Wavelength Transmittance Considerations for DLP® DMD Window

ABSTRACT

The use of DLP technology in advanced imaging and exposure systems such as lithography, additive manufacturing, spectroscopy, optical networking, 3D scanning, and medical systems is growing. Various optical factors must be taken into consideration to facilitate these emerging applications.

The digital micromirror device (DMD) efficiency observed in a specific application depends on equipment-specific design variables such as illumination wavelength, illumination angle, projection aperture size, overfill of the DMD micromirror array, and so on. Overall optical efficiency of each DMD can generally be estimated as a product of window transmission (2 passes), diffraction efficiency, micromirror surface reflectivity, and array fill factor. The first three factors depend on wavelength of the illumination source. This application report provides information specifically on transmittance of DMD windows in different regions of the electromagnetic spectrum.

Trademarks

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1 Introduction

DLP technology uses two types of materials for DMD windows.

- For Type-A DMDs the window uses Corning 7056.
- For all other DMDs the window material is Corning Eagle XG.

Both window types have an anti-reflective (AR) thin film coating on both the top and the bottom of the window glass material. AR coatings reduce reflections and increase transmission efficiency.

The DMD windows are designed for four different transmission regions.

- Ultraviolet (UV) light: 355 to 420 nm
- Visible light: 400 to 700 nm
- Near infrared (NIR) light: 700 to 2500 nm
- Near infrared (NIR2) light: 800 to 2000 nm

The DLP portfolio of chips offers DMDs that span these wavelength regions to enable advanced light control in diverse end equipment designs. DMDs designated as UV devices therefore have windows with AR coatings designed to be more transmissive for ultraviolet wavelengths. Similarly, DMDs designated as NIR devices have windows with AR coatings designed to be more transmissive for NIR wavelengths. Many devices in the DLP portfolio are designed for display applications and therefore considered visible DMDs, having windows with AR coatings designed to be transmissive for visible wavelengths.

The measured data provided in the following sections reflects a typical single-pass transmittance through both top and bottom AR coated window surfaces with random polarization. The angle of incidence (AOI) of 0° is measured perpendicular to the window surface, unless mentioned otherwise. With an increase in the number of window passes, the efficiency would decline.

NOTE: The curves shown are typical performance and not minimum specified limits or ensured values.

2 Corning 7056 Window Transmittance Curves

The window transmission response curves in this section apply to Type-A DMDs in their specified illumination wavelength regions. Figure 1 shows the UV window and visible window transmittance measured perpendicular to the window surface. Figure 2 and Figure 3 are the zoomed-in views of the typical visible and UV AR coated window transmittances in their maximum transmission regions.

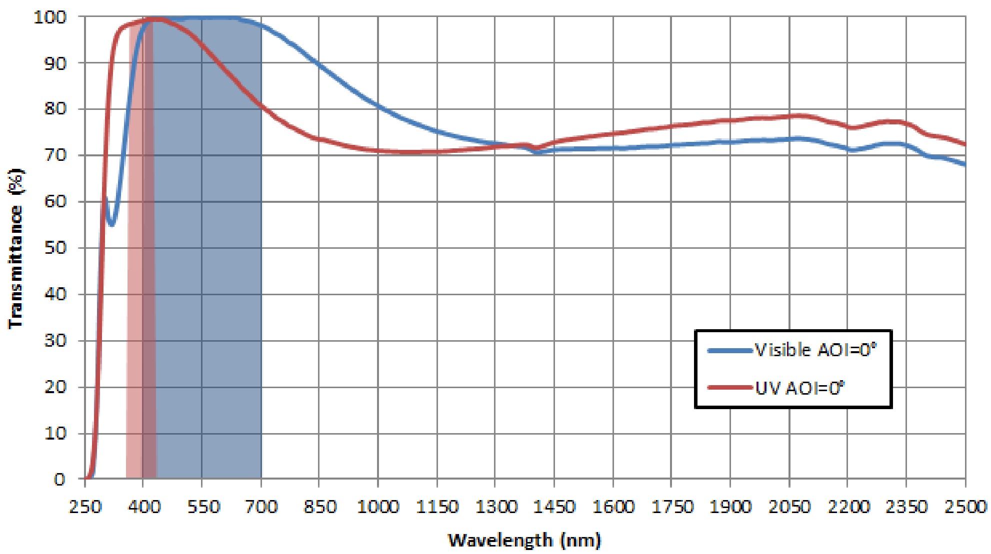

Figure 1. Corning 7056 Visible and UV Window Options

The visible window is optimized for 400 to 700 nm wavelengths. The UV window is optimized for 355 to 420 nm wavelengths.

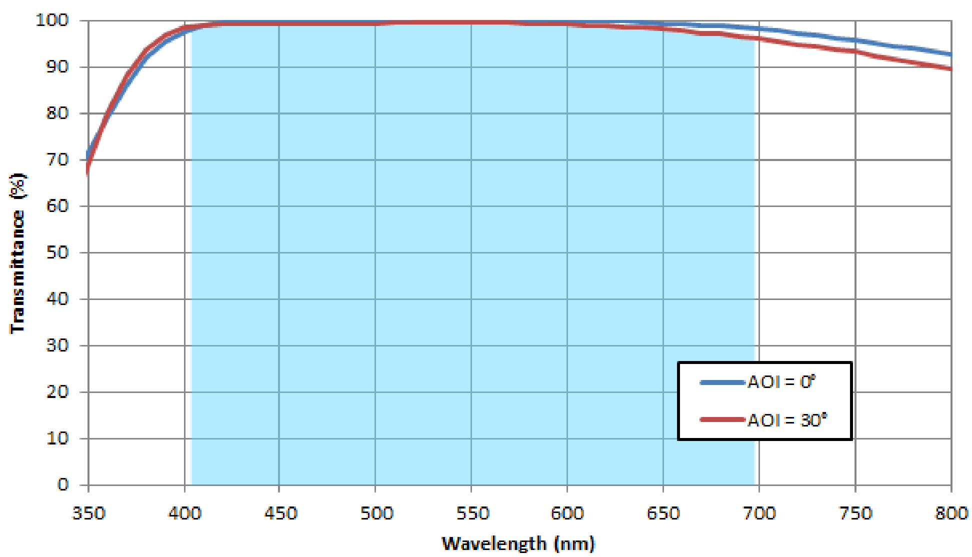

Figure 2. Corning 7056 Visible Window Transmittance (Visible Region)

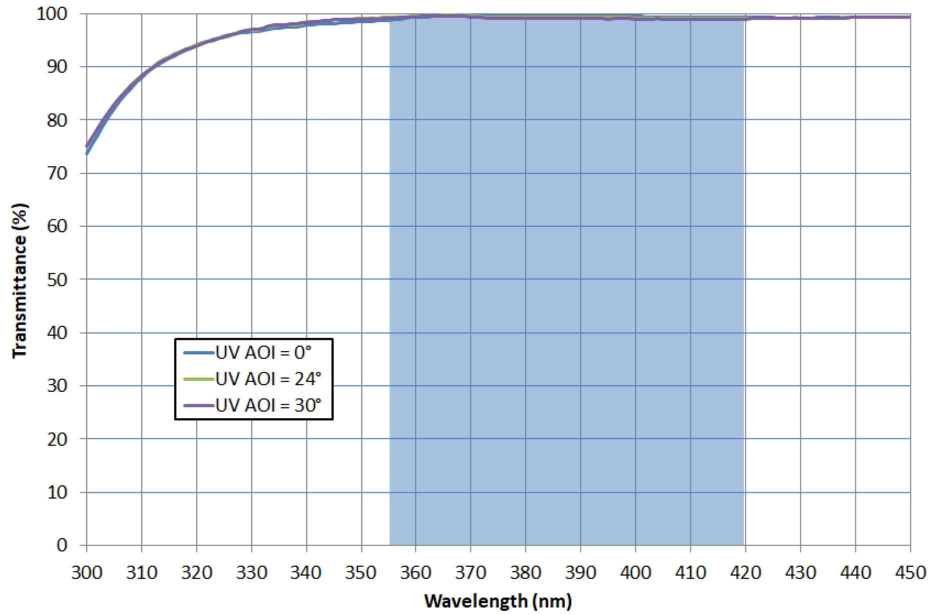

Figure 3. Corning 7056 UV Window Transmittance (UV Region)

3 Corning Eagle XG Window Transmittance Curves

The window transmittance for the different AR coated Corning Eagle XG windows are shown in Figure 4 .

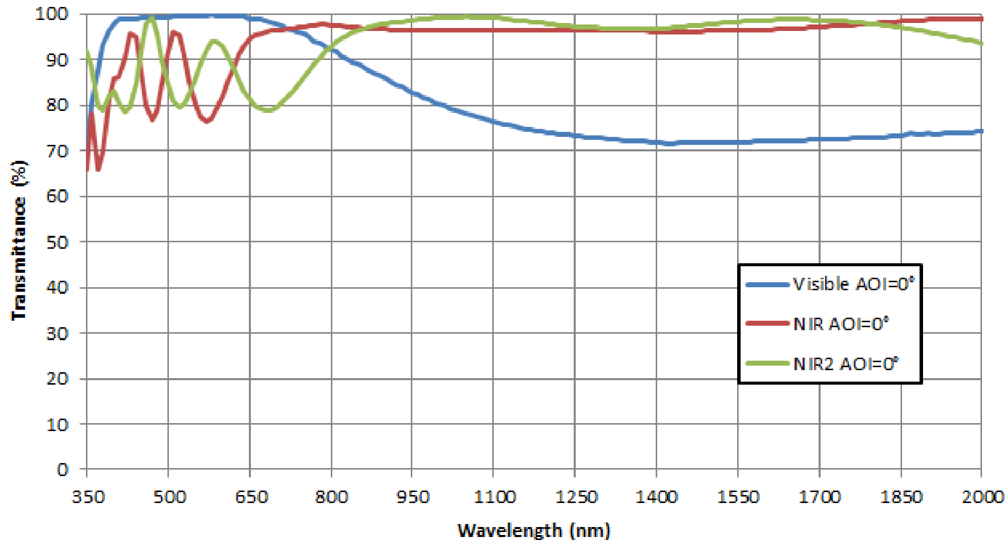

Figure 4. Corning Eagle XG Visible, NIR, and NIR2 Window Options

The visible Corning Eagle XG window transmission data in Figure 5 applies to visible DMDs that are not in Type-A packages. It shows the typical transmittance observed in the broadband visible region is approximately 97% (single-pass through two window surfaces).

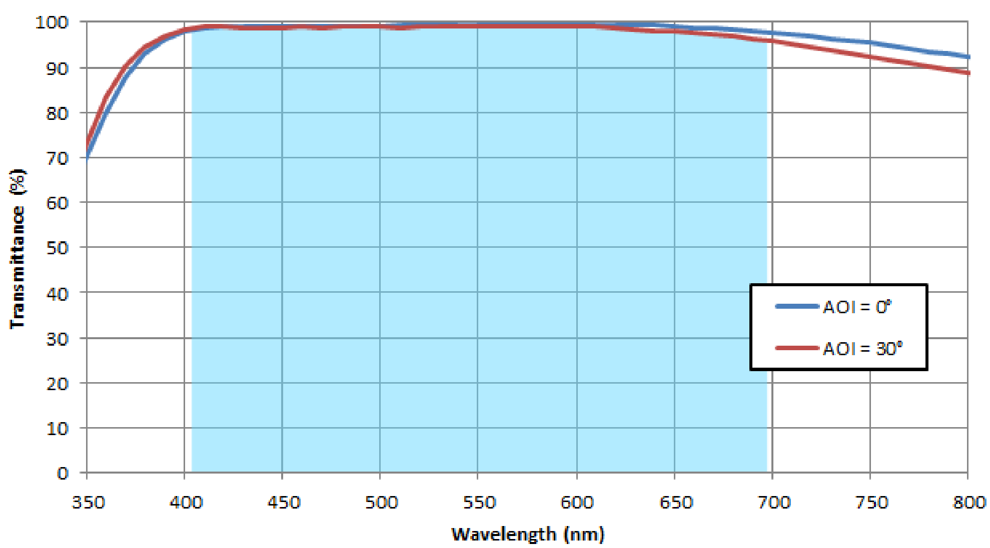

Figure 5. Corning Eagle XG Visible Window Transmittance

The NIR Corning Eagle XG window transmission data in Figure 6 applies to the DLP4500NIR and DLP2010NIR DMDs. The typical transmittance observed in the broadband NIR region is approximately 96% for most of the region (single-pass through two window surfaces), with a dip toward 90% as it nears 2500 nm.

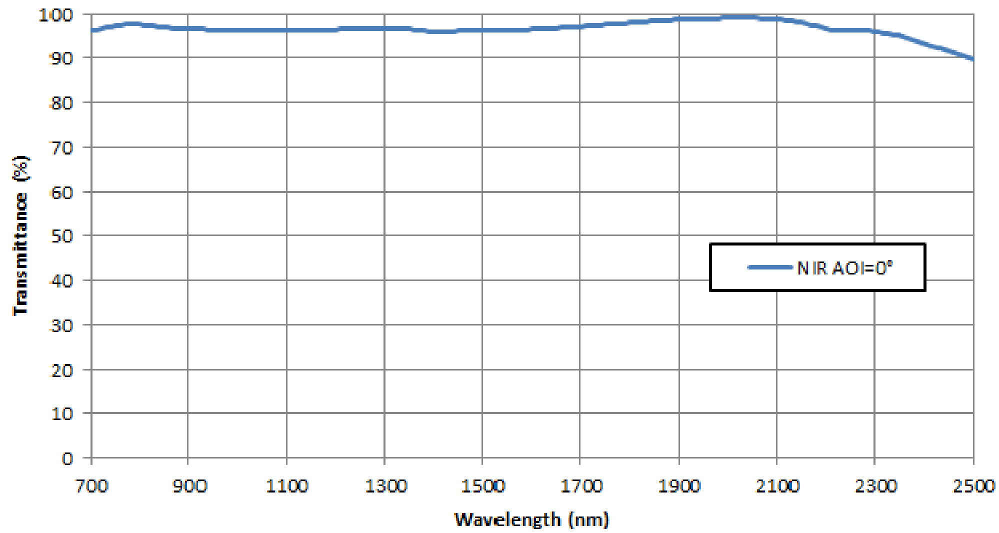

Figure 6. Corning Eagle XG NIR Transmittance (NIR Region)

The NIR2 Corning Eagle XG window transmittance data shown in Figure 7 applies to the DLP650LNIR DMD. The typical transmittance observed in the broadband NIR region is approximately 97% for most of the region (AOI = 0°, single-pass through two window surfaces).

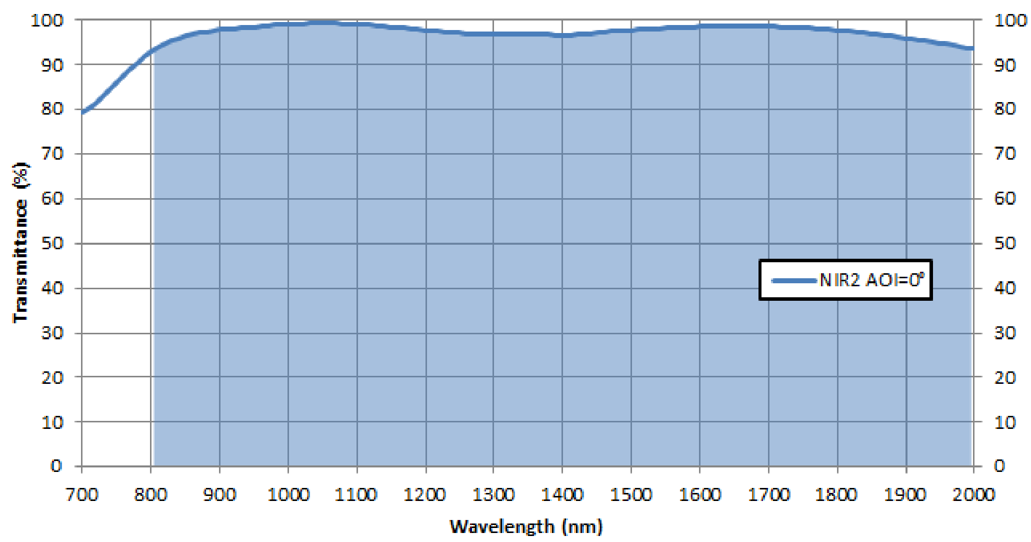

Figure 7. Corning Eagle XG NIR2 Window Transmittance (NIR Region)

Revision History

Changes from D Revision (October 2018) to E Revision	Page
• Updated UV Window Transmission graph to include 24° and 30° AOI	3

Changes from C Revision (March 2014) to D Revision	Page
• Removed visible window transmittance data at AOI = 30° from Figure 1.	2
• Extended highlighted region to 400 to 700 nm Figure 2.	2
• Changed x-axis of Figure 3 to 300 to 450 nm.	3
• Changed x-axis of Figure 4 to 350 to 2000 nm, added data for NIR2 at AOI=0° and removed visible AOI=30° data.	4
• Changed highlighted region of Figure 5 to 400 to 700 nm.	4
• Changed x-axis of Figure 6 to 700 to 2500 nm.	5
• Added Figure 7.	5

Changes from B Revision (November 2012) to C Revision	Page
• Updated Figure 4	4
• Added Figure 6	5

Changes from A Revision (October 2012) to B Revision	Page
• Changed wavelength From: (mm) To: (nm)	2
• Changed wavelength From: (mm) To: (nm)	3

Changes from Original (May 2012) to A Revision	Page
• Added visible window transmittance data at AOI = 30° to Figure 1	2
• Updated figure 2	2
• Added Corning eagle XG visible window transmission data at AOI = 30°	4
• Updated Figure 5	4

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