Quality Assurance for Bare-Die of wireless device

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1. Overview

This document has been created based upon JEITA EDR-4703A “Quality Guidelines for Bare Die” (revised in March, 2008) to share a common recognition between our company and customers with regard to the bare die quality.

2. Classification of the bare die quality in JEITA

In the JEITA EDR-4703A, the quality of the bare die is classified into the following three levels by the appearance, electrical characteristics, and reliability verification.

- Level 1: Known Good Die (KGD)
- Level 2: Known Tested Die (KTD)
- Level 3: Proved Die (PD)

JEITA classifications are shown in Table 2.1.

Level 1 (KGD)

(1) Appearance

The sample visual inspection is conducted to the bare die. Inspection items, inspection methods, and criteria of failures and defects are stipulated in the individual product specification.

(2) Assurance of the electrical function

The bare die is screened by the probe test which is equivalent to the final test for the packaged devices. The details of the test items and the criteria are stipulated in the individual specification. The assurance does not cover the electrical characteristics of the device after printed circuit board assembly because of the possible change of the electrical characteristics by the customer’s process.

(3) Reliability verification

a) EFR

As for the EFR which is attributable to the wafer processing but not to the packaging or board assembly process at the customers’, the evaluation data of one product may represents other products which were designed in the same rule and manufactured in the same process.

b) Screening

If EFR is above the criteria, the screening test (High Temperature Operating Test by wafer or die-level) will be carried out to meet the same criteria of the package products.

c) Product lifetime

The inherent failures particular to the bare die, i.e. intrinsic failures, which are attributable to the wafer processing but not to the packaging or board assembly process at the customer’s site, shall be examined after packaging the bare die.

Level 2 (KTD)

(1) Appearance

The sample visual inspection is carried out in the same way as for the level 1 (KGD).

(2) Assurance of the electrical function

The functional test is performed in the same way as for the level 1 (KGD), although there could be some unassured electrical functions.

(3) Reliability verification

a) EFR

As a general rule, the same procedure of the level 1 (KGD) is employed.

b) Screening

Even If the screening is considered necessary to meet the expected EFR, there are some cases where the screening is not applied.

c) Product lifetime

As a general rule, the same procedure of the level 1 (KGD) is employed.

Level 3 (PD)

(1) Appearance

The sample visual inspection is carried out in the same way as for the level 1 (KGD).

(2) Assurance of the electrical function

The bare die is screened by the prove test, the program of which is the same as that for the packaging device, i.e. DC test and basic function test. They do not include the analogue characteristics, at-speed test, and functional verification over the assured operational temperature range, which are applied to the KGD or KTD level.

(3) Reliability verification

a) EFR

Principally EFR will not be evaluated.

b) Screening

Principally the screening will not be applied.

c) Product lifetime

Principally the product lifetime will not be applied.

Table 2.1 – Verification of the bare die reliability vs. functional assurance

Functional test / Reliability	Simplified test (DC and simplified function tests only)	Assurance covers most of the functions except analogue characteristics, at-speed performance, and functional verification over the assured operational temperature range.	The equivalent test to that of the packaged device (Design-based assurance is also acceptable.)
EFR of the bare die is verified to be similar to that of the packaged device by conducting the equivalent lifetime test to the packaged devices.	Not applicable	KTD (Level 2)	KGD (Level 1)
Lifetime test or EFR verification has not been performed. Or EFR is inferior to that of the packaged devices.	PD (Level 3)	KTD (Level 2)	KTD (Level 2)

3. SEDI's quality assurance for bare die information

SEDI's quality assurance for bare-die of wireless device is based upon "PD".

3.1 Appearance (Visual inspection)

Principally the visual inspection is carried out for all bare-dies.

3.2 Electrical characteristics

The DC test is carried out for all bare dies, and the tested items will be guaranteed. The RF (AC) items are inspected at sampling. The details of the test items and the criteria are stipulated in the individual specification.

The electrical characteristics after printed circuit board assembly may not guarantee because of the possible change of the electrical characteristics by the customer process.

3.3 Reliability Verification

a) EFR

EFR may not be provided, but the data of other products which was designed in the same wafer process technology can be provided instead.

The assurance does not cover the EFR of the device after printed circuit board assembly because of the possible change of the EFR by the customer's process.

b) Screening (i.e. High Temperature Operating by wafer or bare die level)

Any screening tests such as High Temperature Operating Test by wafer or bare die level are not carried out.

c) Product lifetime

Principally the product lifetime will not be applied.

The reliability test result of the assembled wireless device in SEDI will be provided to the customer as a reference. The test result of the representative wireless device will be provided if the object wireless device were designed in the same wafer process technology.

The product lifetime after printed circuit board assembly will not be evaluated because of the possible change of the products lifetime by the customer process.

3.4 Bare die information

SEDI will provide customers with the quality information and design information that are necessary for their circuit design and board assembly design.

3.4.1 Electrical design information

The electrical design information of the bare die corresponds to the electrical specification of the packaged semiconductor devices. The examples are shown below. The extent of the test items, test conditions, and the specification of the electrical characteristics are often constrained by the measurement capability of the wafer probing.

(1) Absolute maximum rating and the recommended operating conditions
(2) Pin information
(3) Electrical characteristics

3.4.2 Physical design information

Physical design information is defined as the information necessary to design the package and board assembly for the bare die. It includes not only dimensions or constituting materials, but also design constraints and information for thermal design.

(1) Die name
(2) Dimensions (including tolerances)
- Die (x, y, t)
- Terminal pad size (x, y, t), Window size of terminal pad (x, y), Coordination of pads

(3) Material
- Terminal pad
- Backside material

(4) Constraints to the packaging process and bare die mount
- Physical design constraint
- Thermal design constraint
- Assembly process constraint

3.4.3 Quality information

Upon agreement, SEDI provides users with the quality information that discloses the details of the quality level of the bare die.

3.5 Shipping

3.5.1 Packing specification

The bare die will be packed and shipped in an appropriate manner to be protected from the physical damage, electrostatic discharge, and contamination. The details are specified in individual specification.

All bare dies are shipped in a "waffle pack" style shipping container. The container consists of layers (Figure 1) which are designed and assembled to provide maximum protection of bare die devices during shipment. The anti-static *carrier tray* (A) has an array of cells in its top surface which isolates the dies and restricts their motion. The dies may move laterally within the cells but it is not possible for the dies to flip upside down. Dies are always packaged with the active area facing upward.

Two paper sheets are held captivated within the bottom cavity of the container *lid* (D) by two plastic tabs. A sheet of translucent, anti-static *lining paper* (B) directly contacts the loaded *carrier tray* to prevent contamination of the bare die devices. A thicker sheet of white *embossed paper* (C) behind the *lining paper* exerts pressure on the *carrier tray/lining paper* interface and prevents dislodging of dies from the cells. The *carrier tray* has two notches corresponding to the paper sheet retaining tabs in the container *li*d. A *label* (E) is affixed to the container *li*d, and the layers are clamped together with a plastic *clamp* (F).

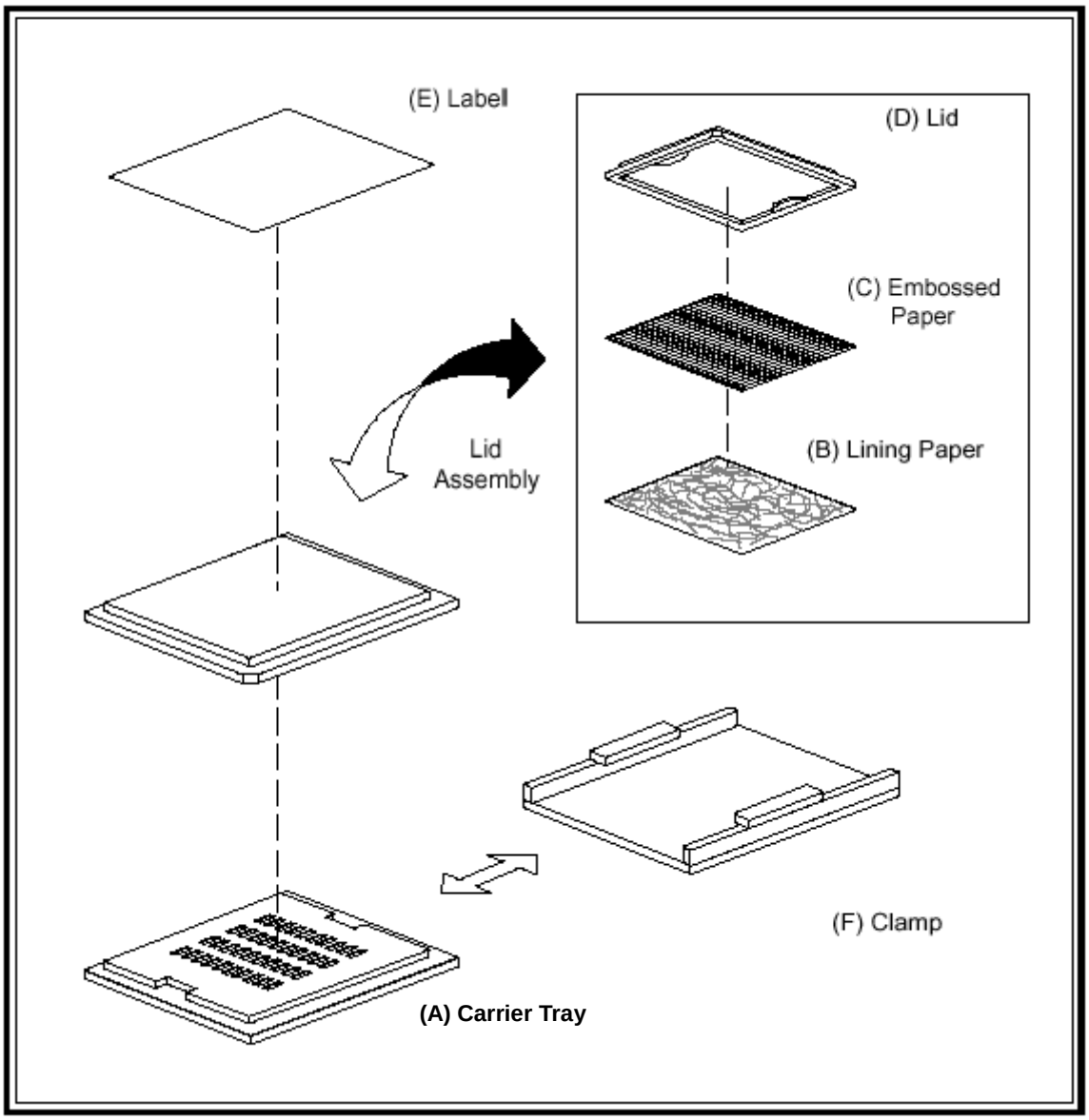

Figure 1. Shipping Container Layers and Order of Assembly

3.5.2 Traceability

SEDI has a wafer lot tracking system for the bare die. Also the customers need to have a similar control system to be capable of tracking the wafer lot of the bare die.

3.5.3 Shipping information

The following information will be attached to the shipment in compliance with individual packing specification.

(1) Manufacturer name
(2) Product name
(3) Quantity
(4) Lot number

3.6 Shelf life

The shelf life of the bare die at customer's site shall comply with Clause 6, EIAJ EDR-4701B, "Handling guidance for semiconductor devices"
The brief contents of the specification are as follows:

(1) Packed products
- Storage conditions: Temperature 15 °C – 35 °C , Relative humidity 45% - 75%
- Target shelf life: 3 months maximum

(2) Unpacked products
- Storage conditions: Dry nitrogen (dew-point temperature shall be -30 °C or below) or dry air
- Target shelf life: 20 days maximum

(3) Printed circuit board assembly
- For the product after taken out from the package, dry nitrogen, or dry air, the waiting time for the printed circuit board assembly shall be 5 days maximum.

3.7 Handling of the bare die

The bare die shall be handled with enough care to avoid physical damage including scratches, contamination, and electrostatic discharge, which can impose fatal impact on the quality.

(1) Requirements
Anti-static work surface
Grounding cable and wrist strap
Metal tweezers or vacuum probe
Clean container to receive transferred dies
Binocular microscope with illuminator

(2) Handling Precautions
Bare die devices are sensitive to electrostatic discharge (ESD). It is very important that the work surface and operator are properly grounded to prevent ESD damage to these devices. Operators should wear a grounding wrist strap which is connected to a grounded anti-static work surface.
A work area of ISO Class 7(Federal Standard Class 10,000) or lower is recommended to prevent contamination of exposed devices.

(3) Procedure
To remove dies from the shipping container, operators should use the following procedure:

a) Follow the precautions described in this note. Work in a clean area and connect grounding straps. The work surface should be clean and light in color.

b) When opening the plastic bag, please use scissors or a retractable knife, etc. to prevent excessive stress being applied to the tray. (Figure 2)

c) Remove the plastic *clamp* from the shipping container by sliding it to either the right or left. Do not remove the *lid* at this time. (Figure 3)

d) Place the shipping container on the work surface right side up. Gently tap the container *lid* to free dies which may have adhered to the *lining pape*r. (Figure 4)

e) Carefully remove the container *lid* assembly. Before setting the *lid* assembly down, inspect the underside for any dies which may have adhered to the *lining* paper. (Figure 5) These dies are not damaged and should be transferred back to the *chip carrier tray* or into the new container. Place the *lid* assembly label-side down in a clean spot nearby. The dies in the *carrier tray* are now exposed and ready to be transferred to the new container. If the *lining paper* and/or *embossed paper* come free from the *li*d, replace them (using tweezers) by slipping the paper sheets under the retaining tabs. The *embossed paper* must be inserted into the *lid* first, followed by the *lining pape*r.

DO NOT ALLOW THE *EMBOSSED PAPER* TO MAKE CONTACT WITH THE BARE DIE DEVICES AS THE DIES MAY ADHERE AND BECOME DAMAGED. THE *LINING PAPER* MUST BE INSERTED LAST.

f) Place the *carrier tray* under a microscope of suitable magnification and focus on the die which is to be transferred. If tweezers are used, there must be enough room between the die edges and cell boundaries to insert the tweezers tips. Gently grip the die and transfer it to the new container. Be careful not to apply excessive pressure as GaAs dies are very brittle and easily damaged. A vacuum probe is preferable to tweezers and should be applied to any of the top corners of the die. (Figure 6)

g) The shipping container may be reassembled to protect any remaining dies. Place the *li*d, with *embossed paper* and *lining paper* inserted, on the *carrier tray* so that the tabs in the *lid* mate with the notches in the *carrier tra*y. Slide the *clamp* onto the *carrier tray lid* assembly. Unused devices should be stored in a dry Nitrogen atmosphere.

Figure 2

Figure 3

Figure 4

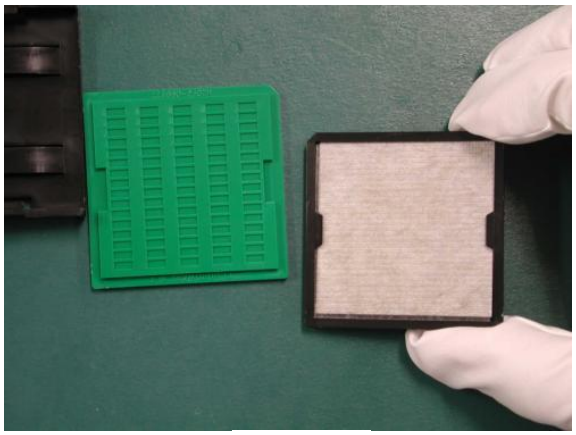

Figure 5

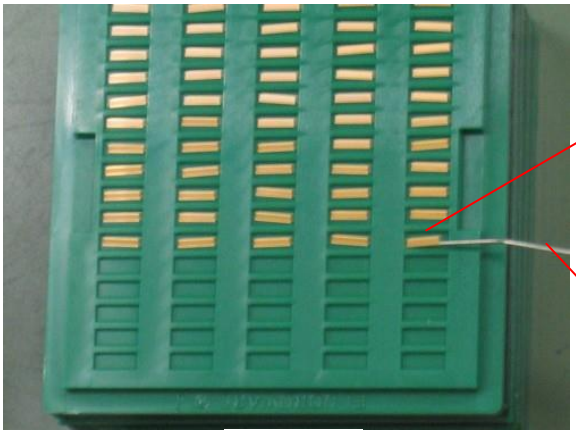

Figure 6

3.8 Handling of the defective parts

If the bare die product was claimed to be conflicted with the specified quality level in Clause 3.1, 3.2 and 3.3, SEDI would like to discuss the details of the disposition beforehand with the customers. In addition, please provide the following information upon its return for failure analysis.

(1) Physical configuration of returns
(2) Information:
- Wafer lot
- Description of non-conformance (failure mode, incidence rate, failure location)