SEMI E154-0814
MECHANICAL INTERFACE SPECIFICATION FOR 450 mm LOAD PORT

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1 Purpose

1.1 The purpose of this Document is to define the basic interface dimensions of a load port on the semiconductor manufacturing equipment (SME), where a 450 FOUP and 450 MAC can be loaded and unloaded. The intention of this Document is to define a set of requirements and features to enable interoperability of load ports and carriers without limiting innovative solutions.

2 Scope

2.1 The interface specification in this Document is driven by and intended to mate with a carrier compliant to the relevant SEMI 450 mm FOUP and 450 mm MAC Standards.

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 carrier.

3.2 The detailed methods and mechanisms inside a 450 FOUP and 450 MAC door of how a carrier door may be engaged to and disengaged from the carrier shell are not specified within this Document.

3.3 Since the direct scale-up of the 300 mm methods (e.g., for how a load port is opening/closing a FOUP, kinematic coupling (KC) pin-to-carrier groove interface, KC pin/groove system-to-load port open/close interface, and wafer pitch/wafer handling) has not yet been demonstrated, this document is to address the need for prototyping and data gathering.

4 Referenced Standards and Documents

4.1 *SEMI Standards and Safety Guidelines*

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

SEMI E110 — Guideline for Indicator Placement Zone and Switch Placement Volume of Load Port Operation Interface for 300 mm Load Ports

SEMI E158 — Mechanical Specification for Fab Wafer Carrier Used to Transport and Store 450 mm Wafers (450 FOUP) and Kinematic Coupling

4.2 *ISO Standards*[1]

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, 1, ch. de la Voie-Creuse, CP 56, CH-1211 Geneva 20, Switzerland; Telephone: +41.22.749.01.11, Fax: +41.22.733.34.30, http://www.iso.org

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5 Terminology

5.1 *Abbreviations and Acronyms*

5.1.1 *BEOL* — back-end-of-line

5.1.2 *BI* — BOLTS interface surface

5.1.3 *BP* — bilateral plane

5.1.4 *EB* — equipment boundary

5.1.5 EB_{UPPER} — equipment boundary above z100

5.1.6 *FEOL* — front-end-of-line

5.1.7 *FP* — facial plane

5.1.8 *HP* — horizontal plane

5.1.9 *KC* — kinematic coupling

5.1.10 *KCP* — kinematic coupling pin

5.1.11 *LB* — load boundary

5.1.12 *OHT* — overhead hoist transport

5.1.13 *RFID* — radio frequency identification

5.1.14 *SME* — semiconductor manufacturing equipment

5.2 *Definitions*

5.2.1 *450 BOLTS interface surface (BI)* — a physical surface on the semiconductor manufacturing equipment intended to mate with a load port.

5.2.2 *450 equipment boundary (EB) and upper 450 equipment boundary (EB_{UPPER})* — consisting of two planes, one 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 1: The 450 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 § 7.9. The equipment front is a real physical feature, while the EB and EB_{UPPER} is a boundary only.

5.2.3 *450 FOUP* — used generally as a 'term' only to identify the front-opening carrier used in fabs for 450 mm wafers.

5.2.4 *450 load boundary (LB)* — a plane parallel to the facial plane establishing the boundary between the load port and the fab aisle (see dimension *y101*).

5.2.5 *450 load height* — the distance from the horizontal plane to the fab floor.

5.2.6 *450 load port* — the interface location on a semiconductor manufacturing equipment, where a 450 FOUP can be loaded and unloaded.

5.2.7 *450 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 plane (BP)* — a vertical plane, defining x=0 of a system with three orthogonal planes (HP, BP, FP), 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 Document to identify the interface between a load port and the semiconductor manufacturing equipment. [SEMI E63]

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5.2.10 *facial plane (FP)* — a vertical plane, defining *y*=0 of a system with three orthogonal planes (HP, BP, FP), *y33*=194 ± 0 mm in front of the nominal location of the rear primary KCP.

5.2.11 *horizontal plane (HP)* — a horizontal plane, defining *z*=0 of a system with three orthogonal planes (HP, BP, FP), coincident with the nominal location of the uppermost points (tips) of the three KCPs.

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 carrier door and together they can be moved away to allow access to wafers in a carrier.

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 Interface Between Load Port and Carrier Delivery System

7.1 *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, must be adjustable at installation over the range associated with *z101* in Table 1. This adjustability requirement also applies for load ports according to Option C (raised load port).

NOTE 2: For more details see Related Information 1.

7.2 *Aisle Clearance of Load Port* — No part of a load port shall protrude beyond the load boundary (LB) 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.

7.3 *Clearance Above Load Port and Below Carrier* — No part of the load port except those features intended for interaction with the carrier (e.g., KC pins, carrier hold-down features) shall protrude above dimension *z160*. There shall be no interference between any part of the load port and the carrier when delivered within the lead-in range defined in the 450 mm FOUP Document.

7.4 *Vertical Clearance for Overhead Transport* — To provide clearance for overhead carrier transport, no part of the equipment (including the 450 FOUP on a load port) in front of a plane defined by the 450 EB (towards the LB) and the entire width of the SME shall be higher than *z100* from the floor. The volume below *z100* may contain carriers stored in an internal buffer. Additionally, no part of the overhead transport system shall protrude below *z102*.

7.5 *Horizontal Clearance for Overhead Transport* — No part of the SME shall protrude towards the facial plane (FP) 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 LB above the HP as defined by dimensions *y100, y101* and *x103* must not be occupied by the SME.

7.6 *Radio Frequency Identification (RFID) Reader/Writer Placement Volume* — A load port must 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 450 FOUP) within the limits of a volume defined by *x110, y110, y111, z110, z111*. Reading/writing is intended to take place with the carrier 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 must fit in the placement volume defined above.

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

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7.7 *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 FP) 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.

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

7.9 *Photo-Coupled I/O Device Placement Volume* — In the lower area of each load port there must be volume, defined by *x120, y120*, the LB, *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 bilateral plane (BP).

7.9.1 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 must be within the vertical limits defined by dimension *z120*. In horizontal direction (perpendicular to the FP) the beam line must also be centered to the BP within the same limits as defined by the tolerance associated to *z120*.

7.9.2 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 LB 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 LB, it may be desirable to mount the device still inside the LP housing by utilizing the full depth of the placement volume.

7.10 *Equipment Front* — A part on the front of the SME protruding furthest towards the FP 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.

7.11 *Docking Interface Placement Volume* — A load port must 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.

7.12 *Volume for Fork-Lift Truck* — The entire volume below a load port between the LB 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 5 for a sketch of the volume.

7.13 *Fork-Lift Exclusion Volume on Load Port Below Carrier* — Two exclusion volumes on the left and right side of the load port must be kept clear so that fork-lifts or conveyors may be used to load/unload a carrier to/from a load port. These exclusion volumes are defined by *x140, x141, y140, y141, z140*, and *z141*.

7.14 *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 FP and BP.

7.15 *Alignment Feature on SME* — The BI was chosen in this standard to reference dimensions in horizontal (*y*) direction, since it is the most accurate stationary and nonadjustable feature on the SME with respect to the load port.

7.15.1 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 carrier transport system upon move-in and install.

7.15.2 For that purpose, the BI shall extend vertically beginning at the minimum value of *z379* from the HP and shall be exposed over its entire width and over a height defined by dimension *z384* (see Figure 13).

7.16 *KC Pins* — A load port must have a set of three primary KCPs as specified in SEMI E158. A load port must be designed such that there will be no interference between any part of the load port and a 450 FOUP delivered within the lead-in range of *r15* specified in SEMI E158.

7.17 *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 carrier buffering), do not preclude the placement of items like EMO, light tower, and GUI within these volumes.

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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.

7.17.1 In Option A, the load port must be at the nominal load height as specified by dimension *z101*, and it must be open from above to facilitate automatic carrier 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*.

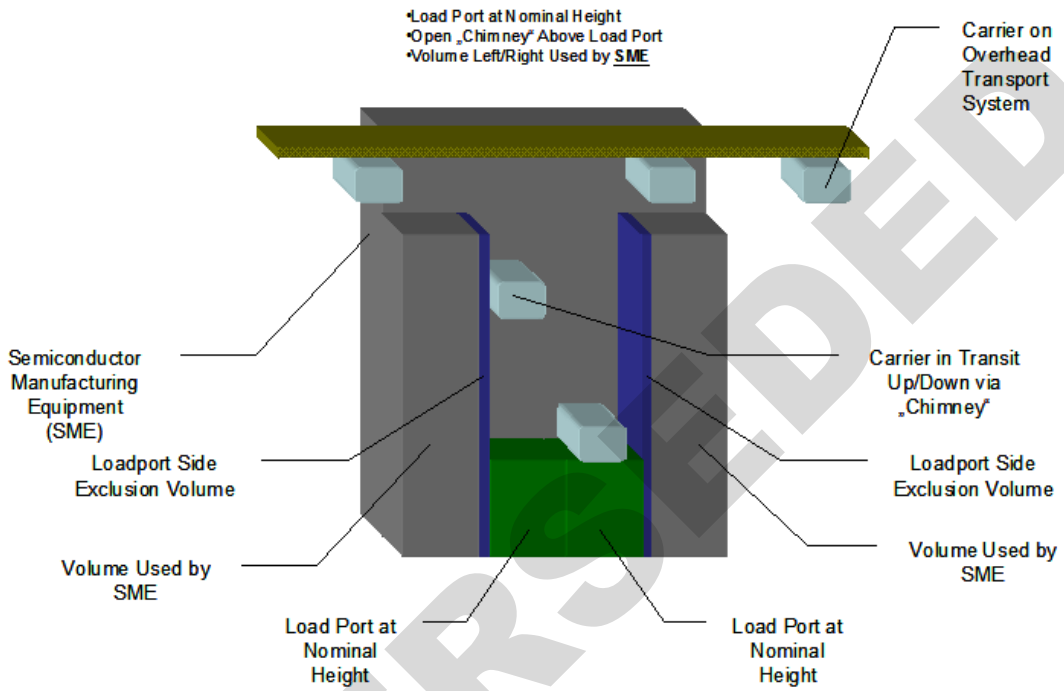

Figure 1
Three-Dimensional View of Option A

7.17.2 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 carrier buffering.

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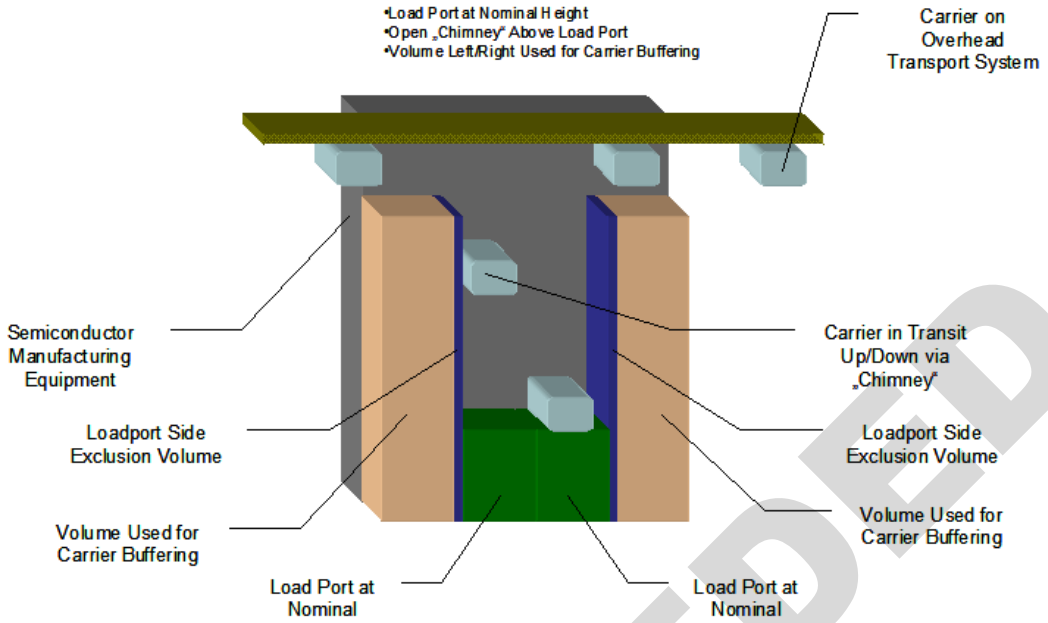

Figure 2
Three-Dimensional View of Option B

7.17.3 In Option C the distance from the HP of the load port may be at any height above *z101* that leaves the top of the carrier under *z100*.

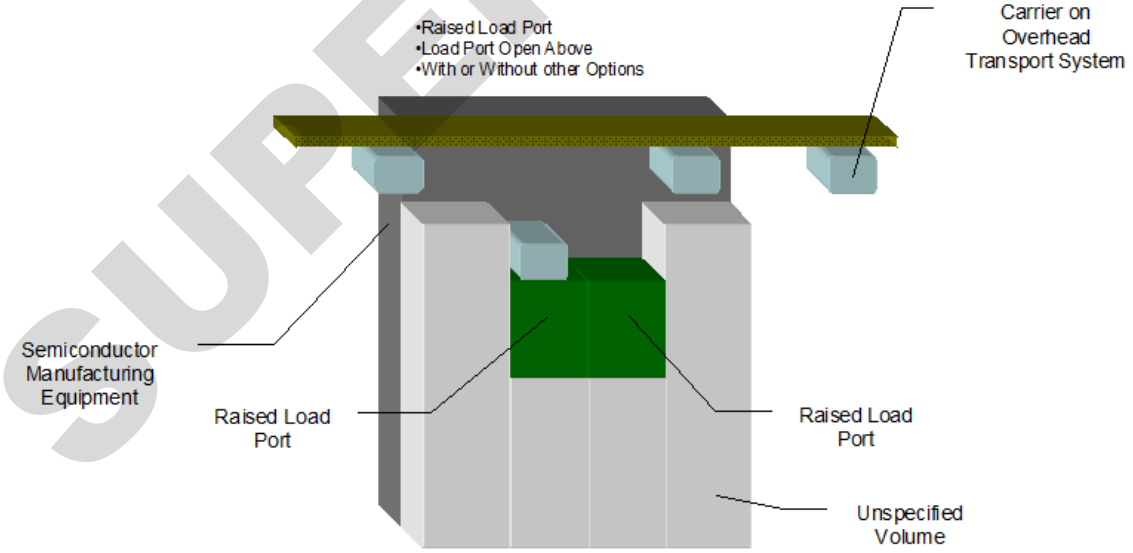

Figure 3
Three-Dimensional View of Option C

7.17.4 In Option D the load port must be at the nominal load height as specified by dimension *z101*, is not open from above, and it must have a clearance around the carrier as specified by dimensions *z103* and *x103*.

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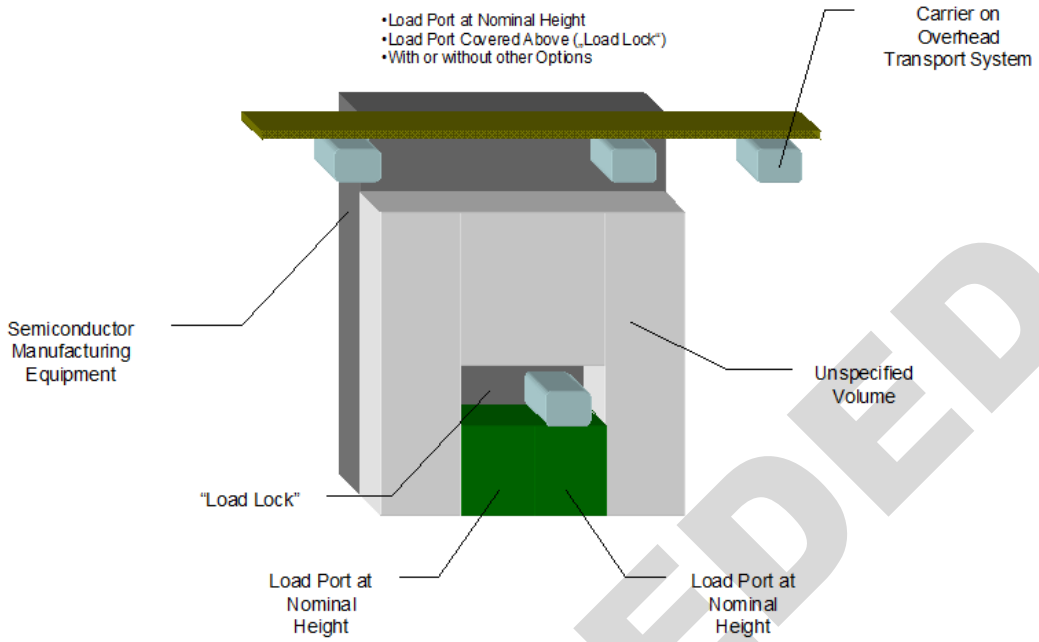

Figure 4
Three-Dimensional View of Option D

7.18 *Load Port Side Exclusion Volume for User Defined Objects* — An exclusion volume shall exist on the equipment if the equipment is wider than the load ports (e.g., equipment with two load ports wider than *x374* + *x100* + *x374* = 1268 mm must incorporate a load port side exclusion volume). This exclusion volume shall exist on both sides of the outer most load ports and shall be bounded by *x143* and *x144* below *z161* and bounded by *x103* and *x144* above *z161*. The exclusion volume shall extend from the EB to the LB. If *x144* extends past the edge of the SME, then *x144* will be reduced to the outermost edge of the SME (i.e., the load port side exclusion volume will not define or increase the width of the SME). The load port side exclusion volume shall remain clear of any obstruction on the SME (e.g., lights, buttons, GUI etc.), and must remain available for any user defined object. This volume will only exist on load port options A and B.

Table 1 Dimensions of Interface Between Load Port and Carrier Delivery System

Symbol Used	*Figure*	*Value Specified*	*Datum Measured From*	*Feature Measured To*
x100	5	638 ± 1 mm	BP of a load port	BP of an adjacent load port
x103	6	≥307.5 mm	BP	Clearance of on both sides of the Option A load port above the HP where no part of the SME shall protrude
x110	5	150 mm	Left hand side edge of placement volume for RFID reader/writer (symmetric to both sides of BP)	Right hand side edge of placement volume for RFID reader/writer (symmetric to both sides of BP)
x120	5	200 mm	Left hand side edge of placement volume for photo-coupled I/O device (symmetric to both sides of BP)	Right hand side edge of placement volume for photo-coupled I/O device (symmetric to both sides of BP)
x140	8	215 mm	BP	Inner edge of fork-lift exclusion volume
x141	8	292.5 mm	BP	Outer edge of fork-lift exclusion volume

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Symbol Used	*Figure*	*Value Specified*	*Datum Measured From*	*Feature Measured To*
x142	5	488 mm	Left hand side edge of exclusion volume for lift-truck access under SME (symmetric about BP)	Right hand side edge of exclusion volume for lift-truck access under SME (symmetric about BP)
x143	6	315 mm	BP of first and last load port of the SME	Inner most surface of Load Port Side Exclusion Volume
x144	6	355 mm	BP of first and last load port of the SME	Outer most boundary of Load Port Side Exclusion Volume
y100	5	40 mm	BI	450 EB
y101	5	573.75 mm	BI	450 LB
y104	5	321.25 (Nominal) With +10/−5 mm adjustability	BI	FP on load port (undocked)
y105	5	10 mm	BI	Equipment Boundary Upper (above *z100*)
y110	5	5 mm	LB	Edge of placement volume for RFID reader/writer towards LB
y111	5	45 mm	LB	Edge of placement volume for RFID reader/writer towards FP
y120	5	473.75 mm	LB	Front edge of placement volume for photo-coupled I/O device
y130	5	100 mm	LB	Front edge of placement volume for docking interface
y140	8	Identical with *y100*	BI	Front edge of fork-lift exclusion volume
y141	8	Identical with *y101*	BI	Rear edge of fork-lift exclusion volume
z100	5	≤2410 mm	Floor	Vertical boundary for SME between the EB and the LB
z101	5	913 mm (Nominal) with ±10 mm adjustability of load port or set of load ports	HP	Floor
z102	5	≥2450 mm	Floor	Vertical boundary for OHT between the EB and the LB
z103	7	≥485 mm	HP	Protrusion of any part of the load port above the carrier towards the HP
z105	5	880 mm	HP	Upper edge of volume below load port recommended to kept empty for fork-lift truck access to SME
z110	5	25 mm	HP	Upper edge of placement volume for RFID reader/writer
z111	5	60 mm	HP	Lower edge of placement volume for RFID reader/writer
z120	5	663 ± 3 mm	HP	Center of optical beam line of photo-coupled I/O device
z121	5	613 mm	HP	Upper edge of placement volume for photo-coupled I/O device
z122	5	100 mm	Upper edge of placement volume for photo-coupled I/O device	Lower edge of placement volume for photo-coupled I/O device

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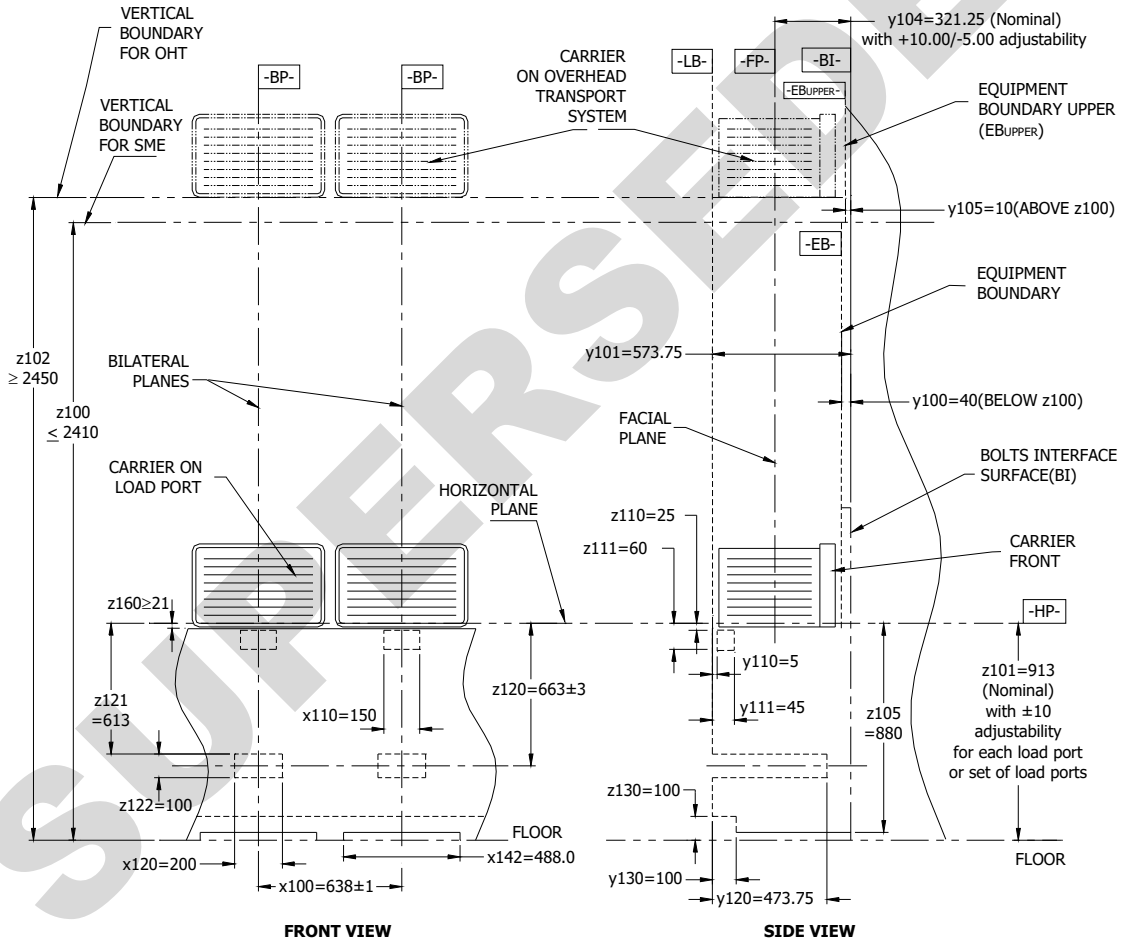
Symbol Used	*Figure*	*Value Specified*	*Datum Measured From*	*Feature Measured To*
z130	5	100 mm	Floor	Upper edge of placement volume for docking interface
z140	8	19 mm	HP	Upper edge of fork-lift exclusion volume
z141	8	≥20 mm	Upper edge of fork-lift exclusion volume	Lower edge of fork-lift exclusion volume
z160	6	≥21 mm	HP	Encroachment of any noninteracting feature on the upper side of the load port towards the bottom of the carrier
z161	6	≥1484 mm	Floor	Lower boundary of load port side exclusion volume in front of LB



#1 See Related Information 1, § R1-9 for considerations regarding load port guarding and clearances.

Figure 5
Interface Between Load Port and Carrier Delivery System

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