

SEMI D24-0200 (Reapproved 0706) SPECIFICATION FOR GLASS SUBSTRATES USED TO MANUFACTURE FLAT PANEL DISPLAYS

This standard was technically approved by the global Flat Panel Display – Factory Automation Committee. This edition was approved for publication by the global Audits and Reviews Subcommittee on May 16, 2006. It was available at www.semi.org in June 2006 and on CD-ROM in July 2006. Originally published February 2000.

1 Purpose

1.1 This standard specifies selected geometrical requirements of glass substrates used to manufacture flat panel displays.

2 Scope

2.1 This standard is intended to set levels of specification for glass substrates to insure repeatable manufacture of flat panel displays and uniformity of substrates from all vendors. This standard will also insure inter-changeability at all mechanical interfaces within process tools as well as with Transportation and Automation Cassettes.

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 Substrate size (edge length and width) and thickness are **not** specified so as not to infringe on supplier/customer relationships. Wherever possible, tolerances are specified independent of substrate size. Additional documents will be developed to specify the standard method of measuring each dimension.

4 Referenced Standards and Documents

4.1 SEMI Standards

SEMI D3 — Quality Area Specification for Flat Panel Display Substrates

SEMI D4 — Method for Referencing Flat Panel Display Substrates

SEMI D5 — Standard Size for Flat Panel Display Substrates

SEMI D6 — Specification for Liquid Crystal Display (LCD) Mask Substrates

SEMI D7 — FPD Glass Substrate Surface Roughness Measurement Method

SEMI D9 — Terminology for FPD Substrates

SEMI D12 — Specification for Edge Condition of Flat Panel Display (FPD) Substrates

SEMI D15 — FPD Glass Substrate Surface Waviness Measurement Method

4.2 ISO Standard¹

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

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

5 Terminology

5.1 Definitions

5.1.1 *FPD Waviness W_{fpd}* — surface profile calculated by a moving minimum zone method. It is expressed as the maximum value of a minimum zone method straightness of a certain sampling within an evaluation length. An approximation in Appendix 1 of SEMI D15 can be used as well.

NOTE 1: It is recommended that the computer approximation method described in Appendix 1 of SEMI D15 be used.

¹ ISO Central Secretariat, C.P. 56, CH-1211 Geneva 20, Switzerland; available in the U.S. from American National Standards Institute, 11 West 42nd Street, 13th Floor, New York, NY 10036

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

5.1.3 *reference edges* — the two edges adjacent to the orientation corner.

5.1.4 *squareness* — the total variation of the position of the short sides of a substrate relative to straight lines drawn between the ends of, and perpendicular to, the long reference edge of the substrate.

5.1.5 *warp* — the gap between a) the bottom surface of an FPD substrate and b) the reference plate on which the substrate rests.

NOTE 2: Warp in other applications has traditionally been the TIR, or peak-to-valley of a surface (top, or bottom or median surface) of a substrate, measured with respect to a reference plane.

6 Test Methods

NOTE 3: The methods described below are approximations, except where they are followed by a reference such as SEMI D7. Formal test methods supporting the parameters in this document will be developed where needed; these will be published as separate documents. References to them will then be added to this document.

6.1 *Thickness* — Measure with differential (2-probe) gage using optical, non-contact, or contact sensors.

6.2 *Edge Squareness* — Measure per Figure 2.

6.3 *Edge Conditions* — To be determined.

6.4 *Edge Straightness* — Measure per Figure 2.

6.5 *Total Thickness Variation* — To be determined.

6.6 *Flatness, medium sheet* — To be determined.

6.7 *Roughness* — SEMI D7 roughness measurement method (contact stylus method, tip radius $\leq 2 \mu\text{m}$).

6.8 *Warp* — Feeler gage with thickness equal to the specified maximum warp value, inserted between substrate bottom edge and surface plate, at any point or at specified points along the edges (formal test method/description to be developed).

6.9 *Waviness* — See SEMI D15.

7 Requirements

7.1 See Table 1.

8 Ordering Information

8.1 *Purchase orders for substrates furnished to this specification shall include the following items:*

8.1.1 Edge length

8.1.1.1 Long reference edge

8.1.1.2 Short reference edge

8.1.2 Orientation corner dimensions, from Table 1

8.1.3 Quality edge area exclusion

8.1.4 Thickness

8.1.4.1 Nominal

8.1.4.2 Tolerance

8.1.5 Warp

8.1.6 Straightness

NOTE 4: Table of Figures:

- Figure 1 — Reference Items
- Figure 2 — Squareness
- Figure 3 — Warp
- Figure 4 — Edge Condition
- Figure 5 — Orientation and Corner Cuts
- Figure 6 — Total Thickness Variation and Local Thickness Variation

Table 1 Specification for Gen III and Larger Active-Matrix LCD Substrates

Reference Information	Range A		Range B		Reference Documents
Edge Length Ranges	550 to 650 mm × 650 to 830 mm		750 to 1000 mm × 900 to 1100 mm		
Edge Length Dimensions	600 × 720 mm, 650 × 830 mm, 550 × 650 mm		800 × 950 mm	900 × 1100 mm	
Edge Length Tolerance ^{#1}	±0.40 mm		±0.40 mm	±0.50 mm	SEMI D5 – Std. Sizes for FPD Substrates
Squareness ^{#1}	±0.83 mm		W = ±0.80 mm L = ±0.95 mm	±1.0 mm	SEMI D4 – Referencing of FPD Substrates
Edge Condition ^{#9}	Rounded ^{#9} Bevel width = 0.1 mm – 0.6 mm, extension onto top/bottom surfaces		Rounded ^{#9} Bevel width = 0.1 mm – 0.6 mm		
Orientation Corner ^{#2}	1 Corner, Symmetric C1x = 4.0 ± 1.0 mm C1y = 4.0 ± 1.0 mm	1 Corner, Asymmetric C1x = 5.0 ± 1.5 mm C1y = 2.0 ± 1.5 mm	1 Corner, Asymmetric C1x = 5.0 ± 1.5 mm C1y = 2.0 ± 1.5 mm		
Corner Cut	3 corners C2x & C2y = 1.5 ± 1.0 mm		3 corners C2x & C2y = 1.5 ± 1.0 mm		SEMI D12 – Edge Condition
Quality Area ^{#3} Edge Exclusion	≤ 0 mm		≤ 20 mm ^{#11}		SEMI D3 – Quality Area for FPD Substrates
Thickness	0.7 mm ± 0.07 mm		0.7 mm ± 0.07 mm		SEMI D5 – Std. Sizes for FPD Substrates
	1.1 mm ± 0.10 mm		1.1 mm ± 0.10 mm		
Total Thickness Variation ^{#4}	60 μm		100 μm		
Local Thickness Variation ^{#5}	≤ 20 μm for ≤ 130 mm		≤ 20 μm for ≤ 130 mm		
Waviness ^{#6} [W _{fpd}]	≤ 0.1 μm, with λ _C = 0.8 mm, λ _L = 8 mm L _S = 20 mm		≤ 0.1 μm, with λ _C = 0.8 mm, λ _L = 8 mm L _S = 20 mm		SEMI D15 – Surface Waviness Measurement
Warp ^{#7}	≤ 0.60 mm		≤ 1.0 mm		
Roughness, R _a	≤ 20 nm		≤ 20 nm		SEMI D7 – Roughness Measurement
Straightness ^{#8}	± 0.4 mm		± 0.4 mm		

#1 For dimensional tolerance and squareness the long edge typically has the maximum tolerance. See Figures 1 and 2.

#2 An asymmetric orientation corner is specified for purposes of mechanical orientation and operator's visual confirmation of orientation within a cassette. Optical means of identifying orientation is under investigation. See Figure 5.

#3 Quality Area is that area in which the specified criteria apply.

#4 Total thickness variation is the peak to valley (TIR) of the entire substrate front surface relative to a reference plane when the substrate back surface is constrained against a vacuum chuck. This scale is typically important for some film deposition and lithography processes. See Figure 6.

#5 Local thickness variation is the absolute value of the maximum deviation of the substrate from a plane constructed in any 100–130 mm square area, within the Quality Area, when the substrate back surface is constrained against a vacuum chuck. This scale is typically important for lithographic stepper processes.

#6 Waviness is the rms (root mean square) surface profile, within the quality area, over 0.8–8 mm spatial wavelengths.

#7 See Figure 3.

#8 See Figure 2.

#9 See Figure 4.

#10 This table applies to the indicated edge length ranges and thicknesses.

#11 Example: For an 800 × 950 mm substrate, the effective process area, which excludes portions not processable for physical reasons, would be ≥ 760 × ≥ 910 mm.