

SEMI E47.1-1101

PROVISIONAL MECHANICAL SPECIFICATION FOR BOXES AND PODS USED TO TRANSPORT AND STORE 300 mm WAFERS

This specification 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 approved by the North American Regional Standards Committee on August 27, 2001. Initially available at www.semi.org September 2001; to be published November 2001. Originally published in 1997; previously published July 2001.

1 Purpose

1.1 This standard partially specifies the boxes and pods used to transport and store 300 mm wafers (which may or may not be in removable cassettes) in an IC manufacturing facility.

2 Scope

2.1 This standard is intended to set an appropriate level of specification that places minimal limits on innovation while ensuring modularity and interchangeability at all mechanical interfaces. Most of the requirements given in this specification are in the form of maximum or minimum dimensions with very few required surfaces. Only the physical interfaces (other than the door mechanism and kinematic couplings) for boxes and pods are specified; no materials requirements or micro-contamination limits are given. The enclosure specified in this standard can be a sealed minienvironment, but it could also just be a box with well-defined interfaces.

2.2 The box has the following components and sub-components:

Key:

- Required feature
- ◇ Optional feature
- top
- top handling flange
- center hole on top handling flange
- ◇ 3 kinematic grooves on top handling flange (optional)
- interior
 - cassette (removable or non-removable with supports for 13 or 25 wafers)
 - wafer capture mechanism
 - 2 end effector exclusion zones
- sides
 - ◇ 2 side fork-lift flanges (optional)

- ◇ 4 side conveyor rails (bottom-opening only) (optional)
- ◇ ergonomic manual handles (optional)
- door (on the bottom or front)
- holes for latch keys that lock the door to the FIMS interface when the door is unlatched from the box (front-opening only)
- holes for registration pins
- door sensing pads (front-opening only)
- bottom
 - 4 bottom conveyor rails (with the bottom of the front seal zone acting as the fourth rail and the rear rail optional in the front-opening box)
 - 2 fork-lift pin holes (front-opening only)
 - 5 carrier sensing pads
 - center retaining feature (front-opening only)
 - front retaining feature (front-opening only)
 - 4 info pads
 - 2 advancing box sensing pads (front-opening only)
 - 3 features that mate with kinematic coupling pins and provide a 10 mm lead in
- ◇ 3 features that mate with kinematic coupling pins and provide a 15 mm lead in (optional)

2.3 This standard is provisional because of concerns about the kinematic coupling pins causing excessive wear on carriers and the usefulness of the robotic handling flanges and conveyor rails. Once box testing is done, this standard should be modified and upgraded from provisional status.

2.4 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 limitations prior to use.

3 Referenced Standards

3.1 SEMI Standards

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

SEMI E15 — Specification for Tool Load Port

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

SEMI E19 — Standard Mechanical Interface (SMIF)

SEMI E19.5 — Specification for 300 mm Bottom-Opening Standard Mechanical Interface (SMIF)

SEMI E44 — Guide for Procurement and Acceptance of Minienvironments

SEMI E47 — Specification for 150 mm/200 mm Pod Handles 150 mm and 200 mm SMIF Pod Handles

SEMI E57 — Provisional Mechanical Specification for Kinematic Couplings Used to Align and Support 300 mm Wafer Carriers

SEMI E62 — Provisional Specification for 300 mm Front-Opening Interface Mechanical Standard (FIMS)

SEMI S8 — Safety Guidelines for Ergonomics/Human Factors Engineering of Semiconductor Manufacturing Equipment

NOTE 1: Unless otherwise indicated, all documents cited shall be the latest published versions.

4 Terminology

4.1 *bilateral datum plane* — a vertical plane that bisects the wafers and that is perpendicular to both the horizontal and facial datum planes (as defined in SEMI E57).

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

4.3 *carrier capacity* — the number of substrates that a carrier holds (as defined in SEMI E1.9).

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

4.5 *facial datum plane* — a vertical plane that bisects the wafers and that is parallel to the front side of the carrier (where wafers are removed or inserted). On tool load ports, it is also parallel to the load face plane specified in SEMI E15 on the side of the tool where the carrier is loaded and unloaded (as defined in SEMI E57).

4.6 *front-opening unified pod (FOUP)* — a box (that complies with SEMI E47.1) with a non-removable cassette (so that its interior complies with SEMI E1.9)

and with a front-opening interface (that mates with a FIMS port that complies with SEMI E62).

4.7 *horizontal datum plane* — a horizontal plane from which projects the kinematic-coupling pins on which the carrier sits. On tool load ports, it is at the load height specified in SEMI E15 and might not be physically realized as a surface (as defined in SEMI E57).

4.8 *minienvironment* — a localized environment created by an enclosure to isolate the product from contamination and people (as defined in SEMI E44).

4.9 *nominal wafer center line* — the line that is defined by the intersection of the two vertical datum planes (facial and bilateral) and that passes through the nominal centers of the seated wafers (which must be horizontal when the carrier is placed on the coupling) (as defined in SEMI E57).

4.10 *pod* — a box having a Standard Mechanical Interface (SMIF) per SEMI E19 (as defined in SEMI E44).

4.11 *robotic handling flanges* — horizontal projections on the top of the box for lifting and rotating the box.

4.12 *wafer carrier* — any cassette, box, pod, or boat that contains wafers (as defined in SEMI E15).

5 Ordering Information

5.1 *Intended Use* — This standard is intended to specify 300 mm boxes over a reasonable lifetime of use, not just those in new condition. For this reason, the purchaser needs to specify a time period and the number and type of uses to which the boxes will be put. It is under these conditions that the boxes must remain in compliance with the requirements listed in Section 6.

5.2 *Temperature Ranges* — The purchaser of 300 mm boxes needs to specify two sets of temperatures to which the boxes might be exposed. An operating temperature range is the set of environmental temperatures in which the boxes will remain in compliance with the requirements listed in Section 6. A temporary temperature range is the set of environmental temperatures to which the boxes can be exposed such that when the boxes return to the operating temperature range, the boxes will be in compliance with the requirements listed in Section 6. Limits on exposure times to elevated temperatures should be specified. Also, the purchaser needs to specify a range of temperatures for the wafers and cassettes that might be inserted in the boxes (if the cassettes are removable).

5.3 *Fire Resistance* — The purchaser of 300 mm boxes may need to consider the flammability of the boxes.

5.4 Info Pad Configurations — The purchaser of 300 mm carriers needs to specify the desired info pad configuration (up or down).

6 Requirements

6.1 External Kinematic Couplings — The physical alignment mechanism from the cassette to the box (if the cassette is removable) and from the box to the tool load-port (or a nest on a vehicle or in a stocker) consists of features (not specified in this standard) on the top entity that mate with three or six pins underneath as defined in SEMI E57. Most of the dimensions of the box are determined with respect to the three orthogonal datum planes defined in that standard: the horizontal datum plane, the facial datum plane, and the bilateral datum plane. All of the dimensions for the box are bilaterally symmetric about both the bilateral and facial datum planes with the following exceptions:

- The features that mate with the kinematic coupling pins and the box sensing pads are symmetrical only about the bilateral datum plane.
- The front-opening box has a door only on the front and conveyor rails on the left and right sides that are required to extend all the way to the front.
- The orientation notches on the robotic handling flange are different for each of the four sides.

The three features that mate with the kinematic coupling pins must provide a lead-in capability that corrects a box misalignment of up to $r69$ in any horizontal direction.

6.2 Internal Kinematic Couplings — If the cassette is removable, the horizontal position of each of the three primary kinematic coupling pins on the inside bottom of the box must be within $r62$ of the horizontal positions of the corresponding pin on which the box is set, so that the vertical datum planes defined by the two sets of kinematic couplings must be nearly identical. Each of the three pins on the inside bottom of the box must be $z44$ higher than the corresponding pin on which the box is set, so that the horizontal datum planes defined by the two sets of kinematic couplings will be parallel and separated by dimension $z44$.

6.3 Nonremovable Cassettes — If the cassette is non-removable, there need not be a kinematic coupling between the box and cassette. However, the interior of such a box must have the interior dimensions of the cassette specified in SEMI E1.9. Many of these dimensions are measured from a horizontal datum plane, so an internal horizontal datum plane is still specified to be $z44$ above the horizontal datum plane under the box.

6.4 Door — There are two options for the location of the box door.

6.4.1 In the Bottom-Opening Door Option, the box door is on the bottom of the box (so the door is parallel to the wafers and the horizontal datum plane) and the door and its frame must be designed to mate with a port that conforms to SEMI E19.5.

6.4.2 In the Front-Opening Door Option, the box door is on the front side of the box (corresponding to the front side of the cassette where wafers are accessed so the door is perpendicular to the wafers and parallel to the facial datum plane), and the door and its frame must be designed to mate with a port that conforms to SEMI E62. Specifically, the box door and its frame must have surfaces that mate with the seal zones and the reserved spaces for vacuum application (which includes all of the circles bounded by $r38$ except for the holes for the registration pins at the center of each circle) defined in Sections 5.3 and 5.6 of SEMI E62 (which specifies $r38$). These box door and frame surfaces must be a distance of $y52$ from the facial datum plane and must have a flatness of $y42$. No surface on the box door may project further from the facial datum plane than the door seal zone and the reserved spaces for vacuum application. The door of the front-opening box must also be designed so that when the box is pressed against the FIMS port, both latch keys on the port are inserted to their full length. Furthermore, when the latch keys are turned more than 45° toward the position that unlocks the box door from the box, the latch key holes on the door must be such that the door is not removable from the latch keys.

6.5 Wafer Capture and Centering — When the box is closed, the cassette and the wafers must be captured in the box to prevent movement during transport. Wafer capture must include gently pushing the wafers to the rear of the cassette to center them.

6.6 Internal Dimensions — If the cassette is removable, the interior of the box (other than the kinematic coupling pins or the devices to capture the cassette and the wafers) must not intrude on any of the cassette domains defined in SEMI E1.9. Furthermore, the cassette must have a clearance of at least $r68$ in any direction while it is being inserted into the box. The interior of any front-opening box must also not intrude on the end effector exclusion zone, and the inside of the door must not intrude more than $y51$ toward the facial datum plane. If the cassette is not removable, the interior of the box between $y11$ and the door opening must not protrude higher than $z6$ above the internal horizontal datum plane and lower than $z15$ above the top nominal wafer plane. Horizontally, it must not protrude closer to the bilateral datum plane than $x51$ between $y11$ and $y49$ or closer than $x52$ between $y49$ and $y52$ (as shown in Figure 10). Dimensions $x51$, $x52$, $y49$, and $y52$ are speci-

fied in Table 1, and y_{11} , z_6 , and z_{15} are specified in SEMI E1.9.

6.7 *External Dimensions* — Figures 1 through 4 respectively show the side view, rear view, top view, and bottom view for the bottom-opening box, and Figures 5 through 8 show the same views of the front-opening box. Table 1 defines all of the dimensions. In this and

following figures, the heaviest lines are used for surfaces that have tolerances (not surfaces that have only maximum or only minimum dimensions). If a box identification tag is used, it must be located at the bottom rear centered on the bilateral datum plane and must be contained within the maximum outer dimensions of the box.

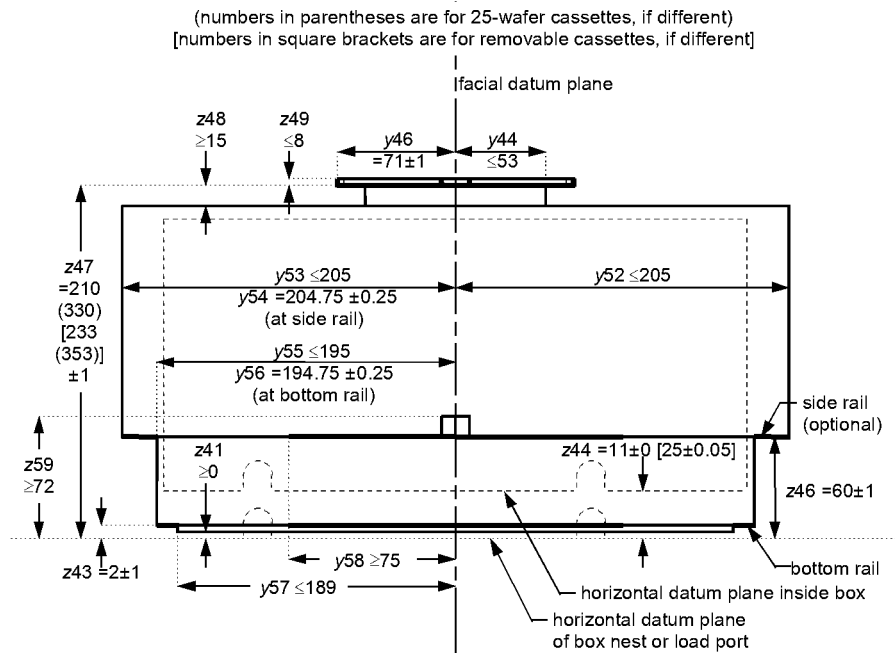


Figure 1
Side View of Bottom-Opening Box

(numbers in parentheses are for 25-wafer cassettes, if different)
[numbers in square brackets are for removable cassettes, if different]

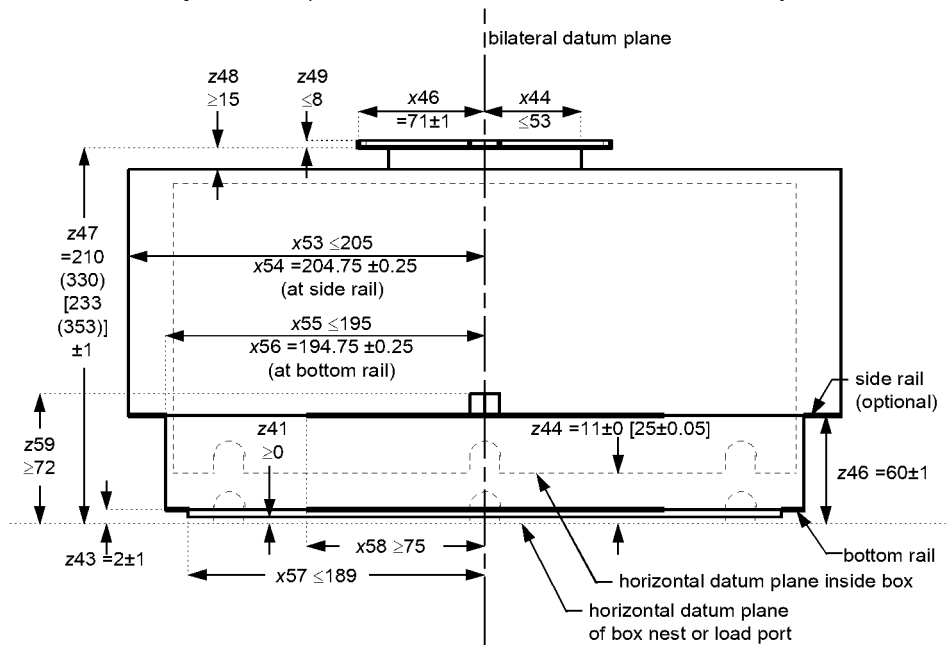


Figure 2
Rear View of Bottom-Opening Box

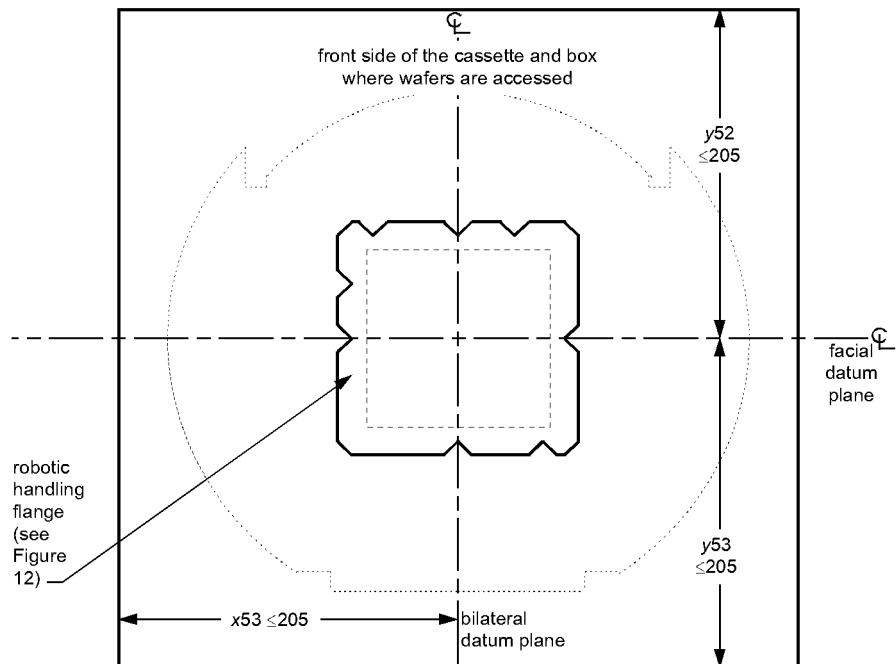


Figure 3
Top View of Bottom-Opening Box

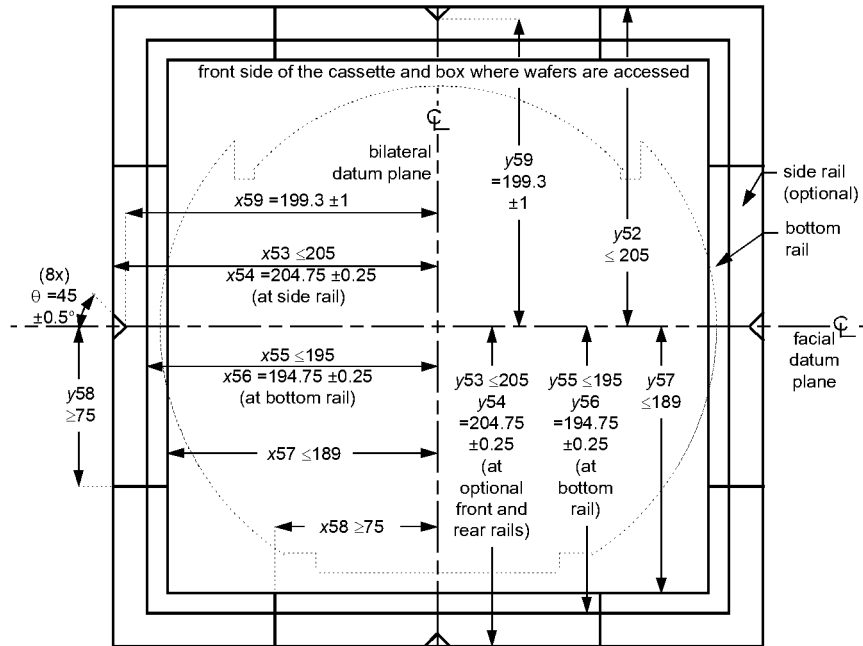


Figure 4
Bottom View of Bottom-Opening Box

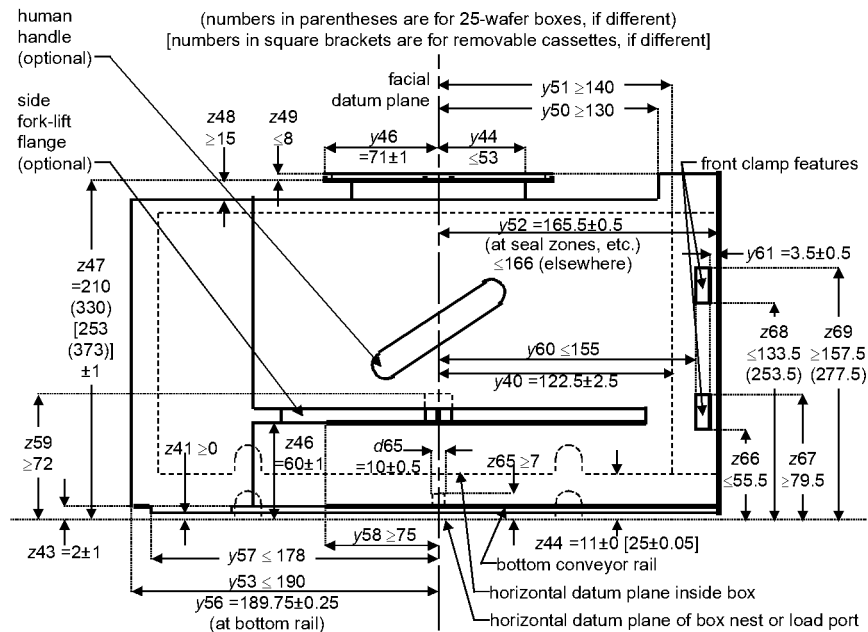


Figure 5
Side View of Front-Opening Box

(numbers in parentheses are for 25-wafer boxes, if different)
[numbers in square brackets are for removable cassettes, if different]

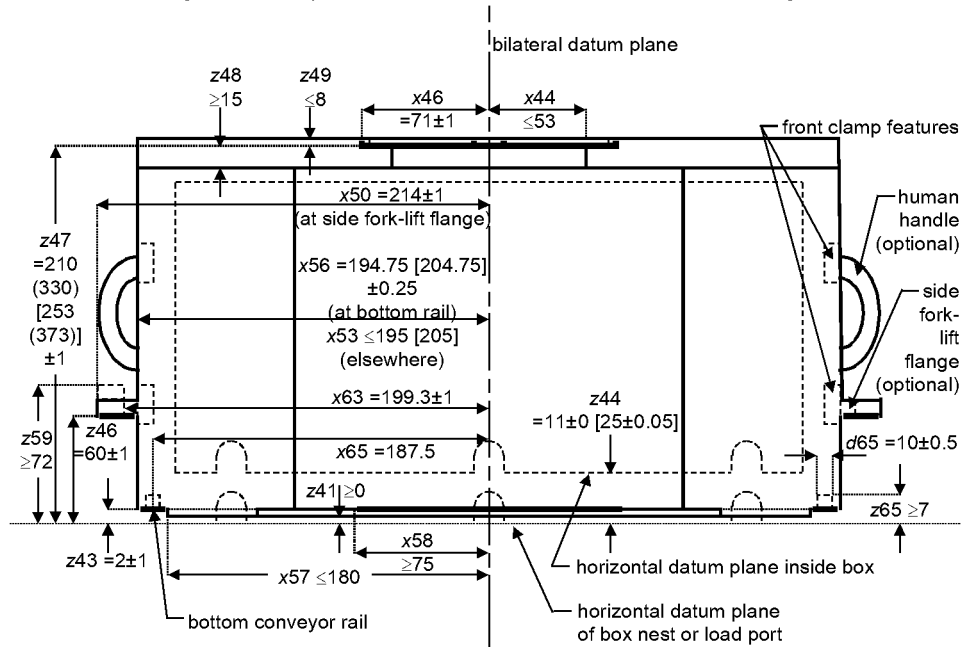


Figure 6
Rear View of Front-Opening Box

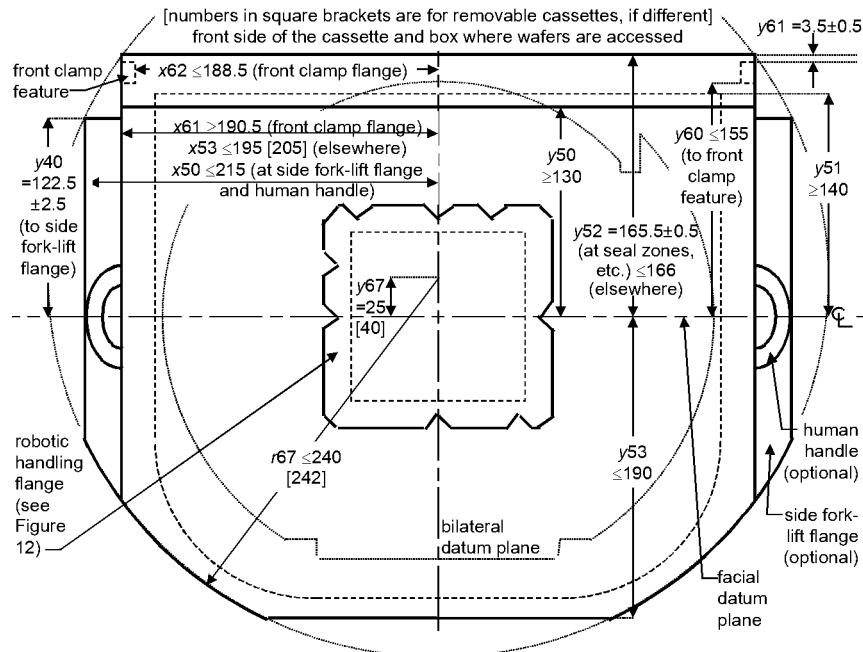


Figure 7
Top View of Front-Opening Box

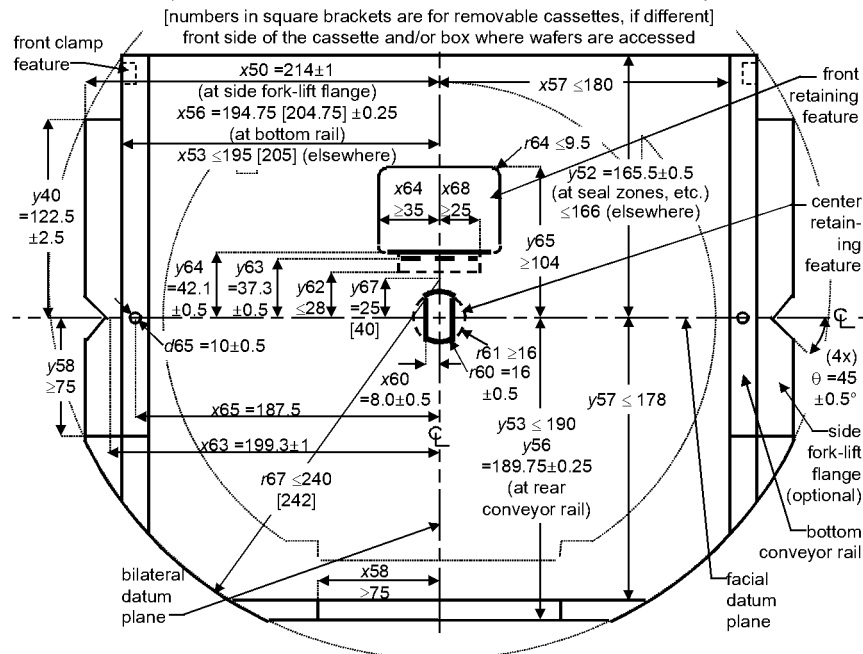


Figure 8
Bottom View of Front-Opening Box

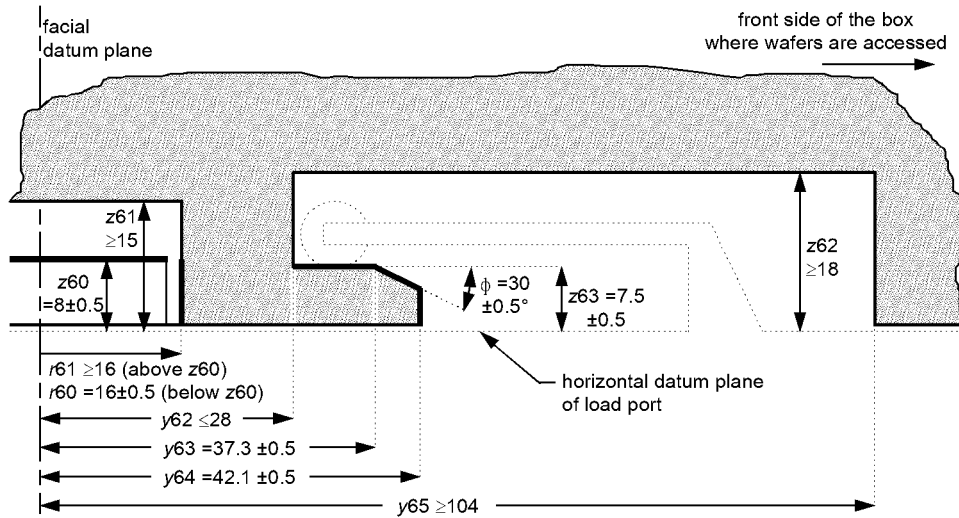


Figure 9
Side View of Retaining Features on Bottom of Front-Opening Box

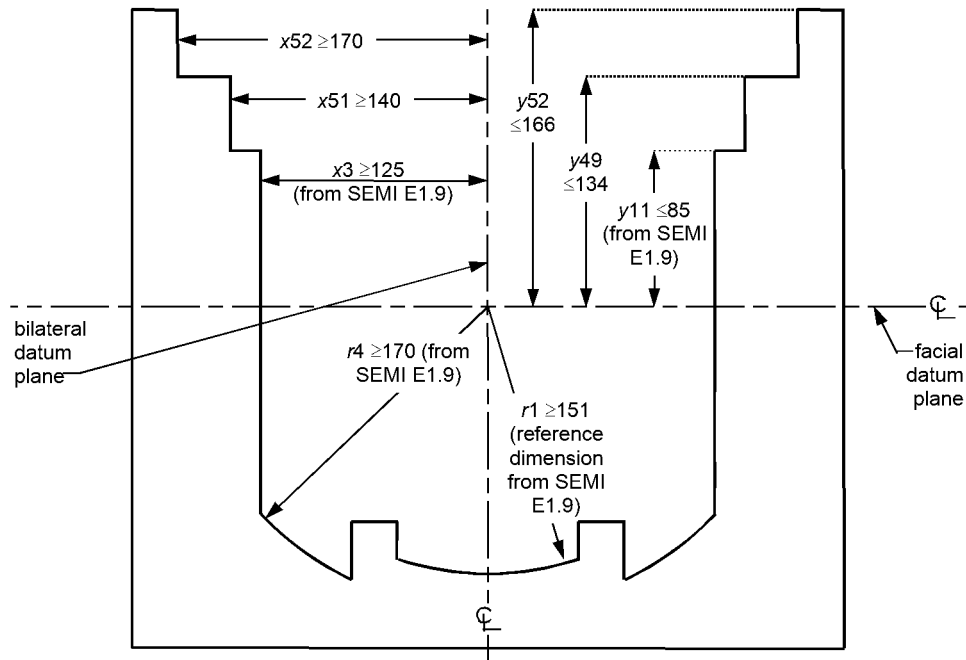


Figure 10
Exclusion Volume Inside Front-Opening Box with Non-Removable Cassette

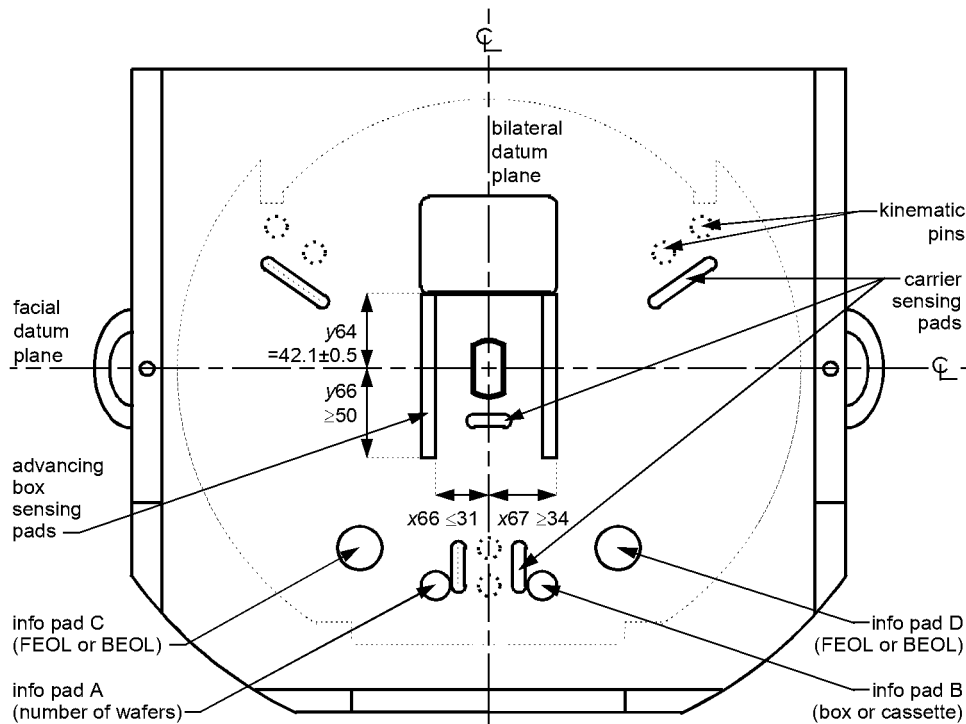


Figure 11
Sensing Pads on Bottom of Front-Opening Box

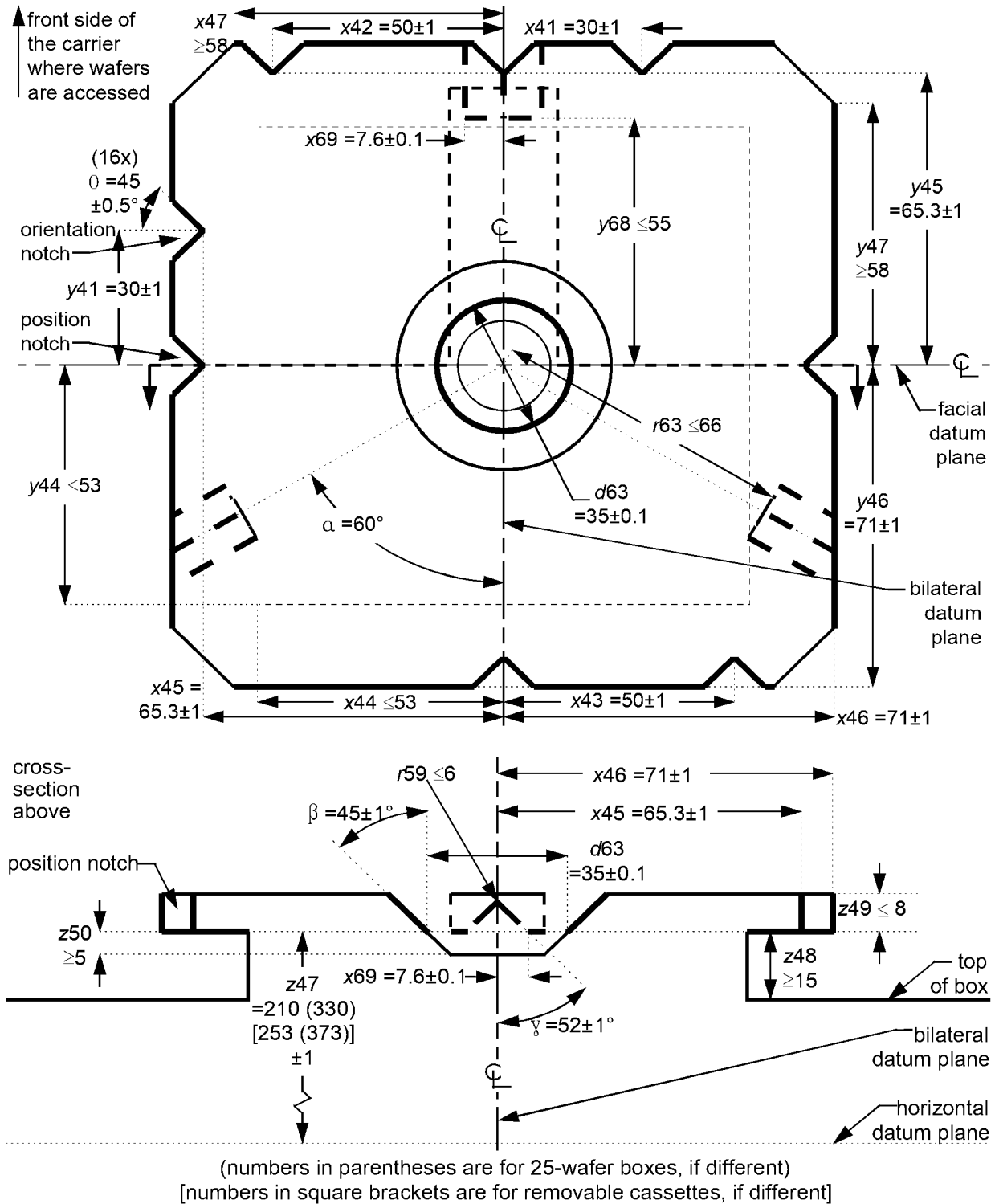


Figure 12
Top Robotic Handling Flange

Table 1 Dimensions for Bottom-Opening and Front-Opening Boxes

<i>Symbol Used</i>	<i>Value Specified</i>		<i>Datum Measured From</i>	<i>Feature Measured To</i>
	<i>Bottom-Opening</i>	<i>Front-Opening</i>		
$\alpha^\ddagger$	60°		bilateral datum plane	center line of the right and left kinematic grooves in the top robotic handling flange
β	45 ± 1°		nominal wafer center line	surface of the center hole in the top robotic handling flange
$\gamma^\ddagger$	52 ± 1°		bilateral datum plane or vertical plane rotated α away from it about nominal wafer center line	angled surface of the kinematic grooves in the top robotic handling flange
$\theta^\ddagger$	45 ± 0.5°		either vertical datum plane	sides of notches in the top robotic handling flange and in the side fork-lift flanges
ϕ	not applicable	30 ± 0.5°	horizontal line on bilateral datum plane	ramp of front retaining feature
$d63$	35 ± 0.1 mm (1.378 ± 0.004 in.)		diameter centered on the nominal wafer center line	sides the center hole in the top robotic handling flange at height z47
$d65$	not applicable	10 ± 0.5 mm (0.39 ± 0.02 in.)	diameter centered on the intersection of x65 and the facial datum plane	surface of cylindrical fork-lift pin holes in left and right bottom conveyor rails
$f60$	not applicable	175 N (39.3 lbf.) minimum	not applicable	force in any direction which both retaining features are able to withstand
$r59^\ddagger$	6 mm (0.24 in.) maximum		not applicable	radius on peak of kinematic grooves in the top robotic handling flange
$r60$	not applicable	16 ± 0.5 mm (0.63 ± 0.02 in.)	nominal wafer center line	ends of slot for center retaining feature
$r61$	not applicable	16 mm (0.63 in.) minimum	nominal wafer center line	walls of chamber above slot in center retaining feature
$r62$	0.05 mm (0.002 in.) maximum		both vertical datum planes defined by the external kinematic couplings	both vertical datum planes defined by the internal kinematic couplings
$r63^\ddagger$	66 mm (2.60 in.) maximum		nominal wafer center line	near end of the right and left kinematic grooves in the top robotic handling flange
$r64$	not applicable	9.5 mm (0.37 in.) maximum	not applicable	corners of front retaining feature
$r65$	1 mm (0.04 in.) maximum		not applicable	all concave features (radius)
$r66$	2 mm (0.08 in.) maximum		not applicable	all required convex features (radius)
$r67$	not applicable	240 mm (9.45 in.) maximum for non-removable cassette and 242 mm (9.53 in.) maximum for removable cassette	y67 in front of nominal wafer center line	any part of box
$r68$	6 mm (0.24 in.) minimum		not applicable	clearance in any direction between the box and cassette while the cassette is being inserted or removed

Symbol Used	Value Specified		Datum Measured From	Feature Measured To
	Bottom-Opening	Front-Opening		
r69	10 mm (0.4 in.) minimum (required) 15 mm (0.6 in.) (recommended for ergonomic reasons)		not applicable	correctable box misalignment in any horizontal direction
x41	30 ± 1 mm (1.18 ± 0.04 in.)		bilateral datum plane	front right orientation notch on robotic handling flange
x42	50 ± 1 mm (1.97 ± 0.04 in.)		bilateral datum plane	front left orientation notch on robotic handling flange
x43	50 ± 1 mm (1.97 ± 0.04 in.)		bilateral datum plane	rear orientation notch on robotic handling flange
x44	53 mm (2.09 in.) maximum		bilateral datum plane	encroachment of box underneath robotic handling flange
x45	65.3 ± 1 mm (2.57 ± 0.04 in.)		bilateral datum plane	nearest point of side position and orientation notches on robotic handling flange
x46	71 ± 1 mm (2.80 ± 0.04 in.)		bilateral datum plane	sides of robotic handling flange
x47	58 mm (2.28 in.) minimum		bilateral datum plane	end of robotic handling flange front and rear
x50‡	not applicable	214 ± 1 mm (8.43 ± 0.04 in.)	bilateral datum plane	outer edge of side fork-lift flanges and furthest reach of human handles
x51	not applicable	140 mm (5.51 in.) minimum	bilateral datum plane	interior of box sides between y11 and y49 in a box with a non-removable cassette
x52	not applicable	170 mm (6.69 in.) minimum	bilateral datum plane	interior of box sides between y49 and y52 in a box with a non-removable cassette
x53	205 mm (8.07 in.) maximum	195 mm (7.68 in.) maximum for non-removable cassette and 205 mm (8.07 in.) maximum for removable cassette	bilateral datum plane	box sides (apart from human handles)
x54‡	204.75 ± 0.25 mm (8.061 ± 0.010 in.)	not applicable	bilateral datum plane	outside edge of upper conveyor rails
x55	195 mm (7.68 in.) maximum	not applicable	bilateral datum plane	box sides underneath side conveyor rails
x56	194.75 ± 0.25 mm (7.667 ± 0.010 in.)	194.75 ± 0.25 mm (7.667 ± 0.010 in.) for non-removable cassette and 204.75 ± 0.25 mm (8.061 ± 0.010 in.) for removable cassette	bilateral datum plane	outside edge of bottom conveyor rails
x57	180 mm (7.09 in.) maximum		bilateral datum plane	box sides underneath bottom conveyor rails
x58‡	75 mm (2.95 in.) minimum		bilateral datum plane	end of front (bottom-opening only) and rear conveyor rails
x59‡	199.3 ± 1 mm (7.85 ± 0.04 in.)	not applicable	bilateral datum plane	nearest point of position notch on side conveyor rails
x60	not applicable	8 ± 0.5 mm (0.31 ± 0.02 in.)	bilateral datum plane	sides of slot for center retaining feature
x61	not applicable	190.5 mm (7.50 in.) minimum	bilateral datum plane	outer edge of front clamp flange

Symbol Used	Value Specified		Datum Measured From	Feature Measured To
	Bottom-Opening	Front-Opening		
x62	not applicable	188.5 mm (7.42 in.) maximum	bilateral datum plane	encroachment of box behind front clamp flange
x63‡	not applicable	199.3 ± 1 mm (7.85 ± 0.04 in.)	bilateral datum plane	nearest point of notches in side fork-lift flanges
x64	not applicable	35 mm (1.38 in.) minimum	bilateral datum plane	sides of front retaining feature
x65	not applicable	187.5 mm (7.38 in.)	bilateral datum plane	vertical axis of cylindrical fork-lift pin holes in left and right bottom conveyor rails
x66	not applicable	31 mm (1.22 in.) maximum	bilateral datum plane	near side of advancing box sensing pads
x67	not applicable	34 mm (1.34 in.) minimum	bilateral datum plane	far side of advancing box sensing pads
x68	not applicable	25 mm (0.98 in.) minimum	bilateral datum plane	sides of volume above ramp on front retaining feature
x69‡	7.6 ± 0.1 mm (0.299 ± 0.004 in.)		bilateral datum plane or vertical plane rotated α away from it about nominal wafer center line	beginning of angled surface of the kinematic grooves in the top robotic handling flange
y40	not applicable	122.5 ± 2.5 mm (4.82 ± 0.10 in.)	facial datum plane	front of side fork-lift flanges and furthest reach of human handles toward the front
y41	30 ± 1 mm (1.18 ± 0.04 in.)		facial datum plane	left orientation notch on robotic handling flange
y42	not applicable	± 0.5 mm (± 0.02 in.) flatness over each area	not applicable	door and frame seal zones and the reserved spaces for vacuum application
y44	53 mm (2.09 in.) maximum		facial datum plane	encroachment of box underneath robotic handling flange
y45	65.3 ± 1 mm (2.57 ± 0.04 in.)		facial datum plane	nearest point of front and rear position and orientation notches on robotic handling flange
y46	71 ± 1 mm (2.80 ± 0.04 in.)		facial datum plane	front and rear edge of robotic handling flange
y47	58 mm (2.28 in.) minimum		facial datum plane	end of robotic handling flange sides
y49	not applicable	134 mm (5.28 in.) maximum	facial datum plane	interior of box sides between x51 and x52 in a box with a non-removable cassette
y50	not applicable	130 mm (5.12 in.) minimum	facial datum plane	rear of upper door frame volume
y51	not applicable	140 mm (5.51 in.) minimum	facial datum plane	rear of door
y52	205 mm (8.07 in.) maximum	165.5 ± 0.5 mm (6.52 ± 0.02 in.) at door and frame seal zones and at reserved spaces for vacuum application and 166 mm (6.54 in.) maximum elsewhere on door or box shell	facial datum plane	box front

Symbol Used	Value Specified		Datum Measured From	Feature Measured To
	Bottom-Opening	Front-Opening		
y53	205 mm (8.07 in.) maximum	190 mm (7.48 in.) maximum	facial datum plane	box rear
y54‡	204.75 ± 0.25 mm (8.061 ± 0.010 in.)	not applicable	facial datum plane	outside edge of front and rear upper conveyor rails
y55	195 mm (7.68 in.) maximum	not applicable	facial datum plane	encroachment of box front and rear upper conveyor rails
y56‡	194.75 ± 0.25 mm (7.667 ± 0.010 in.)	189.75 ± 0.25 mm (7.470 ± 0.010 in.)	facial datum plane	outside edge of front and rear bottom conveyor rails
y57‡	189 mm (7.44 in.) maximum	178 mm (7.01 in.) maximum	facial datum plane	encroachment of box front and rear underneath bottom conveyor rails
y58	75 mm (2.95 in.) minimum		facial datum plane	end of left and right conveyor rails
y59‡	199.3 ± 1 mm (7.85 ± 0.04 in.)	not applicable	facial datum plane	nearest point of position notch on front or rear conveyor rails
y60	not applicable	155 mm (6.10 in.) maximum	facial datum plane	encroachment of box behind front clamp flange
y61	not applicable	3.5 ± 0.5 mm (0.14 ± 0.02 in.)	front of front clamp flange at box front	rear of front clamp flange
y62	not applicable	28 mm (1.10 in.) maximum	facial datum plane	rear of front retaining feature
y63	not applicable	37.3 ± 0.5 mm (1.47 ± 0.02 in.)	facial datum plane	rear of ramp on front retaining feature
y64	not applicable	42.1 ± 0.5 mm (1.66 ± 0.02 in.)	facial datum plane	front of ramp on front retaining feature and front side of advancing box sensing pads
y65	not applicable	104 mm (4.09 in.) minimum	facial datum plane	front of front retaining feature
y66	not applicable	50 mm (1.97 in.) minimum	facial datum plane	rear side of advancing box sensing pads
y67	not applicable	25 mm (0.98 in.) for non-removable cassette and 40 mm (1.57 in.) for removable cassette	facial datum plane	origin of r67 on bilateral datum plane
y68‡	55 mm (2.17 in.) maximum		facial datum plane	near end of the front kinematic groove in the top robotic handling flange
z2	not applicable	2 mm (0.08 in.) maximum	horizontal datum plane	bottom of carrier sensing pads and info pads (when down)
z41	0 mm (0 in.) minimum		external horizontal datum plane	bottom of box
z43	2 ± 1 mm (0.08 ± 0.04 in.)		external horizontal datum plane	bottom conveyor rails
z44	11 ± 0 mm (0.43 ± 0 in.) for non-removable cassette and 25 ± 0.05 mm (0.984 ± 0.002 in.) for removable cassette		external horizontal datum plane	internal horizontal datum plane
z46‡	60 ± 1 mm (2.36 ± 0.04 in.)		external horizontal datum plane	bottom of side fork-lift flanges

Symbol Used	Value Specified		Datum Measured From	Feature Measured To
	Bottom-Opening	Front-Opening		
z47	210 ± 1 mm (8.27 ± 0.04 in.) for non-removable 13-wafer cassette and 330 ± 1 mm (12.99 ± 0.04 in.) for non-removable 25-wafer cassette		external horizontal datum plane	bottom of robotic handling flange
	233 ± 1 mm (9.17 ± 0.04 in.) for removable 13-wafer cassette and 353 ± 1 mm (13.90 ± 0.04 in.) for removable 25-wafer cassette	253 ± 1 mm (9.96 ± 0.04 in.) for removable 13-wafer cassette and 373 ± 1 mm (14.69 ± 0.04 in.) for removable 25-wafer cassette		
z48	15 mm (0.59 in.) minimum		bottom of robotic handling flange	encroachment of box top underneath robotic handling flange
z49	8 mm (0.31 in.) maximum		bottom of robotic handling flange	top of robotic handling flange and upper door frame volume
z50	5 mm (0.20 in.) minimum		bottom of robotic handling flange	encroachment of box top underneath the center hole in the top robotic handling flange
z59	72 mm (0.31 in.) minimum		external horizontal datum plane	top of notches in side fork-lift flanges
z60	not applicable	8.0 ± 0.5 mm (0.31 ± 0.02 in.)	external horizontal datum plane	top of slot in center retaining feature
z61	not applicable	15 mm (0.59 in.) minimum	external horizontal datum plane	top of chamber above slot in center retaining feature
z62	not applicable	18 mm (0.71 in.) minimum	external horizontal datum plane	top of front retaining feature
z63	not applicable	7.5 ± 0.5 mm (0.30 ± 0.02 in.)	external horizontal datum plane	top of ramp on front retaining feature
z65	not applicable	7 mm (0.28 in.) minimum	horizontal datum plane	upper boundary of cylindrical fork-lift pin holes in left and right bottom conveyor rails
z66	not applicable	55.5 mm (2.19 in.) maximum	external horizontal datum plane	encroachment of box behind bottom front clamp flange
z67	not applicable	79.5 mm (3.13 in.) minimum	external horizontal datum plane	encroachment of box behind bottom front clamp flange
z68	not applicable	133.5 mm (5.26 in.) maximum for 13-wafer box and 253.5 mm (9.98 in.) maximum for 25-wafer box	external horizontal datum plane	encroachment of box behind top front clamp flange
z69	not applicable	157.5 mm (6.20 in.) minimum for 13-wafer box and 277.5 mm (10.93 in.) minimum for 25-wafer box	external horizontal datum plane	encroachment of box behind top front clamp flange

‡ These dimensions define optional features.

6.8 Human Handles — All handles for use by humans must either be contained within the maximum outer dimensions of the box, be detached when not in use, or be retractable into the maximum outer dimensions when not in use. On the front-opening box, although such handles may extend past $x53$, they must still be contained within the upper limits of $x50$, $y40$, and $r67$. Handles for use by humans (if present) must follow SEMI S8, and they must require the use of both hands (each using a full wrap-around grip, given the minimum clearance requirement in SEMI E15.1). Automation handling features shall not be considered dual purpose unless they are designed to meet SEMI S8 guidelines.

6.9 Automation Handling Features — On the top of the box is a robotic handling flange for manipulating the box. Shown in Figure 12 (on the top robotic handling flange) are a center hole and 3 optional kinematic grooves (which, if present, must be implemented entirely including the radius at the peak). On the left and right sides of the box (and on the front and back of the bottom-opening box) are optional flanges (of unspecified thickness) for use with fork lifts. On the bottom of the box are rails for use with roller conveyors. Although they are only required to extend $x58$ to the rear (and front for the bottom-opening box) and $y58$ to the left and right, it is recommended that they be as long as possible. Beyond $x58$ and $y58$, only the lower bounds on $z43$ and $z46$ apply. On the bottom-opening box, optional conveyor rails (defined by $x54$, $x55$, $y54$, $y55$, and $z46$) are located on all four sides and required conveyor rails (defined by $x56$, $x57$, $y56$, $y57$, and $z43$) are located on all four bottom edges. The side fork-lift flanges and the left and right bottom conveyor rails of the front-opening box also have vertical cylindrical pin holes for fork lift centering. On the bottom edges of the front-opening box, 2 required conveyor rails (defined by $x56$, $x57$, $y58$, and $z43$) are located on the left and right, and an optional conveyor rail (defined by $x58$, $y56$, $y57$, and $z43$) is located on the rear.

6.10 Retaining Features — Figures 8 and 9 show two features on the bottom of the front-opening box that may be used for retaining the box onto the kinematic couplings. This may be needed to prevent the box from being knocked off the kinematic couplings by the action of pushing the box against the front-opening interface. The front retaining feature contains a ramp that a wheel might roll up while the box is being pushed toward the front-opening interface. The arm with the wheel (not specified here) then holds the box down on the kinematic couplings. The center retaining feature consists of an oblong slot with a chamber above it. The box can be clamped onto the kinematic couplings by inserting an oblong head on a shaft (not specified here) through the slot and rotating it 90° in either direction.

Either retaining feature would only engage after the box is fully seated on the kinematic coupling pins. Either retaining feature must be able to withstand a force in any direction of at least $f60$. It is recommended that SEMI E15.1 tool load ports be designed to accommodate the minimum hole dimensions of the retaining features to ensure carrier interchangeability. Projections on the tool load ports that mate with the retaining features should also not interfere with the misalignment correction function of the kinematic couplings. Figures 5 through 8 also show front clamp flanges and exclusion volumes (defined by $x62$, $y60$, $y61$, $z66$, $z67$, $z68$, and $z69$) behind them that can be used to clamp the box to the box opener when the box is purged with Nitrogen. However, it is strongly recommended that the front clamp flanges not be used for pulling the FOUP from the undocked position into the FIMS interface. Also, all of the dimensions of the FOUP (such as the wafer location, etc.) are defined with reference to the kinematic coupling pins, and most FOUPs are designed so that all of their features are in the proper location only when the FOUP is held in place on the kinematic coupling pins only by gravity. Thus, if the front clamp flanges are used, the wafers and the FOUP features may be in a different position than defined in SEMI E1.9 (possibly resulting in damage to wafers, wafer handlers, and the FOUP).

6.11 Inner and Outer Radii — All required concave features may have a radius of up to $r65$ to allow cleaning and to prevent contaminant build-up. All required convex features may also have a radius of up to $r66$ to prevent small contact patches with large stresses that might cause wear and particles. Note that these limits on the radius of all required features are specified as a maximum (not a minimum) to ensure that the required features are not rounded off too much. The lower bound on the radius is up to the carrier supplier. Note also that this radius applies to every required feature unless another radius is called out specifically. Here a required feature is an area on the surface of the carrier specified by a dimension (or intersections of dimensions) that has a tolerance and not just a maximum or minimum (such as the edges of the robotic handling flange).

6.12 Box Placement Sensing Pads — The box must have the same carrier sensing pads as is required of the cassette in SEMI E1.9, including the info pads that communicate information about the carrier such as the carrier capacity (number of wafers) and type (cassette or box). See SEMI E1.9 for information about info pad configurations for different wafer carriers similar to FOUPs including front-opening shipping boxes (as defined in SEMI M31) and single-wafer interface (SWIF) systems (as defined in SEMI E103). Two additional sensing pads (that can be used continuously

while the front-opening box is advancing into the FIMS interface) must be located near the center of the bottom at the same distance from the horizontal datum plane as the carrier sensing pads. In addition, the surfaces on the door of the front-opening box that mate with the seal zones and the reserved spaces for vacuum application may also be used for door-presence sensing.

7 Related Documents

7.1 SEMI Standards

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

SEMI E103 — Provisional Mechanical Specification for a 300 mm Single-Wafer Box System that Emulates a FOUP

SEMI M31 — Provisional Mechanical Specification for Front-Opening Shipping Box Used to Transport and Ship 300 mm Wafers

APPENDIX 1

APPLICATION NOTES

NOTE: The material in this appendix is an official part of SEMI E47.1 and was approved by full letter ballot procedures on August 27, 2001.

A1-1 The automation handling features do not need to be molded into the plastic shell of the box, but can be attached as a framework around the shell.

A1-2 To increase the stability of the box on the kinematic couplings, it is recommended that the points on the box bottom extend as close as practical to the horizontal datum plane to minimize tipping of the box.

A1-3 Skewness, warp, rock, and stiffness are implicitly defined in the geometric tolerances.

A1-4 Dimension y_{52} is given as a maximum based on the maximum distance to the port door specified in SEMI E62.

A1-5 The position tolerance of the door of the front-opening box is likely to be much larger than the position tolerance of the registration pins. To make both manual and automated door opening easier, it is recommended that the holes for the registration pins on the door of the front-opening box have openings with a lead-in capability.

NOTE A1-1: If the bottom of the box does not extend below the bottom conveyor rail, the conveyor rail may become contaminated and may distribute particles.

A1-6 Although both of the retaining features on the bottom of the front-opening box must be able to withstand a force in any direction of f_{60} , continuously applied stress may result in plastic deformation.

A1-7 In order to minimize particle generation when the box door is opened or closed, it is recommended that the tolerance between the box door and its frame be larger than the tolerance between the box door registration holes and FIMS registration pins.

A1-8 One type of carrier presence sensor uses a beam of light with an optical detector that is triggered when the beam of light is attenuated as it passes through the box shell.

A1-9 The use of the registration pins for FOUF door lead-in to the loadport door is not recommended. The registration pins should be only used to limit the maximum displacement of the FOUF door while on the loadport door. Neither the FOUF nor FOUF door positions should change as a result of engaging or disengaging the registration pins. When the Loadport experiences utility loss (such as EMO, vacuum loss, electrical failure, etc.), the registration pins may be used to maintain the FOUF door's position, and to ensure

that the FOUF door does not fall off. The clearance between the Registration Pins and the Registration Pin Holes should be less than the clearance between the outer edge of the FOUF Door and the inner edge of the FOUF Door Frame. Balancing these tolerances is a FOUF design issue related to the E62 Seal Zone specification. The diameter of the Registration Pin Holes should be designed to accommodate the Registration Pin tolerance defined in E62 (x_{31} , z_{31} , d_{31}) and the Registration Pin Hole location tolerance in a FOUF.

A1-10 It is recommended that the FOUF have a capability to roughly position the FOUF door in the FOUF frame during the door close sequence (during either return of the FOUF door or during latching of the FOUF door). This positioning capability should keep the clearance between the FOUF frame and the FOUF door larger than sum of the FOUF (self) tolerance and the E62 registration pin tolerance along with the FOUF door's circumference. Possible methods for accomplishing this may include positioning by latch motion and positioning by a slope between the FOUF frame and the FOUF door.

A1-11 It is recommended that the FOUF have a lead-in mechanism on its latch key holes. This lead-in mechanism should compensate for the FOUF's latch key hole location error, as shown in Figure A1-1.

A1-12 It is recommended that the latch key hole mechanisms have some flexibility in their position for compliance with the latch key positions. The purpose of this is to adjust for any discrepancy in rotation axis between the latch key and the latch key hole mechanism. As shown in Figure A1-2, if only one side of the latch key pushes on the inside of the latch key hole, the latch key can not rotate more than half way.

A1-13 It is recommended that the torque required to rotate the FOUF latch key holes be kept small enough that it will not produce movement of the FOUF door in the x and z directions during latch key rotation.

A1-14 It is recommended that the latch key holes be maintained in the position that unlocks the box door from the box ($\psi = 0 \pm 1^\circ$ as defined in E62) while the box is open and in the position that locks the box door to the box ($\psi = 90 \pm 1^\circ$) while the box is closed. One method to accomplish this is to have the FOUF latch key hole mechanisms snap into both end points of their rotation ($\psi = 0 \pm 1^\circ$ and $\psi = 90 \pm 1^\circ$) using a detent

mechanism. The torque required to overcome such a detent mechanism should not exceed $f30$ (as defined in E62).

A1-15 Table A1-1 can be used for communicating the compliance of boxes to this standard and the options chosen:

Table A1-1 Optional Features Checklist

<i>Section</i>	<i>Optional Feature</i>	<i>Choice</i>
4.3	carrier capacity (c)	☐ 13 wafers or ☐ 25 wafers
6.4	door location	☐ bottom (complying with SEMI E19.5) or ☐ front (complying with SEMI E62)
6.3	cassette type	☐ removable or ☐ non-removable (complying with interior dimensions of SEMI E1.9)
6.1	full 15-mm lead in provided by 3 features that mate with kinematic coupling pins	Primary kinematic coupling pins ☐ yes or ☐ no and secondary kinematic coupling pins ☐ yes or ☐ no
6.9	4 side conveyor rails (bottom-opening only)	☐ yes or ☐ no
6.8	ergonomic manual handles	☐ yes or ☐ no
6.9	side fork-lift flanges	☐ yes or ☐ no
6.9	3 kinematic grooves on the top robotic handling flange	☐ yes or ☐ no
6.9	rear conveyor rail	☐ yes or ☐ no
6.12	info pad A height	☐ up (pad missing) or ☐ down (pad present)
6.12	info pad B height	☐ up (pad missing) or ☐ down (pad present)
6.12	info pad C height	☐ up (pad missing) or ☐ down (pad present)
6.12	info pad D height	☐ up (pad missing) or ☐ down (pad present)

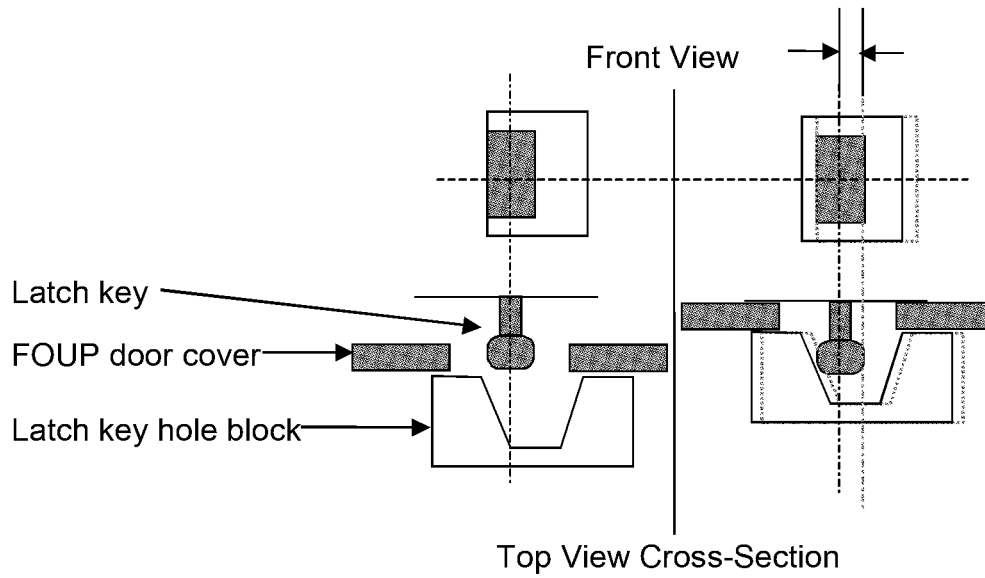
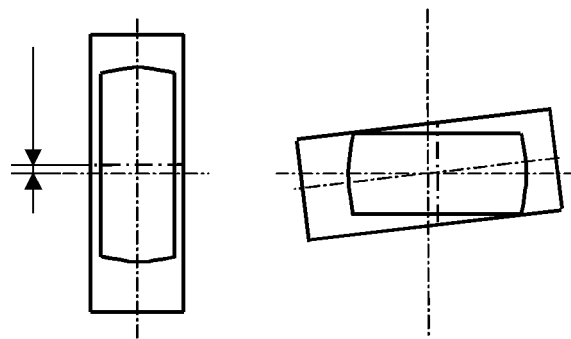
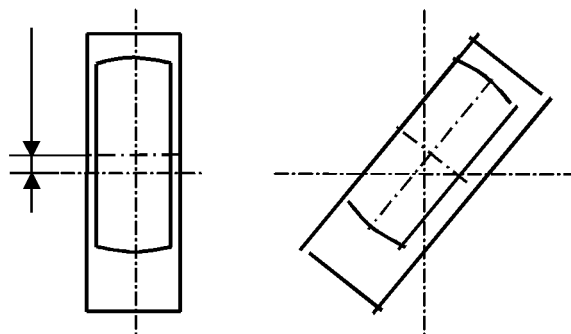


Figure A1-1
Displacement Enabled by Flexibility Around Latch Key Hole Block



Latch key can rotate full 90°



Latch key rotation stops before 90°

Figure A1-2
Need for Latch Key Hole Flexibility

RELATED INFORMATION 1

NOTE: This related information is not an official part of SEMI E47.1, and it is not intended to modify or supercede the official standard. This information was inserted by the North America Physical Interfaces and Carriers Committee to alert the readers to potential changes to this provisional standard.

R1-1 A revision ballot will be submitted to require the same bottom carrier ID label area as in SEMI E1.9.

R1-2 A revision ballot will be submitted to increase the maximum thickness of the top robotic flange by 3 mm.

R1-3 A design exists for a box and adapter mechanism that holds only on wafer and is supposed to comply with SEMI E47.1. A new activity to standardize a “One Wafer FOUP” is being considered.

NOTICE: SEMI makes no warranties or representations as to the suitability of the standards herein set forth for any particular application. The determination of the suit-ability 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 compliance with this standard may require use of copyrighted material or of an invention covered by patent rights. By publication of this standard, SEMI takes no position respecting the validity of any patent rights or copyrights asserted in connection with any item 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.