3M™ Envision™ Translucent and Diffuser Films

Guidelines for Backlit Signs

Recommended Types of Graphics and End Uses

3M™ Envision™ Translucent Films 3730 are perfect for durable, dimensional stable backlit application. The low-gloss surface of film series 3730 eliminates glare and provides a uniform color with both reflected and transmitted light. Film series 3730 is optimized for lighting applications using LED light sources.

3M™ Envision™ Diffuser Films 3735-50, 3735-60 are recommended for LED applications and provide 50% resp. 60% light transmission. These cast films are light managing films to create durable permanent channel letters, signs and displays. They control brightness and light distribution within light boxes without hotspots.

About 3M Envision and 3M Scotchcal films

3M™ Envision™ Translucent films IJ 3730-50 and IJ3730-60 are inkjet printable translucent films and are optimized as 3M™ Envision™ Translucent Graphic Film Series 3730 and 3M™ Envision™ Diffuser Films 3735 to work with LED light sources to deliver backlit graphics with rich, vibrant colors and bright whites. They are designed to provide more light transmission than most graphic constructions using 3M™ Scotchcal™ Translucent Graphic Film Series 3630 and 3M™ Diffuser Films 3635-30 and 3635-50. In addition, they hide LEDs closer to the sign face—eliminating unwanted hot spots. These films give sign makers the flexibility to create brighter sign faces or use fewer LEDs to get the same level of brightness.

The 3730 Films are intended for indoor and outdoor backlit sign applications and have the same physical, application, processing and performance characteristics as the 3630 Films.

FIGURE 1

Backlit Inkjet Printed Graphics comparing 3M Envision and 3M Scotchcal Films

FIGURE 1 shows an example of 3M’s inkjet printable translucent films backlit by LEDs: films IJ3730-50 (left) and IJ3630-20 (right). As shown, the 3M Envision Translucent Film provides higher light transmission than the Scotchcal Translucent Film using the same number of LEDs.

Note: Images are printed using the same printer and inks.

Most graphics using film series 3730 on diffuser film 3735-50 provide more light transmission than other graphics using film series 3630 on diffuser film 3635-30.
FIGURE 2 shows an example of LEDs appearing through diffuser film 3635-70 (right) and LEDs being hidden by diffuser film 3735-60 (left) at a 11 cm depth.

A. Light Transmission

The light transmission of these films varies by the graphic construction, the film color and the film itself.

Comparing Light Transmission using LEDs

This table compares film series 3730 on diffuser film 3735-50 (the “3730 construction”) to film series 3630 on diffuser film 3635-30 (the “3630 construction”) and shows:

- typical gains in light transmission that may be expected from the 3630 constructions to the 3730 constructions.
- a calculated percentage of LEDs needed in 3730 constructions to achieve the same brightness of 3630 constructions.

<table>
<thead>
<tr>
<th>Product Number 3630-xxx / 3730-xxx</th>
<th>Color</th>
<th>Typical % Increase (Gain) in Light Transmission</th>
<th>% LEDs Needed for Equivalent Brightness**</th>
</tr>
</thead>
<tbody>
<tr>
<td>015 / 015L</td>
<td>Yellow</td>
<td>25</td>
<td>80</td>
</tr>
<tr>
<td>20 / 20L</td>
<td>White</td>
<td>56</td>
<td>64</td>
</tr>
<tr>
<td>26 / 26L</td>
<td>Green</td>
<td>20 *</td>
<td>83 *</td>
</tr>
<tr>
<td>33 / 33L</td>
<td>Red</td>
<td>106</td>
<td>49</td>
</tr>
<tr>
<td>36 / 36L</td>
<td>Blue</td>
<td>46 *</td>
<td>68 *</td>
</tr>
<tr>
<td>43 / 43L</td>
<td>Lt. Tomato Red</td>
<td>66</td>
<td>60</td>
</tr>
<tr>
<td>44 / 44L</td>
<td>Orange</td>
<td>55</td>
<td>65</td>
</tr>
<tr>
<td>53 / 53L</td>
<td>Cardinal Red</td>
<td>65 *</td>
<td>61 *</td>
</tr>
<tr>
<td>73 / 73L</td>
<td>Dark Red</td>
<td>82</td>
<td>55</td>
</tr>
<tr>
<td>97 / 97L</td>
<td>Bristol Blue</td>
<td>32 *</td>
<td>76 *</td>
</tr>
<tr>
<td>106 / 106L</td>
<td>Brilliant Green</td>
<td>32</td>
<td>57</td>
</tr>
<tr>
<td>125 / 125L</td>
<td>Golden Yellow</td>
<td>48</td>
<td>68</td>
</tr>
<tr>
<td>127 / 127L</td>
<td>Intense Blue</td>
<td>71</td>
<td>58</td>
</tr>
<tr>
<td>137 / 137L</td>
<td>European Blue</td>
<td>33 *</td>
<td>75 *</td>
</tr>
<tr>
<td>156 / 156L</td>
<td>Vivid Green</td>
<td>69</td>
<td>59</td>
</tr>
<tr>
<td>157 / 157L</td>
<td>Sultan Blue</td>
<td>44</td>
<td>69</td>
</tr>
<tr>
<td>167 / 167L</td>
<td>Bright Blue</td>
<td>96</td>
<td>51</td>
</tr>
<tr>
<td>337 / 337L</td>
<td>Process Blue</td>
<td>80</td>
<td>56</td>
</tr>
</tbody>
</table>

* Value is effective for product manufactured before May 18, 2013 as shown on product label or core tag. For product manufactured after this date, contact 3M Technical Service for available data.
B. Translucent Film Colors

Refer to a Color Card 3630 and to a Color Card 3730 for listing of available standard colors. Note: This film may also be custom color matched.

(1) Reflected Light

The colors of film series 3630 and 3730 appear to be the similar when viewed in reflected light and not illuminated.

(2) Transmitted Light

Because film series 3630 and 3730 are optimized for different light sources, an exact color match between these two colored films may not be possible when illuminated. 3M formulates the film series 3730 colors to the closest color match as possible; however, in some instances a slight color variation between the products may be noticeable in transmitted light.

Light Management Overview

Efficient light management means a more efficient backlit sign. In a light box, light is either (1) transmitted through the face of the sign, (2) reflected (bounced) onto other surfaces or (3) absorbed. The goal is to ensure light is not wasted so the maximum amount of light gets transmitted. Any wasted light impacts the performance of the light box and ultimately impacts the viewer.

Maximizing Light Transmission

- Ensure ALL interior light box surfaces have a reflective white material to redirect light off their surface and out through the sign face.
- Minimize all surfaces that absorb (and waste) light in the interior including:
  - raw metals, such as unpainted aluminum or steel.
  - darkly colored painted surfaces.
  - any other low reflective surfaces.
- Painting or applying a highly reflective film are two common methods for enhancing reflectivity of a light box.

Note: Reflectivity is especially important as some LED module designs rely on reflectance to transmit light out of the sign face.

Using 3M™ Light Enhancement Film 3635-100

Film 3635-100 is a highly reflective film commonly used for lining the interior of backlit light boxes. To learn more about this film, refer to Product Bulletin 3635-100 and Instruction Bulletin 2.4. Based on the intended application, the sign maker needs to determine the proper method to enhance the reflectivity of interior surfaces of the light box.

Guidelines for Brightness

Some communities are adopting illumination levels for their signage. Because this information is subject to change, sign makers and sign owners are responsible to be aware, understand and comply with all illumination standards and guidelines as specified for an intended sign location.

LED Overview

This section provides general information about LED designs and how light source color temperatures affect the appearance of colors in graphics.

LED Modules

Any LED may be used with 3730 Films. In general, select the LED that best meets your customer’s requirements and expectations and before committing to a job, always test and approve to determine if the light source works as expected.

LED modules are available in many sizes, shapes and forms and are designed:
- with or without a lens (FIGURE 3).
- with either tight or widespread light angle output.
- in a full range of color temperatures (e.g., from warm white at 3200K to very cool white at 9000K).
- to meet various levels of performance or durability.

FIGURE 3 LED Modules

LED without lens: angle of light is limited to angles created by LED package

LED with lens: angle of light is increased based on optics of lens
Ingress Protection Ratings for Exterior Applications

LED modules are classified to an Ingress Protection (IP) Rating, such as IP65 and IPX7. These ratings provide the sign maker an indicator of the type of environmental protection provided by a particular LED. This rating indicates how well the LED is protected from dust and water contamination. The first number indicates the level of protection against dirt and dust and the second number indicates level of protection against water penetration. The higher the number, the more protection provided. (If a number is replaced by an X, there is no protection rating for that particular criteria.) Before selecting a suitable LED, consider the environmental condition the light box will be exposed to and then, refer to the guidelines provided by the LED manufacturer.

Color Temperatures

The color of any 3M translucent colored or printed film is affected by the color temperature of the light source used in the backlit light box, sign cabinet or channel letter. These affects can be seen with both fluorescent or LED light sources.

(1) Impact to Sign Face

- **Lower color temperatures (3200K to 4200K)** make whites and the overall sign face appear more yellow.
- **Higher color temperatures (5400K up to 10000K)** make whites and the overall sign face appear more blue and brighter than lower color temperatures.

(2) General Selection Guidelines

There are typically three color temperatures for fluorescent backlit signage: warm white (3200K), daylight (5000K) and cool white (6500K). Sign makers choose the film that provides the best color rendition with the bulb specified for the light box.

- Film series 3630 colors are proofed using 4200K for both reflected and transmitted light.
- Film series 3730 colors are proofed using 4200K fluorescent bulbs for reflected light and 6500K for transmitted light. The choice of a higher color temperature, 6500K for transmitted light, takes advantage of the perception that white generally appears white (bluer) to most people at 6500K.

In general, the guidelines for selecting the appropriate color temperature of LEDs are the same as fluorescent bulbs.

- **For printed graphics of people:** 3600K to 4200K provide good skin tone color rendition. The warmer color temperatures complement skin color better.
- **For printed graphics featuring food:** 4200K to 5000K provide a good blend of warm and cool tones producing a more appealing or appetizing image.
- **For graphics of scenic imagery with large areas of colored or printed film:** 6500K provides good color rendition and color appearance. The blue tones of the higher color temperature help the whites appear whiter, making the other colors appear to have more intensity and contrast.

Design Considerations

Understanding Customer Requirements

Before starting any sign construction, be sure to understand all of the requirements of the backlit sign from the brand owner or sign shop. Some factors to discuss with your customer include:

- Size and shape of the backlit sign
- Ambient lighting conditions (e.g., well lit or very dark at nighttime)
- Intended graphics design and its use of:
  - People, objects, scenery
  - Solid colors or patterns
  - Brand identity and colors, including the company's specifications for color matching their brand.
- Proximity and placement of other adjacent (competing) signage within the area
- Expected service life of the sign

Factors Affecting Quality

Some important characteristics that determine the quality of a light box or channel letter are:

- the uniformity of light across the entire sign face,
- the elimination of hot spots showing through the sign face, and
- the total light output (brightness) of the sign.

Converting Light Boxes

- When converting a light box design from 3630 Films with fluorescent bulbs to 3730 Films with LEDs, 3M recommends the customer review and approve the design in reflected and transmitted light.
- For the most realistic appearance, prototyping the design for approval is recommended.
Light Box Depth

Light box depth is an important factor on the ability to create an uniform sign face. Refer to TABLE 1 and FIGURES 4 to 7 for some design considerations and to understand how light box depth, LED beam angle and pitch are affected by one another.

**Table 1**

<table>
<thead>
<tr>
<th>Depth</th>
<th>Design Considerations</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 to 10 cm</td>
<td>• Consider using LED modules with lenses. Many newer LED modules are designed with lenses to create wider beam angles (some manufacturers report up to 180°). LED modules with lenses redirect light in a sideways directions relying on the internal surfaces of the light box to reflect (redirect) the light forward. In turn, this reflected light results in a uniform light output across the entire sign face.</td>
</tr>
<tr>
<td></td>
<td>• Because newer LEDs with optics reply on the internal surfaces of the light box to reflect (redirect) the light forward, the use of reflective white material on interior surfaces is essential.</td>
</tr>
</tbody>
</table>
|                | • Consider using lower lumen output (less bright) LEDs.  
  - Less light is needed because 3730 Films are more light transmissive and the LEDs are placed closer to the sign face.  
  - To minimize the possibility of hot spots from LEDs being placed closer to the sign face. |
| 10 to 15 cm    | • Consider using LED modules without lenses. This LED design typically has a beam angle sufficient to produce even light distribution on the sign face and create a uniform sign appearance.  
  • This 10 to 15 cm depth typically reduces the risk of hot spots and allows for the use of higher lumen light output LEDs.                                                                 |
| Greater than 15 cm | • Consider creating a false back plate or insert to position the LEDs closer to the sign face.  
  • Investigate using LED tubes as an alternative to fluorescent tubes. Some manufacturers indicate LED tube brightness may equal the light output of fluorescent tubes.  
  • Understand very high output LEDs are needed at this depth, which may increase the manufacturing cost of the light box. |

**FIGURE 4**

**Light Box Depth, Beam Angle and Pitch**

FIGURES 4 to 7 show some general guidelines on how light box depth, along with LED beam angle and pitch, influence sign face uniformity.

**FIGURE 5**

**Box depth: same**

**Beam angle: same**

**Pitch: different**

Narrower pitch is more uniform
Thin Channel Letters

If a brighter sign face is not required and reducing the number of LEDs is not practical in a thin channel letter, consider substituting lower lumen output LEDs to achieve an equivalent level of brightness. In this case, lower manufacturing costs or reduced energy consumption may be some potential benefits of the 3730 Films.

Double Sided Signs

LED tubes are designed as an alternative to fluorescent tubes. Many LED tubes have front- and rear-facing LEDs offering near 360° coverage and high lumen output making them a possible alternative to using twice the number of LEDs required for a single-side sign.

Diffuser Films

Typically, film series 3730 colors will require the use of a diffuser film (e.g., 3735-50 or 3735-60) when applied to clear plastic if the light source is directly behind the film.

LED Layouts

Contact your selected LED manufacturer for guidance on a layout best suited for your application. Currently, there is no commercially available layout software that considers the higher light transmission of the 3730 Films when creating an LED layout pattern.

Designing with Fewer LEDs

The number of LEDs that can be reduced from an existing LED layout depends on several factors including:

- the size and shape of the light box,
- the light level required by the customer, and
- the type of LEDs being used.

**NOTE:** The user is responsible for ensuring the LED layout meets all of its intended performance requirements. A significant reduction in LEDs may affect other performance factors of an illuminated sign, such as sign face uniformity, perceived brightness and visual impact.

The percentage gain in transmission, and therefore the percentage reduction in LEDs, varies by the selected film color, ink color and/or ink laydown.

Size and Shape of Light Box

Generally, signs with large open areas, rectangular or box signs, are best suited for fewer LEDs without noticeably impacting overall sign face uniformity. In smaller signs, it is more challenging to achieve the desired sign face uniformity with fewer LEDs.

Light Level Required by Customer

If your customer finds the brightness of signs created with 3630 Films acceptable, then:

- a comparable brightness may be achieved using 3730 Films with fewer LEDs.
- a similar level of brightness for white may be maintained.
- an acceptable sign face uniformity may be maintained without requiring any change to the light box depth if the LED layout is adjusted properly.

Type of LED Being Used

See Section LED Overview on page 4.

Suggested Layout Modification Techniques

- As a starting point, a 25% to 30% reduction in the number of LEDs for a 3730 Film construction, when compared to a 3630 Film construction, typically yields an acceptable sign face uniformity without requiring any change to the light box depth if the LED layout is adjusted properly.

  **Example:** if a LED layout is designed currently with 30 cm centers, a redesigned layout with 40 to 42 cm centers typically reduces the LEDs by 25 to 30% while, in general, providing an acceptable overall sign uniformity.

- LED modules are designed with either a pre-fixed or variable length of wire between the modules. How LED modules are wired effects how they may be removed in a layout.
- **Pre-fixed string lengths:** Most LED manufacturers do not offer the ability to increase the spacing between LED modules. If the light box is large enough, placing the LEDs rows farther apart is the only viable option.
  - This may be accommodated by including an additional LED module on each side as you bend the string around the corner (FIGURE 8 - wrap).
  - For very large light boxes, it may be more economical to cut the LEDs into rows and splice wire between the rows to achieve the desired spacing (FIGURE 8 - splice).
- **Variable string lengths:** Some manufacturers do offer the ability to adjust the string length between LED modules. In this case, lengthen the distance between modules to reduce the number of LEDs and/or use the other options above.

![FIGURE 8 Pre-fixed LED string lengths](image)

**Other Sign Designs**
- **Thermoformed sign faces:** the properties of the 3730 Films are the same whether the sign face is flat or thermoformed. The same percentage reduction of LEDs can be expected with either sign face construction.
- **Custom shaped light box designs:** depending upon the complexity of the shape, reducing the number of LEDs in the layout may not be as straightforward as a round or rectangular designs.

**Fluorescent Backlit Signs**

3730 Films may be used with fluorescent backlit signs. However, because 3730 Films have higher light transmission, fluorescent signs using these films may be more susceptible to zebra-stripping and other non-uniformities than sign faces using 3630 Films, which are designed for use with fluorescent lamps.

**Remarks**

This bulletin provides technical information only.

**Important Notice**

All questions of warranty and liability relating to this product are governed by the terms and conditions of the sale, subject, where applicable, to the prevailing law.

Before using, the user must determine the suitability of the product for its required or intended use, and the user assumes all risk and liability whatsoever in connection therewith.

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