, lights should illuminate and both controllers should power up.

j. Bring the Placement Arm forward and down, then actuate the VPD Cylinder by pulling out the large black knob on the lower panel. (Note: the black knob is part of the Two-Way Air Cylinder "CHARGER" Assembly that upon being pulling out activates the VPD by an air charge to place or capture a component and when pushed back towards the front panel activates an air charge to return the VPD to rest). The Black Knob is referred to as the "CHARGER"

k. Once this operation is successful return the "CHARGER" to its home position into the lower panel and the VPD will rise, then return the Placement Arm to its original "Up" position – this is the "Component Alignment" position where the split image of component and PCB footprint will be viewed.

Component -Register. (Option)
This is placed under the VPD so that the DABIS vacuum pickup can "capture" the component and place it on the PCB



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Tools Required:
Allen Wrenches
Pliers, Smooth Needle nose
Screw Drivers 1/8, ¼ Flat, & 1+2 Phillips
9/16" & 5/8" Wrenches

Vision test Operation Using Test PCB and Dummy BGA:

This test will enable the user to become familiar with selecting, aligning and placing a component onto a PCB.

Mount a sample or test board in the board frame board holder. Next, place a DUMMY component- appropriate to the PCB footprint where the component will be placed- right side up (or connection side down) in the Component-Register (Option) or by hand.

Ensure the Optic Hood is down. The Vacuum Barb should be in the "Component Alignment", upper or "Rest" position (Placement Arm up) as per "k" in the above Install. If the optional Component-Register is used, slide it under the VPD. Now pull the Placement Arm fully down and activate the VPD by the "CHARGER" on the front panel, a pull action will gently lower the component to the "Placement" position, which will also be the component capture position. The VPD that is now fully, extended will bring the Vacuum Barb assembly to the top of the dummy component.

If the Component-Register was used adjust the height of the component to the Vacuum Barb with the adjusting screw of the Component-Register to just touch the Vacuum Barb. (The most popular method is to simply present the component by hand or from a tray without using the optional Component-Register). Then switch on the vacuum toggle on the front of the base of the unit. Capture the component with the Vacuum Barb. If the Component-Register was used move it out of the way. Raise the VPD by pushing the "CHARGER."

Make sure that the PCB in the board holder is NOT under the VPD! Ensure that the PCB is at its lowest position in the Work Holder. Slide the Work Holder under the VPD and Vacuum Barb with the vacuum held component. Lower the VPD by activating the "CHARGER." Now adjust the Z-axis on the Work Holder so that the component barely touches the board. Raise the VPD by pushing in the "CHARGER". Now retract the Optic Hood by returning the Placement Arm to the Component Alignment for Up/Down viewing of component and footprint.

CONGRATULATIONS! You have now set up your LIBERTY BANDIT for pickup and placement. The next step is to align the component and PCB component footprint. With the Work Holder under the DABIS, line up the balls or leads on the bottom of your component with the corresponding pads on the PCB, adjust the focus on the camera as necessary. Lower the "Optic Hood" for the placement position. Lower the placement Arm and activate the VPD by the "CHARGER" on the front panel to place the component. Switch off the VACUUM PICKUP toggle switch. When the component is released and in position on the PCB raise the VPD by pushing in the "CHARGER" and return the Placement Arm to the upper or rest position so that the Optic Hood is clear for the next step.

Activate the REFLOW "Z" switch on the front of the machine; adjust the reflow nozzle UPWARD so that it clears the board and component. Slide the Board holder/board/component directly under the nozzle. Press the REFLOW "Z" switch to adjust the clearance between the nozzle outlet and the component (Approx. ¼"). The proper clearances are described later in this manual in the Sniper Flo-Master section, so read on!

In a nutshell, then, here is the procedure for alignment and placement:

1. Place a board in the Board holder, and the appropriate component in the Component-Register (option).

2. Switch on VACUUM PICKUP.

3. If the Component-Register is used, move it under the VPD (which should be in the rest or "Component Alignment" switch position).

4. Lower the Optic Hood and lower the Placement Arm and activate the "CHARGER" so that the VPD is in placement position. Capture the component from the Component Register or by hand/tray. The component will be held on the Vacuum Barb for viewing.

5. Raise the VPD and Move the Component-Register out of the way.

6. Lower the VPD and move the board holder under the VPD.

7. Adjust the board holder z-axis, raise the VPD and Optic Hood by the Placement Arm to the "Alignment" Position.

8. Focus and Fine align

9. Lower the Optic Hood and VPD to the placement position. The VPD will place the component on the board.

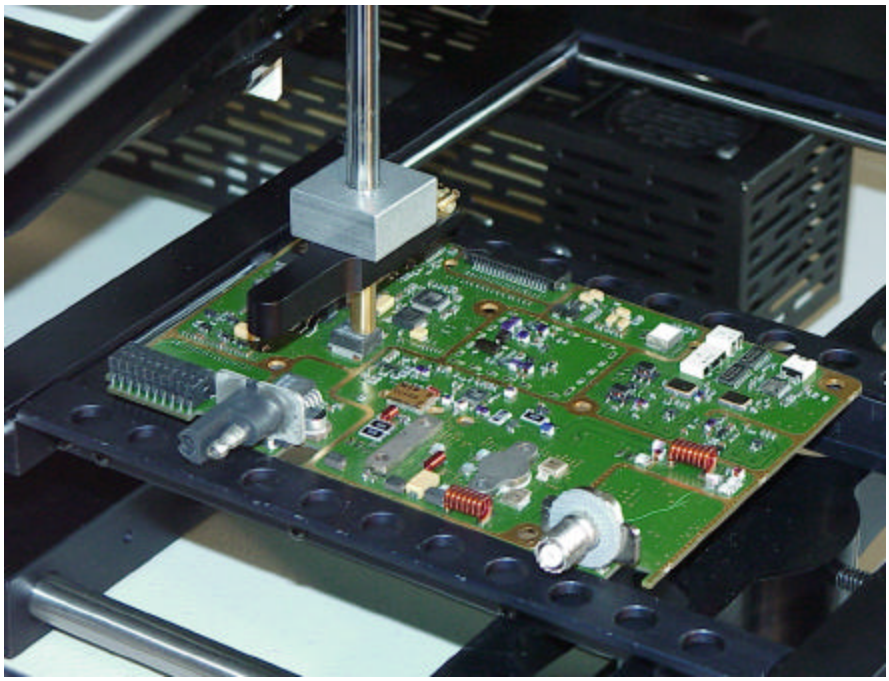
10. Switch off VACUUM PICKUP.

11. Raise the VPD and Optic Hood to the alignment position leaving the component properly placed on the PCB.

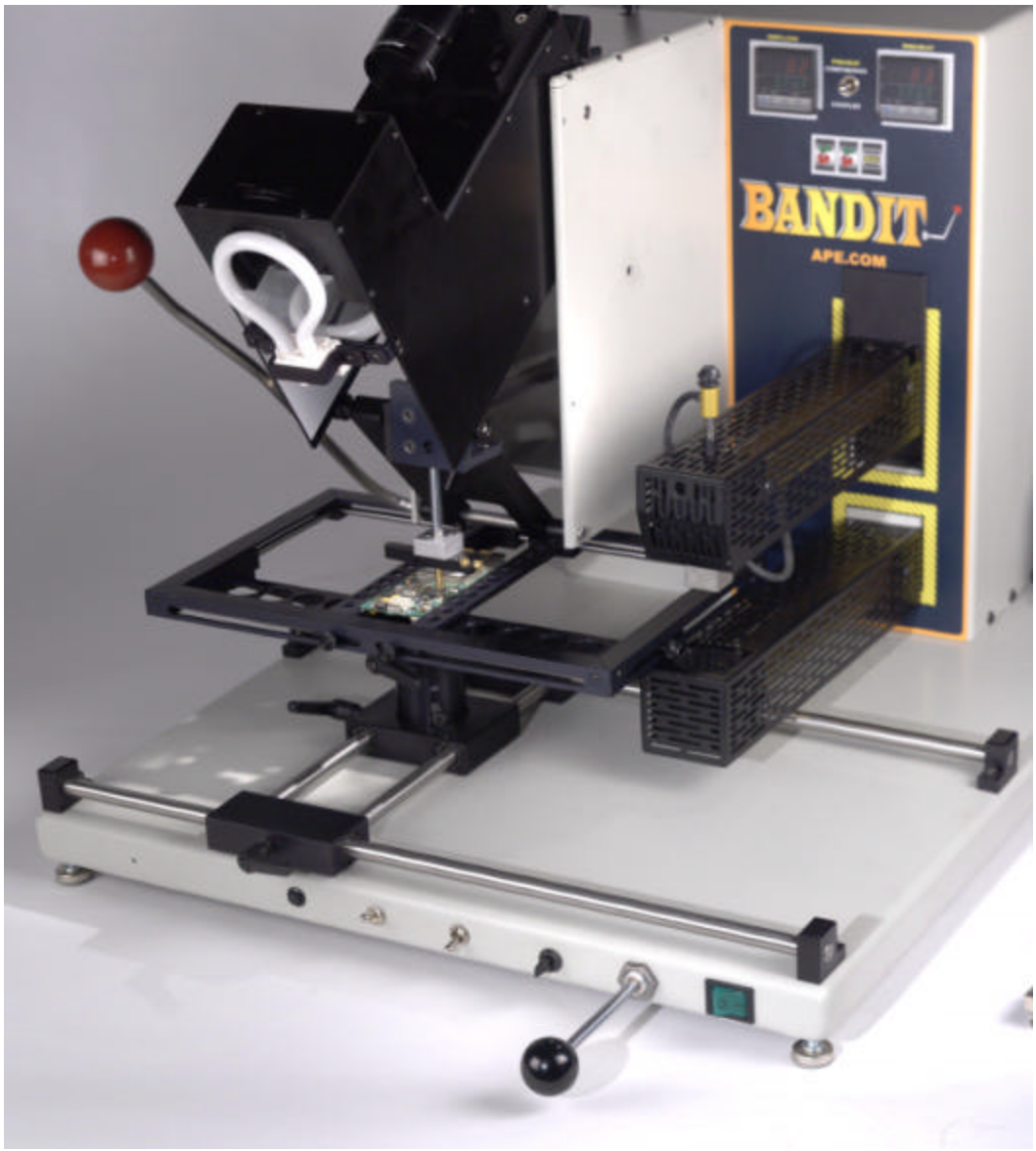
12. Activate the REFLOW "Z" switch to the UP position. The top Reflow Heater will move up and out of the way.

13. Move the board holder and board into position between the heaters.

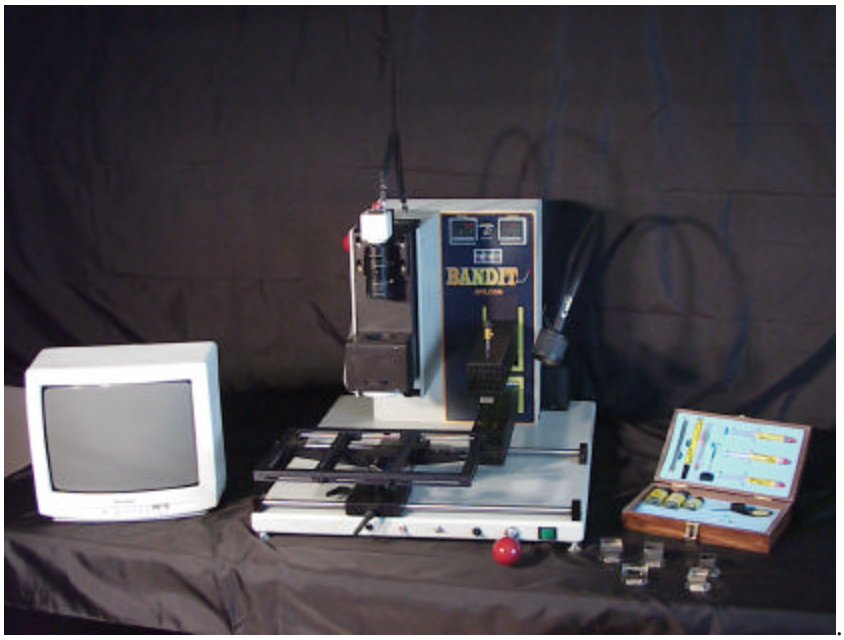
Press REFLOW "Z" to DOWN position, the Reflow Heater down to the component. You are now ready to reflow the component into place!



LIBERTY BANDIT "Placing" a Component on a circuit board. Proper alignment and system adjustment is critical to achieving excellent results!



LIBERTY BANDIT, shown placing a component on a circuit assembly. The PCB is held in the board holder, which can be "locked" into position once the component has been aligned with the pads on the board. Once the component has been accurately placed, it can be soldered in place using the LIBERTY BANDIT heating system shown on the right.



LIBERTY BANDIT with color monitor
Showing LIBERTY BANDIT, nozzles and tool kit.

4. LIBERTY BANDIT Reflow Setup And Operation

The LIBERTY BANDIT ™ is an advanced, programmable hot air-based rework system for removing and replacing BGA, Micro BGA, Chip Scale Package (CSP), QFP, SMD, and essentially all types of surface mounted components from all types of circuit boards.

The LIBERTY BANDIT uses directed forced hot air to gently heat electronic components at a rate of 12.7 CFM to the temperature required to "reflow" or melt the solder connecting their leads to the circuit board. This forced air is provided by an internal blower and heated by a special resistive element in a tubular chamber. A similar system is used for bottom heating to preheat the circuit board prior to actuating the top reflow heat cycle and to maintain constant temperature during reflow.

Simply described, heated air is directed through a nozzle to the surface and lead attach areas of the target component. Many different interchangeable nozzles are available, because there are many different sizes and styles of components. The goal is to heat the target component, and not adjacent areas or components; hence the use of a nozzle approximately matched to the size of the component. Once the component has reached the desired temperature and the solder has melted, a vacuum pickup device lifts the component off the circuit board. The microprocessor-based programmable storage controllers control the temperature of the heated air-as well as the rate that it heats up. These are essentially the "brain" of the unit.

The machine incorporates a vacuum pump to pick up components at the nozzle, once they have reflowed. This pickup is not to be confused with the Sniper placement; it is simply the means of safely removing a defective component from the assembly at the point of reflow. Using a vacuum pickup is much safer than trying to physically pry the component off, whereby delicate pads on the board can be damaged. A vacuum pickup gently removes the component once all the solder connections are safely liquid.

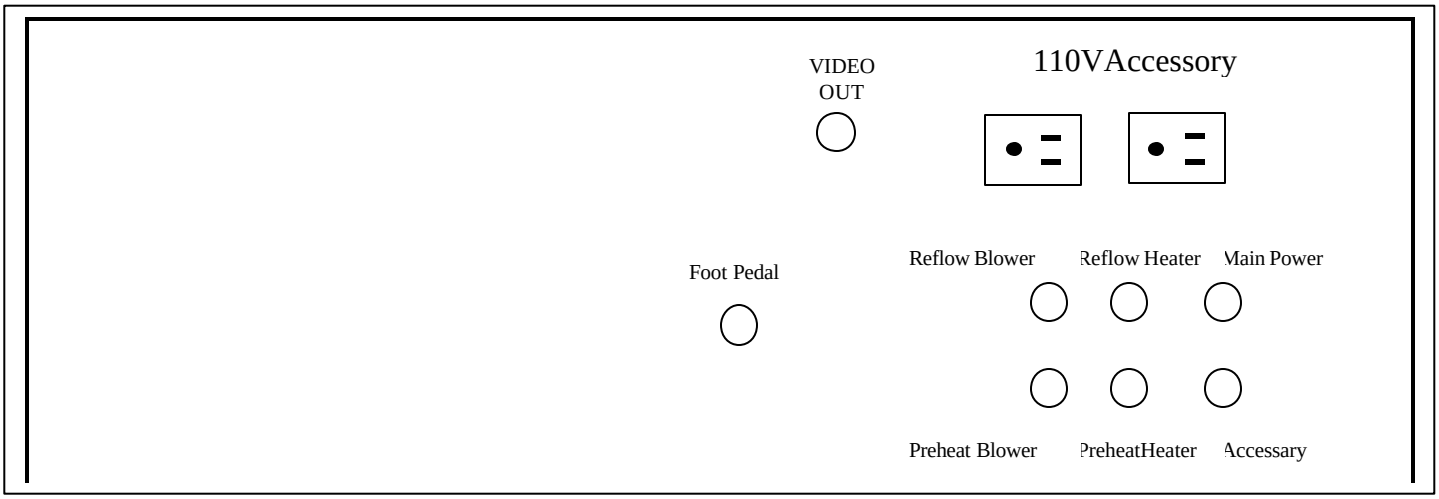
Controls for the LIBERTY BANDIT are located on the front of the unit. These include the following (see **Figure 1 & 2**):

- Main Power On/Off
- *Linear Air Delivery:* The Heat Acceleration Chamber and delivery Nozzle Block are designed to provide maximum air spin of the airflow through the nozzle, ensuring minimal temperature differences.
- Reflow Controller
- Preheat Controller
- Preheat Switch, dedicated three (3) position switch with top position for the Preheat continuous cycle, middle OFF position and a bottom position for Coupled control.
- Vacuum Pickup On/Off
- Vacuum Probe On/Off
- Reflow Z-axis Up/Down

Note the ground socket on the left-hand side of the lower front panel. The socket is a ground only to the cabinet of the unit and cannot expose the operator to machine operating current.

Three (3) Reflow Nozzles are also provided, together with an SMT Tool Kit and extra RTV Silicone Rubber Vacuum Pick Up Cups, these parts should be inventoried and stored where they can be retrieved without delay or difficulty.

Take note of the back of the LIBERTY BANDIT. The following illustration shows the back panel and location of the various connections and elements.



Fuses:

Reflow Blower: 2Amp Part # H0175
Reflow Heater: 12Amp Part # H0139
Main Power: 12 Amp Part # H0139
Accessories: 5Amp Part # H0176

LIBERTY BANDIT Back Panel (Exterior)
Figure 4

Your LIBERTY BANDIT is equipped with a black goose-neck halogen lamp to illuminate the work area. This lamp attaches to the right hand side at the rear of the cabinet. Four tapped holes are provided in the frame for this purpose.

Your LIBERTY BANDIT is supplied with a PC Board Holder, capable of holding up to a 8" x 12" PCB. Make adjustments by loosening the set-screws (Black knobs, as shown) and retighten when the desired width is reached.

Select the appropriate heater nozzle from those supplied with your unit. Locate the underside of the top heater nozzle. Note the machined circular socket, and four retainer screws attached to the nozzle.

Now note the shape of the nozzle, and the circular top with four indents. Nozzles mount bayonet-style onto the heater head. Align the four semicircular holes in the nozzle top with the four retainer screws in the heater head. Push the nozzle in and then turn so that the nozzle cannot drop out. The nozzle does not "lock" in; it can be turned continuously if need be, or until the holes line up with the screws again and the nozzle can be removed. Practice a couple of times, then try inserting, removing nozzles several times without looking. Learn to "feel" the location of the screws and machined receptacle with the nozzle. Keep in mind that during operation, the nozzle will be hot, so a hot pad, or an inverted cool nozzle socketed, either outside or inside the hot one, can be used to capture the nozzle for change. The Bottom Heater Head will accept either one of the two (2) Pre-Heat Nozzles supplied with the unit. Select one that's appropriate for the area to be bottom heated and fit as above.

5. POWER UP AND TEST ROUTINE

NOTE: NEVER OPERATE THE LIBERTY BANDIT WITHOUT A NOZZLE IN PLACE AND NEVER SWITCH OFF THE SYSTEM ABOVE 120 F (48 C) IN EITHER OF THE ORANGE

DISPLAYS

1. Once the LIBERTY BANDIT has been assembled and plugged into a power source, it is ready for power-up and testing. First ensure that a nozzle has been inserted in the top heater arm, as described in the previous paragraph. Depress the Main Power On/Off switch to the ON position. The green-colored switch will illuminate, indicating that power is ON.

2. Both Controllers will light up and indicate "InP" , F or C and thermocouple type, then maximum set point, as it momentarily runs through its test sequence. The unit's blowers will immediately begin operating, and will blow a stream of air through the nozzles. The upper ORANGE L.E.D. indicator will indicate ACUTAL AIR TEMPERATURE in degrees Fahrenheit or Celsius, dependent upon Factory set up. The bottom GREEN L.E.D. will indicate STOP.

2a. Preheat Cycle

2b. Insure the controller is set for T2 Mode, and the ALM is preset to 50 deg. Position the Preheat switch to continuous. Once you are satisfied that the bottom heater is operating, switch to the coupled position for automatic Cool Down. Once the temperature is below 120 F, switch to the middle OFF position. This completes the test for the bottom preheat system of the LIBERTY BANDIT.

3. Top Reflow Heat Cycle

3a To test the Reflow heater. Insure the controller is set to T2 mode. Depress and hold the foot pedal. The Controller's ORANGE L.E.D readout will indicate ACTUAL nozzle air temperature as it ramps and the operator will be able to "feel" the heated air coming out the nozzle. Be careful not to put fingers or hands on or too near the nozzle, as it can injury. The controller will commence gradually heating the air stream to the set point temperature, **CAUTION HOT AIR CAN CAUSE INJURY**. The bottom GREEN L.E.D. will indicate the internal timer. Reset the Timer by depressing the "Up Arrow" key and the "Down Arrow" simultaneously, the Controller Display will flash once indicating that Timer has been set at Zero. The LIBERTY BANDIT Timer will begin to time the process, after 10 seconds release the Foot Pedal momentarily (1 sec), and then depress the Foot Pedal again, notice the Timer counts back towards Zero. This represents a Remove and Replace test using the Timer. This time-out indicator will be explained in greater detail later in the section referring to the controller.

3b. Release the foot pedal. The air coming out the nozzle will begin to cool rapidly. The ORANGE indicator will show the temperature rapidly decreasing. The GREEN readout will again indicate STOP. This completes the test for the reflow heater.

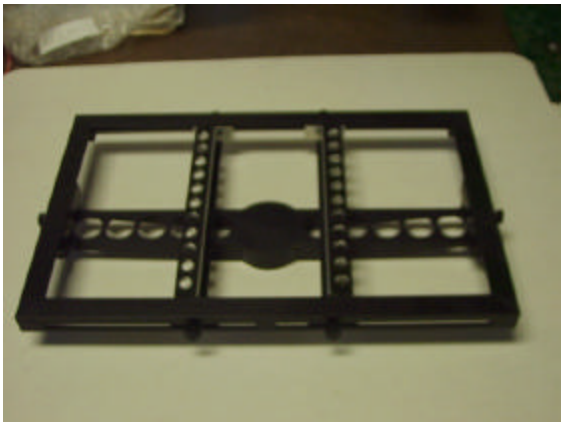
4. With the Main Power switch still ON, test the vacuum pumps. To do this, switch the vacuum probe switch to "ON". Depress the Vacuum Pick Up Assembly plunger (reflow) and feel the bottom of the suction cup with a smooth flat surfaced object. There should be suction, indicating that the vacuum pump is working. Turn off the vacuum probe switch.

4a. Switch on the vacuum pickup switch and check for suction at the placement barb. Turn off

vacuum pickup switch.

At this point, you have completed the assembly and initial power-up and test of the basic LIBERTY BANDIT system. Now this manual will explain its method and theory of operation, and will show you how to use, program, and maintain your LIBERTY BANDIT, as well as how to assemble and use the various options available with the system.

6. BOARD HOLDER, NOZZLE SELECTION AND REWORK PROCEDURES



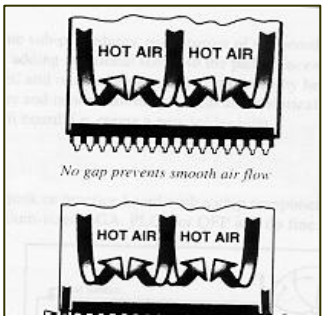
The standard adjustable circuit Board Holder can accommodate boards up to 12" wide. Most PCBs will be smaller. The Board Holder consists basically of two supports with adjustable edge-holding fingers. Both supports can slide back and forth across the adjustment bars, and can be fixed in position by tightening black-knobbed friction screws as shown in the illustration.

The inside edges of the Board Holder supports are grooved so that thin boards may be held securely without dropping. The Board Holder features an adjustable clamping action designed to hold boards securely. To adjust the holder, secure the left side support of the Board Holder, using the Black Friction Knob on the front and back of the board holder. Set one edge of a board in the groove of the fixed edge holding finger. Loosen the other support, by the Black Friction Knobs, and move the adjustable edge holder bar to the edge of the board clamping the board in place.

Some boards will be too thin and delicate for much clamping pressure. It will take practice for you, the operator, to learn just how much pressure is needed to avoid warping thin and delicate substrates.

Nozzle Selection

The height of the Nozzle above the component should be 1/8” to 1/4”, if there is too much space between the nozzle and the component, adjust the z-axis until the component is directly under the nozzle with the correct spacing for air escape.



If the height of the nozzle to the component is incorrect, adjust the Z axis

for the correct distance.

Maintenance Note: On all bearings including Board Holder and X-Y

Bearing Table rods, avoid getting flux, solder, adhesives, etc. on the surfaces that the adjustable edge holder bar and the carriage of the X-Y Table travel on. Foreign material could cause binding. Keep the rods clean and occasionally wipe with a small amount of very light oil or lubricant. The amount should be very small, as larger amounts could get on the circuitry via the operator's hands, and result in contamination problems. Also, never over tighten either of the two friction knobs on the support assemblies. Finger-tight, just enough to prevent movement, this is sufficient.

Once a component has been removed, a new one must be reattached in its place. In the case of BGA components, all solder must be removed from the PCB pads and an SMT Tool Kit is provided to assist in site preparation, all tools and materials necessary are included in the kit. For standard SMT Components, such as QFP devices, surface tension has kept some solder on the pads, and the solder may resemble upside-down icicles, the pads can be hot air leveled if sufficient solder remains rather than removing all the solder and replacing, before a new component can be soldered in place. A documented procedure is available from APE at techsupport@ape.com. It should also be understood that as the LIBERTY BANDIT reflows at low temperatures the original solder could be reused without adding solder.

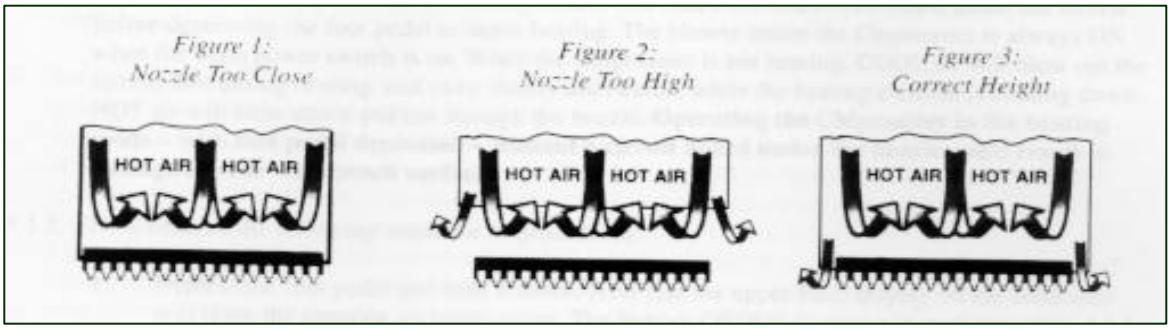
Replacement of components involves three separate sub-procedures: preparation of the board to receive the component, such as hot air leveling or adding additional solder to the pads, if so desired or required; placement of the component and aligning it properly on the pads; and reattachment of the component by heating up the leads and lead attach areas to melt the solder and reestablish the physical and electrical connections between the component and the circuit board, i.e. create a new solder joint. Never operate the LIBERTY BANDIT without a nozzle in place, as this will significantly reduce the life of the heater!

The above Illustration shows the scheme of air flow through the LIBERTY BANDIT - from the blower through the heater tube, into the heater head, and down and out through the nozzle. A close-up of the nozzle area illustrates how the heated air flows down through the nozzle, over the total area of the component, and directly onto any lead attach area. As the heated air contacts the component, leads, pads, and solder joint, it gives up its thermal "load" of heat, transferring it directly or indirectly to the component and the solder joints. The spent air, now cooler, moves up and away from the surface of the board.

The LIBERTY BANDIT heats with directed forced heated convection. Heated air (convection) is directed at the component and solder joints by the nozzle, forced by the blower. The operation and the selected air temperature is assisted by the bottom heater, which has been used to either preheat the circuit board prior to reflow and/or to apply bottom heat during the reflow process, allowing a lower top temperature to be used thus reducing any stress to board and components.

In Figure 1, the nozzle is too close to the component; the convection cannot escape the nozzle, and therefore, fresh heated air cannot reach the component continuously. In Figure 2, the nozzle is too far away. Too large a gap between the nozzle and the component will allow the hot air, to escape from

under the nozzle without effectively heating the component or solder joints. It will also create a laminar (or horizontal) flow across the circuit board, heating other components that you don't want to heat. It will also result in longer removal times, resulting in unnecessary heating of adjacent component and the circuit board.
The following illustration shows the correct height relationship of nozzle to component, with approximately 1/8" to 1/4" gap for air flow escape.

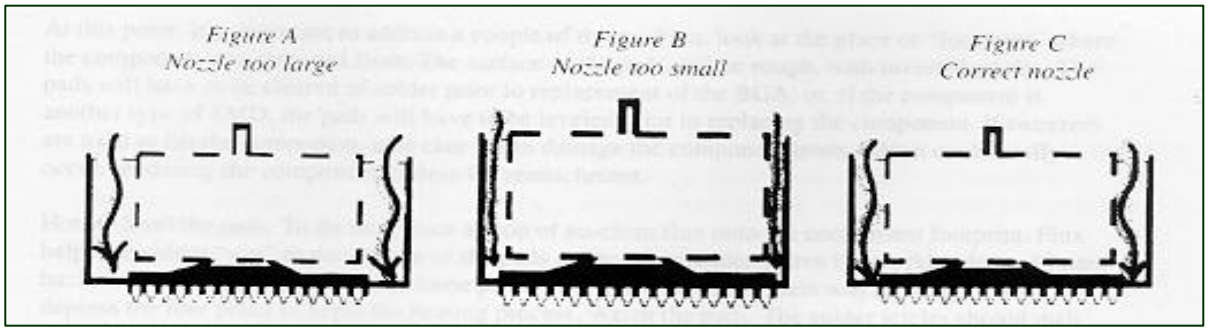


The same problem of heating adjacent areas occurs when nozzles that are too large or too small are used.

Figure A shows a nozzle too large for the component. Adjacent areas are being heated that should not be, including small chip caps.

Figure B shows a too-small nozzle being used. Only the center of the top of the component is being effectively heated. Air flows out across the flat surface of the component, heating adjacent components. The BGA or component being heated does not achieve a uniform heating across the total area of the component, therefore, heating time is prolonged because heat must migrate through the component itself at a slower rate to reach the lead attach area.

Figure C shows the correct nozzle for use with the component.



Now that we have selected a board and component to rework with a top reflow nozzle suitable for the component and with the board secured in the Board Holder, which is in position with the Preheat

Heater under the board, set the nozzle to the correct height above the component by the pressing the Reflow-Z switch to DOWN position. We are now ready to remove the component from the circuit board.

Component Removal

1. Switch the "Preheat Switch" to the bottom "Coupled" position, the bottom heater is enabled to be controlled by the reflow controller.

2. Depress the "UP" and "DOWN" arrow keys on the controller to zero time, then depress the foot pedal to activate the Timer, time will start counting to record the removal cycle, example 2 minutes, the desired result is, warp control and/or component/board stabilization, pre heat time will differ per type of application.

3. Zero the Reflow Timer by depressing the "UP" and "DOWN" keys on the Controller. The top heat Controller should register STOP in green and the actual air temperature in orange, but will not heat until the Foot Pedal is depressed. The top blower is always ON when the Main Power switch is on. When the LIBERTY BANDIT is not heating, COOL air will blow out the nozzle. But during heating, and even shortly afterwards, while the heating element is cooling down, HOT air will blow down and out through the nozzle. **Operating the LIBERTY BANDIT in the heating mode -with foot pedal depressed - without a circuit board under the nozzle could result in harm to the operator.**

4. Depress the foot pedal and hold it down. Note that the upper ORANGE display on the reflow controller will show the ramping air temperature. The bottom GREEN display will read time. Insure that the preheat controller is activated and ramps to set point.

5. When the Top Controller "ORANGE" display reaches (example) 250 F, turn on the vacuum pump. Depress the Vacuum Pick Up Assembly plunger in the heater head until it touches the component top. Remove your finger. The plunger should STAY DOWN, held to the component by the force of the vacuum.

6. Continue heating until the component lifts off the board, picked up by the vacuum plunger. Then release the foot pedal. Both controllers will ramp down as indicated by decreasing values in the orange displays.

7. Allow the board to cool a little then raise the Top Heater Head by depressing the "Reflow Z" switch to UP, slide the board holder out from under the nozzle. The component will still be held up by the vacuum plunger, either grip the component using tweezers and remove the component, or carefully allow the component to drop onto a flat surface close to the nozzle by turning the vacuum off.

At this point, it's important to address a couple of things. First, look at the place or "footprint" where the component was removed. The surface of the pads will be rough, with inverted icicles. The pads will have to be cleared of solder prior to replacement of the BGA; or, if the component is another type of SMD, the pads will have to be leveled prior to replacing the component. If tweezers are used to lift the component, take care not to damage the component leads, which could easily occur, rendering the

component useless for reattachment.

For non BGA components, Hot air level the pads. To do this, place a drop of no-clean flux onto the component footprint. Flux helps the solder "wet" to the surface of the pads and to other solder. Move the Board Holder and component contact area back under the top heater nozzle and lower the Heater. Then depress the foot pedal to begin the heating process. Watch the pads. The solder icicles should melt and the solder should form nicely rounded "pillow" shapes, and become very shiny. This process should take less than the time to remove the component as the mass of the component is removed, it may not be necessary to preheat or apply bottom heat during this operation. Release the foot pedal and allow the board to cool for a minute or so.

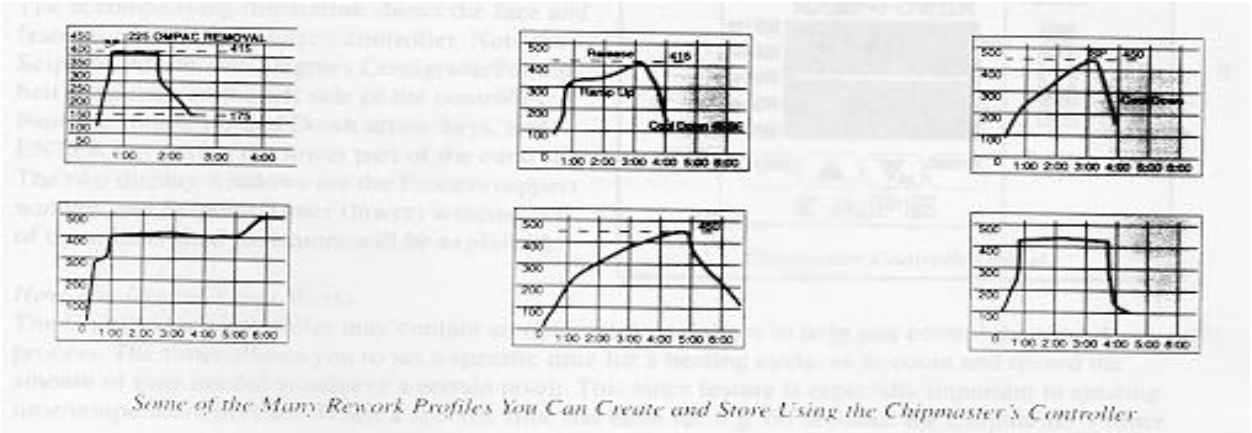
Remove the board and Board Holder from beneath the nozzle. Now clean the contact pads using the Pad Prep Pen and Cleaning Brush supplied in the SMT Tool Kit or by other means available, it is also recommended to finally clean with an Antistatic wipe, now change to the no-clean paste flux supplied in the kit, and apply to the pads spreading evenly using the flux brush, the paste flux will provide better wetting: place the component on the pads using the LIBERTY BANDIT Split Vision System,. Once the component or BGA has been properly placed in position on the prepared circuit board, move the Board Holder back under the nozzle, lining it up carefully, repeat the preheat cycle operation for the same time period as removal, add 15-30 seconds to the Reflow removal time, following the "Adding Time" procedure and depress the foot pedal to begin heating.

When the Timer reaches zero, the component is reflowed. Molten solder surface tension ensures that the leads line exactly on their respective pads. Release the foot pedal, and allow the solder to cool and solidify before moving the board and Board Holder.

7. THE LIBERTY BANDIT CONTROLLER SYSTEM

The LIBERTY BANDIT's "brain" is a sophisticated micro-processor-based patented time/temperature controller developed by A.P.E. The programmable storage controller allows the user to create, duplicate, test, store, and instantly recall reflow and Preheat Patterns.

The following illustration shows some of the many rework Patterns you can create and store using the LIBERTY BANDIT's controller. The curve represents the temperature of the component's lead attach area as it is heated and then allowed to cool.



Some of the Many Rework Profiles You Can Create and Store Using the Chipmaster's Controller

Note that in these Patterns, it is possible to vary the upper temperature reached, as well as the length of time that the component remains at that temperature. Note also that we can control the rate of temperature rise, or ramp. Controlling the ramp rate is an advanced feature of the LIBERTY BANDIT controller, one that we will learn later. We will also learn to store temperature Patterns. Since not every Pattern is right for a given component, establishing the right one is called optimizing a Pattern, i.e., fine-tuning it. You'll want to keep that Pattern for reuse again and again. In fact, you may find that there are one or two Patterns that you use all the time. It's inconvenient to plug in the parameters of a Pattern each time you need to change from one to the other, so A.P.E. has made it possible for you to store up to four of these Patterns in the controller's memory for instant recall. The advantage of an optimized Pattern is that it is repeatable - in other words, it will do the same job, correctly, every time it is called up and used.

Start Out With A "Cool" Circuit Board

It's a general rule that, when establishing a Pattern, or when heating, you start out with a circuit board that is at room temperature.

A single time/temperature Pattern will yield the same results time after time, providing that the starting conditions are the same. Room temperature, or *ambient* temperature, is the starting point for all Patterns and for all rework. If you use a Pattern that was established for a circuit board at ambient temperature, and begin heating a board that's already hot, you will get a different Pattern at the circuit board level. Always let the circuit board cool to room temperature (or very close) before beginning the Pre-Heat and Top Reflow heating cycle.

The Illustration above shows the face and features of the LIBERTY BANDIT's controller. Note the Auto Tune, Output, and Alarm indicators on the center of the controller. Note the Set, Reset, and Up and Down arrow keys, across the lower part of the controller. The two display windows are the Process (upper) window and Set Point/Timer (lower) window. All of these individual indicators will be explained

The Digital Timer - How It Works

The LIBERTY BANDIT's Pattern Storage Controller includes a digital timer to help you control the rework process. The timer allows you to set a specific time for a heating cycle, or to count and record the amount of time needed to achieve a certain result. This latter feature is especially important to creating time/temperature Patterns. When a specific time has been set, e.g. 60 seconds, the LIBERTY BANDIT's timer counts down to zero once the foot pedal that begins the heat cycle has been depressed. The timer will stop at zero, even if the heating continues (foot remains on the pedal). If the timer is reset to zero, it will begin counting UP (adding seconds) once the heat cycle begins and will STOP counting once the operator stops the cycle (foot pedal released). The timer will display the cycle time, i.e. 45 seconds, or whatever. Each time the foot pedal is depressed to start the cycle thereafter, the timer will count DOWN to zero from whatever that cycle time (in this example, 45 seconds) was recorded.

Whenever the LIBERTY BANDIT is turned on, the controller, after going through its self-test, will automatically go to the "Operator Display." This is the menu that should be displayed at all times when the LIBERTY BANDIT is running. One only goes to different menus to change heating cycle parameters. To change the time, for example, begin by resetting the timer to zero. To do this, press the UP and DOWN arrow key simultaneously. The display will flash once, indicating that the timer has been reset to zero. Now press the SET key TWICE (from the Operator Display) to reach the timer set field in the Operator Menu. Use the UP arrow key to increase time in one-second increments; hold the key in to increase time rapidly. Once the time is set, press SET to return to the Operator Display.

Setting Pattern

Press the SET key once to arrive at the Pattern Field, the Pattern number will be displayed, the Pattern may be selected by using the UP or DOWN arrows for Patterns 1 through 4 and pressing SET to finalize the selection. The Patterns are not created in this menu, only selected by the Operator.

Setting Temperature

Setting the temperature "Set Point", or peak temperature, is easy. What you are setting is the temperature of the air coming out of the nozzle, not the temperature of the component or circuit board. The factory default setting for the LIBERTY BANDIT Top Heat temperature is 450 degrees (F), 232 C. To change the temperature, press the SET key for three seconds from the Operator Display. The lower display window will display the letters SV#. # = Pattern Number, SV = Set Point, 1 = Set Point # 1. The lower display window will indicate the current Set Point. Now press either the UP arrow key or DOWN arrow key to raise or lower, respectively, the temperature Set Point. Press SET when the desired Set Point is reached.

Safety Shutoff Timer

The LIBERTY BANDIT Storage Controller has a built in safety shutoff timer to disable the output after a preset time (Factory Default 10Min). Setting the timer to a value of 0 will disable the timer. See Parameter Setup.

Advanced Programming and Process Optimization

The LIBERTY BANDIT's programmable Pattern Storage Controller will allow the user to create and store up to four separate time/temperature Patterns for instant recall and use. The controller set point and ramp time can be controlled. In ramp/soak mode, the advanced operator can not only control the rate of ramp-up, but also program in a deliberate soak time, as the LIBERTY BANDIT ramps from ambient to Set Point. The procedures for doing so are described below.

A.P.E. Storage Controller Specification and Operation

Becoming Familiar With The Controller

The 8100-0114 controller is a digital controller used to control the temperature of the rework equipment. The controller has four operating Modes: 1, Manual Mode; 2. Timer function 2; 3. Timer function 1; 4. Ramp/Soak function.

Manual Mode: RUN/STOP is accomplished by operation of the foot pedal.

Timer Function 2: Same as Manual Mode except the controller can store four (4) Patterns.

Timer Function 1: Same as Timer function 2, except operation is automated. A two second foot pedal input will start RUN mode. If timer has been reset, the timer will count up, and requires a second foot pedal input to STOP. If the timer is set to a time, then a two second input will start the operation and STOP will occur when the timer reaches zero.

Ramp/Soak Mode: Operation includes four (4) Patterns, each having four (4) segments. Operation starts by a two second foot pedal input and STOP occurs at the end of the preset program.

Mode is selected by Pressing SET for approx. 10 seconds. ModE is displayed. Use up and down arrows to select which mode is to be operated. Hold SET for approx. 10 seconds to return to operators menu. Proceed to appropriate section for operating instructions.

Temperature Patterns:

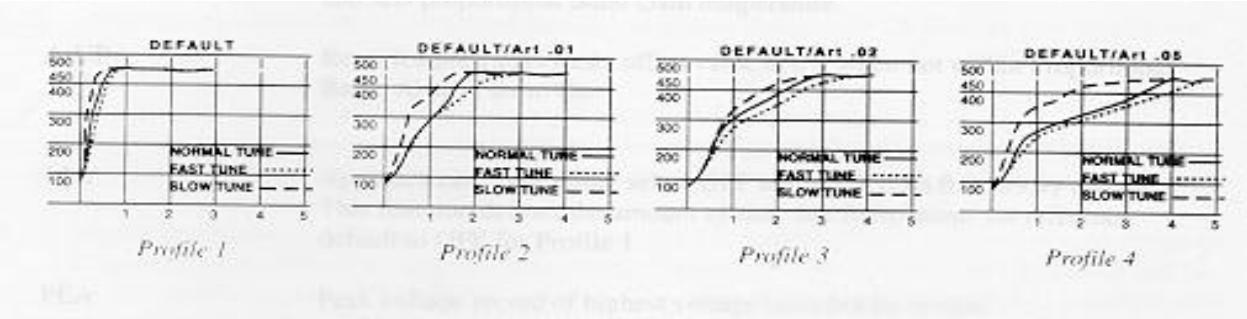
The LIBERTY BANDIT Reflow controller is preset to the following four (4) Patterns, T1 Mode. Each Pattern has a set point of 450F/232C with ramp times set to 0.00(Pattern 1), fastest ramp; 1.00 min (Pattern 2); 2.00 min (Pattern 3); 5.00 min (Pattern 4).

1. PATTERN NO. 1 Pattern for small dry QFPs, LCCs, and SOICs.

2. PATTERN NO. 2 208 QFP to 225 BGA in dry state.

3. PATTERN NO. 3 352 to 400 BGA's and 304 QFPs in 50% dry state.

4. PATTERN NO. 4 >508 BGA, CERAMIC components and large ground planes on Multilayer boards.



The LIBERTY BANDIT Preheat controller is preset to the following four(4) Patterns in T2 Mode. Pattern 1, Set point 300F/149C; Pattern 2, Set Point 250F/121C; Pattern 3, Set Point 225F/107C; Pattern 4, Set Point 200F/93C. All Patterns are preset for 0.00 Ramp time.

Manual Operation (Manual Mode only one Pattern available)

Pattern is started and stopped by foot pedal input. Timer will count up, if reset before or during RUN operation. Timer will count down if timer has been preset.

NOTE: Releasing the Foot pedal or pressing the R/S (Reset) key for one second will stop the program.

1. Pattern setup
    a. Press Set for 3 seconds (Note to exit this menu press SET again for 3 seconds):

b. SV is displayed, use up and down arrows to set temperature Set Point. Factory default: 450F/232C
c. Press Set: rMP is displayed. Ramp time can be set from 0 to 9 minutes 59 seconds. Factory default: 0:00
d. Press Set: TIM is displayed. Use up and down arrows to set Ramp Time. Factory default: 0:00

2. Parameter setting mode
    a. Press SET for approx. 10 seconds. (Note to exit this menu press SET again for 10 seconds)
    b. ModE (Mode) Set for required mode in this instance Man (Manual).
    c. AL1 Reflow Controller Setting 50F/28C Preheat Controller Setting 330F/166C
    d. ATU 0000 (Auto-Tune – only available in Manual Mode)
    e. P 50F/28C (Do Not Change – Factory Set Up)
    f. I 4 (Do Not Change – Factory Set Up)
    g. D 1 (Do Not Change – Factory Set Up)
    h. Ar 10
    i. T 2
    j. Pb 0 Sensor correction
    k. InP 0 = K thermocouple 1 = J thermocouple
    l. UnlT 0 = C degrees 1 = F degrees
    m. AS1 0 = No alarm 1 = Process High Alarm 2 = Process Low Alarm
    n. LCK Parameter mode SV mode
    o. 0000 unlocked unlocked
    p. 0001 unlocked locked
    q. 0010 locked unlocked
    r. 0011 locked locked
    s. Press SET for approx 10 seconds to return to operators menu.

Timer Function 2 (T2 Mode)

Operation is the same as Manual Mode, except there are four, one segment Patterns available. Pattern is started and stopped by foot pedal input. Timer will count up, if reset before or during RUN

operation. Timer will count down if timer has been preset.

NOTE: Releasing the Foot pedal or pressing the R/S (Reset) key for one second will stop the program.

1. Timer Setup
    a. Press SET
    b. ProF Use up and down arrows to select Pattern.
    c. Press SET
    d. TiM Use up and down arrows to set total Pattern time.

2. Pattern Setup:
        a. Press Set for 3 seconds (Note to exit this menu press SET again for 3 seconds):
        b. SV is displayed, use up and down arrows to set temperature Set Point. Factory default: 450F/232C Ramp Setup
        c. Press SET
        d. rMP 1 Use up and down arrows to set Ramp time.

12. Parameter Setup
    B) Press SET for 10 seconds. (Note to exit this menu press SET again for 10 seconds)
    C) ModE Select required Mode in this instance T2.
    D) AL 1 Reflow Controller Setting 50F/28C Preheat Controller Setting 330F/166C
    E) P 50F/28C
    F) I 4
    G) d 1
    H) Ar 10
    I) t 2
    J) Pb 0 Sensor correction
    K) InP 0 = K thermocouple 1 = J thermocouple
    L) UnlT 0 = degrees C 1 = degrees F
    M) AS1 0 = No alarm 1 = Process high alarm 2 = Process low alarm

N) TLMT Safety shutoff timer. 0 to 10 minutes*

***TLMT Note: The safety shutoff timer will shut off the controller output after the preset time. The Factory Setting is 10 minutes.**

O) LCK	Parameter mode	Ramp mode
0000	unlocked	unlocked
0001	unlocked	locked
0010	locked	unlocked
0011	locked	locked

13. Timer Function 1 (T1 Mode)

Operation is the same as timer function 2, except the foot pedal input is automated. Pattern is started and stopped by a two second foot pedal input. It is also possible to activate the cycle by pressing the Start Button on the Front Panel for 2 seconds. Timer will count up, if reset before or during RUN operation. Timer will count down if "TiM" total Pattern timer has been preset and the operation will STOP when timer reaches zero. Add time is also automatically added at the end of the removal cycle.

NOTE: Releasing the Foot pedal or pressing the R/S (Reset) key for one second will stop the program

1. Timer Setup

B) Press SET
C) ProF Choose required Pattern.
D) TiM Use up and down arrows to set timer value.
E) AddT Set add time to On or Off to automatically add time for component replacement.
F) AddT Use up and down arrows to set add time value. This is the amount of time that will be added at end of removal cycle, for component replacement.

2. Pattern Setup

a. Press Set for 3 seconds (Note to exit this menu press SET again for 3 seconds):
b. SV is displayed, use up and down arrows to set temperature Set Point. Factory default: 450F/232C
c. rMP1 Use up and down arrows to set ramp time. Factory default 0:00

14. Parameter Setup

B) Press SET for 10 seconds. (Note to exit this menu press SET again for 10 seconds)

C) ModE Select required Mode in this instance T2.

D) AL 1 Reflow Controller Setting 50F/28C Preheat Controller Setting 330F/166C

E) P 50F/28C

F) I 4

G) d 1

H) Ar 10

I) t 2

J) Pb 0 Sensor correction

K) InP 0 = K thermocouple 1 = J thermocouple

L) UnlT 0 = degrees C 1 = degrees F

M) AS1 0 = No alarm 1 = Process high alarm 2 = Process low alarm

N) TLMT Safety shutoff timer. 0 to 10 minutes*

***TLMT Note: The safety shutoff timer will shut off the controller output after the preset time.**

The Factory Setting is 10 minutes.

O) LCK

	Parameter mode	Ramp mode
0000	unlocked	unlocked
0001	unlocked	locked
0010	locked	unlocked
0011	locked	locked

Ramp/Soak Mode (RamP)

A maximum of four segments per Pattern with a maximum of four Patterns can be stored. Further, each Pattern can be linked together (Pattern link function). So, the setting of the Pattern with more than four segments (Sixteen segments maximum) is possible. The linking order of the pattern can be set freely. Depressing the foot pedal for 2 seconds RUNS the program. The program will automatically STOP at the end of the preset program. Set to pattern 1(first pattern in Pattern) before running the program

NOTE: Releasing the Foot pedal or pressing the R/S (Reset) key for one second will stop the program

The following example is for setting up Pattern # 1, for setting Patterns 2 – 4 use steps 2a – 2j in the example.

1. Program Setup for Pattern # 1
    a. Press SET
    b. Ptrn Select program Pattern (1 - 4)

c. Press SET twice.

2. Pattern Setup for Pattern # 1
   a. Press SET for two seconds.
   b. L1-1 Set temperature for segment 1. Press SET
   c. T1-1 Set Time for segment 1. Press SET.
   d. L1-2 Set temperature for segment 2. Press SET
   e. T1-2 Set time for segment 2. Press SET.
   f. L1-3 Set temperature for segment 3. Press SET.
   g. T1-3 Set time for segment 3. Press SET.
   h. L1-4 Set temperature for segment 4. Press SET.
   i. T1-4 Set time for segment 1. Press SET.
   j. EndP Program End/link setting for Pattern # 1
      0: Operation Stop
      1: Repeats Pattern 1
      2: Links Pattern 1 to Pattern 2
      3. Links Pattern 1 to Pattern 3
      4.Links Pattern 1 to Pattern 4

      k. Press Set and Hold for 3 seconds to exit menu.

3. Program Setup for Pattern # 1
   a. Press SET
   b. Ptrn Select program Pattern (1 - 4)
   c. Press SET twice.

3. Parameter Setting Mode

15. Parameter Setup

   a. Press SET for 10 seconds (Note to exit this menu press SET again for 10 seconds)
   b. ModE Select required Mode in this instance RamP.
   c. AL1 Reflow Controller Setting 50F/28C Preheat Controller Setting 330F/166C
   d. P 50F/28C
   e. I 4
   f. d 1
   g. Ar 10
   h. t 2

i. Pb 0 Sensor correction

j. InP 0 = K thermocouple 1 = J thermocouple

k. UnlT 0 = degrees C 1 = degrees F

l. AS1 0 = No alarm 1 = Process high alarm 2 = Process low alarm

m. TLMT Safety shutoff timer. 0 to 10 minutes*

***TLMT Note: The safety shutoff timer will shut off the controller output after the preset time. The Factory Setting is 10 minutes.**

C) LCK	Parameter mode	Ramp mode
0000	unlocked	unlocked
0001	unlocked	locked
0010	locked	unlocked
0011	locked	locke

8. REWORK CAUTIONS

As you become more familiar with the LIBERTY BANDIT and rework more complex assemblies, you will need to understand more about the LIBERTY BANDIT abilities - and limitations - and how certain applications require specialized techniques. You will also want to protect your machine so that it will give you many years of reliable service.

Nozzle Ventilation

As mentioned earlier, the LIBERTY BANDIT heats components with hot, forced convection. To achieve effective and efficient heating, an appropriate volume of air must always be encountering the target component in order to effect heat transfer from the air to the component. If the air is blocked, the LIBERTY BANDIT can't heat the component. Worse, the LIBERTY BANDIT heating element can overheat and shorten its life. Forced air is always flowing past the heater element when the machine's power switch is on. This cools the element between heating cycles; during heating, it allows the thermal sensor in the heater arm head to know when to add or cut electrical power to the element, because it "knows" how hot the air is. Therefore, always make sure that, during the heating cycle, sufficient convection is flowing through the nozzle for the LIBERTY BANDIT to operate properly. Between heating cycles, and after a shift is done, leave the LIBERTY BANDIT power switch ON for a few minutes to allow the convection flowing through the machine to cool the element down.

There are two instances where forced, heated convection through the LIBERTY BANDIT may be unavoidably restricted:

1. When a very small-diameter nozzle is used on small chip components; or 2. When it is absolutely necessary, on a mixed-technology board, to shroud the component being heated with the nozzle in

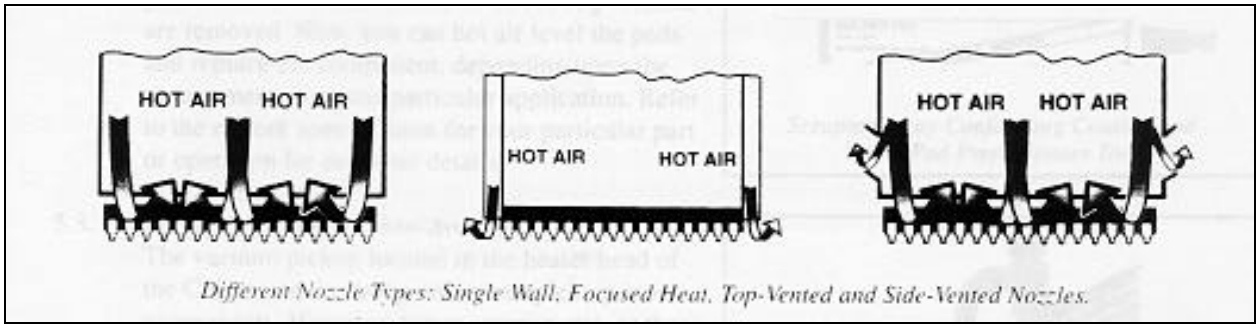
order to avoid heating delicate adjacent circuitry.

In the first instance, a top-vented nozzle is used (See Illustration) so that sufficient air can escape to prevent the LIBERTY BANDIT from overheating. Enough heated convection encounters the component to achieve solder melting. The heated air exiting the vents minimally affects the board (a slight warming) due to the height of the nozzle.

In the second example, a side-vented nozzle is used (See Illustration). This nozzle vents hot air upward out the sides of the nozzle and away from the circuit board. It allows sufficient airflow to heat the component without heating adjacent components; however, it is much less efficient than standard single-wall nozzle types as shown in the Illustration.

Another type of nozzle often used in applications with inert gas is the focused heat nozzle. This nozzle directs forced, heated convection at the component's lead attach area specifically, while shielding the component body from direct exposure. This nozzle is unnecessary for most, if not all applications and is a possible cause of over stress to the die and cannot be used for BGA rework.

IMPORTANT NOTE: When using vented nozzles, pause the machine after 20 - 25 heating cycles and remove the nozzle. Small nozzles are HOT! Use a hot pad or pliers or other hand tool to remove small nozzles - never fingers! Then let the Sniper Flo-Master cool for 15 - 20 minutes with the power switch (and blower) ON, until the controller's temperature indicator reads 120 degrees (F.) or lower, before resuming heating cycles.



Different Nozzle Types: Single Wall, Focused Heat, Top-Vented and Side-Vented Nozzles.

Removing Conformally-Coated Parts

Removing conformal-coated parts can be one of the most frustrating procedures in rework. If not done correctly, either or both the component and the board can be damaged irreparably. Using the LIBERTY BANDIT and a little technique, you can safely remove conformally-coated devices. The key word is patience; it is not only critical to melt the solder connections, but to soften the coating enough to allow the component to be removed. In such cases, the LIBERTY BANDIT vacuum pickup is not strong enough to lift the component off the board while it is held by the coating; probes (such as those in the SMD Tool Kit) must be used to free the component from the conformal coating first.

After heating has been applied long enough to melt the solder, use the probe #2 from the optional SMD Tool Kit (A.P.E. Part No.8100-1097) to apply slight positive pressure under the component to

gently break the bond of the coating as the chip ramps up in temperature.

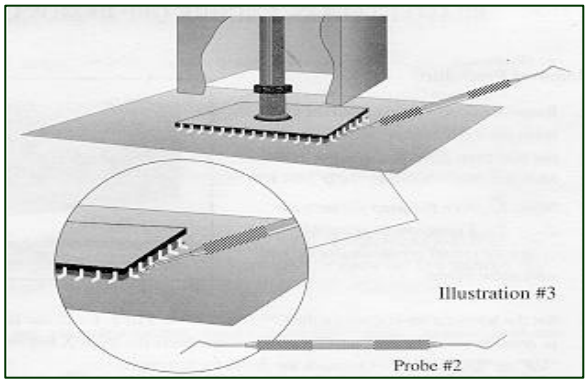
As the coating continues to soften, it will be possible to slide the probe completely under the chip. Loosen the chip gently, releasing it from the bond of the coating all around as shown. Be careful not to attempt to force the probe under the chip; as the coating softens, the probe will slide under the chip easily. Since the coating thickness may vary, the softening time may vary as well.

Once the chip is loosened completely, it can be lifted off the surface by the vacuum pickup.

While the board is still warm, use the probe #3 supplied with the SMD Tool Kit to scrape the coating from the center of the chip area, as shown.

Be sure to use the knife-edge side and take care not to damage the solderable pads. Then, use probe #1 to scrape the residual coating from between the pads, again, being careful not to damage the pads themselves.

Finally, use the Pad Prep supplied in the SMD Tool Kit to complete coating removal from the pads themselves by rubbing the pad prep on the pads themselves until all traces of coating material are removed. Now, you can hot air level the pads and replace the component, depending upon the requirements for your particular application. Refer to the rework specification for your particular part or operation for the other details.



9. Reflow Calibrations:

The "K" Type Thermocouple of the Reflow system is connected to the PID (Proportional Integral Derivative) Controller. The first check we need to do is to ensure that the thermocouple is correctly positioned within the Nozzle Block of the Reflow Head. This will provide an accurate temperature reading by the Controller Display. To carry out the check it is helpful for the user to understand how the system was originally calibrated and the standard that was used. In a hot air environment there are several variables, which effect temperature measurement, not least of which is the open chamber that includes the nozzle. As nozzles sizes obviously vary, the chamber will alter within a few degrees. To standardize a mean average, a PLCC44, 8100-0000-44, 0.80"x 0.80"(20.32mm x 20.32mm) Calibration Nozzle is provided with the system, and a circuit board placed 3/8"(9.52mm) under the nozzle. This environment matches the original calibration set up for the computerized registration of the PID Controller at the factory using Computer Profiling.

There are three (3) methods of calibrating the correct temperature measurement:

1. **Calibration using Computer Patternr.**

The first is to use the optional APE Pattern Development System (PDS) or a similar Profiling System, which will provide and accurate independent feed back of temperature Patterns and assist in amending any which are malfunctioning.

The PDS Test Rig includes embedded thermocouples, providing the feed back to the Patternr. The Test Rig should be mounted in the Board Holder and with the Test Component 3/8"(9.52mm) under the nozzle, Part No. 8100-0000-44. The PDS is then used to create a graph of the Pattern as the LIBERTY BANDIT runs through a selected Pattern from 1-4, which enables the user to confirm that the LIBERTY BANDIT is functioning within specification. The PDS Manual should be referred to for information as to the use of the Kic Patternr.

2. **Calibration using Temperature Probe.**

If the technology described above is not available, then the next alternative is to use a separately calibrated Temperature Probe attached to a temperature-measuring instrument and follow the steps below:

a. Insert an 8100-0000-44 Calibration Nozzle (Supplied with the system).
b. Select Pattern 2 and change the Set Point Temperature as described to 432F(221C).
c. Zero Time.
d. Depress the foot Pedal and allow the temperature to rise to 432F and dwell for a few seconds, check the reading on the probe, which should be within 5%(F) of the Controller, due to the Peak-to-Peak Proportional differential tolerance.
e. Should the readings compare unfavorably and the Thermocouple (TC) require repositioning, use a pair of smooth nose pliers to grip the TC outside of the Nozzle block, under the Heater Tube and if more temperature is required push the TC back towards the system by 1/16"(1.59mm). If less temperature is required, pull the TC into the Nozzle Block by a similar distance.

3. **Calibration using Eutectic Solder.**

If the foregoing Calibration test 1 & 2 are not possible, the properties of Eutectic Solder may be used to test Reflow Temperature.

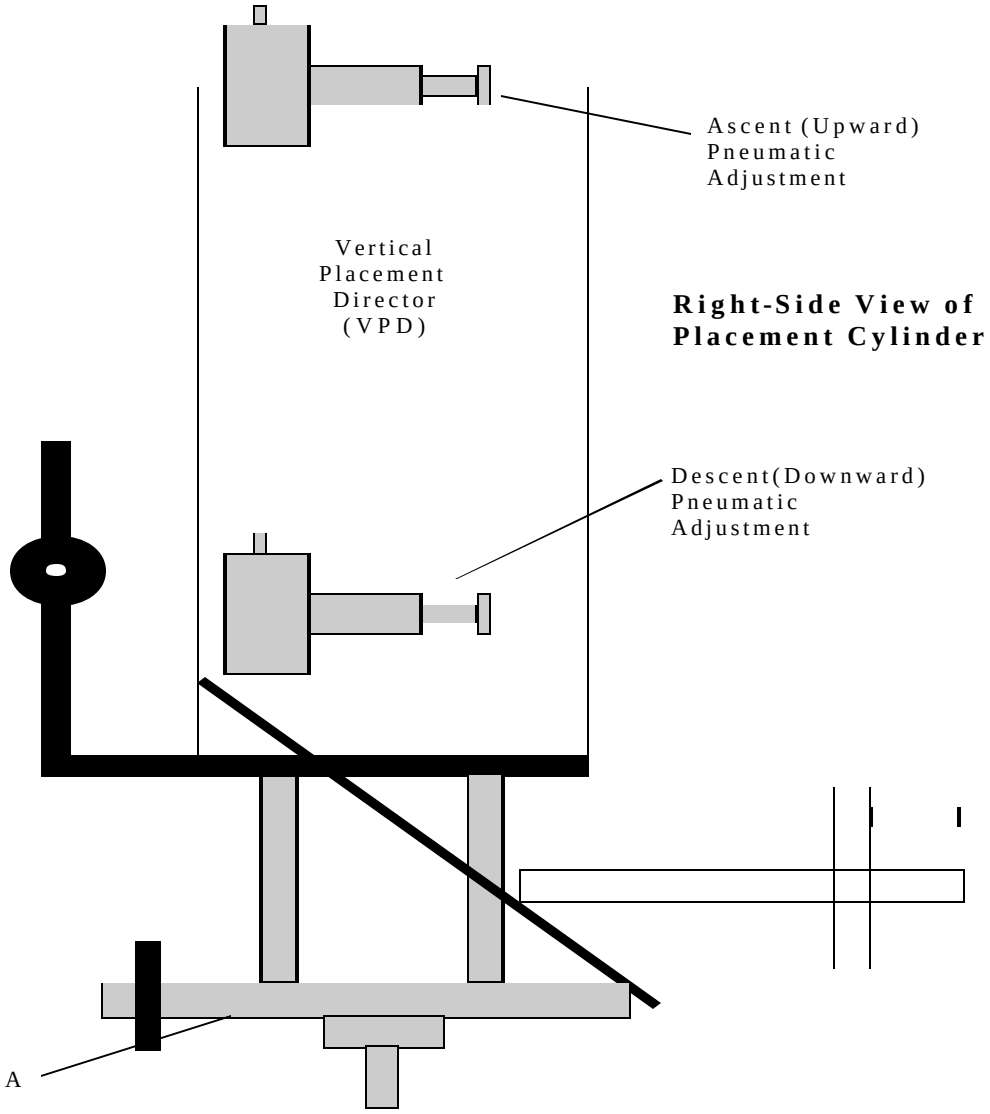
The following steps provide a simple test, checking that when the eutectic temperature is reached, 361F(183C) the controller displays a similar reading. Simply this entails using 63/37(Tin/Lead) solder wire.

a. Inset a 8100-0000-44 Nozzle (Supplied with the system).
b. Take a, 4-6 inch (100-150mm), length of 63/37 30AWG Solder wire and coil into a ball. Place the coil onto a junk or test PCB FR4 material (4"x 4", 100mm x 100mm) and place the Board holder 3/8"under the Nozzle. We now use the rise of temperature to check the eutectic condition.
DO NOT TURN ON THE BOTTOM HEAT FOR THE CALIBRATION TEST

c. Select Pattern 2 and change the Set Point Temperature to 350F.
d. Zero Time.
e. Depress the Foot Pedal and allow the temperature to rise to 350F, note the Timer and dwell for 20 seconds, no reflow should occur.
f. With the Foot Pedal still depressed change the Set Point Temperature to 355F. Return to the Operators Display, raise to temperature, and dwell for 20 seconds, the solder should just start to form a liquid film, due to the Peak to Peak Proportional differential tolerance set in the PID Controller.
g. With the Foot Pedal still depressed change the Set Point Temperature to 361F. Return to the Operators Display, raise temperature for 20 seconds, the solder should go completely liquid.
h. If the solder should go liquid either before or well after 31F, follow the TC adjustment procedure in 2. d1 and run the test again.

10. **Procedure for correct Alignment of the VPD and Prism System.**

In addition to the pneumatic input controls on the rear panel of the LIBERTY BANDIT, it is possible to tune the speed (pressure) of the DOWNWARD motion of the Vertical Placement Drive (VPD), by adjusting the Bottom DOWNWARD release Valve as Fig below. The Top release Valve controls the UPWARD stroke, this is permanently Factory Set and it should no be necessary to be adjusted by the User.



An Alignment Kit is supplied with the LIBERTY BANDIT, comprising a QFP208 Chip and a Test PCB with a QFP208 footprint. Also included is a .312"Vacuum Barb attached to the Vacuum Gantry (A above) to support the chip alignment.

Prism Alignment Procedure

Initial Mechanical Set Up:

A. Checking the VPD Alignment in the "Component View" position. (Note: This is a factory set up Procedure and should not require adjusting).

1. A quick test is to use the Shipping Pin supplied with the system. Insert it into the right hand side of the Hood Assembly, so that it passes all the way through to the left side. The Pin should be tight, but able to be forced through. Alternatively, check the Forward "Front Lock Nut" location, which sets the Right Angle square position from the front of the Hood Assembly to the base of the machine, an Engineers Square is used for this setting.

2. Also ensure that the Hood Return Stop (located at the very top of the system) is not interfering with the return of the Hood to its correct rest position and that the Hood is riding freely in its guide wheels.

B. Checking the VPD Alignment in the "Component Placement" position. (Note this is a factory set up Procedure and should not require adjusting).

1. Check the rear lead screw "Back Lock Nut' location, which sets the Right Angle square position of the VPD Cylinder Bracket to the base of the machine, an Engineers Square is used for this setting. Adjust if necessary.

C. Checking the Cylinder Piston Height:(Note this is a factory set up Procedure and should not require adjusting)

1. With the VPD in the "Component Placement" position and a large vacuum Barb fitted to the Vacuum Gantry, check that the correct height of the vacuum barb is 105-106-mm. Adjust if necessary by loosening two (2) screws, holding the Cylinder to the cylinder Bracket. Then tighten all screws.

D. Checking the Vacuum Gantry position and Focal Adjust. (Note this is a factory set up Procedure and should not require adjusting.)

1. Return the VPD to the component "Component View" position (without a component in place). View the Vacuum Gantry on the Monitor, adjust the camera zoom & focus so that the total Vacuum Gantry is in view. Check that the Vacuum Gantry is to the far right; this can be confirmed if the two Allen screws securing the bar are in the left most position. If needed, adjust the gantry by removing the vacuum barb and loosening the two gantry screws with an Allen Key 7/64"" and move the gantry until right adjusted. Do not over stress. Reinstall the barb.
2. With the Board Holder outside of the Placement area, move the Optics hood and VPD to the "Placement" position.
3. Check that the Focus Adjust Screw, located on the front of the Vacuum Gantry is adjusted, so that only four to five (4-5) threads are seen below the Gantry. This provides the correct prism focal distance for a QFP208 Alignment Procedure.

At this stage the initial mechanical Set Up is completed. The following details the procedures for aligning the Prism using a QFP208, which also acts as a procedure to ensure that BGA and CSP components are correctly placed.

E. QFP Alignment Procedure

1. Use the Alignment Kit comprising a QFP208 and a Stencil Template with a 208 footprint.

2. Install a large 0.512" Vacuum Barb

3. Mark center of QFP with scribe. A small "x" in the center will suffice. (This is helpful, but not essential)

4. Move the Board Holder away from the VPD and adjust the Z-axis on the Board Holder so that the Board Holder is at its lowest level.

5. Place the Stencil Template into the top recess of the Board Holder and very carefully (manually), so as not to bend the delicate leads, place the QFP208 into the Stencil QFP208 footprint. This will exactly align the QFP208 into the Stencil footprint

6. Slide the Board Holder under the Vacuum Barb. Gently adjust the Board Holder using the Z-axis thumb wheel adjustment screws on each side of the Board Holder, so that the Vacuum Barb is just a fraction above the QFP208. Operate the VPD to ensure the Vacuum Barb does not apply any downward pressure on the QFP, so as to distort the leads.

7. Without operating the vacuum switch raise the VPD to the "Component View" position. Now using the Monitor and camera, adjust zoom and focus, so that the entire Component and Stencil footprint can be seen in the center of the screen, with the Vacuum Barb ghosted in the center of the component image.

8. Install the Diagonal Viewer (Mirror Splitter 7000-2500), between the Prism and the camera. Twist the Diagonal Viewer to obtain a correct perspective. Adjust zoom and focus to expand the view and adjust the mirror screws so that two of the (4) corners of the chip and footprint are easily and clearly seen. It may be necessary to adjust the lighting aperture to remove the dark diagonal in the middle. Note that only a few of the leads on two (2) diagonal corners need be seen.

9. Operate the VPD to bring the Vacuum Barb to the center "x" of the chip. Operate the vacuum switch and capture the component. Actuate the VPD to lift the QFP208 from the Stencil. Then return the VPD again to the "Component Placement" position, turn off the vacuum and check that the chip did not fall, or was not pressed into the footprint and that all leads remain centered

10. Also check whether the chip is coplanar from the back to the front during placement. This can be seen as a difference in the placing of the chip, from the back to the front of the component. If a coplanar adjustment needs to be made use a 5/32" Allen Wrench and loosen the lower screw on the right hand side of the Placement Cylinder. It is then possible to pivot, by gently pushing or pulling the Cylinder so that any coplanar issue is resolved. Tighten the screw securely after adjustment.

11. If the chip is still aligned on the monitor, operate the VPD again and switch on the vacuum. Bring the component to the "Component View" position. The component should remain aligned on the monitor, if not then adjustment must be made.

12. Remove four (4) screws retaining the Prism cover. With the Prism and adjusting screws exposed loosen the center-knurled nut of the Rotary Adjust. With a 5/64 Allen Wrench inserted in the center hole, of the Rotator. Exert a little pressure left or right to adjust the vertical leads on the image. Then with an Allen Wrench adjust the Vertical Elevation screws on the right of the Prism.

Adjust the screws to correct the horizontal leads on the image. (Do not over tension these screws as they can bite into the aluminum Prism Plate)

13. Tighten the Rotary Adjust nut and finally check that all leads are aligned to the Stencil footprint. Operate the VPD to bring the component to the "Component Placement" position. Switch off the vacuum and ensure that the component settled evenly and check correct alignment by viewing the monitor. Place a few times to ensure accuracy.

14. If the Alignment Procedure was successful, replace the Prism Cover Plate.

15. If there is difficulty in aligning the component to the Stencil footprint, it may be necessary to again check the Focus Adjust screw and either raise or lower the screw so that 1 more thread is seen under the Vacuum Gantry. An incorrect adjustment will be seen as a theta inaccuracy. If it is still not possible to achieve exact alignment, then the entire Prism mechanism base should be slackened (not removed) and tightening all screws supporting the prism mechanism should enact a gradual adjustment.

Note: The QFP alignment procedure is correct only for the level (height) at which the component is aligned. If another level of component is required, the procedure should be checked again at the new level. This should only be a case of adjusting the Focal Adjust Screw.

For BGA & CSP applications the procedure for level (height) need not be so exact, as the view is two (2) dimensional and parallax is not an issue.

Footnote:

If the Stencil Template is not available, the procedure may be carried out on a Test PCB with a QFP208 footprint, as follows.

When at step 6, of this procedure, align the chip on the QFP Test PCB footprint, this is tricky, but should be done accurately until all leads and pads are exactly centered. Look at the monitor, while lightly moving the component into position using a probe or the edge of your forefingers, take care not to bend the leads. Follow procedure thereafter.

11. Environmental Information:

The system is designed for operation within a modern assembly plant having control of relative Humidity of 60% and temperature of 10° Celsius to 35° Celsius.

Power:

High Voltage Power is used to power the LIBERTY BANDIT SMD-7500. Systems are specifically designed for single phase:

.100/120V
.220/240V

Ventilation:

When in use the materials used in the mounting of components can emit uncomfortable solder fumes during the reflow or chip extraction operation. A flexible arm Fume Extractor is recommended, with a minimum bore of two (2) inches. The inlet should be located as close to the work as possible. The Fume Extractor should be finally exhausted through a filtration unit to a minimum standard of 99-9777% pure air.

Lighting:

The LIBERTY BANDIT SMD-7007, includes illumination for chip placement and a Halogen Light for Reflow attention; however it is recommended that the system be situated in an area of good and adequate lighting, which does not cast shadow.

Electro Static Discharge (ESD) Precautions:

As the LIBERTY BANDIT has been designed to specifically rework modern PCB's and sensitive components, ESD precautions must be taken at all times. The LIBERTY BANDIT should be installed in an EDS safe environment with the necessary controls and grounding conditions. The LIBERTY BANDIT is grounded and being of an, all metal construction, does not support a static charge. However a wrist strap, of 1 Meg ohm impedance, connected through a common point ground connection must ground the operator. All ESD precautions and controls are the responsibility of the User.

12. Maintenance and Cleaning Instructions:

Cleaning: Use only a soft cloth to apply and polish. Nozzles and vacuum pickup suction cups should also be cleaned daily with alcohol to prevent flux buildup. Flux buildup on nozzles can burn and cause contamination of the circuit board. Any flux spillage or buildup, including on the Board Holder, should be removed daily with alcohol.

Lubrication: Occasionally, the Board Holder and Vacuum Pickup Assembly should be lubricated. Apply a drop of high temperature lubrication oil to the exposed part of the assembly above the heater head (under the spring) once every week or two, or whenever movement seems dry of tends to bind. Do not over lubricate! Excess oil can run down and contaminate the circuit board.

Handling: The LIBERTY BANDIT is too heavy for normal lifting, excessive or indelicate handling could result in damage to the Vision Mechanism and Reflow heater elements. When transporting, pack the LIBERTY BANDIT in its original crate and packing material; cushion it well against any impact. Avoid contacting the area beneath the heater arms, or at the VPD and Vision area, always lift from the base. It is recommended that mechanical handling equipment be used in lifting and transporting the LIBERTY BANDIT.

Vacuum Cup Replacement: Vacuum pickup suction cups have a life of approximately 300 – 400 heating cycles (component removals or replacements), depending on temperature. The higher the Set Point the shorter the cup life. When they become cracked, replace them immediately.

Reflow Calibration: See Section 8, for procedure. Recommended check - every six (6) months.

Prism Alignment Check: See Section 9, for procedure. Recommended check - every six (6) months.

Changing Fluorescent and Halogen light bulbs:

1. To replace the PCB Illumination (front) fluorescent bulb, actuate the VPD, so that the VPD is in the Component Placement position, switch off and then disconnect the power to the machine. This provides access under the VPD. Using a 5/64" Allen Wrench remove the two inner screws on the mounting bracket, which support the plastic molding of the bulb. Pull out the bulb and change. Replace the mounting bracket. Replace the connection to the machine and switch the power on. Wait a few seconds before bringing the VPD to the "Component View" position.

2. To replace the component illumination fluorescent bulb, it is necessary to remove the upper most rear panel of the machine. Switch off the power and disconnect the supply cable. Remove the Rear Panel screws using a 5/64" Allen Wrench. The Fluorescent fitting will be clearly seen at the far end of the VPD. Remove the inner mounting bracket screws. Replace the bulb by pulling out and change. Replace the bracket and replace the covers. The power cord may now be connected.

3. Halogen Light: Disconnect the power lead of the Halogen Light from the rear 120V outlet at the rear panel. Unscrew the Hood Shade of the lamp to expose the bulb, pull out the 2-pin fitting and change. Replace the Hood Shade and reconnect the power cord.

13. Technical Specification:

Physical:	**Imperial**	**Metric**
Dimensions:	24" x 32" x 24"	609.6 x 812.8 x 609.6mm
Weight:	80 lbs	36.3 Kgms
Shipping Weight:	95 lbs	43.1 Kgms
Shipping Dimension	26.5" x 33.5" x 25.5"	67.3 x 85.1 x 64.7CM
Shipping Method	Heavy Duty Cardboard Box	

Supply Ratings:

Voltage:	110/120V dedicated system designated by code 7500-1000	
	220/240V dedicated system designated by code 7500-1502	
Power	1800/2500 Watt	
Power Consumption:	110/120V	16.36/15.00 Amp
	220/240V	11.36/10.42 Amp

Fuse Panel:

Description	Rating
Main Power:	15 Amp x 1
Blower Motors:	2 Amp x 2
Heater elements:	12 Amp x 2
Accessories:	5 Amp x 1

Interconnection Accessories 100/120V:

Location:	Bottom Rear Panel See page 14
Fuse Rating:	5 amps
Quantity:	Two (2) Outlets
Purpose:	Connect APE accessories, Halogen Lights and/or Monitor. (See Install Page 9 Sec. H)

Digital Camera:

Signal Format:	NTSC
Power:	DC10-12V
Power Consumption:	250mA

Illumination:

VPD Fluorescent	19V Transformer 120V/19V
Rating:	12 Watt
Halogen Goose Neck:	12V Transformer 120V/12V
Rating:	20 Watt