Package Mounting Guide

BGA

Revision 1.0

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TOSHIBA CORPORATION

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Preface

Purpose of this document

The purpose of this document is to mount our product to a printed wiring board simply and with high quality.

Intended Audience

This document is intended for use as a guide for those who are involved in the printed wiring board design and soldering process. The knowledge of heat dissipation and package mounting methods is required for use.

References for package

This document describes the printed wiring board selection and design, and the PCBA (which means the printed circuit board assembly, referred to as mounting board hereinafter) guidelines. Since each package has a different land pattern dimension, refer to the following documents for each package.

Document	Note
Package Mounting Guide	This document
Technical data sheet	Package information (dimensions)

Abbreviation

Some of the abbreviations used in this document are shown below.

BGA	Ball Grid Array
JEITA	Japan Electronics and Information Technology Industries Association
SMD	Solder Mask Defined
NSMD	Non Solder Mask Defined

1. Outline

Recently, many circuits are integrated in semiconductor devices because of downsizing of a product and advanced features. Therefore, the practical use of BGA package with easy formation of many pins in limited component size is increasing. While the BGA package is suitable for high-density of printed circuit board, it may affect low cost and high quality mounting. The design technique for improving easiness and reliability of mounting method is explained as an example which solves this problem.

2. Package structure

Packages are divided into two types by the mounting method; the pin insertion type and the surface-mount type. This document is targeted to the BGA in the surface-mount type packages. The package characteristics are as follows.

Table 2-1 Package characteristic

Name	Figure	Characteristic
BGA		A package having or bumps on top or bottom face in a matrix of at least three rows and three columns. (Quotations from: JEITA ED-7303C, Names and Codes for Integrated Circuit Packages)

The BGA package is able to arrange many balls on the bottom of the package, and suitable for high-density design. However, since a soldering state cannot be easily checked by appearance, the easiness and reliability of soldering are required.

3. Package Lineup

The following table shows the package lineup. The package size and ball pitch can be adjusted according to the number of balls to be required.

Table 3-1 Maximum number of balls in BGA package

Ball pitch (mm)	Package size (mm)									
	4x4	5x5	6x6	7x7	8x8	9x9	11x11	13x13	15x15	17x17
0.40	64	121	169	256	324	441	676	-	-	-
0.50	49	81	121	169	225	289	441	625	-	-
0.65	25	49	64	100	121	169	256	361	484	625
0.80	16	25	49	64	81	100	169	256	324	400

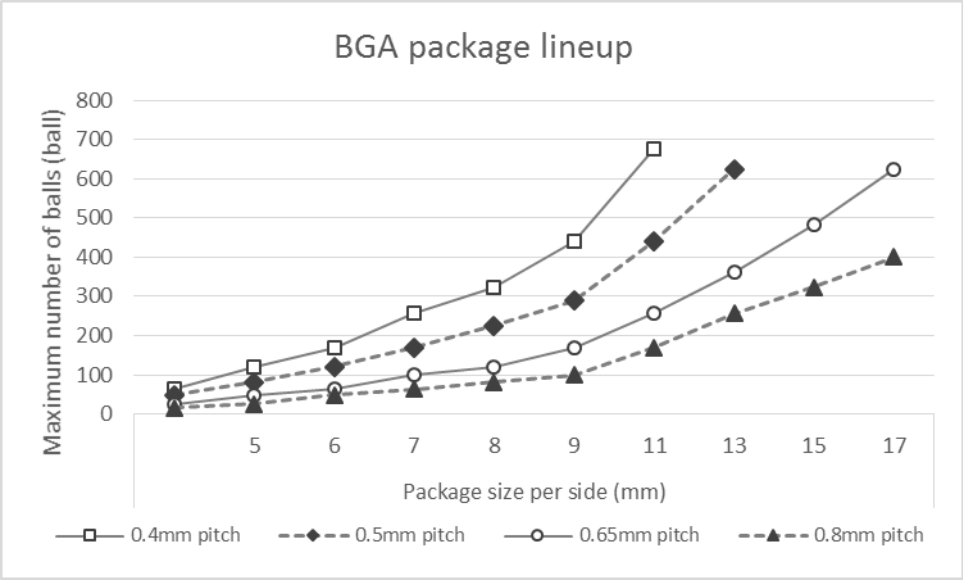


Figure 3-1 BGA package lineup

4. Selection guide for printed wiring board

For the BGA package, high-density of the printed wiring board is required because leading pattern is difficult by the number of arranging balls or the arranging position of them. Therefore, when using the BGA package, it is important to determine the specification to be matched to the printed wiring board in the package selection phase. In this specification check, it should be checked that a pattern layout of a printed wiring board can be designed by a land pattern, taking consideration with ball arranging positions (pitch, columns, and unused pins) and a pin assignment (such as a power supply and GND). Then a printed wiring board which will be suitable balance between costs and mounting quality can be selected.

4.1. Check items of pattern layout

Check items (an example) are shown as follows.

(1) Check the pattern layout between BGA land patterns
Check the pattern layout is possible from balls inside the package to the connection point through between the BGA land patterns.

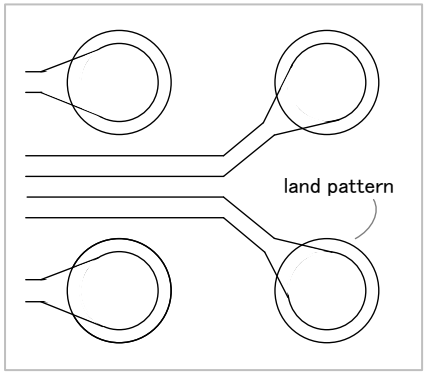


Figure 4-1 Example of pattern layout between BGA land patterns

(2) Check the through-holes position between BGA land patterns
Check the pattern layout is possible from balls inside the package to the connection point through the through-holes between BGA land patterns via the internal layer or back layer.

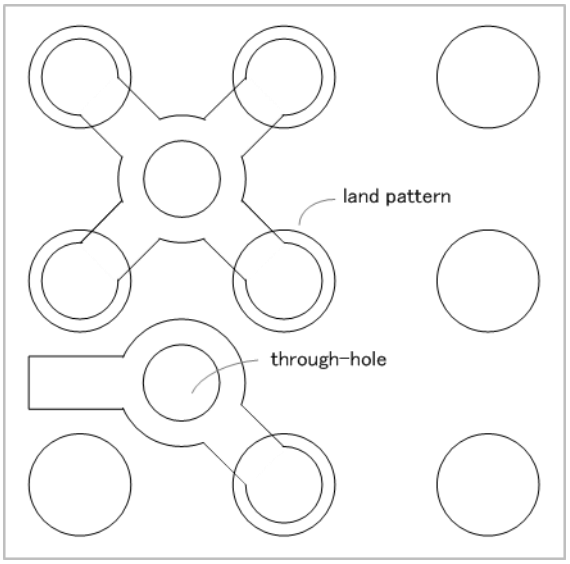


Figure 4-2 Example of through-hole position between BGA land patterns

4.2. Specifications of Printed Wiring Board

Examples of selections for a printed wiring board according to the ball pitch is shown as follows.

Table 4-1 Examples of selections for a printed wiring board

Ball pitch (mm)	Specifications of printed wiring board
0.40	Buildup wiring board
0.50	Buildup wiring board or plating through-hole wiring board
0.65	Buildup wiring board or plating through-hole wiring board
0.80	Plating through-hole wiring board

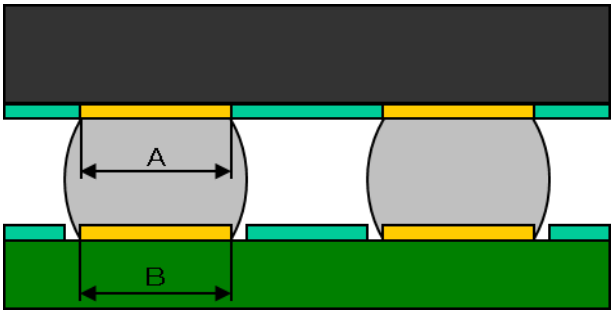
The buildup wiring board is easy to connect to an internal layer and suitable for a layout of narrow pitch BGA package. However, it is expensive because a manufacturing process is complicated.

On the other hand, the plating through-hole wiring board is low price, however, a through-hole cannot be positioned between balls, so that the pattern layout becomes difficult.

5. Design guide for printed wiring board

5.1. Land shape design

To distribute the stress after mounting solder to a solder junction equally, it is advisable that the land size of mounting board is same as a solder resist opening size of package. However, the optimization is necessary in consideration of the soldering intensity to be required and the restrictions of a board design.



Symbol	Item
A	Opening size of solder resist of package
B	Land size of mounting board

Figure 5-1 Example of mounting sectional view of BGA package

For consideration, please contact us about the solder resist opening size of the package.

5.1.1. Land pattern and solder resist design

A land for soldering is formed by the combination of a land pattern and a solder resist. The design methods of this formation are as follows: the over resist design (SMD) of which the solder resist opening becomes the land size, and the clearance resist design (NSMD) of which the land pattern becomes the land size. Each design has the following merits and demerits, so that proper use is required.

Mounting sectional view

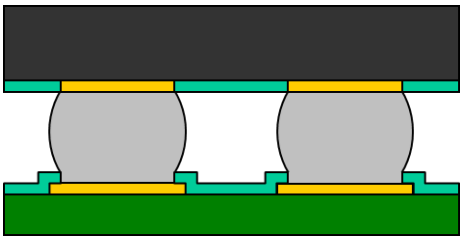


Figure 5-2 Design example of over resist (SMD)

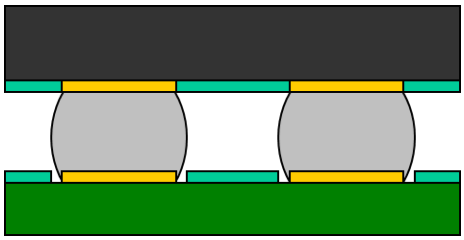


Figure 5-3 Design example of clearance resist (NSMD)

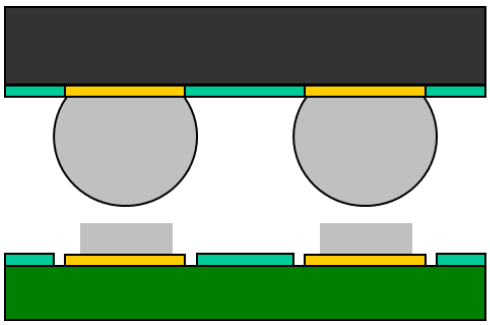
Table 5-1 Merit and demerit of each design methods

Design specifications	Over resist design (SMD)	Clearance resist design (NSMD)
Merit	The sizes of package and land pattern become even. The junction intensity of a land pattern and a base material is strong.	The junction intensity of a land pattern and a solder is strong. Layout area between land patterns is large.
Demerit	The junction intensity of a land pattern and a solder is weak. Layout area between land patterns is small.	According to the pattern layout, the land pattern changes and the soldering state tends to become uneven. The junction intensity of a land pattern and a base material is weak.

5.1.2. Metal mask design

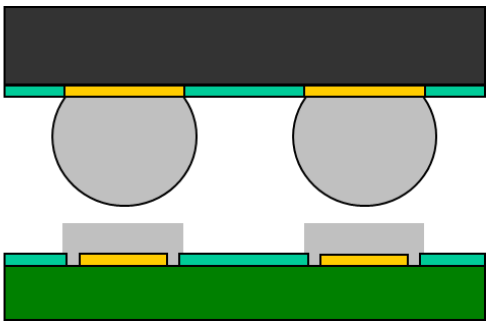
A metal mask is a lithograph for printing a solder paste on the land pattern of a printed wiring board. Recommended thickness of the metal mask is from 100 to 150 (μm). However, the adjustment of the thickness may be also required due to the balance of peripheral parts size.

The metal mask design of the BGA package is basically recommended to design of the same size as the land for soldering. However, when using a narrow pitch package or a solder bump, a soldering defect tends to occur.



Print amount is reduced in the range of which does not affect solder printing

Figure 5-4 In case likely to occur Short-circuit (land for soldering is narrow pitch)



Print amount is increased in the range of which does not affect solder printing

Figure 5-5 In case likely to occur Open (land size for soldering is small)

6. Mounting guide for printed wiring board

6.1. Mounting flow

The recommended soldering method for each package is reflow process. For the reflow process, refer to section 6.1.1 to 6.1.4.

6.1.1. Printing solder paste

A solder paste is a pasty composite material made by mixing solder, flux, and the like. The solder paste is printed through a metal mask to the land pattern of the printed wiring board.

6.1.2. Mounting package

A package is mounted to the position where the solder paste is printed. In addition, use of the package which absorbed moisture may generate a crack because of the heat generated by soldering. Please observe the precautions for unpacking conditions.

6.1.3. Soldering (reflow soldering)

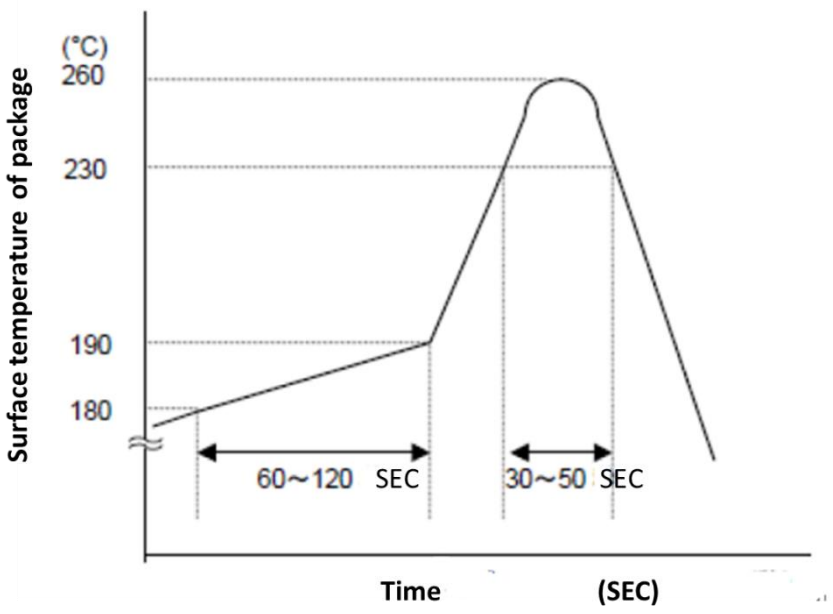
The printed wiring board mounting a package is soldered by the heating of a reflow oven. The package should be heated so that the temperature of the soldering may not exceed the maximum reflow temperature profile.

6.1.4. Visual inspection

In the visual inspection, a position gap, a solder bridge, and a poor-wetting soldering are confirmed with X ray observation equipment.

6.2. Reflow thermal profile

Figure 6-1 shows an example of the reflow thermal profile. In this example, a surface temperature of the package is preheated for 60 to 120 seconds at about 180 to 190°C. After that, the temperature raises gradually, and the surface temperature of the package continues the state which is about 230 to 260°C (peak temperature) for 30 to 50 seconds. In addition, temperature profiles differ due to a package. Confirm the temperature profile of the package to be used.



- Temperature and time should be set less than the above profile.
- Optimum temperature should be set due to solder paste types.

Figure 6-1 Thermal profile example

7. Rework

Use a heater nozzle which heats the target package only to remove the package. The mounting board is preheated using a convection-type heater. Thermal profile at removal is the same as that of mounting, however, the peak time should be as short as possible. When the package is difficult to remove, heat the back of the mounting board with a heater. In the case of removal, please take care so that the land on the board does not exfoliate.

In addition, reuse of the removal package and the soldering reliability of removal part is out of a guarantee range.

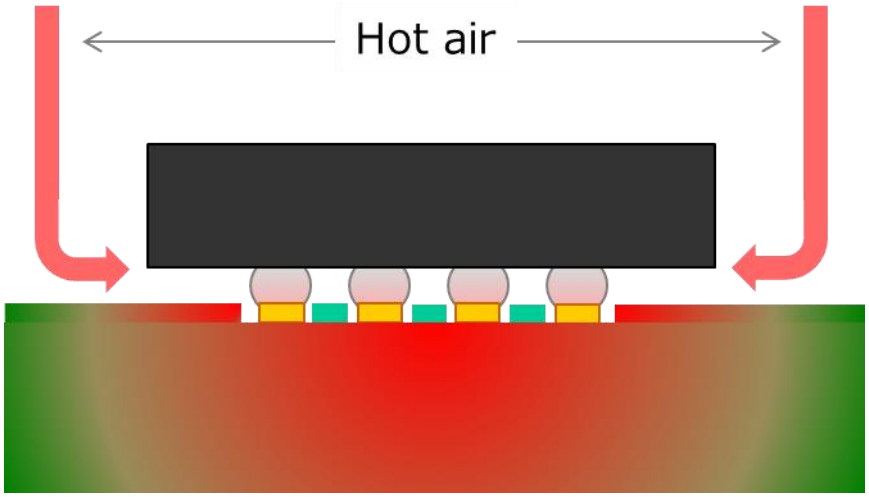
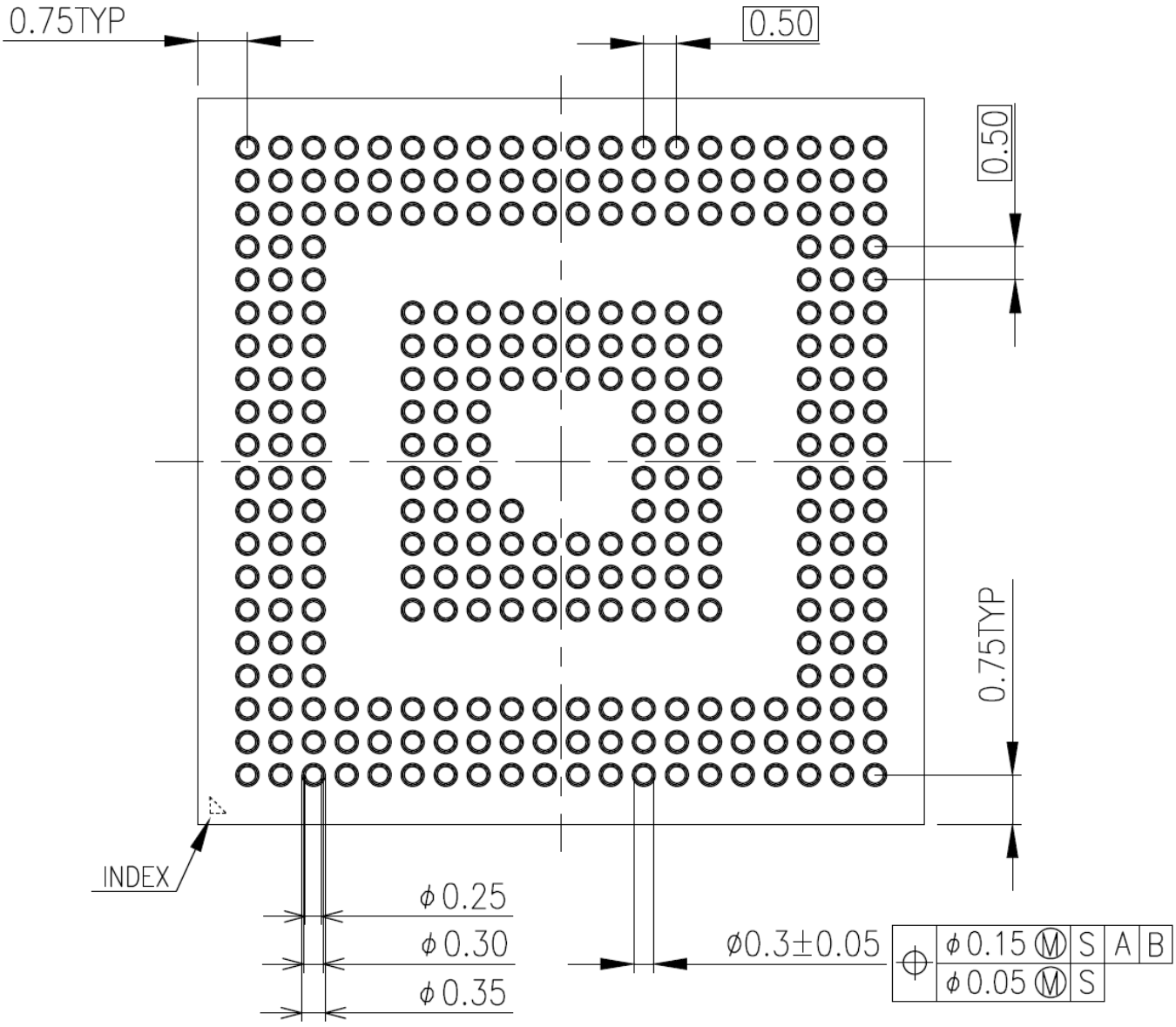


Figure 7-1 Rework overview

8. Design dimensions of mounting board for reference (package: P-VFBGA289-1111-0.50-001)

Unit : mm



Notes

- All linear dimensions are given in millimeters unless otherwise specified.
- TOSHIBA is not responsible for any incorrect or incomplete drawings and information.
- You are solely responsible for all aspects of your own land pattern, including but not limited to soldering processes.
- The drawing shown may not accurately represent the actual shape or dimensions.
- Before creating and producing designs and using, customers must also refer to and comply with the latest versions of all relevant TOSHIBA information and the instructions for the application that Product will be used with or for.

9. Revision History

Table 9-1 Revision History

Revision	Date	Description
1.0	2017-03-17	Newly released

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