TMS320C6x Manufacturing with the BGA Package

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Abstract

This document describes how to solder the Texas Instruments (TI™) TMS320C6x digital signal processor (DSP) to a board. The TMS320C6x DSP is manufactured in the BGA package due to its smaller size, greater pitch, higher manufacturing yields, lower manufacturing cost, better electrical performance at high frequency, and increased durability over pinned devices. Because many DSP products are switching over to this package style, it is important to know the manufacturing considerations that must be taken into account when building a board.

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Design Problem

How do I solder the TMS320C6x to a board?

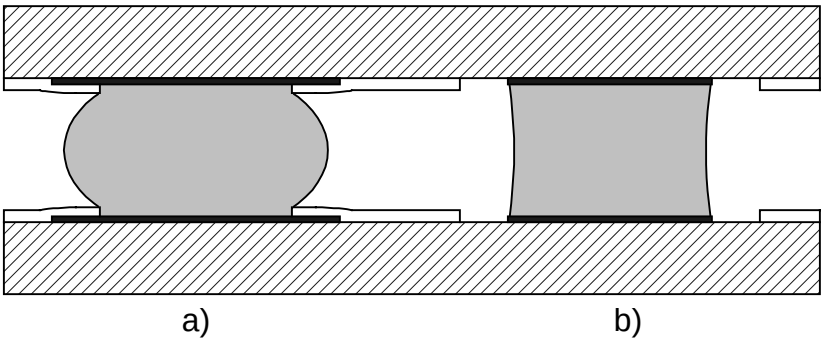
Solution

The TMS320C6x DSP has been manufactured in the BGA package due to its smaller size, greater pitch, higher manufacturing yields, lower manufacturing cost, better electrical performance at high frequency, and increased durability over pinned devices. Because many DSP products are switching over to this package style, it is important to know of the manufacturing considerations that must be taken into account when building a board.

For reliable operation with a BGA package, ensure that the device is correctly attached to the board. The difference in the coefficient of thermal expansion (CTE) between the package and the board can cause fatigue in the solder joints during temperature cycling. The CTE of a board is typically five or six times that of a device. It is therefore necessary to take certain steps to maximize solder joint reliability.

To obtain a good connection between package and board, it is necessary to provide solder lands that are slightly greater in diameter to the via diameters on the device. In practice, optimum land diameters are 0.024inch for non-solder mask defined (NSMD) pads. From experience, it has been demonstrated that NSMD designs have several advantages over SMD designs and are therefore recommended. Due to the smaller section of copper in a NSMD landing, more board space is open between pads for routing purposes. Also, provided that NSMD pads are used on both the device and the board, there is generally a lower stress concentration on the BGA solder joint, which leads to an increased solder joint reliability. Figure 1 shows both SMD and NSMD pad types with the same standoff. It is evident that the NSMD pad type provides a more uniform cross-section throughout the solder joint.

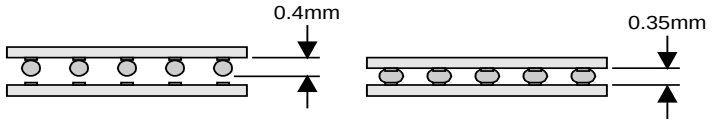
Figure 1. Solder Joints Using a) SMD Pads and b) NSMD Pads



When mounting a BGA device, it is recommended that flux be used, as it aids the wetting of the solder ball to the PCB land.

Solder ball collapse is another important consideration during the mounting process. Depending on conditions such as solder ball volume and pad diameter, the solder balls on the device will collapse to a height of less than the original ball diameter. It is necessary to control this collapse to define package standoff, as a higher standoff will generally give a better solder-joint fatigue strength. Typically, as shown in Figure 2, a solder ball with an original height of 0.4 mm will give a standoff of 0.35 mm after mounting.

Figure 2. Solder Ball Collapse



Reflow for a BGA device is similar to that of standard leaded devices and is compatible with currently used reflow equipment. Reflow may be performed in IR, convection, and mixed heating ovens. Full convection ovens are recommended, however, due to the uniform temperature they provide across the board. The most important parameters in a furnace profile for a BGA[1] device are:

- Peak temperature: 235 °C
- Time over 183 °C: 60 - 75 sec
- Ambient gas: nitrogen

[1] This profile is for a metal package. Ceramic and plastic packages may not tolerate this temperature.

The quality of the solder joints should be monitored while a quality mounting process is developed. Using a boundary scan is the simplest method to verify the quality of the soldering of a BGA. Boundary scan verifies that all of the part's solder balls have made proper connection to the pads.

Additional device information for a BGA package that should be taken into account when designing a mounting process is the package weight (7g) and the solder ball composition (63% Sn, 37% Pb)[2].

References

Lyne, Kevin, *Ball Grid Arrays From Texas Instruments*, Texas Instruments, December 1993.

Mawer, Andrew, *Plastic Ball Grid Array (PBGA)*, Motorola, November 1996 – AN1231.

[2] Values in parentheses are for the 352 pin TMS320C6201 package.