Overview

Making a successful sign face requires manufacturers to consider many factors. This bulletin provides basic guidelines for simple sign face construction, including details on a variety of common sign constructions and design considerations relevant to light boxes.

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Considerations for Creating Backlit Signage

1. Determine the type of backlit graphic you want to make.
2. Review the 3M product bulletins for used films to determine any special usage details or restrictions, and whether an overlaminate is required.
3. Refer to the 3M product and instruction bulletins for used inks and toners to determine processing conditions for backlit signs.
4. Review "Maximizing Image Quality" on page 5.
5. Read "General Assembly" on page 22.
6. Follow the assembly method for your specific construction.

NOTE

Many other options may be available to achieve dramatic special effects which are not listed in this bulletin. Contact 3M Technical Service (1-800-328-3908) with any questions or concerns about making a sign before starting.

Compatible Products

See 3Mgraphics.com for a complete list of compatible translucent materials suitable for creating backlit signage. Refer to the base film's 3M product bulletin for complete details on durability and warranty.

Common Sign Face Definitions

First or Second Surface

Backlit signs are constructed with film applied on either the first or second surface of the substrate. The following illustrations show several first and second surface constructions and their assembly order.

Choosing a surface depends on several factors. First surface graphics can use translucent or clear substrates. Second surface graphics require a clear substrate.

First Surface Application

The first surface is the outside of the sign face, the side visible when first looking at the sign. The colored film or printed film is mounted on the outside surface of the clear sign face. The diffuser is mounted on the second surface.

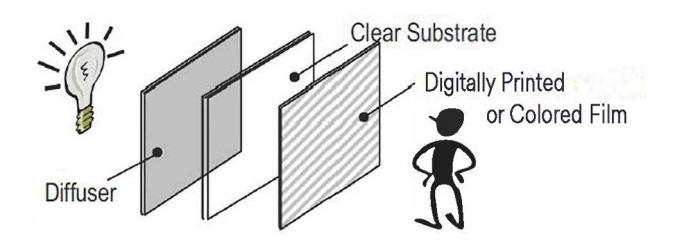


Figure 1. First Surface Application

Second Surface Application

The second surface is the inside of the sign face, the side of the sign facing into the sign box. The colored film or reverse printed film is mounted on the second surface of the clear sign face.

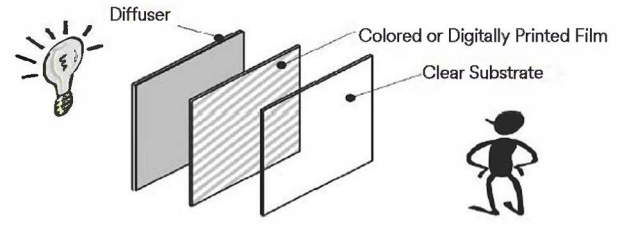


Figure 2. Second Surface Application

Translucent and Diffuser Films

A diffuser film is a white translucent film layer used to hide the light source and improve uniformity of light across the sign face. A diffuser reduces the amount of light transmission through the graphic and reduces the uneven or stripped effect caused by some light sources. Too little diffusion can also make an image look lighter (more washed out) than desired. Using a translucent substrate, translucent imaged film, and/or translucent diffuser film usually results in sufficient diffusion.

3M Envision branded translucent films (the “3730 Films”) and 3M Envision branded diffuser films (the “3735 Films”) are optimized to work with LED light sources to deliver backlit graphics with rich, vibrant colors and bright whites. They are designed to provide greater light transmission than most other graphic constructions using 3M Scotchcal branded translucent films (the “3630 Films”) and other 3M Scotchcal branded diffuser films (“3635 Films”).* In addition, they hide LEDs closer to the sign face, eliminating unwanted hot spots. These films give sign makers flexibility to create brighter sign faces or use fewer LEDs to achieve the same level of brightness.

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

Figure 3 shows an example of the 3M inkjet printable translucent films (3M Envision branded “IJ3730 Films” and 3M Scotchcal branded “IJ3630 Films”) backlit by LEDs. As shown, the IJ3730 Film (left) provides higher light transmission than the IJ3630 Film (right) when the sign uses the same number of LEDs.

NOTE

The images were printed using the same printer and inks.

Figure 3. Blacklit Inkjet Printed Graphics Comparing IJ3730 and IJ3630 Films

*Most graphics using 3730 Films provide more light transmission than the 3630 Films. See Product Bulletin 3630/3730 for details.

Figure 4 shows an example of LEDs appearing through 3635-70 (right) and LEDs being hidden by 3735-60 (left) at a 4.5 in. (11.4 cm) depth.

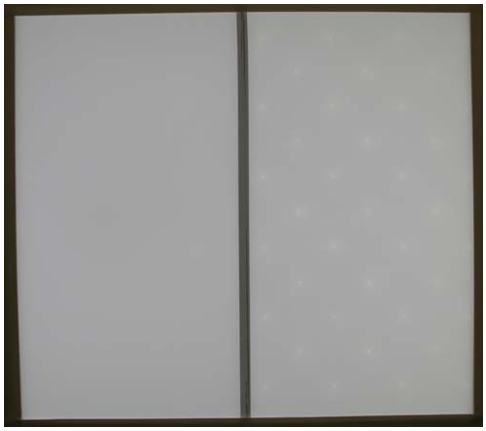


Figure 4. LED Hiding Capabilities of Diffuser Films

Light Transmission

These films' light transmission varies based on graphic construction, film color, and the film itself. Refer to Product Bulletin 3630/3730, Product Bulletin IJ3630, IJ3730, and Product Bulletin 3635-30, 70, 3735-50, 60 for details on expected light transmission.

Translucent Film Colors

Refer to Product Bulletin 3630/3730 for a listing of available standard colors, including select colors with corresponding PANTONE®-identified colors.

Reflected Light

3630 Films and 3730 Films' colors appear similar when viewed in reflected light when not illuminated.

Transmitted Light

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

NOTE

3M does NOT endorse any particular LED or lightning manufacturer or supplier. Users are responsible for ensuring the backlit sign meets all intended performance requirements.

Colored Translucent Film

- 3M™ Scotchcal™ Translucent Graphic Film Series 3630
- 3M™ Envision™ Translucent Film Series 3730

Inkjet Printable Films

- 3M™ Scotchcal™ Translucent Graphic Film IJ3630-20
- 3M™ Scotchcal™ Graphic Film IJ3650-10
- 3M™ Scotchcal™ Graphic Film IJ3650-114
- 3M™ Envision™ Translucent Film IJ3730-50
- 3M™ Envision™ Translucent Film IJ3730-60

Diffuser Films

- 3M™ Diffuser Film 3635-30 has 42% light transmission.
- 3M™ Diffuser Film 3635-70 has 65% light transmission.
- 3M™ Envision™ Diffuser Film 3735-50 has 52% light transmission.
- 3M™ Envision™ Diffuser Film 3735-60 has 63% light transmission.

Flexible Substrates

- 3M™ Panagraphics™ III Wide Width Flexible Substrate
- 3M™ Envision™ Flexible Substrate FS-1

NOTE

Backlit signs made with 3M translucent films must have a separate diffuser film or be made with a diffused substrate such as 3M™ Panagraphics™ III Wide Width Flexible Substrate, 3M™ Envision™ Flexible Substrate FS-1, or a white translucent plastic.

Special Effect Films

Dual Color Film Series 3635-200

This perforated film series offers unique special effects creating one color during the day and another at night. Refer to Product Bulletin 3635-200 for construction options.

Chrome Graphic Film 3635-110

This film offers a chrome-like appearance during the day and illuminates white at night when backlit. Refer to Product Bulletin 3635-110 for construction options.

Blockout Film Series 3635-20b/22b

Available in white or black, this film is used to create opaque areas on a backlit sign faces. Refer to Product Bulletin 3635 for construction uses.

Light Enhancement Film (LEF)

A highly reflective white film intended for use on the interior surfaces of sign boxes. LEF is used to improve the light efficiency of sign boxes. Refer to Product Bulletin 3635-100 for construction uses.

Digital Printing Methods

Maximizing Image Quality

Most customers expect the backlit image to look like the daytime reflective lit image. It is more difficult to create a successful backlit graphic than an opaque graphic. Additional image density and color are required to achieve similar daytime and nighttime appearances. Graphic manufacturers must consider all of the following points and work to balance them until they achieve the desired results. 3M encourages users to experiment with multiple options to determine the best one for each customer's needs.

- Generally two imaging film or ink layers achieve sufficient image density for large areas of digitally printed solid color, unless they are all pastel.
- Very bright or very dark digitally printed images need two imaging film or ink layers to achieve sufficient image density.
- Typically manufacturers use only a single translucent film layer, but two layers can be used when desired.
- Use 3M™ Light Enhancement Film or add film diffusers to distribute light evenly within a light box and prevent inconsistent light distribution becoming more noticeable on images with a lot of variations between light and dark colors.

Digital Inkjet Printing

Refer to the ink's 3M product bulletin for detailed printing recommendations. Do NOT exceed the total ink coverage recommendations in an attempt to increase image density. This will cause other performance problems.

Screen Patterns for Double Layer Backlit Sings that Minimize Moiré

When screen printing Film Series 3630/3730, two screen-printed films placed in close proximity to each other may create a moiré pattern that is visible when viewing the sign face. To minimize the moiré effect, select different screen angles for the different film layers.

Overlaminates

Applying an Overlaminate with a Laminator

An overlaminate can be applied with a roll laminator if the assembled backlit film/substrate construction dries for at least 24 hours prior to lamination and if a laminator capable of handling the thickness and rigidity of the construction is used. See 3M Instruction Bulletin Production: Lamination for details.

Inkjet Graphics, Cut Graphics, or Screen Printed Graphics

Using an overlaminate is optional, but recommended, on most inkjet graphics as well as on colored or screen printed graphics. An overlaminate can also be used to change a graphic's gloss, provide protection from abrasion and UV light, and may also increase the warranted durability of a graphic. Refer to the film's product bulletin for details.

Tools Needed

- 3M™ Plastic Applicator PA-1 (blue or gold)*
  - A low friction sleeve (applied to the squeegee to minimize the possibility of scratching the film)
- Pin or 3M™ Air Release Tool 391X*
- Razor blades/cutting knives
- Straight edge
- Tape measure
- Pencil or pen
- Spray bottle or plastic garden sprayer
- Clean, soft, lint-free cloths or paper towels
- Light table
- Adequate clean work area

*Available from 3M Commercial Branding and Transportation Division.

Construction Options

NOTE

The proportions of the following illustrations are intentionally exaggerated to provide clarity about the order of the materials used.

NOTE

For all of the following constructions, the adhesive side of the film faces the substrate.

Using Three Film Layers

For printed graphics, whenever three consecutive layers of film (two layers of printed film and an overlaminate) are used, the top film layer must extend beyond the edges of the two underlying film layers by at least 1 in. (2.5 cm) on each side. The following illustrations show the proper constructions when using three layers of film.

Undercutting the First Two Layers

Cut the underlying two layers smaller than the substrate so that the top (third layer) can adhere directly to the substrate.

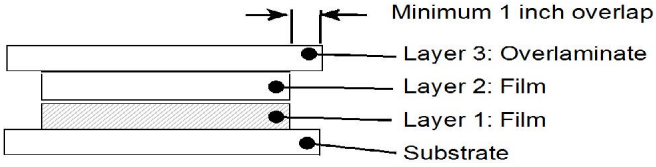


Figure 5. Two Film Layers with Overlaminate Cut Larger

Wrapping the Third Layer

Wrap at least a 1 in. margin of the top film (third layer) around the substrate. This is applicable for first surface graphics but not for second surface graphics.

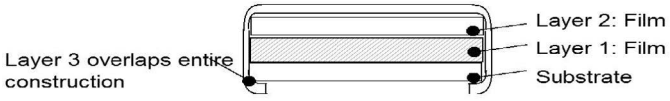
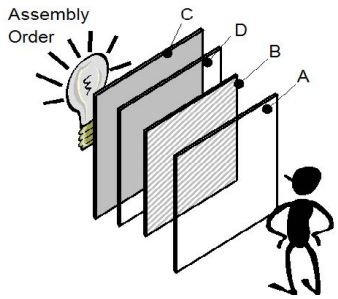


Figure 6. Overlaminate Shown Wrapped Around Construction

First Surface Sign Face Options

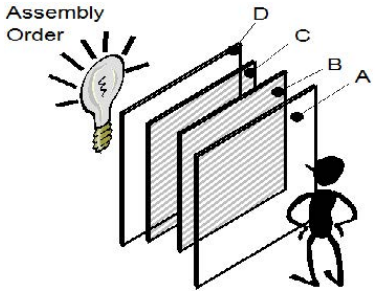
For first surface graphics the film image should be viewed from the front of the sign with the colored film or printed film mounted on the first surface of the clear sign face. An overlaminate may be used to protect the graphic from abrasion and UV light, change the gloss and/or increase the graphic's warranted durability.

Option 1: Non-printed, colored translucent film, first surface, on a clear rigid substrate



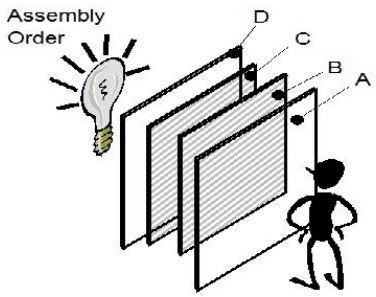
Ref. Letter	Component	Typical Compatible Materials
A	Overlaminate *If required*	3658G, 3660M, None
B	Colored translucent film *First layer*	3630, 3730 (no overlaminate)
C	Diffuser	3635-30, 3635-70, 3735-50, 3735-60 A diffuser is commonly used to eliminate hot spots. Make a test sign to check for hot spots.
D	Substrate	Rigid clear
	1. Apply overlaminate (A) to colored translucent film (B). 2. Apply colored translucent film (B) to the front (first surface) of substrate (D). 3. Apply diffuser film (C) to the back (second surface) side of substrate (D).	

Option 2: Digitally printed film, first surface, on a clear rigid substrate



Ref. Letter	Component	Typical Compatible Materials
A	Overlaminate *If required*	3658G, 3660M, 3619, 3620, None
B	White digital print translucent film *First layer*	IJ3630-20, IJ3730-50, IJ3730-60
C	Transparent digitally printed film *Second layer if required*	IJ3650-114 (transparent)
D	Substrate	Rigid clear
	NOTE: This may be a three layer construction. 1. Apply overlaminate (A) to white digital translucent film (B). 2. Apply white digital translucent film (B) to the front (first surface) of transparent digitally printed film (C). 3. Apply transparent digitally printed film (C) to the front (first surface) side of substrate (D).	

Option 3: Colored translucent film or digitally printed film, first surface, on a white translucent rigid or flexible substrate

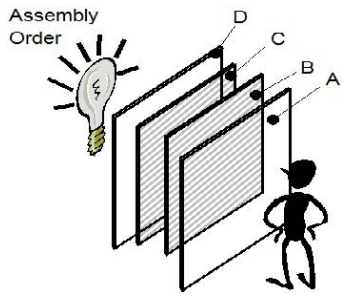


Ref. Letter	Component	Typical Compatible Materials
A	Overlaminate *If required*	3658G, 3660M, 3619, 3620, None
B	White digital print translucent film or colored translucent film *First layer*	IJ3630-20, IJ3730-50, IJ3730-60, *or* 3630, 3730, colored translucent film
C	Transparent digitally printed film *Second layer (if required)*	IJ3650-114 translucent (used with imaging film only)
D	Substrate	White translucent or flexible substrate layer
	NOTE: This may be a three layer construction. 1. Apply overlaminate (A) to layer (B). 2. Apply layer (C) (if required) to the first surface of layer (D). 3. Apply layer (B) to first surface of layer (C).	

Second Surface Sign Face Options

The graphic is printed as a mirror image and mounted on the second surface of the sign face. The clear, rigid substrate protects the graphic. Overlaminates are generally not used on second surface applications.

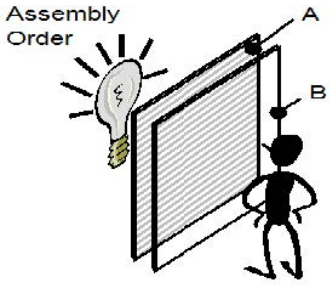
Option 1: Colored translucent film or digitally printed film, second surface, on a clear rigid substrate



Ref. Letter	Component	Typical Compatible Materials
A	Substrate	Rigid clear
B	Transparent digitally printed film *First layer*	IJ3650-114 transparent
C	White digitally printed film or white translucent film *First or only layer*	IJ3630-20; *or* IJ3730-50; *or* IJ3730-60
D	Diffuser film	Use with translucent colored film. This is not required when using imaging film.
	1. Apply film (B) to the back (second surface) of substrate (A). 2. For digitally printed film only, align and apply the second layer of imaging film (C) to the first layer of film (B). 3. Apply diffuser film (D) to film (B) or to film (C) if used. Read "Using Three Film Layers" on page 6.	

Direct Printing on Flexible Substrates

Direct Inkjet Printing on Flexible Substrates



Ref. Letter	Component	Typical Compatible Materials
A	Panagraphics™ III or Envision™ FS-1 Substrates	See Product Bulletin PIII or Product Bulletin FS-1 for a full list of compatible printers/inks and overlaminates.
B	Overlaminate	
	• Refer to the 3M product and instruction bulletins for inks used to determine processing conditions for backlit signs. Print the same image on both the first and second surface of the flexible substrate when printing on systems without white ink capability. • Print three layers of ink, (colored, white, colored), on the first surface of the flexible substrate when printing on white ink capable systems. **NOTE:** A single layer of ink applied to the first surface of a flexible surface sign face generally appears pale or washed out when lit.	

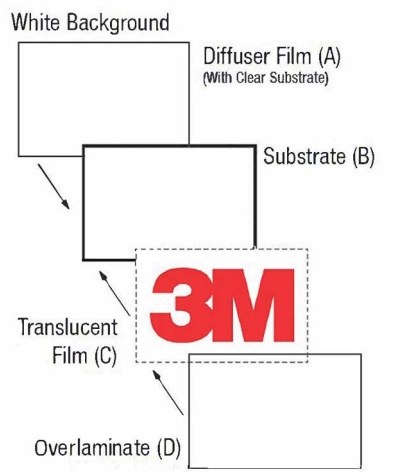
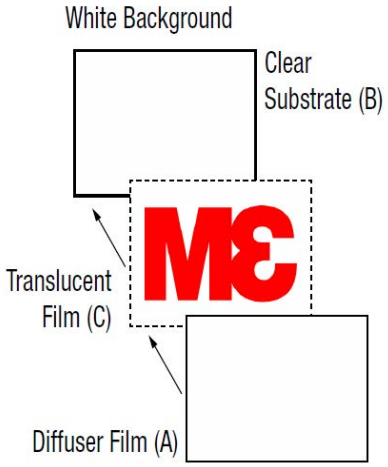
Basic Techniques

Single Color Image on White Background

The majority of backlit sign applications are single color images on a white background, or a white image reverse cut out of a single color background. Both methods use simple letter cutting and film application techniques that can be done either by hand or on an electronic film cutter.

White Background: Day

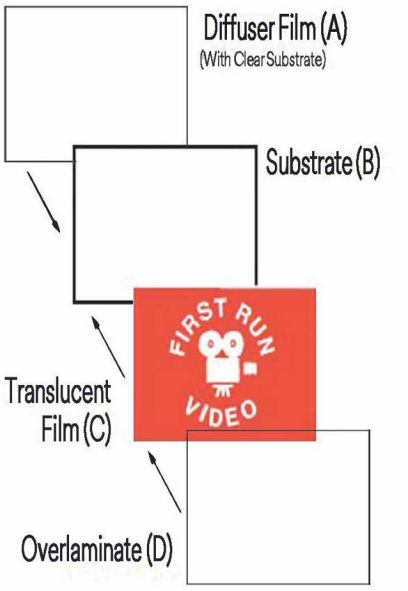
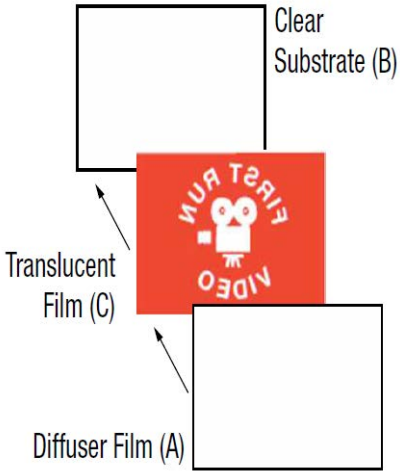
White Background: Night

First Surface Application	Second Surface Application
	
First Surface Assembly: 1. Cut, weed, and prespace the image on colored translucent film (C). 2. Prepare white translucent substrate (B). 3. Apply colored translucent film (C) to the front of the substrate (B). 4. Apply diffuser film (A) to the back of substrate (B) if using a clear substrate. 5. Apply overlaminate film (D) over colored translucent substrate (C) when maximum graphic protection is needed.	Second Surface Assembly: 1. Reverse cut, weed, and prespace the image on colored translucent film (C). 2. Prepare clear substrate (B). 3. Apply colored translucent film (C) to the back of substrate (B). 4. Apply diffuser film (A) to the back of colored translucent film (C).

White Image on Single Color Background

Color Background: Day

Color Background: Night

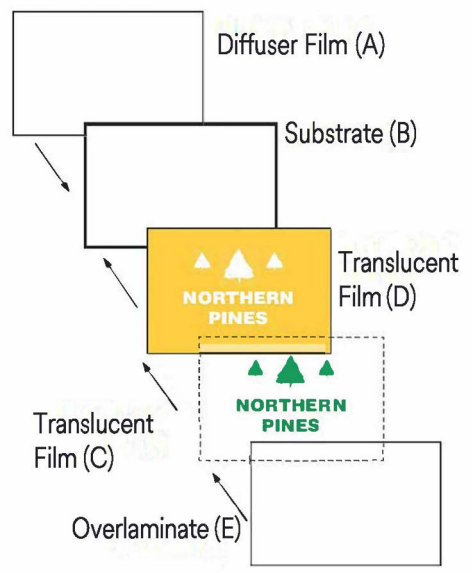
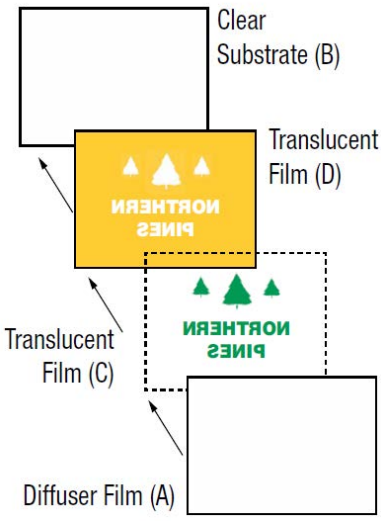
First Surface Application	Second Surface Application
	
First Surface Assembly: 1. Cut, weed, and prespace the image on colored translucent film (C). 2. Prepare white translucent substrate (B). 3. Apply colored translucent film (C) to the front of substrate (B). 4. Apply diffuser film (A) to the back of substrate (B) if using a clear substrate. 5. Apply overlaminate film (D) over colored translucent film (C) when maximum graphic protection is needed.	Second Surface Assembly: 1. Reverse cut, weed, and prespace the image on colored translucent film (C). 2. Prepare clear substrate (B). 3. Apply colored translucent film (C) to the back of substrate (B). 4. Apply diffuser film (A) to the back of color translucent film (C).

Color Image on Color Background

A colored background with a color image is more complex, but still easy to add to a sign shop's capabilities. Color is increasingly important for this technique, and important considerations include contrast, eye appeal, legibility, and lay-out.

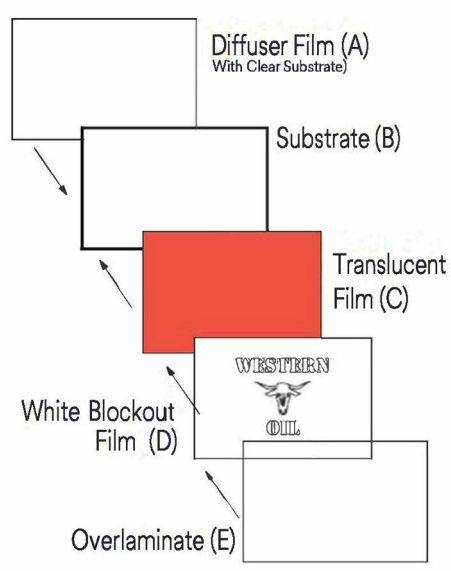
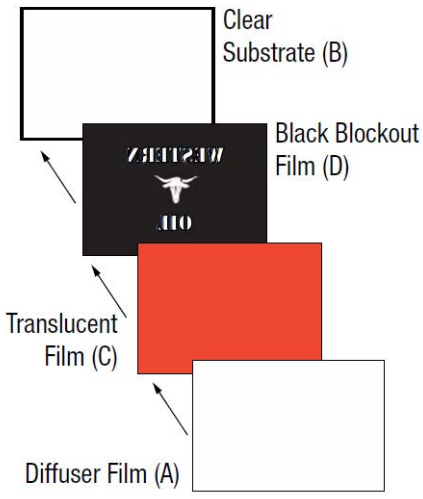
Day

Night

First Surface Application	Second Surface Application
	
First Surface Assembly: 1. Cut, weed, and prespace the image on color translucent films (D) and (C). 2. Prepare white translucent substrate (B). 3. Apply color translucent film (D) to the front of substrate (B). 4. Apply color translucent film (C) to color translucent film (D). 5. Apply diffuser film (A) to the back of substrate (B). 6. Apply overlaminate film (E) over color translucent substrate (D) when maximum graphic protection is needed.	Second Surface Assembly: 1. Reverse cut, weed, and prespace the images on color translucent films (C) and (D). 2. Prepare clear substrate (B). 3. Apply color translucent film (D) to the back of substrate (B). 4. Apply color translucent film (C) to color translucent film (D). 5. Apply diffuser film (A) to the back of color translucent film (D).

White Background by Day, Black Background by Night

This technique gives customers a background that appears white by day and black by night. At night, the colored image appears to float, similar to the appearance created by push-through letters in a routed metal face. The color image will be the same color both at day and at night.

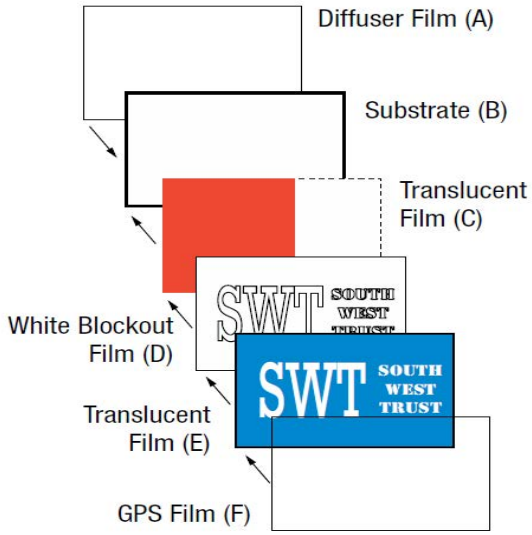
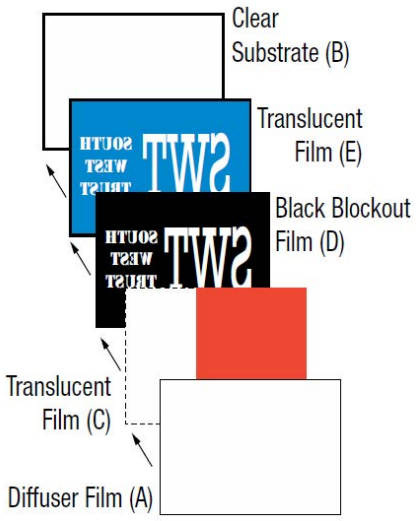
First Surface Application	Second Surface Application
	
First Surface Assembly: 1. Prepare substrate (B). 2. Apply colored translucent film (C) to the front of substrate (B). 3. Cut, weed, and prespace the image on white block-out film (D). 4. Apply white block out film (D) over translucent film (C). 5. Apply diffuser film (A) to the back of substrate (B) when using a clear substrate. 6. Apply overlaminate film (E) over block-out film (D) when maximum graphic protection is needed.	Second Surface Assembly: 1. Reverse cut, weed, and prespace the image on black block-out film (D). 2. Prepare clear substrate (B). 3. Apply black block-out film (D) to the second surface of substrate (B). 4. Apply translucent color film (C) over black block out film (D). 5. Apply diffuser film (A) over color translucent film (C).

Color Background by Day, Black Background by Night

This special effect technique gives customers a background that appears in color by day and black at night. At night, the colored image appears to float, similar to the appearance created by push-through letters in a routed metal face. The colored image will be the same color both at day and at night.

Day

Night

First Surface Application	Second Surface Application
	
First Surface Assembly: 1. Prepare substrate (B). 2. Apply color translucent film (C) to the front of substrate (B). 3. Cut, weed, and prespace the image on white block out film (D). 4. Apply white block out film (D) over translucent film (C). 5. Cut, weed, and prespace the image on color translucent film (E). 6. Apply color translucent film (E) over white block out film (D). 7. Apply diffuser film (A) to the back of substrate (B) if using a clear substrate. 8. Apply overlaminate film (F) over block out film (D) when maximum graphic protection is needed.	Second Surface Assembly: 1. Reverse cut, weed, and prespace the image on color translucent film (E). 2. Prepare clear substrate (B). 3. Apply color translucent film (E) to the back of substrate (B). 4. Reverse cut, weed, and prespace the image on black block out film (D). 5. Apply black block out film (D) over color translucent film (E). 6. Apply color translucent film (C) over black block out film (D). 7. Apply diffuser film (A) over color translucent film (C).

Special Effects

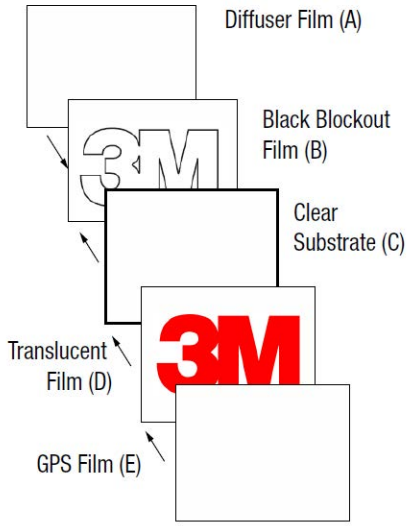
White Halo Background with Color Image

This special effect technique creates a halo of light around the color image.

Sign by Day

Sign by Night

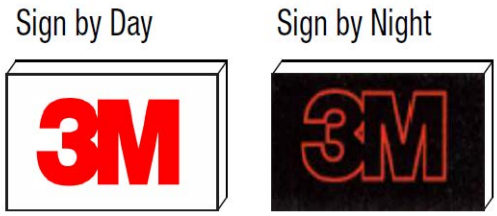
Combined First & Second Surface Application



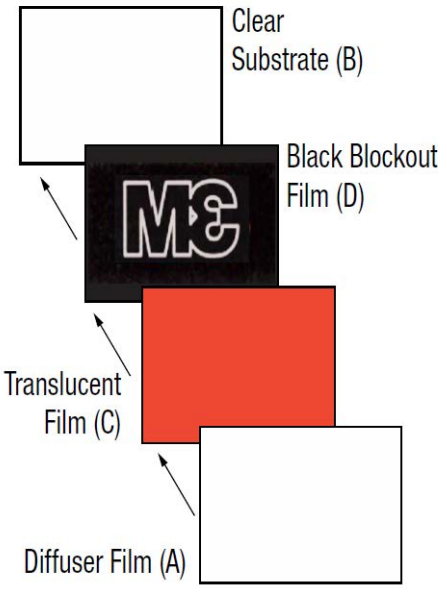
1. Cut, weed, and prespace the image on translucent film (D).
2. Prepare clear substrate (C).
3. Apply translucent film (D) to the front of clear substrate (C).
4. Reverse cut, weed, and prespace the image on black blockout film (B).
5. Apply black blockout film (B) to the back of clear substrate (C).
6. Apply diffuser film (A) to the back of black blockout film (B).
7. Apply overlaminate film (E) over translucent film (D) if maximum graphic protection is needed.

Neon Effect at Night

This special effect technique creates a background that appears white by day. At night, the color image will appear to glow, giving the appearance of a neon sign.



Second Surface Application



Second Surface Assembly:

1. Reverse cut, weed, and prespace the image on black blockout film (D).
2. Prepare clear substrate (B).
3. Apply black blockout film (D) to the back of clear substrate (B).
4. Apply colored translucent film (C) to the back of black blockout film (D).
5. Apply diffuser film (A) to the back of colored translucent film (C).

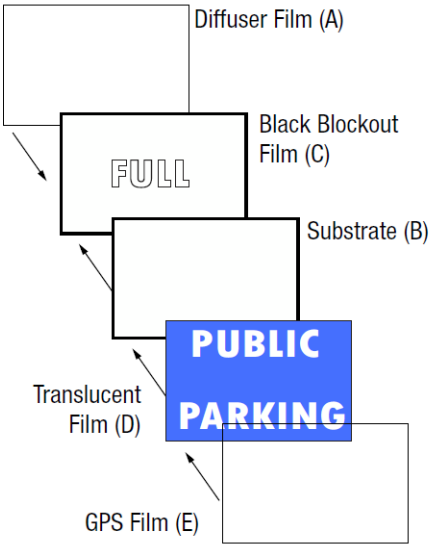
Hidden Message Until Illuminated

This easy-to-make special effect sign changes the message as internal lighting is turned off and on. Part of the message is hidden until illuminated. Use a color background that best meets the customer's requirements for aesthetics and impact.

Internal Lamp Off

Internal Lamp On

3 - Hidden Message Until Illuminated



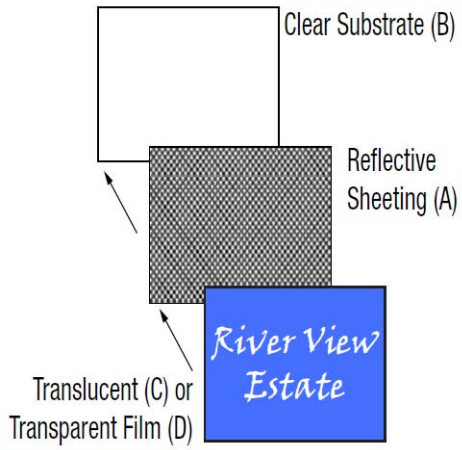
First Surface Assembly:

1. Reverse cut, weed, and prespace the image on black block-out film (C).
2. Apply black blockout film (C) to the back of clear substrate (B).
3. Apply diffuser film (A) to the back of black blockout film (C).
4. Cut, weed, and prespace the image on colored translucent film (D).
5. Apply colored translucent film (D) to the front of clear substrate (B).
6. Apply overlaminate film (E) over color translucent film (D) when maximum graphic protection is needed.

Transmissive and Reflective at Night

Incoming light rays from vehicle headlights striking 3M™ Scotchlite™ Reflective Sheeting in the dark or at low light levels are reflected back to the light source for visibility and message effectiveness. 3M™ Scotchlite™ Diamond Grade™ Reflective Sheeting is also transparent to the internal light, providing double visual impact reflectivity and internal illumination.

4 - Transmissive and Reflective at Night



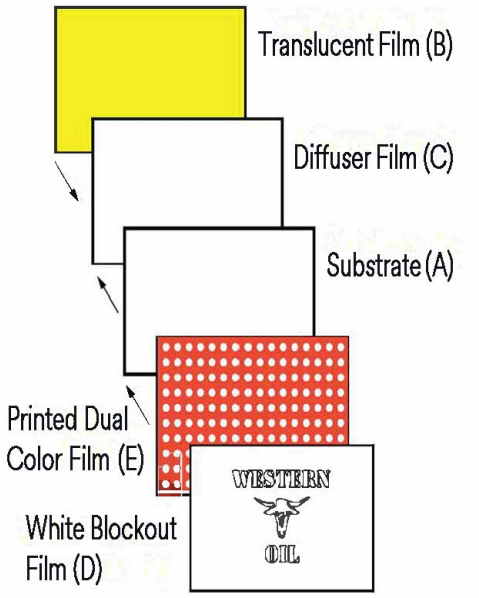
Second Surface Assembly:

1. Prepare clear substrate (B).
2. Apply reflective sheeting (A) to the front of substrate (B).
3. Cut, weed, and prespace the image on colored translucent film (C) or transparent film (D).
4. Apply colored translucent film (C) or transparent film (D) to reflective sheeting (A).

Dual Color - One Color by Day; Different by Night

This special effect technique allows manufacturers to fabricate signs that have one color by day and a different color at night when internally illuminated.

5 - Color by Day/Different Color by Night
Combine First & Second Surface Application

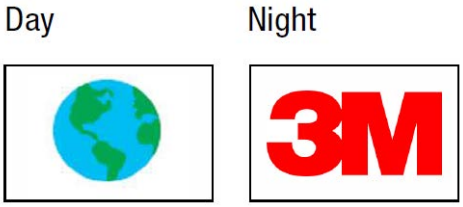


First Surface Assembly:

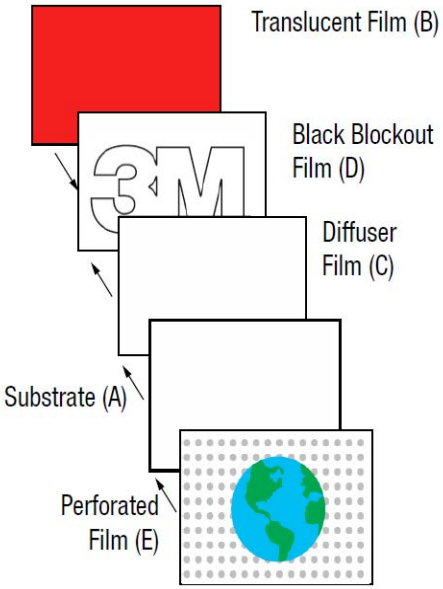
1. Prepare clear substrate (A).
2. Apply diffuser film (C) to the back of clear substrate (A).
3. Apply colored translucent film (B) to diffuser film (C).
4. Apply printed dual color film (E) to the front of clear substrate (A).
5. Cut, weed, and prespace the image on white blockout film (D).
6. Apply white blockout film (D) to dual color film (E).
7. Apply an overlaminate film (not shown) over white blockout film (D) when maximum graphic protection is needed.

One Image by Day; Different Image by Night

This special effect technique allows manufacturers to fabricate signs that have a colored image by day and a different colored image by night when internally illuminated.



One Image by Day; Different Image by Night



First and Second Surface Assembly:

1. Prepare clear substrate (A).
2. Apply printed dual color film (E) to the front of clear substrate (A).
3. Apply diffuser film (C) to the back of clear substrate (A).
4. Reverse cut, weed, and prespace the image on black blockout film (D).
5. Apply black blockout film (D) to diffuser film (C).
6. Apply colored translucent film (B) to black blockout film (D).
7. Apply an overlaminate film (not shown) over printed dual color film (E) when maximum graphic protection is needed.

General Assembly

Key Graphic Construction Tips

Keep these key application tips in mind before and during application.

1. Clean the work surface and surrounding areas properly to avoid contaminating the graphics.
2. Ensure the film, air, and surface temperatures are between 60°F and 100°F (16°C and 38°C).
3. Use the wet application method involving slip solution made with baby shampoo and water. See 3M Instruction Bulletin Application: Backlit Signage for details. Lack of application fluid may cause dark marks which can be visible in transmitted light.
4. Do NOT allow paper liners to get wet before removing them from film. A wet paper liner is difficult to remove.
5. Seams can be made using the overlap method. See "Constructing Proper Film Overlaps (Seams)" section on page 24.
6. Use a smooth, undamaged 3M™ Plastic Applicator PA-1. A large window squeegee may be used with light pressure to initially flatten and adhere the film. The final squeegeeing must be done with a 3M™ Hand Applicator PA-1 squeegee covered by a low friction sleeve.
7. Review the "Squeegee Techniques and Squeegee Procedures" section on page 23.
8. Puncture air bubbles using a pin or air release tool, do NOT use a knife or blade. See the "Removing Bubbles Under the Film" section on page 24.
9. Remove application tape by peeling it back on itself – as close as possible to 180 degrees – and immediately re-squeegee the film.
10. Cut and weed within one hour after application for the best results. See the "Cutting and Weeding After Application" section on page 25.
11. Keep newly fabricated sign faces in ambient shop temperatures for at least 24 hours. This allows any remaining moisture to diffuse through the film.
12. Re-squeegee the edges 24 hours after creating the sign face.
13. When using 3M flexible substrates, refer to 3M Instruction Bulletin Application: Backlit Signage for additional details to help ensure a successful application.

Preparing and Cleaning Substrates

Plastic Substrates

Plastic substrates (also called plastic sheets or rigids) have a protective film covering. Peel it off and remove all traces of the adhesive, then clean the substrate following the instructions in 3M Instruction Bulletin Application: Backlit Signage.

Oven dry polycarbonate substrates before applying film. Use the method, time, and temperature recommended by the plastic manufacturer. Failure to properly dry the plastic can result in trapped water migrating to the surface of the material, which may cause film to bubble.

NOTE

High temperature copolyesters and most acrylic substrates generally do not require pre-drying. Consult the manufacturer.

3M Flexible Substrates

1. Mix a solution of 1 ounce of synthetic detergent per gallon of water. Avoid soaps or preparations containing waxes, oils, fragrances, or lotions.
2. Clean the substrate with the solution.
3. Dry the substrate thoroughly with clean, lint-free paper towels.
4. Saturate a clean paper towel with a 70% isopropyl alcohol solution.
5. Wipe the substrate completely dry with clean lint-free paper towels before the IPA evaporates from the substrate. Discard the paper towels as they become dirty.

Assembly Preparation

Make the Slip Solution

Prepare a slip solution of 1 tsp (5 ml) of baby shampoo, containing no lotions, soaps, oils, waxes, or enzymes, for each 1 quart (946 ml) of clean, cool water. One quart of slip solution is usually enough to complete a single small- or medium-sized graphic.

After mixing the slip solution, pour it into a spray bottle. This solution is essential for wet application of film.

Proper Liner Removal and Adhesive Wetting

1. Place the film liner-side-up on a clean light table.
2. Avoid placing fingers on the adhesive edge of the film when holding it down to remove the liner. Doing so may contaminate the adhesive and lead to lifting of the film or poor adhesion of the film to the substrate.
3. Lift one corner of the liner while spraying the slip solution onto the exposed adhesive.
4. Continue removing the liner and spraying the slip solution. By the time the liner is completely removed, the entire adhesive surface should be wet. Spray on more solution if necessary.

Squeegee Techniques and Squeegee Procedures

General Procedure

1. Use proper squeegee technique. Always squeegee across the shortest distance. Start in the center of the graphic and squeegee straight out to one edge. Do NOT use an arcing stroke. Doing so may trap slip solution and air.
2. Return to the center and squeegee to the opposite edge.
3. Return to the center and start the next stroke so it overlaps the first stroke by about 50%.
4. Work up from the center of the graphic, return to the center, then work down the film until it is completely adhered.

Proper Technique without Premasking Tape

1. To avoid friction, spray additional slip solution onto the substrate.
2. Use a large, undamaged, window cleaning squeegee on the first pass on a film to quickly smooth out wrinkles and remove most of the application solution.
3. Use a hand to push out excess water and smooth the film if a large amount of film builds up ahead of the squeegee. Then continue using light overlapping strokes across the entire graphic.
4. Firmly re-squeegee the film with a standard 4 in. squeegee with a low friction sleeve.
5. Dry the graphic with a clean, lint-free cloth or paper towel. Be sure to absorb the moisture along the graphic's edges.

Proper Technique with Premasking Tape

1. Follow the same squeegee technique as described above in "General Procedure" using firm strokes with a 4 in. squeegee.
2. Remove the premasking tape at an 180 degree angle.

Finish the Squeegee Procedure

1. Re-squeegee the entire graphic until all water is removed from between the image and the substrate. This may require going over the graphic several times. If needed, use a little of the detergent and water solution to lubricate the squeegee.
2. If the application has bubbles, see "Removing Bubbles Under the Film" section on page 24.
3. Check for good adhesion by trying to lift a corner.
4. Re-squeegee all film edges after again at room temperature after 24 hours have passed. Use a low friction sleeve on the applicator to prevent scratching.

Removing Bubbles Under the Film

1. Puncture the film at one end of the bubble with a pin or another sharp, round pointed tool, such as a 3M™ Air Release Tool 391X.
2. Press the entrapped air or slip solution out of the hole with a thumb or squeegee, moving toward the puncture.

NOTE

Do NOT use a knife or razor blade to puncture the film. Doing so may create an opening which will eventually become a light leak.

3. Some bubbles may be removed by spraying the top area with solution and squeegeeing it out with rapid strokes of the squeegee.

Assembling Single Panels

NOTE

This example is based on "Option 1: Non-printed, colored translucent film, first surface, on a clear rigid substrate". Each film layer is applied one at a time using the wet application method. Adapt this procedure for your specific construction.

1. Follow the instructions in the "Preparing and Cleaning Substrates" section on page 22.
2. Remove the film liner slowly, wetting the adhesive on the diffuser film as it becomes exposed.
3. Thoroughly flood the second surface of the substrate with slip solution.
4. Position the adhesive side of the diffuser film against the second surface of the plastic substrate.
5. Wet the top of the diffuser film.
6. Squeegee the film thoroughly. See the "Squeegee Techniques and Squeegee Procedures" section on page 23.
7. Turn the substrate over so the first surface faces up.
8. Remove the film liner from the translucent film, wetting the adhesive as it becomes exposed.
9. Thoroughly flood the first surface of the substrate with slip solution.
10. Position the adhesive side of the translucent film against the substrate.
11. Wet the top of the translucent film.
12. Squeegee the film thoroughly to the substrate.
13. When using an overlaminate:
    a. Remove the liner from the overlaminate, wetting the adhesive as it becomes exposed.
    b. Thoroughly flood the translucent film with slip solution.
    c. Position the adhesive side of the overlaminate against the translucent film.
    d. Wet the top of the overlaminate.
    e. Squeegee the overlaminate thoroughly to the film.
14. Re-squeegee all edges after 24 hours.
15. Mount the construction in the light box.

Constructing Proper Film Overlaps (Seams)

Graphic manufacturers can create multi-panel signs for most digitally-imaged graphics. Construction of proper overlaps (seams) on such signs is required to prevent light leaks and maintain eligibility for 3M warranties.

- Digitally-imaged film may shrink after installation.
- If the film shrinks at a seam, there will be a light leak that is usually unacceptable.
- Create overlaps at panel seams to reduce the likelihood of light leaks. The seam will appear darker than the rest of the image, especially when backlit, but it is generally more acceptable than a light leak. This is the only method recommended by 3M for handling light leaks.

Two Films - Single Seam

- Overlap colored translucent and digitally printed panels by 3/16 in. to 1/4 in. (4.8 mm to 6.4 mm).
- Do NOT use a combination of seam directions. Use only horizontal *or* vertical seams on a given sign.
- When making horizontal seams, place the top panel so it overlaps the bottom panel (shingle overlap).

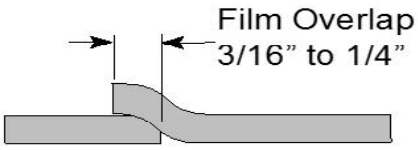


Figure 7. Recommended Film Overlaps

Multiple Film Layers - Multiple Seams

- Seams for each layer of film, diffuser, and/or overlaminate must each be offset by at least 1/4 in. (6.4 mm). Figure 8 illustrates the preferred method for offsetting overlaps. This method eliminates all gaps except in the bottom layer of film, creating a better sealed seam.

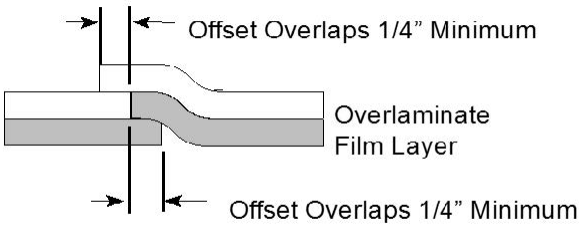


Figure 8. Offset Overlaps Required for Each Layer

Cutting and Weeding After Application

For the best results, cut and weed the film within an hour of application. The adhesive bond builds with time and weeding becomes more difficult.

- Cutting may be done with conventional graphic knives, either fixed or swivel, or with a sharp razor blade in a safety holder.
- Patterns may be placed on the surface of the applied film by pouncing with chalk or carbon dust. Some carbon papers and some graphic pens may permanently mark the film. Check the film's suitability before using.
- Avoid or minimize over cuts to eliminate light leaks.
- To weed, carefully pick up a corner of the weed and pull it back with sharp, short jerks at a shallow angle. If adhesive transfers to the substrate during removal, warm the surface slightly during removal to reduce the adhesive transfer.
- Any adhesive left on the substrate may be removed by rubbing it with the thumb or finger.

Light Box Sign Construction

- Use a diffuser film between the light source and the image to minimize hot spots and any washed out graphic appearance. This may dim the image slightly, but will result in a more uniform image.
- Line the box with 3M™ Light Enhancement Film 3635-100 to maximize the use of light inside the light box. This is a highly efficient diffuse reflective film that creates a brighter, more uniform appearing sign face.
- 3M™ Blockout Films 3635-20b or 3635-22b can also be used to blockout transmitted light in some signs.
- See "Digital Printing Methods" on page 5.

Light Management Overview

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

Maximizing Light Transmission

Ensure ALL interior light box surfaces are covered with a reflective white material to redirect light out through the sign face. Painting the interior or applying a highly reflective film are common methods to enhance light box reflectivity. Pay special attention to surfaces that absorb light, including:

- Raw metals, such as unpainted aluminum or steel
- Darkly colored painted surfaces
- Any other low reflectivity surfaces

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 to line the interior of backlit light boxes.

However, sign makers should determine the proper method to enhance their light box's interior reflectivity based on the intended application.

Guidelines for Brightness

Many state, local, and national governments regulate the maximum illumination level for signage. Sign makers and sign owners are responsible for understanding and complying with all illumination standards, regulations, 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. See the "Understanding Customer Requirements" section on page 27. 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 available:

- with or without a lens (See Figure 9);
- with either tight or widespread light angle outputs;
- in a full range of color temperatures (e.g., from warm white at 3200K to very cool white at 9000K); and
- in various levels of performance and durability.

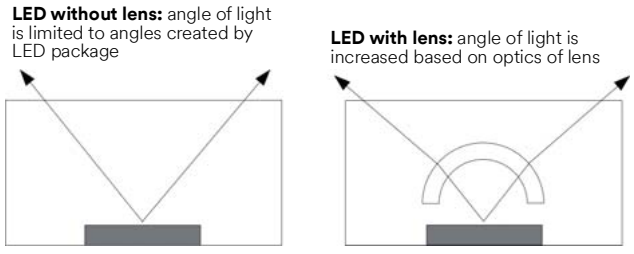


Figure 9. LED Modules

Ingress Protection Ratings for Exterior Applications

- LED modules are classified according to an Ingress Protection (IP) Rating, such as IP65 and IPX7. These ratings indicate how well an 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 the level of protection against water penetration. The higher the number, the more protection provided. (If there is an X in place of a number, the LED does not have a protection rating for that particular criteria.)
- Before selecting a suitable LED, consider the environmental conditions the light box will be exposed to, 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 effects can be seen with both fluorescent and LED light sources.

Impact to Sign Face

- **Lower color temperatures (3200K to 4200K)** make whites and the overall sign face appear yellower.
- **Higher color temperatures (5400K up to 10000K)** make whites and the overall sign face appear bluer and brighter.

General Selection Guidelines

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

- 3630 Films' colors are proofed using 4200K fluorescent bulbs for reflected light and 6500K bulbs for transmitted light. The higher color temperature was selected since white generally appears white (bluer) to most people at 6500K.
- 3730 Films' colors are proofed using 4200K for both reflected and transmitted light.

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

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

Design Considerations

Understanding Customer Requirements

Sign manufactures should understand all of their customer's requirements for the backlit sign before starting construction. Factors to discuss include:

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

Factors Affecting Quality

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

- uniformity of light across the entire sign face,
- prevention 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 both reflected and transmitted light.
- 3M recommends prototyping the graphic's design for the customer's approval to ensure the most accurate appearance.

Light Box Depth

Light box depth is an important factor in creating a uniform sign face. Refer to Table A and Figures 10 through 13 for some design considerations, including how light box depth, LED beam angle, and LED pitch are affected by one another. The images also show how these factors influence sign face uniformity.

Table A. Light Box Depth Design Considerations

Depth	Design Considerations
2 in. to 4 in. (5 cm to 10 cm)	• 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 sideways, relying on the internal surfaces of the light box to reflect the light forward. This results in a uniform light output across the entire sign face. • Using reflective white material on interior surfaces is essential since newer LEDs with optics rely on the light box's internal surfaces to reflect light forward. • Consider using lower lumen output (dimmer) LEDs. - Less light is needed because 3730 Films are more light transmissive and the LEDs are placed closer to the sign face. - This also minimizes the possibility of hot spots from the LEDs' closer placement to the sign face.
4 in. to 6 in. (10 cm 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 4 in. to 6 in. (10 cm to 15 cm) depth typically reduces the risk of hot spots and allows for the use of higher lumen light output (brighter) LEDs.
Greater than 6 in. (15 cm)	• Consider creating an insert or a false back plate to position the LEDs closer to the sign face. • Consider using LED tubes as an alternative to fluorescent tubes. Some manufacturers indicate LED tube brightness may be equivalent to the light output of fluorescent tubes. • Very high output LEDs are needed at this depth, which may increase the manufacturing cost of the light box.

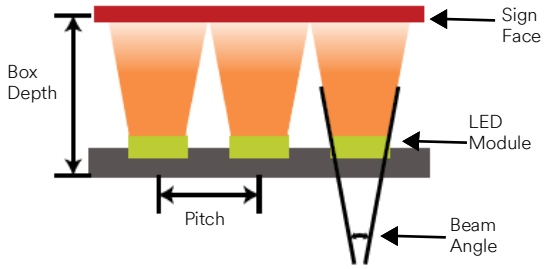


Figure 10. Light Box Depth, Beam Angle, and Pitch

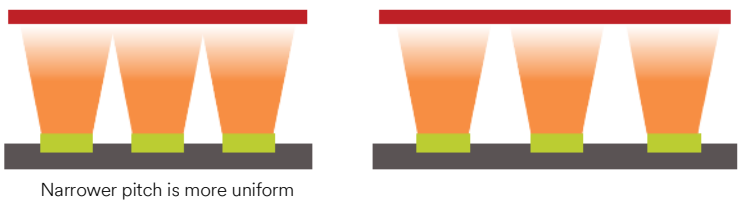


Figure 11. Box depth: *same*; Beam angle: *same*; Pitch: *different*

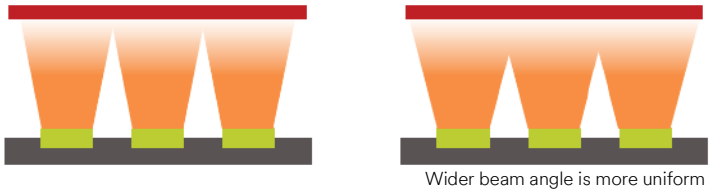


Figure 12. Box depth: *same*; Beam angle: *different*; Pitch: *same*

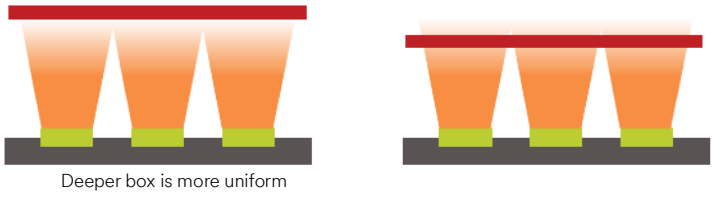


Figure 13. Box depth: *different*; Beam angle: *same*; Pitch: *same*

Thin Channel Letters

For instances where 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, use of 3730 Films may lower manufacturing costs or reduce energy consumption.

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 a high lumen output making them a possible alternative to using twice the number of LEDs required for a single-sided sign.

Diffuser Films

Typically, 3730 Films' colors require the use of a diffuser film when applied to clear plastic if the light source is directly behind the film. See Product Bulletin 3630/3730 for details.

LED Layouts

Users should contact their LED manufacturer for help creating a layout best suited to their application.

Designing with Fewer LEDs

Fewer LEDs can be used on a given LED layout depending 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. For more details on typical light transmission, see Product Bulletin 3630/3730 (color films), Product Bulletin IJ3630, IJ3730 (printable films), and Product Bulletin 3635-30, 70, 3735-50, 60.

Size and Shape of Light Box

Generally, signs with large open areas, such as rectangular or box signs, are best suited to use 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 customers find the brightness of signs created with 3630 Films acceptable:

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

Type of LED Being Used

See the "LED Overview" section on page 26.

Suggested Layout Modification Techniques

- For constructions using 3730 Films, a 25% to 30% reduction in the number of LEDs typically yields acceptable sign face uniformity compared to constructions using 3630 Films. Doing so does not require any change to the light box depth if the LED layout is adjusted properly.
  - **Example:** If an LED layout's current design uses 12 in. (30.5 cm) centers, a redesigned layout with 16 in. to 17 in. (40.6 cm to 32.3 cm) centers typically reduces LED usage by 25% to 30%, while, in general, providing acceptable overall sign uniformity.
- LED modules are designed with either a pre-fixed or variable length wire between modules. How LED modules are wired affects how they may be removed in a layout.
  - **Pre-fixed string lengths:** Most LED manufacturers do not offer the ability to increase spacing between LED modules. Users must place LED rows farther apart, if the light box is large enough to allow this.
    - Increased spacing may be accomplished by including an additional LED module on each side as the string is bent around the corner (See Figure 14 - wrap).
    - For very large light boxes, it may be more economical to cut LEDs into rows and splice wire between the rows to achieve the desired spacing (See Figure 14 - splice).

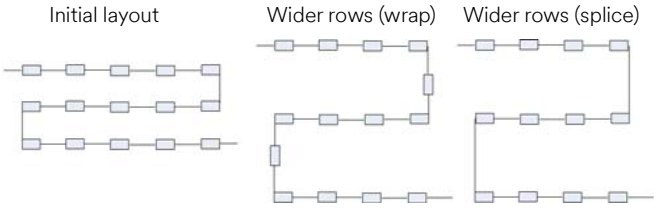


Figure 14. Pre-fixed LED string lengths

  - **Variable string lengths:** Some manufacturers do offer the ability to adjust the spacing between LED modules. In this case, lengthen the distance between modules to reduce the number of LEDs and/or use the other options above.

Other Sign Designs

- **Thermoformed sign faces:** The properties of 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.
- **For 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 with 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-striping and other non-uniformities than sign faces using 3630 Films, which are designed for use with fluorescent lamps.

Installing Decorated Substrate in Sign Frames

Graphics cut flush with the edge of a rigid substrate can be damaged from handling, or from mounting the sign frame. Two methods to protect the edges of the decorated plastic substrate and reduce damage during installation are:

- Trim at least 1/8 in. (3.2 mm) of film away from the substrate edges all around the graphic. The retainer will hide the trimmed area.
- Apply a clear protective tape to the edges of the graphic to reduce the risk of film damage due to constant rubbing.

Take care when inserting the sign face into the sign frame to ensure the sharp edges do not catch or tear the film.

Health and Safety

Tools and Equipment Usage

When using any equipment, always follow the manufacturer's instructions for safe operation.

Chemicals

When handling any chemical products, read the manufacturers' container labels and the Safety Data Sheets (SDS) for important health, safety, and environmental information.

Follow this link to obtain SDS sheets for 3M products.

Follow this link to obtain information about substances of very high concern (SVHC) for EU products.

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