



Standard Test Method for Measuring Optical Angular Deviation of Transparent Parts¹

This standard is issued under the fixed designation F801; 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 reappraisal. A superscript epsilon (ε) indicates an editorial change since the last revision or reappraisal.

This standard has been approved for use by agencies of the U.S. 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 it is possible to perform the procedure 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:²

E691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method

F2156 Test Method for Measuring Optical Distortion in Transparent Parts Using Grid Line Slope

F733 Practice for Optical Distortion and Deviation of Transparent Parts Using the Double-Exposure Method

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 provides a basic procedure for measuring the angular deviation induced by a transparent part. Angular deviation measurements are made by an optoelectronic system employing collimated light from an appropriate target pattern, a field lens, and a position-detecting device/system such as linear diode arrays or a two-dimensional diode array. Hold the transparent part either in its installed angle or perpendicular to the collimated light source or any other orientation suitable for the purpose of making the measurement. One specific optoelectronic system suitable for conducting this test method is provided in **Appendix X2 and Appendix X3** and in **Section 6** below.

5. Significance and Use

5.1 One of the measures of optical quality of a transparent part is its angular deviation. It is possible that excessive angular deviation, or variations in angular deviation throughout the part, will 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). It is possible that HUDs will 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

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

Current edition approved April 1, 2016. Published April 2016. Originally approved in 1983. Last previous edition approved in 2008 as F801 – 96 (2008). DOI: 10.1520/F0801-16.

² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.