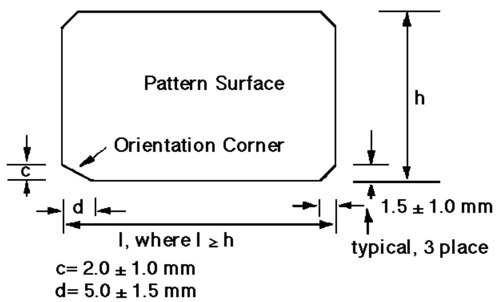

Figure 2
Substrate Corner Dimensions
(shown in 0,0 orientation)

RELATED INFORMATION 1

NOTICE: This related information is not an official part of SEMI D12 and is not intended to modify or supercede the official standard. Rather, this note describes methods for producing FPD substrate edges which may be under development. Publication was authorized by full letter ballot procedures.

R1-1 Current Practice

R1-1.1 The edges of FPD substrates are modified during the substrate manufacturing process so that, in subsequent panel processing, operator safety is improved and particulate generation is minimized. Currently, a "chamfered edge" process is in general use. This modifies the two "corners" of each edge as shown in Figure 1.

R1-2 Future Developments

R1-2.1 Other edge treatments may prove more efficient, and several alternate approaches are under development. Two of these are a "Radiused Edge" and "Rounded Edge," shown in Figures R1-1 and R1-2. The radiused edge initially appears simple, but appropriate values of R, for various substrate thicknesses (T), are being examined for manufacturability. For cases where R > T, the proper "edge blend," where R intercepts the substrate pattern and back surfaces, may prove difficult to define and control.

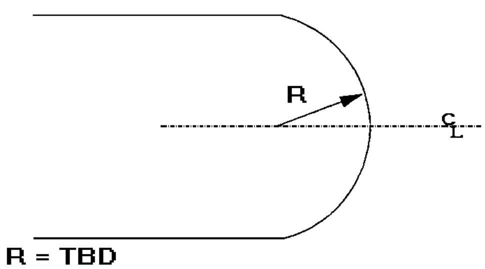

Figure R1-1
Radiused Edge

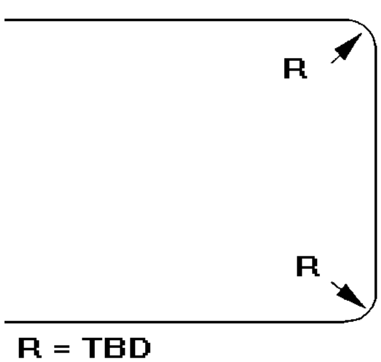

Figure R1-2
Rounded Edge

SEMI

SEMI D13-1101
TERMINOLOGY FOR FPD COLOR FILTER ASSEMBLIES

These specifications were technically approved by the Committee and are the direct responsibility of the Japanese FPD Materials and Components Committee. Current edition approved by the Japanese Regional Standards Committee on April 19, 2001. Initially available at www.semi.org August 2001; to be published November 2001. This document was originally published in 1995.

1 Purpose

1.1 These terms and definitions describe various elements and characteristics of FPD color filter (CF) assemblies. They are intended to assist in future CF standardization activity.

2 Scope

2.1 Color filters comprise the front plate assembly in a colored flat panel display. They consist of a number of material layers such as glass substrate, color filter layer, black matrix, overcoat layer, and Indium Tin Oxide (ITO) films. Each of these layers has various properties which may need to be specified, produced, controlled, and characterized. This document provides an overview of these layers, with terms and definitions for selected elements, and indicates the appearance of some color filter defects. This document may be useful in developing material specifications, inspection criteria, and test methods.

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

3 Limitations

3.1 This document does not contain detailed measuring and test methods. Such methods may be developed separately, and references to them may be incorporated into color filter specification documents where appropriate. The assembly of color filters into a flat panel display assembly is not covered herein.

4 Related Standards

4.1 *SEMI Standards*

SEMI D3 — Quality Area Specification for Flat Panel Display Substrates

SEMI D20 — Defect Terminology for Flat Panel Display Masks

SEMI D21 — Terminology for Flat Panel Display Masks

SEMI M21 — Specification for Assigning Addresses to Rectangular Elements in a Cartesian Array

5 Color Filter Elements (see Figure 1)

5.1 *alignment control projection* — a rib-shaped protrusion created within the display pixel on the color filter film surface for the purpose of controlling alignment direction of the liquid crystal.

5.2 *backside ITO film* — a thin film of Indium Tin Oxide formed on the glass surface on the back of the color filter substrate.

5.3 *black matrix (BM)* — layer which blocks light transmission. It provides a boundary between color filter pixels, preventing the transmitting light between adjacent pixels.

5.4 *color filter layer* — colored layer through which light is transmitted. It is deposited in three colors—red, green, and blue—which are patterned to produce an array of contiguous, rectangular, or square-shaped pixels.

5.5 *glass substrate* — the base material onto which black matrix and color filter layer are deposited. Also called the Front Plate. After assembly into a Display, its back surface faces the observer. See SEMI D3 and SEMI D21 for parameters, definitions, and dimensional specifications.

5.6 *ITO Film* — a thin film of Indium Tin Oxide.

5.7 *overcoat layer* — transparent material deposited over the color filter material. This provides a smooth surface and enough adhesion for subsequent ITO material deposition.

5.8 *post spacer* — a fixed pillar-shaped spacer formed outside of the pixel opening.

5.9 *reflective film* — a light-reflective layer created on the color filter substrate below the color filter layer.

6 Color Filter Pixel (RGB) Layout

6.1 The color filter pixels are arranged in one of several array patterns. The array is constructed from m vertical columns and n horizontal rows of identical pixels of dimensions a horizontally and b vertically. The number of pixels in different rows and columns may vary to suit the application. These are illustrated in Figure 2.

7 Color Filter Types and Fabrication Methods

7.1 *Fabrication Methods*

7.1.1 *photolithography* — Patterning method by using micro photolithograph machines and photopatternable materials. Precise patterns can be formed.

7.1.2 *color photoresist method* — Defined as color photoresist, it is possible to create a pattern through a direct exposure method using color pigment or dye dispersed on a photoresist.

7.1.3 *dyeing* — Dyeable photoresist materials are patterned by photolithographic image processing. These patterned materials are dyed by a special method. The various colors may be introduced sequentially.

7.1.4 *etching* — Dye or pigment-dispersed color material is coated on substrate, and it is patterned by photolithographic etching method.

7.1.5 *printing* — Pigment-dispersed color ink is placed and patterned on the substrate by printing method.

7.1.6 *electric deposition* — Micro cells capsulating pigment particles are dispersed in water solvent and deposited on the selected electrode on glass substrate.

7.1.6.1 *patterned ITO method* — Color filter layers are accumulated using a micell distribution liquid for each color of the ITO pattern formed according to the various RGB color filter layers.

7.1.6.2 *resist pattern method* — Color filter layers are accumulated on non-patterned ITO film by using a micell distribution liquid through openings (windows) in the photoresist according to the RGB pattern.

7.1.7 *multi-layer interference CF (Dichroic CF)* — Multiple layers of inorganic transparent thin films are patterned by photolithography method.

7.1.8 *ink jet method* — Color filter layers are formed by pigment or dye-colored ink blown out from an ink jet head nozzle onto the substrate pixels.

7.1.9 *others* — Fabrication methods other than those above.

7.2 *coloring materials* — Other than the multi-layer interference method, these are formed using pigments or dyes.

7.2.1 *pigment* — This can be pigment in fine powder form dispersed into plastic, or it can be pigment in fine powder form then capsulated in micell (microcell) and dispersed in a water solution.

7.2.2 *dye* — Patterned plastic or gelatin is colored using dye. Also, dyed plastic or gelatin can be patterned using photolithography.

7.2.3 *inorganic permeable thin film* — A clear thin film of inorganic material formed through methods such as vacuum deposition or sputtering.

7.2.4 *Other*

Table 1 Color Filter Fabrication Methods and Materials

Fabrication Method (main category)	*Fabrication Method (subcategory)*	*Material*
Photolithography	Color Resist Method	Pigment/Dye
	Dyeing Method	Dye
	Etching Method	Pigment/Dye
Printing		Pigment
Electric Disposition	Patterned-ITO Method	Pigment
	Resist Pattern Method	Pigment
Mulit-layer Interference	Vacuum Evaporation Method	Inorganic Material
	Sputtering Method	Inorganic Materials
Ink Jet Method		Pigment/Dye

8 Visible Defects

8.1 *black defect* — Black dot-shaped defect existing in the quality area that can be detected using transmitted light.

8.2 *white defect* — White dot-shaped defect existing in the quality area that can be detected using transmitted light.

8.3 *BM (Black Matrix) spot* — A dot-shaped defect caused by extraneous BM material deposited within the quality area, not related to the BM pattern.

8.4 *BM (Black Matrix) pin hole or pinhole* — A dot-shaped defect located within the BM pattern.

8.5 *decolorant* — The absence of a color element in a normally tri-colored pixel. This may occur in a partial area of one pixel.

8.6 *color non-uniformity* — Variation in brightness or chromaticity within the quality area.

8.7 *color spot* — A mixing or overlapping of color materials within an RGB pixel.

8.8 *reflectance non-uniformity* — Variation in reflectance of the surface of color filter within the quality area.

8.9 *hill* — A gently sloping projection smaller than the cell gap width. Will cause cell gap defect.

8.10 *stain* — A small-area spot, with no appreciable thickness, on the surface of some color filter material. It may be caused by introduction of foreign substances during processing.

8.11 *layer particle* — A three-dimensional substance adhered to the surface of some color filter layer material.

8.12 *protrusion* — A large, severe projection larger than the cell gap width. Will cause cell gap defect.

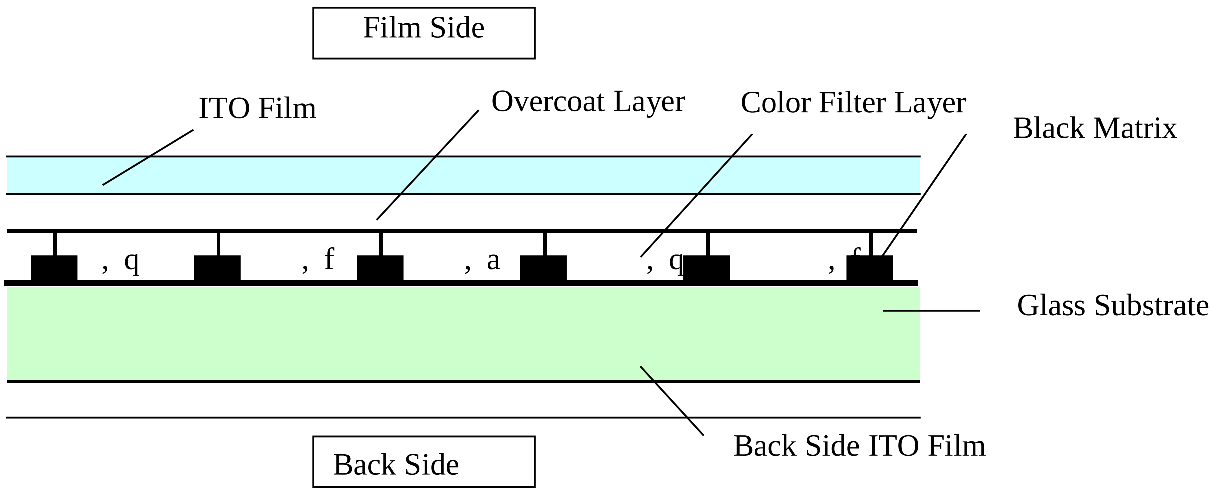

Figure 1
Color Filter Elements

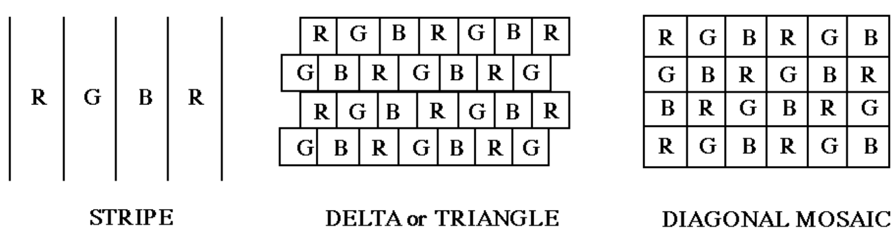

Figure 2
Color Filter Array Patterns

NOTICE: SEMI makes no warranties or representations as to the suitability of the standards set forth herein for any particular application. The determination of the suitability 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.

SEMI D15-1296 (Reapproved 0703)
FPD GLASS SUBSTRATE SURFACE WAVINESS MEASUREMENT METHOD

This method was technically approved by the Global Flat Panel Display Committee and is the direct responsibility of the Japanese FPD Materials and Components Committee. Current edition approved by the Japanese Regional Standards Committee on April 28, 2003. Initially available at www.semi.org June 2003; to be published July 2003. Originally published December 1996.

1 Purpose

1.1 This document covers the measurement of FPD glass substrate surface waviness by measuring instruments employing mechanical stylus, optical stylus, and optical interferometric measurement methods.

2 Scope

2.1 This test method is applicable to the documentation of waviness of all types of glass substrates used for flat panel displays.

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 D3 — Quality Area Specification for Flat Panel Display Substrates

SEMI D4 — Method for Referencing Flat Panel Display Substrates

SEMI D9 — Terminology for FPD Substrates

3.2 *ISO Documents*[1]

ISO 1101 — Technical drawings — Geometrical Tolerances — Tolerances of Form, Orientation, Location and Run-Out — Generalities, definitions, symbols, indications on drawings.

ISO 3274 — Instruments for the Measurement of Surface Roughness by the Profile Method — Contact (Stylus) Instruments of Consecutive Profile Transformation

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

4 Terminology

4.1 *Definitions*

4.1.1 *2CR filter* — a profile filter equivalent to a series of two CR filter circuits (see ISO 3274).

4.1.1.1 The standard transmission coefficients at cut-off wavelength are 75%.

4.1.2 *bandpass filtered waviness profile* — a profile obtained by removing the long wavelength form components and short wavelength roughness components from a sampled real profile (see Figure 2).

4.1.3 *evaluation length, L_e* — the length of the profile used for assessing the waviness profile under evaluation. A traced length after deduction of both pre-travel and post-travel.

4.1.4 *FPD waviness, W_{fpd}* — moving minimum zone method straightness of waviness. The maximum value of a minimum zone method straightness of a certain sampling length within an evaluation length. An approximation in Appendix 1 can be used as well.

4.1.4.1 *Discussion* — In fact, it takes a long time to calculate W_{fpd} by the above method because of too large a number of sampling lengths which are all sampled data points within evaluation length minus the number of data points within a sampling length.

4.1.4.2 Therefore, is recommended that the computer approximation method described in Appendix 1 be used to save time.

4.1.4.3 Another manual evaluation method is the following:

1. Prepare the template which has a sampling length width window.
2. Scan the template with fitting properly on the recorded chart of bandpass-filtered waviness profile through the evaluation length.
3. Read out every straightness of the profile within the window of the template on every fitted position.
4. The maximum value of all of the readings is W_{fpd}.

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

4.1.5 *long wavelength cut-off, λ_L* — wavelength that the attenuation ratio of its amplitude becomes a standard value when the traced profile is passed through the high-pass wavelength filter which eliminates form element.

4.1.6 *minimum zone method straightness* — the smallest distance between two parallel straight lines between which all of objective profile is included (see ISO 1101, Section 3.1).

4.1.7 *optical interferometric flatness Measuring instrument* — instrument that analyzes the surface irregularities of a target, from the distribution of light intensity of laser interferometer between the target surface and datum flat.

4.1.8 *optical stylus method measuring instrument* — instrument that uses the same profile method that a stylus method instrument uses. This instrument uses the displacement transducer to apply the spotlight to the target surface instead of using the stylus to apply the spotlight.

4.1.9 *phase correct filter* — a profile filter which does not cause phase shifts between total profile and filtered profile.

4.1.9.1 The standard transmission coefficients at cut-off wavelength are 50%.

4.1.10 *pre-travel (and post-travel), L_p* — eliminated portions from a traced length for avoiding the profile distortion caused by transient response of the cut-off filter.

4.1.10.1 Recommended pre-travel with 2CR filter is double the long wavelength cut-off, λ_L, at the beginning of the traced length and no post-travel.

4.1.10.2 Recommended both pre-travel and post-travel with phase correct filter are the same as long wavelength cut-off, λ_L.

4.1.11 *real profile* — An intersection of a target surface with a plane perpendicular to the surface (see Figure 2).

4.1.12 *sampling length, L_s* — the length of the profile for calculations of waviness parameters in an evaluation length (L_e).

4.1.13 *short wavelength cut-off, λ_c* — wavelength that the attenuation ratio of its amplitude becomes a standard value when the traced profile is passed through the low-pass wavelength filter which eliminates roughness element.

4.1.14 *streak* — a defect whose appearance is a transparent line on the glass substrate surface. It can either be caused by a micro surface discontinuity or a cord due to the heterogeneity of glass composition.

4.1.15 *stylus method measuring instrument* — instrument that traces on a section of a surface by a stylus, records irregularity on the surface in an enlarged form, and indicates its amplitude as parameters (see ISO 3274).

4.1.16 *traced length* — total traversing length of stylus or spotlight.

4.1.17 *waviness* — components of surface irregularities with spatial wavelength intermediate between long wavelength (flatness) and short wavelength (roughness) (see Figure 2).

4.1.17.1 *Discussion* — Especially on FPD substrates, those components cause visual irregularity of the shade of the panel due to deviations of the cell gap.

4.1.17.2 Waviness includes not only periodic waviness, but also streaks.

5 Measuring Instrument

5.1 *Method* — Stylus method measuring instrument, optical stylus instrument, or optical interferometric flatness measuring instrument.

5.2 *Stylus or Spotlight*

5.2.1 *Shape* — circular cone or sphere

5.2.2 *Tip Radius* — from 2µm to 0.8 mm (0.03 inch)

5.2.3 *Spotlight Diameter of Optical Stylus Method* — 0.2 mm (0.0079 inch) or less

5.2.4 *Horizontal Resolution of Interferometer* — 0.2 mm (0.0079 inch) or less

5.3 *Measuring Force for Stylus Method* — 4 mN (0.4 gf) or less

5.4 *Sampling Interval* — 0.2 mm (0.0079 inch) or less

5.5 *Profile Filter* — 2CR filter or phase correct filter

5.5.1 *Discussion* — The filtering method should be specified because the evaluated value of W_{fpd} with phase correct filter will be smaller than that with 2CR filter.

6 Measurement Conditions

6.1 *Target Surface* — The pattern surface (see SEMI D4, Section 5)

6.2 *Long Wavelength Cut-Off, λ_L* — 8 mm (0.3 inch) or 25 mm (1 inch)

6.3 *Short Wavelength Cut-Off, λ_c* — 0.8 mm (0.03 inch)

6.4 *Evaluation Length, L_e* — Is recommended to be Q_{ax} or Q_{ay}, total edge length of quality area of a substrate. If

Q_{ax} or Q_{ay} is longer than (L_t – 2*λ_L), L_e is recommended to be (L_t – 2*λ_L).

6.4.1 If the measurable length of the instrument is shorter than the recommended length, then the overlapped section, which contains several traced profiles covering all of the recommended lengths, should be used to evaluate W_{fpd}.

6.5 *Sampling Length, L_s* — Is recommended to be 20 mm (0.79 inch) at λ_L = 8 mm (0.3 inch) or 25 mm (1 inch) at λ_L = 25 mm (1 inch).

7 Test Specimen

7.1 A clean FPD glass substrate. No strain or oils should be seen by the naked eye with fluorescent lamps or incandescent lamps.

8 Measurement Procedure

8.1 Put the specimen on the leveled stage of the instrument without bend and leave for five minutes or more to condition the specimen to room temperature.

8.2 Put the stylus on the specimen and measure a real profile parallel to the edge of substrate by tracing the surface.

8.3 Apply the bandpass profile filter to the real profile and get the bandpass-filtered waviness profile.

8.4 *Calculate the FPD Waviness* — W_{fpd} with manual template method or computer-aided method from the bandpass-filtered waviness profile.

9 Reporting Results

9.1 *Measurement Location and Direction* — Describe the measurement location and direction on the report; for example, measure along the following two directions:

a. the center line of the specimen parallel to the long edge

b. the center line of the specimen parallel to the short edge

9.2 *Interpretation of Results* — Show the measurement results in units of 0.01 µm (micron) and count fractions of 0.5 and over as a unit and cut away the rest.

Table 1 Example: Measurement Result

Direction	L_e	W_{lcd}
Long Edge	**mm	0. **µm
Short Edge	**mm	0. **µm

Measuring Condition

Surface — The pattern surface

Instrument — Stylus method (type of instrument)

Long cut-off, λ_L — 8 mm

Short cut-off, λ_c — 0.08 mm

Sampling length, L_s — 20 mm

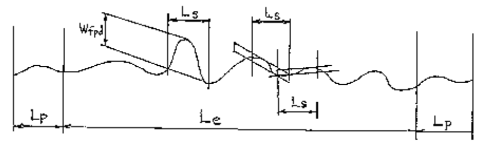

Figure 1
Explanation of L_e, L_p, L_s

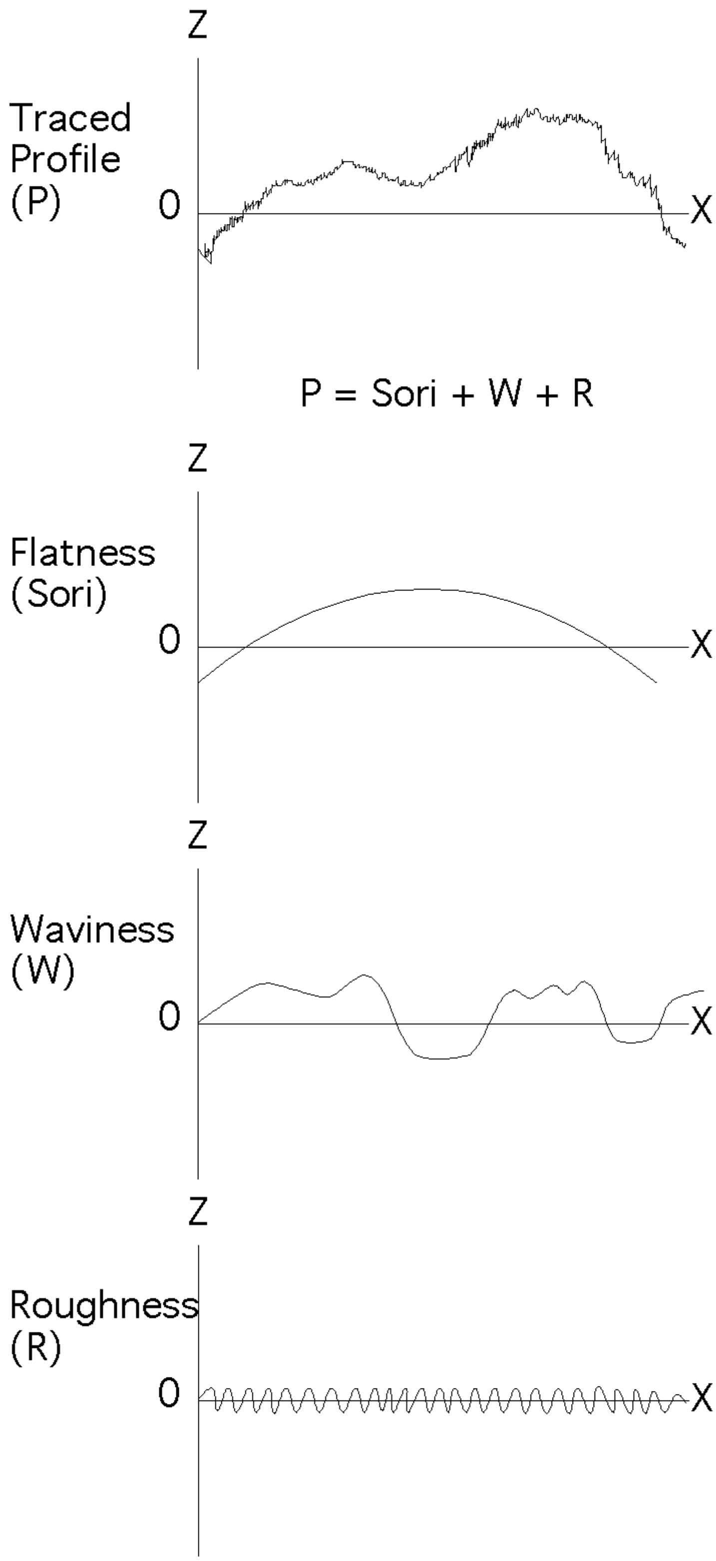

Figure 2
Explanation of Surface Profiles

APPENDIX 1

NOTICE: This appendix was approved as an official part of SEMI D15 by full letter ballot procedures.

A1-1 Purpose

A1-1.1 FPD waviness W_{fpd} requires a large amount of calculation on this standard.

A1-1.2 Therefore, the approximate calculation method shown below can be used instead.

A1-2 Terminology

A1-2.1 *local peak of profile* — the highest point of profile between two adjacent minima of the profile.

A1-2.2 *local valley of profile* — the lowest point of profile between two adjacent maxima of the profile.

A1-2.3 *window* — a sampling length for evaluation.

A1-3 Calculation Method

A1-3.1 Search all local peaks and local valleys within the evaluation length.

A1-3.2 Calculation of a waviness value based on a local peak.

A1-3.2.1 Calculation of a waviness value, W_{iL}, based in the left window of a local peak, P_i (position X_i).

1. Open the left window ($L_1 - X_i$) with $L_s/2$ width from the local peak, P_i.
2. Search the lowest point, V_L (position L_2), in the window ($L_1 - X_i$).
3. Find the point $L_3 = L_2 + L_s$ and open the window ($X_i - L_3$).
4. Search the lowest point, V_{LR}, in the window ($X_i - L_3$).
5. $W_{iL} = |Z_i - (V_L + V_{LR})/2|$

A1-3.2.2 Calculation of a waviness value, Wi_R, based in the right window of a local peak, P_i.

1. Open the right window ($X_i - R_1$) with $L_s/2$ width from the local peak, P_i.
2. Search the lowest point, VR (position R_2), in the window ($X_i - R_1$).
3. Find the point $R_3 = R_2$ - Ls and open the window ($R_3 - X_i$).
4. Search the lowest point, V_{RL}, in the window ($R_3 - X_i$).
5. $W_{iR} = |Z_i - (V_R + V_{RL})/2|$

A1-3.2.3 Calculate W_{iL} and W_{iR} on all local peaks, P_i, then calculate the maximum value, WP_{max}.

$WP_{max} = \max\{W_{iL}, W_{iR}\}$ (i = 1 to n)

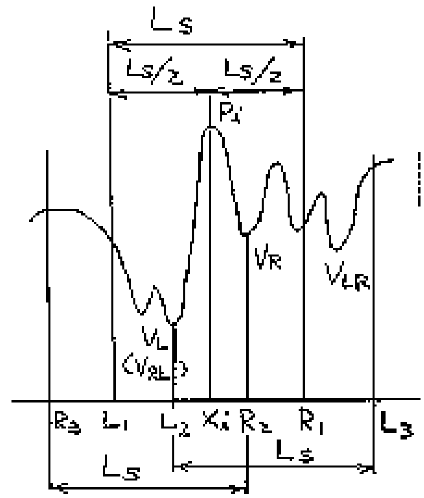

Figure A1-1
Calculation Points of a Local Peak

A1-3.3 Calculation of a waviness value based on a local valley.

A1-3.3.1 Calculation of a waviness value, W_{jL}, based in the left window of a local valley, V_j (position X_j).

1. Open the left window ($L_1 - X_j$) with $L_s/2$ width from the local valley, V_j.
2. Search the highest point, P_L (position L_2), in the window ($L_1 - X_j$).
3. Find the point $L_3 = L_2 + L_s$ and open the window ($X_j - L_3$).
4. Search the highest point, P_{LR}, in the window ($X_j - L_3$).
5. $W_{jL} = |Z_j - (P_L + P_{LR})/2|$

A1-3.3.2 Calculation of a waviness value, W_{jR}, based in the right window of a local valley, V_j.

1. Open the right window ($X_j - R_1$) with $L_s/2$ width from the local valley, V_j.
2. Search the highest point, P_R (position R_2), in the window ($X_j - R_1$).
3. Find the point $R_3 = R_2 - L_s$ and open the window ($R_3 - X_j$).

4. Search the highest point, P_{RL}, in the window ($R_3 - X_j$).

5. $W_{jR} = |Z_j - (P_R + P_{RL})/2|$

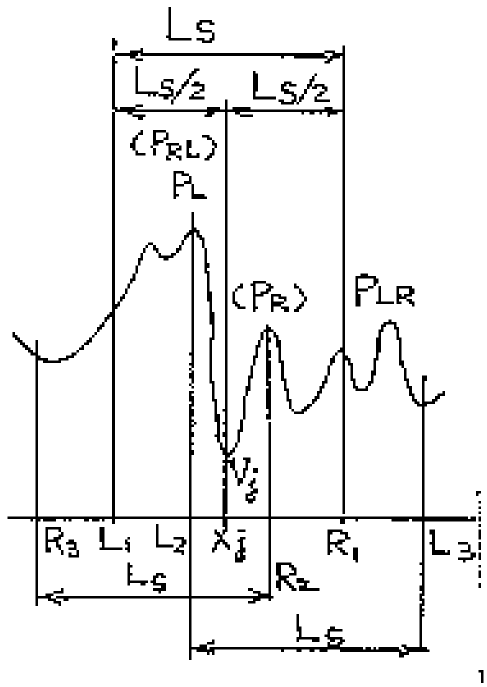

Figure A1-2
Calculating Points of a Local Valley

A1-3.3.3 Calculate W_{jL} and W_jR on all local valleys, V_j, then calculate the maximum value, WV_{max}.

$WV_{max} = \max\{W_{jL}, W_{jR}\}$ (j = 1 to n)

A1-3.4 *Calculation of FPD Waviness, W_{fpd}* — Calculate the maximum value among all maximum values calculated in Sections 3.2.3 and 3.3.3.

$W_{fpd} = \max\{WP_{max}, WV_{max}\}$

SEMI D16-0998
SPECIFICATION FOR MECHANICAL INTERFACE BETWEEN FLAT PANEL DISPLAY MATERIAL HANDLING SYSTEM AND TOOL PORT

This specification was technically approved by the 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 Stadards Committee July 1998. Published on SEMI OnLine September 1998; print version published September 1998.

1 Purpose

1.1 This specification defines feature requirements on and about tool ports of process tools used in manufacturing of flat panel displays. These feature requirements facilitate the interfacing of transport equipment to the tool by standardizing the feature requirements. Such standards are intended to promote cost-effective interfacing while preserving freedom of choice in material handling equipment.

2 Scope

2.1 These standards define mechanical features on or about the process tool port, and in front of or on the tool face. Although these features are intended for specific functions, they do not set design requirements for any particular functionality. The interface requirements are meant to be universal and to avoid the promotion of any particular form of transport. Therefore, they are useful for the interfacing of continuous direct WIP transports, such as conveyors, or discrete vehicles of foreseeable future design, such as AGVs, to the process tool port. The dimensions incorporated in the standard apply to single panel handling as well as substrate carriers.

3 Limitations

3.1 Current display manufacturing utilizes several substrate sizes, many of them "non-standard." This proposed interface specification includes dimensions for the substrate sizes of 550 × 650 mm, and 600 × 720 mm and anticipates the establishment of standard dimension in future substrate sizes. For these future substrate sizes, a universal dimensioning method based on substrate size may be possible.

4 Referenced Documents

4.1 *SEMI Standards*

SEMI D5 — Standard Size for Flat Panel Display Substrates

SEMI D11 — Specification for Flat Panel Display Glass Substrate Cassettes

5 Terminology

5.1 *Definitions*

5.1.1 *facial datum plane* — the plane coincident with the front face of the tool and perpendicular to the horizontal and vertical datum planes.

5.1.2 *horizontal datum plane* — the plane coincident with the top surface of the floor and perpendicular to the facial datum plane of the tool.

5.1.3 *vertical datum plane* — the plane that bisects the tool port and is perpendicular to the horizontal and facial datum planes.

5.2 *Functional Description of Dimensions*

5.2.1 *X1* — width of exclusion zone reserved for vertical material handling devices; maximum.

5.2.2 *X2* — width of the tool port at Z7 below tool load plane. This defines the horizontal limit of the tool port in the x-y plane at that level, beyond which space is reserved for transport equipment; maximum.

5.2.3 *Y1* — maximum tool port protrusion from the tool face. This dimension defines the limits of tool port attachments.

5.2.4 *Y2* — the centerline distance between substrate and tool face when the substrate is delivered to the tool port; ± 10 mm.

5.2.5 *Y3* — depth of the exclusion zone used for PGV cart alignment devices; maximum.

5.2.6 *Y4* — overhead exclusion zone for ceiling-hung material delivery systems; maximum.

5.2.7 *Y5* — maximum protrusion from tool port. May be used for mounting docking devices (mostly PGVs).

5.2.8 *Z1* — height of tool port; ± 10 mm (load plane of reference).

5.2.9 *Z2* — the lowest point on an overhead delivery system; minimum.

5.2.10 *Z3* — the maximum volume height of an overhead delivery system. This dimension extends the full width of the tool.

5.2.11 *Z4* — the height of the exclusion zone used for PGV cart alignment devices.

5.2.12 *Z5* — the maximum height of the protrusion used for docking devices.

5.2.13 *Z6* — the location for the bottom plane of the first substrate. This dimension is not specified in this document.

5.2.14 *Z7* — height of exclusion zones used by conveyor rails and fork lifts; maximum.

6 Requirements

6.1 Dimensions and tolerances of the required features are specified in Table 1 and Figures 1A and 1B.

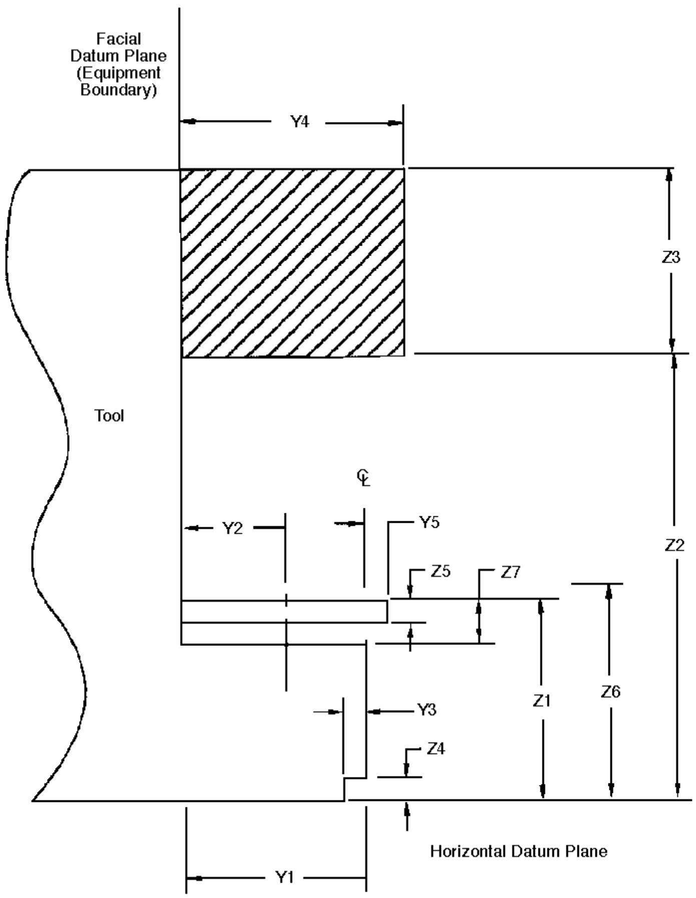

Figure 1A
Proposed Transport System to Tool Interface

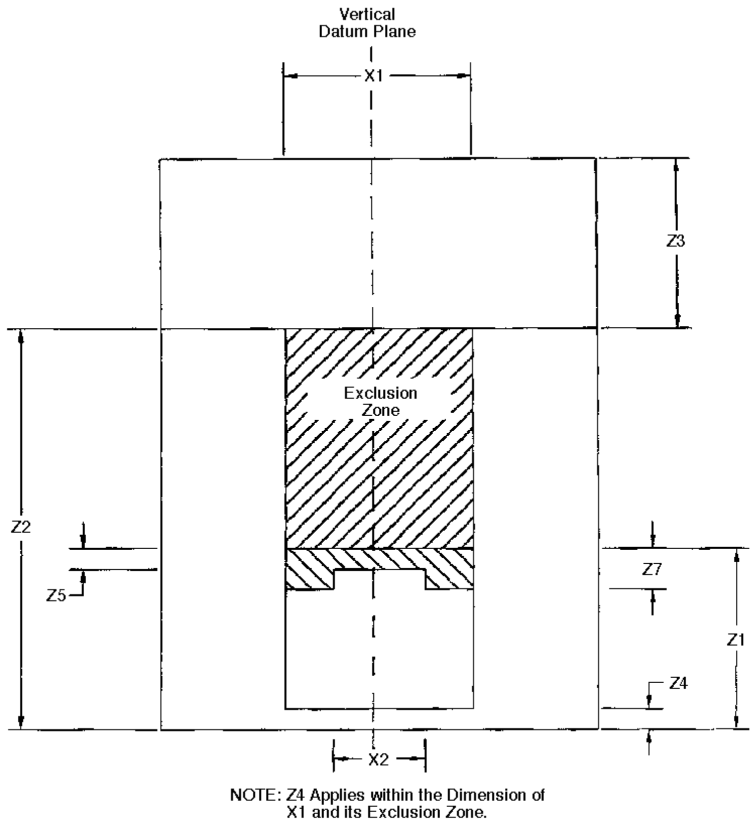

Figure 1B
Proposed Transport System to Tool Interface

6.2 Centerline location of the substrate, as it is delivered by the material handling equipment, with respect to the tool face may not coincide with the centerline location of the substrate when the latter is finally positioned on the tool port for substrate handling.

6.3 Substrate delivery is to be horizontal, active (pattern) face up.

6.4 The single substrate or carrier is to have a horizontal loading orientation with shorter side parallel to the tool face plane.

6.5 Load height of the single substrate or carrier shall be adjustable on the material handling system within 20 (± 10) mm of the nominal height.

6.6 There should be no obstruction between the load port and the material delivery system within the defined adjustable range of the load port height.

6.7 Load and unload mechanisms must allow operator-assisted loading. This implies clearance space for the operator, as well as mechanisms that allow manual override.

Table 1 Substrate Edge Length, Interface Dimensions, and Tolerances (mm)

	Interface Dimensions and Tolerances													
Edge Length (mm)	*X1 max.*	*X2 max.*	*Y1 max.*	*Y2 ± 10 mm*	*Y3 max.*	*Y4 max.*	*Y5 max.*	*Z1 ± 10 mm*	*Z2 min.*	*Z3 max.*	*Z4 max.*	*Z5 max.*	*Z6*	*Z7 max.*
550 × 650	925	450	800	400	100	1000	100	900	2000	850	100	105	tba	200
600 × 720	980	500	865	435	100	1065	100	900	2000	850	100	105	tba	200
960 × 1100	1450	900	1360	650	100	1500	100	900	2000	850	100	105	tba	200

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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 90ºC, 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 dimensiona 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 hither 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/cm^2 of a size ≥ 0.5 µm (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): ± 5 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

Symbol Used	*Shown In*	*Dimensions Description*	*Algebraic Relation or Value*
d1	Figure 5	diameter of pin centered on the center axis line	= 12 ± 0.05 mm (0.4724 ± 0.002 in.)
r2	Figure 5	radial distance from the center axis line to the origin of shoulder radius *r*5	= 6 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 ± 0.05 mm (0.5906 ± 0.002 in.)
r4	Figure 5	blend radius for the intersection of *r*3 and *r*5	= 2 ± 0.1 mm (0.0787 ± 0.004 in.)
r5	Figure 5	radial distance from the intersection of the horizontal datum plane and *r*2 to the far shoulder of the pin	= 15 ± 0.05 mm (0.5906 ± 0.002 in.)
r6	Figure 5	blend radius for the intersection of *r*5 and *d*1	= 2 ± 0.1 mm (0.0787 ± 0.004 in.)
r7	Figure 5	roughness (R_a) as defined in ISO 4287	0.30 µm (12 µin.) max.
z13	Figure 5	vertical distance from the horizontal datum plane to the origin of top radius *r*3	= 2 ± 0 mm (0.08 in.)

Table 2 Cassette Registration Type B Roller Pin Dimensions

Symbol Used	*Shown In*	*Dimensions Description*	*Algebraic Relation or Value*
r8	Figure 7	radius about roller circumference revolved about the revolute axis	= 4.8 ± 0.12 mm
r9	Figure 7	radius of roller measured from the tangential surface created by *r*8 to the revolute axis	≥ 20 ± 0.12 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	≤ W + 37
x3	Figure 2	bilateral datum plane	inside edge of rear cassette domains	≥ 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	≥ W + 2
x6	Figures 2 and 4	nominal substrate center line	encroachment of cassette side domains on substrate extraction volume	≥ x5
x7	Figure 2	nominal substrate center line	outside edge of cassette top and bottom domain	≤ W + 37
x8	Figure 3	bilateral datum plane	inside edge of cassette sensing pad areas	= W * 0.71 ± 5.0 mm
x9	Figure 3	bilateral datum plane	outside edge of cassette sensing pad areas	= W * 0.78 ± 5.0 mm
x10	Figure 4	bilateral datum plane	encroachment of cassette top domain on robotic handling flange space	≤ W * 1.02
x11	Figure 4	bilateral datum plane	far side of robotic handling flanges	≤ W * 1.05
x12	Figure 3	bilateral datum plane	inside edge of conveyor rail exclusion zones	≥ W * 0.752
x13	Figure 3	bilateral datum plane	outside edge of conveyor rail exclusion zones	≤ W * 0.877
x14	Figure 3	bilateral datum plane	center of coupling exclusion zones	= W * 0.9455 ± 0.1 mm
x15	Figures 3 and 6	bilateral datum plane	centerline of v-rail roller	= W * 0.815 ± 0.2 mm
x16	Figure 6	bilateral datum plane	centerline of float roller	= x19 ± 2.0 mm
x17	Figure 3	bilateral datum plane	inside edge of facial datum plane v-groove	= W * 0.0245 ± 0.2 mm
x18	Figure 3	bilateral datum plane	outside edge of facial datum plane v-groove	= W * 0.020 ± 0.2 mm
x19	Figure 6	bilateral datum plane	left edge of v-groove exclusion zone	≥ W * 0.069
x20	Figure 6	bilateral datum plane	right edge of v-groove exclusion zone	≥ W * 0.109
x21	Figure 6	bilateral datum plane	inside edge of float roller exclusion zone	≤ W * 0.742
x22	Figure 6	bilateral datum plane	outside edge of float roller exclusion zone	≥ W * 0.884
y1	Figure 2	facial datum plane	encroachment of cassette side domain	≥ L * 0.031
y2	Figure 2	facial datum plane	encroachment of cassette side domain	≤ L * 0.454
y3	Figure 2	facial datum plane	encroachment of cassette side domain	≥ L * 0.515
y4	Figure 2	facial datum plane	encroachment of cassette side domain	≤ L * 0.938
y5	Figure 2	facial datum plane	outside edge of substrate pick-up volume	≤ L + 1
y6	Figure 2	facial datum plane	encroachment of cassette side domains on substrate set-down volume	≥ L + 1
y7	Figure 2	facial datum plane	encroachment of cassette side domains on substrate extraction volume	≥ L + 3
y8	Figure 2	facial datum plane	boundary of rear cassette domain	≤ L * 1.12

Symbol Used	*Shown In*	*Datum Measured From*	*Boundary or Feature Measured To*	*Algebraic Relation or Value*
y9	Figure 2	facial datum plane	outside edge of cassette top and bottom plate domain	≤ L * 1.21
y10	Figure 3	facial datum plane	inside edge of cassette top and bottom plate indent	≤ L * 0.985
y11	Figure 3	facial datum plane	inside edge of cassette sensing pad areas	≥ L * 0.708
y12	Figure 3	facial datum plane	outside edge of cassette sensing pad areas	≤ L * 0.954
y13	Figure 3	facial datum plane	center of coupling exclusion zones	= L * 0.923 ± 0.1 mm
z1	Figure 4	horizontal datum plane	bottom of cassette bottom domain	≥ 2 mm
z2	Figure 4	horizontal datum plane	bottom of cassette sensing pads	= 3 ± 0.5 mm
z3	Figure 6	horizontal datum plane	bottom surface of conveying surface	= 2 ± 0.5 mm
z4	Figure 4	horizontal datum plane	top of cassette bottom domain	≤ 40 mm
z5	Figure 4	horizontal datum plane	bottom nominal substrate seating plane	= 60 mm
z6	Figure 4	each nominal substrate seating plane	bottom of substrate	= ± 0.5 mm
z7	Figure 4	each nominal substrate seating plane	encroachment of cassette side domains on clearance above the substrate	See Table 4.
z8	Figure 4	each nominal substrate seating plane	adjacent nominal substrate seating planes	See Table 4.
z9	Figure 4	top nominal substrate seating plane	bottom of cassette top domain	≥ z7 + 1 mm
z10	Figure 4	top nominal substrate seating plane	bottom of clearance under robotic handling flange	≤ 30 mm
z11	Figure 4	top nominal substrate seating plane	top of clearance under robotic handling flange	= 40 ± 1 mm
z12	Figure 4	top nominal substrate seating plane	top of top cassette domain	≤ 50 mm
z14	Figure 6	horizontal datum plane	top of v-rail, v-groove, and float roller exclusion zones	= 24.86 ± 0.12 mm

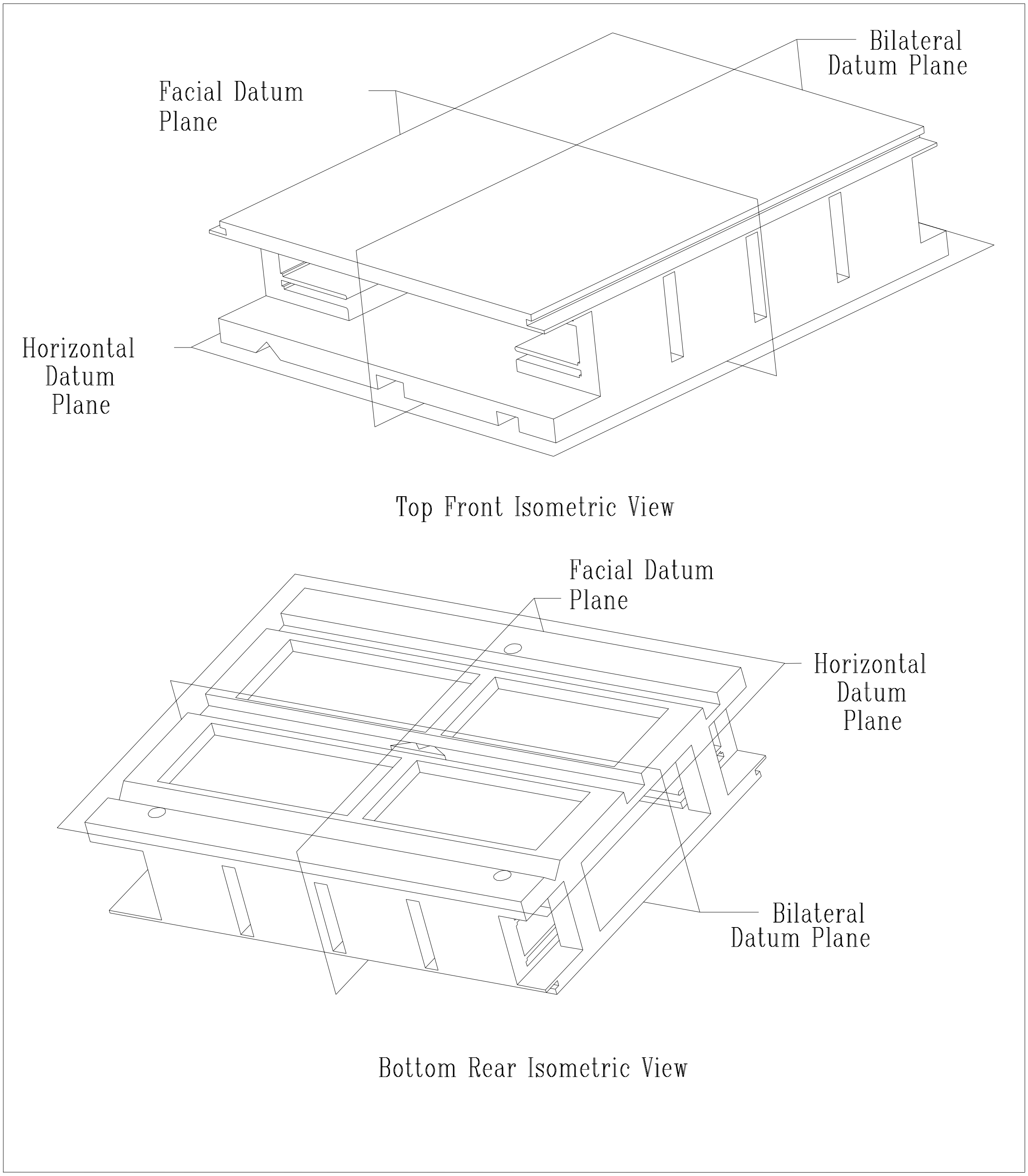


Figure 1
Isometric Views

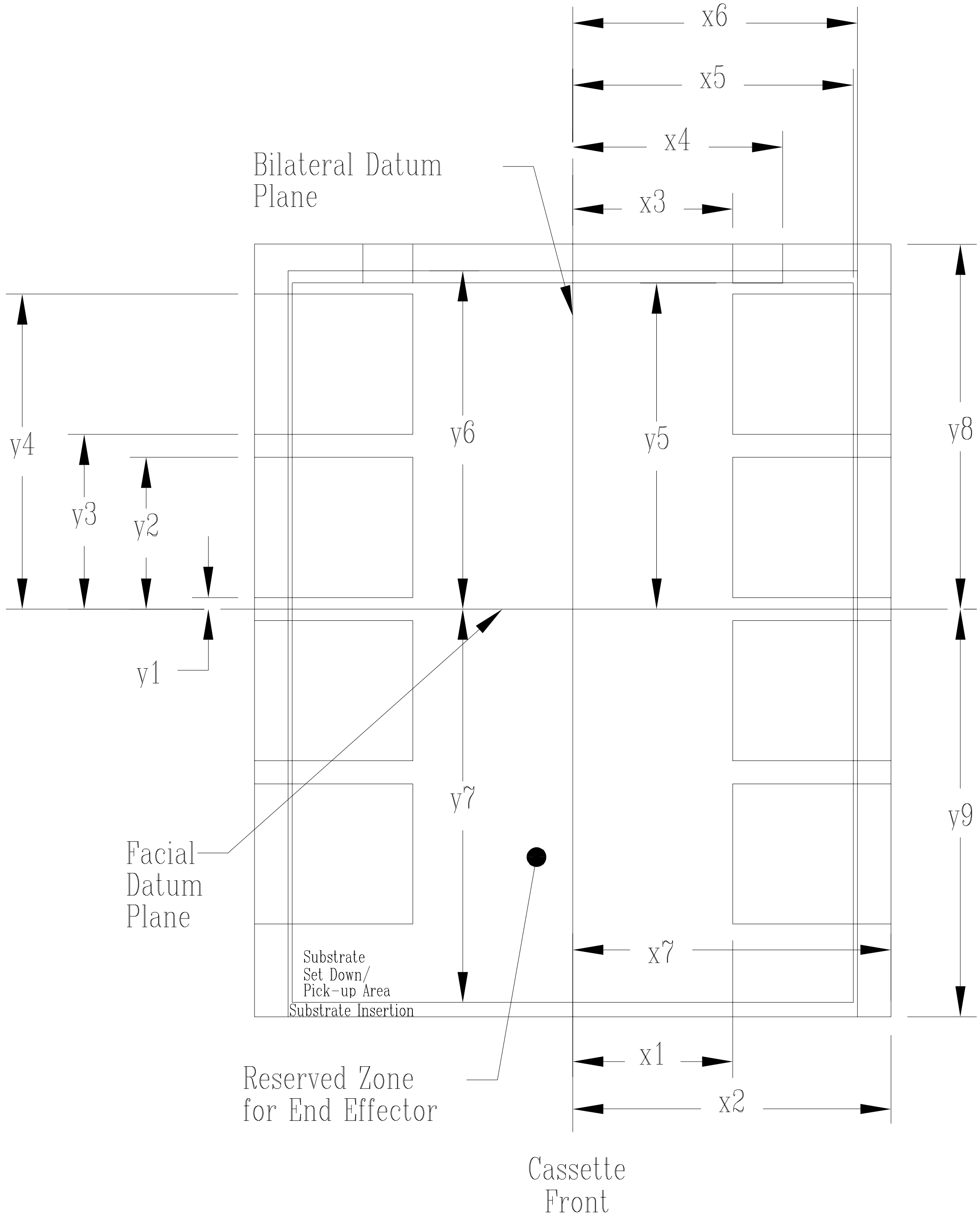


Figure 2
Cassette Side Domains

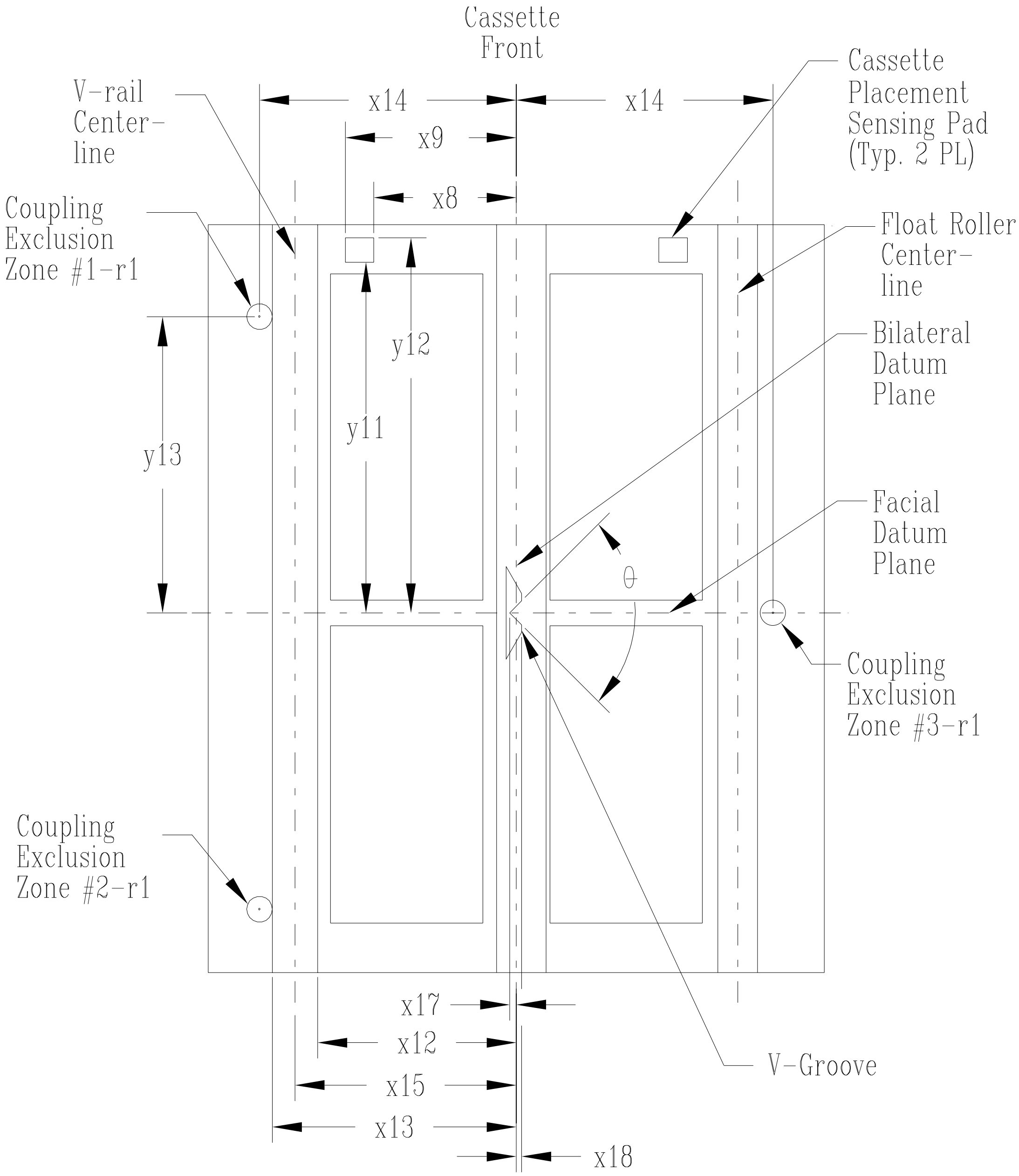


Figure 3
Cassette Bottom Domain

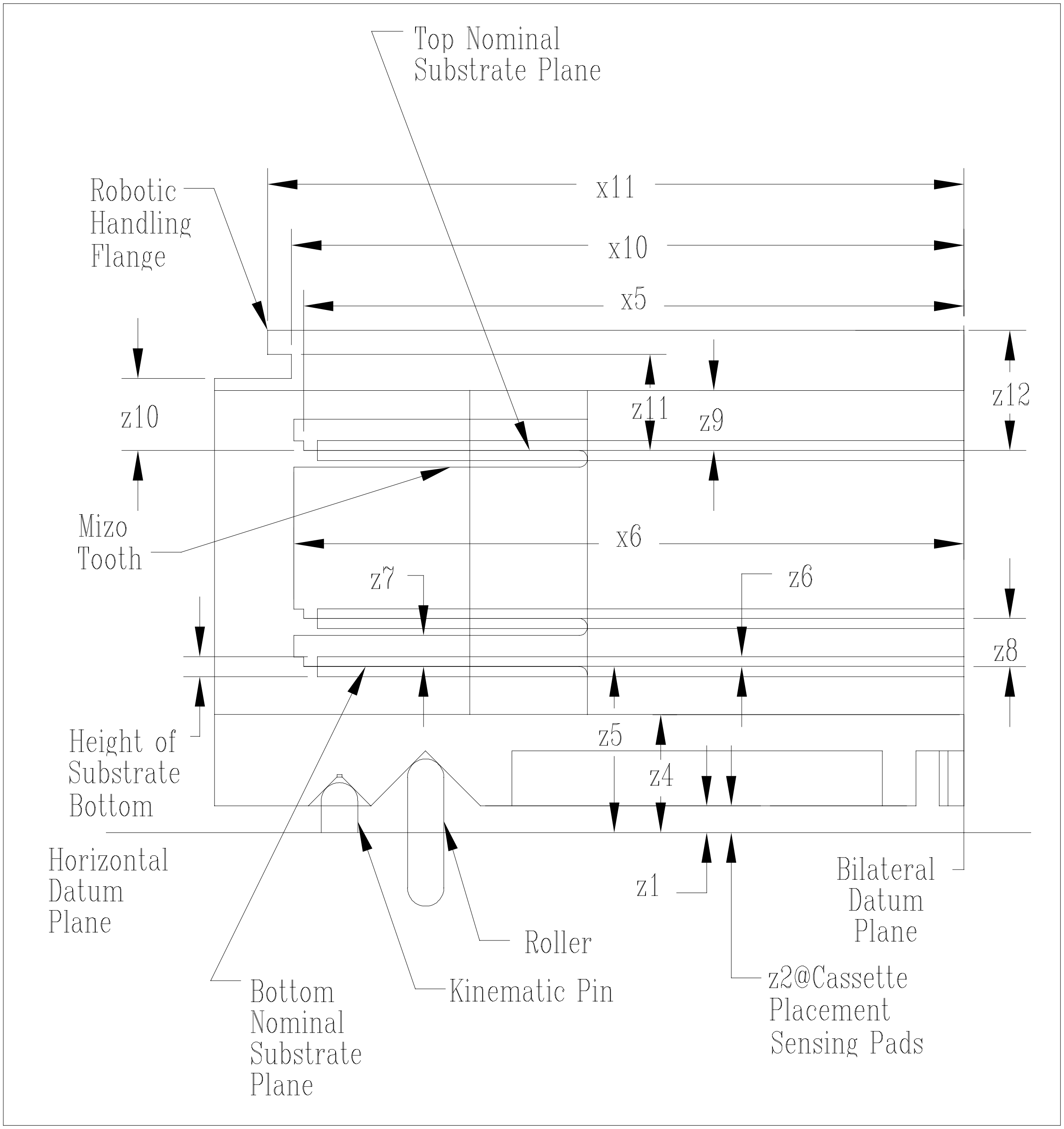


Figure 4
Cassette Vertical Dimensions

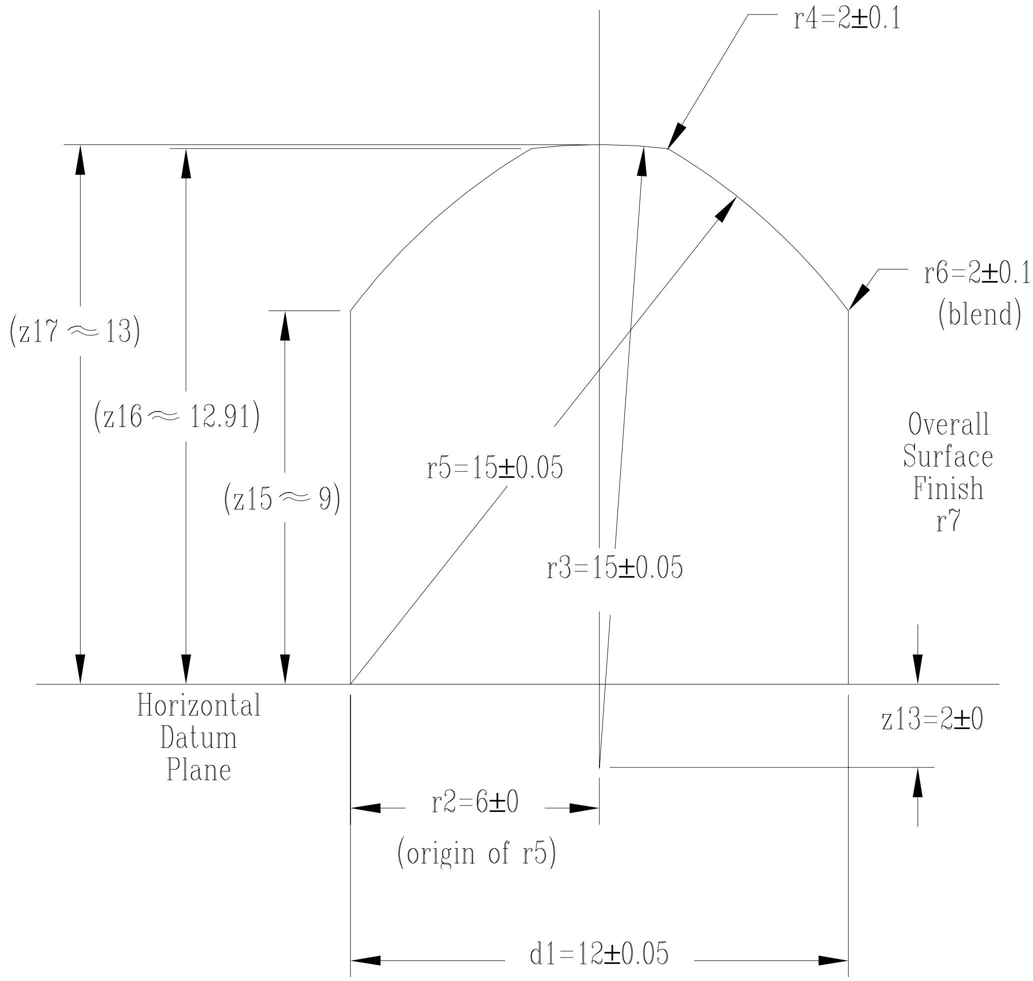


Figure 5
Cassette Physical Alignment Interface – Type A
Coupling Pin Shape

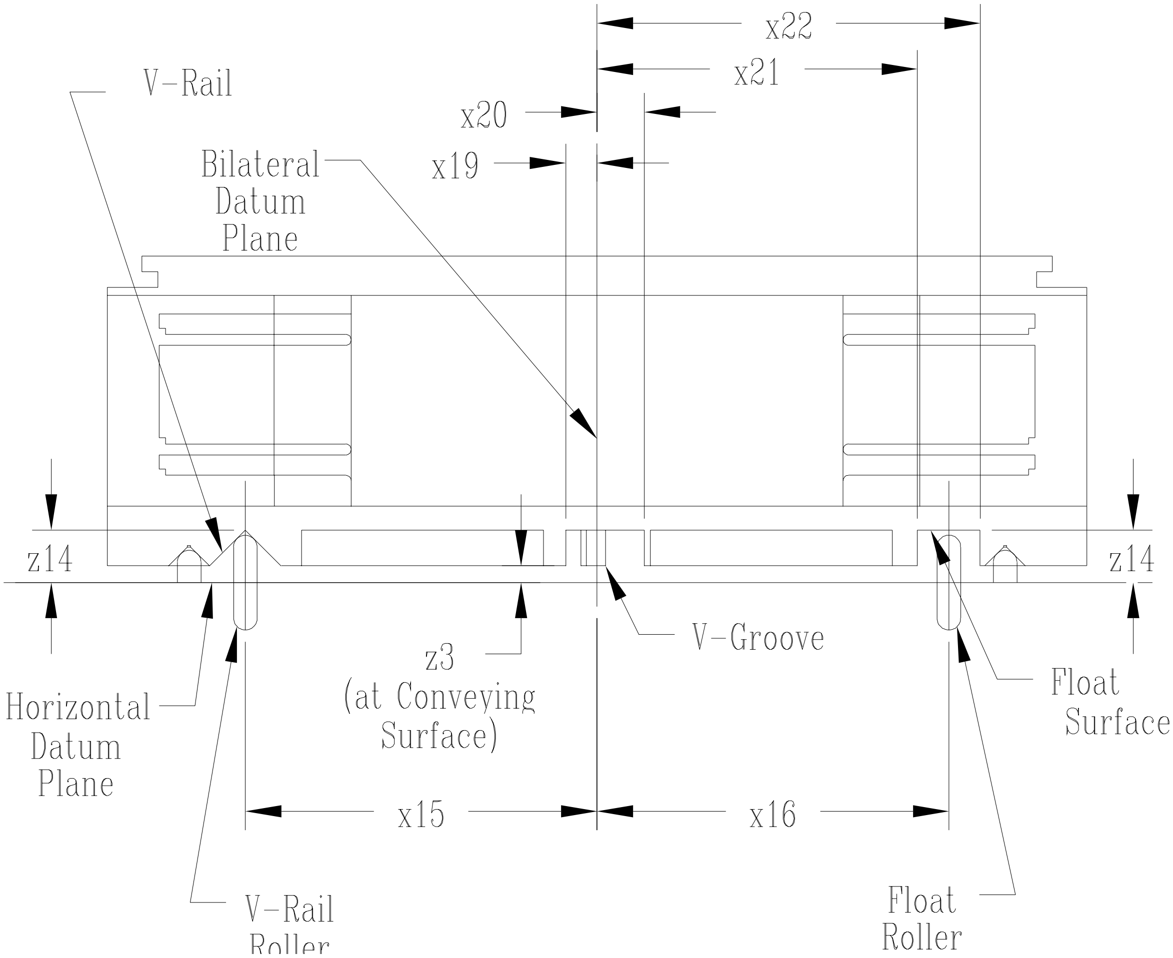


Figure 6
Cassette Physical Alignment Interface – Type B
Roller Position

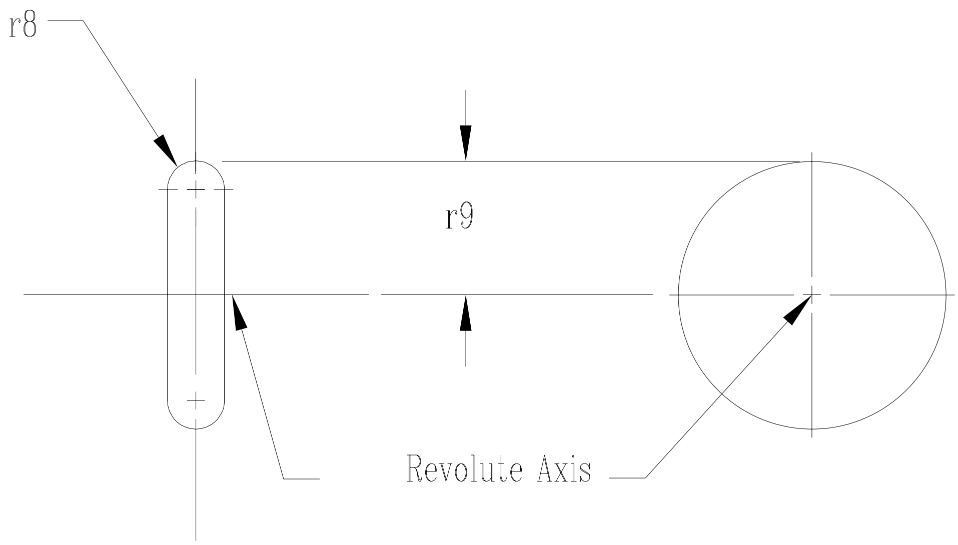


Figure 7
Cassette Physical Alignment Interface – Type B
Roller Shape

APPENDIX 1

NOTE: The material in this appendix is an official part of SEMI D17 and was approved by full letter ballot procedures on December 15, 1999 by the North American Regional Standards Committee. Determination of the suitability of the material herein is solely the responsibility of the user.

A1-1 Application Notes

A1-1.1 The shape of the teeth holding the substrates is not specified in this standard. The tooth surface that touches the substrate should have a large radius to minimize stress on the substrate and tooth.

A1-1.2 Extra clearance (larger than the pitch) has been added below the bottom substrate (for non-random sequential access to the substrates with a faster or less precise robot). To increase the stability of Type A Cassettes, the points on the cassette bottom that are the most distant from the lines connecting each pair of coupling pins should be made as close as practical to the horizontal datum plane so that the cassette cannot tip very far off of the kinematic coupling.

SEMI D18-0299^E
SPECIFICATION FOR CASSETTES USED FOR HORIZONTAL TRANSPORT AND STORAGE OF FLAT PANEL DISPLAY SUBSTRATES

This specification was technically approved by the 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 August 15, 1998. Initially available at www.semi.org September 1998; to be published February 1999.

E This document was editorially modified in October 2000 to correct a formatting error. Changes were made to Figure 5.

1 Purpose

1.1 This standard specifies the cassettes used to horizontally transport and store glass substrates 0.7 mm-1.1 mm thick (max) in a flat panel display (FPD) 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 algebraic expressions defining maximum or minimum dimensions referenced from the length and width of the intended substrate with very few required surfaces. Only the mechanical interfaces for cassettes are specified; no materials requirements or micro-contamination limits are given. However, this standard has been written so that cassettes of various designs and materials can be manufactured in conformance with it.

3 Referenced Standards

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

3.1 *SEMI Standards*

SEMI D3 — Quality Area Specification for Flat Panel Display Substrates

SEMI D5 — Standard Size for Flat Panel Display Substrates

SEMI D6 — Standard Edge Length and Thickness for Flat Panel Display Mask Substrates

SEMI D9 —Definitions for Flat Panel Display Substrates

SEMI D11 — Specification for Flat Panel Display Glass Substrate Cassettes

SEMI D21 — Terminology for Flat Panel Display Masks

SEMI E15 — Specification for Tool Load Port

SEMI E44 — Guide for Procurement and Acceptance of Minienvironments

4 Terminology

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

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

4.3 *cassette* — (as defined in SEMI E44)

4.4 *cassette bottom domain* — volume (below *z*4 above the horizontal datum plane) that contains the bottom of the cassette.

4.5 *cassette bottom opening* — an opening through the cassette bottom domain that provides access to the glass substrates for external roller drive mechanisms to move substrates into/from the cassette.

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

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

4.8 *cassette rear domains* — volumes (from *z*4 above the horizontal datum plane to *z*9 above the top substrate) that contain rear columns which prevent the substrates from exiting the cassette rear.

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

4.10 *cassette side domains* — volumes (from *z*4 above the horizontal datum plane to *z*9 above the top substrate) that contain the mizo teeth and mizo plates that support the substrates.

4.11 *cassette top domain* — volume (higher than *z*9 above the top substrate) that contains the top of the cassette.

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

4.13 *conveying surface* — entire bottom surface of cassette (*z*15 above the horizontal datum plane), excluding the V-rail, V-groove, and float roller zones, for supporting the cassette on roller conveyors

4.14 *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.

4.15 *first substrate end-effector clearance* — the distance (dimension *z*9) between the top of the cassette bottom domain and the first nominal substrate seating plane.

4.16 *first nominal substrate height* — the distance (dimension *z*5) from the horizontal datum plane to the first nominal substrate seating plane.

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

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

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

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

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

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

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

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

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

4.26 *substrate set-down volume* — the open space for inserting and setting down a substrate in the cassette.

4.27 *substrate pick-up volume* — the space that contains entire bottom of a substrate if the wafer is pushed to the rear of the cassette.

5 Ordering Information

5.1 *Intended Use* — This standard is intended to specify cassettes over a reasonable lifetime of use, not just those in new condition. The purchaser needs to specify the time period, the number of cycles and any special conditions to which the cassettes will be exposed. It is under these conditions that the cassettes must remain in compliance with the requirements listed in Section 6.

5.2 *Temperature Ranges* — The purchase of the cassettes needs to specify three sets of temperatures to which the cassettes might be exposed. An operating temperature range is the set of environmental temperatures in which the cassettes will remain in compliance with the requirements listed in Section 6 (e.g. 23°C ± 5°C). A temporary temperature range is the set of environmental temperatures to which the cassettes can be exposed such that when the cassettes return to the operating temperature range, the cassettes will be in compliance with the requirements listed in Section 6 (e.g. 90°C maximum during cleaning of the cassette). Also, the purchaser needs to specify a range of temperatures for the substrates that might be inserted in the cassettes.

5.3 *Pitch and Capacity Options* — The purchaser needs to specify the pitch and capacity of the cassettes. Table 2 provides two options of pitch and capacity. Additional pitch and capacity options are not yet defined, but should be specified in the same manner.

5.4 *Material* — To be agreed upon between supplier and user. Construction may be of one or more molded or machines parts.

6 Requirements

6.1 *Dimensions* — Most of the dimensions of the cassette 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 (see Figure 1).

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

6.2.1 *Cassette Physical Alignment Interface-Type A* — This registration 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 *x*14 and *y*13 relative to the bilateral and facial datum planes respectively.

6.2.1.1 *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 *d*1 and a sphere of radius *r*3 (which might contact a flat plate). An additional rounding radius *r*5 provides contact with angled mating surfaces, and blend radii *r*4 and *r*6 smooth the resulting edges. The final roughness height of the over-all surface finish must be less than or equal to *r*7. Dimensions *r*2 and *z*13 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.)

6.2.1.2 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 is shown in Figure 3 and Table 1 and specified by dimensions *x*14, *z*9 and *r*1.

6.2.2 *Cassette Physical Alignment Interface-Type B* — 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 *x*15 and *x*16 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 Figure 3 and 6. The float surface roller revolute axis must lie on the facial datum plane.

6.2.2.1 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 *r*8. The diameter of the rollers is not specified but the tangential surface created by dimension *r*8 must lie on the horizontal datum plane. The facial datum plane lock pin radius is equal to *r*8 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 *r*8 dimension lies below the horizontal datum plane.

6.2.2.2 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 Figure 3 and 6 and specified by dimensions *x*15, *x*16 through *x*22.

6.2.3 *Cassette Physical Alignment Interface-Type C* — to be developed.

6.3 *Conveyor Rails* — If the cassette is to be used on roller conveyors, each conveyor rail should extend the maximum distance from front to back. The exclusion zones for conveyor rails are shown in Figure 3 and 6 and specified by dimensions *x*13 and *x*22 and extends to the outer boundary of the cassette.

6.4 *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 *z*3.

6.5 *Substrate Orientation and Numbering* — The substrates must be horizontal when the carrier is placed on the coupling, and the substrates are numbered in increasing order from bottom to top (so the bottom substrate is substrate number 1, the next substrate up is substrate number 2, etc.)

6.6 *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 *z*4 above the horizontal datum plane and lower than *z*9 above the top substrate). Table 1 defines the dimensions shown in this and following figures.

6.7 *Cassette Top* — The boundaries of the cassette top domain contain any part of the cassette higher than *z*9 above the top substrate.

6.8 *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 *z*4 above the horizontal datum plane). When the cassette is fully down, the cassette placement sensing pads must be *z*2 above the horizontal datum plane.

6.9 *Vertical Dimensions* — Figure 4 shows the vertical dimensions of the left half of the cassette as viewed from the rear. Note that *z*5 (the height of the bottom nominal substrate seating plane above the horizontal datum plane) and *z*8 (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 *z*6 with no further stack-up at each higher substrate.

6.9.1 The open space for the substrate extraction volume is indicated by dimensions *x*6 and *y*7 and is symmetric about the bilateral and facial datum planes, respectively. The top of the extraction volume is *z*7 above the nominal substrate seating plane and its bottom is half of the minimum *z*7 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.

6.9.2 The open space for the substrate set-down volume is indicated by dimensions *x*5 and *y*6 and is symmetric about the bilateral and facial datum planes, respectively. The top of this volume is half of *z*7 above the nominal substrate seating plane and its bottom is *z*6 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.

6.9.3 The substrate pick-up volume is defined by an area indicated by dimensions *x*5 and *y*5 and is symmetric about the bilateral and facial datum planes, respectively. Its top and bottom are the upper and lower tolerance of *z*6 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 volume.

6.10 *Pitch and Capacity* — Table 2 shows the different options with regard to the substrate pitch (spacing) and the cassette capacity.

6.11 *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 small contact patches with large stresses that might cause wear and particles.

Table 1 Cassette Side Domains

Symbol Used	*Shown in*	*Datum Measured From*	*Boundary or Feature Measured To:*	*Algebraic Relation or Value*
*r*1	Figure 3	center of coupling exclusion zone	outside edge of coupling exclusion zone	<15
*x*1	Figure 2	bilateral datum plane	encroachment of cassette side domains on substrate extraction volume	$\geq \frac{W \times 0.57}{2}$
*x*2	Figures 2	bilateral datum plane	outside edge of cassette side domains	$\leq W_1 + 37$
*x*3	Figures 2	bilateral datum plane	inside edge of rear cassette domains	$\geq x1 - 40$
*x*4	Figures 2	bilateral datum plane	outside edge of rear cassette domains	$\geq \frac{W \times 0.57}{2}$
*x*5	Figures 2 and 4	nominal substrate center line	outside edge of substrate pick-up volume	$\geq W_1 + 2$
*x*6	Figures 2 and 4	nominal substrate center line	encroachment of cassette side domains on substrate extraction volume	$\geq x5$
*x*7	Figures 2	nominal substrate center line	outside edge of cassette top and bottom domain	$\leq W_1 + 37$

Symbol Used	*Shown in*	*Datum Measured From*	*Boundary or Feature Measured To:*	*Algebraic Relation or Value*
$x8$	Figure 3	bilateral datum plane	inside edge of cassette sensing pad areas	$= W1 \times 0.71 \pm 5.0$
$x9$	Figure 3	bilateral datum plane	outside edge of cassette sensing pad areas	$= W1 \times 0.78 \pm 5.0$
$x10$	Figure 4	bilateral datum plane	encroachment of cassette top domain on robotic handling flange space	$\leq W1 \times 1.02$
$x11$	Figure 4	bilateral datum plane	far side of robotic handling flanges	$\leq W1 \times 1.05$
$x12$	Figures 3	bilateral datum plane	inside edge of conveyor rail exclusion zones	$\geq W1 \times 0.752$
$x13$	Figures 3	bilateral datum plane	outside edge of conveyor rail exclusion zones	$\leq W1 \times 0.877$
$x14$	Figure 3	bilateral datum plane	center of coupling exclusion zones	$= W1 \times 0.9455 \pm 0.1$
$x15$	Figures 3 and 6	bilateral datum plane	centerline of V-rail roller	$= W1 \times 0.815 \pm 0.2$
$x16$	Figure 6	bilateral datum plane	centerline of float roller	$= x19 \pm 2.0$
$x17$	Figure 3	bilateral datum plane	inside edge of facial datum plane V-groove	$= W1 \times 0.0245 \pm 0.2$
$x18$	Figure 3	bilateral datum plane	outside edge of facial datum plane V-groove	$= W1 \times 0.020 \pm 0.2$
$x19$	Figure 6	bilateral datum plane	left edge of V-groove exclusion zone	$\geq W1 \times 0.069$
$x20$	Figure 6	bilateral datum plane	right edge of V-groove exclusion zone	$\geq W1 \times 0.109$
$x21$	Figure 6	bilateral datum plane	inside edge of float roller exclusion zone	$\leq W1 \times 0.742$
$x22$	Figure 6	bilateral datum plane	outside edge of float roller exclusion zone	$\geq W1 \times 0.884$
$y1$	Figure 2	facial datum plane	encroachment of cassette side domain	$\geq L1 \times 0.031$
$y2$	Figure 2	facial datum plane	encroachment of cassette side domain	$\leq L1 \times 0.454$
$y3$	Figure 2	facial datum plane	encroachment of cassette side domain	$\geq L1 \times 0.515$
$y4$	Figure 2	facial datum plane	encroachment of cassette side domain	$\leq L1 \times 0.938$
$y5$	Figure 2	facial datum plane	outside edge of substrate pick-up volume	$\leq L1 + 1$
$y6$	Figure 2	facial datum plane	encroachment of cassette side domains on substrate set-down volume	$\geq L1 + 1$
$y7$	Figure 2	facial datum plane	encroachment of cassette side domains on substrate extraction volume	$\geq L1 + 3$
$y8$	Figure 2	facial datum plane	boundary of rear cassette domain	$\leq L1 \times 1.12$
$y9$	Figures 2	facial datum plane	outside edge of cassette top and bottom plate domain	$\leq L1 \times 1.21$
$y10$	Figures 3	facial datum plane	inside edge of cassette top and bottom plate indent	$\leq L1 \times 0.985$
$y11$	Figure 3	facial datum plane	inside edge of cassette sensing pad areas	$\geq L1 \times 0.708$
$y12$	Figure 3	facial datum plane	outside edge of cassette sensing pad areas	$\leq L1 \times 0.954$
$y13$	Figure 3	facial datum plane	center of coupling exclusion zones	$= L1 \times 0.923 \pm 0.1$

Symbol Used	Shown in	Datum Measured From	Boundary or Feature Measured To:	Algebraic Relation or Value
$z1$	Figure 4	horizontal datum plane	bottom of cassette bottom domain	≥ 2
$z2$	Figure 4	horizontal datum plane	bottom of cassette sensing pads	=3 ± 0.5
$z3$	Figure 6	horizontal datum plane	bottom surface of conveying surface	=2 ± 0.5
$z4$	Figure 4	horizontal datum plane	top of cassette bottom domain	≤ 40
$z5$	Figure 4	horizontal datum plane	bottom nominal substrate seating plane	= 60
$z6$	Figure 4	each nominal substrate seating plane	bottom of substrate	= ± 0.5
$z7$	Figure 4	each nominal substrate seating plane	encroachment of cassette side domains on clearance above the substrate	See Table 2.
$z8$	Figure 4	each nominal substrate seating plane	adjacent nominal substrate seating planes	See Table 2.
$z9$	Figure 4	top nominal substrate seating plane	bottom of cassette top domain	≥ $z7$ + 1
$z10$	Figure 4	top nominal substrate seating plane	bottom of clearance under robotic handling flange	≤ 30
$z11$	Figure 4	top nominal substrate seating plane	top of clearance under robotic handling flange	= 40 ± 1
$z12$	Figure 4	top nominal substrate seating plane	top of top cassette domain	≤ 50
$z14$	Figure 6	Horizontal Datum Plane	top of V-rail, V-groove, and float roller exclusion zones	= 24.86 ± 0.12

W= the length in millimeters of the substrate edge perpendicular to the bilateral datum plane.

W_1= one half the length of W

L= the length in millimeters of the substrate edge perpendicular to the facial datum plane.

L_1= one half the length of L

All values in millimeter (mm)

Table 2 Pitch and Capacity Options

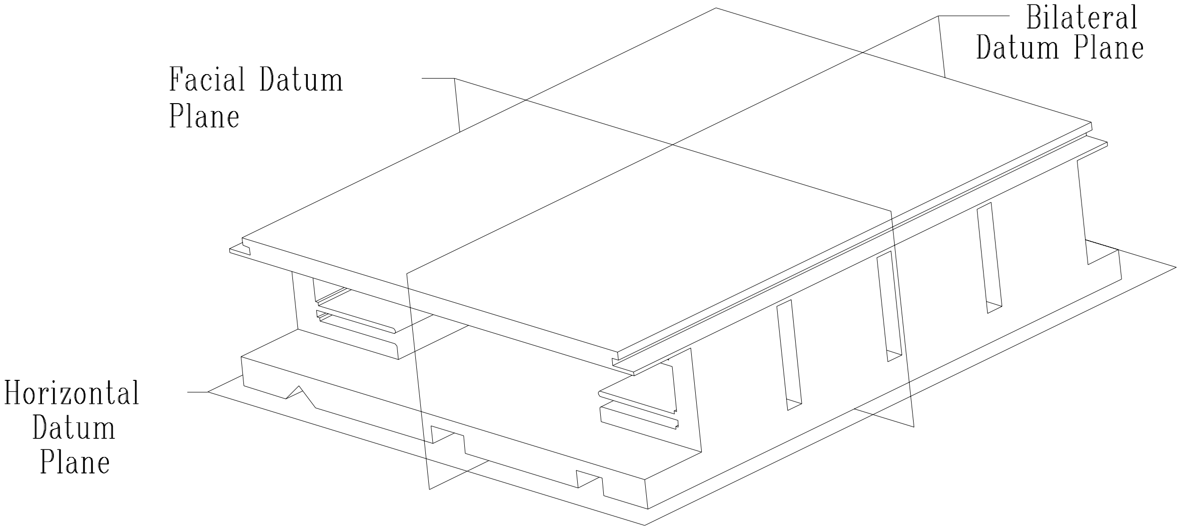
Substrate Size	Cassette Capacity (c)	Substrate Pitch (z8)	Substrate Clearance (z7)	Resulting Cassette Height (z5-z1)+((z8*(c-1))+z12
550 mm x 650 mm	25 substrates	20 mm (0.79 in.)	16 mm (0.63 in.) minimum	580 mm (22.83 in.) maximum
600 mm x 720 mm	25 substrates	20 mm (0.79 in.)	16 mm (0.63 in.) minimum	580 mm (22.83 in.) maximum
960 mm x 1100 mm	20	30 mm (1.18 in.)	20 mm (0.79 in.)	678 mm (26.7 in.) maximum
4	not yet defined			

Table 3 Type A Cassette Registration - Coupling Pin Dimensions

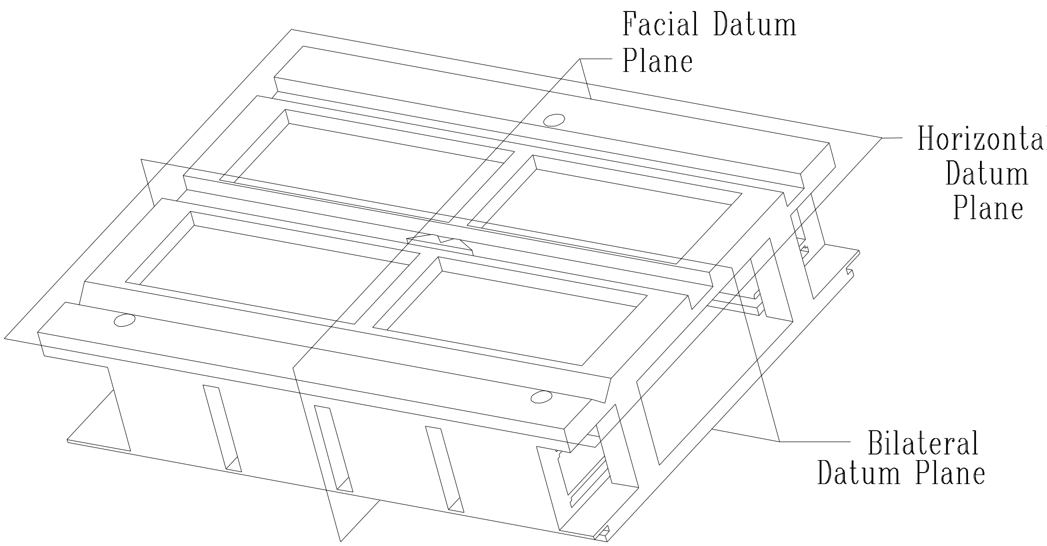
Symbol Used	*Shown In:*	*Dimensions Description*	*Algebraic Relation or Value*
*d*1	Figure 5	diameter of pin centered on the center axis line	12 ± 0.05 mm (0.4724 ± 0.002 in.)
*r*2	Figure 5	radial distance from the center axis line to the origin of the shoulder radius *r*5	6 mm (0.2362 in.)
*r*3	Figure 5	radial distance from the intersection of the center axis line and *z*13 to the top of the pin	15 ± 0.05 mm (0.5906 ± 0.002 in.)
*r*4	Figure 5	blend radius for the intersection of *r*3 and *r*5	2 ± 0.1 mm (0.0787 ± 0.004 in.)
*r*5	Figure 5	radial distance from the intersection of the horizontal datum plane and *r*2 to the far shoulder of the pin	15 ± 0.05 mm (0.5906 ± 0.002 in.)
*r*6	Figure 5	blend radius for the intersection of *r*5 and *d*1	2 ± 0.1 mm (0.0787 ± 0.004 in.)
*r*7	Figure 5	Roughness (R_a) as defined in *ISO 4287*	0.30 µm (12 µin.) maximum
*z*13	Figure 5	vertical distance from the horizontal datum plane to the origin of top radius *r*3	2 mm (0.08 in.)

Table 4 Type B Cassette Registration - Roller Dimensions

Symbol Used	*Shown In:*	*Dimensions Description*	*Algebraic Relation or Value*
r8	Figure 7	Radius about roller circumference revolved about the revolute axis	= 4.8 ± 0.12 mm
r9	Figure 7	Radius of roller measured from the tangential surface created by r8 to the revolute axis	≥ 20 ± 0.12 mm



Top Front Isometric View



Bottom Rear Isometric View

Figure 1
Isometric Views

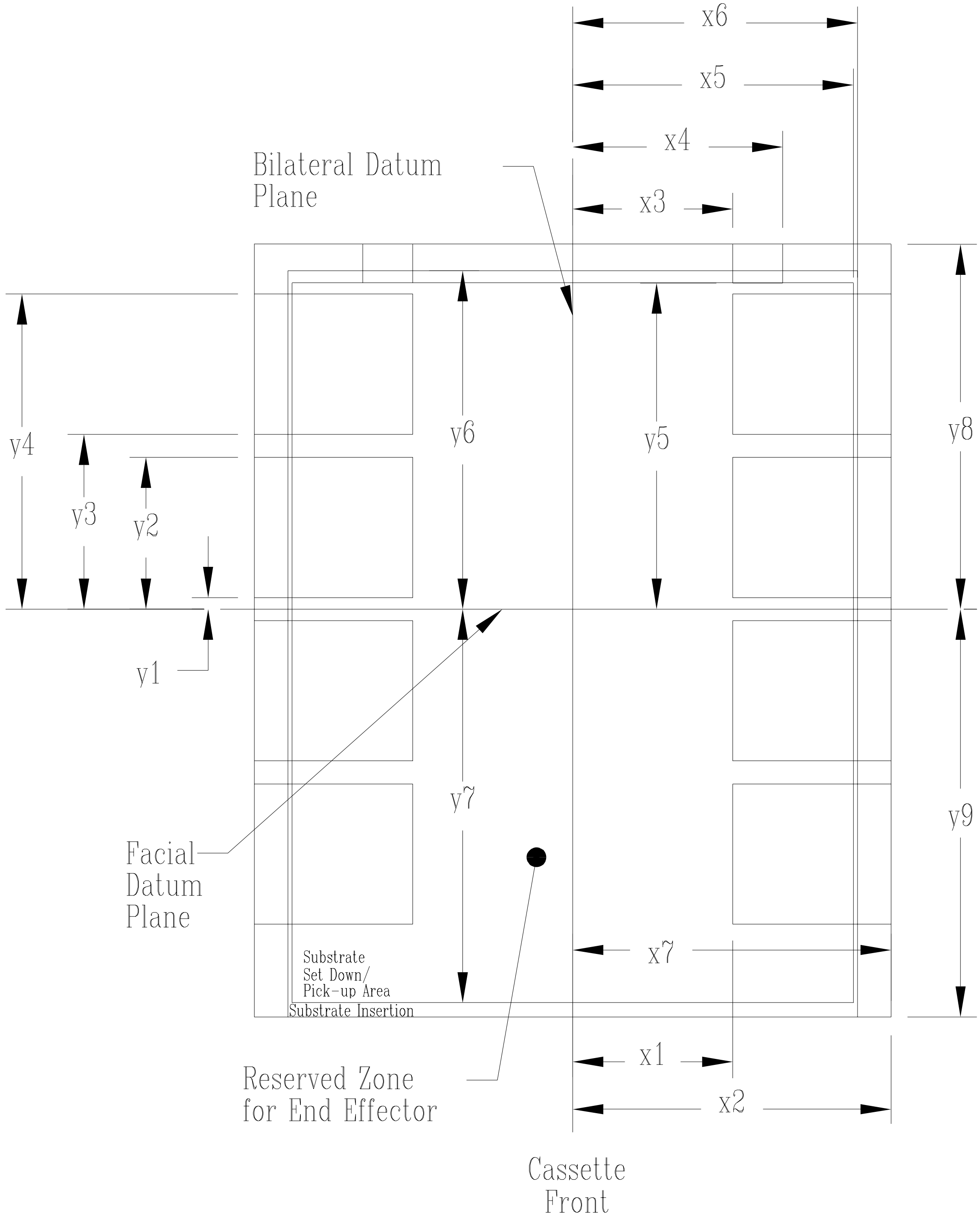


Figure 2
Cassette Side Domains

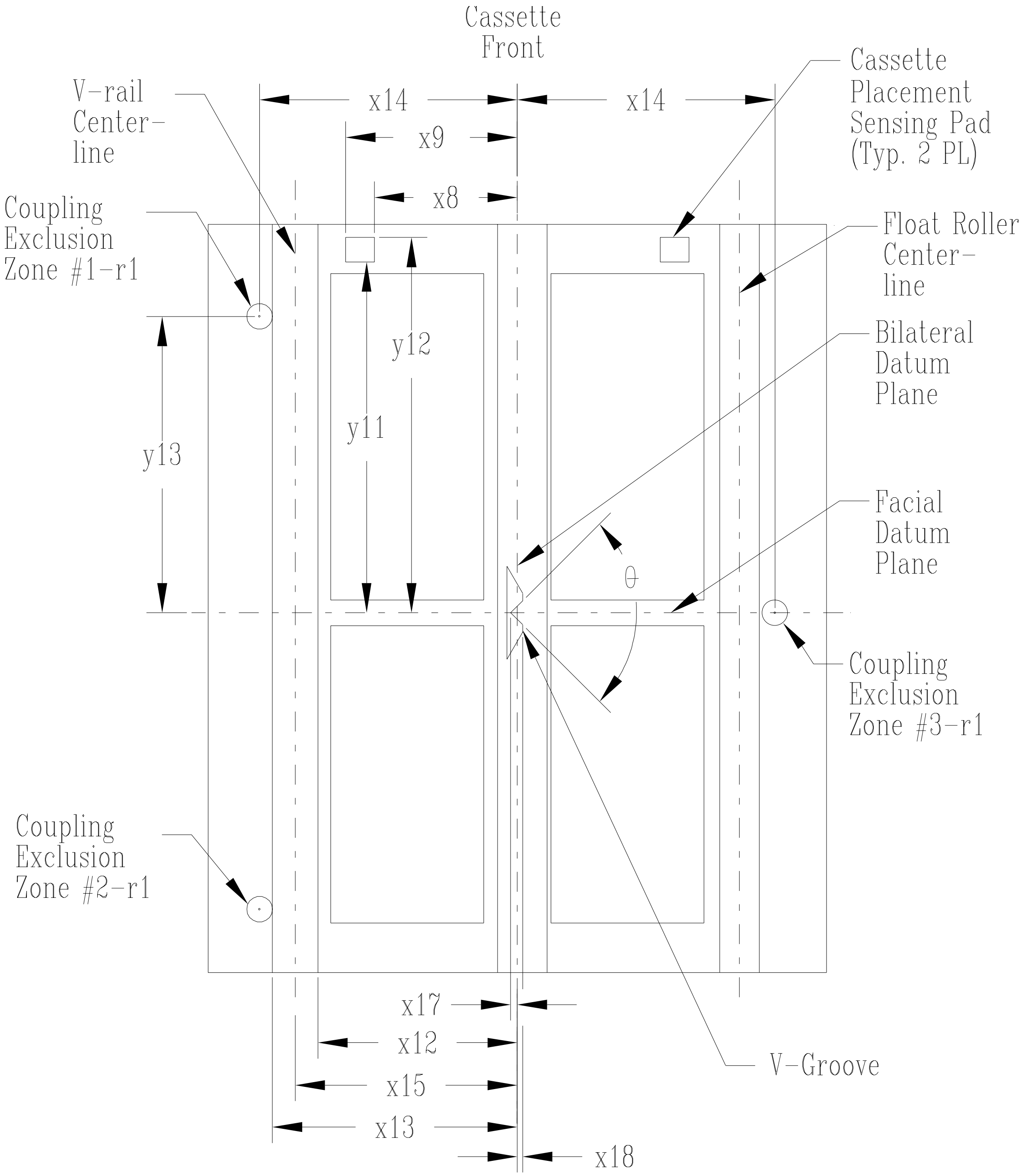


Figure 3
Cassette Bottom Domain

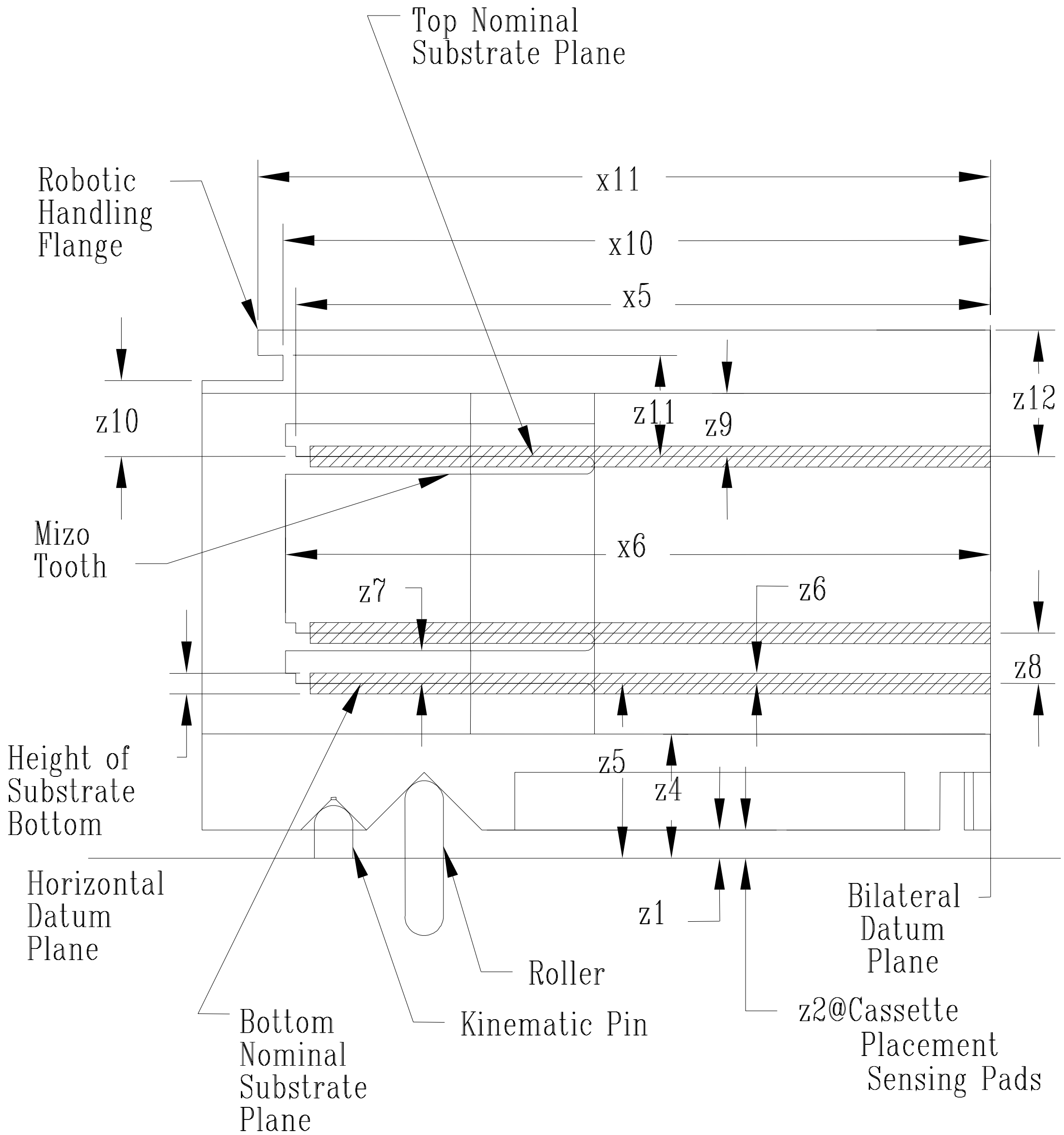


Figure 4
Cassette Vertical Dimensions

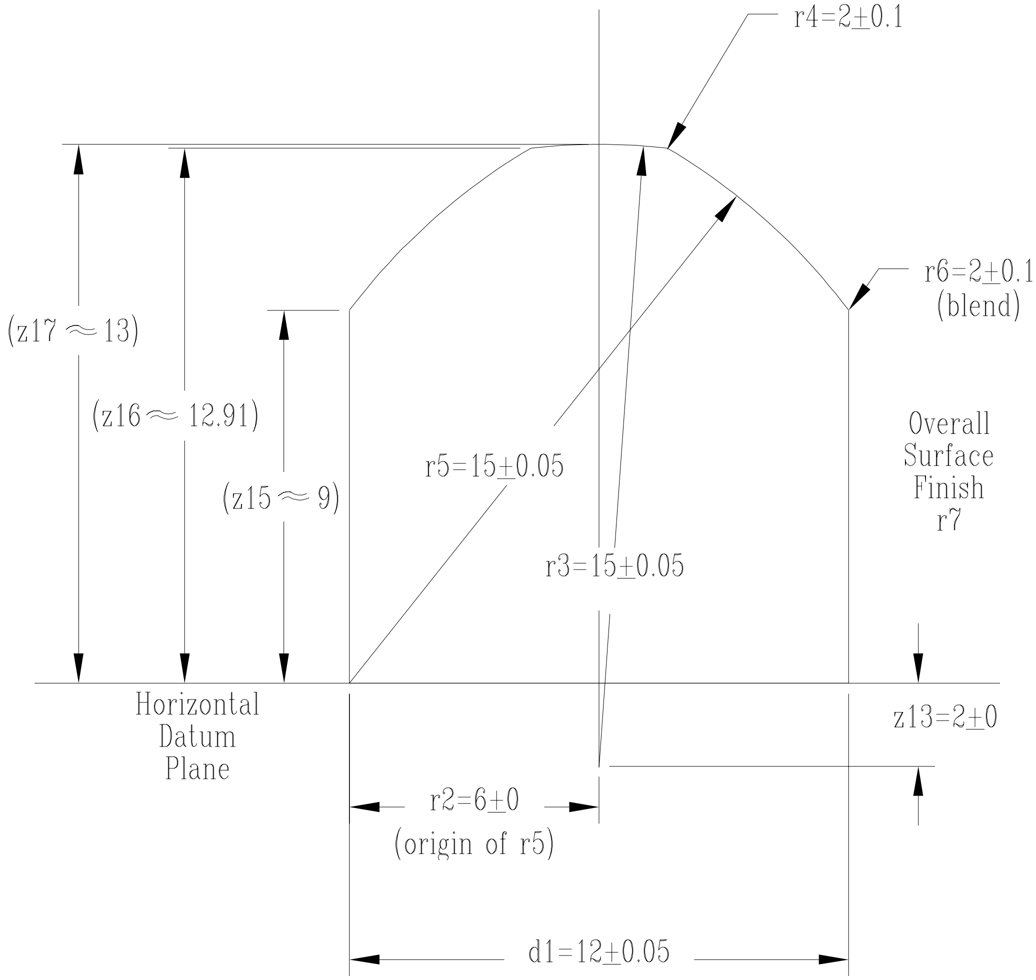


Figure 5
Cassette Physical Alignment Interface-Type A
Coupling Pin Shape

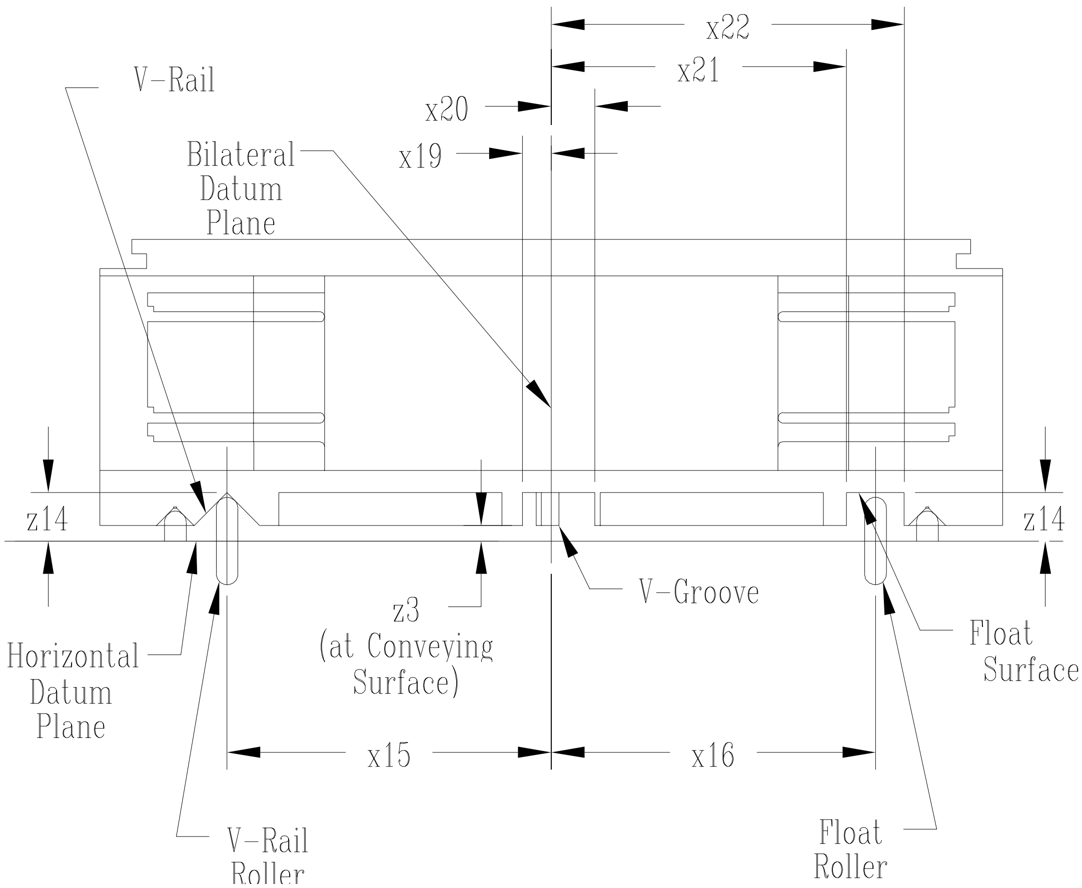


Figure 6
Cassette Physical Alignment Interface-Type B
Roller Position

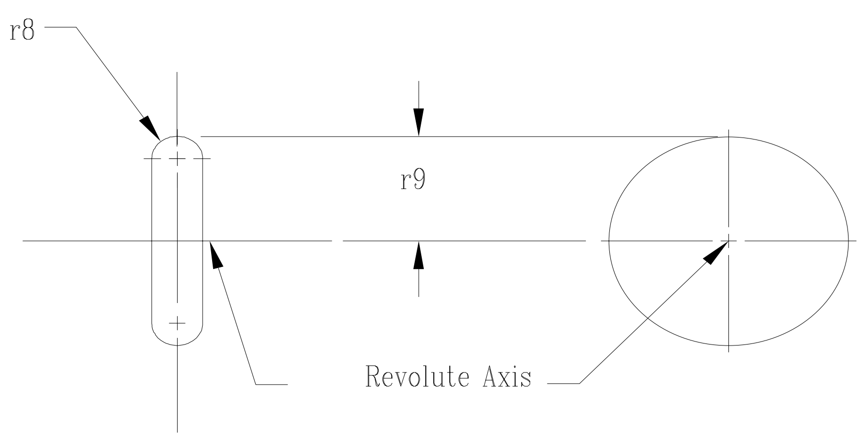


Figure 7
Cassette Physical Alignment Interface-Type B
Roller Shape

APPENDIX 1

NOTE: The material in this appendix is an official part of SEMI D18 and was approved by full letter ballot procedures on August 15, 1998.

A1-1 Application Notes

A1-1.1 The shape of the teeth holding the substrates is not specified in this standard. The tooth surface that touches the substrate should have a large radius to minimize stress on the substrate and tooth.

A1-1.2 Extra clearance (larger than the pitch) has been added below the bottom substrate (for non-random sequential access to the substrates with a faster or less precise robot). To increase the stability of Type A Cassettes the points on the cassette bottom that are the most distant from the lines connecting each pair of coupling pins should be made as close as practical to the horizontal datum plane so that the cassette cannot tip very far off of the kinematic coupling.

SEMI D19-0305
TEST METHOD FOR THE DETERMINATION OF CHEMICAL RESISTANCE OF FLAT PANEL DISPLAY COLOR FILTERS

This test method was technically approved by the Global Flat Panel Display Committee and is the direct responsibility of the Japanese FPD Color Filter & Optical Elements Committee. Current edition approved by the Japanese Regional Standards Committee on November 24, 2004. Initially available at www.semi.org January 2005; to be published March 2005. Originally published in 1999; previously published in February 1999.

1 Purpose

1.1 This standard establishes two methods for evaluating the chemical resistance of FPD color filters. One of these methods is qualitative, the other is quantitative.

2 Scope

2.1 These methods may be used by suppliers and users of color filters for FPD applications, for use in judging quality of production and developing samples.

2.2 These methods test the chemical resistance of color filters by utilizing chemicals and conditions typically employed in FPD manufacturing.

2.3 These methods are destructive.

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 Limitations

3.1 This standard specifies only the methods for testing and evaluating chemical resistance of FPD color filters; however, it does not specify the criteria against which the test results are compared.

3.2 This standard specifies only items for color filters, but not for flat panel displays incorporating color filters.

4 Referenced Documents

4.1 *JIS Standards*[1] *(available in Japanese only)*

JIS Z8113 — Glossary of Lighting Terms

JIS Z8120 — Glossary of Optical Terms

JIS Z8722 — Methods of Measurement of Color of Reflecting

JIS Z8730 — Method for Specification of Color Difference for Opaque Materials

4.2 *Others*[2]

IEC Publication 50 (845) — International Electro-chemical Vocabulary (IEV)

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

5 Terminology

5.1 *Definitions*

5.1.1 *color illuminator* — A light source having a uniform illumination plane which radiates diffuse light onto the back surface of a sample to permit direct observation of the sample.

1 Japanese Standards Association, 4-1-24 Akasaka Minato-ku,Tokyo 107-8440 Japan, Telephone: +81-3-3583-8005, Fax: +81-3-3586-2014, http://www.jsa.or.jp/

2 International Electrotechnical Commission, 3, rue de Varembé, Case Postale 131, CH-1211 Geneva 20, Switzerland. Telephone: 41.22.919.02.11; Fax: 41.22.919.03.00, www.iec.ch

5.1.2 Definitions of additional terms used in this document may be found in JIS Z8113, JIS Z8122 and IEC Publication 50 (845).

6 Summary of Method

6.1 A sample is placed in a suitable test container at controlled temperature for a specified period of time.

6.2 The sample is removed from the bath and residual chemicals removed.

6.3 The sample is examined visually for qualitative changes in appearance.

6.4 The sample is examined by microscope and/or surface profiler (stylus type) for material swelling.

6.5 The sample is measured per color layer for spectra transmittance.

6.6 The color difference for each color layer is calculated in one of two systems.

7 Apparatus

7.1 *Test Container* — A clean container shall be used with a sufficient size and depth to accommodate the sample and appropriate chemicals. The container material must be chosen which will not be affected by tests executed under this method. Note that chemicals should not change in quality by test container.

7.2 *Instrumentation*

7.2.1 *Color Illuminator* — This light source shall have chromaticity, color rendering, luminance and intensity uniformity, diffusion, and a sufficient illumination area for observation of the samples to be measured.

7.2.2 *Floodlight* — This light shall have luminance uniformity and an illumination area sufficient for the samples to be measured.

7.2.3 *Microscope* — The microscope used shall have appropriate magnification, normally 50×–400×.

7.2.4 *Spectrophotometer* — The spectrophotometer shall be in conformance with JIS Z8722 or an equivalent standard.

7.2.5 *Surface Profiler* — The equipment which can measure the thickness with X-Y stage.

8 Reagents and Test Conditions

8.1 No specific requirements are described for the reagents. As long as the test conditions are reported with the test result, any combination of chemical reagents with any condition can be used for the test. The test conditions should reflect actual process conditions, which are specific for the selected FPD manufacturer. Some reagents suggested for the test are given in Table 1.

Table 1 Chemicals Used for Chemical Resistance Tests and Related Conditions

Chemical[#1]	*Liquid Temperature (°C)*	*Soak Time (minutes)*
N-methyl-2 pyrolidone (NMP)	23 ± 2	30
γ-butyrolactone	23 ± 2	30
2-propanol (IPA)	23 ± 2	30
propylene glycol monomethyl ether Acetate	23 ± 2	30
ethylene glycol monobutyl ether	23 ± 2	30
2.38% tetramethyl-ammoniumhydroxide (TMAH)	23 ± 2	30
18% HCl	23 ± 2	30
18% HCl	40 ± 5	10
5% NaOH	23 ± 2	10
5% KOH	23 ± 2	10

[#1] % = % by weight

8.2 This standard may involve hazardous materials, operations and equipment. This standard does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determines the applicability of regulatory limitations prior to use.

9 Samples

9.1 FPD color filters are used as samples. For HCl resistance tests, color filters without ITO should be used.

NOTE 1: The test report shall identify whether or not ITO is present on the sample.

10 Procedure

10.1 Pour the selected chemicals into a test container.

10.2 Adjust the temperature of the chemicals to a predetermined value.

10.3 Place the sample, film side up, into the chemicals and cover the test container to prevent chemical evaporation.

10.4 Leave the sample in the chemicals for a predetermined period of time.

10.5 Remove the sample from the chemical bath. Completely remove all chemicals remaining on the sample.

NOTE 2: For chemicals, temperature and soaking time, refer to §8, *Reagents and Test Conditions.*

10.6 Evaluate the sample condition according to the following criteria:

10.6.1 *Change of Appearance* — During each test, observe any change of appearance, e.g., wrinkles, cracks, change of surface conditions due to swelling, film peeling, and discoloration. The sample is compared with untreated sample. Various observation techniques can be employed, including the following which is included for reference only:

10.6.1.1 Visual observation of transmission of the color filter by use of a color illuminator (Figure 1).

10.6.1.2 Visual observation of reflectance of the film side of the color filter by use of a floodlight.

10.6.1.3 Microscope observation or transmission of a color filter by use of transmitted illumination.

10.6.1.4 Microscope observation of reflectance of the color filter by use of reflected illumination.

10.6.1.5 A surface profiler (stylus type) is used in order to measure the changes of film thickness of the color filter.

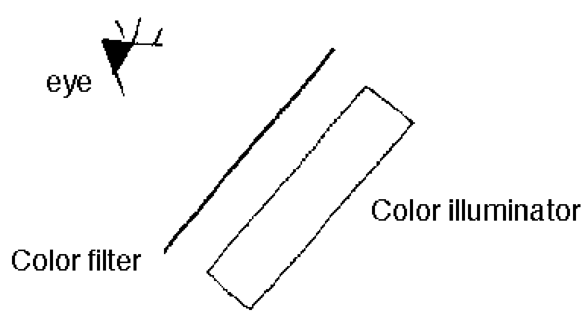


Figure 1
Visual Observation of Transmission of a Color Filter by Use of a Color Illuminator

10.6.2 *Color Differences*

10.6.2.1 Measure transmitted spectra of each colored layer of the color filter at any location. The center area of the sample is recommended.

10.6.2.2 Calculate tri-stimulus values of each colored layer of the color filter in accordance with JIS Z8730.

10.6.2.3 Repeat ¶¶10.6.2.1 and 10.6.2.2 on the same location of the sample.

10.6.2.4 Calculate color difference for each colored layer in the L*a*b* color system or the L*u*v* color specification system from the tri-stimulus values measured before and after this test, according to the method specified in JIS Z8730. Calculate either the difference)E*ab or)E*uv as the amount of color change of the color filter.

NOTE 3: Both the L*a*b* and L*u*v* color specification system can be used to evaluate the color change.

11 Report

11.1 Report the following:

11.1.1 Report date

11.1.2 Test date

11.1.3 Ambient temperature, in °C

11.1.4 Conditions of the sample (construction of FPD color filter) – presence or absence of ITO film

11.1.5 Test conditions (name of chemicals, concentration, temperature and volume of chemicals, soaking time)

11.1.6 Observed changes in sample appearance between, before, and after the test.

11.1.7 The calculated color differences, for measurement location on each sample, and the color system used for these calculations.

12 Precision and Accuracy

12.1 No test data currently exists on which to base these statements. Tests are planned to develop such data for both single-laboratory repeatability and multi-laboratory reproducibility, on samples of the same nominal characteristics, and across a range of nominal characteristics.

SEMI D20-1000
DEFECT TERMINOLOGY FOR FLAT PANEL DISPLAY MASKS

This terminology was technically approved by the Global Flat Panel Display Committee and is the direct responsibility of the Japanese Flat Panel Display Materials and Components Committee. Current edition approved by the Japanese Regional Standards Committee on July 28, 2000. Initially available on SEMI OnLine September 2000; to be published October 2000. Originally published in 1993.

1 Purpose

1.1 This document defines defect terminology for FPD masks. By this standard, it is intended that the concepts of terms which should be used at the technical conferences, business discussion, etc are clarified and that standardization as to masks will be promoted.

2 Scope

2.1 These terms apply to photomasks that are principally used in fabricating flat panel display.

2.2 These definitions do not purport to address safety issues, if any, associated with their use. It is the responsibility of the user of these definitions to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. SEMI makes no warranties or representations as to the suitability of the definitions set forth herein for any particular application. The determination of the suitability of the definitions 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 definitions are subject to change without notice.

3 Referenced Documents

None.

4 Terminology

4.1 *pin hole* — a small hole-shaped opening defect on the chrome-pattern.

4.2 *intrusion* — an absence of chrome extending inward from boundary.

4.3 *pattern disconnect* — an intrusion which completely separates the continuity of the chrome-pattern.

4.4 *missing pattern image* — complete disappearance of the designed chrome-pattern.

4.5 *spot* — isolated chrome residue on the etched area.

4.6 *protrusion* — an extension of chrome beyond the desired boundary.

4.7 *bridge* — an extension of chrome which connects completely and continuously from an edge to another edge.

4.8 *edge roughness* — subtle roughness and/or jagged zone on the pattern edge.

4.9 *round of corner* — unintended round on the pattern corner.

4.10 *flaw*

4.10.1 *scratch* — relatively thick and deep linear friction defect on the surface of the glass.

4.10.2 *sleek* — extremely thin and light linear friction defect on the surface of the glass.

4.10.3 *pit* — small dot-shaped depression on the surface of the glass.

4.11 *chipping* — chipping of edge of the glass caused by cutting or treatment.

4.12 *bubble* — void in the interior of the glass substrate.

4.13 *foreign substance*

4.13.1 *particle* — relatively high foreign substance attached on the surface of the substrate.

4.13.2 *contamination* — cluster of relatively small substances attached on the surface of the substrate in the shape of thin film.

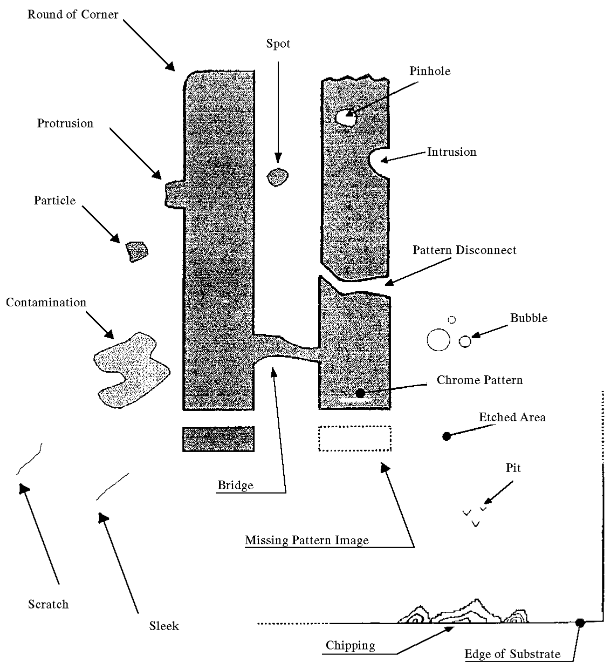


Figure 1
Image of Defects for FPD Mask

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SEMI D21-1000
TERMINOLOGY FOR FLAT PANEL DISPLAY MASKS

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3 Referenced Documents

None.

4 Pattern Dimension

4.1 *Long Dimension Accuracy*

4.1.1 *Long Dimension* — The distances in the X and Y directions between the outermost elements of a pattern on the mask.

4.1.1.1 *Long Dimension Error* — The difference (ΔD) between the measured value (DM) and designed value (DD) of the long distance.

$\Delta D = DM - DD$

4.1.2 *Rectangularity* — Rectangularity of array pattern. Generally, it is indicated as deviation between X coordinate 3 and 4 , when Y coordinate of 1 and 2 are coincident.

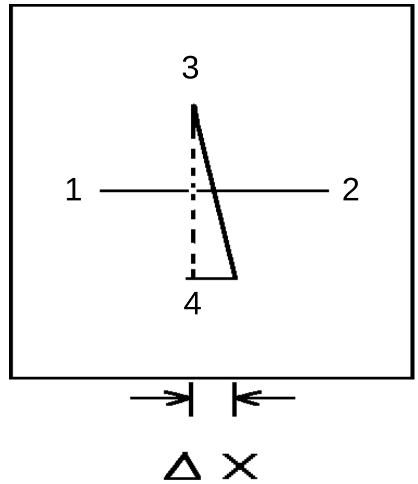

Figure 1
Rectangularity

4.2 *Overlay Accuracy* — Deviation between two or more masks in the direction of the long dimension X, Y. Generally, the two methods are as follows:

- Deviation is measured by comparing the two masks.
- Deviation is measured by comparing measured data of each long dimension of the two masks.

4.3 *Element Dimension Accuracy* — Dimension accuracy of element (line or space).

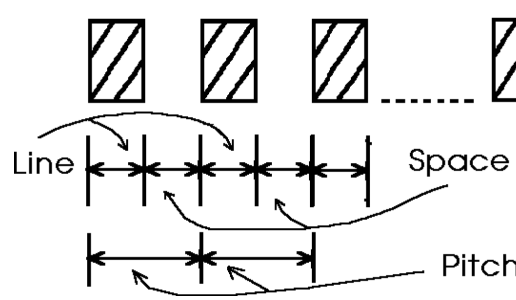

Figure 2
Element Dimension Accuracy

4.4 *Repeat Pitch Accuracy* — Deviation of measured pitch length from designed value.

4.5 *Stitching Error* — Joint accuracy of a pattern when a pattern is composed in a mask (e.g., pattern