STANDARD PROCEDURES AND PRACTICES

Number: **SPP-024, Issue A**

Subject: **Reflow Flatness Requirements for Ball Grid Array Packages**

Effective date: **March 2009** Item Number: **11.2-783**

BACKGROUND

This document states the procedures for using component land side flatness during simulated reflow as an alternative to coplanarity in certain limited cases for BGA components.

PRACTICE

Components should meet coplanarity requirements specified by the applicable Registration, Standard, or Design Guide. However, in some limited cases the coplanarity requirements cannot reasonably be met. In other cases, package warpage (deviation from flatness caused by internal stress) may cause unacceptable SMT quality (as defined by end use customer requirements) even when the coplanarity requirements have been satisfied. In either of the above two cases, the reflow flatness requirements given in this document may be used as an alternative, provided the supplier and customer agree. In these cases, the Design Guide coplanarity requirements will not apply. The flatness methods used herein apply best during development and qualification of a component. Coplanarity should be monitored during production to ensure process stability based on requirements set by the component manufacturer in the place of the Design Guide requirements.

The flatness requirement shall only apply to the land area of the component. The measurement area may be expanded if it simplifies the measurement.

This document applies to Ball Grid Array (BGA) components as described by Design Guide 4.14 and Fine-pitch Ball Grid Array (FBGA) as described by Design Guide 4.5 and Design Guide 4.6 components mounted directly to the printed wiring board.

The values in Table 2 assumes the following:

- Total component mass of most components in the study was less than 10 grams; values listed may not apply for components with larger mass.
- Component ball pad diameter follows the requirements listed in the applicable JEP95 Design Guide document.
- Board warpage in the component land area is less than or equal to 25% of the ball diameter (b).

The flatness and coplanarity measurement methods shall follow JESD22-B112 and JESD22-B108, respectively.

APPLICATION INFORMATION

The reflow temperature flatness requirements listed in Tables 1 and 2 shall apply if one of the following conditions is satisfied.

- The component does not meet the corresponding, registration, standard, or Design Guide coplanarity requirements.
- The component meets the corresponding Design Guide coplanarity requirements, but SMT solder reflow losses exceed customer expectations, attributable to package warpage (solder ball bridging, or non-wet opens).

A component supplier may elect to use this procedure in cases where these conditions are not met in the interests of more complete component characterization. A component supplier should notify customers of the use of this procedure and obtain customer agreement for its use.

Sign Convention: A convex package (corners down during SMT) shall be considered positive in sign. Conversely, a concave component (corners up during SMT) shall be assigned a negative flatness value. When the shape is ambiguous or complex, the sign should be assigned a negative flatness value.

Convex: Positive Flatness Concave: Negative Flatness

PROCEDURE

The following procedure shall be used to demonstrate compliance to the high temperature flatness requirements.

1. All flatness measurements shall be taken using JESD22-B112. No component measured shall exceed the flatness requirement listed in the applicable table, see Table 1 and Table 2.
2. Parts shall be measured at room temperature, solder flux activation (typically 150 °C), solder liquidus, and reflow peak temperature (per JSTD-020 requirement).[i] Measurement at other temperatures may also be useful depending on the component behavior or expected reflow process. The greatest deviation from flatness (greatest magnitude of warpage) in the range from the lowest active temperature of the board paste to peak reflow temperature shall be used to show compliance to the flatness requirement, see Table 1 and Table 2.
3. Component shall be measured on the first reflow cycle. If the component is expected to be subjected to multiple reflow cycles, the parts shall be measured during two additional reflow cycles.[ii] Measurements should be reported for each reflow cycle.

[i] The temperature range is based on the assumption that all component balls must be near the board paste starting from flux activation (to be properly cleaned) to ball liquidus (for joint formation). The measurement through reflow peak is needed to minimize ball bridging or shorting due to excessive warpage.
[ii] Measurement is repeated due to risk of ball bridging during subsequent reflow cycles.

PRACTICE (cont'd)

4. Parts shall be measured in both an as-manufactured condition and with a full moisture exposure as per J-STD-020. This requirement may be waived if previous measurement of similar components, manufactured with the same process and materials did not show a significant impact of moisture on the component flatness.
5. Component drawings shall show the component ball coplanarity tolerance. The package flatness tolerance and the flatness measurement temperature range shall also be shown, preferably as a flagged note indicated at the coplanarity tolerance.

Table 1 — Flatness requirements (mm) during reflow for components less than or equal to 15mm on any side, applies to temperature range from flux activation to reflow peak. Follows JEITA ED-7306.

		b - Ball Diameter(mm)[iii]												
		0.20	0.25	0.30	0.35	0.40	0.45	0.50	0.55	0.60	0.65	0.80	0.90	1.00
e - Ball Pitch (mm)	0.40	±0.10	±0.10	±0.10										
	0.50		±0.10	±0.10	±0.10									
	0.65		±0.10	±0.10	±0.10	±0.11	±0.12							
	0.80		±0.10	±0.10	±0.10	±0.11	±0.12	±0.13	±0.14					
	1.00					±0.11	±0.12	±0.13	±0.14	±0.17	±0.17			
	1.27									±0.17	±0.17	±0.21	±0.23	±0.25
	1.50									±0.17	±0.17	±0.21	±0.23	±0.25

Table 2 — Flatness requirements (mm) during reflow for components greater than 15mm on any side, applies to temperature range from flux activation to reflow peak.

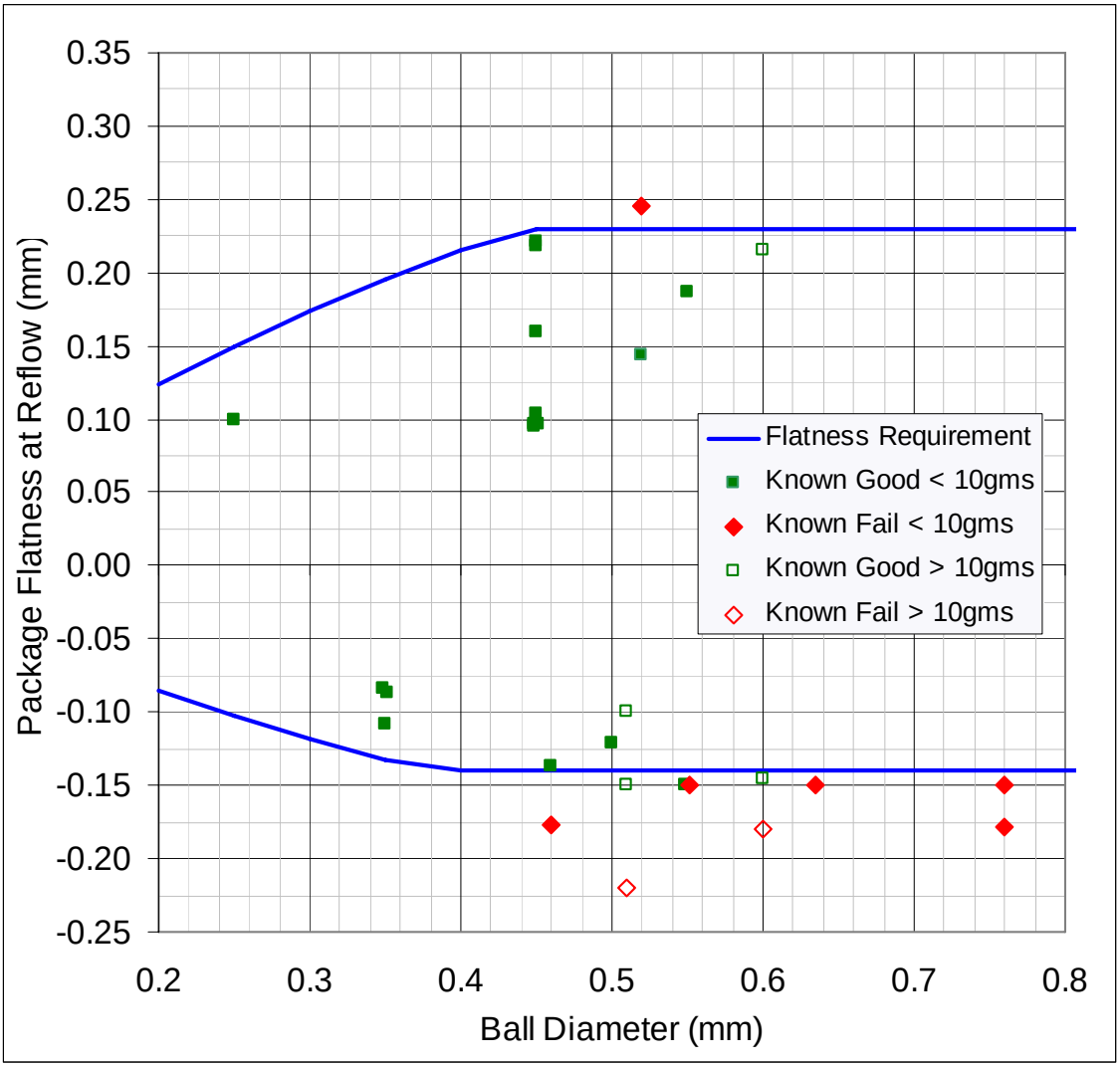
		b - Ball Diameter (mm)[iv]										
		0.20	0.25	0.30	0.35	0.40	0.45	0.50	0.55	0.60	0.80	0.90
e - Ball Pitch (mm)	0.40	-0.09 +0.12	-0.10 +0.15	-0.12 +0.17								
	0.50		-0.10 +0.15	-0.12 +0.17	-0.13 +0.20							
	0.65		-0.10 +0.15	-0.12 +0.17	-0.13 +0.20	-0.14 +0.22	-0.14 +0.23					
	0.80		-0.10 +0.15	-0.12 +0.17	-0.13 +0.20	-0.14 +0.22	-0.14 +0.23	-0.14 +0.23	-0.14 +0.23			
	1.00					-0.14 +0.22	-0.14 +0.23	-0.14 +0.23	-0.14 +0.23	-0.14 +0.23		
	1.27									-0.14 +0.23	-0.14 +0.23	-0.14 +0.23
	1.50									-0.14 +0.23	-0.14 +0.23	-0.14 +0.23

[iii] JEITA ED-7306 is specified using ball pitch (e) and height (A1), whereas JEDEC design guides use ball pitch (e) and ball diameter (b). Table assumes that the A1=0.6b, per the JEDEC design guides JEP95 4.5 & 4.14 to translate from ball height (A1) to ball diameter (b).

[iv] Values calculated using the following model based on industry survey data provided by task group members (see Annex A):
Concave Flatness (negative) Minimum = $0.35b^2$ - 0.5b not to exceed -0.14mm
Convex Flatness (positive) Maximum = $-0.4b^2$ + 0.7b not to exceed 0.23mm
where b is the ball diameter.

ANNEX A

Table 2 is based on a survey of task group participants. Participants provided maximum warpage data during reflow for components with known SMT performance. Components known to fail in SMT and those known to have acceptable SMT are denoted in Figure 1. The flatness requirement is also shown, both positive and negative.



NOTE Solid data points are for components with mass less than 10 grams. Hollow data points are for components greater than 10 grams. Flatness requirement for components greater than 15mm on side (Table 2 requirements) is shown.

Figure 1 — Summary of Task Group survey data for known good and known failing components.

Change Record

If the change involves any words added or deleted (excluding deletion of accidentally repeated words), the change is to be included below. Puntuation changes may or may not be included.

Initial Issue: A	Date: March 2009	Item number 11.2-783

Change Record History		
Issue:	Date:	Item Number:
	Description of Changes	

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