SEMI E119-1102
PROVISIONAL MECHANICAL SPECIFICATION FOR REDUCED-PITCH FRONT-OPENING BOX FOR INTERFACTORY TRANSPORT OF 300 mm WAFERS

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1 Purpose

1.1 This standard partially specifies a reduced-pitch front-opening box for interfactory transport of 300 mm wafers (FOBIT). This reduced-pitch box, with a capacity of 25 wafers but with the approximate physical volume of a 13-wafer FOUP, is intended to reduce the cost of transporting wafers between IC manufacturing sites. To leverage current industry 300 mm technology, this reduced-pitch front-opening box is intended to interface with 13-wafer FIMS, as specified in SEMI E62.

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 FOBIT 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 FOBITs can be manufactured in conformance with it.

2.2 This standard assumes that the FOBIT is intended for use in the interfactory transportation of wafers. The following boundary conditions were used in the creation of this specification:

- Minimizing the pitch between wafers will reduce the cost of transporting wafers.
- The FOBIT will be used for interfactory transportation of both processed and unprocessed wafers.
- The box will have a 25-wafer capacity.
- Random access of wafers, using edge grip handling devices, is not a requirement for this standard.
- The FOBIT will be compatible with the following 300 mm Standards:
- 13-wafer FIMS Interface (SEMI E62)
- 300 mm Load Port (SEMI E15.1)
- Kinematic Coupling (SEMI E57)
- The FOBIT will not necessarily be compliant with the following 300 mm Standards due to wafer restraint requirements and product applications during transportation:
- 300 mm Front-Opening Unified Pod (SEMI E47.1)
- 300 mm Open Cassette (SEMI E1.9)
- 300 mm Front-Opening Shipping Box (SEMI M31)
- The technical requirements of this standard are written for the transportation of nominal thickness wafers, as defined by SEMI M1.15.

2.3 This reduced-pitch, 25-capacity FOBIT is designed for use with the 13-capacity FIMS interface, as specified in SEMI E62.

2.4 This standard is provisional. Once FOBIT testing and initial volume production is done (or any change related to the FOBIT is made to a document listed in Section 3 below), this standard should be modified and upgraded from provisional status.

2.5 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 health practices and determine the applicability or regulatory limitations prior to use.

3 Referenced Standards

3.1 *SEMI Standards*

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

SEMI E15 — Specification for Tool Load Port

SEMI E15.1 — Provisional 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

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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 M1.15 — Standard for 300 mm Polished Monocrystalline Silicon Wafers (Notched)

SEMI M31 — Provisional Mechanical Specification for Front-Opening Shipping Box Used to Transport and Ship 300 mm Wafers

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

NOTE 1: 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.

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 box for interfactory transport (FOBIT)* — a transportation box with a front-opening interface (that mates with a FIMS port that complies with SEMI E62).

4.1.11 *front-opening shipping box (FOSB)* — a shipping box (that complies with SEMI M31) with a front-opening interface.

4.1.12 *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).

4.1.13 *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).

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

4.1.15 *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).

4.1.16 *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).

4.1.17 *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.

4.1.18 *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).

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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

The FOBIT has the following components and sub-components:

Key:

- Required feature
- ◊ Optional feature

- Door on front
  - Holes for latch keys that lock the door to the FIMS interface when the door is unlatched from the box
  - Holes for registration pins
  - Door presence sensing areas
- Top
  - ◊ Top robotic handling flange (optional)
- Interior
  - Non-removable cassette with supports for 25 wafers
  - Wafer capture mechanism
  - 2 end-effector exclusion zones
- Sides
  - ◊ Ergonomic manual handles (optional)
- Bottom
  - 5 carrier sensing pads
  - Center retaining feature
  - Front retaining feature
  - 4 info pads
  - 2 advancing box sensing 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)
  - ◊ 2 bottom side rails for use with roller conveyor or forklifts (optional)

5.1 *Kinematic Couplings* — The physical alignment mechanism from the FOBIT 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 FOBIT misalignment of up to *r*69 in any horizontal direction.

5.2 *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 FOBIT supplier. Note also that this radius applies to every required feature unless another radius is called out specifically. A required feature is an area on the surface of the FOBIT 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).

5.3 *Door* — It is recommended that the FOBIT be in a horizontal orientation when it is opened or closed (corresponding to the front side of the cassette where wafers are accessed so the door is perpendicular to the wafers and parallel to the facial datum plane). The door and its frame must be designed to mate with a port that conforms to SEMI E62. Specifically, the FOBIT door and its frame must have surfaces that mate with the seal zones and the reserved spaces for vacuum application (which includes all of the circles bounded by *r*38 except for the holes for the registration pins at the center of each circle) defined in Sections 5.3 and 5.6 of SEMI E62 (which specifies *r*38). These FOBIT door and frame surfaces must be a distance of *y*52 from the facial datum plane and must have a flatness of *y*42. No surface on the FOBIT door may project further from the facial datum plan than the door seal zone and the reserved spaces for vacuum application. The door of the FOBIT must also be designed so that when the FOBIT 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 FOBIT door, the latch key holes on the door must be such that the door is not removable from the latch keys.

5.4 *Wafer Capture and Centering* — When the FOBIT is closed, the wafers must be captured in the FOBIT to prevent movement during subsequent handling,

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including transportation. It should be noted that wafers are typically transported 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 FOBIT from the secondary package.

5.5 *Wafer Orientation and Numbering* — The wafers must be horizontal when the FOBIT is placed on the kinematic 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.).

5.6 *Internal Horizontal Dimensions* — Figure 1 shows a cross-section of the horizontal boundaries of the FOBIT side domains (which contain the parts of the FOBIT higher than *z*6 above the horizontal datum plane and lower than *z*15 above the top wafer). In this and following figures, the heaviest lines are used for surfaces that have tolerances (not surfaces that have only maximum or minimum dimensions). Table 1 defines the dimensions shown in this figure.

5.7 *Internal Vertical Dimensions* — Figures 2 through 5 show the vertical dimensions of the internal FOBIT. 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 FOBIT 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 FOBIT supplier. Table 1 defines all dimensions for Figures 2 through 5.

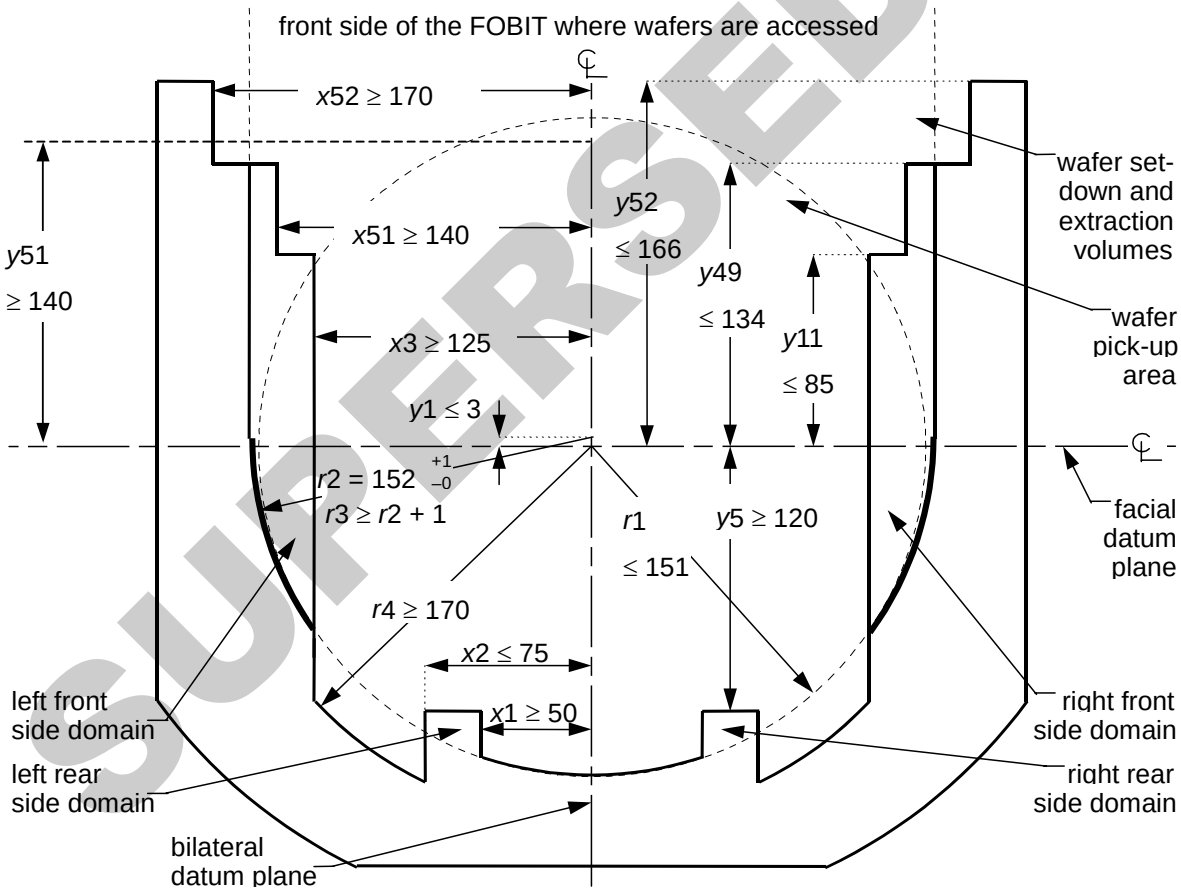

Figure 1
Top View of FOBIT Internal Dimensions

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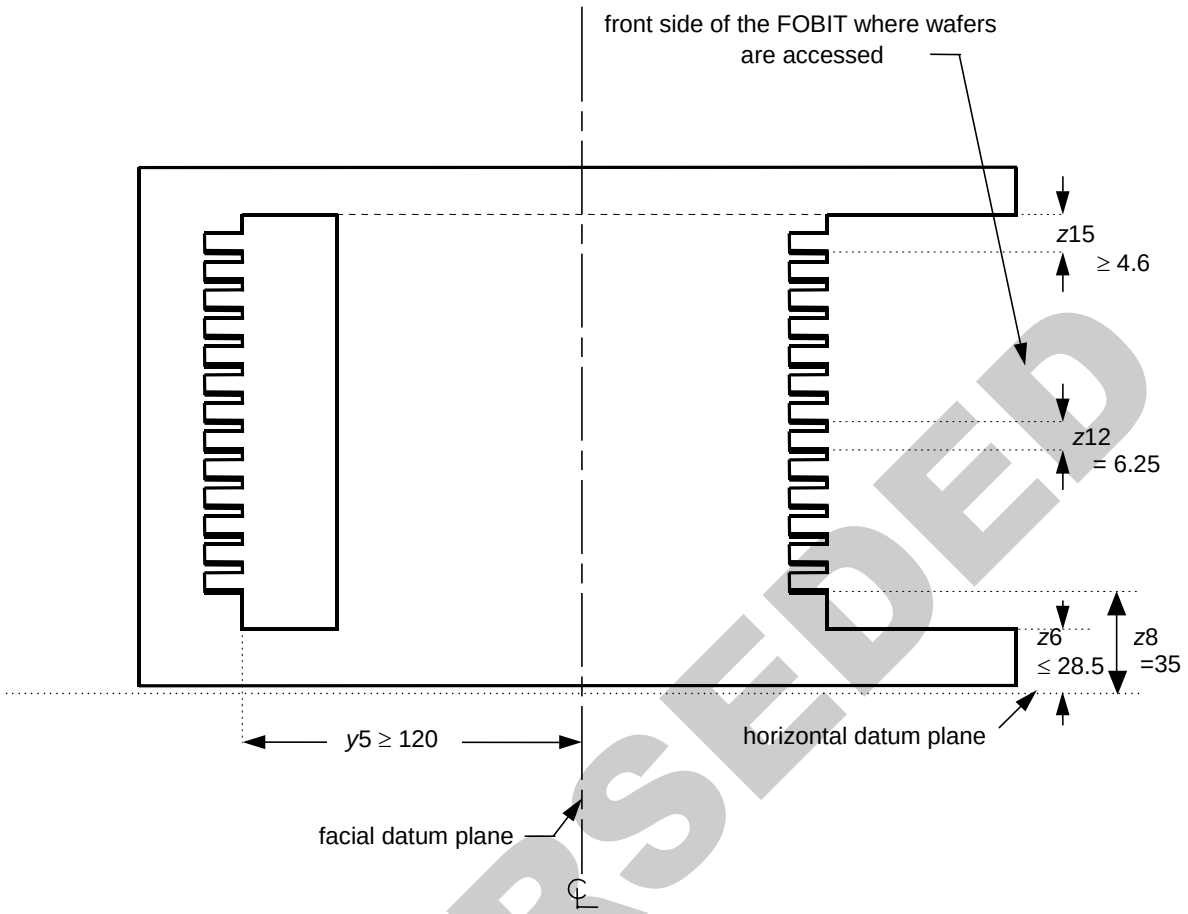

Figure 2
Side View of FOBIT Internal Dimensions

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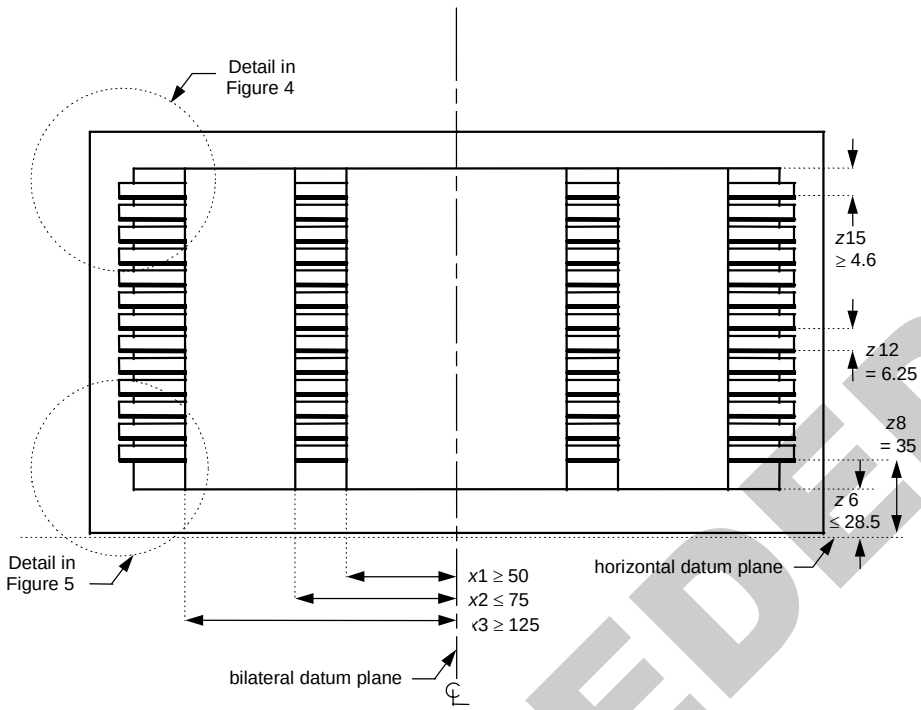

Figure 3
Front View of FOBIT Internal Dimensions

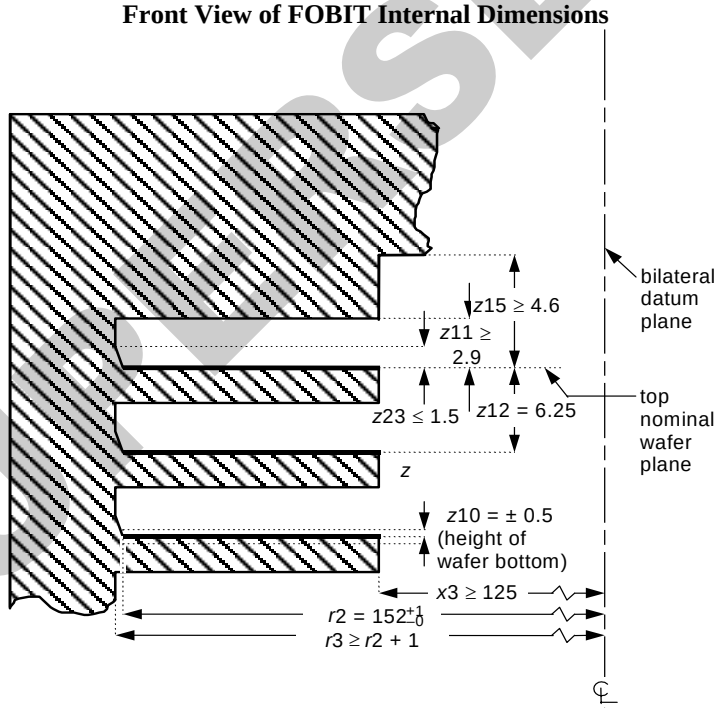

Figure 4
Upper Cross-Section at Facial Datum Plane

5.7.1 *Wafer Set-Down Volume* — The open space for the wafer set-down volume consists of a cylindrical section with radius $r2$ and a main axis parallel to and $y1$ in front of the nominal wafer centerline. The top of this cylindrical section is $z11$ above the nominal wafer-seating plane and its bottom is $z10$ above the nominal wafer-seating plane. The implications for wafer positioning of the tolerance on $r2$ are as follows. The wafers should be placed in the FOBIT within a circle of radius corresponding to the smaller bound on $r2$ to avoid touching the edge of the wafer to the side of the FOBIT. Once the wafer has been placed, the FOBIT

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