

SEMI E57-0600 (Reapproved 0305) MECHANICAL SPECIFICATION FOR KINEMATIC COUPLINGS USED TO ALIGN AND SUPPORT 300 mm WAFER CARRIERS

This specification was technically reapproved 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 November 4, 2004. Initially available at www.semi.org January 2005; to be published March 2005. Originally published in 1996; previously published June 2000.

1 Purpose

1.1 This standard specifies the mechanical couplings used to ergonomically align and precisely support 300 mm wafer carriers (including transport cassettes, process cassettes, quartz boats, pods, lot boxes, and shipping boxes). Such a kinematic coupling can be used at several interfaces, including:

- between a box or cassette and a tool load-port or vehicle nest,
- between a transport cassette and a box, and
- between a process cassette or quartz boat and the floor of a process chamber.

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 inter-changeability at all mechanical interfaces. Only the bottom half of the kinematic coupling is specified so that suppliers can be flexible in designing wafer carriers that can mate with it.

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 E15 — Specification for Tool Load Port

SEMI E19 — Standard Mechanical Interface (SMIF)

SEMI E19.4 — 200 mm Standard Mechanical Interface (SMIF)

3.2 ISO Document¹

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.

4 Terminology

4.1 Definitions

4.1.1 *bilateral datum plane* — a vertical plane that bisects the wafers and that is perpendicular to both the horizontal and facial datum planes.

4.1.2 *box* — a protective portable container for a cassette and/or substrate(s).

4.1.3 *cassette* — a open structure that holds one or more substrates.

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

4.1.4 *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.

4.1.5 *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.

4.1.6 *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).

4.1.7 *pod* — a box having a Standard Mechanical Interface (SMIF) per SEMI E19.

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

5 Requirements

5.1 *Kinematic Coupling Pin Shapes* — The physical alignment interface on the bottom of the wafer carrier consists of features (not specified in this standard) that mate with six pins underneath. As shown in Figure 1 and defined in Table 1, each pin is radially symmetric about the vertical center axis line and can be seen as the intersection of a cylinder of diameter $d91$ and a sphere of radius $r93$ (which might contact a flat plate). An additional rounding radius $r95$ provides contact with angled mating surfaces, and blend radii $r94$ and $r96$ smooth the resulting edges. The final roughness height of the over-all surface finish must be less than or equal to $r97$. Dimensions $r92$ and $z91$ have zero tolerance because they only give a distance to another toleranced dimension. (Dimensions in parenthesis are not part of the requirements in this standard but are intended to clarify the preparation of manufacturing instructions.)

5.2 *Kinematic Coupling Pin Locations* — The pins are arranged in three sets with two pins in each set. As shown in Figure 2, the outer pin in each set is designated the primary pin for use on a tool load-port or vehicle nest or inside a box, and the inner pin in each set is designated the secondary pin for use on a robotic arm that would pick up the carrier (typically from the side opposite the load face plane). The location of each pin is determined with respect to the three orthogonal datum planes defined in §4: the horizontal datum plane, the facial datum plane, and the bilateral datum plane. Figure 3 shows the locations of the kinematic coupling pins as viewed from above, and Table 2 defines the locations (all of which are bilaterally symmetric about the bilateral datum plane). Angle θ is shown in Figure 3 for clarity and is not part of the requirements in this standard.

5.3 *Empirical Determination of Datum Plane Locations* — Given a set of three primary or secondary kinematic coupling pins, the datum planes should be determined as follows. The two pins that are closest together are the front pins which (along with a known vertical direction) define a Cartesian coordinate system. The center axis line of each pin is defined to be the vertical line whose x (left-right) coordinate is the average of the maximum protrusions of the pin to the left and to the right and whose y (front-back) coordinate is the average of the maximum protrusions of the pin to the front and to the back. The bilateral datum plane is defined to be the vertical plane that contains the center axis line of the rear pin and that is equally distant from the center axis lines of the front pins. The facial datum plane is defined to be the vertical plane that is perpendicular to the bilateral datum plane and whose distance to the center axis line of the rear pin is 1.5 times the average of the distances to the center axis lines of the front pins. The horizontal datum plane is defined to be the horizontal plane that is 13 mm (0.51 in.) below the average of the heights of the highest and lowest pin tops. Once these datum planes have been determined, the three kinematic coupling pins can be evaluated to see if they conform to §§5.1 and 5.2 of this specification. If they comply, the kinematic coupling pins and datum planes can be used to evaluate the compliance of carriers to standards cited in §6.

6 Related Documents

6.1 SEMI Standards

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

SEMI E47.1 — Provisional Mechanical Specification for Boxes and Pods Used to Transport and Store 300 mm Wafers

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

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

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

6.2 Other Documents

Alexander H. Slocum, *Precision Machine Design*, Society of Manufacturing Engineers, Item Code 2597, 1992 (originally published by Prentice-Hall, 1992)

Table 1 Kinematic Coupling Pin Dimensions

Symbol Used	Value Specified	Dimension Description
d_{91}	$12 \pm 0.05 \text{ mm}$ ($0.4724 \pm 0.002 \text{ in.}$)	Diameter of pin centered on the center axis line.
r_{92}	6 mm (0.2362 in.)	Radial distance from the center axis line to the origin of the shoulder radius r_{95} .
r_{93}	$15 \pm 0.05 \text{ mm}$ ($0.5906 \pm 0.002 \text{ in.}$)	Radial distance from the intersection of the center axis line and z_{91} to the top of the pin.
r_{94}	$2 \pm 0.1 \text{ mm}$ ($0.0787 \pm 0.004 \text{ in.}$)	Blend radius for the intersection of r_{93} and r_{95} .
r_{95}	$15 \pm 0.05 \text{ mm}$ ($0.5906 \pm 0.002 \text{ in.}$)	Radial distance from the intersection of the horizontal datum plane and r_{92} to the far shoulder of the pin.
r_{96}	$2 \pm 0.1 \text{ mm}$ ($0.0787 \pm 0.004 \text{ in.}$)	Blend radius for the intersection of r_{95} and d_{91} .
r_{97}	$0.30 \mu\text{m}$ ($12 \mu\text{in.}$) maximum	Roughness (R_a) as defined in ISO 4287.
z_{91}	2 mm (0.08 in.)	Vertical distance from the horizontal datum plane to the origin of top radius r_{93} .

Table 2 Distances to the Center Axis Lines of the Coupling Pins

Symbol Used	Value Specified	Datum Plane Measured from	Pin Center Axis Line(s) Measured to
r_{97}	$0.30 \mu\text{m}$ ($12 \mu\text{in.}$) maximum	Roughness (R_a) as defined in ISO 4287	r_{97}
x_{91}	$115 \pm 0.05 \text{ mm}$ ($4.5276 \pm 0.002 \text{ in.}$)	bilateral	front right and left primary
x_{92}	$92 \pm 0.05 \text{ mm}$ ($3.6220 \pm 0.002 \text{ in.}$)	bilateral	front right and left secondary
y_{91}	$80 \pm 0.05 \text{ mm}$ ($3.1496 \pm 0.002 \text{ in.}$)	facial	front right and left primary
y_{92}	$120 \pm 0.05 \text{ mm}$ ($4.7244 \pm 0.002 \text{ in.}$)	facial	rear primary
y_{93}	$64 \pm 0.05 \text{ mm}$ ($2.5197 \pm 0.002 \text{ in.}$)	facial	front right and left secondary
y_{94}	$96 \pm 0.05 \text{ mm}$ ($3.7795 \pm 0.002 \text{ in.}$)	facial	rear secondary