SEMI E92-0302[E]
SPECIFICATION FOR 300 mm LIGHT WEIGHT AND COMPACT BOX OPENER/LOADER TO TOOL-INTEROPERABILITY STANDARD (BOLTS/LIGHT)

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1 Purpose

1.1 *Provide Standard for Box Opener/Loader Interoperability* — This standard is intended to provide standard specifications such as interfaces between the component that opens the boxes and presents the boxes to the equipment wafer handler for unloading and loading 300 mm wafers (BOLTS/Light unit) and higher level part of equipment and its functions to provide: (see Figure 1)

- High level of interchangeability/ interoperability,
- Quick attachment/detachment capability with high mechanical repeatability,
- Light weight, and
- Compactness.

1.1.1 In order to provide a high level of interchangeability and interoperability, this standard specifies not only interfaces but also some of the box opener/loader's functions that affect interoperability.

1.2 *Usage of This Standard* — Interoperability specifications defined by this standard are intended to be used as interfaces and functionality between BOLTS/Light compliant box opener/loader and:

- A BOLTS/M compliant loadport unit (that would conform to SEMI E63).
- An integrated loadport such as four box opener/loader in one chassis.
- High-densely packaged equipment that uses the space under the box opener/loader.

1.3 *SEMI Standards Compatibility* — This standard is compatible with 300 mm SEMI standards including SEMI E15.1, E47.1, E1.9, E62, E63 and E64.

1.4 *Open Cassette Application* — The BOLTS/Light unit might be configured to handle boxes that would conform to SEMI E47.1 and SEMI E62.

1.5 A similar unit may be compatibly designed which does not have box opener capability, but facilitates placement of an open cassette (that would conform to SEMI E1.9).

1.6 *Carrier Capacities* — This standard defines one interface for 13 or 25 carrier capacity box opener/ loaders.

1.7 The interface specified in this standard is designed for equipment with a sealed mini-environment, but it is not limited to such.

2 Scope

2.1 *Items Specified* — This standard is intended to set an appropriate level of specification that places minimal limits on innovation while ensuring modularity, interchange-ability, and interoperability including:

- Box opener/loader functions that affect interoperability.
- Mechanical interface features between the box opener/loader and equipment.

2.2 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 limitations prior to use.

3 Limitations

3.1 This specification does not apply to the following application:

- Direct insertion of open cassettes into load-lock chambers.

4 Referenced Standards

4.1 *SEMI Standards*

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

SEMI E15 — Specification for Tool Load Port

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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 E63 — Mechanical Specification for 300 mm Box Opener/Loader to Tool Standard (BOLTS-M) Interface

SEMI E64 — Specification for 300 mm Cart to SEMI E15.1 Docking Interface Port

4.2 *Other Standard*

I300I/J300 GJG — I300I/J300 Global Joint Guidance for 300 mm Semiconductor Factories

NOTE 1: As listed or revised, all documents cited shall be the latest publications of adopted standards.

5 Terminology

5.1 *Abbreviations and Acronyms*

5.1.1 *AMHS* — Automated Material Handling System

5.2 *Definitions*

5.2.1 *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).

5.2.2 *BOLTS/Light exclusion volume* — a volume reserved by equipment or loadport unit to put BOLTS/Light compliant box opener/loader.

5.2.3 *BOLTS/Light plane* — a vertical plane that interfaces BOLTS/Light compliant box opener/loader and equipment.

5.2.4 *bottom interface plane*— an interface means between the equipment and box opener/loader.

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

5.2.6 *box opener/loader* — the equipment component that opens wafer carriers (if needed) and presents the carriers to the equipment's wafer handler for unloading and loading wafers.

5.2.7 *carrier* — any cassette, box, pod, or boat that contains wafers (as defined in SEMI E1.9). Also known as wafer carrier.

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

5.2.9 *cassette* — an open structure that holds one or more substrates.

5.2.10 *control connection area* — an area to be used for placement of connectors for electrical signals, power supplies, and other inlets/outlets.

5.2.11 *docked facial datum plane* — a vertical plane that bisects the wafers at the carrier docked position. It is also parallel to the load face plane specified in SEMI E15.

5.2.12 *docking stroke* — the travel distance of the carrier center between its load position (facial datum plane) and the position where the door opening/closing is done.

5.2.13 *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 equipment load ports, it is also parallel to the load face plane specified in SEMI E15 on the side of the equipment where the carrier is loaded and unloaded (as defined in SEMI E57).

5.2.14 *front-opening unified pod (FOUP)* — a box (that complies with SEMI E47.1) with a nonremovable 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).

5.2.15 *horizontal datum plane* — a horizontal plane from which projects the kinematic-coupling pins on which the carrier sits. On equipment 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).

5.2.16 *load face plane* — the furthest physical vertical boundary plane from the cassette centroid or carrier centroid on the side (or sides) of the equipment where loading of the equipment is intended (as defined in SEMI E15).

5.2.17 *loading slider area* — two flat surfaces on equipment which may be used by a maintenance supporting mechanism (not defined in this standard) to support the box opener/loader during attachment and detachment.

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

5.2.19 *pod* — a box having a Standard Mechanical Interface (SMIF) per SEMI E19.

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5.2.20 *seal zone* — a surface on the equipment at the BOLTS/Light plane for sealing to the box opener/loader.

5.2.21 *side interface feature* — an interface means to perform a seal between the mini-environment of the equipment and box opener/loader.

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

6 Functional Requirements

6.1 This standard does not define actual implementation but requires functional compliance with the following standards for interchangeability and interoperability of box opener/loader.

6.2 The box opener/loader of this standard should be compliant with related sections of factory interface standards such as SEMI E15.1, SEMI E57, SEMI E47.1 and SEMI E62.

6.3 *Outer Dimensions and Physical Factory Material Delivery Interface Compatibility* — Physical dimensions, such as clearances and trenches required for factory delivery systems (human or automated), should be compliant with SEMI E15.1.

6.3.1 *Carrier Registration* — The physical alignment mechanism for the box consists of features (not specified in this standard) on the box that mate with three pins underneath as defined in SEMI E57. Primary kinematic coupling pins should be used.

6.3.2 *Loadport Pitch* — The loadport pitch which conforms to this standard is S ≥ 475 mm (minimum value for FOUP without handles as defined in SEMI E15.1).

6.4 *Carrier ID Reader/Writer Head Exclusion Volume* — The box opener/loader compliant with this standard should have a carrier ID reader/writer head exclusion volume defined in SEMI E15.1 for automated units that read or write to an ID tag. Regarding the box opener/loader, the front end of this exclusion volume is limited by *y111*. And the rear end of this exclusion volume is defined in SEMI E15.1 D3. The difference between *y111* and SEMI E15.1 D4 should be supplied by the equipment.

6.5 *Carrier Sensing* — The box opener/loader compliant with this standard has to have the following capabilities:

6.5.1 *Carrier Presence Sensor* — Carrier sensing capability which detects carrier presence regardless of its correct placement.

6.5.2 *Carrier Placement Sensor* — Carrier sensing capability which detects correct carrier placement on the kinematic coupling.

6.6 *Info-pad Interfaces* — Optional info-pad sensing/detecting capability as defined in SEMI E1.9 and SEMI E15.1.

6.6.1 *Info-pad A, B Sensors* — Optional carrier sensing capability which detects carrier type as defined in SEMI E1.9 and SEMI E15.1.

6.6.2 *FEOL/BEOL Lockout Pin* — Optional pin that physically detects/rejects a misplaced carrier by using info-pads C and D to distinguish a FEOL carrier vs. a BEOL carrier. This pin should be capable of being installed easily after the equipment is delivered.

6.7 *Box to Equipment Sealing Interface and Door Lock/Unlock Interface* — This standard requires a box to equipment seal interface and door lock/unlock interface compliant with SEMI E47.1 and SEMI E62. This standard does not specify any of the actual design.

7 Mechanical Requirements

7.1 *Datum Planes and Dimensioning Rules* — Dimensions defined in this standard are determined with respect to the following datum planes and default dimensioning rules.

NOTE 2: Unless otherwise stated, perpendicularity and parallelism are implicitly defined in the geometric tolerances.

7.1.1 *Three Common Datum Planes* — Many of the dimensions of the BOLTS/Light interface are determined with respect to the three orthogonal datum planes defined in SEMI E57: the horizontal datum plane, the facial datum plane, and the bilateral datum plane.

7.1.2 *Symmetry* — All of the dimensions for the interface are bilaterally symmetric about the bilateral datum plane unless otherwise noted. These dimensions are shown in Figures 2 and 3 and specified in Table 1.

7.1.3 *Inner and Outer Radii* — All required concave features may have a radius of up to *r100* to allow cleaning and to prevent contaminant build-up. All required convex features may also have a radius of up to *r101* 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 equipment supplier. Note also that this radius applies to every required feature unless another radius is called out specifically.

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7.2 *BOLTS/Light Exclusion Volume* — Equipment or loadport unit compliant with this standard must provide a BOLTS/Light exclusion volume defined in this section. BOLTS/Light exclusion volume consists of multiple sub-volumes and spaces defined in this section. The box opener/loader compliant with this standard must be compatible with BOLTS/Light exclusion volume. Bolts/Light exclusion volume is shown in Figure 2.

7.2.1 *Loader Exclusion Volume* — Loader exclusion volume is an exclusion volume for the main part of box opener/loader that is defined by *x108, y101, y110, y111,* and *z107*. *y111* is intentionally shorter than SEMI E15.1 D dimension in order to allow the equipment integrators to place a safety door, a carrier ID reader/writer, and/or any other features required by the user. An additional removable cover can be mounted on the box opener/loader if it is to be supplied as a complete unit compliant with the SEMI E15.1 D dimension.

7.2.2 *Door Seal Exclusion Volume* — Door seal exclusion volume is an exclusion volume for the door seal portion of box opener/loader that is defined by the distance between the plane at the SEMI E15.1 D1 and *y101, x108,* and *z109*.

7.2.3 *BOLTS/Light Opening Exclusion Volume* — BOLTS/Light opening exclusion volume is an exclusion volume for the box opener/loader encroachment of equipment from BOLTS/Light plane at portion above the permanent reserved space. There should be an opening when the door is opened. Through this opening substrates may be moved between the box on the BOLTS/Light compliant box opener/loader and the equipment by a wafer handler in the equipment. BOLTS/Light opening exclusion volume is defined by *x102, y103, z103,* and *z108*.

7.2.4 *Permanent Reserved Space* — Space that is reserved permanently in the equipment defined by *x102, y102, z105,* and *z108*.

7.2.5 *Temporarily Reserved Space* — Space that is reserved temporarily during a door open/close motion is being done and when the door is closed. The temporarily reserved space during a door open/close is defined by *x102, y102, y103, z103,* and *z108*. The temporarily reserved space when a door is closed is defined by *x102, y103, y112, z103,* and *z108*.

7.2.6 *The Loader Bottom Flange Exclusion Volume* — The loader bottom flange exclusion volume is an exclusion volume for fixing the box opener/loader to bottom interface plane. Loader bottom flanges are located on the both bottom side of the box opener/loader and directly mounted on bottom interface plane. The loader bottom flange exclusion volume is defined by *x108, x109, y115, y116,* and *z113 measured* from the bottom end of *z107*.

NOTE 3: The spaces to access the fixing bolt should be reserved by equipment side. This document does not define these spaces.

7.3 *Side Interface Features* — This standard defines the equipment side of the side interface features. Side interface features are defined with respect to "Docked facial datum plane" instead of "Facial datum plane". The box opener/loader should mate with these features to provide the seal to the equipment. The side interface features are shown in Figure 2.

7.3.1 *BOLTS/Light Plane* — The BOLTS/Light plane is defined to be parallel to and at a distance *y101* from the docked facial datum plane. The Seal Zone is on this plane.

7.3.2 *Cycle-to-Cycle Repeatability* — The cycle-to-cycle repeatability of *y101* must be within *y113*.

7.3.3 *Seal Zone* — The equipment side of the BOLTS/Light plane specified by *x101, x103, z101, z102, z104,* and *z106* must be a flat area for sealing between the equipment and the box opener/loader.

7.3.3.1 The flatness of the seal zone must be within *y114* and the perpendicularity of the seal zone to the facial and horizontal datum planes must be within $\sigma 1$.

7.3.3.2 This standard only defines the seal zone on the equipment side. The actual seal is not defined in this standard, but should be mounted on the box opener/loader.

7.3.4 *Wafer Position* — This standard defines a typical wafer position when the box opener/loader positions the wafers to the equipment. The facial datum plane of a docked carrier is defined by *y110* from the facial datum plane. This provides compatible wafer center positions from the facial datum plane.

NOTE 4: This means that this standard defines a specified typical docking stroke.

7.4 *Bottom Interface Features* — This standard defines mainly the equipment side of the bottom interface features. Bottom Interface Features are shown in Figure 3.

7.4.1 Regarding the box opener/loader, parallelism of the bottom interface feature and the horizontal datum plane must be within $\sigma 2$.

7.4.2 *Bottom Interface Planes* — The Bottom Interface Feature should have two Bottom Interface Planes defined by *x104, x105, y104, y105,* and *z107*. Nothing other than locating pins can protrude above these planes. During maintenance, the front end of the

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