A.P.E. Chipmaster™ BGA/QFP/SMD Rework and Repair Station

Operator's Manual   Revision IV 09/13/01

Contents:

1.1. INTRODUCTION

1.1.1 Automated Production Equipment's Chipmaster ™ BGA/QFP/SMD Rework and Repair Station is an advanced, programmable hot air-based rework station for removing and replacing BGAs and other surface mounted components from printed circuit boards. The Chipmaster is designed to remove and replace defective BGAs, QFPs, and all SMDs, essentially all types of surface mounted components from all types of circuit boards from military/aerospace guidance systems and mainframe computers to pagers, 2-way radios and cellular phones.

1.1.2. The Chipmaster uses directed forced hot air to gently heat electronic components at a rate of 12.7 CFM to the temperature required to "re-flow" or melt the solder connecting their leads to the circuit board. This forced air is provided by an internal blower and heated by a resistive element in a tubular chamber.

The 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 mainly 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 temperature of the heated air - as well as the rate that it heats up, is controlled by the Chipmaster's microprocessor-based programmable storage controller. This is essentially the "brain" of the unit.

1.1.3. The Chipmaster contains a vacuum pump to pick up components at the nozzle. Placement of components can be done manually or with the aid of a vision system, which could be a Microscope or a "Look Up Look Down" automatic placement system, such as APE's "Sniper." Because the Chipmaster contains an internal vacuum pump, it does not require any shop air or utilities beyond a single 110/220VAC power outlet, either wall outlet or strip, 3-leg grounded, like any other power appliance. The Chipmaster requires a maximum of 15 amp service.

1.1.4. Controls for the Chipmaster are located on the front of the unit. These include Main Power On/Off, Vacuum Pump On/Off, the Controller itself, and a ground plug for wrist straps or other ESD protective devices..

1.1.5. This manual is designed and intended for personnel actually using the Chipmaster. This manual contains an overview of the Chipmaster itself, how to unpack, inspect, assemble, and power up the unit. It contains an overview of the rework process, and how to use the Chipmaster to remove and replace defective components, and how to accomplish light assembly using the Chipmaster. The operator will learn how to create, test, store, retrieve, and modify thermal profiles for removal, and to program the controller. By the end of this manual, you, the operator, will understand the essentials of hot air rework, and the essentials of operating the Chipmaster to service virtually all types of surface mount circuitry. The Chipmaster is an easy to use, reliable machine that is easy to understand and learn. 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 sales@apecorp.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.

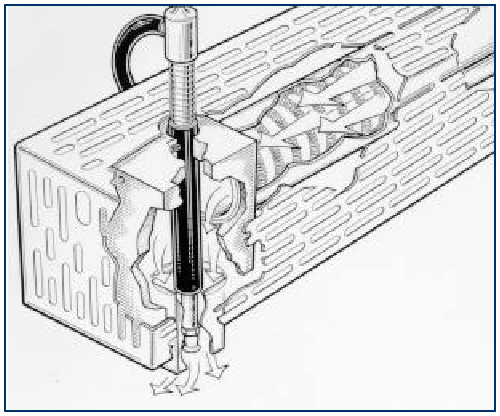
1.2 UNPACKING AND INSPECTION

1.2.1. Before opening the shipping box, make sure that the box is in an upright position. Gently remove the package sealing tape, and open the box. Remove the top Styrofoam panel. Beneath will be a molded Styrofoam compartment containing parts and accessories to the Chipmaster. Remove that compartment and set it aside gently. CAUTION: the top compartment contains small parts. The bottom molded Styrofoam compartment contains the Chipmaster, plus other boxed accessories, depending upon the model that you purchased and options. If there are other boxes, open them in the same manner, and inventory the parts inside, checking them carefully against the packing list and shipping documents. Inspect for damage. Report any damage immediately to the A.P.E. factory, Tel. (305) 451-4722.

1.3 ASSEMBLY

1.3.1. Remove the Chipmaster from the box and set on a firm and level benchtop near a 110/220VAC power source with a grounded (3-prong) outlet. Do not attach the Chipmaster's power cord until all other parts of the unit have been attached or installed!

1.3.2. The component pickup vacuum plunger is shipped in the top molded Styrofoam compartment. A small clear plastic bag also will contain extra red or blue RTV silicone rubber suction cups and an extra black rubber plunger cap. These are spare parts and should be inventoried and stored where they can be retrieved without delay or difficulty. Remove the plunger assembly from its wrapper and inspect. It should have a black cap attached to the top, and a red suction cup to the bottom. The plunger's precision controlled force spring should be on the barrel of the pickup assembly. Remove the plastic wrap from the plunger assembly.



Insert the barrel of the plunger through the top of the sleeve in the Chipmaster's heater head. Push the plunger up and down a few times to make sure that the action is smooth, fluid, and without friction or binding.

1.3.3. The black hose looped and tucked into the left side of the heater head should be gently pulled until the loose end, tucked under the heater arm, comes out. Do not pull the end going into the side of the perforated heat shield. Gently attach the open end of the tube to the barbed brass nipple on the fitting on top of the plunger assembly, up under the black rubber cap. The vacuum pickup plunger assembly is now ready to operate.

1.3.4. Unwrap the foot pedal actuator and place the pedal itself on the floor. The connection end is a 3-prong in-line male connector with a white plastic sleeve. Locate the corresponding fitting on the back of the Chipmaster. NOTE: The configuration of the plug is such that it can only go in one way. Do not try to force the plug! Turn it over and try it the other way. It should slip into the socket easily.

1.3.5. The Chipmaster's power cord is similar to the power cords used for computers. It is removable, and the end *opposite* the male 3-prong plug that goes into the wall outlet is a six-sided female 3-prong plug. This end attaches to the back of the Chipmaster, and will only go in one way. Before plugging the cord into a wall outlet, locate the green plastic Main Power switch on the front of the Chipmaster (See Illustration) and make sure that it is in the OFF position.

Locate the red plastic Vacuum Pump power switch and make sure that it is in the OFF position. Then plug the main power cord into the wall outlet or appropriate 110/220VAC power source. Make sure, however, that the power cord end is firmly pushed into the socket on the back of the machine.

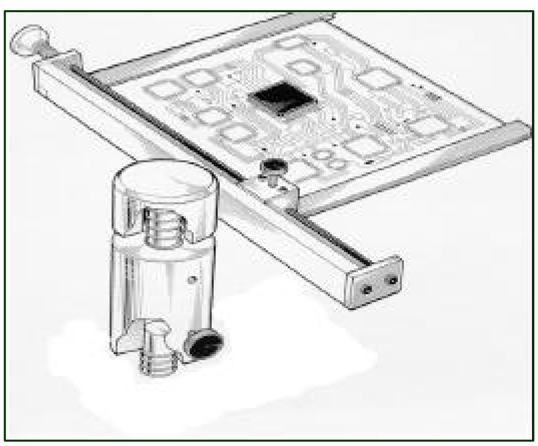
Note also the ground socket on the right-hand side of the Chipmaster front panel. This is for wrist straps and other ESD protection devices with standard plugs. The socket is a ground only to the cabinet of the unit and cannot expose the operator to machine operating current.

1.3.6. Take note of the back of the Chipmaster. Besides the plugs for the foot pedal actuator and power cord, there are two three-prong 110/220VAC outlets. These outlets are for Chipmaster accessories, such as the illuminated magnifier and the goose neck halogen lamp. They are NOT for high-demand electrical soldering tools, other Chipmaster power cords, etc. There is also a 15 ABC amp fuse socket on the back of the Chipmaster. The Chipmaster contains its own internal vacuum pump.

1.3.7. Your Chipmaster may be equipped with a black goose neck halogen lamp to illuminate the work area. This lamp attaches to a mounting plate that must be attached to the bottom of the Chipmaster.

Halogen Lamp

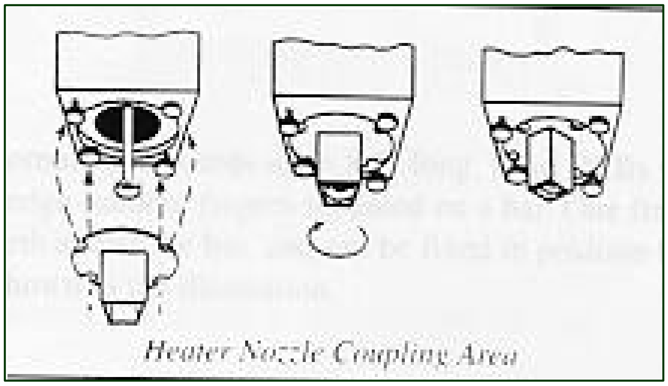
UNPLUG THE CHIPMASTER FROM THE 110V WALL OUTLET PRIOR TO LAMP INSTALLATION. Remove the plastic covering from the halogen lamp, and from the black anodized mounting plate. A small clear plastic bag, in the mounting plate wrapper, contains six (6) hex head machine bolts; four (4) are black colored, and two (2) are metallic. Use a 9/64" hex key to attach the bolts. The plate mounts under the right-hand side of the Chipmaster (when facing the unit), fitted such that the top of the beveled plate is flat or level with the table beneath. The “thick” part of the plate should face forward, the “thin” part aft. First, mount the lamp to the plate using the four pre-drilled holes and the black bolts. Then, lift the Chipmaster and turn it over so that it is resting on its side. Use the two remaining metallic-colored bolts to fasten the mounting plate (and lamp) to the bottom of the Chipmaster through the pre-drilled and pre-tapped holes in the bottom of the unit. Return the Chipmaster unit to its proper upright position. Insert the power plug from the halogen lamp into one of the outlets on the back of the Chipmaster. Plug the Chipmaster’s power cord back into the wall outlet.



1.3.8. Your Chipmaster is supplied with a PC board holder. This holder, as shipped, is in two parts, each individually wrapped in clear plastic, in the upper molded Styrofoam compartment. The base of the unit is black anodized and cylindrical, attached to a flat base plate. The holder frame itself is golden in color (anodized) and attaches to the base unit via a single hex head machine bolt in a square machined slot on the cylindrical base. Use a 9/64" hex key to attach the bolts. Simply loosen and remove the bolt, and fit the holder frame into the

slot, black knob on the holder frame upward, and then insert the bolt and tighten. Due to the position of the pre-drilled hole, it is not possible to attach the frame upside-down.
The black knob can be loosened to allow the holder slide finger to move. The use of the board/workpiece holder will be discussed in greater detail later in this Manual.

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


Heater Nozzle Coupling Area

Now note the shape of the nozzle, and the circular top with four indents. Nozzles mount bayonet-style onto the heater head. Align two of the four semicircular holes in the nozzle top with the two 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 inverted cool nozzle socketed inside the hot one, will be required for nozzle changing.

1.4 POWER UP

NOTE: NEVER OPERATE THE CHIPMASTER WITHOUT A NOZZLE IN PLACE AND NEVER SWITCH OFF THE SYSTEM ABOVE 120 F IN THE RED DISPLAY.

1.4.1. Once the Chipmaster has been assembled and plugged into a power source, it is ready for power-up. First ensure that a nozzle has been inserted, 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. Immediately, the Controller 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 blower will immediately begin operating, and will blow a stream of cool air down through the nozzle. The upper ORANGE L.E.D. indicator will indicate ACTUAL AIR TEMPERATURE in degrees Fahrenheit. The bottom GREEN L.E.D. will indicate STOP. Insure the controller is set for T2 Mode, by pressing and holding the set button until ModE is displayed(Approx 10 seconds). Use up or down arrow to select T2, then hold set button for 10 seconds to return to operators menu.

1.4.2. Depress the foot pedal and HOLD IT DOWN. The Chipmaster air temperature will begin to ramp. The Controller's ORANGE readout will indicate 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, since the air exiting the Chipmaster rises rapidly in temperature and within a few seconds becomes quite HOT. The GREEN readout on the controller will indicate time. This is a timeout indicator and will be explained in greater detail later in the section referring to the controller (Section 4.2.1.).

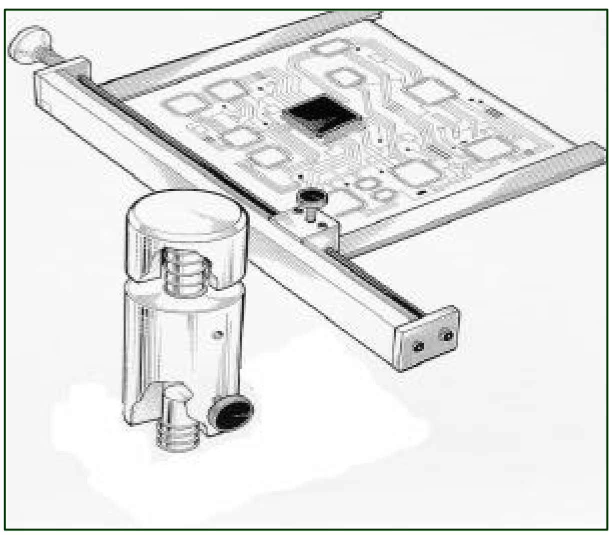
1.4.3. Release the foot pedal. The air coming out the nozzle will begin to cool rapidly. The ORANGE indicator will show the temperature rapidly decreasing. The GREEN readout will again indicate STOP.

1.4.4. With the Main Power switch still ON, test the vacuum pump. To do this, depress the red vacuum pump switch to the ON position. The red switch will illuminate, indicating that power is ON, and a sound from the interior of the machine will indicate that the vacuum pump is operating. Depress the pickup plunger and feel the bottom of the suction cup with your finger. There should be a slight suction feeling, indicating that the vacuum pump is working.

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

2.0 THE CIRCUIT BOARD WORKHOLDER

2.1 . The adjustable circuit board workholder can accommodate boards up to 8.5" long. Most PCBs will be smaller. The holder consists basically of two edge-holding fingers mounted on a bar. One finger is fixed in position; the other can slide back and forth across the bar, and can be fixed in position by tightening the black-knobbed friction screw as shown in the illustration.

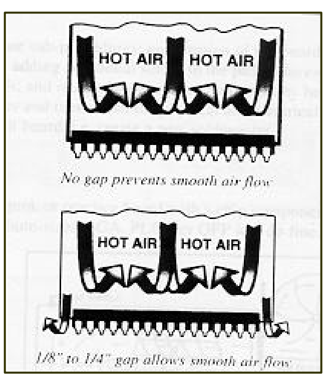


2.2. The inside edges of the edge holder fingers are V-grooved so that thin boards may be held securely without dropping. The workholder features a unique gentle constant pressure clamping action designed to hold boards securely. To adjust the holder, set one edge of a board in the V-groove of the fixed edge holding finger. Loosen the friction screw and move the adjustable edge holder finger out to within 1/4" or so of the edge of the board. In other words, the distance between the two fingers should be LESS than the length of the board. Now tighten the screw. Depress the black knob (push in to compress the spring) at the end of the holder to open the “jaws”. Slip the board in between the holders. Release the knob. The spring pressure against the knob will hold the jaws together and effectively "clamp" the board in place in the holder.

2.3. 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. Some boards may be too large for the holder, and may be positioned on top. The Chipmaster Circuit Board Workholder is not intended to handle all circuit boards, only the most common sizes.

2.4. The cylindrical column of the workholder stand can be height adjusted using the black-knobbed friction screw on the side of the column. The column height is spring-tensioned. To adjust column height, loosen the screw. The column will go to its absolute height limit. Grip the body (not the top) of the cylinder and gently push down until the desired height is reached. Then tighten the screw.

2.5. The "plunger" action of the top of the unit is designed to allow components with heat sinks on top, or with special accessibility problems, to be positioned under the nozzle. First, however, the height of the stand must be optimized. To do this, mount a board in the holder and slide the stand and board under the Chipmaster. Depress the plunger top and move the target component directly under the appropriate nozzle. Release the plunger slowly. The spacing, from the top of the component to the bottom of the nozzle should be 1/8" to 1/4." If there is too much space between the nozzle and the component, loosen the friction knob on the side of the column and adjust until the component is directly under the nozzle with the right spacing for air escape

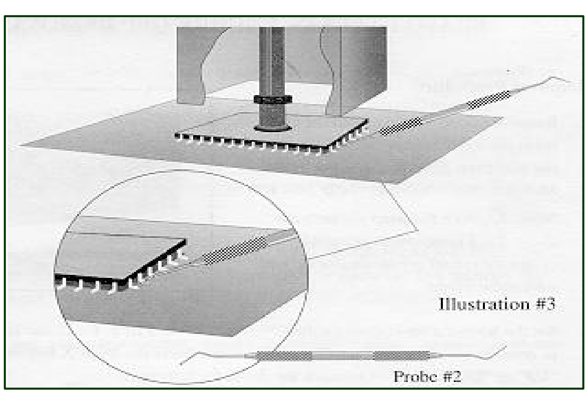


If the adjustment is too high and there is danger of the component touching the nozzle, adjust the cylinder down. In almost all cases, you should need to depress the plunger to slide the board in, and the same to slide it out.. The plunger is also useful to prevent other higher components from striking the heater nozzle. Therefore, always keep the plunger depressed when sliding the board holder assembly and boards around in the vicinity of the Chipmaster nozzle.

2.6. **Maintenance Note:** Avoid getting flux, solder, adhesives, etc. on the metal rod that the adjustable edge holder finger slides on. Foreign material could cause it to bind. Keep the rod 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 screws on the holder assembly. Finger-tight, just enough to prevent movement, is sufficient.

3.0 Getting Started

3.1. Rework is the process of removing and replacing BGA and chip components on a circuit assembly. Removal involves heating up the component area and the component's leads, until the solder connecting the leads to the board melts and becomes liquidous, or molten. It's important to remember that the solder establishes both a *physical* as well as an *electrical* connection between the legs or leads of the component and the circuit board. This connection is called a *solder joint*. Once the solder holding the solder joint together is molten, the component can be lifted off the circuit board by the Chipmaster's vacuum nozzle pickup, or by an external vacuum wand. The only force holding the component to the board will be the surface tension of the solder. This surface tension can help align or center components when re-attaching them; it also ensures that, after removal, some solder will be left on the component leads, and some will be left on the "pads" on the circuit board.



Sometimes, components are also held down by a clear *conformal coating* that must be softened and broken before a component can be lifted off the circuit board. This procedure will be covered later in this manual.

Once a component has been removed, a new one must be reattached in its place. Since surface tension has kept some solder on the pads, and the solder may resemble upside-down icicles, the pads must be *hot air leveled* before a new component can be soldered in place. This topic will also be covered later in this manual.

Replacing components involve three separate sub-procedures:

Preparation of the board to receive the component, such as hot air leveling or adding additional solder to the pads.

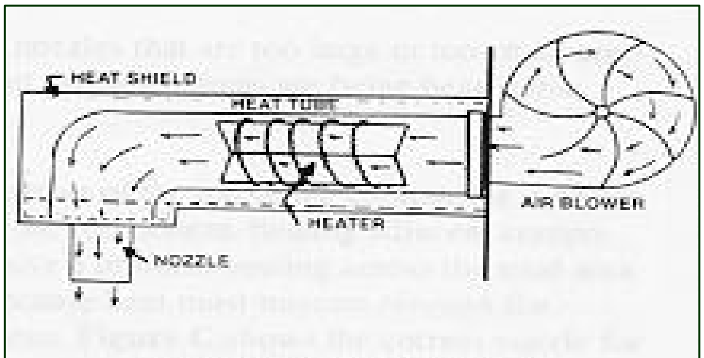
Placement of the component, and aligning it properly on the pads.

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.

3.2. *Let's Get Started!*

The best way to get started is to practice. Select a junk or practice board with a chip component attached. Don't pick one that's too difficult; a medium-sized BGA, PLCC or QFP will do fine. Select a nozzle that fits the component. Attach this nozzle to the Chipmaster, by fitting it into the machined recessed cavity and turning it so that the retainer screws hold the lip of the nozzle in. Now set the nozzle height by adjusting or setting the height of the circuit board holder. What height is correct? To understand the correct relationship between nozzle and component, we have to understand the heated air flow scheme of the Chipmaster. Never operate the Chipmaster without a nozzle in place, as this will significantly reduce the life of the heater!

The scheme of air flow through the Chipmaster is 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, shows 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 BGA and the solder joints. The spent air, now cooler, moves up and away from the surface of the board.



Chipmaster Air Flow System

The Chipmaster, then, 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 Chipmaster is unique in that it heats with *high power, low velocity* convection. This means that components can be removed and replaced at much lower temperatures than would otherwise be necessary; and at a moderate air flow velocity of 12.7 CFM, reducing risk of thermal damage to adjacent components. The Chipmaster can heat gently without moving or dislocating components. Most importantly, it minimizes the potential for heating areas or components adjacent to the area you want to heat.

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 much unnecessary heating of adjacent component and the circuit board.

In rework, the primary goal is to heat at an optimum low temperature removing and replacing components without damage to the board and surrounding components or the integrity of the remaining solder.

Figure 3 shows the correct height relationship of nozzle to component, with 1/8" to 1/4" gap for air flow escape.

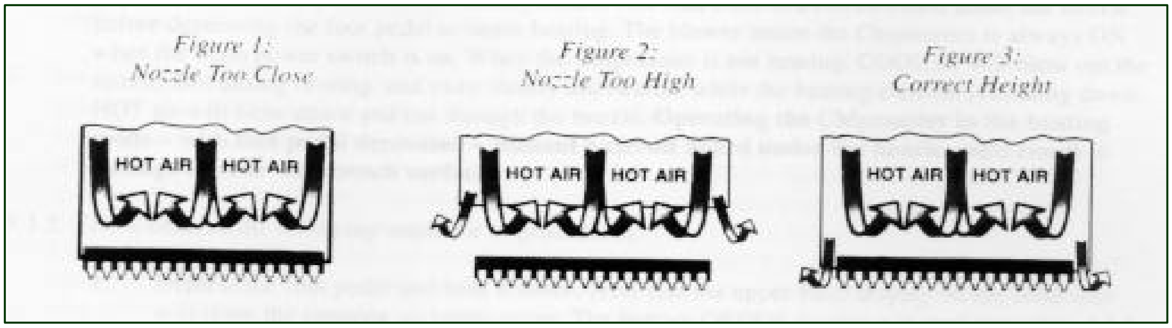


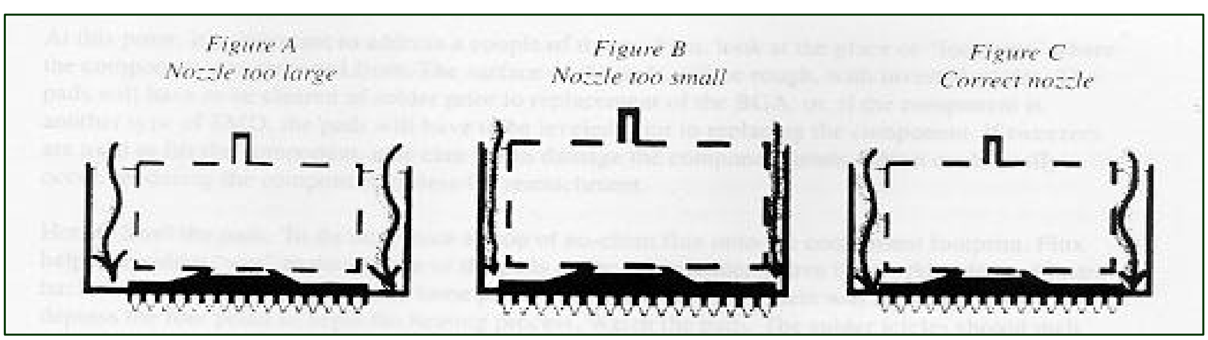
Figure 1: Nozzle Too Close

Figure 2: Nozzle Too High

Figure 3: Correct Height

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.

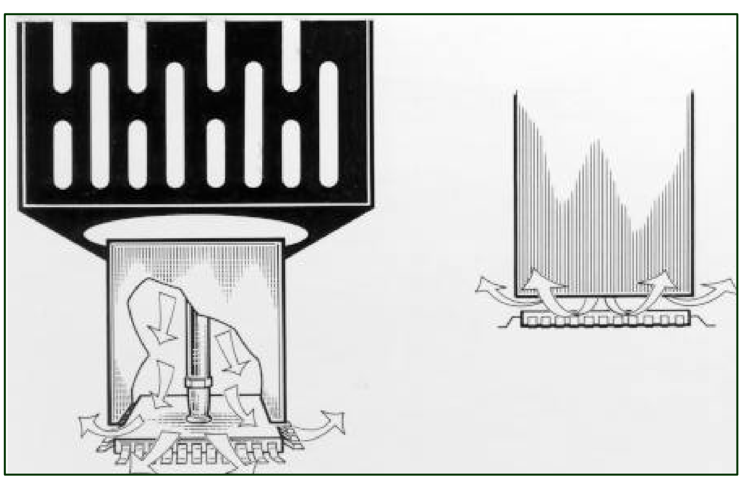
Figure A - Nozzle too large

Figure B - Nozzle too small

Figure C - Correct nozzle

Circuit boards are designed to dissipate heat - spread it out evenly. Since different types of materials expand at different rates when heated, heat applied to a circuit board results in *thermal stress* - physical forces that increase as the board gets hotter. These stresses can break electrical connections within the components, cause solder joints to fail, and cause chip caps to crack. Fatigue caused by thermal stress can cause the circuit board to fail later on, perhaps at a critical time. When we heat the circuit board during rework, we are actually trying to heat a certain area up faster than the board can dissipate the heat. We are creating thermal stresses. Since there is no way to avoid doing so, the least we can do is minimize these stresses, *by heating only the area we need to, at the lowest possible temperature and for only as long as we need to.*

3.3. Now that we have selected a board and component to rework, set the board in the workholder, select the correct nozzle for the component, and set the correct component-to-nozzle height, we are ready to remove the component from the circuit board. Remember that to set height, use the knurled knob set screw at the lower side of the workholder cylinder. It should be necessary, once proper height is set, to depress the plunger top of the



workholder in order to get the component under the nozzle!

Center the BGA under the nozzle. Make sure that the Chipmaster is plugged in, and then turn the Main Power On/Off switch to ON. Always make sure that there is a circuit board under the nozzle before depressing the foot pedal to begin heating. The blower inside the Chipmaster is always ON when the main power switch is on. When the Chipmaster 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 Chipmaster in the heating mode - with foot pedal depressed - without a circuit board under the nozzle could result in damage to your workbench surface!**

Now follow the following sequence of procedures:

1. Reset the timer, by pressing the up and down arrow at the same time. Depress the foot pedal and hold it down. Note that the upper ORANGE display on the controller will show the ramping air temperature. The bottom GREEN display will read time (See 4.2.1.).

2. When the ORANGE display reaches 250 F, turn on the vacuum pump.. Depress the vacuum 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.

3. Continue heating until the component *lifts off* the board, picked up by the vacuum plunger. Then release the foot pedal. Allow the board to cool a little then slide the board holder out from under the nozzle. The component will still be held up by the 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.

3.4. 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.

3.5. 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 workholder and board back under the heater nozzle in the same position as when the component was removed. 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. Release the foot pedal and allow the board to cool for a minute or so.

3.6. Remove the board and workholder from beneath the nozzle. Now add another drop of the no-clean flux to the pads, and place the component on the pads, lining it up as carefully as possible. Then move the workpiece back under the nozzle, lining it up carefully, and depress the foot pedal to begin heating. Note Section 4.2.1 for explanation of using the timer.

3.7. There are various ways to place/replace components on a circuit board prior to reattachment. It's important to line up the component precisely prior to initiating the heating cycle. Depending on the type of component, different procedures may need to be followed. For example, in BGA replacement, it is typical procedure to remove all solder from the pads. For large pin-out QFPs, it is common practice to line up a component precisely and then "tack" opposite corners with a soldering iron. Such procedures are well documented in rework and repair manuals available from various sources including the IPC; additionally A.P.E. has published several procedures which assist the user in reworking many different types of components, contact 305-451-4722 for further information.. It is not the purpose of this manual to elaborate on those procedures. However, once a component has been properly placed and is ready for reattachment, the Chipmaster can be used to re-solder the component in place.

Proper pad preparation - including removal of old solder, pad cleaning and prep, and the application of flux, solder paste, and other materials necessary for replacement - can be achieved with the SMD Tool Kit 8100-1097 also available from A.P.E. This tool kit contains virtually everything necessary to quickly remove and replace BGAs and all surface mounted components on printed circuit boards when used with the Chipmaster. The SMD Tool Kit contains an SMD pad prep cleaner that gently removes oxidation and contamination to restore pads to optimum solderability. The cleaner is non-toxic to workers. The kit also contains an assortment of dental-quality probe tools to help remove components, clear away debris, scrape off coatings, and more. Also supplied with the kit is a quantity of “no-clean” Wetting Solution for BGAs and an assortment of activated “no-clean” syringes so that the right amount of flux can be deposited where needed. The kit also contains a wick gun for wicking away old solder, assorted dispensing needles for the syringes, and tweezers.

Once the component or BGA has been properly placed in position on the prepared circuit board, heating may commence. The operator depresses the foot pedal to begin the heating sequence.

3.8. Watch the component leads as heating commences. One by one or several at a time, you will begin to see the solder melt and the solder connections form. Once all the solder is melted, the component may align itself; if it is slightly skewed, a gentle touch with a probe is usually all that is needed to align the component perfectly. Molten solder surface tension does the rest, helping to line the leads up on their respective pads. Release the foot pedal, and allow the solder to cool and solidify (a few seconds) before moving the board and workholder.

The procedure above has allowed you to remove and replace a surface mounted component in the simplest manner possible using the Chipmaster. Obviously, there were many other aspects to Chipmaster operation - such as temperature, controlled heating times, etc. - that were not used, but must be when reworking a "live" board. The purpose of the above exercise was to give you the basics of rework using the Chipmaster, a hot air rework system that differs in many ways from hand soldering tools as well as other hot air-based systems. Now that you understand the basics of the process, the how and why things are done, we will now show you how to *control* your rework process, and fine-tune your Chipmaster so that you can accomplish virtually any removal/replacement procedure safely, repeatably, and easily. You will also use other resources of the Chipmaster - such as its programmable storage controller - and accessories provided by A.P.E. through its SMD Tool Kit, such as the Pad Prep Cleaner and more.

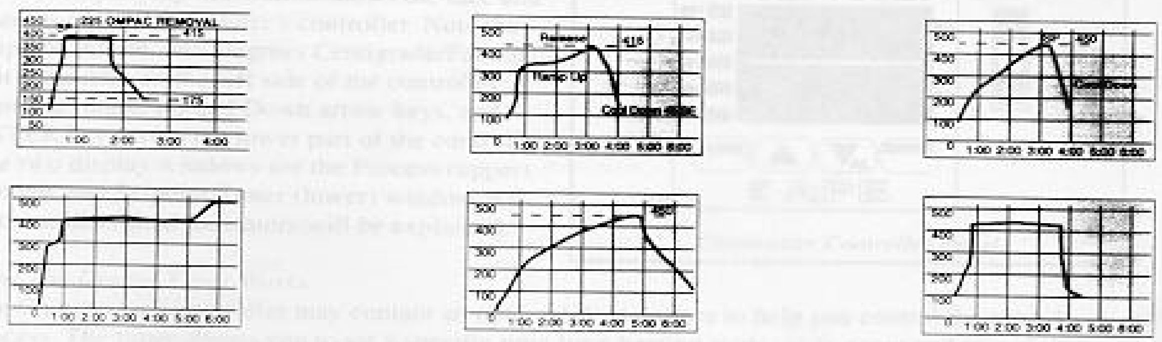
4.0 The Chipmaster's Controller

4.1. The Chipmaster's "brain" is a sophisticated microprocessor-based patented time/temperature controller developed by A.P.E. There are four separate versions of the controller available; the basic controller with digital timer option, four profile programmable storage controller with digital timer option, automated four profile programmable storage controller, automated four profile ramp/soak programmable storage controller, which is the most sophisticated version and incorporates the digital timer. The programmable storage controller allows the user to *create, duplicate, test, store*, and *instantly recall* rework profiles.

So what's a profile?

Successfully removing and replacing components means that you must heat the component and lead attach area to the correct *temperature,* at the correct *rate,* and for the correct *time.* This "recipe" is called a time/temperature thermal *profile*. Each component has its own correct thermal profile. Sometimes the same profile will work for components that are similar in size and on the same type and thickness of circuit board. Usually, though, different profiles must be established for different types of components on different boards. On a single circuit board, however, one or two separate profiles is usually as many as are ever needed.

Thermal profiles can be depicted visually on two-dimensional graphs. Illustration # shows some of the many rework profiles you can create and store using the Chipmaster'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 profiles, 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 Chipmaster controller, one that we will learn later. We will also learn to *store* temperature profiles. Why? Because establishing the right profile for a component takes some work. Since not every profile is right for a given component, establishing the right one is called *optimizing* a profile, i.e., fine-tuning it. You'll want to keep that profile for re-use again and again. In fact, you may find that there are two or three profiles that you use all the time. It's inconvenient to plug in the parameters of a profile 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 profiles in the controller's memory for instant recall. The beauty of an optimized profile is that it is repeatable - in other words, it will do the same job, correctly, every time it is called up and used.

The Importance Of Starting Out With A "Cool" Circuit Board

It's a general rule that, when establishing a profile, or when heating, you start out with a circuit board that is at room temperature. A single time/temperature profile 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 profiles and for all rework. If you use a profile that was established for a circuit board at ambient temperature, and begin heating a board that's already hot, you will get a different profile at the circuit board level, and that means that you will probably overheat the board and component. Always let the circuit board cool to room temperature (or very close) before beginning the heating cycle.

Why do we need separate profiles?

Practically, no two board/component combinations are the same. Some components are large with a high "heat sink" capacity. They usually must be heated for a longer period of time than smaller components. Similarly, many thick, multilayer circuit boards require lengthy heating times. Although the peak temperature Set Point on the controller usually stays the same (depending upon the melting point of the solder), the ramp rate can change, too. Remember our earlier discussion on thermal stress? Sometimes it is necessary to ramp the component and board up at a more gradual rate to minimize the physical stresses caused by heating a large mass on a thick board to such a high temperature. We still want to heat a limited area, and stop heating as soon as we can; but we may have to heat large masses more slowly. The Pre Heat bottom heater assist the process of stabilizing these large masses, reduces time for removal and placement and also prevents adverse warping, the pre heat can also be programmed to a profile providing an optimum ramp rate for the board to be repaired.

4.2. *Becoming Familiar With The Controller*

The Illustration above shows the face and features of the Chipmaster's controller. Note the Auto Tune, Output, and Alarm indicators in 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 Value (upper) window and Timer (lower) window. All of these individual indicators will be explained.

4.2.1. *The Digital Timer - How It Works*

The 8100-0xxx controller is a digital controller used to control the temperature of the rework equipment. The controller has four operating functions: 1, Manual Mode 2, Timer function 2, Timer function 1, 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) profiles.
Timer Function 1   Same as Timer function 2, except operation is automated. A "two second" foot pedal input will start RUN mode. If the 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 Operation includes four (4) profiles, each having four (4) segments. Operation starts by a “two second” foot pedal input and STOP occurs at the end of the preset program.

The Operating 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.

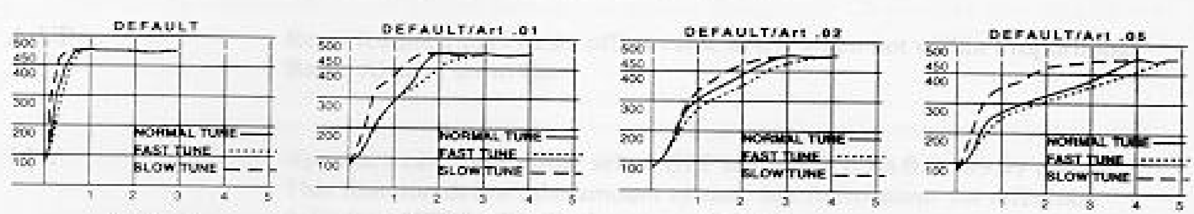
Temperature Profiles:

1. PROFILE NO. 1 Profile for small dry QFPs, LCCs, and SOICs.

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

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

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



Profile 1 Profile 2 Profile 3 Profile 4

Manual operation

Profile 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.

1. Profile setup

a. Press Set: SV is displayed, use up and down arrows to set temperature Set Point. Factory default: 450

b. Press Set: rMP is displayed. Ramp time can be set from 0 to 9 minutes 59 seconds. Factory default: 0:00

c. Press Set: TIM is displayed. Use up and down arrows to set Profile Time. Profile time can be set from 0 to 9 minutes 59 seconds. Factory default: 0:00

2. Parameter setting mode

a. Press SET for approx. 10 seconds.

b. ModE

Man – Manual Mode

T2 – Four profile manual Mode

T1 – Four profile auto Mode

Ramp – Ramp/soak Mode

c. AL1 Alarm setting , Factory default 475

d. ATU Autotuning, Factory default 0000(Manual mode only)

e. P Proportional band setting, Factory default 450

f. I Integral time setting, Factory default 12

g. D Derivative time setting, Factory default 3

h. Ar Anti-reset windup setting, Factory default 10

i. T Proportioning cycle setting, Factory default 2

j. Pb PV bias setting, Factory default 0 (Sensor correction)

k. InP Input type selection, Factory default 0, 0 = K thermocouple 1 = J thermocouple

l. UnlT Unit selection, 0 = C degrees 1 = F degrees

m. AS1 Alarm type selection, Factory default 1, 0 = No alarm 1 = Process High Alarm 2 = Process Low Alarm

n. LCK Parameter mode SV mode

0000	unlocked	unlocked
0001	unlocked	locked
0010	locked	unlocked
0011	locked	locked

o. Press SET for approx 10 seconds to return to operators menu.

Timer Function 2

Operation is the same as Manual Mode, except there are four profiles available. Profile 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: The program can be stopped by hitting the R/S key for one second.

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

2. Ramp Setup
    a. Press SET for 2 seconds
    b. SV 1 Use up and down arrows to set temperature value.
    c. Press SET
    d. rMP 1 Use up and down arrows to set Ramp time.
3. Paarameter Setup
    a. Press SET for 10 seconds
    b. ModE Select required Mode

c. AL 1 475

d. P 450

e. I 12

f. d 3

g. Ar 10

h. t 2

i. Pb 0

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

n. LCK

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

4. Timer Function 1

Operation is the same as timer function 2, except the foot pedal input is automated. Profile is started and stopped by a two second foot pedal input. Timer will count up, if reset before or during RUN operation. Timer will count down if timer has been preset and operation will STOP when timer reaches zero. Add time is also automaticly added at the end of the removal cycle.

NOTE: The program can be stopped by hitting the R/S key for one second.

1. Timer Set Mode
   a. Press SET
   b. ProF Choose required profile.
   c. TiM Use up and down arrows to set timer value.
   d. AddT Set add time to On or Off to automaticly add time for component replacement.
   e. 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. Ramp Setting Mode
   a. Press SET for 2 seconds.
   b. SV1 Use up and down arrows to set Temperature Set Point. Factory default 450 degrees F.
   c. rMP1 Use up and down arrows to set ramp time. Factory default 0:00

3. Parameter Setting Mode
   a. See Timer Funtion 1 parameter setting mode.

Ramp/Soak Mode

A maximum of four segments per pattern can be stored, and the 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. The program is RUN by depressing the foot pedal for 2 seconds. The program will automaticly STOP at the end of the preset program.

NOTE: The program can be stopped by hitting the R/S key for one second.

1. Program Setting Mode
    a. Press SET
    b. Ptrn   Select program pattern
    c. Press SET twice.
2. Pattern Setting Mode
    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. Press SET.
        0: Operation Stop
        1: Connects to pattern 1
        2: Connects to pattern 2
        3. Connects to pattern 3
        4. Connects to pattern 4
    k. Return to L1-1
    l. Continue setting profiles 2 – 4 using steps 2a – j.
3. Parameter Setting Mode
    a. See Timer Function 1, Parameter setting mode.

5.0 Operating Tips

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

5.1. *Nozzle Types*

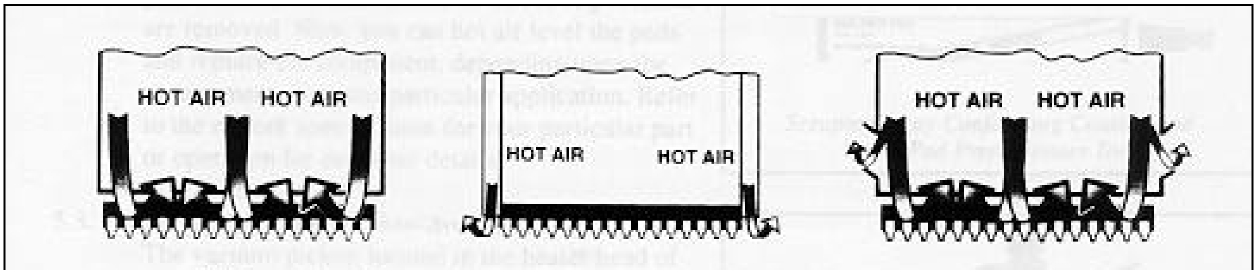
As mentioned earlier, the Chipmaster heats components with hot, forced convection. To achieve effective and efficient heating, an appropriate volume of air must always be encountering the target component in order to effect heat transfer from the air to the component. If the air is blocked, the Chipmaster can't heat the component. Worse, the Chipmaster's heating element can overheat and shorten its life. Forced air is *always* flowing past the heater element when the Chipmaster'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 Chipmaster to operate properly. Between heating cycles, and after a shift is done, leave the Chipmaster 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 Chipmaster may be unavoidably restricted:

1. When a very small-diameter nozzle is used on small chip components;
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 Chipmaster 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 air flow 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.



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

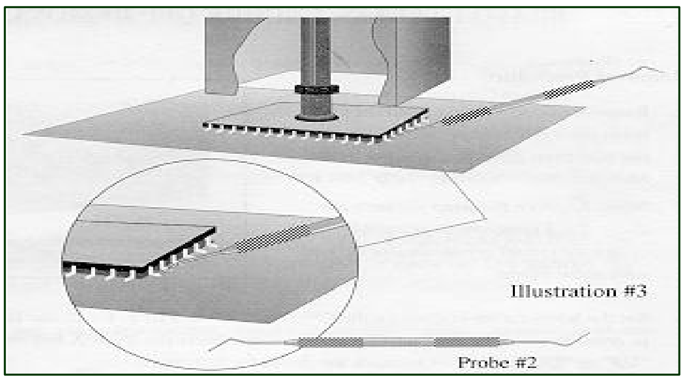
IMPORTANT NOTE: When using vented nozzles, pause the machine after 20 - 25 heating cycles and remove the nozzle. Small nozzles are HOT! use a hot pad or pliers or other hand tool to remove small nozzles - never fingers! Then let the Chipmaster cool for 15 - 20 minutes with the power switch (and blower) ON, until the controller's temperature indicator reads 100 degrees (F.) or lower, before resuming heating cycles.

5.2 *Removing Conformally-Coated Parts*

Removing conformally-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

Chipmaster 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 Chipmaster's 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 solder 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.

5.3 *Lifting Off Heavier-Than-Average Components*

The vacuum pickup located in the heater head of the Chipmaster is strong enough to pick up most components. However, larger components, or those with many leads or solder-attach areas (where solder surface tension can become a factor) might require a stronger “pull”. The spring tension of the Chipmaster’s vacuum pickup has been pre-set at the factory. You, the user, are cautioned not to change the spring tensioning adjustment unless absolutely necessary. If you choose to do so, the spring tension adjustment port is on the front of the Chipmaster heater arm (See Illustration). Use a 3/32” hex key to adjust spring tension by turning clockwise or counter-clockwise in quarter-turn increments. Turn clockwise to increase height/lifting strength; counter-clockwise to lower/decrease.

6.0 CHIPMASTER MAINTENANCE, TROUBLESHOOTING AND CALIBRATION

During this manual, at various times, certain maintenance procedures have been suggested in the context of operation. For example, lubricating the workholder; or letting the machine cool between repeated rework cycles with small nozzles. Although there is very little actual maintenance that needs to be done on the Chipmaster, there are a few small procedures that must be adhered to on a regular basis to ensure smooth and consistent operation.

6.1 Cleaning:

Nozzles and vacuum pickup suction cups should be cleaned daily with alcohol to prevent flux buildup. Flux buildup on nozzles can burn and cause contamination of the circuit board. Flux buildup on suction cups can cause blockage of the vacuum flow, with a corresponding loss of pickup ability. Any flux spillage or buildup, including on the workholder, should be removed daily with alcohol.

6.2 Lubrication:

Occasionally, the vacuum pickup assembly should be lubricated. Apply a drop of high temperature lubricating 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 or tends to bind. Do not over-lubricate! Excess oil can run down and contaminate the circuit board.

6.3 Handling:

The Chipmaster is a portable unit; however, excessive or indelicate handling could result in damage to the heater element and its insulation. Avoid rough usage; move the Chipmaster only when necessary, and always by the handle on top of the unit. When transporting, pack the Chipmaster in its original box and packing material, or cushion it well against any impact. ***Avoid contacting the area beneath the heater arm, because damage to the thermocouple may result.***

6.4 Replace:

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

6.5 Calibration:

From time to time or dependent upon the users internal company procedures it is necessary to check that the Chipmaster is within the original calibrated temperature tolerance for the PID Controller. To carry out this check it is necessary for the user to understand how the system was originally calibrated and the standards which were used.

In a convection hot air environment there are several variables, which effect temperature measurement, not least of which is the open chamber which includes the nozzle, as nozzle sizes obviously vary, the chamber will alter within a few degrees, to standardize a mean average, a PLCC 44 pin 8100-0000-44, 0.80” x 0.80” nozzle is used, together with a circuit board placed 3/8” under the nozzle. This environment matches the original calibration set up for the computerized registration of the PID Controller at the factory.

The Chipmaster includes a K thermocouple, which provides a close loop sense to the Controller. The K thermocouple is a highly sensitive sensor, which needs to be correctly positioned within the Nozzle Block of the Chipmaster to ensure an accurate response.

The Chipmaster is factory calibrated to provide a correct correlation of the sensor measurement to the display reading. If by any mischance the thermocouple is dislodged from its correct location the following simple procedure can be followed to relocate the position.

The procedure uses the exact melting point of eutectic solder (183°C, 361°F) as a calibration medium to check that the Controller display registers the correct temperature as the solder begins to melt i.e. (183°C, 361°F).

Calibration Steps:

Place a 0.80" x 0.80" Nozzle APE # 8100-0000-44 in position in the Nozzle Block.

Use a small 3" x 3" piece of junk PCB material and place in the Board Holder.

Tightly Roll a 6 inch length of thin gauge eutectic solder, or a size that when rolled into a ball is approx. 5/16" in size.

Place the solder roll on the junk PCB to become a Test Rig.

Position the Test Rig under the nozzle allowing approx. 3/8" gap between the PCB and the Nozzle, this should be sufficient to allow the user to slide the board holder and the Test Rig from under the nozzle during the calibration process.

Set the Controller to Profile 2 and the temperature to 177°C, (350°F), and run to temperature using the Foot Pedal. When at temperature note the time and add 20 seconds to ensure saturation, quickly check that the solder coil is still intact and return to position under the nozzle, the solder should not melt at this temperature.

With the Foot Pedal still depressed change the temperature to 183°C (361°F), when at temperature , add 20 seconds and the solder should be showing the first sign of melting. It is permitted to continue to 190°C (375°F) before total melt down. Within this measurement the machine is calibrated. A 3-5% Hot Air difference, is an aggregate of the PID holding pattern and the distance from the thermocouple location and the point of contact on the board.

h. **Reflow before 177°C, (350°F)**

If the solder starts reflowing at or before177°C, (350°F), the test must be stopped (foot off the pedal) and the thermocouple wire adjusted. The wire runs along the bottom of the Heater Tube, entering the Nozzle Block through a small aperture in it's rear. Adjust the wire by using a pair of smooth snipe nose pliers to grip the wire before the entry aperture to the Nozzle Block and move (pull) the thermocouple **INTO** the Nozzle Block by 1/16". Be careful not to over adjust and pull too much, which would reverse the problem. Run the test again.

i. **Reflow after 190°C (375°F)**

If the solder does not melt at 190°C (375°F) or over, the test must be stopped (foot off the pedal) and the thermocouple wire adjusted. The wire runs along the bottom of the Heater Tube, entering the Nozzle Block through a small aperture in it's rear. Adjust the wire by using a pair of smooth snipe nose pliers to grip the wire before the entry aperture to the Nozzle Block and move (push) the thermocouple **OUT OF** the Nozzle Block, TOWARDS THE REAR OF THE MACHINE by 1/16". Be careful not to over adjust and push too much, which would reverse the problem. Run the test again.

j. Using this simple test procedure it is possible to obtain very accurate results, however if a Temperature Meter is available the Meter probe can be inserted between the Nozzle and the PCB instead of the solder coil and the test conducted in the manner described above. **IMPORTANT: IT IS NECSSARY TO ATTENUATE THE THERMAL ENVIORNMENT BY USING THE 0.80" x 0.80" NOZZLE AND A PCB UNDER THE NOZZLE WHEN CONDUCTING THERMAL MEASUREMENTS.**

7. HEATER ELEMENT REPLACEMENT PROCEDURE

1st. Work to be carried out at the rear of the Chipmaster:

1. Check that the power is disconnected from the rear of the machine.
2. Remove the cover panel of the Chipmaster to expose the systems wiring.
3. Disconnect one leg (live) of the Heater Coil wiring from the Solid State Relay. Noting the terminal and the correct wire for the new Heater.
4. Disconnect the other wire (Neutral) from the Terminal Block, again noting the location and the correct wire for reassembly of the new part.

1st. Work to be carried out at the front of the Chipmaster:

5. Remove the Heater Tube Black Heat Guard, by removing the five fixing screws.
6. Carefully pull out the Thermocouple from the front of the Nozzle Block. Do not unduly bend or stress the Thermocouple.
8. Loosen the three supporting screws on the Nozzle Block.
9. Carefully remove the Heater Tube, which will expose the Heater Coil.
10. Remove the old Heater Coil, ensuring that the wires are free to pull out without snagging, note the feed aperture where the wires feed into the machine.
11. Install a new heater feeding the wires into the aperture.
12. Slide the Heater Tube over the Heater Coil and ensure that the coil mica supports are perpendicular and horizontal. (Not laid in an X)
13. Tighten the three (3) supporting screws evenly, fixing the Tube.
14. Reinstall the Heater Tube Black Guard.

2nd Work to be carried out at the rear of the Chipmaster:

15. Re-connect the two wires, ensuring Live connects to the Solid State Relay and the Neutral connects to the Terminal Block.
16. Replace the cover panel.

2nd Work to be carried out at the front of the Chipmaster:

17. If the Silicone Grommet was removed with the Thermocouple, carefully slide it off the Thermocouple and insert it into the hole where the Thermocouple will enter the Heater Assembly.
18. With great care, so as not to damage the Thermocouple sensor wires, insert the Thermocouple through the Grommet. The Grommet will insulate the Thermocouple through the Heater Assembly.
19. Reconnect the Power Cable and switch on the Chipmaster.
20. It is now necessary to recalibrate the Heater using the APE Thermal Trace system. During the calibration procedure, the Round Nozzle Guard should be in place at each reading. Only two (2) screws need to be in place during the tests to easily locate the Nozzle Guard and the Calibration Nozzle 8100-0000-44.
    After calibration the four Nozzle Guard Fixing screws should be adjusted so that a nozzle can easily be installed without vibration.