APPENDIX 1
APPLICATION NOTES

NOTICE: This appendix was approved as an official part of SEMI E19.4 by full letter ballot procedure, but the recommendations in this appendix are optional and are not required to conform to this standard.

A1-1 Notes

A1-1.1 Automated pod transfer between load port and automated material handling system (AMHS) might require a lead-in capability of more than 5 mm. This can be achieved by increasing the height of the guide rails (dimension B5). SEMI standard E15 limits this height to 50 mm (1.97 inches) maximum (see Figure A1-1). The capture range can be increased to more than 15 mm (0.6 inches) if supplier and customer agree to increase the guide rail height without violating SEMI E15.

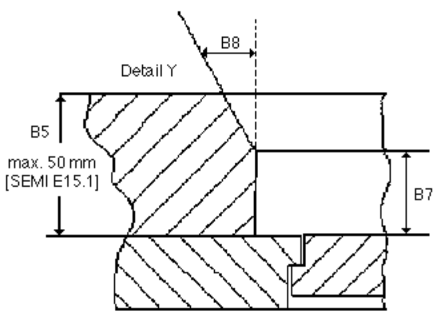


Figure A1-1
Optional Rail Dimensions

A1-1.2 The dimensions of the pod bottom are not specified in this standard (see Section 6.2.5.1). It is recommended that these dimensions should not exceed 282.0 mm (11.14 inches) in one direction and 292.6 mm (11.52 inches) in the other direction. These maximum outer dimensions ensure a sufficient gap around the pod and the guide rails in relation to B1 and B2 to allow a reliable motion of the pod onto the port plate.

A1-1.3 It is important that the external top of the pod does not exceed the top of the cassette by more than 50 mm (1.97 inches). This is to prevent possible interference between the pod and the equipment.

SEMI E19.5-0996 (Withdrawn 1103)
SPECIFICATION FOR 300-mm BOTTOM-OPENING STANDARD MECHANICAL INTERFACE (SMIF)

NOTICE: This document was balloted and approved for withdrawal in 2003.

NOTICE: Hewlett-Packard has patent coverage for this concept and is offering non-exclusive licenses on an equal basis to any company. Companies intending to manufacture products to this standard should be aware of Hewlett-Packard's position.

The user's attention is called to the possibility that compliance with this standard may require use of an invention covered by patent rights. By publication of this standard, Semiconductor Equipment and Materials International (SEMI) takes no position with respect to the validity of any patent rights asserted in connection with any item mentioned in this document. Users of this document are expressly advised that determination of any such patent rights, and the risk of infringement of such rights are entirely their own responsibility.

1 Purpose

This standard specifies a standard interface for containers intended to control the transport environment of contained wafers. The interface must address the proper container orientation for material transfer and maintain continuity between the container and equipment environment in order to control particulate and non-particulate contamination.

2 Scope

This specification describes an approach to interfacing a clean transport container (pod) to a clean environmental housing on a piece of semiconductor processing equipment or to other clean environments. The system concept involves mating a pod door to a port door in an equipment interface and transferring the wafers into, and out of, the equipment without exposing the wafers to outside contamination.

The incorporation of this standard may require equipment designers to include the features of the interface into the tool design. Spacing between equipment interface ports must be considered when incorporating this interface. Designers are directed to the recommendations made in SEMI E15.1 in this regard.

This standard is specific to the size of the designated wafer and references the appropriate Semiconductor Equipment and Materials International (SEMI) cassette and wafer diameter. This specification focuses on applications in which the interface port is positioned horizontally.

3 Referenced Documents

3.1 *SEMI Standard*

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

4 Terminology

(See Figure 1 for a pictorial depiction of most terms.)

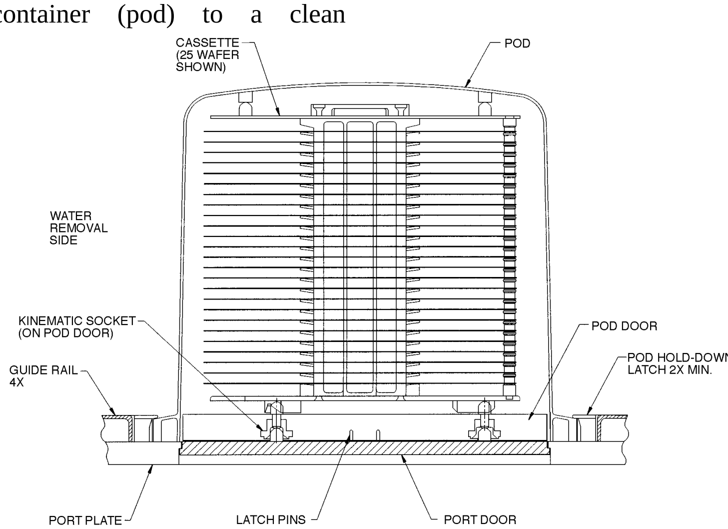


Figure 1
Port Terminology

4.1 *box* — A protective portable container for a cassette and/or substrate(s) (as defined in SEMI E44).

4.2 *cassette* — An open structure that holds one or more substrates (as defined in SEMI E44).

4.3 *horizontal datum plane* — A plane that is parallel to the floor and coincides with the tool interface surface. A more detailed definition will be included in a companion document currently under development.

4.4 *guide rail* — A component of a port plate that provides coarse and final location for placing the pod on the port assembly.

4.5 *hold-down latch* — A mechanism for securing the pod to the port plate.

4.6 *kinematic socket (pod door)* — Grooves in the bottom of the pod door that fit over kinematic pins on the top of the port door when the pod is placed on the port door.

4.7 *kinematic pins (port door)* — Pins that provide fixed position and orientation between the port door and pod door. The kinematic pins fit into the kinematic sockets in the bottom of the pod door.

4.8 *latch pins* — Pins that engage the pod door latch and accomplish the pod door lock/unlock functions. Latch pins are carried by the port door.

4.9 *pod* — A box having a Standard Mechanical Interface (as defined in SEMI E19, SEMI E44).

4.10 *pod door* — A removable bottom for the pod that contains a means for properly positioning the wafer cassette.

4.11 *pod lock* — A mechanical latch that holds the pod door to the pod until activated by the latch mechanism pins. Upon activation, the pod door is released from the pod.

4.12 *port assembly* — An assembly of the port plate and port door.

4.13 *port door* — A door for the port plate opening that provides a mating surface for the bottom of the pod door when the pod is in place on the port plate. The port door contains the kinematic location pins and the pod door latch pins.

4.14 *port plate* — A horizontal mating surface for the base of the pod that provides a seal surface for the bottom surface of the pod perimeter. The port plate contains the guide rails and the pod hold-down latches.

5 Requirements

(See Table 1 for 300 mm (12-inch) port dimensions.)

Table 1 Port Dimensions for 300 mm (12-inch) Wafer Cassette

Port Door:	A1	185.00 mm rad. ± 0.13 mm	(7.283 in. rad. ± 0.005 in.)
Guide Rails:	B1	208.71 mm rad. ± 0.13 mm	(8.217 in. rad. ± 0.005 in.)
	B2	106.00 mm ± 0.13 mm	(4.190 in. ± 0.005 in.)
	B3	119.00 mm ± 0.13 mm	(4.690 in. ± 0.005 in.)
	B4	25.00 mm max.	(0.984 in. max.)
	B5	70.0 mm max.	(2.75 in. max.)
Latch Pins:	C1	16 deg. ± 0 deg. 30min.	(16 deg. ± 0 deg. 30 min.)
	C2	86 deg. ± 0 deg. 30 min.	(86 deg. ± 0 deg. 30 min.)
	C3	26.72 mm dia. ± 0.05 mm	(1.052 in. dia. ± 0.002 in.)
	C4	3.175 mm dia. ± 0.025 mm	(0.125 in. dia. ± 0.001 in.)
	C5	-----------	----------
	C6	9.14 mm ± 0.25 mm	(0.360 in. ± 0.010 in.)
	C7	Full Spherical Radius	Full Spherical Radius
Pod Hold-Down Latches:	D1	22.10 mm ± 0.25 mm	(0.870 in. ± 0.010 in.)
	D2	10 deg. ± 0 deg. 30 min.	(10 deg. ± 0 deg. 30 min.)
Pod in Place Sensor:	E1	26.92 mm ± 0.25 mm	(1.060 in. ± 0.010 in.)
	E2	12.70 mm ± 0.25 mm	(0.500 in. ± 0.010 in.)
Activation Height:	E3	4.32 mm min.	(0.170 in. min.)
Latch Pin Force (Torque):	F1	8.08 kg cm min.	(7 lbs. in. min.)
		17.27 kg cm max.	(15 lbs. in. max.)

The requirements and dimensions for the design of 300 mm standard mechanical interface ports and pods are given in this section. All external dimensions of the interface between a pod and port are specified in SEMI E15.1.

5.1 *Port Design Requirements* — The general design of the port is shown in Figures 2 and 3. Design requirements for the interface components are provided in Sections 5.1.1 through 5.1.6.

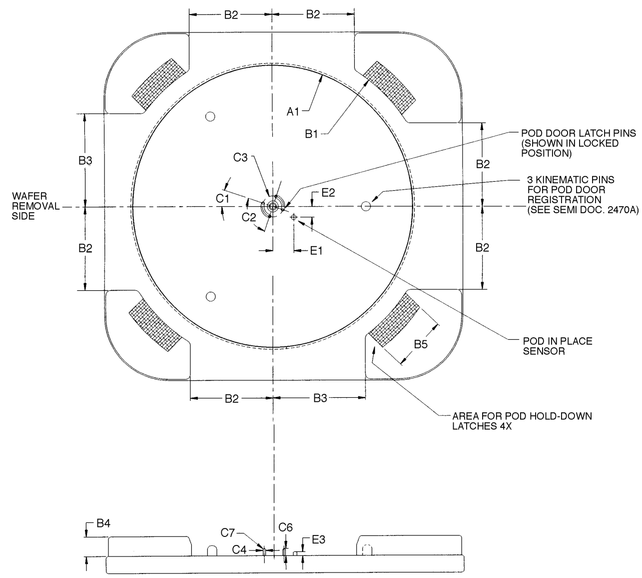


Figure 2
Port Dimensions

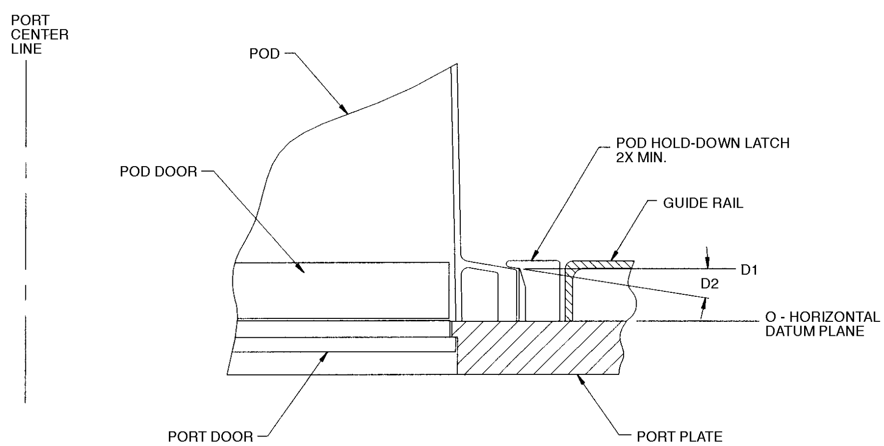


Figure 3
Port Detail

5.1.1 *Port Door* — Dimension Al specifies the port door radius. The gap between port door and port plate is not specified, but should be kept to a minimum distance to restrict particle transport.

5.1.2 *Pod Guide Rails* — The inside feature of the pod guides rails of the port are specified by B1, B2, and B3. The features provide alignment for the pod top.

5.1.3 *Pod Hold-Down Latches* — The available latch area is specified by dimensions B1, B4, and B5 in Figure 2. Latch detail dimensions are specified by D1 and D2 in Figure 3.

5.1.4 *Pod Door Latch Pins* — Two latch pins are located around the port door center and are specified by C1, C2, and C3.

5.1.5 *Kinematic Pins* — Three kinematic pins provide registration of the pod door to port plate. Details and locations of the kinematic pins are not specified in this standard. They are being addressed in a separate document currently under development.

5.1.6 *Pod in Place Sensor* — An optional sensor, for the sensing of proper pod placement shall be located on the port door as specified by E1 and E2. The sensor shall have a minimum activation height of E3 and full travel to the port plate.

5.2 *Pod* — The bottom surfaces of the pod body and pod door shall conform to the specified port dimensions. Although the pod dimensions are not explicitly specified by this standard, the following requirements apply. (Pod dimensions are being addressed in a separate document currently under development.)

5.2.1 The upper part of the pod body and the top surface of the pod door must fit and hold in place the wafer cassette, which will be specified in a separate document currently under development.

5.2.2 The center of the wafers and pod door shall coincide. The top surface of the pod door incorporates kinematic features that position the cassette on the pod door.

5.2.3 The bottom surface of the pod door at its perimeter shall match the radius of the port door top (dimension Al). The tolerances shall be chosen so that the pod door does not extend over the port door in any instance, even when the port door is built to its minimal acceptable dimensions and potential variance between kinematic pins and socket is considered. This is to ensure an interference-free passage of the pod door through the port opening.

5.2.4 The base of the pod body shall fit freely but with close tolerance between the pod guide rails, which not only hold the pod in place while the port is open, but also provide proper alignment for closure of the pod at the end of the open/close cycle.

6 Related Documents

The following articles describe the standard mechanical interface concept:

6.1 “The Challenge to Control Contamination: A Novel Technique for the IC Process,” The Journal of Environmental Sciences, (May/June, 1984), page 23.

6.2 “SMIF, A Technology for Wafer Cassette Transfer in VLSI Manufacturing,” Solid State Technology, (July, 1984), page l11.

SEMI E20-0697 (Reapproved 1102)
CLUSTER TOOL MODULE INTERFACE: ELECTRICAL POWER AND EMERGENCY OFF STANDARD

This standard was technically approved by the Global Physical Interfaces and Carriers Committee and is the direct responsibility of the North American Physical Interfaces and Carriers Committee. Current edition approved by the North American Physical Interfaces and Carriers Committee on July 21, 2002. Initially available at www.semi.org October 2002; to be published November 2002. Orignally published in 1991; previously published June 1997.

1 Purpose

1.1 The purpose of the standard is to specify the Emergency Off capability to the modules of a cluster tool; to allow module Emergency Off disconnect and reconnect in a safe manner without removing power from the rest of the tool; and to prevent power from being applied to a module when its Emergency Off is non-functional.

2 Scope

2.1 The standard deals with the delivery and emergency interruption of electrical power to the modules of a cluster tool.

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

3 Impact

3.1 The standard requires that power can be delivered to an individual module only if its Emergency Off is functional. This does not preclude removal of power from the module by non-emergency means.

3.2 The standard specifies the Emergency Off circuit functions that must be provided at the Emergency Off interfaces of a cluster tool, including the plug, momentary bypass switch and bypass jumper plug. Pinouts for the Emergency Off plug and bypass jumper plug are specified.

4 Referenced Standards

4.1 *SEMI Standards*

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

4.2 *Military Standards*[1]

MIL-C-26500E — General Specification for Connectors — General Purpose, Electrical, Miniature, Circular, Environmental Resisting

5 Terminology

5.1 *Definitions*

5.1.1 *daisy-chained* — Connected so that the removal of one component causes the interruption of the circuit to another component.

5.1.2 *emergency off (EMO)* — Fail-safe control switch or circuit which, when de-energized, will stop the operation of associated equipment and will shut off all potential hazards outside the main power enclosure.

5.1.3 *EMO interface* — The location at which a process or cassette module EMO cable is connected into the cluster tool circuit.

6 Requirements

6.1 *Power Distribution*

6.1.1 *Mains* — Each cluster tool (as defined in SEMI E21) shall have its power provided by one or more contactors enabled by the EMO. The power is to be delivered to one or more power distribution enclosures, where voltage transformation may take place before distribution to the module (as defined in SEMI E21).

6.1.2 *Module Power Distribution* — The power distribution to each module is provided through a dedicated circuit breaker in the power distribution enclosure. The rated current and voltage in each circuit is determined by the tool configuration. A discussion of how this standard may be implemented is given in Related Information R1-1.

6.1.3 *Operation of the EMO* — Activation of the EMO shall not cause or allow an unsafe condition to exist (see Related Information R1-2).

6.2 *EMO Circuit*

6.2.1 *Description* — Each module attached to the cluster tool is to have at least one EMO button operating an EMO switch (see Related Information R1-3). The switches are daisy chained into a circuit, or circuits, that disconnect the main power and any backup

1 Available through the Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, PA 19120-5099, USA. Telephone: 215.697.3321

power sources. The 24 VAC power to energize this circuit is provided from within a main power enclosure, so that the EMO circuit is independent of module power. Each module EMO is connected to the chain at its EMO interface. A momentary bypass switch, also located at each module EMO interface, allows separation of the module from the cluster tool without tripping the EMO, provided that electrical power is removed from the module by turning off the dedicated circuit breaker (see Related Information R1-4). Jumpers in the bypass jumper plug connect the EMO circuit in series with contacts that open if the dedicated circuit breaker is turned on.

6.2.2 *Wiring* — Copper wire used in the EMO circuits shall be 0.82 mm^2 cross-section (#18 AWG) or larger.

6.2.3 *Labeling* — A label with the following legend is to be affixed to the power distribution enclosure near each module circuit breaker: Caution: Energizing this circuit with the associated EMO bypass jumper plug installed will interrupt power to the entire cluster tool.

6.3 *Connection at EMO Interface*

6.3.1 *EMO Connector* — The connector at the EMO interface is reserved for EMO functions only. Metal shell bayonet-type connectors are specified per MIL-C-26500E as follows: MS24265R16B10SN on the panel, and MS24266R16B10PN on the cable and on the EMO bypass jumper plug. The receptacle is panel mounted at the EMO interface and the plug is mounted on the module EMO cable.

6.3.2 *Module EMO Connector Pinouts* — Pins 1 and 2 of the EMO cable plug connect across contacts in the module EMO switch. In the receptacle, pins 1 and 2 connect to the EMO circuit and pins 3 and 4 connect across the contacts specified in Section 6.2.1.

6.3.3 *EMO Bypass Jumper Plug* — Pin 1 is jumpered to pin 4 and pin 2 is jumpered to pin 3 in the plug. This will result in placing the contacts specified in Section 6.2.1 into the EMO circuit when the plug is installed.

NOTICE: The user’s attention is called to the possibility that compliance with this standard may require use of an invention covered by patent rights. By publication of this standard, Semiconductor Equipment and Materials International (SEMI) takes no position respecting the validity of any patent rights asserted in connection with any item mentioned in this standard. In particular, users of the specification should be aware that Drytek, Inc., A Unit of General Signal, 16 Jonspin Road, Wilmington, MA 01887-1087, Phone: (508) 657-3933, has neither claimed nor disclaimed that compliance with this specification would require use of an invention covered by one or more of its patents. Users of this standard are expressly advised that determination of any such patent rights, and the risk of the infringement of such rights, are entirely their own responsibility.

NOTICE: SEMI makes no warranties or representations as to the suitability of the standards set forth herein for any particular application. The determination of the suitability of the standard is solely the responsibility of the user. Users are cautioned to refer to manufacturer' s instructions, product labels, product data sheets, and other relevant literature, respecting any materials or equipment mentioned herein. These standards are subject to change without notice.

By publication of this standard, Semiconductor Equipment and Materials International (SEMI) takes no position respecting the validity of any patent rights or copyrights asserted in connection with any items mentioned in this standard. Users of this standard are expressly advised that determination of any such patent rights or copyrights, and the risk of infringement of such rights are entirely their own responsibility.

RELATED INFORMATION 1

NOTE: The material contained in these application notes is not an official part of SEMI E20 and is not meant to modify or supersede it in anyway. Rather, these notes are provided primarily as a source of information to aid in the application of the standard. As such, they are to be considered as reference material only. The standard should be referred to in all cases.

R1-1 AC Power Distribution

R1-1.1 One method of providing power and EMO functions to a cluster tool is shown in Figure R1-1 (see Section 6.1.2). A standby power supply (SPS) or uninterruptible power supply (UPS) is included to maintain EMO and selected cluster tool functions in the event of main power failure. It may be desirable to include additional circuit breakers in the main power enclosure if individual module disconnects are needed at level I in Figure R1-1. Disconnect at level II in Figure R1-1 is made possible by the module circuit breakers; SEMI E7, “Electrical Interfaces Specification,” should be used for loads up to 10 kW. Additional main power enclosures could be provided for modules with heavy AC loads, provided that each main contactor is operated by one common EMO circuit, however, some user’s safety codes may demand a single source of supply.

R1-2 Operation of Remote Equipment

R1-2.1 Activation of the EMO shall stop, by fail-safe means at the tool, the delivery of potentially hazardous energy (e.g., high voltage, laser) or hazardous material (e.g., toxic process gas, coolant) to the cluster tool (see Section 6.1.3).

R1-3 EMO Switch Placement

R1-3.1 The EMO switches on each module (see Section 6.2.1) need to be placed so that they are accessible to any person in the vicinity of the cluster tool. Local safety codes may take precedence in matters of EMO switch placement. The standard ensures that each module has at least one EMO switch and that its operation, when the module is attached, removes power from the entire cluster tool.

R1-4 EMO Bypass

R1-4.1 *Implementation* — The functions, specified in Section 4.2.1, to allow EMO bypass and to ensure that module power is off when the EMO is removed from the cluster tool EMO circuit, can be implemented as shown in Figure R1-2. A relay or switch, operated in parallel with the dedicated circuit breaker specified in Section 6.1.2 for the module, provides 24 VAC to the coil of a double pole relay when the circuit breaker is de-energized. An indicator light in parallel with the coil illuminates when the bypass is enabled and the power to the module is off. One set of contacts of this relay is used to enable the momentary EMO bypass switch. The other set is connected across pins 3 and 4 of the EMO receptacle at the EMO interface and is in the EMO circuit when the EMO bypass jumper plug is installed. Both sets of contacts are wired to open when voltage is removed from the relay coil, i.e., when the circuit breaker is closed.

R1-4.2 *Module Disconnect* — The dedicated circuit breaker (see Section 6.2.1) to the module must be turned off prior to disconnect. This causes the contacts in series with the momentary EMO bypass switch to close, rendering it operational. At this point, the EMO switch on the module is still in the cluster tool EMO circuit. To disconnect, the operator holds in the EMO bypass switch while removing the module EMO plug from the EMO interface and then connecting the EMO bypass jumper plug. The momentary bypass switch can then be released.

R1-4.3 *Module Connect* — To connect a module, the dedicated circuit breaker (see Section 6.2.1) must be off at the power distribution point to the module. The power cable may be attached to the module at this time. The operator holds in the momentary bypass switch while disconnecting the EMO bypass jumper plug from the EMO interface and connecting the module EMO Plug. The momentary bypass switch can then be released. Power cannot be applied to the module unless the EMO is connected (as shown in Figure R1-2).

R1-5 Additional Documents and References

In implementing the standard, documents that may provide additional guidance include:

R1-5.1 *SEMI Document*

SEMI S2 — Safety Guidelines for Semiconductor Manufacturing Equipment

R1-5.2 *Other Documents*

International Electrotechnical Commission (IEC)

Standard 204, Sections 1, 2 and 3.

(U.S.) National Electrical Code (NEC).[2]

2 National Fire Protection Association, Batterymarch, Quincy, MA 02269.

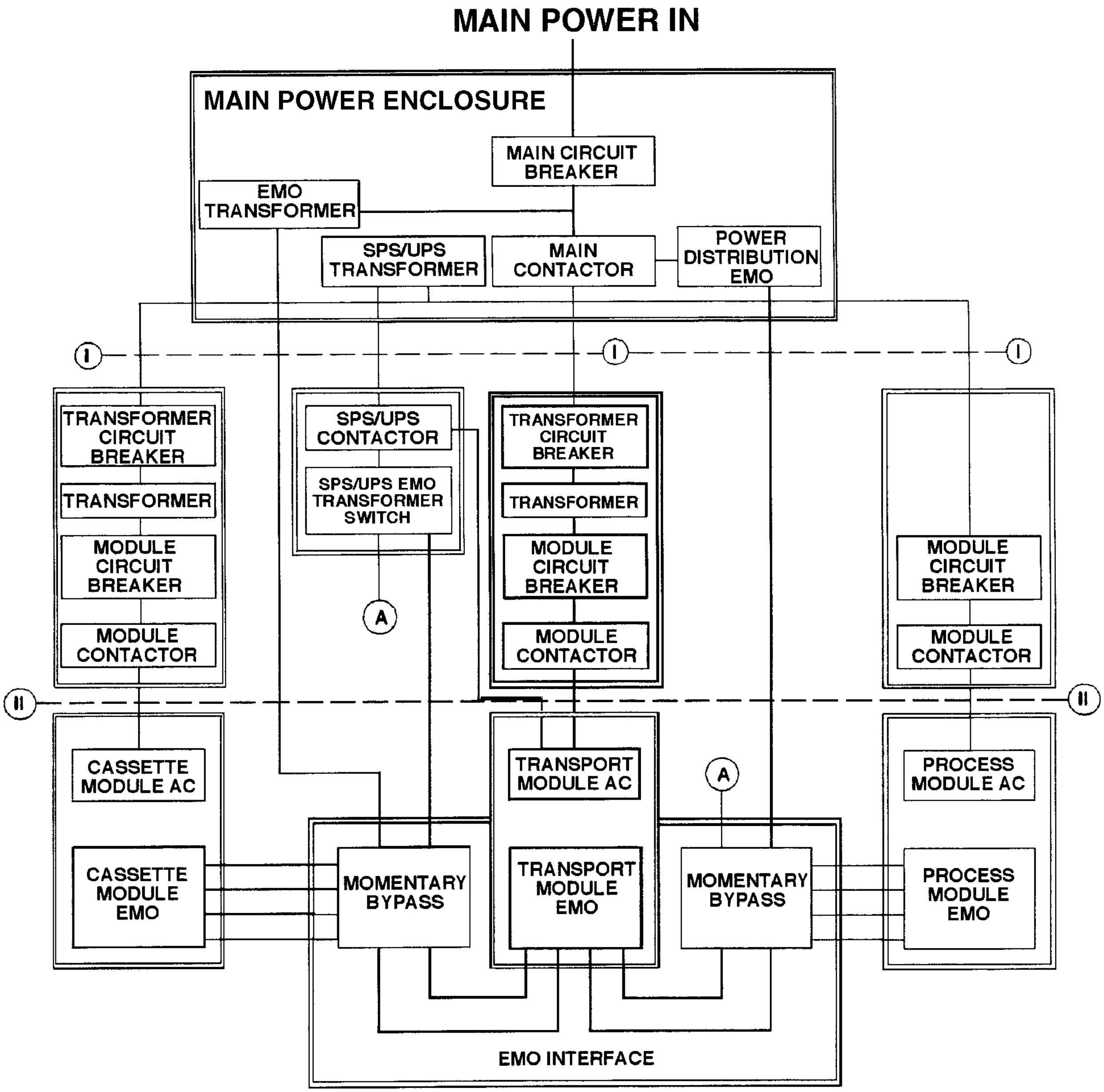


Figure R1-1
Example: AC Distribution/EMO Block Diagram

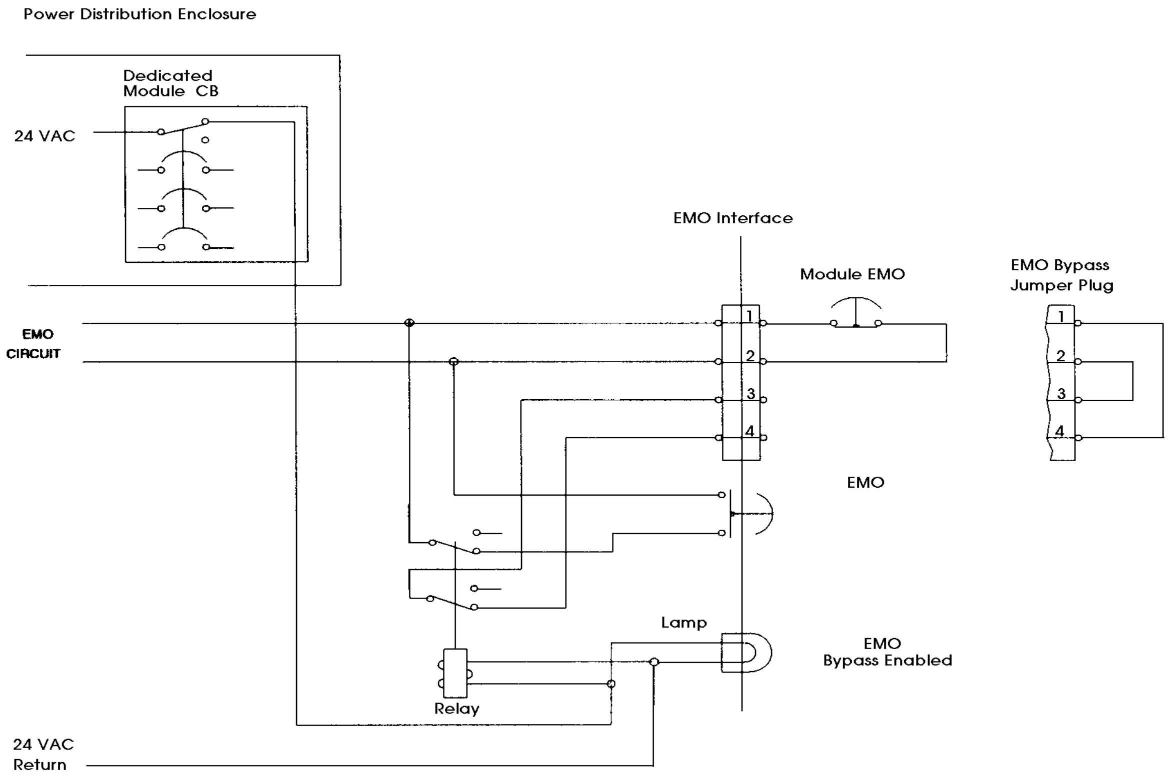


Figure R1-2
Example: EMO Connect/Disconnect Circuit(Module Power is "off," as drawn.)

NOTICE: The user's attention is called to the possibility that compliance with this standard may require use of an invention covered by patent rights. By publication of this standard, Semiconductor Equipment and Materials International (SEMI) takes no position respecting the validity of any patent rights asserted in connection with any item mentioned in this standard. In particular, users of the specification should be aware that Drytek, Inc., A Unit of General Signal, 16 Jonspin Road, Wilmington, MA 01887-1087, Phone: (508) 657-3933, has neither claimed nor disclaimed that compliance with this specification would require use of an invention covered by one or more of its patents. Users of this standard are expressly advised that determination of any such patent rights, and the risk of the infringement of such rights, are entirely their own responsibility.

NOTICE: SEMI makes no warranties or representations as to the suitability of the standards set forth herein for any particular application. The determination of the suitability of the standard is solely the responsibility of the user. Users are cautioned to refer to manufacturer' s instructions, product labels, product data sheets, and other relevant literature, respecting any materials or equipment mentioned herein. These standards are subject to change without notice.

By publication of this standard, Semiconductor Equipment and Materials International (SEMI) takes no position respecting the validity of any patent rights or copyrights asserted in connection with any items mentioned in this standard. Users of this standard are expressly advised that determination of any such patent rights or copyrights, and the risk of infringement of such rights are entirely their own responsibility.

SEMI

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

This standard was technically reapproved by the Global Physical Interfaces & Carriers Committee and is the direct responsibility of the North American Physical Interfaces & Carriers Committee. Current edition reapproved by the North American Regional Standards Committee on July 21, 2002. Initially available at www.semi.org October 2002; to be published November 2002. Originally published in 1991; previously published in June 1999.

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.

2.1.1 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.

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

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

ISO 1609-1986 (E)[1] — “Vacuum Technology — Flange Dimensions,” International Organization for Standardization (ISO).

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.

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.

1 International Organization for Standardization, ISO Central Secretariat, 1, rue de Varembé, Case postale 56, CH-1211 Geneva 20, Switzerland. Telephone: 41.22.749.01.11; Fax: 41.22.733.34.30 Website: www.iso.ch

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 Section 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-culmulative 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 Section 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 Section 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 or equal to 0.8 micrometer (32 microinches) parallel to the circumference (see Section 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 Section 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 Section 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 Section 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 Section 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-250 mm (1.575 in.Ð9.843 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 Section 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.

LIST OF FIGURES

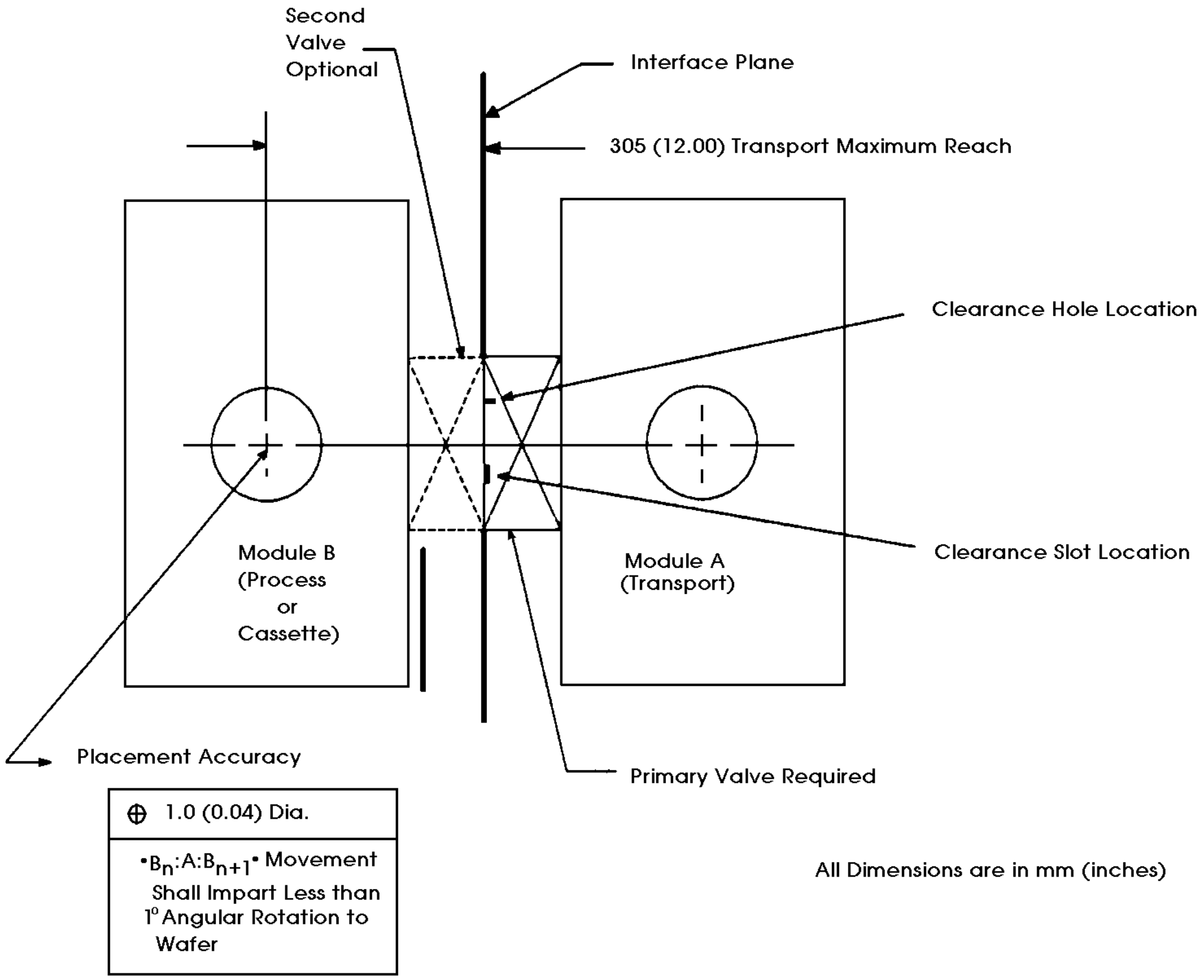


Figure 1
Module Interface with Wafer Transport and Placement Detail (Plan View)

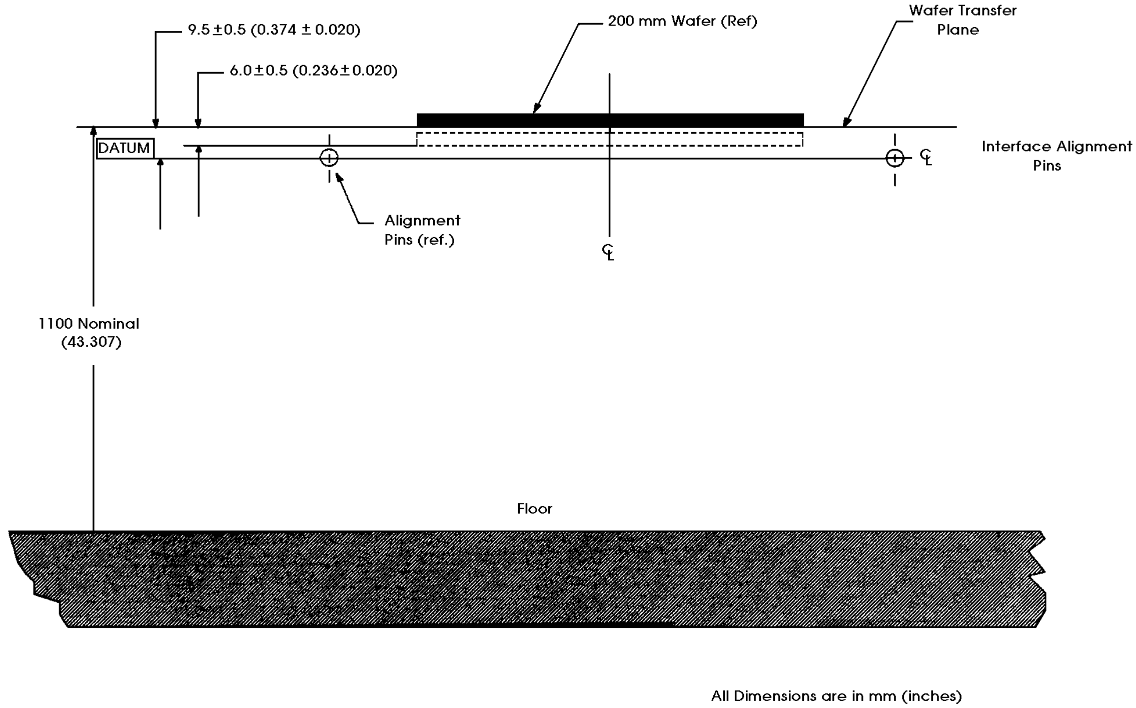


Figure 2
Wafer Transport Plane Elevation

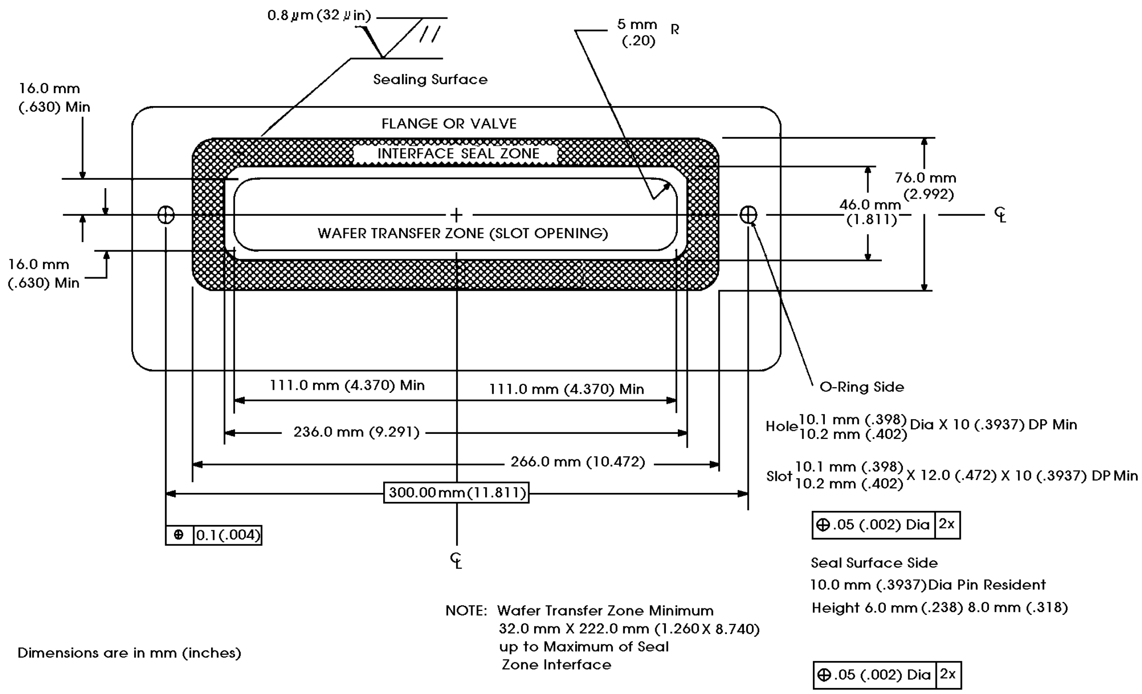


Figure 3
Interface Plane

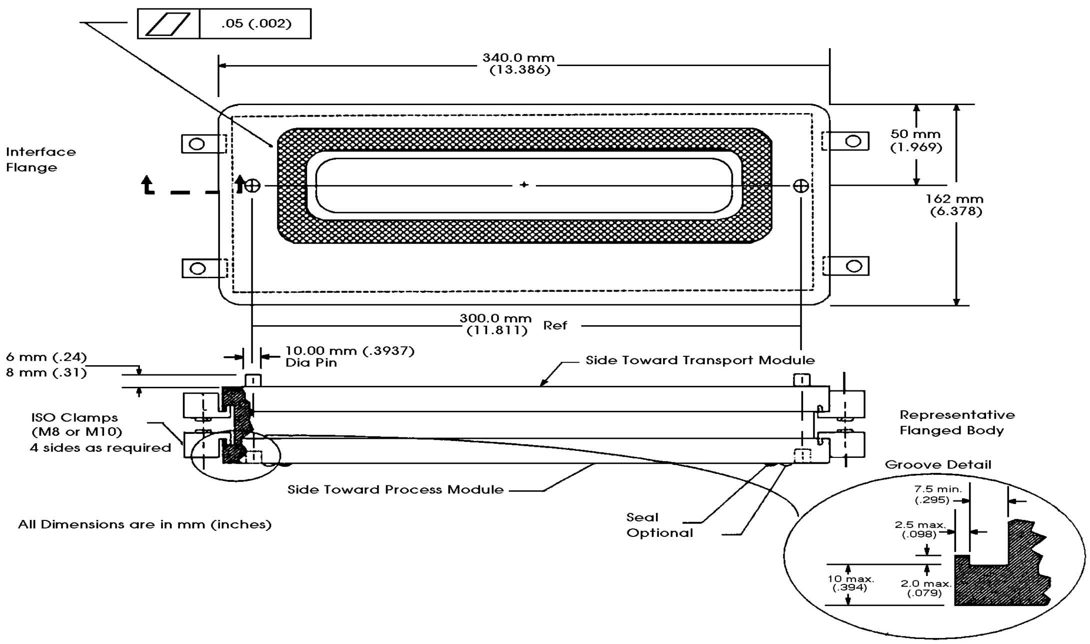


Figure 4
Flange Specification

RELATED INFORMATION 1

NOTE: This related information is not an official part of SEMI E21 but was reapproved for publication by full letter ballot procedures on July 21, 2002.

R1-1 Transport Module Reach

R1-1.1 The reach (see Section 4.1.1) permits a wafer of 200 mm (8 in.) diameter or smaller to be placed on a wafer support platform in a process chamber with allowance for the optional isolation valve on the process module and the chamber wall thickness. The substantial clearance between the wafer and the chamber wall is to allow freedom for process-specific design requirements.

R1-1.2 Individual process chamber designs may place the wafer closer to the interface plane than 305 mm (12 in.) and still conform to the standard.

R1-1.3 Wafers are transported individually in a horizontal attitude. Modules may contain any number of wafers. For example, batch processing is allowed.

R1-2 Vertical Position of Transport Plane

R1-2.1 The transport plane elevation of 1100 mm (43.307 in.) (see Section 4.1.2) is positioned within the constraints placed on the cluster tool by the Inter-Equipment Automation requirement for cassette placement (SEMI E15). SEMI E15 specifies the load height for cassettes to be 900 mm (35.46 in.) ± 10 mm (0.394 in.) outside an environmental load-lock.

R1-2.2 The vertical position of the transport plane is derived from the following contributions:

- 910 mm (35.854 in.) is a worst-case cassette load height position.
- 12 mm (0.473 in.) is a nominal pickup clearance to zero a wafer elevator indexer after the cassette is drawn into the environmental load-lock.
- 178 mm (7.01 in.) is the location of the top slot in a standard 200 mm (8 in.) wafer carrier (SEMI E1.7).

R1-2.3 These additive contributions assure that the transport plane elevation allows as much space as possible for location of support equipment such as pumps, electronics, and power supplies below the process chamber. The 1100 mm (43.307 in.) “nominal” dimension could be adjustable by the module(s) to within ± 25 mm (1 in.).

R1-3 Vertical Motion

R1-3.1 The standard (see Section 4.1.2.1) requires that the transport module be capable of moving in two planes. An ability to move in other planes is optional.

R1-3.2 The transport module moves the wafer in the horizontal wafer transport plane (see Definition 3.12). The transport module has a vertical motion capability for wafer handoff or pickup. It is assumed that the transport module moves in the lower plane after wafer handoff or prior to wafer pickup.

R1-4 Interface Seal Zone

R1-4.1 The interface seal zone (see Section 4.2.1) is sufficiently wide to permit double seals with intermediate pumping.

R1-4.2 *Blank-Off Plates* — The location of the seals on the transport module allows plain blank-off plates to be used for environmental sealing.

R1-5 Wafer Transport Zone

R1-5.1 The minimum specified height of 32 mm (1.184 in.) (see Section 4.2.2) provides sufficient clearance for passage of a knuckle joint or pivot point in the transport module end effector (see SEMI E22, " Cluster Tool Module Interface: Transport Module End Effector Exclusion Volume Standard") and for 6 mm (0.238 in.) of vertical motion. The wafer transport zone may be expanded up to the boundary of the interface seal zone when a module requires a larger opening (see Section 4.2.1 and Figure 3).

R1-6 Interface Plane Alignment Pins

R1-6.1 The standard (see Section 4.2.3) implies the normal engineering practice of chamfering pin ends and countersinking pin locating holes. Actual dimensions for this have been specified or recommended by other authorities.

R1-6.2 Pins reside in the sealing surface to avoid accidental damage to the surface finish during assembly and disassembly. With centrally placed pins, valves may be mounted in either orientation if this simplifies servicing or accessibility.

R1-6.3 A clearance hole and slot arrangement allows use of dissimilar flange materials in a dynamic thermal environment.

R1-7 Isolation Valves

R1-7.1 The standard (see Section 4.2.4) allows the valves to be integral to the modules or discrete separable units.

R1-8 Clamping

R1-8.1 The standard (see Section 4.3.1) allows a universal clamping scheme to be employed. Claw clamps designed for use with ISO flanges are accommodated by the use of a perimeter groove around the flange.

R1-8.2 The clamping scheme provides several benefits:

- Independence from any hole pattern requirements.
- Flanges may be connected to flat plates or to other flanges.
- The number of clamps and the number of sides used to draw the flanges together may be varied as required by the compression forces necessary for the sealing method used. For example, clamps may be spaced on 30 mm (1.191 in.) centers for metal seals and on 150 mm (6 in.) centers for elastomeric seals.
- Any type of clamp may be used that accommodates the perimeter groove.

SEMI

SEMI E21.1-1296 (Reapproved 1102)
CLUSTER TOOL MODULE INTERFACE 300 mm: MECHANICAL INTERFACE AND WAFER TRANSPORT STANDARD

This standard was technically reapproved by the Global Physical Interfaces & Carriers Committee and is the direct responsibility of the North American Physical Interfaces & Carriers Committee. Current edition reapproved by the North American Regional Standards Committee on July 21, 2002. Initially available at www.semi.org October 2002; to be published November 2002. Originally published in 1992; previously published December 1996.

1 Introduction

1.1 The standard provides the requirements to extend the limits of SEMI E21 from 200 mm diameter wafers or smaller to 300 mm diameter wafers or smaller.

2 Referenced Standards

2.1 *SEMI Standards*

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

3 Requirements

3.1 The standard is identical to E21 (see Related Infornation R1-1) except for the requirements listed in Table 1 and Figures 1 and 2.

Table 1 Mechanical Interface Requirements for 300 mm Diameter Wafers

	E21 Requirements	*300 mm Wafer Requirements*
Transport Maximum Reach[1]	305.0 mm (12.01 in.)	380.0 mm (14.96 in.)
Inside Boundary Width-Interface Seal Zone[2]	236.0 mm (9.29 in.)	336.0 mm (13.23 in.)
Outside Boundary Width-Interface Seal Zone[2]	266.0 mm (10.47 in.)	366.0 mm (14.41 in.)
Wafer Transfer Zone Minimum Width[2]	222.0 mm (8.74 in.)	322.0 mm (12.68 in.)
Alignment Pins Centerline Separation[2]	300.0 mm (11.81 in.)	400.0 mm (15.75 in.)
Flange Width[2]	340.0 mm (13.39 in.)	440.0 mm (17.32 in.)
Vertical Slot Opening (Inner boundary of Seal Zone)	46 mm (1.811 in.) Maximum	50 mm (1.969 in.)
Distance of Wafer Transfer Plane above Alignment Pin Datum Line (see Figure 1)	9.5 ± 0.5 mm (0.37 ± 0.02 in.)	15.5 ± 0.5 mm (0.61 ± 0.02 in.)
Vertical Motion Capability (see Figure 1)	6 ± 0.5 mm (0.24 ± 0.02 in.)	10 ± 0.5 mm (0.39 ± 0.02 in.)
Minimum Distance of Slot Top above Alignment Pin Datum on Attached Modules	(13 mm)	23 mm (0.906 in.)
Minimum Distance of Slot Bottom below Alignment Pin Datum on Attached Modules	(13 mm)	13 mm (0.512 in.)

1. See Related Information R1-2.
2. See Related Information R1-3.

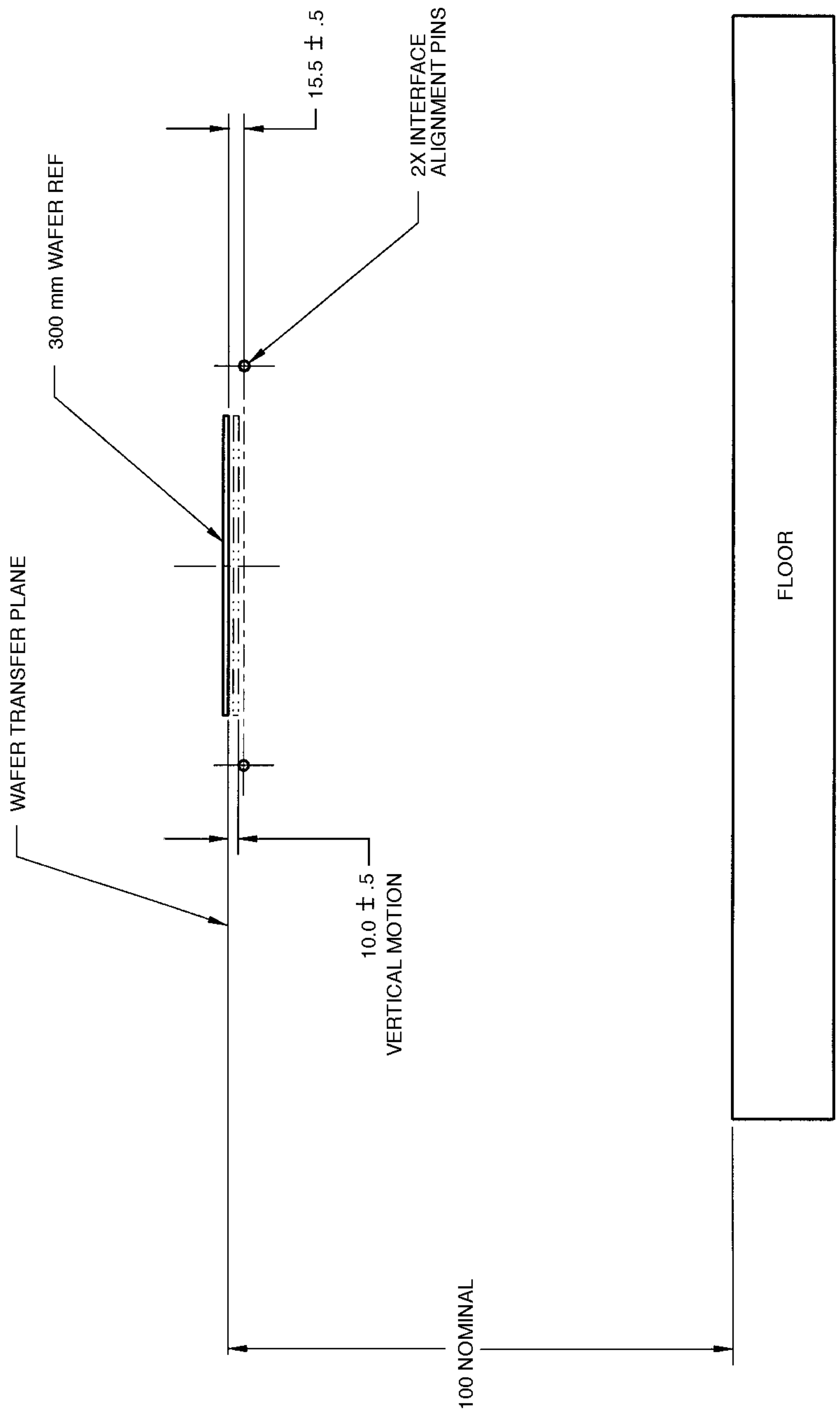


Figure 1
Proposed 300 mm Wafer Transport Plane Elevation

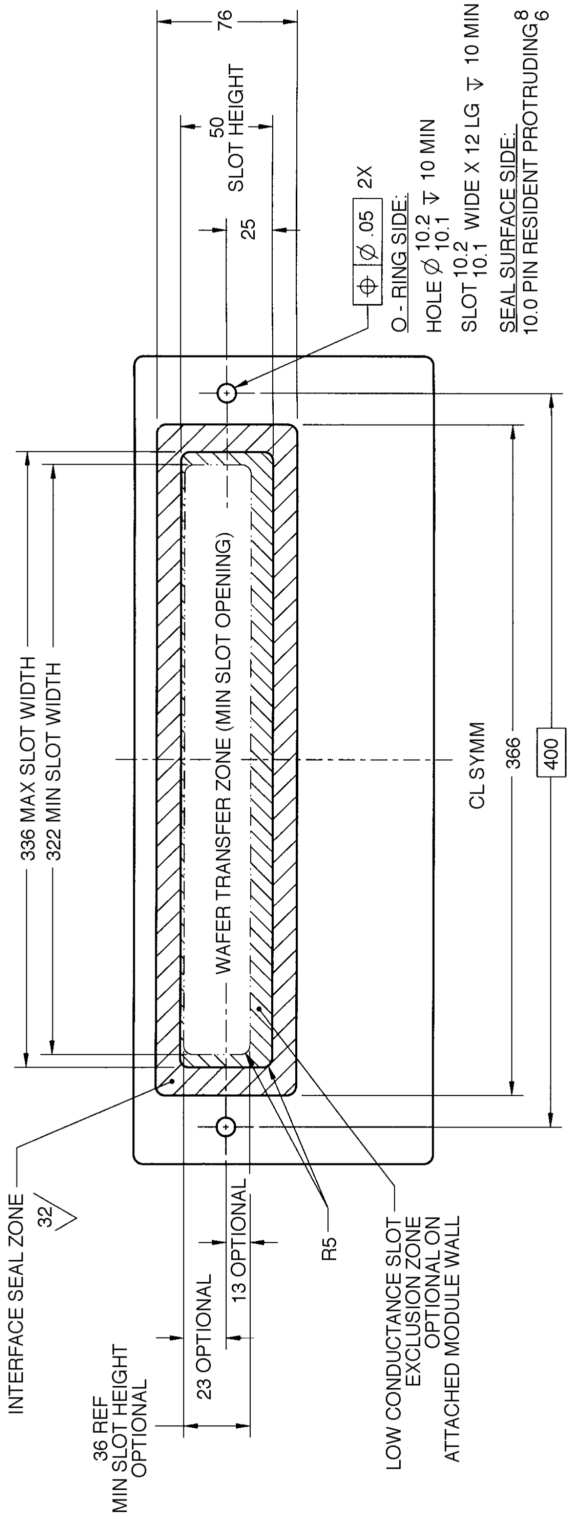


Figure 2
Proposed 300 mm Interface Plane

NOTICE: SEMI makes no warranties or representations as to the suitability of the standards set forth herein for any particular application. The determination of the suitability of the standard is solely the responsibility of the user. Users are cautioned to refer to manufacturer's instructions, product labels, product data sheets, and other relevant literature, respecting any materials or equipment mentioned herein. These standards are subject to change without notice.

The user's attention is called to the possibility that compliance with this standard may require use of an invention covered by patent rights. By publication of this standard, Semiconductor Equipment and Materials International (SEMI) takes no position respecting the validity of any patent rights asserted in connection with any item mentioned in this standard. In particular, users of the specification should be aware that Drytek, Inc., A Unit of General Signal, 16 Jonspin Road, Wilmington, MA 01887-1087, Phone: (508) 657-3933, has neither claimed nor disclaimed that compliance with this specification would require use of an invention covered by one or more of its patents. Users of this standard are expressly advised that determination of any such patent rights, and the risk of the infringement of such rights, are entirely their own responsibility.

RELATED INFORMATION 1

NOTE: The material contained in this related information is not an official part of SEMI E21.1, and is not meant to modify or supersede it in any way. Rather, these notes are provided primarily as a source of information to aid in the application of the standard. As such they are to be considered as reference material only. The standard should be referred to in all cases.

R1-1 Vertical Requirements

R1-1.1 Changes in vertical requirements are made because of the need to provide adequate transport arm stiffness (thickness) for the longer reach specified for 300 mm. However, for many processes, it is desirable to limit the slot size as far as possible. An option is now allowed to reduce the vertical slot opening on the Attached Modules side of the Interface Plane (see Figure 1, E21), but any such reduction will compromise the space otherwise available for transport arm vertical thickness and/or movement. Specification of the extent of this option will be needed in each case it is used.

R1-2 Transport Maximum Reach

A1-2.1 The maximum reach beyond the interface plane (see Table 1) is increased by 75 mm (from 305.0 mm to 380.0 mm); a 50 mm increase in wafer radius (from 100 mm to 150 mm) and a 25 mm increase in clearance between the wafer and the chamber walls.

R1-3 Width Requirements

R1-3.1 The increase in wafer diameter from 200 mm to 300 mm necessitates a 100 mm increase in all width values (see Table 1) specified in SEMI E21.

The user’s attention is called to the possibility that compliance with this standard may require use of an invention covered by patent rights. By publication of this standard, Semiconductor Equipment and Materials International (SEMI) takes no position respecting the validity of any patent rights asserted in connection with any item mentioned in this standard. In particular, users of the specification should be aware that Drytek, Inc., A Unit of General Signal, 16 Jonspin Road, Wilmington, MA 01887-1087, Phone: (508) 657-3933, has neither claimed nor disclaimed that compliance with this specification would require use of an invention covered by one or more of its patents. Users of this standard are expressly advised that determination of any such patent rights, and the risk of the infringement of such rights, are entirely their own responsibility.

SEMI E22-0697 (Reapproved 1102)
CLUSTER TOOL MODULE INTERFACE: TRANSPORT MODULE END EFFECTOR EXCLUSION VOLUME STANDARD

This standard was technically reapproved by the Global Physical Interfaces & Carriers Committee and is the direct responsibility of the North American Physical Interfaces & Carriers Committee. Current edition reapproved by the North American Regional Standards Committee on July 21, 2002. Initially available at www.semi.org October 2002; to be published November 2002. Originally published in 1991; previously published June 1997.

1 Purpose

1.1 The purpose of the standard is to provide sufficient detail to allow the transport module end effector to move wafers to and from process and cassette modules in a cluster tool without mechanical interference.

2 Scope

2.1 The standard describes the volume within any process or cassette module which shall be accessible to the transport module end effector in a cluster tool. The standard is limited to modules which accommodate wafer sizes from 100 mm up to and including 200 mm in diameter.

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

3 Impact

3.1 The adoption of the standard requires equipment designers to allow specific unobstructed volumes within process and cassette modules for wafer transport and places restrictions on the design of the transport module end effector. Some restrictions are dependent on the wafer size.

4 Referenced Standards

4.1 *SEMI Standards*

SEMI E1 — Specification for 3 inch, 100 mm, 125 mm, and 150 mm Plastic and Metal Wafer Carriers

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

5 Terminology

5.1 *Definitions*

5.1.1 *exclusion zone* — A restricted area within a process or cassette module reserved for access by the transport module end effector during wafer handling.

5.1.2 *fork* — A two-prong transport module end effector designed to hold the wafer around its periphery.

5.1.3 *paddle* — A blade transport module end effector designed to support the wafer.

5.1.4 *pedestal* — A support pillar axially symmetric to the wafer transport position in a process or cassette module.

5.1.5 *slot* — A two-sided support, for example as defined for a standard wafer carrier in SEMI E1 when the carrier is oriented with its axis in a vertical attitude.

5.1.6 *transport module end effector* — That part of the transport module that supports the wafer and can extend beyond the interface plane (defined in SEMI E21).

5.1.7 *wafer support platform* — A slot, pedestal, or set of pins used to hold a wafer in a horizontal attitude.

5.1.8 *wafer transport axis* — The centerline of transport module end effector motion. This centerline is symmetric with the wafer transport zone as described in SEMI E21.

5.1.9 *wafer transport position* — A location within a process or cassette module where the wafer is accepted or presented by the transport module end effector. This is also the location of the wafer centroid.

6 Requirements

6.1 *Wafer Transport* — The wafer is to be transported in a horizontal attitude (see Related Information R1-1).

6.2 *Wafer Transport Plane Exclusion Zone* — The exclusion zone is illustrated in Figure 1, and the variables are defined in Table 1 and specified in Table 2 (see Related Information R1-2). The clear areas between B and C and along the wafer transport axis are specified to allow the transport module end effector to be retracted after the wafer has been placed on the support platform in the process or cassette module. The right-hatched (////) area denotes the exclusion zone which could be occupied by a paddle. The left-hatched (\ \ \ \ ) area denotes the additional exclusion zone which could be occupied by a fork. The cross-hatched (XXXX) area denotes the reduction in the dimensions of the paddle exclusion zone to accommodate a pedestal and or pin(s) in a process or cassette module (referred to as a pedestal or pin exclusion zone).

6.3 *Maximum Pedestal Diameter* — The diameter is not to exceed dimension H given in Table 2.

6.4 *Pin Location* — Wafer support pins to be located relative to the wafer transport plane exclusion zone. The pins are to be located at radii dependent upon wafer diameter as specified in Table 2.

6.5 *Vertical Plane Exclusion Zone* — The extent of the exclusion zone in the vertical plane is indicated by the hatched area and the dashed outline in Figure 2. The maximum extent of the exclusion zone allows the transport module end effector to clear the minimum wafer transport zone at the interface plane (see Related Information R1-3). The vertical plane exclusion zone is decreased in height in the vicinity of the wafer transport position to allow the presence of shields, electrodes, etc. in the process or cassette module.

6.6 *Transport Module End Effector Exclusion Volume* — The exclusion volume within a process or cassette module reserved for access by the transport module end effector is defined by the intersection of the two orthogonal exclusion zones described in Sections 6.2 and 6.5. This exclusion volume allows the transport module end effector to accept or present a wafer at the wafer transport position within a process or cassette module (see Related Information R1-4).

LIST OF FIGURES

Table 1 Wafer Transport Plane Exclusion Zone Variables

A	Maximum width of the wafer transport plane exclusion zone
B	Minimum outside clearance for support pins
C	Maximum inside clearance for support pins and/or slot
D	Minimum radial clearance for support pins
E	Outermost radius of wafer transport plane exclusion zone
F	Minimum clearance for entry into SEMI Standard Wafer Carrier
G	Maximum clearance for support pins
H	Maximum clearance for support pedestal

Table 2 Wafer Transport Plane Exclusion Zone Dimensions

Variables	*Wafer Size*			
	100 mm (4 in.)	*125 mm (5 in.)*	*150 mm (6 in.)*	*200 mm (8 in.)*
A	120 mm (4.72 in.)	145 mm (5.71 in.)	170 mm (6.69 in.)	220 mm (8.66 in.)
B	86 mm (3.39 in.)	107 mm (4.21 in.)	129 mm (5.08 in.)	172 mm (6.77 in.)
C	50 mm (1.97 in.)	66 mm (2.60 in.)	78 mm (3.07 in.)	104 mm (4.09 in.)
D	47 mm (1.85 in.)	60 mm (2.36 in.)	72 mm (2.83 in.)	97 mm (3.82 in.)
E	60 mm (2.36 in.)	72 mm (2.83 in.)	85 mm (3.35 in.)	110 mm (4.33 in.)
F	70 mm (2.76 in.)	82 mm (3.23 in.)	95 mm (3.74 in.)	120 mm (4.72 in.)
G	47 mm (1.85 in.)	60 mm (2.36 in.)	72 mm (2.83 in.)	97 mm (3.82 in.)
H	30 mm (1.18 in.)	38 mm (1.50 in.)	45 mm (1.77 in.)	60 mm (2.36 in.)

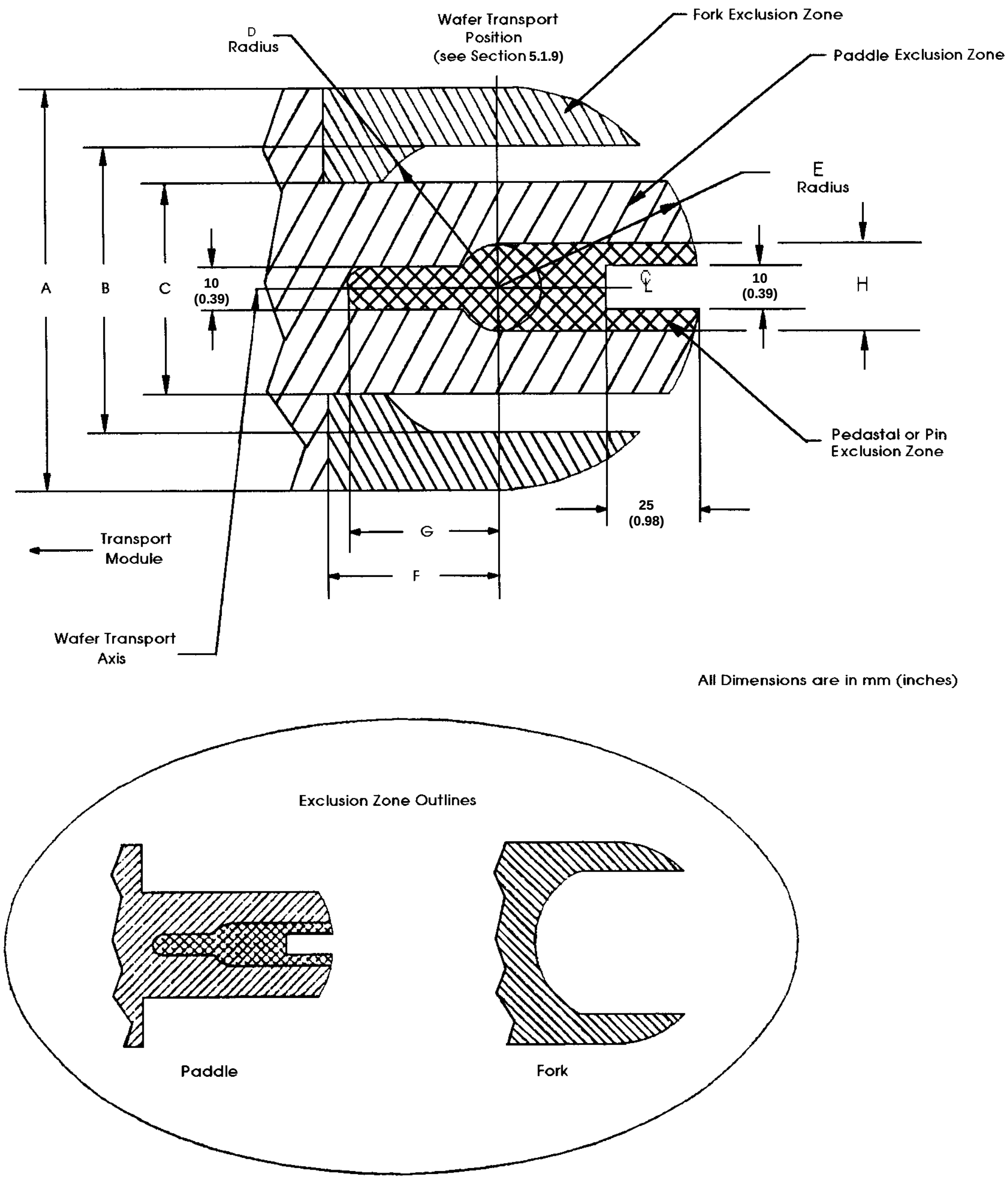


Figure 1
Wafer Transport Plane Exclusion Zone (Plan View)

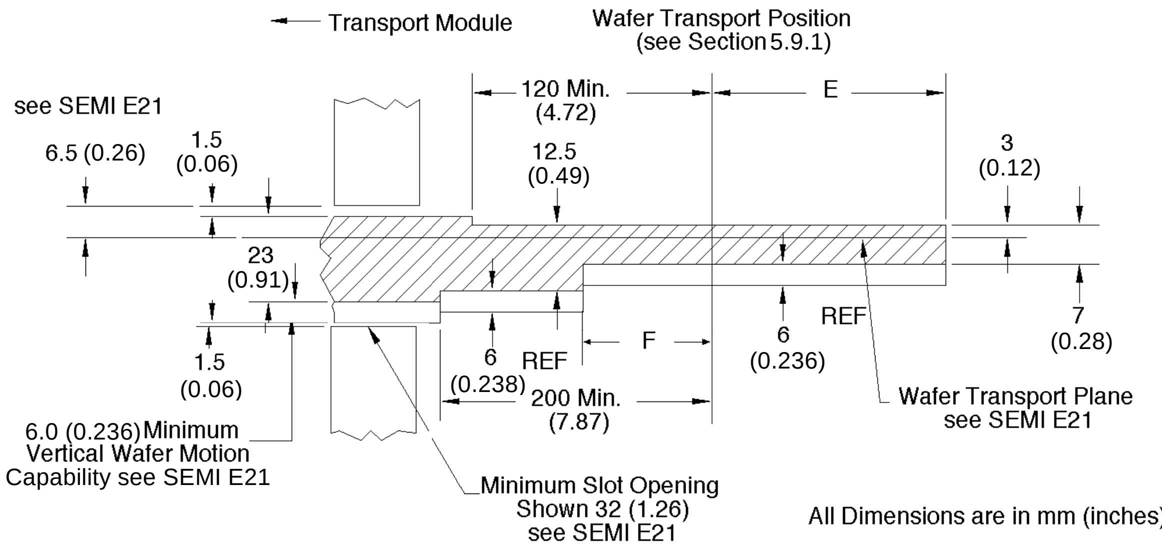


Figure 2
Vertical Plane Exclusion Zone (Elevation View)

NOTICE: The user's attention is called to the possibility that compliance with this standard may require use of an invention covered by patent rights. By publication of this standard, Semiconductor Equipment and Materials International (SEMI) takes no position respecting the validity of any patent rights asserted in connection with any item mentioned in this standard. In particular, users of the specification should be aware that Drytek, Inc., A Unit of General Signal, 16 Jonspin Road, Wilmington, MA 01887-1087, Phone: (508) 657-3933, has neither claimed nor disclaimed that compliance with this specification would require use of an invention covered by one or more of its patents. Users of this standard are expressly advised that determination of any such patent rights, and the risk of the infringement of such rights, are entirely their own responsibility.

NOTICE: SEMI makes no warranties or representations as to the suitability of the standards set forth herein for any particular application. The determination of the suitability of the standard is solely the responsibility of the user. Users are cautioned to refer to manufacturer' s instructions, product labels, product data sheets, and other relevant literature, respecting any materials or equipment mentioned herein. These standards are subject to change without notice.

By publication of this standard, Semiconductor Equipment and Materials International (SEMI) takes no position respecting the validity of any patent rights or copyrights asserted in connection with any items mentioned in this standard. Users of this standard are expressly advised that determination of any such patent rights or copyrights, and the risk of infringement of such rights are entirely their own responsibility.

.

RELATED INFORMATION 1

NOTE: The material contained in these application notes is not an official part of SEMI E22, and it is not meant to modify or supersede it in any way. Rather, these notes are provided primarily as a source of information to aid in the application of the standard. As such, they are to be considered as reference material only. The standard should be referred to in all cases.

R1-1 Wafer Transport

R1-1.1 The standard (see Section 6.1) does not require that the entire transport module end effector move in a horizontal attitude while the wafer does have this requirement. For example, the transport module end effector may have a component of motion in a plane other than the horizontal during wafer transport across the interface plane.

R1-2 Variables — Definitions and Dimensions

R1-2.1 The function of Table 2 (see Section 6.2) is to list the numerical values for the wafer dependent variables used in Figures 1 and 2. The values are wafer size dependent so as not to penalize the design of a transport module end effector when handling only small diameter wafers. For example, the physical size of a transport module end effector for a 100 mm diameter wafer may be smaller than that for a 200 mm diameter wafer.

R1-3 Vertical Plane Exclusion Zone

R1-3.1 The development of the numeric values specified in the standard (see Section 6.5) and given in Figure 2 are described below.

R1-3.2 The 3 mm height above the wafer transport plane (defined in SEMI E21) allows for transport module end effectors which use contraints (e.g., a cupped device or pins) to ensure the wafer does not slide. Also, this may be necessary if the wafer is transported with the circuit side facing down.

R1-3.3 The 7 mm value allows for a 4 mm thickness below the wafer transport plane to accommodate a structurally and thermally strong transport module end effector design.

R1-3.4 The 12.5 mm thickness allows for process or cassette modules with a minimum slot opening value of less than 32 mm (see SEMI E21).

R1-3.5 The 200 mm minimum length part of the exclusion zone allows for a transport module end effector of limited reach to pass into modules with slot openings smaller than the minimum value of 32 mm.

R1-3.6 The 23 mm thickness allows for the presence of a “wrist” joint or for additional rigidity in the transport module end effector.

R1-3.7 The 120 mm length is specified as a fixed number to ensure that multiple wafer sizes (and transport module end effectors) do not necessarily demand a change in geometry of the receiving module around the wafer transport position.

R1-3.8 The minimum nominal clearance above and below the exclusion zone is 1.5 mm on both sides of the transport module end effector when it passes through the minimum slot opening. This takes into account the exclusion zone size due to the vertical travel the transport module end effector may experience.

R1-3.9 A subset of the vertical plane exclusion zone (see Figure R1-1) is required by a transport module end effector which must access wafers directly from SEMI standard or equivalent cassettes. The vertical plane exclusion zone described in the standard (see Figure 2) was not subject to these restrictions since a single generic transport module end effector design was found not to be practical.

R1-4 Transport Module End Effector Exclusion Volume

R1-4.1 This volume as described in Section 6.6 is intended to be the volume within which the transport module end effector has complete autonomy. Therefore, process and cassette modules are not allowed to violate this volume during wafer transport. This prevents mechanical interference between the transport module end effector and the process or cassette module.

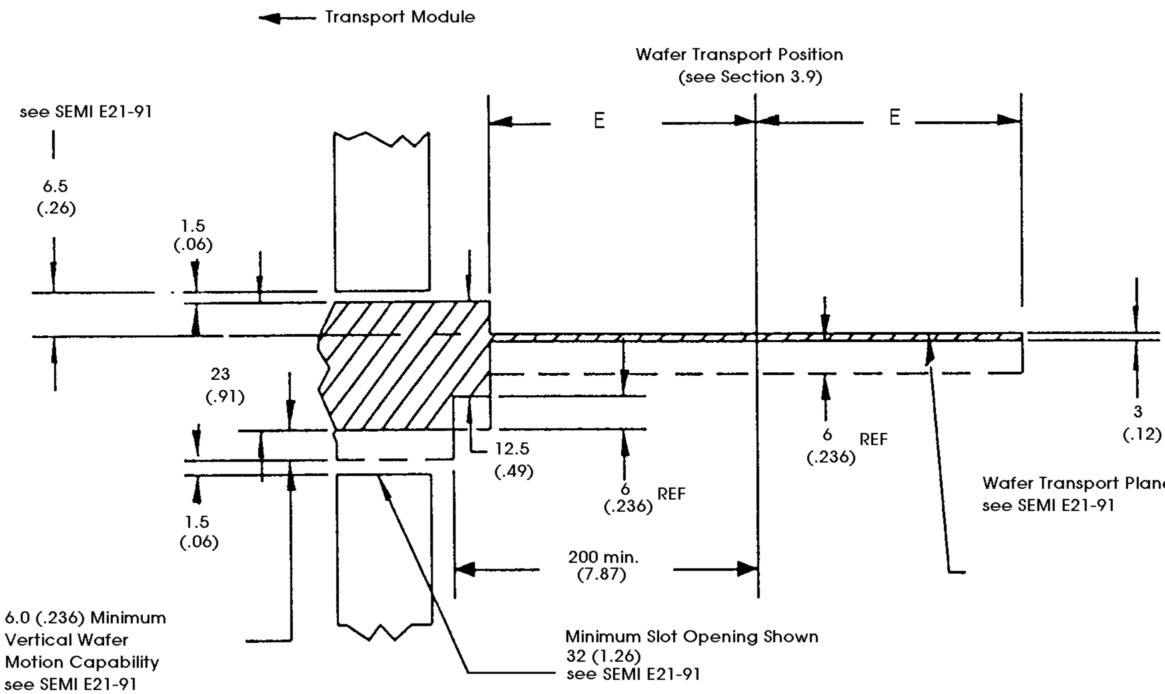


Figure R1-1
Vertical Plane Exclusion Zone (Elevation View)
(Restricted Case for SEMI Standard Cassette Access)

NOTICE: The user’s attention is called to the possibility that compliance with this standard may require use of an invention covered by patent rights. By publication of this standard, Semiconductor Equipment and Materials International (SEMI) takes no position respecting the validity of any patent rights asserted in connection with any item mentioned in this standard. In particular, users of the specification should be aware that Drytek, Inc., A Unit of General Signal, 16 Jonspin Road, Wilmington, MA 01887-1087, Phone: (508) 657-3933, has neither claimed nor disclaimed that compliance with this specification would require use of an invention covered by one or more of its patents. Users of this standard are expressly advised that determination of any such patent rights, and the risk of the infringement of such rights, are entirely their own responsibility.

NOTICE: SEMI makes no warranties or representations as to the suitability of the standards set forth herein for any particular application. The determination of the suitability of the standard is solely the responsibility of the user. Users are cautioned to refer to manufacturer' s instructions, product labels, product data sheets, and other relevant literature, respecting any materials or equipment mentioned herein. These standards are subject to change without notice.

By publication of this standard, Semiconductor Equipment and Materials International (SEMI) takes no position respecting the validity of any patent rights or copyrights asserted in connection with any items mentioned in this standard. Users of this standard are expressly advised that determination of any such patent rights or copyrights, and the risk of infringement of such rights are entirely their own responsibility.

SEMI E22.1-1296 (Reapproved 1102)
CLUSTER TOOL MODULE INTERFACE 300 mm: TRANSPORT MODULE END EFFECTOR EXCLUSION VOLUME STANDARD

This standard was technically reapproved by the Global Physical Interfaces & Carriers Committee and is the direct responsibility of the North American Physical Interfaces & Carriers Committee. Current edition reapproved by the North American Regional Standards Committee on July 21, 2002. Initially available at www.semi.org October 2002; to be published November 2002. Originally published in 1992; previously published December 1996.

1 Introduction

1.1 The standard provides the requirements to change the limits of applicability of SEMI E22 from 100 mm to 200 mm diameter wafers to 300 mm diameter wafers.

2 Referenced Standards

2.1 *SEMI Standards*

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

SEMI E22 — Cluster Tool Module Interface: Transport Module End Effector Exclusion Volume Standard

3 Requirements

3.1 *Wafer Transport Plane Exclusion Zone* — All fixed dimensions remain the same as for SEMI E22 with the following exception. The 25 mm and 10 mm dimenions for the rectangular space excluded from the front of the Paddle Exclusion Zone are expanded and defined by Variables I and H respectively. These variables are shown in Figure 1. Variables for 250 mm and 300 mm diameter wafers are specified in Table 1.

Table 1 Wafer Transport Plane Exclusion Zone Dimensions for 250 mm and 300 mm Diameter Wafers

	Wafer Size	
	250 mm (10 in. nom.)	*300 mm (12 in. nom.)*
A	270 mm (10.63 in.)	320 mm (12.60 in.)
B	215 mm (8.46 in.)	250 mm (9.84 in.)
C	130 mm (5.12 in.)	225 mm (8.86 in.)
D	122 mm (4.80 in.)	147 mm (5.79 in.)
E	135 mm (5.31 in.)	160 mm (6.30 in.)
F	145 mm (5.71 in.)	170 mm (6.69 in.)
G	122 mm (4.80 in.)	147 mm (5.79 in.)
H	75 mm (2.95 in.)	154 mm (6.06 in.)
I		117 mm (4.61 in.)

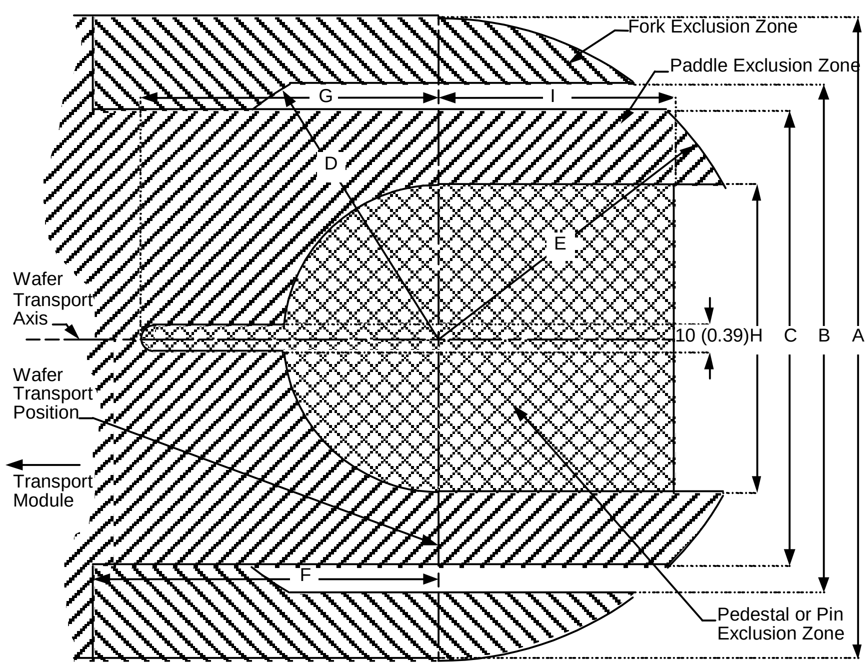


Figure 1
New Wafer Transport Plane Exclusion Zone Dimensions

3.2 *Vertical Plane Exclusion Zone* — This zone is illustrated in Figure 2, which defines dimensional values.

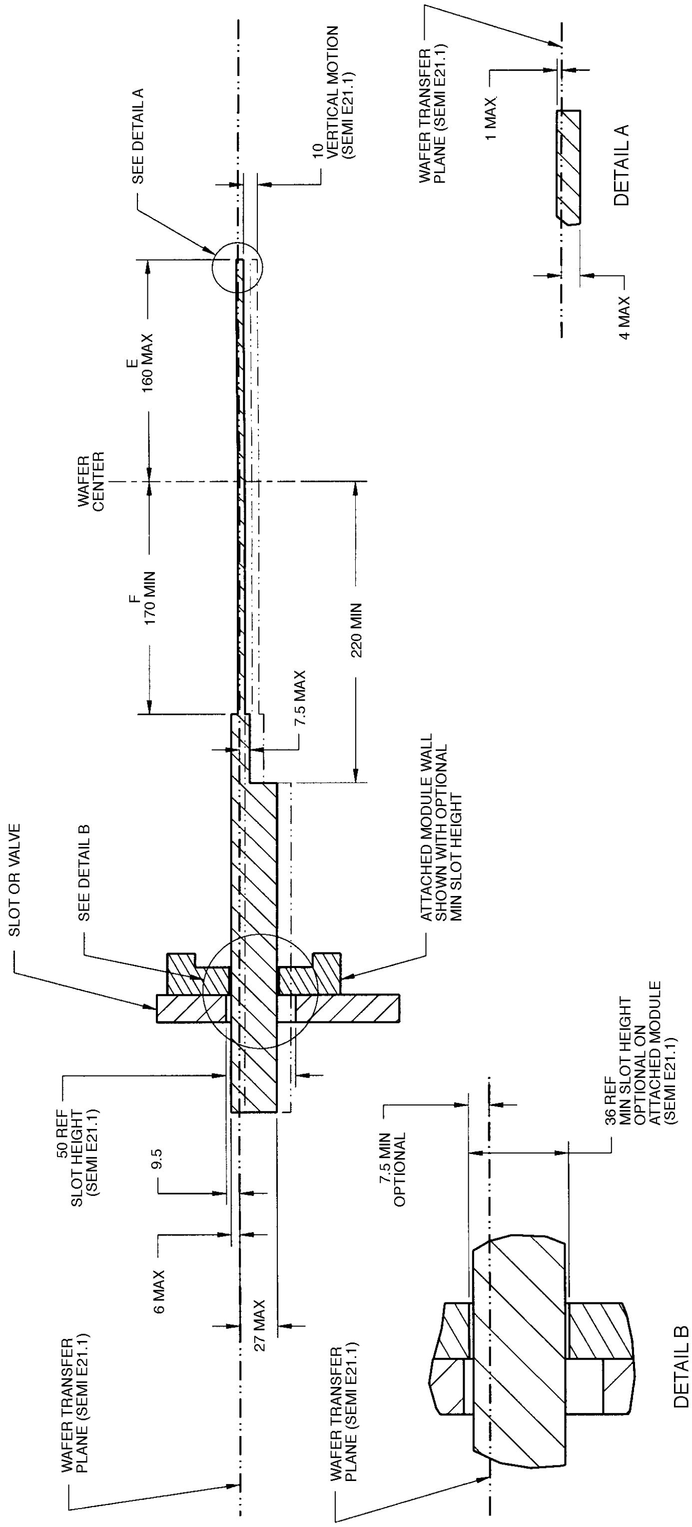


Figure 2
Proposed 300 mm Vertical Plane Exclusion Zone (Elevation View)

RELATED INFORMATION 1

NOTE: This related information is not an official part of SEMI E22.1, and is not meant to modify or supersede it in any way. Rather, these notes are provided primarily as a source of information to aid in the application of the standard. As such they are to be considered as reference material only. The standard should be referred to in all cases.

R1-1

R1-1.1 The standard applies to both attached modules and wafer carriers; there is no special subset for carriers. The extreme end of the exclusion zone should allow adequate stiffness for end effectors and also permit insertion into carriers (with a 10 mm pitch).

NOTICE: The user's attention is called to the possibility that compliance with this standard may require use of an invention covered by patent rights. By publication of this standard, Semiconductor Equipment and Materials International (SEMI) takes no position respecting the validity of any patent rights asserted in connection with any item mentioned in this standard. In particular, users of the specification should be aware that Drytek, Inc., A Unit of General Signal, 16 Jonspin Road, Wilmington, MA 01887-1087, Phone: (508) 657-3933, has neither claimed nor disclaimed that compliance with this specification would require use of an invention covered by one or more of its patents. Users of this standard are expressly advised that determination of any such patent rights, and the risk of the infringement of such rights, are entirely their own responsibility.

NOTICE: SEMI makes no warranties or representations as to the suitability of the standards set forth herein for any particular application. The determination of the suitability of the standard is solely the responsibility of the user. Users are cautioned to refer to manufacturer' s instructions, product labels, product data sheets, and other relevant literature, respecting any materials or equipment mentioned herein. These standards are subject to change without notice.

By publication of this standard, Semiconductor Equipment and Materials International (SEMI) takes no position respecting the validity of any patent rights or copyrights asserted in connection with any items mentioned in this standard. Users of this standard are expressly advised that determination of any such patent rights or copyrights, and the risk of infringement of such rights are entirely their own responsibility.

SEMI E23-1104
SPECIFICATION FOR CASSETTE TRANSFER PARALLEL I/O INTERFACE

This specification was technically approved by the Global Physical Interfaces and Carriers Committee and is the direct responsibility of the North American Physical Interfaces and Carriers Committee. Current edition approved by the North American Regional Standards Committee on August 16, 2004. Initially available at www.semi.org September 2004; to be published November 2004. Originally published in 1991; previously published in 2002.

1 Purpose

1.1 Cassette transfer between process equipment and transport equipment is performed by means of a mechanical operation in the interactive area and requires quick response and reliable interlock signals.

1.2 The purpose of this specification is to provide a cassette transfer parallel input/output (I/O) interface for control of the interface mechanism that supplements the SECS standard for material movement.

2 Scope

2.1 This specification deals with the parallel I/O interface for the cassette transfer between two pieces of equipment, such as a piece of process equipment and a piece of transport equipment.

2.2 This standard defines the wire-connected parallel I/O interface between two pieces of equipment and the photo-coupled parallel I/O interface between the process equipment and the transport equipment.

2.3 The application of the parallel I/O interface to the cassette transport is as follows.

2.4 Each piece of equipment is connected to the HOST at the SECS interface, and each of the two pieces of equipment between which the cassette transfer will be made is connected at the parallel I/O interface as shown in Figure 1.

2.5 The cassette transfer request, or load/unload command, is notified by the SECS-II message. The actual cassette transfer action is executed using the parallel I/O interface, interlocking each mechanism. (An example of a cassette transfer transaction using the parallel I/O interface is shown in Related Information 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.

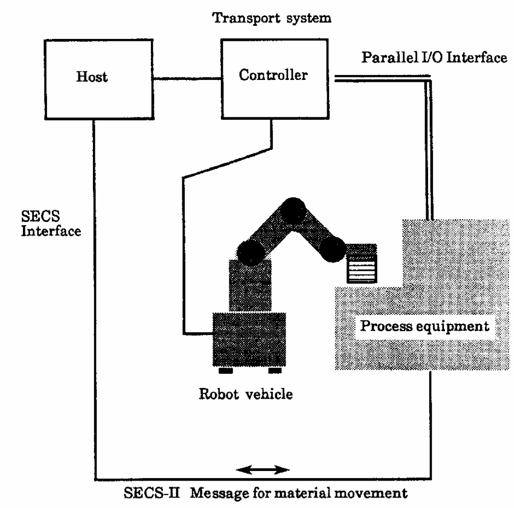


Figure 1
Application of Parallel I/O Interface to Cassette Transport

3 Referenced Standards

3.1 *SEMI Standards*

SEMI E1 — Specification for 3 inch, 100 mm, 125 mm, and 150 mm Plastic and Metal Wafer Carriers

SEMI E4 — SEMI Equipment Communications Standard 1 Message Transfer (SECS-I)

SEMI E5 — SEMI Equipment Communications Standard 2 Message Content (SECS-II)

3.2 *ISO Standards*[1]

ISO 4902 — Information Technology — Data Communication — 37-pole DTE/DCE Interface Connector and Contact Number Assignments

3.3 *Japanese Industrial Standards Committees*[2]

JIS-X-5103 — The Interface Between Data Circuit Terminating Equipment (DCE) and Data Terminal Equipment (DTE) (37/9-Pin Interface)

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

4 Terminology

4.1 *Definitions*

4.1.1 *active equipment* — Equipment that loads a cassette onto the cassette stage of another piece of equipment or unloads a cassette from the cassette stage of another piece of equipment.

4.1.2 *cassette* — A plastic or metal wafer carrier as defined in SEMI E1.

4.1.3 *cassette stage* — A stage on a piece of equipment on which a cassette is placed or from which it is removed that allows the cassette transfer.

4.1.4 *cassette transfer robot* — A robot that transfers cassettes (see Figure 2).

4.1.5 *passive equipment* — Equipment that is loaded or unloaded by the active equipment.

4.1.6 *photo-coupled interface* — A parallel I/O interface connected without contact by means of a photo-coupled device.

4.1.7 *process equipment* — Fabrication equipment, inspection equipment, and cassette stage equipment used in semiconductor manufacturing.

4.1.8 *robot vehicle* — A piece of equipment having a cassette transfer robot on the vehicle that moves to another piece of equipment and transfers cassettes (see Figure 2).

4.1.9 *transfer* — To either load or unload.

4.1.10 *transport equipment* — A piece of equipment (or system) which transports or transfers cassettes. It mainly consists of a transport vehicle, a robot vehicle, and a cassette transfer robot.

4.1.11 *transport vehicle (see Figure 2)* — A vehicle which transports cassettes but which has no mechanism for cassette transfer.

4.1.12 *wire-connected interface* — A parallel I/O interface connected by means of wire and a connector.

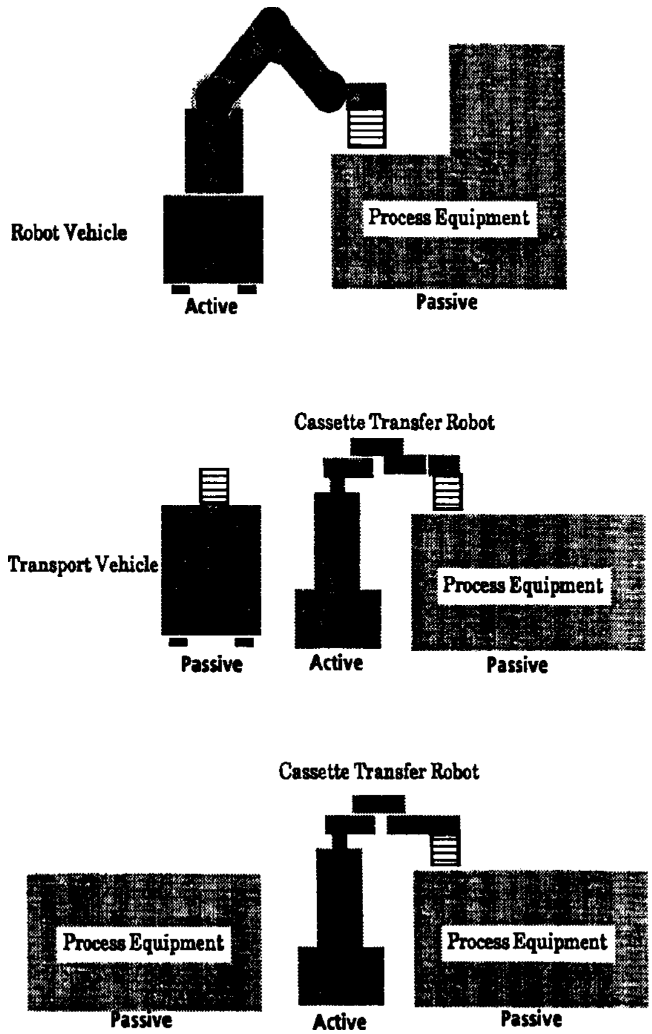


Figure 2
Cassette Transfer between Active Equipment and Passive Equipment

1 International Organization for Standardization, ISO Central Secretariat, 1, rue de Varembé, Case postale 56, CH-1211 Geneva 20, Switzerland. Telephone: 41.22.749.01.11; Fax: 41.22.733.34.30 Website: www.iso.ch

2 Japanese Industrial Standards, Available through the Japanese Standards Association, 1-24, Akasaka 4-Chome, Minato-ku, Tokyo 107-8440, Japan. Telephone: 81.3.3583.8005; Fax: 81.3.3586.2014 Website: www.jsa.or.jp

5 Parallel I/O Interface Specification

5.1 This standard refers only to the cassette transfer between active and passive equipment.

5.2 *Wire-Connected Parallel I/O Interface Specification* — The equipment is to have a parallel I/O interface for the passive mode when it becomes passive, and the parallel I/O interface for the active mode when it becomes active.

5.2.1 *Signals for Each Cassette Stage* — The cassette stage is to have the input/output signal lines listed in Table 1.

Table 1 Signals for Each Cassette Stage (Wire-Connected Interface)

Signal Type	*P/A*	*Description*
L_REQ (LOAD REQUEST)	P->A	This signal means that the CS can be loaded. The signal turns OFF when the cassette is detected on the CS. (The CS is a cassette stage.)
U_REQ (UNLOAD REQUEST)	P->A	This signal means that the CS can be unloaded. The signal turns OFF when it is detected that the cassette has been removed from the CS.
READY	P->A	This signal means that the CS is in a state where it can be accessed by the active equipment. It turns ON when the CS is in the READY state after the TR_REQ signal from the active turns ON. The signal turns OFF by handshakes with the COMPT signal.
TR_REQ (TRANSFER REQUEST)	A->P	This signal turns ON when the active equipment is going to start transferring the cassette. It turns OFF when the BUSY signal is OFF. (Active equipment starts transferring the cassette with the BUSY ON after recognizing the READY ON.)

5.2.2 *Common Signals* — The signals in Table 2 show the status of the cassette transfer action of the active equipment. The CS's are allowed to input these signals commonly from active equipment.

Table 2 Common Signals (Wire-Connected Interface)

Signal Type	*P/A*	*Description*
BUSY	A->P	This signal turns ON when the active equipment starts transferring the cassette to the CS while it is in READY and turns OFF after the robot has loaded or unloaded a cassette and has moved away from the interactive zone. The passive equipment does not perform any mechanical action in the interactive zone while this signal is ON.
COMPT (COMPLETE)	A->P	This signal means the active equipment has completed the transfer action. It turns OFF after handshaking with the READY signal.

NOTE 1: It is recommended that the BUSY signal turn OFF after the active equipment has confirmed L_REQ (or U_REQ) is OFF.

5.2.3 *Cassette Transfer Sequence* — Time charts for the cassette transfer sequence are shown in Figures 3 (a) and (b).

5.2.3.1 The TR_REQ from the active equipment initiates the cassette transfer sequence. The active equipment starts carrying out the transfer action with the BUSY ON as soon as it recognizes that the READY signal of the passive equipment is ON. The handshake is finished after the cassette transfer action has been completed.

5.3 *Photo-Coupled Parallel I/O Interface Specification* — This interface is concerned only with the cassette transfer between the process equipment and the transport robot vehicle. The robot vehicle is active and the process equipment is passive.

5.3.1 This interface is defined between the robot and the cassette stages to which the robot can transfer a cassette at the same stopping position.

5.3.2 *Signals* — The signals for the photo-coupled parallel I/O interface are listed in Table 3. The CS_0, CS_1, and CS_2 signals specifying the CS to or from which the active equipment transfers and the VALID signal indicating effectiveness of the data of CS_0~CS_2, are newly added to the signals defined in the wire-connected parallel I/O interface.

Table 3 Signals for the Photo-Coupled Parallel I/O Interface

Signal Type	*P/A*	*Description*
VALID	A->P	This signal remains high (ON) while the data of CS_0, CS_1, CS_2 is effective. (The data of CS_0, CS_1, CS_2 is not effective when VALID signal is OFF.)
CS_0 (LSB) CS_1 CS_2 (MSB)	A->P	The 3-bit signals specify the cassette stage number (0 ~ 7) of the passive equipment, to or from which the active equipment (robot vehicle) is going to transfer a cassette. They are set before the VALID signal turns ON. VALID and CS_0~CS_2 signal.
TR_REQ	A->P	This is the same in the wire-connected parallel I/O specification and is valid for the specified CS.
L_REQ	P->A	This is the same in the wire-connected parallel I/O specification and is valid for the specified CS.
U_REQ	P->A	This is the same in the wire-connected parallel I/O specification and is valid for the specified CS.
READY	P->A	This is the same in the wire-connected parallel I/O specification and is valid for the specified CS.
BUSY	A->P	This is the same in the wire-connected parallel I/O specification.
COMPT	A->P	This is the same in the wire-connected parallel I/O specification.

5.3.3 *Cassette Transfer Sequence* — Time charts for the cassette transfer sequence in the case of the photo-coupled interface are shown in Figure 4 (a) and (b). After the active equipment (robot vehicle) reaches the process equipment, it sets the CS_0, CS_1, CS_2 3-bit-signals to specify the CS number of the passive equipment, to or from which the active equipment (robot vehicle) is going to transfer a cassette. Then the robot vehicle turns the VALID signal ON, which shows the date of the CS_0, CS_1, CS_2 signal is effective. After the cassette stage is specified, cassette transfer sequence is the same as in the wire-connected parallel I/O specification. TR_REQ, L_REQ,U_REQ, READY signals show the data for the specified CS while the VALID signal is ON, and the CS_0, CS_1, CS_2 signals are inhibited to change their data while the VALID signal is ON.

5.4 *Error Detection and Recovery* — The cassette transfer using this interface in the practical manufacturing lines will need handshake time interval control, cassette misalignment detection, and report of alarm or error to find an error or abnormal termination in the cassette transfer. An error recovery procedure with appropriate assist by human operators will be also required. This standard, however, does not define the specifications related to the error detection and recovery because of difference in process time, failure mode, and error recovery procedure of individual equipment and system.

5.4.1 The recommendation for basic error detection is that the active equipment should control handshake time intervals, and at least the interval time T between the beginning of the cassette transfer and the end of the transfer should be controlled — see the time chart of the cassette transfer sequence shown in Figures 3(a), 3(b), 4(a), and 4(b), describing the time chart of the cassette transfer sequence.

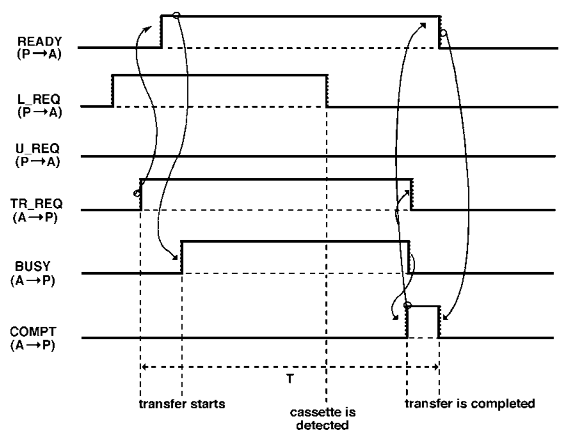


Figure 3A
Cassette Load Sequence
(Wire-Connected Interface)

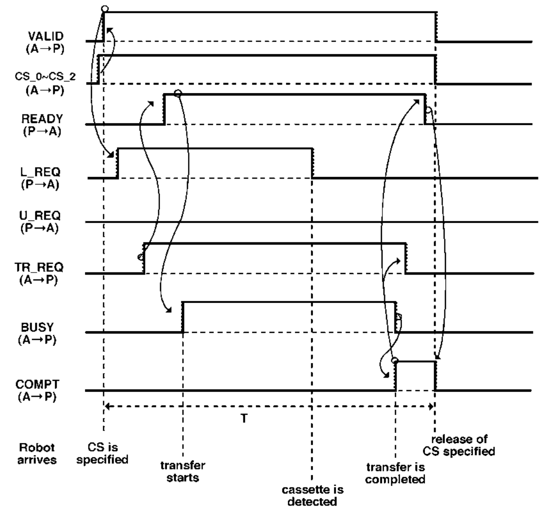


Figure 4A
Cassette Load Sequence
(Photo-Coupled Interface)

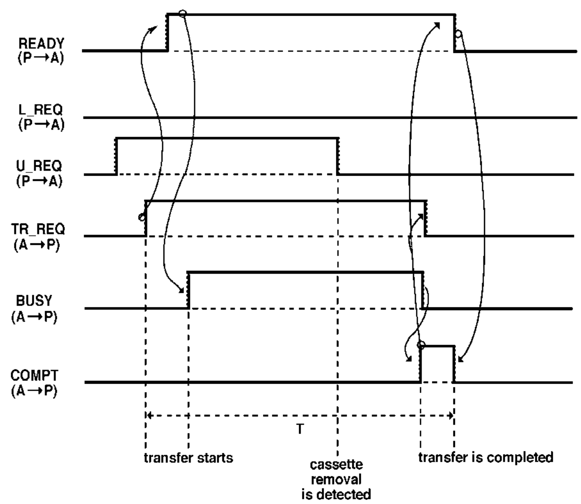


Figure 3B
Cassette Unload Sequence
(Wire-Connected Interface)

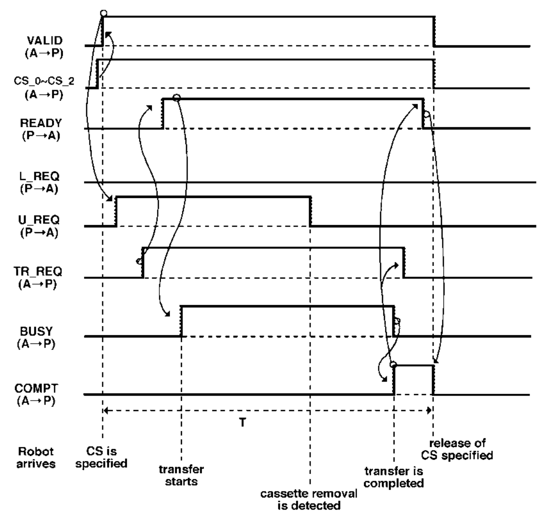


Figure 4B
Cassette Load Sequence
(Photo-Coupled Interface)

6 Connector and Interface Circuit

6.1 *Wire-Connected Interface* — One set of connectors is provided for the CS's that commonly input the BUSY and COMPT signals.

6.1.1 *Connector and Pin Assignment*

1. Connector JIS-X-5103 (D-SUB type) ISO-4902 Every piece of equipment is to have female type connectors.

2. *Pin Assignment* — The connector with 37 pins is used. One connector is used for 1 to 4 cassette stages and another connector is used for 5 to 7 cassette stages. The pin assignment is listed in Tables 4a and 4b. Figure 5 shows the pin assignment of the connector for 4 cassette stages.

Table 4 Pin Assignment for Wire-Connected Parallel I/O Interface (Connector 2)

Pin No.	*Signal*	*Pin No.*	*Signal*
1	CS1 L_REQ	20	CS1 L_REQ*
2	CS1 U_REQ	21	CS1 U_REQ*
3	CS1 READY	22	CS1 READY*
4	CS2 L_REQ	23	CS2 L_REQ*
5	CS2 U_REQ	24	CS2 U_REQ*
6	CS2 READY	25	CS2 READY*
7	CS3 L_REQ	26	CS3 L_REQ*
8	CS3 U_REQ	27	CS3 U_REQ*
9	CS3 READY	28	CS3 READY*
10	CS4 L_REQ	29	CS4 L_REQ*
11	CS4 U_REQ	30	CS4 U_REQ*
12	CS4 READY	31	CS4 READY*
13	CS1 TR_REQ	32	CS1 TR_REQ*
14	CS2 TR_REQ	33	CS2 TR_REQ*
15	CS3 TR_REQ	34	CS3 TR_REQ*
16	CS4 TR_REQ	35	CS4 TR_REQ*
17	COMPT	36	COMPT*
18	BUSY	37	BUSY*
19		38	

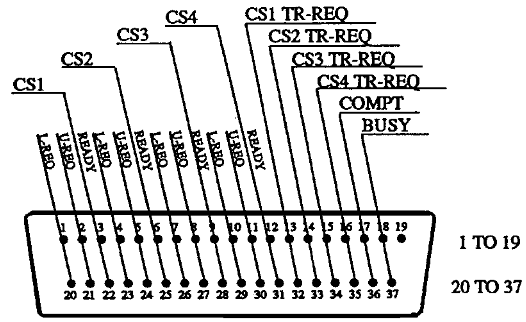
*Vcc side (power source) for the current-driven type circuit. Common side for the voltage-driven type circuit.

6.1.1.1 When one connector is used for only one cassette stage, the connector with 15 pins may be used. The pin assignment is listed in the Table 5.

6.1.2 *Interface Circuit* — The following two types of interface circuits are used. (Interface circuit examples are shown in Related Information 3.)

1. Voltage-driven Type Circuit — Driving voltage: DC24 ± 2 V

2. Current-driven Type Circuit — Driving current: 10 mA ~ 20 mA



JIS-X-5103 37-pin connector

Figure 5
Pin Assignment for Wire-Connected Parallel I/O Interface

Table 5 Pin Assignment for Wire-Connected Parallel I/O Interface (Connector 1)

Pin No.	*Signal*	*Pin No.*	*Signal*
1	CS5 L_REQ	20	CS5 L_REQ*
2	CS5 U_REQ	21	CS5 U_REQ*
3	CS5 READY	22	CS5 READY*
4	CS6 L_REQ	23	CS6 L_REQ*
5	CS6 U_REQ	24	CS6 U_REQ*
6	CS6 READY	25	CS6 READY*
7	CS7 L_REQ	26	CS7 L_REQ*
8	CS7 U_REQ	27	CS7 U_REQ*
9	CS7 READY	28	CS7 READY*
10		29	
11		30	
12		31	
13	CS5 TR_REQ	32	CS5 TR_REQ*
14	CS6 TR_REQ	33	CS6 TR_REQ*
15	CS7 TR_REQ	34	CS7 TR_REQ*
16		35	
17		36	
18		37	
19			

*Vcc side (power source) for the current-driven type circuit. Common side for the voltage-driven type circuit.

Table 6 Pin Assignment for Wire-Connected Parallel I/O Interface 15 Pins Connector

Pin No.	*Signal*	*Pin No.*	*Signal*
1	CS1 L_REQ	9	CS1 L_REQ*
2	CS1 U_REQ	10	CS1 U_REQ*
3	CS1 READY	11	CS1 READY*
4		12	
5	CS1 TR_REQ	13	CS1 TR_REQ*
6	COMPT	14	COMPT*
7	BUSY	15	BUSY*
8			

*Vcc side (power source) for the current-driven type circuit. Common side for the voltage-driven type circuit.

6.2 *Photo-Coupled Interface*

6.2.1 *Photo-Coupled Device and Bit Assignment* — To date, there is no applicable documentor standard for photo-coupled devices. This defines the usage of a photo-coupled device of 8 bit-input/8 bit-output two-way communications type. The bit assignment is shown in Figure 6.

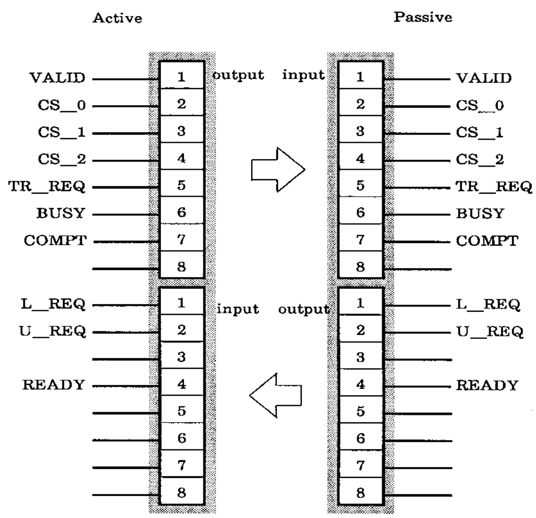


Figure 6
Bit Assignment of Photo-Coupled Device for the Photo-Coupled Parallel I/O Interface

7 Installation Space

7.1 *Wire-Connected Interface* — Not specified.

7.2 *Photo-Coupled I/O Interface* — The photo-coupled I/O interface must be located within the hatched area indicated in Figure 7.

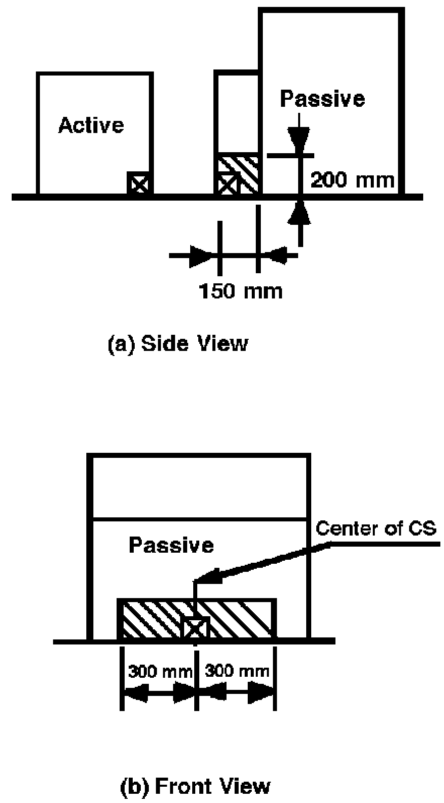


Figure 7
Installation Space of Photo-Coupled I/O interface

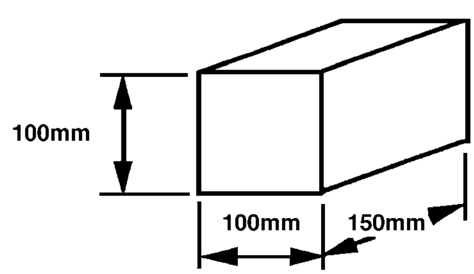


Figure 8
Maximum Size of Photo-Coupled I/O Interface

RELATED INFORMATION 1
EXAMPLE OF A CASSETTE TRANSFER TRANSACTION USING THE PARALLEL I/O INTERFACE

NOTICE: This example of a cassette transfer transaction using the parallel I/O interface is not an official part of this document and is not intended to modify or supercede the official standard. Determination of the suitability of the material is solely the responsibility of the user.

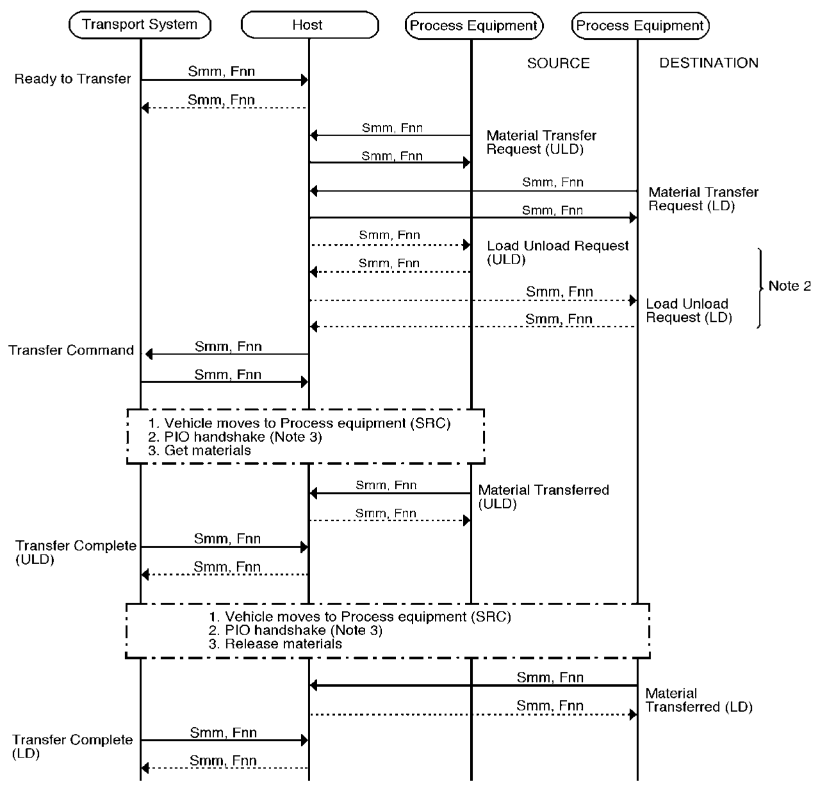


Figure R1-1
Example of a Cassette Transfer Transaction Using the Parallel I/O Interface

R1-1 NOTES

R1-1.1 LD = load, ULD = unload.

R1-1.2 The load/unload request (Smm, Fnn) may be eliminated if the material transfer request (Smm, Fnn) issued after the materials have been prepared on the specified port for unloading or specified port has been readied for loading.

R1-1.3 Multiple PIO handshakings may be required if material transfer request message (Smm, Fnn) has multiple MID's and PIN's for multiple material transfers. MID: Material ID, PIN: Port number.

R1-1.4 The dotted line means optional message.

R1-1.5 In the future, the appropriate specific SECS-II message may be assigned for above Smm, Fnn message, respectively.

RELATED INFORMATION 2
APPLICATION EXAMPLES OF INTERFACING

NOTICE: This application example of interfacing is not an official part of this document and is not intended to modify or supercede the official standard. Determination of the suitability of the material is solely the responsibility of the user.

R2-1

R2-1.1 Figure R2-1 shows some application examples for the wire-connected parallel I/O interface. One set of connectors is provided for the CS’s that commonly input the BUSY and COMPT signals.

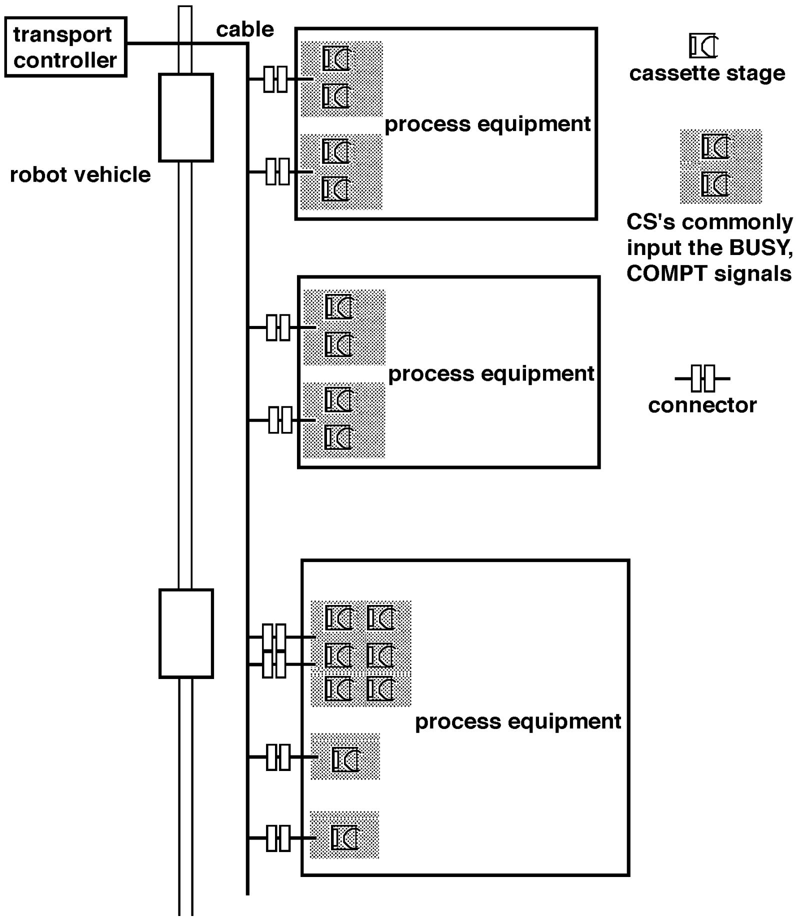


Figure R2-1
Application Example of the Wire-Connected Parallel I/O Interface

R2-2

R2-2.1 Figure R2-2 shows some application examples for the photo-coupled parallel I/O interface. One connector is provided for the CS's to or from which the robot vehicle transfers a cassette at the same stopping position.

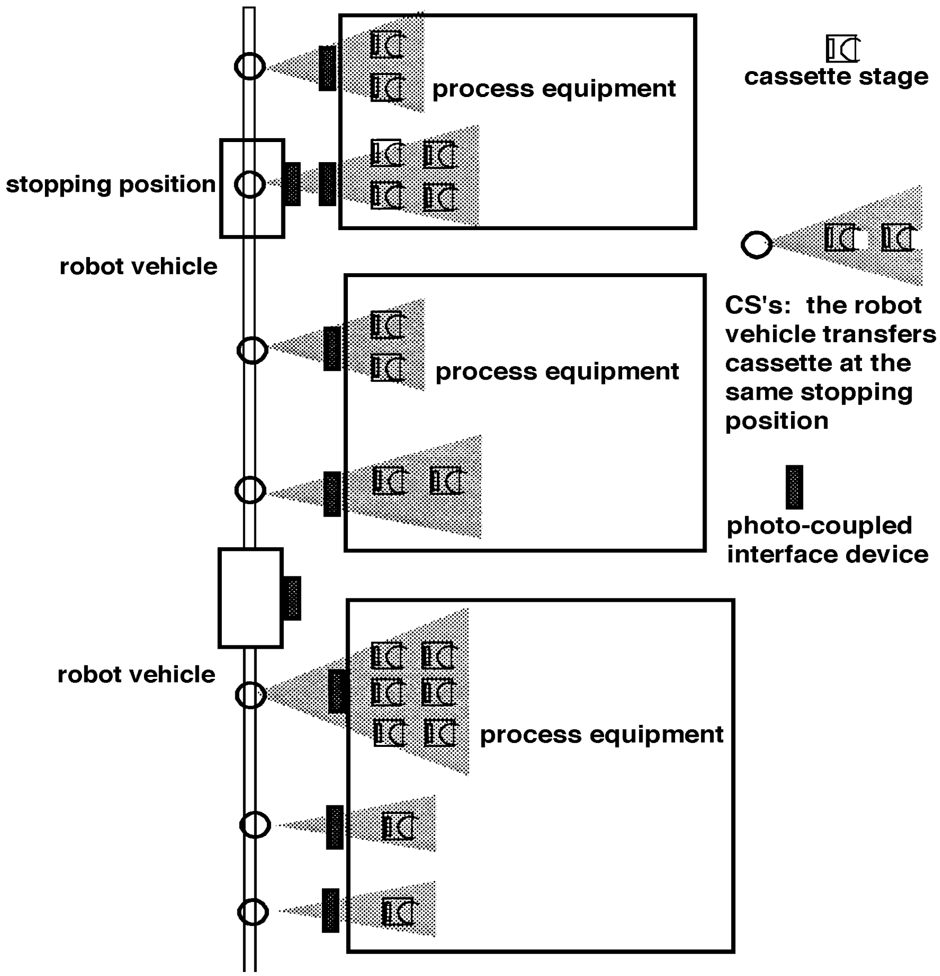


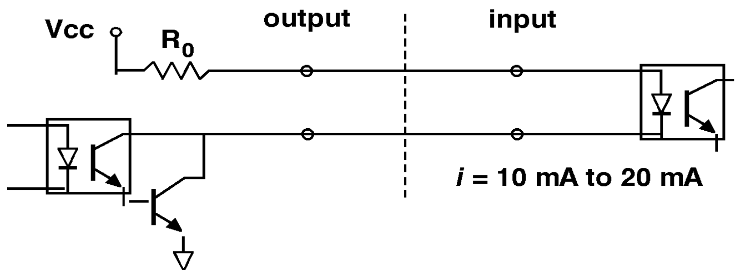
Figure R2-2
Application Example of the Photo-Coupled I/O Interface

RELATED INFORMATION 3
INTERFACING CIRCUIT EXAMPLES

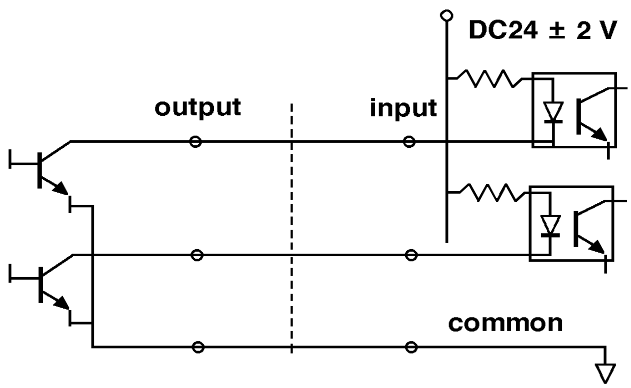
NOTICE: These examples of interfacing circuit examples are not an official part of this document and is not intended to modify or supercede the official standard. Determination of the suitability of the material is solely the responsibility of the user.

R3-1

R3-1.1 Figure R3-1 shows typical examples of the two types of the interface circuits for the wire-connected interface.



Current-Driven Type Circuit Example



Voltage-Driven Type Circuit Example

Figure R3-1
Interface Circuit Examples for Wire-Connected Interface

NOTICE: SEMI makes no warranties or representations as to the suitability of the standards set forth herein for any particular application. The determination of the suitability of the standard is solely the responsibility of the user. Users are cautioned to refer to manufacturer's instructions, product labels, product data sheets, and other relevant literature respecting any materials mentioned herein. These standards are subject to change without notice.

The user's attention is called to the possibility that some implementations of this standard may involve use of inventions covered by U.S. patents 4,306,292 and other patents issued or pending, held by Texas Instruments Incorporated. By publication of this standard, SEMI takes no position respecting either the applicability or the validity of these or other patent rights asserted in connection with any item mentioned in this standard. Users of this standard are expressly advised that determination of any such patent rights, and the risk of infringement of such rights, are entirely their own responsibility.

SEMI E24-92 (Reapproved 0704)
CLUSTER TOOL MODULE INTERFACE: ISOLATION VALVE INTERLOCKS STANDARD

This standard was technically reapproved by the Global Physical Interfaces & Carriers Committee and is the direct responsibility of the North American Physical Interfaces & Carriers Committee. Current edition reapproved by the North American Regional Standards Committee on April 22, 2004. Initially available at www.semi.org June 2004; to be published July 2004. Originally published in 1992.

1 Purpose

1.1 The purpose of this standard is to prevent any opening or closing of the isolation valve(s) which would result in an unsafe condition or possible damage to material or equipment.

1.2 *Impact* — This standard requires cluster tool module suppliers to implement the interlock and to define the conditions that trip the interlock.

2 Scope

2.1 This standard requires hardware inter-locks that govern the opening and closing of the environmental isolation valve(s) at the interface planes of a cluster tool. This standard applies to all modules of a cluster tool (as defined in SEMI E21).

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 E21 — Cluster Tool Module Interface: Mechanical Interface and Wafer Transport Standard

3.2 *Other Documents*

MIL-C-26500E[1] — General Specification for Connectors — General Purpose, Electrical, Miniature, Circular, Environmental Resisting

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

4 Requirements

4.1 *Interlock Provision and Use* — Each module joined to another module, across a common interface plane (as defined in SEMI E21), must provide a fail-safe interlock that enables opening and closing of the isolation valve of the other module. Each module that has an isolation valve must use the interlock provided by the module it is joined to across their common interface plane.

4.2 *Interlock Trip* — Conditions that trip the interlock must be defined by the module supplier. (See Section R1-1.)

4.3 *Interlock Logic* — The interlock is to consist of two normally open relays and associated actuation circuitry in each module. (See Section R1-2.)

4.3.1 *First Relay* — One relay enables opening of the isolation valve of the attached module. Contact closure indicates a safe condition, enabling valve opening. Contact opening disables valve opening if the valve is closed. Contact opening does not cause the valve to close if the valve is open. (See Section R1-3.)

4.3.2 *Second Relay* — The other relay enables closure of the isolation valve of the attached module. Contact closure indicates a safe condition, enabling valve closure. Contact opening disables valve closure if the valve is open. Contact opening does not cause the valve to open if the valve is closed.

4.3.3 *Monitoring* — Situations can arise where the module A interlock inhibits an operation of the valve on module B, when that valve is already in the inhibited condition. This potential conflict must be detected and resolved within module B. (See Section R1-3.)

4.4 *Contact Rating* — The relay contacts shall be rated for a minimum of 1 A at 24 VDC.

4.5 *Wiring* — Copper wire used in the interlock circuit shall be 0.82 mm^2 cross section (18 AWG) or larger.

4.6 *Interlock Connectors* — Metal shell bayonet-type connectors are specified per MIL-C-26500E as follows: MS24265R18B11SN panel mounted receptacles on each of the modules and MS24266R18B11PN plugs terminating each end of the cable which interconnects the interlock receptacles of two connected modules.

4.7 *Interlock Connector Pinouts*

4.7.1 *Receptacle* — Pins 2 and 3 of the receptacle are connected across the contacts of the relay specified in

1 United States Military Standards, Available through the Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, PA 19120-5099, USA. Telephone: 215.697.3321

Section 4.3.1. Pins 5 and 6 are connected to the circuit which enables opening of the module's isolation valve at that interface. Pins 7 and 8 are connected across the contacts of the relay specified in Section 4.3.2. Pins 9 and 10 are connected to the circuit which enables closure of the module's isolation valve at that interface.

4.7.2 *Cable and Plugs* — Pins 2 and 3 of each plug on the interlock cable are connected to pins 5 and 6 respectively of the other plug. Pins 7 and 8 of each plug on the interlock cable are connected to pins 9 and 10 respectively of the other plug. The resulting interlock cable is symmetric.

RELATED INFORMATION 1

NOTICE: This related information is not an official part of SEMI E24 but was reapproved for publication by full letter ballot procedures on February 28, 1999.

R1-1 Interlock Situations

R1-1.1 Examples are given below, for the different types of modules, of situations in which it might be considered hazardous for a connected module to operate its isolation valve. Note that some of these conditions prevent opening and others prevent closing of the valves. (See Section 4.1.). Module types are defined in SEMI E21. SEMI S2 provides guidance in defining potential safety hazards. It is common practice to detect valve positions and so verify operation, but this is not an interface matter.

R1-1.2 *Transport Module Examples* — The transport module end effector (see SEMI E22) is extended beyond the interface plane. The connected module should not close its isolation valve, as such an operation could damage the end effector.

R1-1.2.1 The transport module is not at an acceptable transfer pressure. Opening the isolation valve of the connected module could result in damage to the valve or wafer.

R1-1.3 *Process Module Examples* — The transport module end effector exclusion volume (see SEMI E22) is obstructed. The transport module should not open its isolation valve and attempt to extend its end effector.

R1-1.3.1 The process module is not at an acceptable transfer pressure. For instance, the module may be at atmospheric pressure for preventive maintenance. The transport module should not open its isolation valve.

R1-1.3.2 An unsafe partial pressure of a hazardous gas exists in the process module. The transport module should not attempt to open its isolation valve.

R1-1.4 *Cassette Module Example* — The cassette port (loading door) is open, indicating the possibility of a person' s hand in the cassette module. The transport module should not operate its isolation valve to avoid the possibility of injury to personnel.

R1-2 Illustration of Logic

R1-2.1 The interlock logic is illustrated in Figure A1 and described in Section 4.2. In the figure, the contacts in module B are closed, enabling operation of the isolation valve controlled by module A, while one of the contacts in module A is open, preventing closure of the isolation valve controlled by module B.

R1-3 Interlock Example

R1-3.1 This example elucidates some of the interlock logic described in Section 4.2. In the case described here, the Transport Module (TM) end effector is extended into a Process Module (PM), which is equipped with an isolation valve. This valve is inhibited from closing by the interlock in the TM.

R1-3.2 A situation arises in the PM which results in its interlock inhibiting the opening of the isolation valve (which is already open) on the TM. As specified in Section 4.3.3, the TM detects the interlock change and immediately withdraws its end effector from the PM. The TM interlock enables the closure of the PM isolation valve (which the PM may do if that is the appropriate response to the situation) and the TM can close its isolation valve.

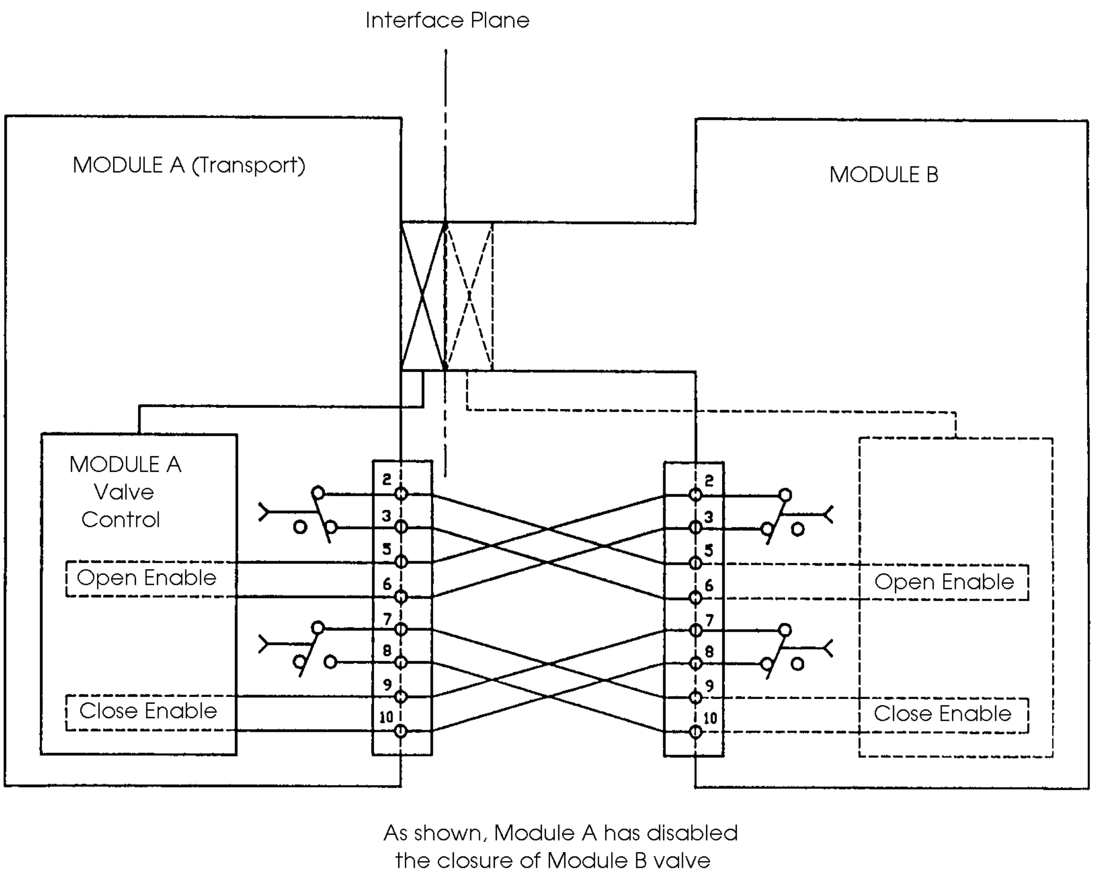


Figure R1-1
Illustration of Isolation Valve Interlock Standard

NOTICE: The user's attention is called to the possibility that compliance with this standard may require use of an invention covered by patent rights. By publication of this standard, Semiconductor Equipment and Materials International (SEMI) takes no position respecting the validity of any patent rights asserted in connection with any item mentioned in this standard. In particular, users of the specification should be aware that Drytek, Inc., A Unit of General Signal, 16 Jonspin Road, Wilmington, MA 01887-1087, Phone: (508) 657-3933, has neither claimed nor disclaimed that compliance with this specification would require use of an invention covered by one or more of its patents. Users of this standard are expressly advised that determination of any such patent rights, and the risk of the infringement of such rights, are entirely their own responsibility.

These standards do not purport to address safety issues, if any, associated with their use. It is the responsibility of the user of these standards to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. SEMI makes no warranties or representations as to the suitability of the standards set forth herein for any particular application. The determination of the suitability of the standard is solely the responsibility of the user. Users are cautioned to refer to manufacturer's instructions, product labels, product data sheets, and other relevant literature respecting any materials mentioned herein. These standards are subject to change without notice.

SEMI E25-92 (Withdrawn 1104)
CLUSTER TOOL MODULE INTERFACE: MODULE ACCESS GUIDELINE

This guideline 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 reapproved by the North American Regional Standards Committee on August 16, 2004. Initially available at www.semi.org September 2004; to be published November 2004. Originally published in 1992; last published June 1999.

Minor editorial changes were made to this document to conform to editorial guidelines.

NOTICE: This document was balloted and approved for withdrawal in 2004.

1 Introduction

1.1 *Scope* — This guideline specifies an envelope within which a cluster tool module is situated. Entry and exit locations through the envelope and connection locations to the module for utilities and facility services are recommended.

1.2 *Purpose* — The purpose of the cluster tool module access guideline is to provide assistance in the placement of utilities and facility services to cluster tool modules in order to improve access for maintenance and service and to simplify cluster tool installation.

1.3 *Impact* — This guideline recommends that equipment designs limit the placement of utility lines and facility services to specific portions of the module envelope.

1.4 *Exceptions* — Local safety regulations must always take precedence over this guideline. Local conditions may justify exceptions to this guideline.

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

2 Referenced Documents

2.1 *SEMI Documents*

SEMI E20 — Cluster Tool Module Interface: Electrical Power and Emergency Off Standard

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

SEMI E24 — Cluster Tool Module Interface: Isolation Valve Interlocks Standard

SEMI S2 — Safety Guidelines for Semiconductor Manufacturing Equipment

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

3 Module Envelope

3.1 For the purpose of this guideline, the module envelope is taken to be a set of six surfaces that completely encloses a module. Individual module envelopes may contact but not penetrate adjacent module envelopes. The six surfaces are the inboard and outboard planes, the two sides, the bottom and the top.

3.2 The inboard plane is the interface plane between a transport module and any other module as defined in SEMI E21; thus, a transport module possesses multiple inboard planes. The outboard surface is parallel to the interface plane and normally coincides with that part of the module which is farthest from the interface plane. Each side of the module envelope consists of several vertical planes. The bottom surface generally coincides with the floor, and the top is a horizontal plane that contains the highest point of the module.

3.3 In the sections that follow, the distinction between the physical module and the space reserved for the module within the envelope must be kept in mind. Section 4 refers to where utility lines penetrate the envelope, and Section 5 refers to constraints on where these lines connect to the physical module.

4 Allocation of Module Envelope Surfaces

4.1 The allocation of surfaces is subject to the need for access to the interface plane, module movement, maintenance access space, and protection of module components (particularly electrical components) from liquid leaks.

4.2 *Inboard Plane* — To allow access to the isolation valve(s), no utilities or facility services should be routed through the inboard surface close to the valve boundary. (See SEMI E21) The inboard surface is preferred for intra-tool communications, EMO (see SEMI E20) and the interlock interface between the transport module and the attached modules. (See SEMI E24.)

4.3 *Outboard Plane* — The outboard surface should be limited to non-rigid lines. To minimize potential mechanical damage, chemical utilities should not enter through the lower half of this surface.

4.4 *Sides* — In order to facilitate maintenance access, utilities and facility services should not penetrate the module envelope sides.

4.5 *Top Surface* — The top surface is preferred for power, exhaust, process gases and make-up air. Communications and electronic control harnesses could also enter through this surface.

4.6 *Bottom Surface* — The bottom surface is preferred for vacuum lines and all liquid supplies, returns and drains. The location of all lines should not restrict the removal of the module.

5 Module Considerations

5.1 The locations of utility and facility lines and connections to the module, which is located within the module envelope, are given below.

5.2 *Exhaust, Vacuum and Make-up Air* — The size of piping for exhaust, vacuum and make-up air suggests that the module sides are undesirable locations for connections.

5.3 *Maintenance Access* — Utility and facility lines and connections to the module sides should not compromise maintenance access to the module. Connections should be located above or below areas requiring periodic maintenance access.

5.4 *Liquids* — Liquid supply connections to the module sides should be as low as practical.

5.5 *Electrical Components* — Electrical components that need to be accessible for maintenance while energized should not be located at the sides of the module. (See SEMI S2.)

5.6 *Remote Equipment* — For ease of maintenance access, some pieces of equipment (for example, coolant chiller and RF power supplies) may be located outside the module envelope. In such cases, the lines and connections between the remote equipment and the module should follow this guideline.

6 Examples

6.1 The relationship between the location of specific utility and facility lines entering the module envelope and their subsequent routing and connection to the module within the module envelope is illustrated by the following examples.

6.2 *Liquid Connections* — Two suggested methods of providing liquid connections are shown in Figures 1 and 2. The liquid lines enter through the bottom of the module envelope (see Section 4.5) then connect to either the side of the module or the bottom of the module (see Section 5.3).

6.3 *Gas Connections* — Two suggested methods of providing gas connections are shown in Figure 2. The gas lines pass through the top of the module envelope (see Section 4.4), and then connect to the module either at the top or at the side.

6.4 *Exhaust and/or Make-Up Air* — Two suggested methods of providing exhaust and/or make-up air connections are shown in Figure 2. The exhaust line passes through the top of the module envelope (see Section 4.4) and then connects to the module at or near the top. Exhaust and make-up air connections are flanged in Figure 2.

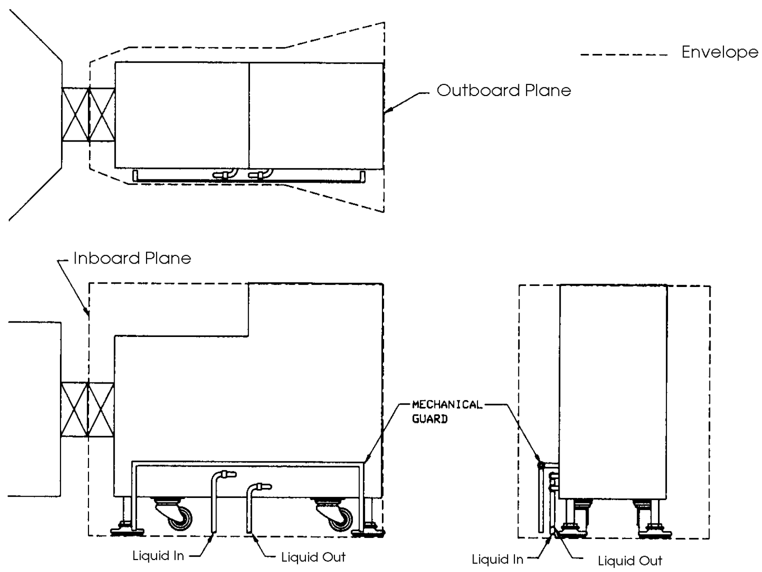


Figure 1

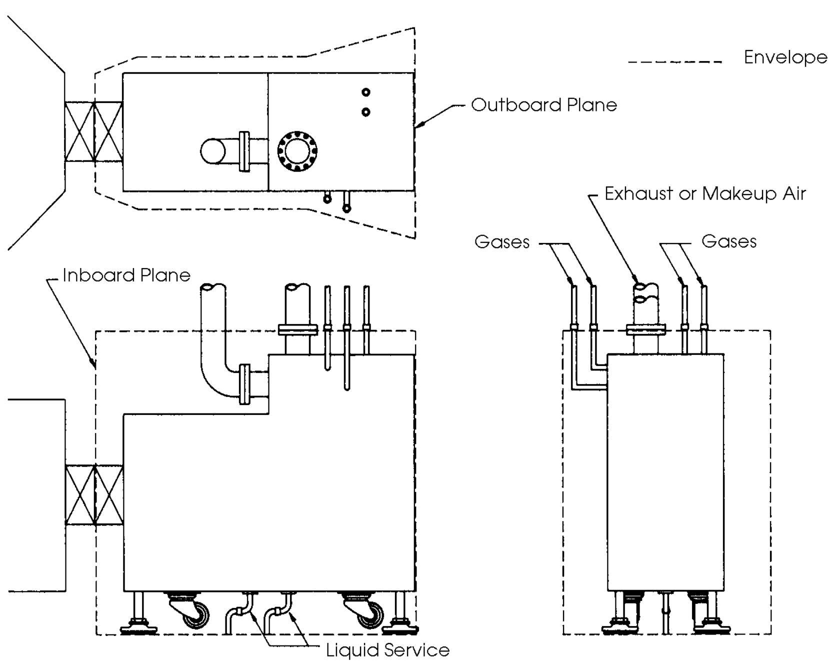


Figure 2

7 Related Documents

7.1 *SEMI Documents*

SEMI E6 — SEMI Facilities Interface Specifications Guideline and Format