

SEMI D17-0200

MECHANICAL SPECIFICATION FOR CASSETTES USED TO SHIP FLAT PANEL DISPLAY GLASS SUBSTRATES

This specification was technically approved by the Global Flat Panel Display – Equipment Committee and is the direct responsibility of the North American Flat Panel Display Committee. Current edition approved by the North American Regional Standards Committee on December 15, 1999. Initially available on SEMI OnLine January 2000; to be published February 2000. Originally published September 1998.

1 Purpose

1.1 This standard specifies selected requirements of the cassettes used to ship flat panel substrates from the substrate finisher to the display maker and between process-added users.

1.2 This document incorporates pertinent dimensional data from SEMI D18, Specification for Cassettes Used for Horizontal Transport and Storage of Flat Panel Display Substrates.

2 Scope

2.1 This standard is intended to set levels of specification for a reusable cassette to ship clean glass substrates and process-added substrates between organizations without compromising substrate integrity. This standard is intended to set an appropriate level of specification that places minimal limits on innovation while ensuring modularity and interchangeability at common mechanical interfaces.

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

3 Limitations

3.1 Substrate size and thickness are not specified so as not to cause constraints on supplier/customer relationships.

4 Referenced Standards

4.1 SEMI Standards

SEMI D18 — Specification for Cassettes Used for Horizontal Transport and Storage of Flat Panel Display Substrates

SEMI E15 — Specification for Tool Load Port

SEMI E44 — Guide for Procurement and Acceptance of Minienvironments

NOTE 1: As listed or revised, all documents cited shall be the latest publications of adopted standards.

5 Terminology

See Figure 1 and Table 1.

5.1 *bilateral datum plane* — a vertical plane that equally bisects the substrate and that is perpendicular to both the horizontal and facial datum planes.

5.2 *carrier capacity* — the number of substrates that a carrier holds.

5.3 *cassette* — as defined in SEMI E44.

5.4 *cassette bottom domain* — volume (below z4 above the horizontal datum plane) that contains the bottom of the cassette.

5.5 *cassette front* — the area between the cassette top and bottom domains through which substrates pass during loading and unloading.

5.6 *cassette placement sensing pads* — surfaces on the bottom of the cassette for triggering optical or mechanical sensors.

5.7 *cassette rear* — the area between the cassette top and bottom domains opposite the cassette front.

5.8 *cassette rear domains* — volumes (from z4 above the horizontal datum plane to z9 above the top substrate) that contain rear columns which prevent the substrates from exiting the cassette rear.

5.9 *cassette side domains* — volumes (from z4 above the horizontal datum plane to z9 above the top substrate) that contain the mizo teeth and mizo plates that support the substrates.

5.10 *cassette top domain* — volume (higher than z9 above the top substrate) that contains the top of the cassette.

5.11 *conveyor rails* — features on the bottom of the cassette for supporting the cassette on roller conveyors.

5.12 *conveying surface* — entire bottom surface of cassette (z15 above the horizontal datum plane), excluding the v-rail, v-groove, and float roller zones, for supporting the cassette on roller conveyors.

5.13 *facial datum plane* — a vertical plane that equally bisects the substrates when the centers of the substrates are aligned and that is parallel to the front

side of the carrier (where substrates are removed or inserted) and is perpendicular to the bilateral datum plane. On tool load ports, it is also parallel to the load face plane (as defined in SEMI E15) on the side of the tool where the carrier is loaded and unloaded.

5.14 *first nominal substrate height* — the distance (z5) from the horizontal datum plane to the first nominal substrate seating plane.

5.15 *first substrate end-effector clearance* — the distance (dimension z9) between the top of the cassette bottom domain and the first nominal substrate seating plane.

5.16 *horizontal datum plane* — load height as defined in SEMI E15.

5.17 *mizo plate* — a plate that contains mizo teeth and may provide structure to the cassette.

5.18 *mizo teeth* — elements that support the substrates in the cassette.

5.19 *nominal center line* — the intersection of the facial and bilateral datum planes.

5.20 *nominal substrate seating plane* — a horizontal plane that contains the nominal bottom surface of the substrate as it rests on the mizo teeth.

5.21 *optical substrate sensing paths* — lines of sight for optically sensing the positions of the substrates.

5.22 *polystyrene latex sphere (PSL)* — Reference material used to calibrate surface inspection systems.

5.23 *robotic handling flanges* — projections on the cassette for handling of the cassette.

5.24 *substrate extraction volume* — the open space for extracting a substrate from the cassette.

5.25 *substrate pick-up zone* — the space that includes the volume in which the substrate bottom may be found.

5.26 *substrate pitch* — the distance between adjacent nominal substrate seating planes.

6 Requirements

6.1 Physical Protection of Substrate

6.1.1 No chipping, scratching, or other damage shall occur under normal handling and shipping conditions.

6.1.2 Substrates shall be contained to prevent excess movement during shipment.

6.2 *Provisions for Tracking and Identification* — Provision for a printed label should be made.

6.3 *Thermal Requirements* — Construction materials shall withstand cleaning temperatures of 90°C,

following which the cassette shall meet the dimensional and other requirements of this specification.

6.4 Loading/Unloading of Substrates

6.4.1 Cassettes furnished to this specification must be compatible with manual and automated loading/unloading systems, while minimizing cassette volume.

6.4.2 Such cassettes must also facilitate transfer of substrates to and from, a Transportation/Automation Cassette.

6.5 *Cassette Physical Alignment Interface* — The cassette should be registered to the tool interface by one of the three following registration types, A, B, or C. The locations of the registration features have been chosen such that all three types may coexist on the same cassette.

6.5.1 *Cassette Physical Alignment Interface Type A* — This interface consists of three features (not specified, but recommended to be inverted V-shaped grooves) placed on the bottom of the cassette that mate with three coupling pins located on the tool interface. The coupling pins are located by dimensions x14 and y13 relative to the bilateral and facial datum planes respectively.

6.5.1.1 *Coupling Pin Shapes* — The physical alignment mechanism on the bottom of the wafer carrier consists of features (not specified in this standard) that mate with three pins underneath. As shown in Figure 5 and defined in Table 3, each pin is radially symmetric about the vertical center axis line and can be seen as the intersection of a cylinder of diameter d1 and a sphere of radius r3 (which might contact a flat plate). An additional rounding radius r5 provides contact with angled mating surfaces, and blend radii r4 and r6 smooth the resulting edges. The final roughness height of the overall surface finish must be less than or equal to r7. Dimensions r2 and z13 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.)

6.5.1.2 The three features on the bottom of the cassette that mate with the coupling pins must provide a lead-in capability that corrects a cassette misalignment of up to 10 mm (0.4 in.) in any horizontal direction, although 15 mm (0.6 in.) is recommended. The exclusion zones for the three coupling features on the cassette are shown in Figure 3 and Table 1 and specified by dimensions x14, z9 and r1.

6.5.2 *Cassette Physical Alignment Interface Type B* — This interface consists of three features, a v-rail, float surface, and facial datum plane v-groove. The v-rail and

float surface are located on the bottom of the cassette and mate with the two v-rail rollers and one float surface roller, respectively, mounted on the tool interface. The facial datum plane v-groove is located about the facial datum plane through the bottom surface of the cassette and mates with the facial datum plane lock pin located on the tool interface shown in Figure 3. The v-rail roller and the float surface roller are located by dimensions x15 and x16 relative to the bilateral datum plane, respectively, shown in Figure 6. The dimension relative to the facial datum plane for the v-rail rollers are not specified but recommended to be located furthest from and symmetrical about the facial datum plane as shown in Figures 3 and 6. The float surface roller revolute axis must lie on the facial datum plane.

6.5.2.1 The v-rail and float surface rollers are defined in Figure 7 and Table 4. Each roller is radially symmetric about the revolute axis. The rollers are circumferentially radiused of dimension r8. The diameter of the rollers is not specified, but the tangential surface created by dimension r8 must lie on the horizontal datum plane. The facial datum plane lock pin radius is equal to r8 and must be positioned into the facial datum plane v-groove to fully constrain the cassette to the facial datum plane. The facial datum plane lock pin is translated out of the facial datum plane v-groove to allow the cassette to be rolled in and out of the tool interface. Although only three rollers are specified, it is recommended to increase the total number of rollers so that the cassette is fully supported while being loaded and unloaded to the tool interface. All rollers, except for the v-rail and float roller, must be positioned so that the tangent of the r8 dimension lies below the horizontal datum plane.

6.5.2.2 The three features on the bottom of the cassette that mate with the rollers and lock pin must provide a lead-in capability that corrects a cassette misalignment of up to 10 mm (0.4 in.) in any horizontal direction, although 15 mm (0.6 in.) is recommended. The v-rail and facial datum plane v-groove are not specified but recommended to be inverted v-shaped grooves. The v-rail is recommended to extend the full length of the cassette from the cassette front to the cassette rear. The float surface is not specified but recommended to be a flat surface extending the full length of the cassette from the cassette front to the cassette rear. The exclusion zones for these features are shown in Figures 3 and 6 and specified by dimensions x15 and x16 through x22.

6.5.3 *Cassette Physical Alignment Interface Type C* — To be developed.

6.6 *Conveyor Rails* — If the cassette is to be transported on roller conveyors, each conveyor rail

should extend the maximum distance from front to back. The exclusion zones for conveyor rails are shown in Figures 3 and 6 and specified by dimensions x13 and x22 and extend to the outer boundary of the cassette.

6.7 *Conveying Surface* — If the cassette is to be transported on roller conveyors that support the entire bottom of the cassette, the bottom surface excluding the v-rail, v-groove, and float roller zones is to be used. The location of this surface with respect to the horizontal datum plane is specified by dimension z3.

6.8 *Substrate Orientation* — The substrates must be horizontal when the carrier is placed on the coupling.

6.9 *Cassette Sides and Rear* — Figure 2 shows a top view of the boundaries of the cassette side domains (which contain the parts of the cassette higher than z4 above the horizontal datum plane and lower than z9 above the top substrate). Table 1 defines the dimensions shown in this and following figures.

6.10 *Cassette Top* — The boundaries of the cassette top domain contain any part of the cassette higher than z9 above the top substrate.

6.11 *Cassette Bottom* — Figure 3 shows a bottom view of the boundaries of the cassette bottom domain (which contains any part of the cassette lower than z4 above the horizontal datum plane). When the cassette is fully down, the cassette placement sensing pads must be z2 above the horizontal datum plane.

6.12 Vertical Dimensions

6.12.1 Figure 4 shows the vertical dimensions of the left half of the cassette as viewed from the rear. Note that z5 (the height of the bottom nominal substrate seating plane above the horizontal datum plane) and z8 (the distance between adjacent nominal substrate seating planes) are given as reference dimensions with no tolerance. This means that the sum of actual height variations in the cassette from the horizontal datum plane to the mizo tooth or slot holding each substrate must be contained within the tolerance of z6 with no further stack-up at each higher substrate.

6.12.2 The open space for the substrate extraction volume is indicated by dimensions x6 and y7 and is symmetric about the bilateral and facial datum planes, respectively. The top of the extraction volume is z7 above the nominal substrate seating plane and its bottom is half of the minimum z7 dimension above the nominal substrate seating plane. The cassette must give extra horizontal clearance once the substrate is picked up from wherever it ends up (within the bounds of the substrate pick-up volume) after transport in the cassette.

6.12.3 The open space for the substrate set-down volume is indicated by dimensions x5 and y6 and is

symmetric about the bilateral and facial datum planes, respectively. The top of this volume is half of z7 above the nominal substrate seating plane and its bottom is z6 above the nominal substrate seating plane. The substrate should be placed within the bounds of the substrate set-down volume to avoid touching the edge of the substrate to the side of the cassette.

6.12.4 The substrate pickup zone is defined by an area indicated by dimensions x5 and y5 and is symmetric about the bilateral and facial datum planes, respectively. Its top and bottom are the upper and lower tolerance of z6 around the nominal substrate seating plane. If a substrate is placed in the substrate set-down volume and is then pushed to the rear of the cassette, then the entire bottom of the substrate must be contained in the substrate pick-up zone.

6.13 *Particle Generation* — The cassette will not add more than 0.05 particles/cm² of a size $\geq 0.5 \mu\text{m}$ (PSL

equivalent) per substrate pass per shipping cycle. The shipping cycle is to be defined by the customer.

6.14 *Inner and Outer Radii* — All concave features may have as much as a 1 mm (0.04 in.) radius to allow for cleaning and to prevent contaminant build-up. All required convex features (such as the robotic handling flanges and the corners of the cassette top and bottom domains) must also have a minimum radius of 1 mm (0.04 in.) to prevent large stress contacts of the cassette that might cause wear and particles.

6.15 *Dimensional Tolerances* — Width (W), Length (L), and Height (H): $\pm 5 \text{ mm}$

6.16 *Special Design Features*

6.16.1 Compatible with automated cleaning tools.

6.16.2 External features that are compatible with material handling systems such as, but not limited to, Guided Vehicles, Stocker, and Conveyors.

Table 1 Cassette Registration Type A Coupling Pin Dimensions

<i>Symbol Used</i>	<i>Shown In</i>	<i>Dimensions Description</i>	<i>Algebraic Relation or Value</i>
d1	Figure 5	diameter of pin centered on the center axis line	$= 12 \pm 0.05 \text{ mm}$ (0.4724 $\pm$ 0.002 in.)
r2	Figure 5	radial distance from the center axis line to the origin of shoulder radius r5	$= 6 \text{ mm}$ (0.2362 in.)
r3	Figure 5	radial distance from the intersection of the center axis line and z13 to the top of the pin	$= 15 \pm 0.05 \text{ mm}$ (0.5906 $\pm$ 0.002 in.)
r4	Figure 5	blend radius for the intersection of r3 and r5	$= 2 \pm 0.1 \text{ mm}$ (0.0787 $\pm$ 0.004 in.)
r5	Figure 5	radial distance from the intersection of the horizontal datum plane and r2 to the far shoulder of the pin	$= 15 \pm 0.05 \text{ mm}$ (0.5906 $\pm$ 0.002 in.)
r6	Figure 5	blend radius for the intersection of r5 and d1	$= 2 \pm 0.1 \text{ mm}$ (0.0787 $\pm$ 0.004 in.)
r7	Figure 5	roughness (R_a) as defined in ISO 4287	0.30 μm (12 $\mu\text{in.}$) max.
z13	Figure 5	vertical distance from the horizontal datum plane to the origin of top radius r3	$= 2 \pm 0 \text{ mm}$ (0.08 in.)

Table 2 Cassette Registration Type B Roller Pin Dimensions

<i>Symbol Used</i>	<i>Shown In</i>	<i>Dimensions Description</i>	<i>Algebraic Relation or Value</i>
r8	Figure 7	radius about roller circumference revolved about the revolute axis	$= 4.8 \pm 0.12 \text{ mm}$
r9	Figure 7	radius of roller measured from the tangential surface created by r8 to the revolute axis	$\geq 20 \pm 0.12 \text{ mm}$

Table 3 Cassette Side Domains

Symbol Used	Shown In	Datum Measured From	Boundary or Feature Measured To	Algebraic Relation or Value
r1	Figure 3	center of coupling exclusion zone	outside edge of coupling exclusion zone	< 15 mm
x1	Figure 2	bilateral datum plane	encroachment of cassette side domains on substrate extraction volume	$\geq \frac{W * 0.57}{2}$
x2	Figure 2	bilateral datum plane	outside edge of cassette side domains	$\leq W + 37$
x3	Figure 2	bilateral datum plane	inside edge of rear cassette domains	$\geq x1 - 40$
x4	Figure 2	bilateral datum plane	outside edge of rear cassette domains	$\geq \frac{W * 0.57}{2}$
x5	Figure 2	nominal substrate center line	outside edge of substrate pick-up zone	$\geq W + 2$
x6	Figures 2 and 4	nominal substrate center line	encroachment of cassette side domains on substrate extraction volume	$\geq x5$
x7	Figure 2	nominal substrate center line	outside edge of cassette top and bottom domain	$\leq W + 37$
x8	Figure 3	bilateral datum plane	inside edge of cassette sensing pad areas	$= W * 0.71 \pm 5.0 \text{ mm}$
x9	Figure 3	bilateral datum plane	outside edge of cassette sensing pad areas	$= W * 0.78 \pm 5.0 \text{ mm}$
x10	Figure 4	bilateral datum plane	encroachment of cassette top domain on robotic handling flange space	$\leq W * 1.02$
x11	Figure 4	bilateral datum plane	far side of robotic handling flanges	$\leq W * 1.05$
x12	Figure 3	bilateral datum plane	inside edge of conveyor rail exclusion zones	$\geq W * 0.752$
x13	Figure 3	bilateral datum plane	outside edge of conveyor rail exclusion zones	$\leq W * 0.877$
x14	Figure 3	bilateral datum plane	center of coupling exclusion zones	$= W * 0.9455 \pm 0.1 \text{ mm}$
x15	Figures 3 and 6	bilateral datum plane	centerline of v-rail roller	$= W * 0.815 \pm 0.2 \text{ mm}$
x16	Figure 6	bilateral datum plane	centerline of float roller	$= x19 \pm 2.0 \text{ mm}$
x17	Figure 3	bilateral datum plane	inside edge of facial datum plane v-groove	$= W * 0.0245 \pm 0.2 \text{ mm}$
x18	Figure 3	bilateral datum plane	outside edge of facial datum plane v-groove	$= W * 0.020 \pm 0.2 \text{ mm}$
x19	Figure 6	bilateral datum plane	left edge of v-groove exclusion zone	$\geq W * 0.069$
x20	Figure 6	bilateral datum plane	right edge of v-groove exclusion zone	$\geq W * 0.109$
x21	Figure 6	bilateral datum plane	inside edge of float roller exclusion zone	$\leq W * 0.742$
x22	Figure 6	bilateral datum plane	outside edge of float roller exclusion zone	$\geq W * 0.884$
y1	Figure 2	facial datum plane	encroachment of cassette side domain	$\geq L * 0.031$
y2	Figure 2	facial datum plane	encroachment of cassette side domain	$\leq L * 0.454$
y3	Figure 2	facial datum plane	encroachment of cassette side domain	$\geq L * 0.515$
y4	Figure 2	facial datum plane	encroachment of cassette side domain	$\leq L * 0.938$
y5	Figure 2	facial datum plane	outside edge of substrate pick-up volume	$\leq L + 1$
y6	Figure 2	facial datum plane	encroachment of cassette side domains on substrate set-down volume	$\geq L + 1$
y7	Figure 2	facial datum plane	encroachment of cassette side domains on substrate extraction volume	$\geq L + 3$
y8	Figure 2	facial datum plane	boundary of rear cassette domain	$\leq L * 1.12$