SEMI E21-94 (Reapproved 1102)
CLUSTER TOOL MODULE INTERFACE: MECHANICAL INTERFACE AND WAFER TRANSPORT STANDARD

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1 Purpose

1.1 The purpose of the standard is to simplify cluster tool implementation in the fab. Equipment suppliers are required to provide modules that can be connected into any cluster tool using the specifications contained herein.

1.1.1 Process and cassette modules accept wafers at locations that may vary substantially from one module to another. This places a burden on the capabilities of transport modules to move wafers to and from various modules in a cluster tool. This specification defines wafer transport planes within cassette and process modules. This obviates the wafer transport problem to a large extent, but does not unduly restrict module content.

2 Scope

2.1 The standard defines the interface plane between modules in a cluster tool. It provides the mechanical specifications at the interface that allow modules from different suppliers to be connected together; no requirements are imposed on the module content.

2.2 The standard is limited to wafers which are 200 mm (~8 in.) in diameter or smaller and to the interface between cluster tool modules, with the following exception. The transport module operates across the interface plane; thus, a definition of the wafer transport plane within cassette and process modules is required.

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3 Impact

3.1 The adoption of the standard requires cluster tool equipment designers to limit the wafer transport height to a nominal value at the interface plane between two modules. It also requires equipment designers to assure that wafer transport planes within cassette and process modules be clear for wafer transport. The transport module requires the capability for a minimum reach outside the module across the interface plane. Modules may be connected using a quick connect/disconnect clamping system. Constraints are placed on sealing surfaces.

4 Referenced Standards and Documents

4.1 *ISO Standards*[1]

ISO 1609-1986 (E) — Vacuum Technology – Flange Dimensions

NOTICE: Unless otherwise indicated, all documents cited shall be the latest published versions.

5 Terminology

5.1 *Definitions*

5.1.1 *cassette module* — a two-port module. One port accepts or presents a cassette of wafers or possibly, in an automated factory, an individual wafer for intertool transport; the second port accepts or presents a single wafer within the module for intratool transport.

5.1.2 *cluster tool* — an integrated, environmentally isolated manufacturing system consisting of process, transport, and cassette modules mechanically linked together. The modules may or may not come from the same supplier.

[1] International Organization for Standardization, ISO Central Secretariat, BIBC II, Chemin de Blandonnet 8, CP 401, 1214 Vernier, Geneva, Switzerland; Telephone: +41.22.749.01.11, http://www.iso.org

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5.1.3 *environmental isolation* — separated from the ambient atmospheric environment.

5.1.4 *interface plane* — the vertical surface defined by the mating surfaces of two joined modules.

5.1.5 *interface seal zone* — an absolute surface or face reserved for establishing an environmental seal between modules.

5.1.6 *intertool transport* — wafer or cassette movement between independent tools.

5.1.7 *intratool transport* — wafer movement inside a cluster tool.

5.1.8 *module* — an independently-operable unit that is part of a tool or system.

5.1.9 *process module* — a module that accepts or presents a single wafer inside the module for intratool transport.

5.1.10 *reach* — the distance measured from the interface plane to the wafer centroid within a process or cassette module.

5.1.11 *transport module* — a module that accepts or presents a single wafer outside the module across the interface plane for intratool transport.

5.1.12 *wafer transport plane* — the horizontal surface a wafer traverses between modules.

5.1.13 *wafer transport zone* — the area of the interface plane free of physical obstructions, reserved for wafer movement between modules.

6 Requirements

6.1 *Wafer Transport and* Placement

6.1.1 *Horizontal Transport Plane* — The dimensions for wafer placement during wafer transport are referenced from the interface plane in the plan view shown in Figure 1. The transport module is required to present or accept a horizontal wafer outside the module *anywhere* along an axis perpendicular to the center of the interface plane to a maximum 305 mm (12 in.) from the interface plane. Thus, a transport module is required to have the capability to reach 305 mm (12 in.) beyond its interface plane to a wafer centroid (see § R1-1). However, location of the wafer at a distance less than 305 mm (12 in.) from the interface plane requires that the transport module be capable of addressing the intermediate location. Similarly, a cassette module or process module accepts a horizontal wafer inside the module *anywhere* along an axis perpendicular to the center of its interface plane up to a maximum 305 mm (12 in.) from the interface plane as required by the application.

6.1.1.1 *Placement Accuracy* — The requirements for placement accuracy of a wafer in the horizontal plane within a module are 1.0 mm (0.04 in.) true position, ±0.5 mm (±0.020 in.) radially, with less than one degree angular rotation for every module-to-transport-to-module wafer transport (B_n:A:B_n + 1as shown in Figure 1). If the wafer is displaced in the process module, it must be returned to the original position within the non-cumulative placement accuracy of 1.0 mm (0.04 in.) true position, ±0.5 mm (±0.020 in.) radially.

6.1.2 *Vertical Position of Transport Plane* — The elevation of the wafer transport plane is measured from the facility floor as shown in Figure 2. The transport module is required to present or accept a horizontal wafer outside the module at a nominal wafer transport height of 1100 mm (43.307 in.) from the facility floor (see § R1-2).

6.1.2.1 *Vertical Motion* — The transport module is required to move the wafer to within ±0.5 mm (0.020 in.) in the wafer transport plane. The transport module is also required to posess a vertical motion capability to a second plane 6.0 mm ± 0.5 mm (0.236 in. ± 0.020 in.) below the wafer transport plane in order to allow wafer handoff to or from passive cassette or process modules (see Figure 2 and § R1-3).

6.1.2.2 *Reference Plane* — The interface plane alignment pins define a reference plane 9.5 mm (0.374 in.) below the wafer transport plane (see Figure 2).

6.2 *Interface Plane* — The interface plane contains the interface seal zone and the wafer transport zone, which do not overlap, and the location of the interface plane alignment pins (see Figures 3 and 4).

6.2.1 *Interface Seal Zone* — The interface seal zone is rectangular and symmetrically referenced to the interface plane alignment pins. The inside boundary dimension of the interface seal zone is 46 mm (1.811 in.) by 236 mm (9.291 in.). The outside boundary is 76 mm (2.992 in.) by 266 mm (10.472 in.). A seal zone is either a seal surface or an O-ring face. All interface seal zones facing toward a transport module are seal surfaces polished to a surface finish less than

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or equal to 0.8 micrometer (32 microinches) parallel to the circumference (see § R1-4). All interface seal zones facing toward a cassette or process module are O-ring faces equipped with the appropriate capture groove for the sealing method employed (see Figure 3 and § R1-4.1).

6.2.2 *Wafer Transport Zone* — The wafer transport zone is the area within the interface seal zone reserved for moving the wafer between modules. The wafer transport zone which cannot be compromised by any module is defined as the area at least 16 mm (0.630 in.) above and below the alignment pin centerlines, and 111 mm (4.370 in.) to the left and right of the centerline between the two alignment pins (see Figure 3 and § R1-5).

6.2.3 *Interface Plane Alignment Pins* — Provisions are made for two 10 mm (0.394 in.) diameter locating pins (see Figure 4) to be used as alignment aids between modules. Under no circumstances should the flanges at the interface plane and the alignment pins be subject to a total load exceeding 500N (112 lbf) in shear. The alignment pins have an absolute centerline separation of 300.0 mm (11.811 in.) in the horizontal plane. The pins reside in the seal surface side of the flange pair, opposite the O-ring, facing toward the transport module. Mild press fit holes are provided in the seal surface flange face. A clearance hole and a slot are provided in the O-ring flange face as shown in Figure 1 and specified in Figure 3. Alignment pin height above the flange face is 6 mm (0.24 in.) minimum to 8 mm (0.31 in.) maximum (see § R1-6).

6.2.4 *Isolation Valves* — The transport module is always equipped with a valve for environmental isolation at each module interface plane. The intratool transport port on a process or cassette module may be equipped with an environmental isolation valve (see § R1-7).

6.3 *Flange* — A flange is specified as 162 mm (6.378 in.) by 340 mm (13.386 in.). One horizontal edge is specified to be 50 mm (1.969 in.) from the alignment pins' centerline (see Figure 4).

6.3.1 *Clamping* — Clamping grooves as specified in the International Standards Organization document, Vacuum Technology, Flange Dimensions (ISO 1609-1986), Table 2, nominal bores 40 mm to 250 mm (1.575 in. to 9.843 in.) are located at the flange perimeter (see groove detail in Figure 4). Clamps for ISO flanges can be used to generate the force necessary to produce an environmental seal (see § R1-8).

6.3.2 *Non-Flanged Surfaces* — A non-flanged surface may be used to join with a flanged surface. An attachment means to engage the flange must be provided. If a flanged adaptor piece is necessary to join two non-flanged surfaces, then the adaptor piece shall be located on the process or cassette side of the interface plane.

7 List of Figures

7.1 *Figure 1* — Module Interface with Wafer Transport and Placement Detail (Plan View)

7.2 *Figure 2* — Wafer Transport Plane Elevation

7.3 *Figure 3* — Interface Plane

7.4 *Figure 4* — Flange Specification

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