FLIP CHIP
MOUNTING TUTORIAL
**INTRODUCTION**

The Flip Chip mounting tutorial recommends pad sizes, stencil sizes, pick and place tools as well as reflow characteristics. These recommendations should be followed to insure proper manufacturing assembly. The following illustration is a basic overview of the processes required to solder ProTek’s flip chips onto the printed circuit board.

**Product Definition:**
1. Solder bumped flip chip - die that has solder pre-tinned to the flip chip contacts.
2. Unbumped flip chip - die that has solderable metallic contacts only.

**HANDLING & ENVIRONMENTAL SPECIFICATIONS**

1. **HUMIDITY:** Insure that the relative humidity in the assembly area is approximately 30% or more. Low humidity can cause static build up, which inhibits removal and placement of the flip chip (loss of parts, slowed production).
2. **DO NOT BAKE REELS** prior to use. Baking is not necessary and if done, may cause static problems such as loss of parts and production slow down.
3. **TAPE HANDLER:** Make sure the tape handler is well grounded. This will help prevent static charge build-up. A static charge build-up can cause the Flip Chip to stick to the cover tape causing misfeeds and slow production. Please note flip chips are very light in weight.
4. **DO NOT BEND OR CRIMP TAPE:** This can cause lifting of sealing tape causing the flip chips to turn in the tape pockets causing loss of parts and leading to production slow down.
Flip chips are available in single or multiple chip configurations. The following guidelines are provided to insure proper assembly using ProTek’s flip chip devices:

Printed Circuit Board Construction/Finish

Recommended Finishes
1. Immersion nickel gold flash
2. Tin lead plate
3. Tin plate
4. Organic surface protectant

Not Recommended Finishes
1. Non-uniform finishes - air knife or pre-reflowed solder

PCB MOUNTING PADS

The following mounting pad configurations are recommended for either the solder bumped flip chips or the unbumped flip chip:

1. Option 1 is recommended for single and multi-chip placements. The recommended rectangular copper pad has a width of 0.012” ± 0.002” (0.30mm ± 0.05mm) and a length of 0.018” ± 0.002” (0.46mm ± 0.05mm). The mask opening has a width of 0.017” ± 0.002” (0.43mm ± 0.05mm) and a length of 0.023” ± 0.002” (0.584mm ± 0.05mm).

2. Option 2 is recommended for multi-chip configurations (dual through quad chips). This option is not recommended for single chip placement. The recommended copper pad size is 0.009” ± 0.002” (0.23mm ± 0.05mm) and a solder mask opening of 0.014” ± 0.002” (0.30mm ± 0.05mm).

OPTIMAL STENCIL DESIGN

The key to achieving production speed and high yields is in the design of the solder stencil. The following is recommended:

1. Thickness: 0.004” (0.100mm)
2. Laser cut
3. Electro-polished
4. Solder stencil opening size: 0.010” - 0.012” (0.254mm - 0.305mm)
PICK AND PLACE PROCESS
The proper pick and place tools (nozzle) are essential for speed and accuracy of flip chip placement in a manufacturing environment. Tool head selection can be either round or rectangular.

CAUTION: To eliminate flip chip damage, the tool (nozzle) tip should be spring loaded. Pick and place tool spring pressure should be less than 300 grams. The spring loaded tool (nozzle) will allow for over travel when flip chips are picked from the tape or placed on the printed circuit board.

ROUND TOOLS: DEFINED IN THREE DISTINCT VERSIONS
1. BEST: The tool that is shown in Figure A is the best tool to accomplish the pick and place for the flip chip. The tip of the tool outside the diameter extends past the sides of the flip chip tape pocket. This extension past the pocket minimizes damage to the flip chip and insures greater ability to pick, hold and place the flip chip. Centering of the pick-up tool is not as crucial as for the tool shown in Figure B. However, the vacuum hole in the pick-up tool is centered and does not extend beyond the edges of the flip chip.

2. ACCEPTABLE: The tool shown in Figure B is acceptable but does not provide the accuracy and speed of the tool described in Figure A. The centering of the pick and place tip over the flip chip is critical to insure a proper vacuum thus eliminating the possibility of a vacuum break. Losing the vacuum on the flip chip during pick up and placement can cause damage to the flip chip as well as a loss of product during the placement process. Damage can also be caused to the edge of the tape pocket if the tool is not centered properly, causing a vacuum break and damage the flip chip top side because of the small diameter of the pick-up tool (nozzle).

3. NOT ACCEPTABLE: The tool shown in Figure C is not acceptable because of its lack of pickup accuracy and the tendency for the tool to damage the tape pocket edge thus causing a vacuum break and loss of the flip chip die.

RECTANGULAR TOOLS: DEFINED IN TWO DISTINCT VERSIONS
1. CURRENT DESIGN: The design shown in Figure D meets the current needs of pick and placement of chip components. However, it does not meet the criteria to pick and place flip chips. The design of the pick-up head vacuum opening extends past the geometry of the flip chip, causing chipping and cracking of the back side of the flip chip and effecting accuracy in pick-up and placement of the flip chip.

2. SUGGESTED DESIGN: The design shown in Figure E provides improved accuracy and speed for pick and placement of the flip chip. In addition, the design lessens the probability of damage to the back side of the flip chip.
REFLOW RECOMMENDATIONS

The reflow process is one of the most important steps for insuring proper placement and attachment of the flip chip to the printed circuit board pads. The following reflow process recommendations are to be considered after the initial application of solder paste and flip chip placement has been completed. The suggested profile is typical and is made to accommodate other surface mount components being re-flowed during the same process. Some adjustments must be made depending on the mass of the board and its components. The five reflow process steps to consider are as follows:

1. PREHEAT: The rate of heating from ambient temperature to a temperature (5-10°C) below the solder flux activation temperature. This typically takes the board temperature from 20°C to 135°C. Rise time is generally 30 to 60 seconds. It is recommended that you ask your solder paste supplier what the activation temperature is for the flux in the solder paste used.

2. PREHEAT SOAK: This is the temperature that is maintained in order to bring all the board components up to the same approximate uniform temperature. This temperature peaks at a few degrees below the flux activation temperature of approximately 135°C and is maintained for 30 to 60 seconds.

3. REFLOW RAMP-UP: This increase in temperature (from 135°C to 180°C) takes the board and its components up to the solder reflow temperature. The solder flux is activated during this temperature rise and should remove all oxides from the board and its components. The temperature rise time should be as rapid and as short as possible, minimizing component temperature exposure.

4. SOLDER REFLOW: This cycle is relatively short and should be 30 seconds or less. This is the temperature where the solder is melted and wetting to the board and components. The general solder flow range is between 179°C and 230°C for all 60/40 Sn/Pb type solders. This temperature range may vary based on solder paste composition, so insure the melt and wet temperatures of the solder paste being used.

5. COOL DOWN: After the solder reflow process, it is important to cool the board and its components down at a rate not to exceed 4°C per second. This process will minimize the bonding stress at the solder joints between the printed circuit board and the chip components.

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**Reflow Chamber:** Note all solder flow operations, if enclosed, should be done in a nitrogen or forming gas atmosphere where the solder flux fumes from the burn-off are filtered out or completely vented away from the printed circuit board. This venting, or filtering is necessary to insure removal of all contaminate. The filtering process is critical if the gas atmosphere is recirculated in the reflow chamber.

**PRINTED CIRCUIT BOARD REWORK**

The rework process consists of three individual steps: step 1 is flip chip removal, step 2 is inspection and cleaning off excess solder and step 3 is flip chip replacement. The removal replacement process should always be done using a 7x30 power stereo microscope.

1. This process heats and melts the solder holding the flip chip in place. To accomplish this process without damaging the printed circuit board, it is recommended that a bottom side pre-heater be used to raise the board temperature to approximately 135°C thus eliminating the possibility of board damage (warpage) due to the focus of heat in the component area. The heating of the component is applied from the top and is accomplished using a soldering iron of no greater than 25 Watts. The size of the soldering iron tip should be consistent with the size of the flip chip being removed. For instance, a different size for a single, dual, triple or quad chip. When the solder has reached the melting stage, lift the flip chip off with adjustable closure stop tweezers, keeping the solder iron on the top of the flip chip during the removal process. NOTE THE REMOVAL PROCESS IS A QUICK PROCESS.

2. This process cleans the area of the removed chip insuring proper flip chip replacement. Inspect and clean the area with a small cotton swab using isopropyl alcohol and blow dry. Insure that no solder bridging or pieces of die remain. If any particles remain, clean using a non abrasive scraper.

3. This process replaces the removed flip chip. This step assumes that steps 1-2 have been performed successfully. Mix a non-activated solder flux with 50% isopropyl alcohol. Using a small cotton swab, put a very thin coat on the cleaned printed circuit board pads used for the flip chip. As the alcohol dries it will leave a thin, tacky coat of flux on the pads. Pre-heat the PCB to 125°C. Using adjustable closure stop tweezers, place the flip chip onto the PCB pad, place the soldering iron tip onto the top of the flip chip then after solder refinements remove the soldering iron with great care. After flip chip replacement, clean any flux that may be on the board using standard flux removal solvents. NOTE THE REPLACEMENT IS A QUICK PROCESS.

4. **CAUTION!** BOARD DAMAGE IS GENERALLY CAUSED BY EXCESSIVE HEAT DURING THE REMOVAL AND REPLACEMENT PROCESS. INSURE THAT ALL PRECAUTIONS ARE TAKEN TO ELIMINATE ANY POSSIBILITY OF DAMAGE! ALL REWORK SHOULD BE ACCOMPLISHED USING A 7X30 POWER STEREO MICROSCOPE.
STANDARD FLIP CHIP VISUAL INSPECTION - BUMPED DIE

1. Solder Bump Defects - no device shall be acceptable that exhibits the following:
   a. Any cut or break on the solder bump where less than 80% of the solder bump remains intact.
2. Missing Solder Bump - Any solder bump missing on the die pad is a reject (see Figures 2 and 4). Die must have three to four bumps to accept (see Figures 1 and 3).

3. IRREGULAR BUMP - Where one side of the bump is greater than the other side by 6 mils (see Figure 5).

4. BACKSIDE CHIP-OUT - Accept if backside chip-out is less than 20% in width and height. Reject if greater than 20% (see Figure 6 and 7).
5. **UNCUT OR FOREIGN MATERIALS** - Reject if die is not cut correctly or if there are foreign materials on the backside of the die (see Figures 8 and 9).

![Figure 8](image1.png)  
**Reject**

![Figure 9](image2.png)  
**Foreign Material**

**Bottom View**

6. **SCATTERED SOLDER** - Scattered solder or gold spot in center area of die should be rejected (see Figures 10 and 11).

![Figure 10](image3.png)  
**Reject**

**Scattered Solder**

![Figure 11](image4.png)  
**Reject**

**Gold Spots**
7. BRIDGING SOLDER BUMP - Applicable for dual, triple and quad die. Any amount of solder bump that bridge adjacent die (see Figures 12 and 13).

**Figure 12**

**ACCEPT**

**Figure 13**

**REJECT**

Bridging solder bump on adjacent die
COMPANY INFORMATION

COMPANY PROFILE

ProTek Devices, based in Tempe, Arizona USA, is a manufacturer of Transient Voltage Suppression (TVS) products designed specifically for the protection of electronic systems from the effects of lightning, Electrostatic Discharge (ESD), Nuclear Electromagnetic Pulse (NEMP), inductive switching and EMI/RFI. With over 25 years of engineering and manufacturing experience, ProTek designs TVS devices that provide transient protection solutions for all electronic applications.

ProTek Devices Analog Products Division, also manufactures analog interface, control, RF and power management products.

CONTACT US

ProTek Devices L.P.
2929 South Fair Lane
Tempe, Arizona 85282
USA
Phone: +1 602-431-8101
FAX: +1 602-431-2288

ProTek Devices (Asia Pacific) Pte. Ltd.
8 Ubi Road 2, #06-19, Zervex
Singapore 408538
Phone: +65 6748-8312
FAX: +65 6748-8313

By E-mail:
Sales: sales@protekdevices.com
Customer Service: service@protekdevices.com
Technical Support: support@protekdevices.com

Web
www.protekdevices.com