

SEMI E184-1221^E

SPECIFICATION FOR 300 mm TAPE FRAME FOUP LOAD PORT

This Standard was technically approved by the Physical Interfaces & Carriers Global Technical Committee. This edition was approved for publication by the global Audits and Reviews Subcommittee on July 13, 2021. Available at www.semiviews.org and www.semi.org in December 2021.

^E This Standard was editorially modified in December 2021 to correct a reference error. Changes were made to Figure 14.

NOTICE: The section symbol (§) is used to reference a numbered section, paragraph, or header and all subordinate paragraphs, headers, and embedded material (i.e., EXCEPTIONs, lists) therein. The paragraph symbol (§) is used to reference a particular numbered paragraph and embedded material therein. When duplicated (i.e., §§ and §§) the symbols are used to reference more than one section or paragraph, respectively.

NOTICE: Paragraphs entitled ‘NOTE:’ are not an official part of this Standard or Safety Guideline and are not intended to modify or supersede the official Standard or Safety Guideline. These have been supplied by the global technical committee to enhance the usage of the Standard or Safety Guideline.

1 Purpose

1.1 The purpose of this Specification is to define the basic interface dimensions of a load port on the semiconductor manufacturing equipment (SME), where a 300 mm Tape Frame FOUP can be loaded and unloaded. The intention of this Specification is to define a set of requirements and features to enable interoperability of load ports and Tape Frame FOUPs without limiting innovative solutions.

2 Scope

2.1 The interface specification in this Standard is driven by and intended to mate with a Tape Frame FOUP compliant to the relevant SEMI 300 mm Tape Frame FOUP Standard.

2.2 Loading and unloading is assumed to take place in semi-automated and automated mode by using any kind of system or device (i.e., person guided vehicle or overhead hoist vehicle).

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

3 Limitations

3.1 This Standard does not intend to address manual loading or unloading of a Tape Frame FOUP.

3.2 The detailed methods and mechanisms inside a 300 mm Tape Frame FOUP door of how a Tape Frame FOUP door may be engaged to and disengaged from the Tape Frame FOUP shell are not specified within this Standard.

4 Referenced Standards and Documents

4.1 SEMI Standards and Safety Guidelines

NOTE 1: A Document covering specification of FOUP that is correspond to this Standard is under development by the Physical Interfaces and Carriers Global Technical Committee.

4.2 ISO Standards¹

ISO 68-1 — ISO General Purpose Screw Threads – Basic Profile – Part I: Metric Screw Threads

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

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

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

5 Terminology

5.1 Abbreviations and Acronyms

- 5.1.1 *BI* — BOLTS interface surface
- 5.1.2 *BDP* — bilateral datum plane
- 5.1.3 *EB* — equipment boundary
- 5.1.4 *EB_{UPPER}* — equipment boundary above *z100*
- 5.1.5 *FDP* — facial datum plane
- 5.1.6 *HDP* — horizontal datum plane
- 5.1.7 *KC* — kinematic coupling
- 5.1.8 *KCP* — kinematic coupling pin
- 5.1.9 *LFP* — load face plane
- 5.1.10 *OHT* — overhead hoist transport
- 5.1.11 *RFID* — radio frequency identification
- 5.1.12 *SME* — semiconductor manufacturing equipment

5.2 Definitions

5.2.1 *BOLTS interface surface (BI)* — a physical surface on the semiconductor manufacturing equipment intended to mate with a load port.

5.2.2 *equipment boundary (EB)* — a plane parallel to the facial plane establishing the boundary between the semiconductor manufacturing equipment and the load port (see dimension *y100*). And the second plane parallel to the facial plane and above *z100* establishing the boundary between the semiconductor manufacturing equipment and the overhead transport vehicle (see dimension *y105*).

NOTE 2: The EB is not defining a physical feature. It is a boundary only between the load port and the SME. The EB and *EB_{UPPER}* should not be confused with the ‘physical’ equipment front as defined in § 8.9. The equipment front is a real physical feature, while the EB and *EB_{UPPER}* is a boundary only.

5.2.3 *300 mm Tape Frame FOUP* — used generally as a ‘term’ only to identify the front-opening carrier used in fabs for 300 mm wafers.

5.2.4 *load face plane (LFP)* — a plane parallel to the facial plane establishing the boundary between the load port and the fab aisle (see dimension *y101*).

5.2.5 *load height* — the distance from the horizontal datum plane to the fab floor.

5.2.6 *load port* — the interface location on a semiconductor manufacturing equipment, where a 300 mm Tape Frame FOUP can be loaded and unloaded.

5.2.7 *spacing* — the distance from the bilateral plane of one load port to the bilateral plane of an adjacent load port on a semiconductor manufacturing equipment.

5.2.8 *bilateral datum plane (BDP)* — a vertical plane, defining *x=0* of a system with three orthogonal planes (*HDP*, *BDP*, *FDP*), coincident with the nominal location of the rear primary *KCP*, and midway between the nominal locations of the front primary *KCPs*.

5.2.9 *BOLTS* — used generally as a ‘term’ only within this Standard to identify the interface between a load port and the semiconductor manufacturing equipment. [SEMI E63]

5.2.10 *facial datum plane (FDP)* — a vertical plane, defining *y=0* of a system with three orthogonal planes (*HDP*, *BDP*, *FDP*).

5.2.11 *horizontal datum plane (HDP)* — a horizontal plane, defining *z=0* of a system with three orthogonal planes (*HDP*, *BDP*, *FDP*), from which projects the kinematic-coupling pins on which the Tape Frame FOUP sits.

5.2.12 *indicator placement area* — an area in which load port status indicators may be placed. [SEMI E110]

5.2.13 *load port door* — mechanical feature on a load port surrounded by the load port frame. It can be engaged with the Tape Frame FOUP door and together they can be moved away to allow access to wafers in a Tape Frame FOUP.

5.2.14 *load port frame* — mechanical feature on a load port surrounding the load port door.

5.2.15 *load port status indicator* — any kind of visualization means (e.g., lamp, LED, display) to indicate the status of a load port to an operator. [SEMI E110]

5.2.16 *nominal location* — the value a dimension would have if its tolerance were reduced to zero.

5.2.17 *plane* — a theoretical surface which has infinite width and length, zero thickness and zero curvature.

6 Ordering Information

6.1 The user should specify which of the load port options is required.

7 Requirements for KCPs

7.1 *KCP Shape* — The physical alignment interface on the bottom of the Tape Frame FOUP consists of features that mate with six pins underneath. As shown in Figure 1 and defined in Table 1, each pin shall be radially symmetric about its vertical center axis line and can be seen as the intersection of a cylinder of radius $r1$ and a sphere of radius $r4$ (which establishes the tip of the pin and might contact a flat plate). The radius $r4$ shall be centered on the axis of symmetry at a height $z3$ above the horizontal datum plane (HDP). An additional radius $r3$ establishes the contact with the angled mating groove surface on the Tape Frame FOUP. The center of the radius $r3$ shall be defined by the intersection of a vertical plane through the axis of symmetry of the pin with the horizontal circle of radius $r2$ at the height $z4$ below the HDP. A blend radius of $r5$ shall be applied at the intersection of $r1$ and $r3$, and at the intersection of $r3$ and $r4$. The minimum height of the pin shall be $z4$. Surface finish roughness shall be $Ra1$, as defined by ISO 4287, of all features defined by $r1$, $r3$, $r4$, and $r5$. Dimensions $r2$, $z3$, and $z4$ have zero tolerance because they only define offsets and not physical features.

7.2 *KCP Locations* — The KCPs shall be arranged in three sets with two pins in each set, as shown in Figure 2. The outer pins of each set are designated the primary pins for use on a load port or vehicle nest, and the inner pins are designated the secondary pins for use on a robotic arm used to pick up a Tape Frame FOUP from the primary pins. The rear pins (farthest from the door) shall be located on the bilateral datum plane (BDP), at a distance from the facial datum plane (FDP) of $y18$ for the secondary pin and $y15$ for the primary pin. The front primary pins shall be located at a distance of $y16$ from the FDP, symmetric across the BDP with distance $x18$ from the BDP. The front secondary pins shall be located at a distance of $y17$ from the FDP, symmetric across the BDP with distance $x19$ from the BDP. For reference only, the front KCPs are located symmetrically with respect to the BDP at an angle of $(\theta2)$.

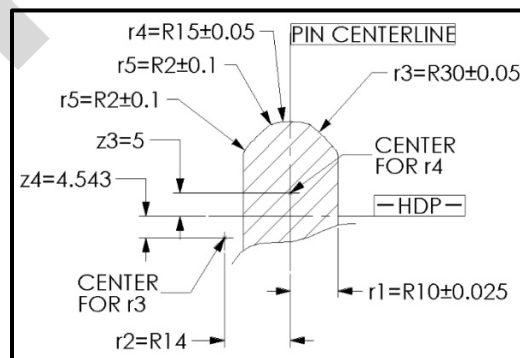


Figure 1
KCP

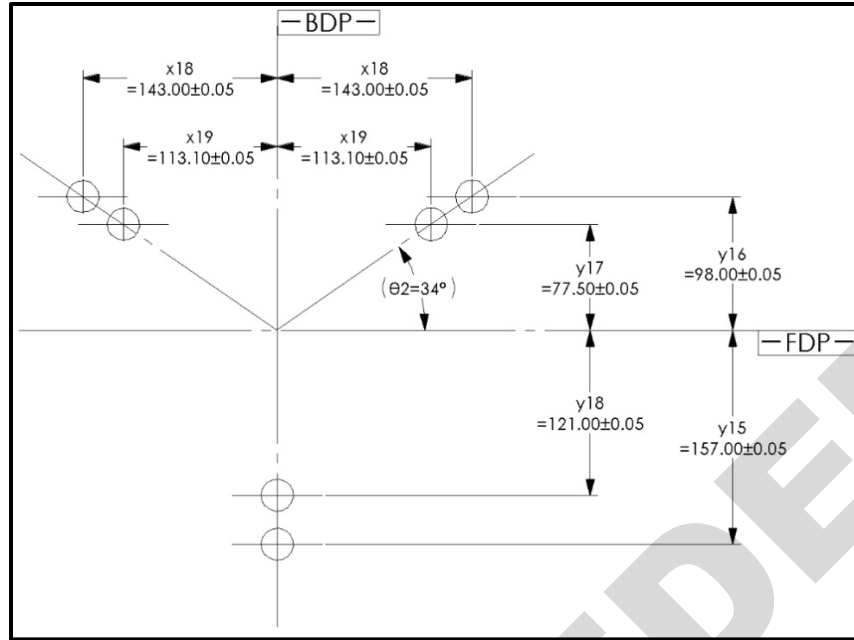


Figure 2
Bottom View – KCP Locations

Table 1 Dimensions of KCP

Symbol Used	Figure	Value Specified	Datum Measured From	Feature Measured To
($\theta 2$)	2	(34.0 degrees)	BDP	Axis of symmetry of front pin-mating grooves
r1	1	10.0 ± 0.025 mm	Centerline of KCP	Cylindrical (side) surface of KCP
r2	1	14 ± 0 mm	Centerline of KCP	Circle to define center of curvature of KCP contact surface
r3	1	30.0 ± 0.05 mm	Circle defined by r2 and z4	Contact surface of KCP
r4	1	15.0 ± 0.05 mm	Centerline of KCP and z3	Top surface of KCP (sphere)
r5	1	2.0 ± 0.1 mm	Blend radius	Surface between KCP contact surface and adjacent surfaces
Ra1	¶ 7.1	≤ 0.30 µm	N/A	Kinematic Coupling Pin surface finish roughness per ISO 4287
x18	2	143.00 ± 0.05 mm	BDP	Location of front primary KCP
x19	2	113.10 ± 0.05 mm	BDP	Location of front secondary KCP
y15	2	157.00 ± 0.05 mm	FDP	Location of rear primary KCP
y16	2	98.00 ± 0.05 mm	FDP	Location of front primary KCP
y17	2	77.50 ± 0.05 mm	FDP	Location of front secondary KCP
y18	2	121.00 ± 0.05 mm	FDP	Location of rear secondary KCP
z3	1	5 ± 0 mm	HDP	Point on KCP centerline to define KCP top surface, r4
z4	1	4.543 ± 0 mm	HDP	Center of radius, r3

8 Requirements for Interface Between Load Port and Tape Frame FOUN Delivery System

8.1 *Load Height* — The nominal load height of any load port in a fab is defined by dimension z101 and depicts the nominal distance from the horizontal plane to the floor. A set of load ports, but not necessarily each load port separately,

shall be adjustable at installation over the range associated with $z101$ in Table 2. This adjustability requirement also applies for load ports according to Option C (raised load port).

8.2 *Aisle Clearance of Load Port* — No part of a load port shall protrude beyond the load face plane (LFP) as measured from the BOLTS interface surface. See dimension $y101$.

NOTE 3: There is no requirement for any kind of physical plate of a certain height or shape at the load boundary.

8.3 *Clearance Above Load Port and Below Tape Frame FOUP* — No part of the load port except those features intended for interaction with the Tape Frame FOUP (e.g., KC pins, Tape Frame FOUP hold-down features) shall protrude above dimension $z160$. There shall be no interference between any part of the load port and the Tape Frame FOUP when delivered within the lead-in range defined in the 300 mm Tape Frame FOUP Standard.

8.4 *Vertical Clearance for Overhead Transport* — To provide clearance for overhead Tape Frame FOUP transport, no part of the equipment (including the 300 mm Tape Frame FOUP on a load port) in front of a plane defined by the EB (towards the LFP) and the entire width of the SME shall be higher than $z100$ from the floor. The volume below $z100$ may contain Tape Frame FOUPs stored in an internal buffer. Additionally, no part of the overhead transport system shall protrude below $z102$.

8.5 *Horizontal Clearance for Overhead Transport* — No part of the SME shall protrude towards the FDP beyond both the EB and upper equipment boundary (EB_{UPPER}) as defined by dimension $y100$ and $y105$. The vertical ‘chimney’ between both of the equipment boundaries and the LFP above the HDP as defined by dimensions $y100$, $y101$ and $x103$ shall not be occupied by the SME.

8.6 *Radio Frequency Identification (RFID) Reader/Writer Placement Volume* — A load port shall allow for installation of a unit that can read from or write to an RFID tag (as it may be installed in the corresponding placement volume on the rear of a 300 mm Tape Frame FOUP) within the limits of a volume defined by $x110$, $y110$, $y111$, $z110$, $z111$. Reading/writing is intended to take place with the Tape Frame FOUP in a position as initially delivered to the load port (undocked position). If no reader/writer unit is installed, this placement volume may be covered.

NOTE 4: As a consequence of the requirement defined above, any RFID reader/writer unit should fit in the placement volume defined above.

NOTE 5: RFID reader/writer within this context is understood as those parts that should be located within this volume in order to be able to communicate with the tag on the Tape Frame FOUP. Usually this is the antenna. Other components of an RFID reader/writer system are not necessarily required to be placed within this volume.

8.7 *Numbering of Load Ports* — On each SME, load ports are physically numbered in increasing order (beginning with 1) from left to right (as seen by a person facing the FDP) beginning with load ports that are nominally at the lowest position and then continuing (from left to right) with any load ports that are higher.

8.8 *Spacing* — Load ports adjacent to each other on the SME shall be located at a distance as defined by dimension $x100$.

8.9 *Photo-Coupled I/O Device Placement Volume* — In the lower area of each load port there shall be volume, defined by $x120$, $y120$, the LFP, $z121$, and $z122$, allowing for placement of a photo-coupled I/O device for communication to floor-based transport vehicles. This placement volume is centered on the BDP.

8.9.1 A photo-coupled I/O device may be installed anywhere within this placement volume upon the discretion and design requirements of the load port supplier. However, the center of its beam line shall be within the vertical limits defined by dimension $z120$. In horizontal direction (perpendicular to the FDP) the beam line shall also be centered to the BDP within the same limits as defined by the tolerance associated to $z120$.

8.9.2 If no photo-coupled I/O device is installed, the placement volume may be covered by a panel.

NOTE 6: A photo-coupled I/O device is much smaller than the placement volume defined above, thus providing some design freedom for device mounting. Typical I/O devices have a depth of 20 to 70 mm. The load port supplier is free to mount the I/O device either closer to the LFP or closer to the EB, depending on the actual design of the load port. If the lower part of a load port is recessed from the LFP, it may be desirable to mount the device still inside the LP housing by utilizing the full depth of the placement volume.

8.10 *Equipment Front* — A part on the front of the SME protruding furthest towards the FDP is defined as the equipment front. The equipment front shall not penetrate the EB.

NOTE 7: While the EB is a virtual boundary plane at a fixed distance from the BOLTS interface surface (BI), the equipment front is a physical feature.

8.11 *Docking Interface Placement Volume* — A load port shall provide clearance for installation of a docking interface within the limits of a volume defined by $y130$ and $z130$. It extends over the full width of the SME. If no docking interface is installed, this placement volume may be covered by a panel.

8.12 *Volume for Fork-Lift Truck* — The entire volume below a load port between the LFP and the BI shall be kept clear up to height above the floor defined by dimension $z105$ and $x142$ in order to allow for access by a fork-lift truck upon equipment move-in. The volume may be covered by a removable panel. See Figure 7 for a sketch of the volume.

8.13 *Fork-Lift Exclusion Volume on Load Port Below Tape Frame FOUP* — Two exclusion volumes on the left and right side of the load port shall be kept clear so that fork-lifts or conveyors may be used to load/unload a Tape Frame FOUP to/from a load port. These exclusion volumes are defined by $x140$, $x141$, $y140$, $y141$, and $z141$.

8.14 *Alignment Mark on Load Port* — In order to support alignment and verification a load port shall have a visible mark (cross-hair) to depict the intersection of the FDP and BDP.

8.15 *Alignment Feature on SME* — SME shall have an alignment feature (e.g., a vertical line) above the top of the FOUP.

8.15.1 Because the BI may not be accessible when a load port is attached, a rigid, always exposed feature on the SME is required to support alignment of the SME to the Tape Frame FOUP transport system upon move-in and install.

8.15.2 For that purpose, the BI shall extend vertically beginning at the minimum value of $z379$ from the HDP (see Figure 14).

8.16 *Options* — SME can be configured with a variety of load port combinations chosen from the options defined in this section. If no option is specified, Option A is assumed. The three-dimensional sketches within the options sections are for illustration. Dimensional requirements are shown in the figures at the end of the entire section.

NOTE 8: Volumes depicted for certain purposes (e.g., for a load port or for Tape Frame FOUP buffering), do not preclude the placement of items like EMO, light tower, and GUI within these volumes.

NOTE 9: Options are shown symmetrically with two load ports for clarity. However, configurations with one load port only as well as asymmetrical configurations are not excluded.

8.16.1 In Option A, the load port is at the nominal load height as specified by dimension $z101$, and it is open from above to facilitate automatic Tape Frame FOUP delivery from an overhead transport system. The volume left and right of the load port may be occupied by the SME, with a side clearance of $x144$ between any part of the SME on the side of the load port above $z160$.

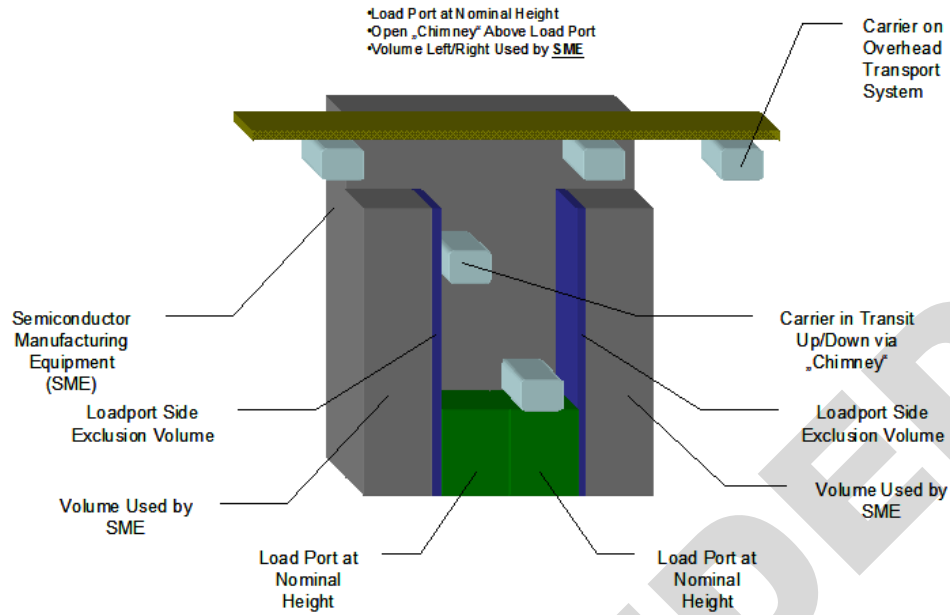


Figure 3
Three-Dimensional View of Option A

8.16.2 Option B is identical to Option A with the exception that the volume left and right of the load port over the entire width of the SME is used for Tape Frame FOUP buffering.

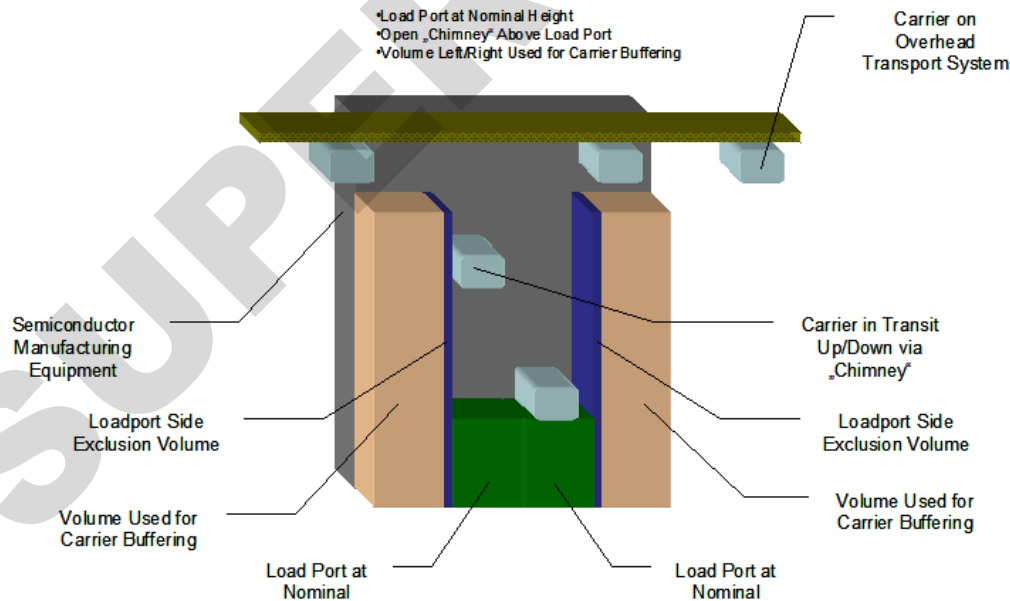


Figure 4
Three-Dimensional View of Option B

8.16.3 In Option C the distance from the HDP of the load port may be at any height above $z101$ that leaves the top of the Tape Frame FOUP under $z100$.