SEMI M31-1103[E]
PROVISIONAL MECHANICAL SPECIFICATION FOR FRONT-OPENING SHIPPING BOX USED TO TRANSPORT AND SHIP 300 mm WAFERS

This provisional specification was technically approved by the Global Physical Interfaces & Carriers Committee and is the direct responsibility of the North American Physical Interfaces & Carriers Committee. Current edition approved by the North American Regional Standards Committee on September 3, 2003. Initially available at www.semi.org September 2003; to be published November 2003. Originally published in 1998; previously published March 2003.

[E] This standard was editorially modified in May 2004 to reflect the withdrawal of SEMI E19.5. Changes were made to Section 6.1.

SUPERSEDED

1 Purpose

1.1 This standard partially specifies the front-opening shipping box (FOSB) used to ship 300 mm wafers from wafer suppliers to their customers (typically IC manufacturers).

2 Scope

2.1 This standard is intended to set an appropriate level of specification that places minimal limits on innovation while ensuring modularity and inter-changeability at all mechanical interfaces. Only the physical interfaces for FOSB are specified; no materials requirements or micro-contamination limits are given. However, this standard has been written so that both metal and injection-molded plastic FOSBs can be manufactured in conformance with it.

2.2 This standard assumes that the FOSB is used in the last process in wafer manufacturing, in acceptance and inspection, and in transferring the wafers from the FOSB to a FOUP or open cassette inside an IC manufacturing facility. The FOSB is not intended to be used in IC manufacturing processes. It is recommended that wafers be transferred from the FOSB to a FOUP or open cassette using automated methods. As described in Section 5.4, the purchaser needs to specify which type of shipper door is required:

1) Manual door as described in Section 5.4.1; or

2) Automated door as described in Section 5.4.2.

2.3 This standard (as well as other 300 mm standards) is provisional. Once FOSB testing and initial volume production is done (or any change related to the FOSB is made to a document listed in Section 3 below), this standard should be modified and upgraded from provisional status. Where possible, the specified design features are in accord with like features in SEMI E1.9 and SEMI E47.1.

NOTICE: This standard does not purport to address safety issues, if any, associated with its use. It is the responsibility of the users of this standard to establish appropriate safety and health practices and determine the applicability of regulatory or other limitations prior to use.

3 Referenced Standards

3.1 *SEMI Standards*

SEMI E1.9 — Mechanical Specification for Cassettes Used to Transport and Store 300 mm Wafers

SEMI E15 — Specification for Tool Load Port

SEMI E15.1 — Specification for 300 mm Tool Load Port

SEMI E47.1 — Provisional Mechanical Specification for Boxes and Pods Used to Transport and Store 300 mm Wafers

SEMI E57 — Mechanical Specification for Kinematic Couplings Used to Align and Support 300 mm Wafer Carriers

SEMI E62 — Provisional Specification for 300 mm Front-Opening Interface Mechanical Standard (FIMS)

SEMI S8 — Safety Guidelines for Ergonomics Engineering of Semiconductor Manufacturing Equipment

NOTICE: As listed or revised, all documents cited shall be the latest publications of adopted standards.

4 Terminology

4.1 *Definitions*

4.1.1 *bilateral datum plane* — a vertical plane that bisects the wafers and that is perpendicular to both the horizontal and facial datum planes (as defined in SEMI E57).

4.1.2 *box* — a protective portable container for a carrier and/or substrate(s).

4.1.3 *carrier* — an open structure that holds one or more substrates.

Documents Document Sharing Hub

Full document details: SEMI M31-1103E

4.1.4 *carrier bottom domain* — volume (below *z*6 above the horizontal datum plane) that contains the bottom of the carrier (as defined in SEMI E1.9).

4.1.5 *carrier capacity* — the number of substrates that a carrier holds (as defined in SEMI E1.9).

4.1.6 *carrier sensing pads* — surfaces on the bottom of the carrier for triggering optical or mechanical sensors (as defined in SEMI E1.9).

4.1.7 *carrier side domains* — volumes (from *z*6 above the horizontal datum plane to *z*15 above the top nominal wafer seating plane) that contain the mizo teeth or slots that support the wafer and the supporting columns on the sides and rear of the carrier (as defined in SEMI E1.9).

4.1.8 *carrier top domain* — volume (higher than *z*15 above the top wafer) that contains the top of the carrier (as defined in SEMI E1.9).

4.1.9 *facial datum plane* — a vertical plane that bisects the wafers and that is parallel to the front side of the carrier (where wafers are removed or inserted). On tool load ports, it is also parallel to the load face plane specified in SEMI E15 on the side of the tool where the carrier is loaded and unloaded (as defined in SEMI E57).

4.1.10 *front-opening shipping box (FOSB)* — a shipping box with a front-opening interface.

4.1.11 *front-opening unified pod (FOUP)* — a box (that complies with SEMI E47.1) with a non-removable cassette (so that its interior complies with SEMI E1.9) and with a front-opening interface (that mates with a FIMS port that complies with SEMI E62) (as defined in SEMI E47.1).

4.1.12 *horizontal datum plane* — a horizontal plane from which projects the kinematic-coupling pins on which the carrier sits. On tool load ports, it is at the load height specified in SEMI E15 and might not be physically realized as a surface (as defined in SEMI E57).

4.1.13 *minienvironment* — a localized environment created by an enclosure to isolate the product from contamination and people.

4.1.14 *nominal wafer centerline* — the line that is defined by the intersection of the two vertical datum planes (facial and bilateral) and that passes through the nominal centers of the seated wafers (which must be horizontal when the carrier is placed on the coupling) (as defined in SEMI E57).

4.1.15 *optical wafer sensing paths* — lines of sight for optically sensing the positions of the wafers. Several horizontal optical wafer sensing paths are present in between the carrier side domains. In addition, two vertical optical wafer sensing paths are created by rectangular exclusion zones in the front of the carrier top and bottom (as defined in SEMI E1.9).

4.1.16 *shipping box* — a protective portable container for a carrier and/or wafer(s) that is used to ship wafers from the wafer suppliers to their customers.

4.1.17 *shipping-box front-opening mechanical interface (SFMI)* — optional automated door style for a shipping box that is compatible with SEMI E62, with exceptions as noted in Section 5.4.2.

4.1.18 *virtual tracking unit* — an entity (which could be a number of substrates or an individual die or mask group) that the factory floor control system treats as a single unit for tracking purposes (as defined in SEMI E1.9).

4.1.19 *wafer carrier* — any cassette, box, pod, or boat that contains wafers (as defined in SEMI E15).

4.1.20 *wafer extraction volume* — the open space for extracting a wafer from the carrier (as defined in SEMI E1.9).

4.1.21 *wafer pick-up volume* — the space that contains entire bottom of a wafer if the wafer has been pushed to the rear of the carrier (as defined in SEMI E1.9).

4.1.22 *wafer set-down volume* — the open space for inserting and setting down a wafer in the carrier (as defined in SEMI E1.9).

5 Requirements

5.1 The shipping box has the following components and sub-components:

Key:

- • Required feature
- ◊ Optional feature

- • Door on front
  - ◊ Manual door (optional)
  - ◊ Automated door (optional)
    - • Holes for latch keys that lock the door to the SFMI interface when the door is unlatched from the box
    - • Holes for registration pins
    - • Door presence sensing areas
- • Top
  - ◊ Top robotic handling flange (optional)

SUPERSEDED

Documents
Document Sharing Hub
Full document details: SEMI M31-1103E

- Interior
  - Non-removable cassette with supports for 13 or 25 wafers
  - Wafer capture mechanism
  - 2 end effector exclusion zones
- Sides
  - ◊ Ergonomic manual handles (optional)
- Bottom
  - 5 carrier sensing pads
  - 4 Info pads
  - 3 features that mate with kinematic coupling pins and provide a 10 mm lead-in
  - ◊ 3 features that mate with kinematic coupling pins and provide a 15 mm lead-in (optional)

5.2 *Kinematic Couplings* — The physical alignment mechanism from the FOSB to the tool load-port (or a nest on a vehicle or in a stocker) consists of features (not specified in this standard) on the top entity that mate with three or six pins underneath as defined in SEMI E57. The three features that mate with the kinematic coupling pins must provide a lead-in capability that corrects a FOSB misalignment of up to *r*69 in any horizontal direction.

5.3 *Inner and Outer Radii* — All required concave features may have a radius of up to *r*65 to allow cleaning and to prevent contaminant build-up. All required convex features may also have a radius of up to *r*66 to prevent small contact patches with large stresses that might cause wear and particles. Note that these limits on the radius of all required features are specified as a maximum (not a minimum) to ensure that the required features are not rounded off too much. The lower bound on the radius is up to the FOSB supplier. Note also that this radius applies to every required feature unless another radius is called out specifically. Here a required feature is an area on the surface of the FOSB supplier. Note also that this radius applies to every required feature unless another radius is called out specifically. Here a required feature is an area on the surface of the FOSB specified by a dimension (or intersections of dimensions) that has a tolerance and not just a maximum or minimum (such as the edges of the robotic handling flange).

5.4 *Door* — It is recommended that the FOSB not be vertical when it is opened or closed. When the FOSB is in a vertical orientation with the door removed, the wafers must be restrained from touching each other by appropriate wafer support design or other retaining techniques.

5.4.1 *Manual Door* — If chosen, the manual door option requires no automation to open the door. An exclusion zone surrounding the manual door area is specified in the standard. There are several possible techniques for sealing and clamping the manual door that meet user requirements. Therefore, only an exclusion zone surrounding the manual door area is specified in this standard. All features of the door and door retaining mechanism must lie within the exclusion zone illustrated in Figure 1 and must not interfere with other specified features (including the kinematic couplings). Figure 1 and dimensions x81, y50, y81, y82, z47, z48 and z49 define the manual door area and therefore apply only to the manual door option as described in this section. The y81 dimension applies from the horizontal datum plane to the top surfaces of the FOSB (z47-z48 or z47+z49 at the upper door frame volume specified by y50).

5.4.2 *Automated Door* — If chosen, the SFMI automated door must be designed to mate with a port that conforms to SEMI E62. Note the following exceptions: the maximum required latch torque is 4.4 N-m instead of 1.7 N-m. It is recommended then that the automated door opener provide at least 4.5 N-m to open or close the automated door in conjunction with the increased torque. If the increased torque does not allow for the FOSB to be clamped solely using the front clamping feature, the FOSB might need to be supported with additional devices attached to the equipment load port.

5.4.2.1 Since the FOSB has a *y*51 ≥ 50 mm, instead of 140 mm as in SEMI E47.1, a longer stroke is required to remove the door. Note that there must be a provision for opening the automated door without a loadport.

5.5 *Seal Zones for Door* — In the Front Opening Shipping Box Automated Door Option the automated box door is on the front side of the box (corresponding to the front side of the carrier where wafers are accessed so the door is perpendicular to the wafers and parallel to the facial datum plane). The automated door and the carrier frame must have surfaces that mate with the seal zones defined in SEMI E62. Specifically, the FOSB automated box door option and the carrier frame must have surfaces that made with the seal zones and the reserved spaces for vacuum application (which includes all of the circles bounded by r38 except for the holes for the registrations at the center of each circle) defined in Section 5 of SEMI E62 (which specifies r38 as well as the seal zone dimensions). These automated door and frame surfaces must be a distance of y52 from the facial datum plane and must have a flatness of y42. No surface on the automated door may project further

SUPERSEDED

Documents Document Sharing Hub
Full document details: SEMI M31-1103E

from the facial datum plane than the door seal zone and the reserved spaces for vacuum application. The automated door must also be designed so that when the box is pressed against the FIMS port, both latch keys on the port are inserted to their full length. Furthermore, when the latch keys are turned more than 45° toward the position that unlocks the automated door from the box, the latch key holes on the door must be such that the door is not removable from the latch keys. There are no door seal zone requirements for the manual door option, but a FOSB with the manual door must contain a frame seal zone that meets the frame seal zone requirements specified in this section.

5.6 *Wafer Capture and Centering* — When the FOSB is closed, the wafers must be captured in the FOSB to prevent movement during subsequent handling, including shipping. It should be noted that wafers are typically shipped in a vertical orientation and generally require support from a secondary package. It is recommended that this secondary package be designed to allow for easy removal of the FOSB from the secondary package.

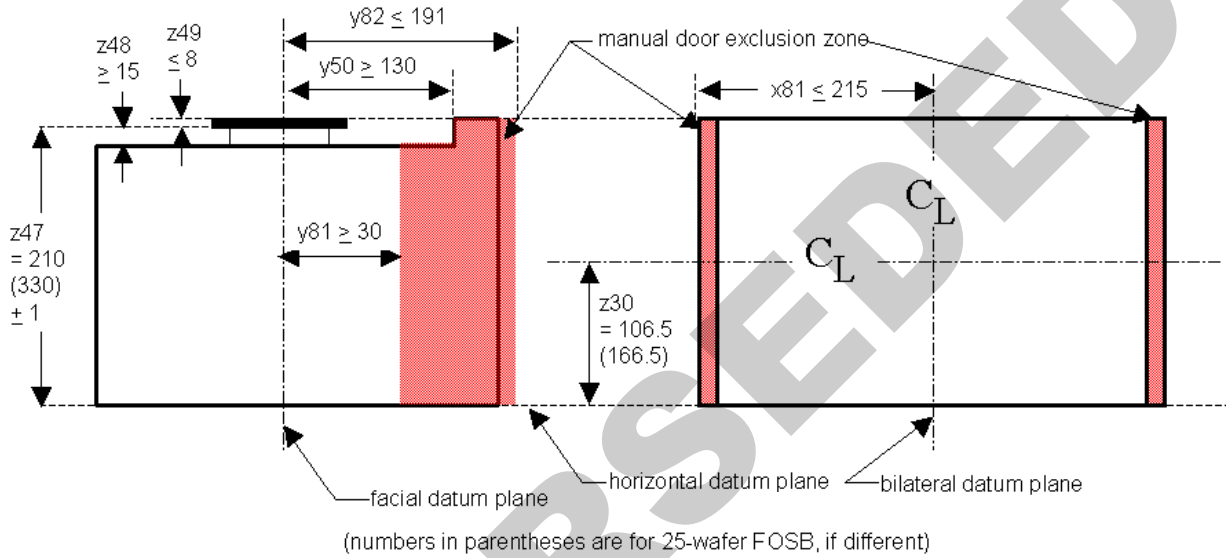

Figure 1
Manual Door Area

5.7 *Wafer Orientation and Numbering* — The wafers must be horizontal when the FOSB is placed on the coupling, and the wafers slots are numbered in increasing order from bottom to top (so the bottom wafer is wafer number 1, the next wafer up is wafer number 2, etc.).

5.8 *Internal Horizontal Dimensions* — Figure 2 shows a cross-section of the horizontal boundaries of the FOSB side domains (which contain the parts of the FOSB higher than z6 above the horizontal datum plane and lower than z15 above the top wafer). In this and following figures, the most heavy lines are used for surfaces that have tolerances (not surfaces that have only maximum or minimum dimensions).

SUPERSEDED

Documents
Document Sharing Hub
Full document details: SEMI M31-1103E

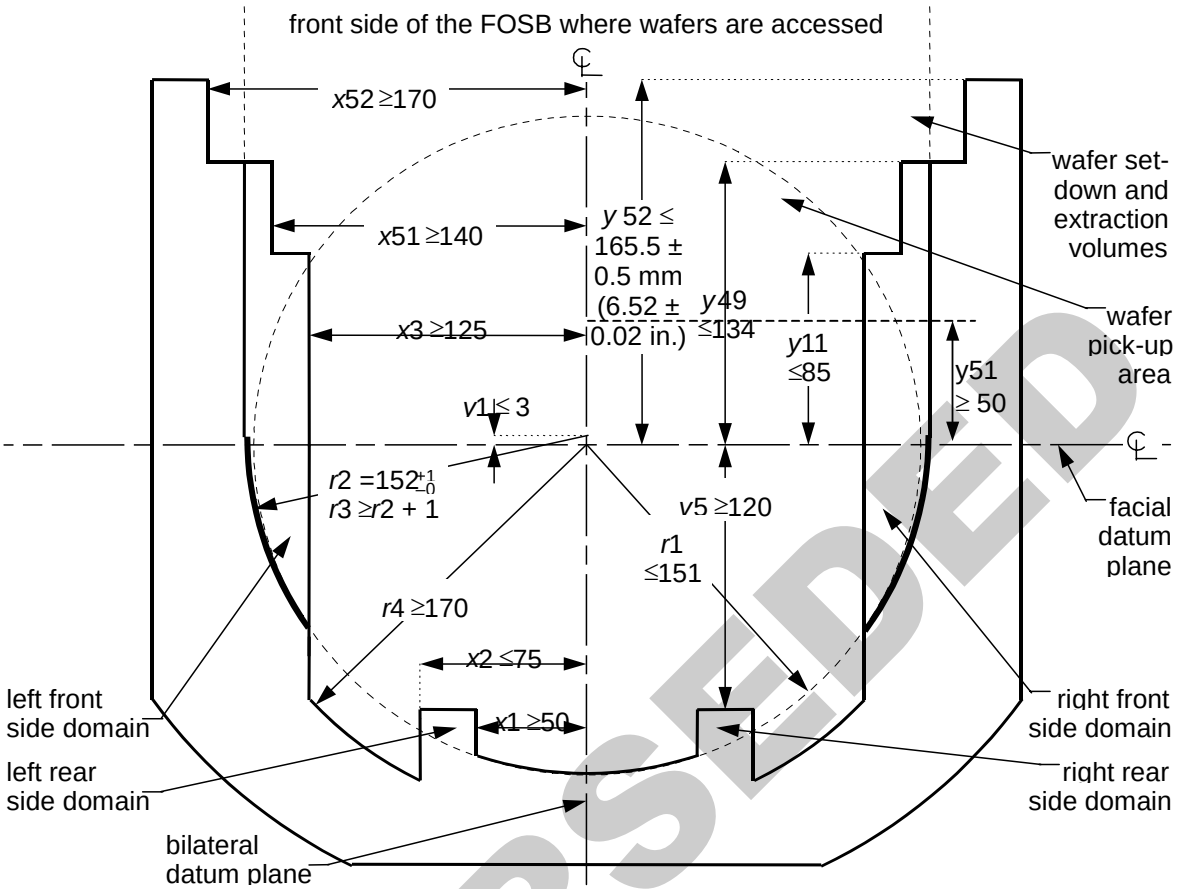

Figure 2
Top View of FOSB Internal Dimensions

SUPERSEDED

Documents Document Sharing Hub
Full document details: SEMI M31-1103E

5.9 *Internal Vertical Dimensions* — Figures 3 through 7 show the vertical dimensions of the internal FOSB. Note that *z*8 (the height of the bottom nominal wafer seating plane above the horizontal datum plane) and *z*12 (the distance between adjacent nominal wafer seating planes) are given as absolute distances with no tolerance. This means that the sum of actual height variations in the FOSB from the kinematic coupling to the supporting features holding each wafer must be contained within the tolerance of *z*10 with no further stack-up at each higher wafer. The method for meeting this requirement is left up to the FOSB supplier. Table 2 defines all dimensions for Figures 3 through 7.

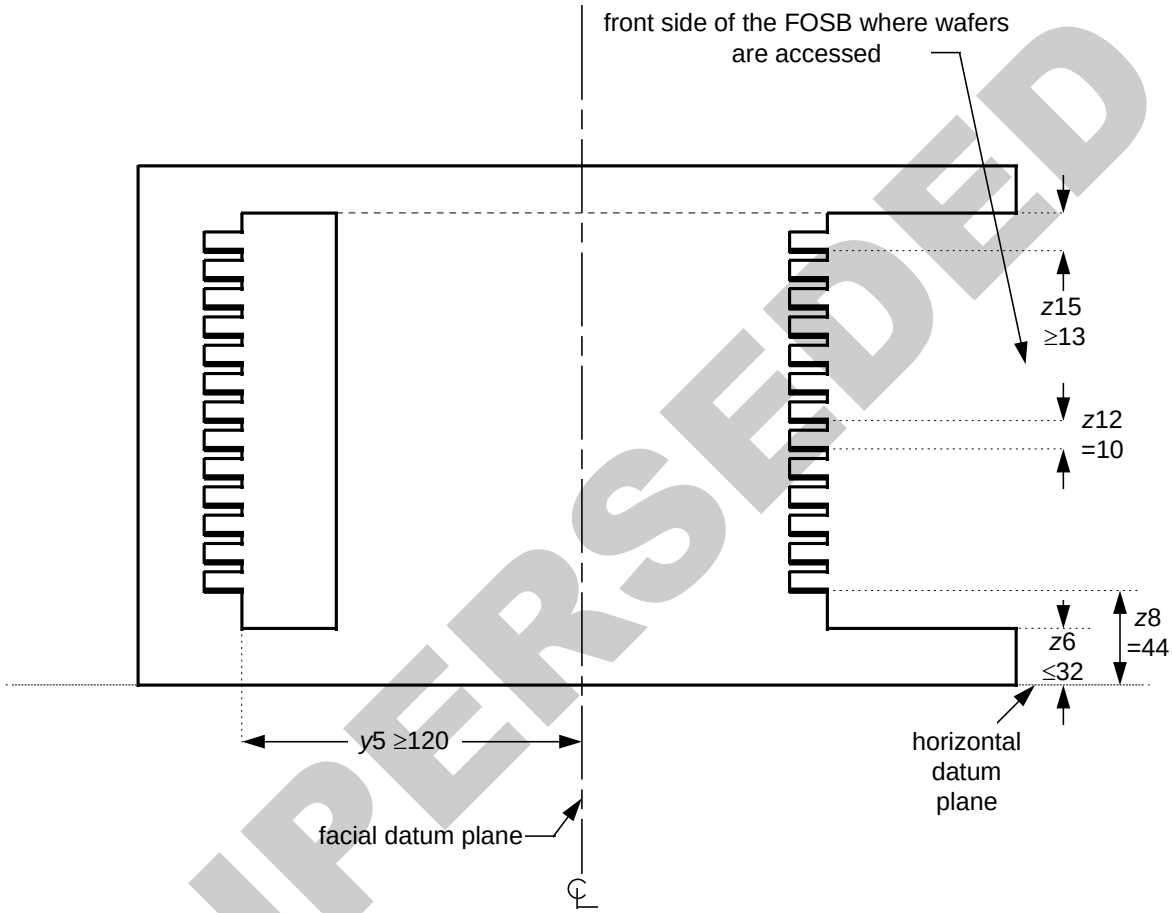

Figure 3
Side View of FOSB Internal Dimensions

SUPERSEDED

Documents
Document Sharing Hub
Full document details: SEMI M31-1103E