

Designation: F 801 – 96

Standard Test Method for Measuring Optical Angular Deviation of Transparent Parts¹

This standard is issued under the fixed designation F 801; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the Department of Defense.

1. Scope

1.1 This test method covers measuring the angular deviation of a light ray imposed by transparent parts such as aircraft windscreens and canopies. The results are uncontaminated by the effects of lateral displacement, and the procedure may be performed in a relatively short optical path length. This is not intended as a referee standard. It is one convenient method for measuring angular deviations through transparent windows.

1.2 *This standard does not purport to address all of the safety concerns, 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.*

2. Referenced Documents

2.1 ASTM Standards:

E 691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method²

3. Terminology

3.1 Definitions:

3.1.1 *angular deviation*—the departure of a light ray from its original path as it passes through a transparent material. The change in angle of such a light ray. The displacement of an image due to the change in direction of the light ray.

3.1.2 *lateral (or linear) displacement*—the shift or movement of a light ray from its original path as it passes through a transparent material, while maintaining parallelism between the original and final paths. The change in location of an image due to this change in path.

3.1.3 *modulation transfer function (MTF)*—the ratio of output modulation to the input modulation. The modulus of the Fourier transform of the optical spread function.

4. Summary of Test Method

4.1 This test method outlines how measurements can be made by an optoelectronic system employing collimated light, a field lens, and linear diode arrays as the part is held in its

installed angle. The positions of two images of a collimated light source are recorded using two linear diode arrays. One array records azimuth or horizontal position while the other records elevation or vertical position. These arrays are at the posterior focal plane of a field lens. The positions are again recorded after the interposition of a transparent part in the optical path. The difference in image position is directly related to the angular deviation imposed by the transparent part. The effects of lateral displacement are removed by the field lens. Sensitivity of measurement may be controlled by choosing appropriate focal length field lenses and spacing of elements on the diode arrays.

5. Significance and Use

5.1 One of the measures of optical quality of a transparent part is its angular deviation. Excessive angular deviation, or variations in angular deviation throughout the part, result in visible distortion of scenes viewed through the part. Angular deviation, its detection, and quantification are of extreme importance in the area of certain aircraft transparency applications, that is, aircraft equipped with Heads-up Displays (HUD). HUDs may require stringent control over the optics of the portion of the transparency (windscreen or canopy) which lies between the HUD combining glass and the external environment. Military aircraft equipped with HUDs or similar devices require precise knowledge of the effects of the windscreen or canopy on image position in order to maintain weapons aiming accuracy.

5.2 Two optical parameters have the effect of changing image position. The first, lateral displacement, is inherent in any transparency which is tilted with respect to the line of sight. The effect of lateral displacement is constant over distance, and seldom exceeds a fraction of an inch. The second parameter, angular deviation, is usually caused by a wedginess or nonparallelism of the transparency surfaces. The effect of angular deviation is related to the tangent of the angle of deviation, thus the magnitude of the image position displacement increases as does the distance between image and transparency. The quantification of angular deviation is then the more critical of the two parameters.

6. Apparatus

6.1 *Transmitter*, capable of projecting collimated light rays from a suitable target. The target may be a transparent cross or

¹ This test method is under the jurisdiction of ASTM Committee F-7 on Aerospace and Aircraft and is the direct responsibility of Subcommittee F07.08 on Transparent Enclosures and Materials.

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² *Annual Book of ASTM Standards*, Vol 14.02.