

3M Optical Systems Division
Liquid Crystal Display

Customer Quality Specification

Vikuiti™

Dual Brightness Enhancement Film
Diffuse - DBEF-D2-400 (parts greater than or
equal to 635 mm diagonal)

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1.0 Scope

This document provides customer specifications for Vikuiti™ Dual Brightness Enhancement Film – Diffuse DBEF-D2-400

2.0 Function

DBEF-D2-400 is a reflective polarizing film used in LCD displays to increase brightness over a wide viewing angle.

3.0 Material

A multilayer polyester-based film which has diffuse polycarbonate laminated to both sides.

4.0 Structure

Structure (not to scale)



5.0 Definitions

5.1 Optical

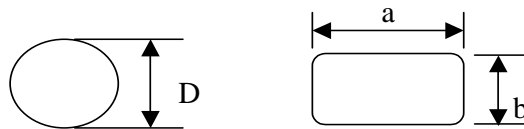
5.1.1 Effective Transmission: With respect to a standard tester: Luminance measured with a sample divided by the luminance measured without a sample on the tester.

5.1.2 Color shift: Change in color (x,y) at normal axis (0°) and off axis (60°) of LCD module with and without DBEF-D2-400.

5.2 Cosmetic

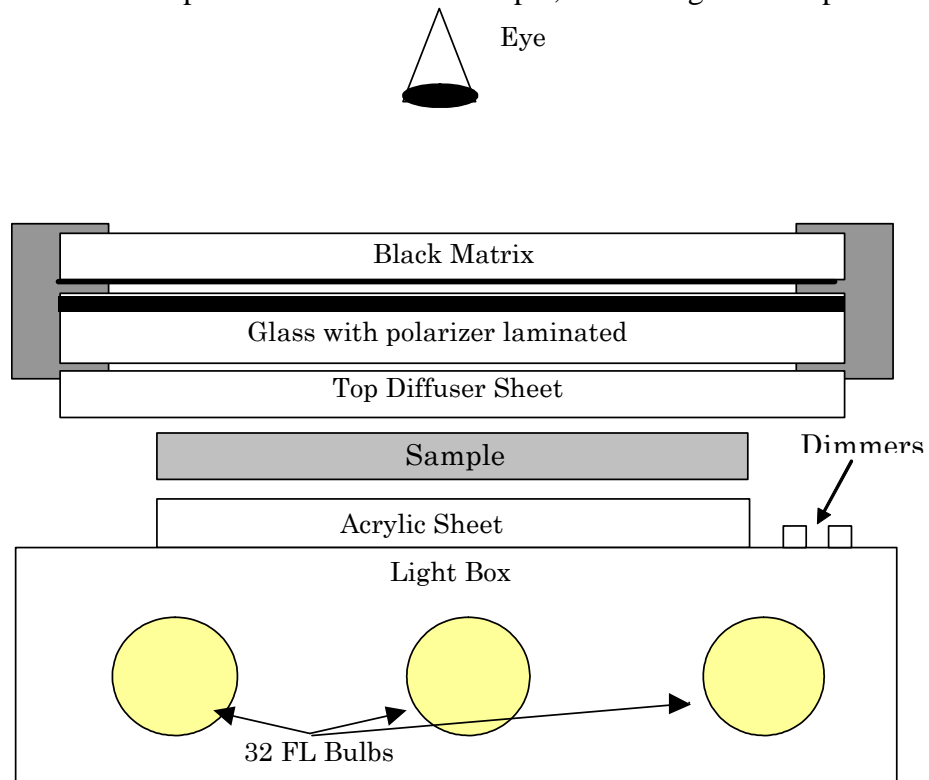
5.2.1 White dot: Lightly colored or translucent dot with defined edges. Size of defect is judged by "D" below.

5.2.2 Black dot: Black or dark colored opaque dot with defined edges. Size of defect is judged by "D" below.



$$D=(a+b)/2$$

- 5.2.3 Color non-uniformity: Color streaks that are visible at higher observation angles than normal.
- 5.2.4 Scratch: Any line-like defect. Size and shape defined as greater than 4:1 aspect ratio and $a \geq 0.5\text{mm}$, where "a" is defined in drawing above.
- 5.2.5 Flow Bands: Transmission axis flow patterns within the film.
- 5.2.6 Other Defects: Contamination, distortion, and others that may affect the performance of DBEF-D2-400. Dust or lint on the surface of DBEF-D2-400 that is easily removed by wiping and/or air flow is excluded.
- 5.2.7 Fitness for use (FFU): Accept/reject decision made based on a part being fit for use in an application.
- 5.2.8 3M Standard Display: (CIS-Cosmetic Inspection Station, Model# CIS2001) Constructed as shown below. The sample is inspected by transmitted light with diffuser polarizer filter on the sample, simulating an LCD panel.



- 5.2.8.1 Light box: Lumimed LD12AD Viewbox with two banks of 16 EEFL bulbs (Toshiba) apiece. Total viewing surface of light box is 28" X 17" (L X H).

- 5.2.8.2 Luminance: 1250 +/- 200 cd/m² (Display center: typical 1250 cd/m²)
- 5.2.8.3 Top diffuser filter: Keiwa PC1050T
- 5.2.8.4 Top diffuser filter haze: Nominal 50%
- 5.2.8.5 Glass with polarizer laminated: SanRitz HLC2-5618 or equivalent laminated
- 5.2.8.6 Transmittance: 35 to 45%, Polarization efficiency ≥99.9%
- 5.2.8.7 Black matrix: Pixel = 0.5mm x 0.167mm (BM = 0.01mm x 0.03mm)
- 5.2.8.8 Aperture ratio: 81%

5.3 Physical:

Delamination: Separation of the polycarbonate from the DBEF or a separation of the layers within the DBEF.

6.0 Physical Characteristics

- 6.1 Thickness: 390 ± 40µm
- 6.2 Delamination: ≤1.0mm from edge
- 6.3 Part dimensions: Per approved drawing

7.0 Optical Characteristics

- 7.1 Effective Transmission Minimum 1.60
- 7.2 Color shift 0°
 - Δx: maximum 0.010
 - Δy: maximum 0.010
- 7.3 Color shift 60°
 - Δx: maximum 0.030
 - Δy: maximum 0.030
- 7.4 Haze: 79.5 ±10%
- 7.5 Total Transmittance: 48.5 ±5%

8.0 Appearance

- 8.1 Inspection condition:
 - Cosmetic quality will be evaluated using Fitness for Use (FFU) criteria on a 3M Standard display (CIS) as defined in section 5.2.8.
- 8.2 Inspection: Transmitted diffuse white light with BEF grooves up
 - 8.2.1 Inside of 1.0mm from the part edges
 - 8.2.2 Horizontal viewing angle ±80°
 - 8.2.3 Vertical viewing angle ±80°
 - 8.2.4 Viewing distance from sample to eye is minimum 50cm.

8.3 Specification:

Item	Spec. /mm	Allowable number of defects
White Dot	Accept if not visible in 3M standard display (CIS) or if D < 0.4mm	no limit *1
Black Dot	Accept if not visible in 3M standard display (CIS) or if D < 0.3mm	no limit *1
Other Defect	Accept if not visible in 3M standard display (CIS)	no limit *2
Scratch	Accept if not visible in 3M standard display (CIS)	no limit *2
Banding	Accept if not visible in 3M standard display (CIS)	no limit *2
Color non-uniformity	If equal to or better than DBEF PAS, accept any length, size, width, diameter	no limit

*1: When there are defects that size (D) is over 0.2mm, distance between each defect has to be more than 10mm.

*2: To be judged with PAS if necessary. If equal to or better than PAS accept any length, size, width, diameter. PASs provided to customers will be selected by 3M using 3M Standard Display (CIS).

8.4 Acceptance criteria:

8.4.1 If a defect is visible per section 8.1, refer to the size requirement shown in the table in section 8.3.

8.4.2 If the defect is not visible per section 8.1, the part is acceptable.

8.4.3 If the defect (dust, lint, fiber, or contamination) can be removed by air-blowing the part with ionized air, the part is acceptable.

9.0 Measurement

Note: Gain and color shift depend on the backlight material, design, and lighting efficiency.

Item	Method
Effective Transmission	Sample: 76.2mm x 127mm (3"x5") 0° bias Light source: Fostec-DCR II DC regulated light source Equipment: Spectra Colorimeter, Model PR-650 SpectraScan - Photo Research, Inc., Polarizer assembly Procedure: Measure luminance with DBEF-D sample on the teflon box in correct orientation.
Color Shift 0°	Module : 11.3" SVGA TFT LCD (Normally white, no-electrical driving) Sample : 185mm x 247 mm, 45° bias Backlight : edge light Equipment : Photo Research, Inc., SpectraColorimeter, Model: PR-650 SpectraScan Procedure - In dark room: Measure color x and y at 0° (xN0, yN0) Measure color x and y with DBEF-D between backlight and LCD panel (xD0, yD0) Calculate color shift by following equation $\Delta x = xD0 - xN0 $ $\Delta y = yD0 - yN0 $ *color x and y are based on 1931 CIE.

Item	Method
Color Shift 60°	Module : 11.3" SVGA TFT LCD (Normally white, no-electrical driving) Sample : 185mm x 247 mm, 45° bias Backlight : edge light Equipment : Photo Research, Inc., SpectraColorimeter, Model: PR-650 SpectraScan Procedure - In dark room Measure color x and y at 60° (xN60, yN60) Measure color x and y with DBEF-D between backlight and LCD panel (xD60, yD60) Calculate color shift by following equation $\Delta x = xD60 - xN60 $ $\Delta y = yD60 - yN60 $ *color x and y are based on 1931 CIE.
Color Change ΔE	3M TM-019, ASTM E 1164 Light Source: D65/10 Measurement: transmission Size: 40mm x 40mm, 45° bias Equipment: Equipment: BYK Color Sphere (equivalent to Minolta Co., Ltd., Spectrophotometers CM-3500) Procedure: Measure color (L*,a*,b*) of transmitted light through DBEF-D before and after testing. Then, color change (ΔE^*) is calculated, $\Delta E^* = (\Delta L^{*2} + \Delta a^{*2} + \Delta b^{*2})^{1/2}$
Haze	3M TM-016, ASTM D1003-00 Sample: DBEF-D (size: 40mm x 40mm, 45° bias) Equipment: BYK Haze-Gard Plus Cat. No 4725

10.0 Environmental Testing

10.1 Testing condition:

DBEF-D400 is tested under the following conditions with film free floating.

Test	Condition
Humidity resistance	65°C, 95% relative humidity, 1000 hours
Heat resistance	85°C for 1000 hours
Cold resistance	-40°C for 1000 hours
Thermal shock	85°C for 1 hr to -40°C for 1 hr, 100 cycles
Accelerated UV exposure test	288 hours, 0.5 W/m ² at 448 nm, 83 C Philips F40/50U bulbs in QUV/cw chambe from Q-Panel Lab Products

10.2 Specification:

Item	Judgement
Appearance	No significant appearance change
Change of effective transmission	Minimum 80% vs. initial value
Change of color	Maximum 2.0 in ΔE^* vs. initial value

11.0 Patent

This product, uses thereof, or its manufacture may be covered by one or more of the patents listed on the package labels.

12.0 Packaging

Packaging per local supply agreement. The label includes the following information:

- 12.1 Product name
- 12.2 Quantity
- 12.3 Lot number
- 12.4 Patent numbers

13.0 Film Handling

- 13.1 Store parts flat and in original packaging.
- 13.2 Avoid applying pressure or resting objects on the product to prevent marking, denting or deforming the surface.
- 13.3 Wear gloves to prevent fingerprints or nail marks.
- 13.4 Hold product by the edges to prevent touching display area..
- 13.5 Do not slide the product.
- 13.6 Product must be stored away from the direct sunlight.

14.0 Warranty Period and Storage Conditions

3M warrants that the products produced to this specification will meet this specification for twelve (12) months after the date of receipt at the purchaser location provided that the product is stored flat in accordance with the requirements in section 13.0 above and in the original package under the following conditions: temperature of $20 \pm 10^{\circ}\text{C}$ and at a relative humidity of $45 \pm 15\%$. If product is shown to be defective during this warranty period, 3M's sole liability and purchaser's exclusive remedy is, at 3M's option, for 3M to refund the purchase price of the product or provide replacement product in the quantity shown to be defective.

3M makes no additional warranties, express or implied, including but not limited to, any implied warranties of merchantability or fitness for a particular purpose. In particular, but without limitation, 3M makes no representations or warranties concerning the effective life of the products or their ability to survive user's environmental testing. Purchaser is responsible for determining whether the 3M products are fit for the purchaser's particular purpose and suitable for the purchaser's method of production.

3M shall not be liable for any loss or damages, whether non-specified direct, indirect, special, incidental or consequential (including downtime, loss of profits or goodwill) regardless of the legal theory asserted.

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