SEMI E166-0814 (Reapproved 0220)
SPECIFICATION FOR 450 mm CLUSTER MODULE INTERFACE: MECHANICAL INTERFACE AND TRANSPORT STANDARD

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1 Purpose

1.1 The purpose of this Standard is to ensure minimum necessary level of physical connectivity between the transport module and process modules comprising the cluster tool for 450 mm. It is expected that a process module can be connected to the transport module of any cluster tool with least design change provided that both modules meet the requirement of this Standard.

1.1.1 Process 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 process modules in a cluster tool. This Specification defines wafer transport planes within modules. This obviates the wafer transport problem to a large extent, but does not unduly restrict process module content.

2 Scope

2.1 This Standard defines the interface plane between modules in a cluster tool. It provides the mechanical specifications at the interface between the transport module and process module to be connected together; no requirements are imposed on the module content.

2.2 This Standard is applicable only to wafers that are 450 mm in diameter 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 process modules is required.

NOTICE: SEMI Standards and Safety Guidelines do not purport to address all safety issues associated with their use. It is the responsibility of the users of the Documents to establish appropriate safety and health practices, and determine the applicability of regulatory or other limitations prior to use.

3 Referenced Standards and Documents

3.1 *SEMI Standards and Safety Guidelines*

SEMI E21 — Specification for Cluster Tool Module Interface: Mechanical Interface and Wafer Transport

SEMI E21.1 — Specification for Cluster Tool Module Interface 300 mm: Mechanical Interface and Wafer Transport

SEMI E154 — Specification for Mechanical Features of 450 mm Load Port

3.2 ISO Standards[1]

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

ISO 4287 — Geometrical Product Specifications (GPS) – Surface Texture: Profile Method – Terms, Definitions and Surface Texture Parameters

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

[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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4 Terminology

4.1 *Definitions*

4.1.1 *cluster tool* — an integrated, environmentally isolated manufacturing system having process and transport modules mechanically linked together.

4.1.2 *environmental isolation* — separated from the ambient atmospheric environment. [SEMI E21]

4.1.3 *interface plane* — the vertical surface defined by the mating surfaces of two joined modules. [SEMI E21]

4.1.4 *interface seal zone* — an absolute surface or face reserved for establishing an environmental seal between modules. [SEMI E21]

4.1.5 *intratool transport* — wafer movement inside a cluster tool. [SEMI E21]

4.1.6 *module* — an independently-operable unit that is part of a tool or system. [SEMI E21]

4.1.7 *passive process module* — a process module that has no wafer moving mechanism for wafer handoff

4.1.8 *process module* — a module that accepts or presents a single wafer inside the module for intratool transport. [SEMI E21]

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

4.1.10 *transport module* — a module that accepts or presents a single wafer outside the module across the interface plane for intratool transport. [SEMI E21]

4.1.11 *wafer transport plane* — the virtual horizontal plane a wafer traverses between modules.

4.1.12 *wafer transport zone* — the area of the interface plane free of physical obstructions, reserved for wafer movement between modules. [SEMI E21]

5 Requirements

5.1 *Wafer Transport and Placement*

5.1.1 *Wafer Transport Axis and Reach* — The dimensions for wafer placement during wafer transport are specified in Table 1 and 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 at any point along an axis (see Figure 1) perpendicular to the center of the interface plane to a maximum *y100* from the interface plane. Thus, a transport module is required to have the capability to reach *y100* beyond its interface plane to a wafer centroid (see § R1-1). However, location of the wafer at a distance less than *y100* from the interface plane requires that the transport module be capable of addressing the intermediate location. Similarly, a process module can be designed to accept a horizontal wafer inside the module at any point along an axis perpendicular to the center of its interface plane up to y100 from the interface plane as required by the application.

5.1.2 *Vertical Position of Wafer 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 plane height of z100 from the facility floor (see § R1-2).

EXCEPTION: Alternative wafer transport height of *z101* may be applied for a cluster tool in which process performance related design constraints require a higher wafer transport plane in at least one of the process modules.

5.1.2.1 *Vertical Motion* — The robot is required to possess a vertical motion capability to a second plane *z110* below the wafer transport plane in order to allow wafer handoff to or from passive process modules (see Figure 2 and § R1-3).

5.1.2.2 *Reference Plane* — The interface plane alignment pins define a reference plane *z111* below the wafer transport plane (see Figure 2).

5.2 *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).

5.2.1 *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 *z130* by *x120*. The outside boundary is

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z131 by *x121*. 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 or equal to *Ra100* parallel to the circumference (see § R1-4). All interface seal zones facing toward a process module are O-ring faces equipped with the appropriate capture groove for the sealing method employed (see Figure 3).

5.2.2 *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 *z120* by *x110*. One horizontal edge of the zone is *z121* above the alignment pin centerlines. Its vertical edges are equally distanced to the left and right of the centerline between the two alignment pins (see Figure 3 and § R1-5).

5.2.3 *Interface Plane Alignment Pins* — Provisions are made for two *d100* locating pins (see Figures 4 and 5) 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 500 N in shear. The alignment pins have an absolute centerline separation of *x100* in the horizontal plane (see Figure 3). The pins reside in the seal surface side (i.e., process module 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 Figures 4 and 5. The center axis of the alignment pin hole shall be located within a circular zone of diameter *d120* (0.05 mm) whereby the zone is nominally positioned on the alignment pin datum line and *x101* (275 mm) from the nominal wafer center. Alignment pin height above the flange face is *y110* (see § R1-6).

5.2.4 *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 module may be equipped with an environmental isolation valve (see Figure 1 and § R1-7).

5.3 *Flange* — A flange for ISO-K flange connection is specified as *z140* by *x130*. One horizontal edge is specified to be *z141* from the alignment pins' centerline (see Figure 4).

EXCEPTION: Alternative flange is specified as *z150* by *x140* in order to allow a direct flange to flange connection by bolts (ISO-F flange connection). One horizontal edge is specified to be *z15*1 from the alignment pins' centerline (see Figure 5).

NOTE 1: It may be appropriate to connect flanges directly by bolts to meet vacuum seal performance requirement for some tools.

5.3.1 *Clamping* — Clamping grooves as specified in ISO 1609-1986 (E), Vacuum Technology – Flange Dimensions, Table 2, nominal bores 40 mm to 250 mm 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 § R1-9).

5.3.2 *Nonflanged Surfaces* — A nonflanged 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 nonflanged surfaces, then the adaptor piece shall be located on the process side of the interface plane.

Table 1 Dimensions of Interface Between Transport Module and Process Module

Symbol Used	*Figure*	*Value Specified*	*Datum Measured From*	*Feature Measured To*
d100	4, 5	10 +0/−0.015 mm	The intersection of *x100* and *z141*	Shaft diameter of alignment pin
d110	3	10 +0.2/+0.1 mm	*x100*, CL	Diameter of alignment pin opening
d111	3	10 +0.2/+0.1 mm	(*x100* and *x150*), CL	Diameter of slot for alignment pin
d120	3	ϕ0.05	Nominal Intersection of *x101* and *z111*.	Boundary of tolerance zone for alignment pin hole center axis placement.
r100	3	≤13 mm	N/A	Corner radii of the wafer transport zone
Ra100	3	≤0.8 µm Roughness(Ra) as defined in ISO 4287	N/A	Interface seal zone surface

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Symbol Used	*Figure*	*Value Specified*	*Datum Measured From*	*Feature Measured To*
s100	4	0.3 mm flatness over seal area	Interface surface	Interface seal zone surface
s101	5	0.3 mm flatness over seal area	Interface surface	Interface seal zone surface
x100	3	550 mm	Center of left alignment pin (symmetric about vertical center line of the opening)	Center of right alignment pin (symmetric about vertical center line of the opening)
x101	3	275 mm	Nominal wafer center	Center of left alignment pin (symmetric about vertical center line of the opening)
x110	3	≥490.0 mm	Left edge of wafer transport zone (symmetric about vertical center line of the opening)	Right edge of wafer transport zone (symmetric about vertical center line of the opening)
x120	3	≤496.0 mm	Left inside edge of interface seal zone (symmetric about vertical center line of the opening)	Right inside edge of interface seal zone (symmetric about vertical center line of the opening)
x121	3	≥520.0 mm	Left outside edge of interface seal zone (symmetric about vertical center line of the opening)	Right outside edge of interface seal zone (symmetric about vertical center line of the opening)
x130	4	590.0 mm	Left edge of flange or valve (ISO-K) (symmetric about vertical center line of the opening)	Right edge of flange or valve (ISO-K) (symmetric about vertical center line of the opening)
x140	5	625.0 mm	Left edge of flange or valve (ISO-F) (symmetric about vertical center line of the opening)	Right edge of flange or valve (ISO-F) (symmetric about vertical center line of the opening)
x150	3	≥2 mm	Centered at *x100*	Length of slot for alignment pin
y100	1	490.0 mm	Interface plane	Center of the wafer
y110	4, 5	≥6 mm, ≤8 mm	Interface plane	Tip of the alignment pin
y120	4, 5	≥10 mm	O-ring side surface	Clearance for alignment pin
y121	4, 5	≥10 mm	O-ring side surface	Clearance for alignment pin
z100	2	1230 mm	Floor	Wafer Transport Plane: Nominal Value
z101	2	1350 mm	Floor	Wafer Transport Plane: Alternative Value
z110	2	12 ± 0.5 mm	Wafer Transport Plane	End of Vertical Motion Capability
z111	2	18.5 ± 0.5 mm	Alignment Pin Datum Line	Wafer Transport Plane
z120	3	≥56 mm	Upper edge of Vertical Slot Opening (symmetric about horizontal center line of the opening)	Lower edge of Vertical Slot Opening (symmetric about horizontal center line of the opening)
z121	3	≥28 mm	Alignment Pin Datum Line	Upper edge of Vertical Slot Opening

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