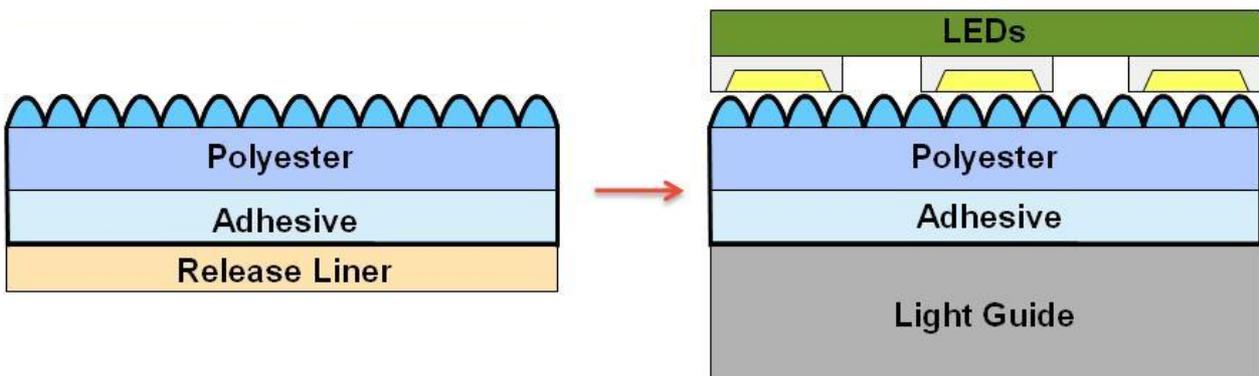
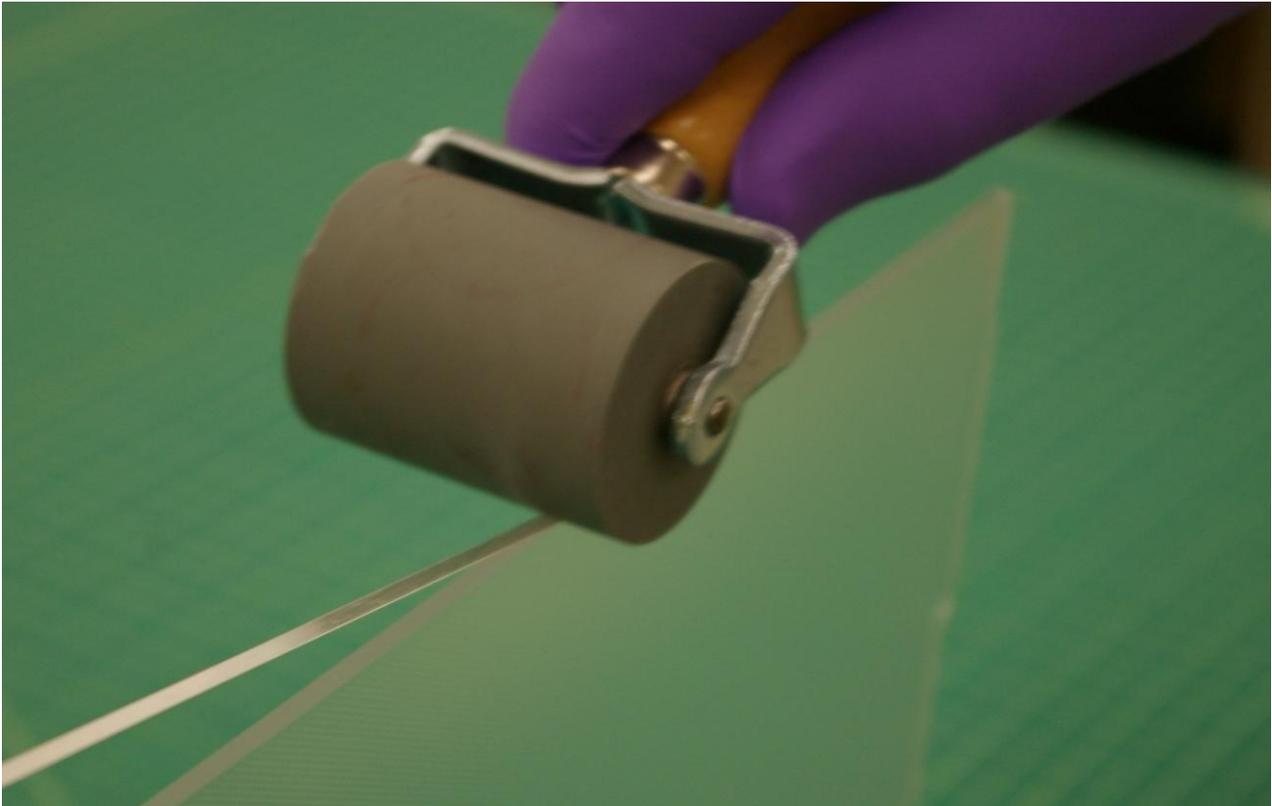




# Application Guidelines

## 3M Uniformity Tape

May 2011



***This is just experimental data and not specification.***

Customer application may differ from test conditions and individual data points may vary depending on sample or preparation or test conditions. 3M makes no expressed or implied warranties based on below information. Customers should consult product specification for product specifications. Material is provided to help determine possible product application restrictions, limitations or opportunities.

# Application Guidelines

## 3M Uniformity Tape

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### Product Description

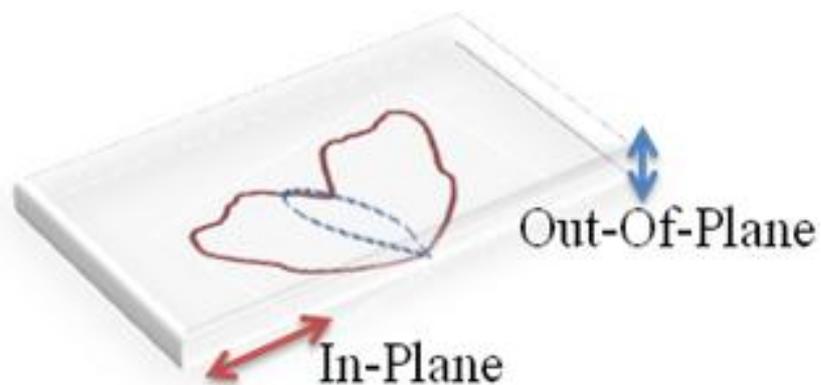
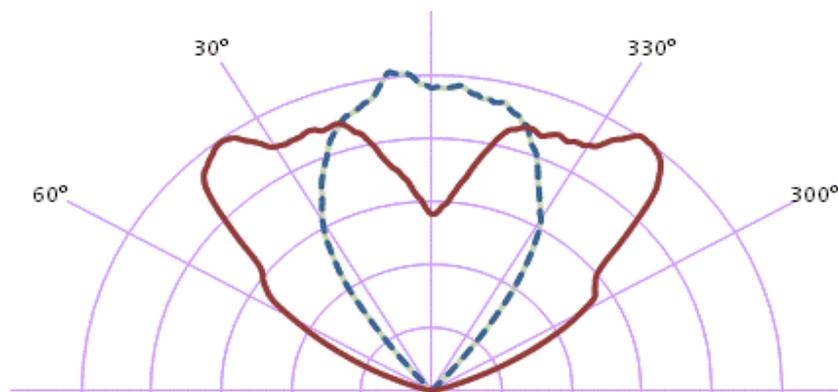
#### *Function and Optical Properties*

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**FUNCTION** Uniformity Tape is applied to the injection edge of the light guide plate (LGP), enabling improved brightness uniformity near the light source. This may help reduce the number of LEDs required.

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**OPTICAL PROPERTIES** Uniformity Tape alters the light path inside the Light Guide from the injection edge to enable better light spreading near the LEDs.



**Angular Distribution of Light Intensity Inside a Light Guide with Uniformity Tape.** Solid red line represents light distribution with Uniformity Tape from the injection edge inside the light guide (in plane). Dashed blue line represents light distribution out of plane of the light guide with Uniformity Tape. For a light guide without Uniformity Tape, the in plane shape of the light distribution is similar to the out of plane representation on the graph. Maximum intensities are normalized to 1 for both lines.

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# Application Guidelines

## 3M Uniformity Tape

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SYSTEM 3M tests with Uniformity Tape showed acceptable uniformity with 67% of  
PERFORMANCE LEDs removed. Results will vary, as each system is different.

While Uniformity Tape does alter the angles at which the light travels through the light guide, it should not significantly affect the color or luminance of the display, as long as the following guidelines are followed:

- 1) Extraction Dot Pattern must be adjusted to work with the Uniformity Tape light distribution, otherwise the light guide will be too bright next to the LEDs
- 2) Light Guide non-illuminated edges should have a reflector, either diffuse or specular in order to prevent loss of light.

3M tests have shown average luminance to drop less than 3% with a color shift of less than 0.003 (dx or dy). Please consult 'System Consideration' section of this document for information on overall system design recommendations.



**Uniformity Tape drastically reduces the head-lighting effect, which results from the removal of LEDs.** Above images illustrate the benefits of Uniformity Tape. Left image is the corner of display as received. Middle image shows the effect of the removal of 2/3 of the LEDs (LED pitch increased from 9 mm to 27 mm). Right image shows the backlight in the middle with the addition of Uniformity Tape.

# Application Guidelines

## 3M Uniformity Tape

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### Product Description

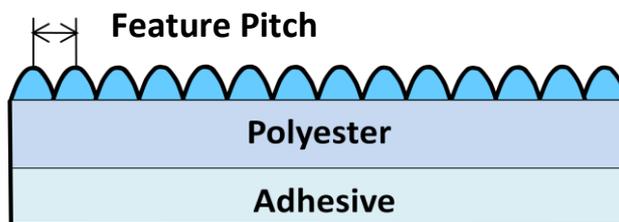
#### *Materials and Mechanical Dimensions*

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**MATERIALS**      Substrate:      Polyester film  
                         Feature layer:    Acrylic resin  
                         Adhesive:        Acrylic PSA

**STRUCTURE**      Acrylic resin optical features formed on polyester film substrate.  
                         Cross section image is not to scale.    Values in this section are typical values  
                         but not property limits.

**STRUCTURE**  
(continued)



Polyester film thickness: 50  $\mu\text{m}$   
Adhesive thickness: 50  $\mu\text{m}$   
Feature pitch: 24  $\mu\text{m}$

Please contact your local 3M team for more detail and support.

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**PRODUCT**      Applied Thickness:      ~115  $\mu\text{m}$   
**FEATURES**      Part dimensions:        Sheet format 2-5 mm width strips

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# Application Guidelines

## 3M Uniformity Tape

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## Application Guidelines

### *Lamination of Uniformity Tape to a Light Guide*

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**MATERIALS NEEDED**      **3M Uniformity Tape** - Height and length of 3M Uniformity Tape sample is cut to match the light guide edge dimensions

**Gloves** - Powder-free gloves (such as Nitrile or Latex) are recommended to protect against skin oils. In order to prevent lint fabric gloves are not recommended.

**Handheld rubber roller** - The roller should be wider than guide thickness.

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**LAMINATION INSTRUCTION**

**Start with a clean light guide plate**

Prepare surface for lamination by removing any dust or other residue.

Clean surface with isopropyl alcohol if not clean.

Preferred conditions: Lamination of Uniformity Tape is best when surface is smooth, so a smooth polished light guide will provide the best results.

**Alignment of 3M Uniformity Tape**

While wearing protective gloves, peel back liner on the Uniformity Tape until roughly 20 mm of tape with adhesive is exposed.

Align and adhere exposed end of Uniformity Tape to the corner of light guide illuminated edge; with gloved hand press the tape so that it adheres to the light guide edge.

Once an end of Uniformity Tape is tacked down, keep the tape under light tension and remove the rest of the protective liner. Start at adhered corner and press down UT with free hand every 10 - 15 cm, using minimal contact area.

**Laminating the UT to the light guide**

With the tape fully tacked to light guide edge, begin lamination with roller. Starting at one end of the light guide edge, press the roller down with firm and consistent pressure, and move along the edge of the light guide.

Move the roller at a consistent pace allowing the air to escape from under the UT as the adhesive wets out evenly on the light guide edge.

In one continuous motion continue until entire length of light guide has been laminated.

**Evacuate any remaining air bubbles**

Inspect for any remaining air bubbles.

Work the roller back and forth along light guide edge where bubbles are present.

*Note:* For difficult air bubbles, while moving roller vigorously back and forth with short motions, use edge of rubber roller to work out bubbles in the direction perpendicular to edge length.

# Application Guidelines

## 3M Uniformity Tape

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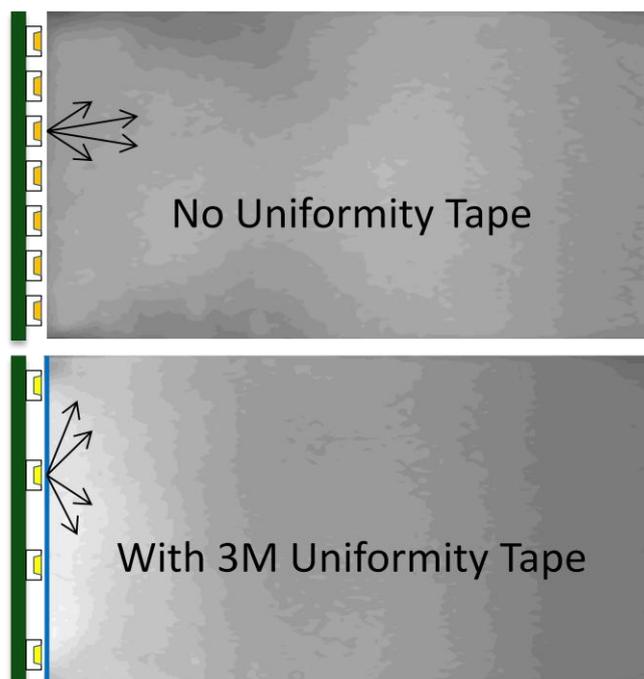
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### Application Guidelines

#### System Considerations

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**EXTRACTION PATTERN MODIFICATION** Uniformity tape helps improve brightness uniformity near the source (LEDs) by increasing the angles at which the light enters the light guide beyond the total external reflection limit of flat acrylic and air. Uniformity Tape changes the light distribution and increases the injection angles into the light guide; however it also affects how the light propagates through the guide away from the light source. Since the angles at which the light enters and travels through the light guide are different from a system without a Uniformity Tape, adjustments are required in the design of light extraction dot pattern in order to retain the same light distribution. If the extraction pattern is not changed, one can expect a display which is brighter near the LEDs, and less bright in center and further away from the light source.



**Light distribution comparison.** Images above show a light guide optimized for a backlight without Uniformity Tape. When Uniformity Tape is applied, the brightness intensity increases near the light source, and drops further away, which requires an extraction pattern adjustment.

# Application Guidelines

## 3M Uniformity Tape

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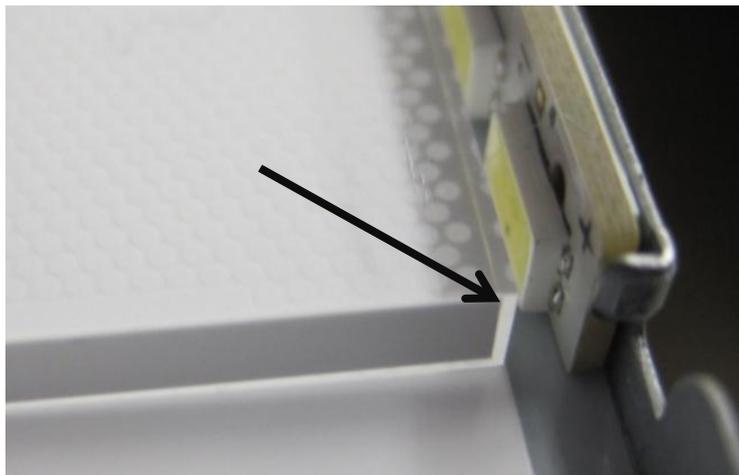
### Application Guidelines

#### System Considerations

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#### EDGE REFLECTOR

*Extraction pattern modification* section explains that the Uniformity Tape helps keep the display area near the widely spaced LEDs uniform by sending the light through the light guide at higher angles. Higher angle light is more likely to be incident on the non-illuminated side edges of the light guide. In order to prevent loss of light at the edges of the guide, it is recommended that a reflector tape (diffuse or specular) be used on all non-illuminated edges (see *Illustration 3*). The reflector should be applied to cover all of the area of non-illuminated sides, especially near the corners closest to the injection edge. If reflectors are used at non-illuminated edges of the light guide then minimal light loss (total less than 2%) is to be expected with the application of the Uniformity Tape.



**Edge Reflector.** An Edge reflector should be used on all non-illuminated edges of the light guide with Uniformity Tape. In order to prevent loss of brightness, edges closest to the light source are most critical to cover with a reflector.

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#### SYSTEM MODIFICATION SUMMARY

Uniformity Tape allows backlight designers and engineers more freedom to space LEDs further apart, however it is not a 'drop in' solution. Some extraction pattern design work is required in order to obtain a desired brightness distribution across the backlight. Also, 3M recommends that an edge reflector tape be used on all non-illuminated edges of the light guide to prevent loss of brightness.

# Application Guidelines

## 3M Uniformity Tape

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## Application Guidelines

### *Troubleshooting Guide and Frequently Asked Questions*

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**PROBLEM**      **3M Uniformity Tape is a new product and 3M is committed in ensuring good**  
**DIAGNOSTICS**   **technical service and support during the adoption of this product.**  
**Please contact your country's technical service representatives if issues arise.**

**Issue:** On-Axis Luminance has dropped more than 5%.

**Solution:** Please check the following:

- 1) Make sure Extraction Dot Pattern has been adjusted to work with Uniformity Tape.
- 2) Make sure non-illuminated edges of the light guide have reflector tape.
- 3) Inspect Tape for bubbles.
- 4) Contact 3M for further assistance if none of the above resolves the issue

**Issue:** Color Shift of more than 0.003 in dx or dy is measured after application of Tape.

**Solution:** First determine accuracy of the color measurement. Please identify where the color shift is occurring on the display.

- A. If the color shift (yellow) is appearing near the LED light source or across the whole display.

Uniformity Tape will sometimes reveal angular color non-uniformities present in today's LEDs. This will result in a yellower display next to the LED bar. Please try a different type of LED or a more 'square' package. For example a 5630 package is better than 6030. If a long package must be used, we recommend two chip in one architecture to reduce color non-uniformity present in today's LEDs.

- B. If the color shift is appearing away from the LED light source  
Because the Uniformity Tape sends light at higher angles, it will increase the path of light inside a light guide plate. The color shift away from the light source could be an indication of a slight blue absorption in the extraction dots or perhaps the light guide plate.

Contact 3M for further assistance if the issue cannot be resolved.

# Application Guidelines

## 3M Uniformity Tape

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FREQUENTLY  
ASKED  
QUESTIONS

**Question:** Is there a certain type of LED that 3M recommends for use with Uniformity Tape?

**Answer:** One of key benefits of the Uniformity Tape is that it opens up the design space to more options for LEDs. 3M does not recommend any specific LED package.

**Question:** Does 3M recommend a certain distance between Uniformity Tape and LEDs?

**Answer:** Uniformity Tape is not sensitive to the distance away from the LEDs. Uniformity Tape is designed to be in close proximity to the light sources, but shouldn't be pushed against the LEDs.

**Question:** Does Uniformity Tape require registration to the LEDs?

**Answer:** Uniformity Tape is designed not to require registration.

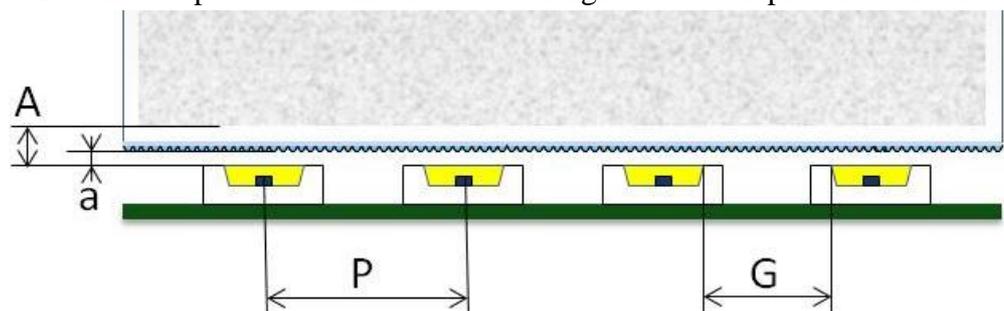
COMMON  
TERMINOLOGY

**A** – Distance from top of LED to active display area

**P** – Center to Center distance between LEDs

**a** – Distance from light guide edge to top of LED

**G** – Distance Gap between emissive areas of light bar. G represents dark area.



**Common Terms Graphic.** Uniformity tape allows greater G distance, thus improving the A/P ratio. In addition, by increasing the freedom for the G gap, shorter LEDs can be used, thus potentially reducing material cost of LED part.

# Application Guidelines

## 3M Uniformity Tape

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### Storage and Lifetime

#### *Environmental Test Results*

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TEST	Test Conditions
OVERVIEW	1) 85 °C, no humidity control : 1000hrs 2) 65°C / 95%RH : 1000hrs 3) -40 °C (1hr) ⇔ 85 °C (1hr) Thermal Shock : 100cycle

Test Sample : 1 experimental lot of Uniformity Tape samples were tested for each condition

Measurement Items
1) Delta E*
2) Transmission
3) Adhesion to Light Guide Plate

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TEST RESULTS In summary, there are no concerns with Uniformity Tape, and all data indicates acceptable performance after standard 1000hour environmental testing. The tables below summarize the results.

#### Color change (Delta E\*)

Item	Delta E*	
Delta-E* after thermal shock (100 cycles)	0.71	
After 85 °C	1000 hours	0.73
After 65 °C / 95%RH	1000 hours	0.67
After UV test	288 hours	0.94

#### Transmission

Item	Average % Transmission	
Transmission at Room Temperature	92.3	
Transmission after thermal shock (100 cycles)	91.3	
After 85 °C	1000 hours	90.5
After 65 °C / 95%RH	1000 hours	90.1
After UV test	366 hours	89.8

# Application Guidelines

## 3M Uniformity Tape

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### Adhesion

TEST	Item (adhesion to PMMA light guide)	Adhesion (g/0.5")	
RESULTS (continued)	Initial Adhesion	1048	
	Adhesion after thermal shock (100 cycles)	1740	
	After 85 °C	1000 hours	1630
	After 65 °C / 95%RH	1000 hours	1320

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**STORAGE AND HANDLING** 3M recommends that Uniformity Tape is stored in a temperature of  $20 \pm 10$  °C and at a relative humidity of  $45 \pm 15\%$ .

The recommended temperature range for 3M Uniformity Tape during application is  $20 \pm 10$ °C and at a relative humidity of  $45 \pm 15\%$ .

3M Company  
Optical Systems Division  
3M Center, 235-1E-54  
Maplewood, MN 55144

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