

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

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NOTICE: This Standard or Safety Guideline has an Inactive Status because the conditions to maintain Current Status have not been met. Inactive Standards or Safety Guidelines are available from SEMI and continue to be valid for use.

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: SEMI Standards and Safety Guidelines do not purport to address all safety issues associated with their use. It is the responsibility of the users of the Documents to establish appropriate safety and health practices, and determine the applicability of regulatory or other limitations prior to use.

3 Referenced Standards and Documents

3.1 SEMI Standards and Safety Guidelines

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 Documents¹

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.

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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 reading is W_{fpd} .

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, § 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_c).

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 2 μm to 0.8 mm (0.03 in.).

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

5.2.4 *Horizontal Resolution of Interferometer* — 0.2 mm (0.0079 in.) 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 in.) 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, § 5).

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

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

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 $(L_t - 2*\lambda_L)$, L_e is recommended to be $(L_t - 2*\lambda_L)$.

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 in.) at $\lambda_L = 8$ mm (0.3 in.) or 25 mm (1 in.) at $\lambda_L = 25$ mm (1 in.).

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: