

SMT BGA (Ball Grid Array) Eutectic Solder Balls

Application Note

Products Affected: M21131, M21131V, M21136, M21141G4, M21141G5, M21151, M21151V, M21156, M21161G4, M21161G5

Introduction

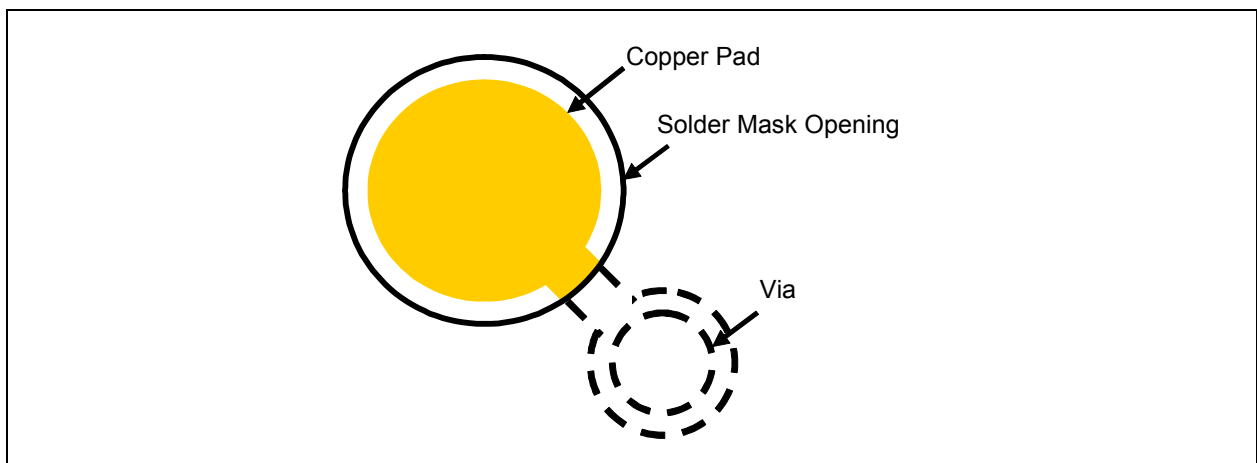
The objective of this application note is to provide the basic SMT design and process requirements necessary to ensure high assembly yield and product reliability for Ball Grid Array (BGA) packages. The BGA packages that can be found in Mindspeed's product portfolio include standard Plastic BGA (PBGA), Chip Array BGA (CABGA), Cavity Down BGA (CDBGA), Fine Pitch BGA (FPBGA), Heat Slug Fine Pitch BGA (HSFBGA), Tape BGA (TBGA), and High Performance BGA (HPBGA). These packages can be placed onto printed circuit boards and assembled using existing surface mount equipment.

Printed Circuit Board Design

In order to obtain reliable solder joints, printed circuit boards designed for BGA packages should follow these guidelines:

- a. **Pad Design.** Non-solder mask defined (NSMD) pad is the preferred pad structure to be used for BGA packages. This design prevents creation of a stress concentration point in the solder by pulling the solder-mask away from the pads. Figure 1 illustrates the NSMD pad structure.

Figure 1. Non-Solder Mask Defined Pad



- b. **Pad Geometry.** The recommended PCB pad diameter is 90% (+/-10%) of the package solder mask opening. Based on the PCB manufacturer process capability, the NSMD pad design should target a 0.075 - 0.1 mm (3 to 4 mils) clearance between the copper pad and the solder mask. Any overlapping of solder mask on pad metal is prohibited. A recommended PCB pad diameter for Mindspeed BGA products is summarized in Table 1.

Table 1. Mindspeed Recommended PCB Pad Diameter for BGA Packages

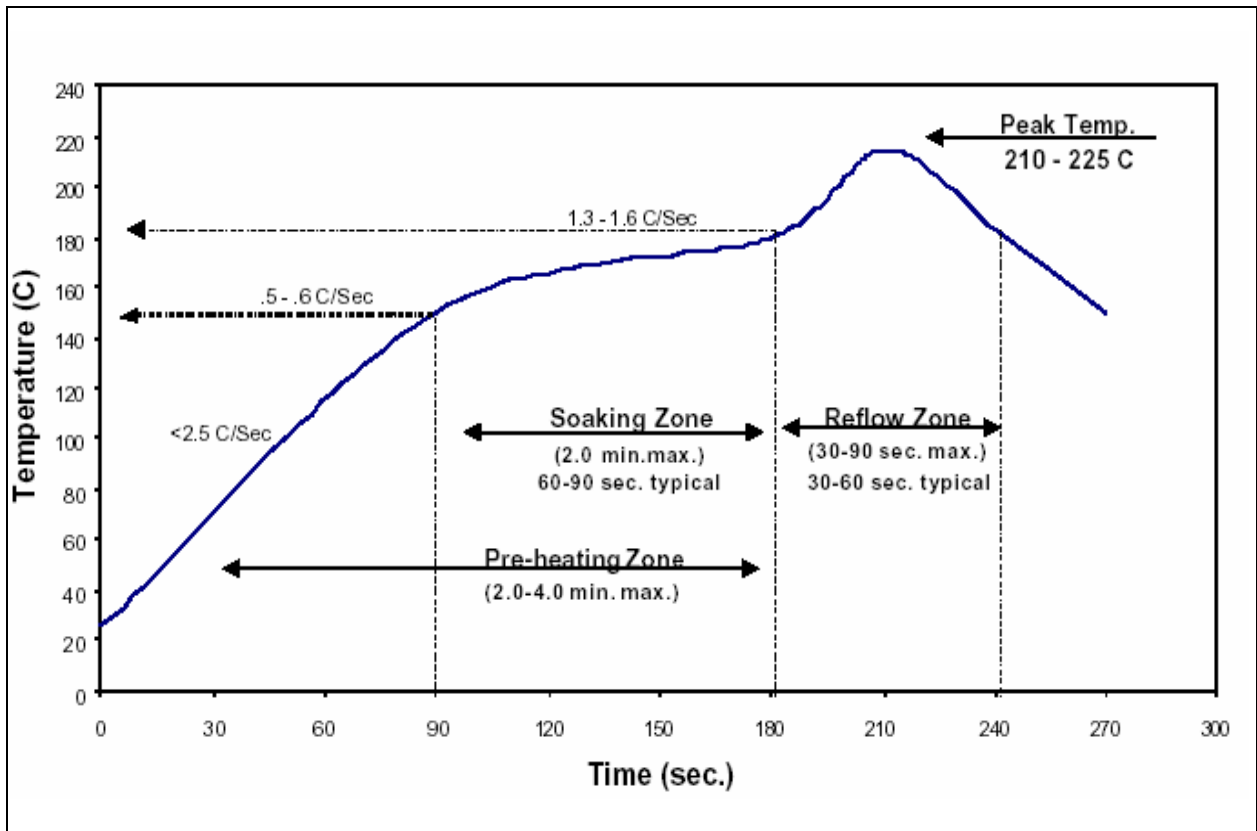
BGA Pitch	Recommended PCB Pad Diameter
0.8 mm	0.32 mm - 0.40 mm
1.0 mm	0.36 mm - 0.45 mm
1.27 mm	0.48 mm - 0.60 mm

- c. **PCB Pad Finish.** PCB with Organic Solderability Preservative (OSP) or Hot Air Solder Leveling (HASL) surface finish is recommended.

SMT Assembly Process

- a. **Solder Paste or Flux Deposition.** Eutectic solder paste or flux should be printed onto the PC board copper pads prior to the assembly of BGA packages. For optimal solder joint reliability, solder paste printing is recommended. Industrial standard eutectic solder pastes (37/63 Pb/Sn) or flux, either no-clean or water soluble, can be used. If solder paste is used, type 3 or type 4 particle sizes is recommended; depends on the process and equipment compatibility. Typical solder paste contains 90% solder by weight or 50% solder by volume. The recommended stencil is laser-cut, stainless-steel type with thickness of 5 to 7 mils and approximately a 1:1 ratio of stencil opening to pad dimension. To improve paste release, a positive taper with bottom opening 1 mil larger than the top can be utilized. Post print inspection and paste volume measurement is very critical to ensure good print quality and uniform paste deposition. Printed paste volume could be measured either manually or by automated paste-measurement tool. The measured data should be recorded onto SPC chart for process monitoring and continuous improvement. Poor print quality or volume control will result in defect and rework; therefore, it is strongly recommended that 100% print inspection and paste volume SPC chart be established.
- b. **Placement.** With the self-aligning characteristic of the BGA packages during reflow, the placement accuracy is not very critical. A placement off-set of 30% of the pad diameter or as long as the solder balls can touch solder paste or flux, they will self-align after reflow.
- c. **Solder Reflow Profile.** The solder reflow profile should follow the paste manufacturer's recommendation. A typical SMT eutectic solder reflow profile is shown in Figure 2 as a reference. The peak temperature at the solder joints should not exceed 220 °C; and the reflow should occur in the next-to-last oven zone to prevent thermal shock and board warping. All Mindspeed BGA packages are qualified for up to three times reflow at 225 °C peak temperature per J-STD-020 standard.

Figure 2. A Typical SMT Reflow Profile



- d. **Temperature Profiling.** Temperature profiling is very important for BGA package to establish proper reflow and to ensure all solder joints meet profile requirements. The most accurate temperature profiling is achieved by placing the thermocouple directly in the solder ball joint. A good technique for this is to drill small holes through the back-side of the board, insert thermocouples, and then fill the holes with thermally conductive epoxy. Thermocouples should be placed at the center and corner of the package, as well as other selected locations on the board to capture temperature variations.

Temperature profiling is strongly dependent on board construction, component density, furnace type, and furnace loading; one profile does not fit all designs. It is recommended that temperature profiling be performed for each new board assembly or product change-over at the assembly facility.

Assembly Inspection

Due to the area array format of the BGA, it is impossible to perform 100% inspection of all the solder joints. An outer-row inspection can be used to verify the solder wetting, and alignment. X-ray can be used to identify solder bridging. However, these techniques are often implemented on a sampling basis for high volume manufacturing. A good SMT process control is the key to ensure high assembly yield and reliable product.

Rework

Rework should be performed using an industrial standard rework station such as SRT, SEC, PACE or equivalent.

- a. **BGA Package Removal.** This process requires to preheat the PCB, from bottom side, to 80 °C to 120 °C to enhance the temperature uniformity and process control. After the PCB has reached the set temperature, the package can be locally heated with hot-gas nozzle to above solder liquidus temperature (183 °C). Care should be taken to limit the temperature in solder joints to be less than 220 °C. Once all solder joints melts, the package can be removed with a vacuum pick up tool.
- b. **Site Preparation.** Hand-held solder vacuum tool or de-soldering braid can be used to remove residue solder from the pads. No-clean flux is recommended to improve the cleaning efficiency.
- c. **Solder Paste or Flux Printing.** If solder paste is used, the printing requirements should follow the standard SMT process requirements. If flux is used, it can be printed on the PCB pads or applied on the package BGA.
- d. **Component Placement.** Utilize the pick and place feature of the rework station for accurate component placement. Manual pick and place is not recommended.
- e. **Component Reflow.** Similar to the package removal, the PCB should be preheated to 80 °C to 120 °C and the hot-gas nozzle be used to apply thermal energy to the package. It is recommended the rework profile should follow the same guidelines as the initial SMT assembly profile; or as close as possible.

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