

# Light Guide Application Guideline



## What is GLT?

Since 2000, GLT has led the industry in advanced light guide development. We take a collaborative approach – from discovery and design through prototyping and manufacturing – for virtually any custom light guide application.

With nearly two-million-square feet of ISO- and TS-certified manufacturing space and more than 1,600 employees worldwide, GLT is committed to providing the efficiency and high quality that our innovative clients require.

**When you need it brighter, more uniform and more efficient, contact GLT, your partner in emerging light guide technology.**



## What needs to be illuminated?

### Automotive

- Instrument panels
- Navigation systems
- Rear camera displays
- Foot well pockets
- Door sill plates
- Tail lights
- Indicator lights
- Decorative illumination

### Consumer Electronics

- Computer keyboards
- VOIP phones system sensors
- User interfaces
- Set-top boxes
- Ring lights
- Front lights

### General Lighting

- Architectural accents
- Egress, pathway and exit sign illumination
- Ambient ceiling or wall lighting
- Cabinet lighting
- Task lighting

### Instrumentation

- Speedometers
- Thermostats
- GPS devices
- Panel voltage meters
- Water sensors

### Medical

- Blood glucose meters
- Thermometers
- Feeding pumps

### White Goods

- Washer and dryers
- Dishwashers
- Refrigerators
- Stoves

## What components are needed?

### Lightguide

- Optical Pattern
- Lens Array & Edge Finish
- Flat/Taper/Wedge



### PCBA/FPCA

- LED
- Resistors
- Wiring

### Film

- Back Reflector
- Diffusers
- BEF – Brightness Enhancement Film
- DBEF – Dual Brightness Enhancement Film
- Mask
- Adhesive

### Housing

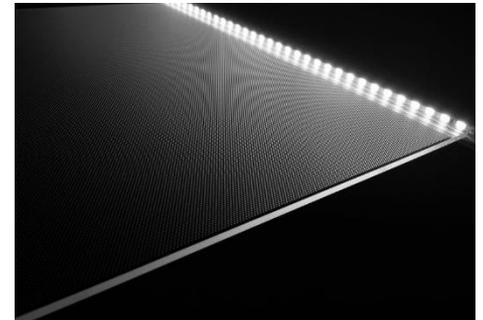
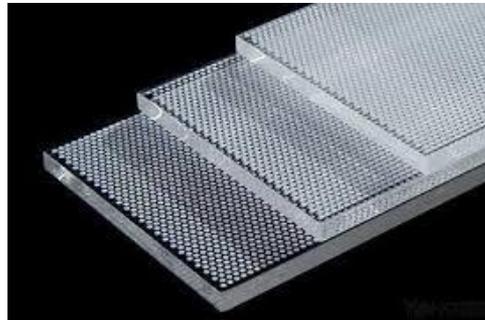
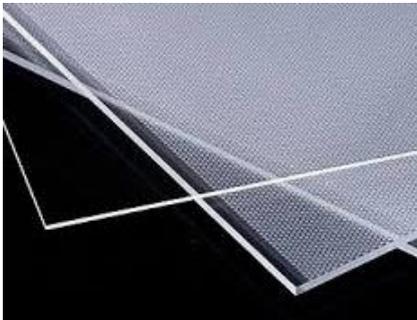
- Reflective Capabilities
- Thermal Management
- Assembly Security



## Lightguide: Optical Pattern

### Optical Pattern Impact

- Optical pattern increases the amount of light extracted through the LGP due to controlling the direction and minimizing light loss.
- Pattern density and gradient can be altered in order to produce the brightest and most uniform component.
- Pattern does not need to be uniform and can also be selective in location



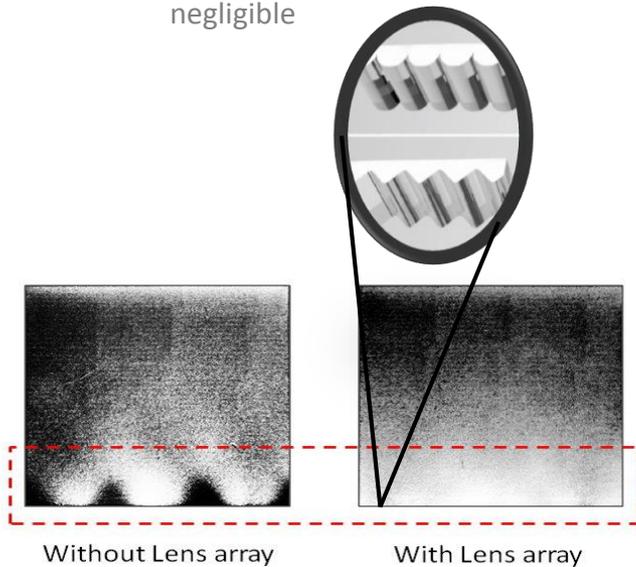
## Lightguide: Lens Array & Edge Finish

### Pros

- Decreases transition area length
- Spreads out initial light
- Can reduce needed LED count

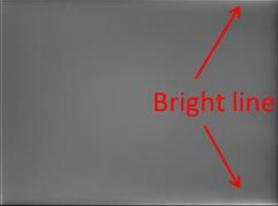
### Cons

- Can reduce light efficiency, however, the difference is often negligible



### Polished & Unpolished

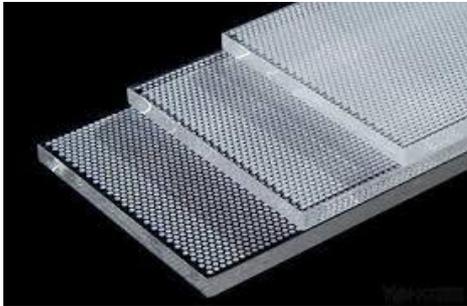
- It is helpful to polish LGP edges in order to avoid bright spots.
- Unpolished edges act as optical features, which if not controlled, can cause part inefficiencies.

	Unpolish	Polish
Optical performance		
Side view image		
Surface roughness (Ra)	0.5~0.7um	<0.125um

## Lightguide: Shape

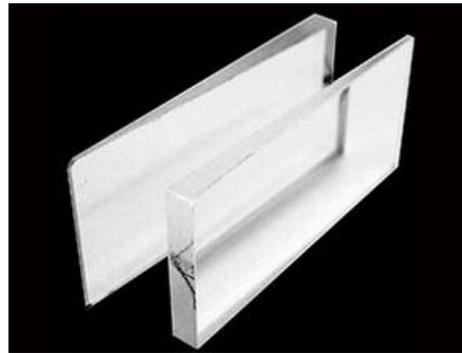
### Flat

- Consistent thickness throughout
- Easy to work with



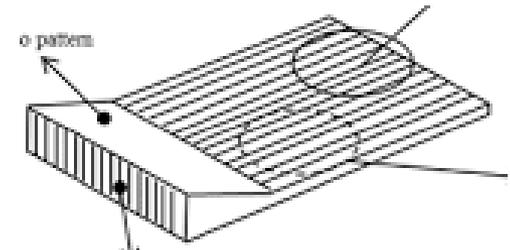
### Wedge

- Increases number of light bounces which forces the light to travel a further distance within the LGP



### Tapered

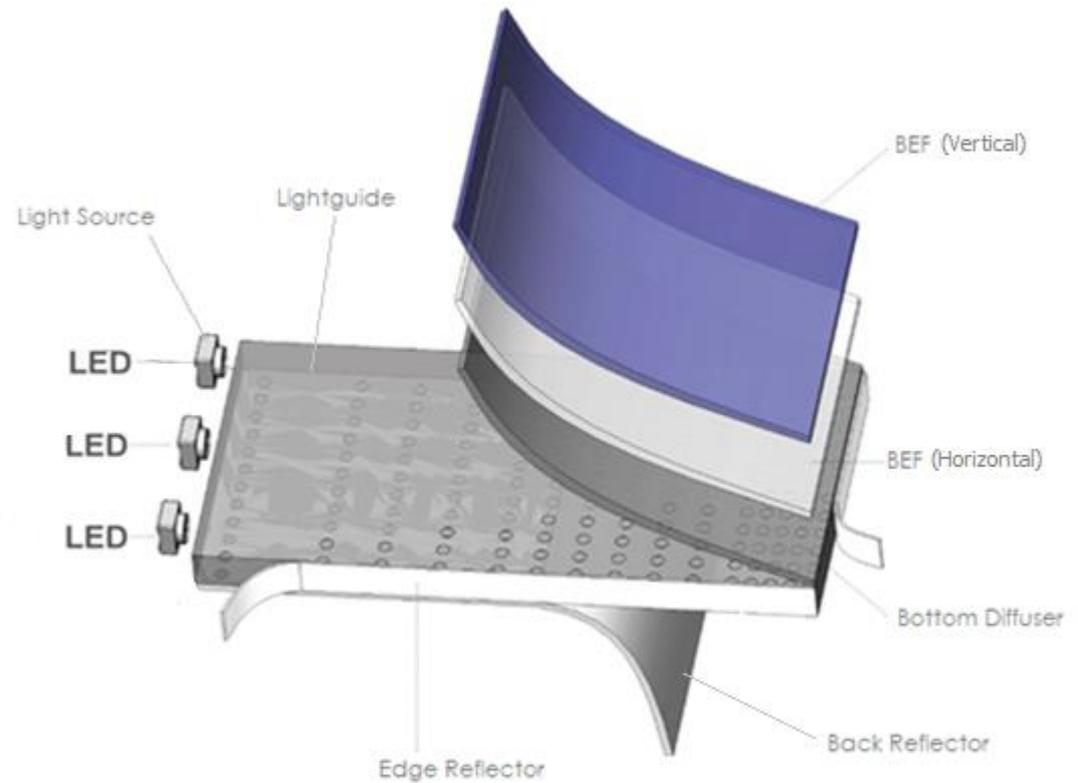
- Ensures minimal light is lost from coupling with LED while maintaining thin illumination area



## Films

### Increase Directionality and Uniformity

- The purpose of using Films is to increase light directionality and uniformity. Different films provide different solutions to issues when lighting difficult fixtures.



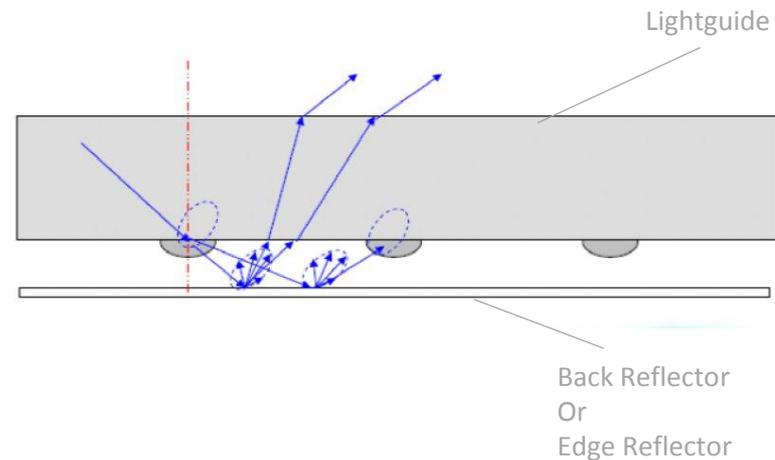
## Films: Back Reflector & Edge Reflector

### Back Reflector

- The function of the back reflector is to reflect the light from the bottom of lightguide back into lightguide in order to reduce the light loss and increase the efficiency of the module.
- Materials used to reflect the light include white polyester films, ESR film, and molded tray/housings

### Edge Reflector

- An edge reflector functions similarly to the back reflector by reflecting the light from the edges of the lightguide back into lightguide in order to reduce the light loss and increase the efficiency of the module.



## Films: Diffuser

### Diffuser

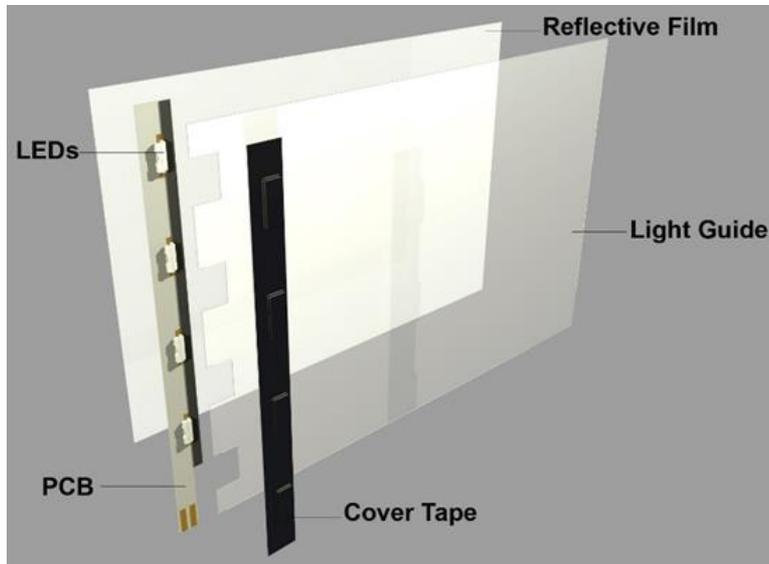
- The function of diffuser plate is to blur or diffuse uneven light in order to allow the visual appearance to look smooth.
- Materials that act as diffusers can be glossy films or even glossy glasses/plastics.



## Films: Mask

### Mask

- The function of a mask is to prevent light from escaping into unwanted areas. Masks/cover tapes are often placed over LEDs in order to avoid illuminating a housing or fixture. (See below)
- Masks are generally black on the top and white on the bottom in order to block or allow light to reflect off.



## Films: Adhesive

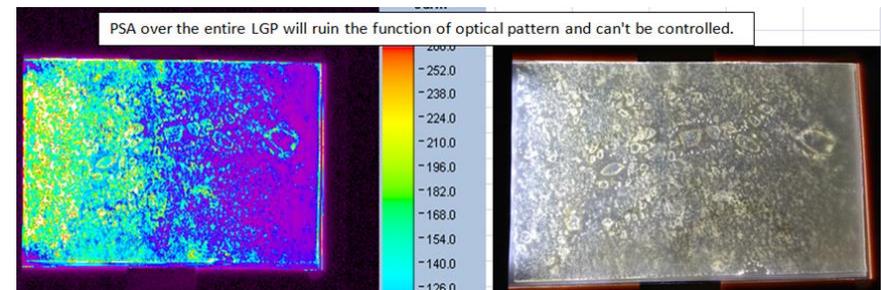
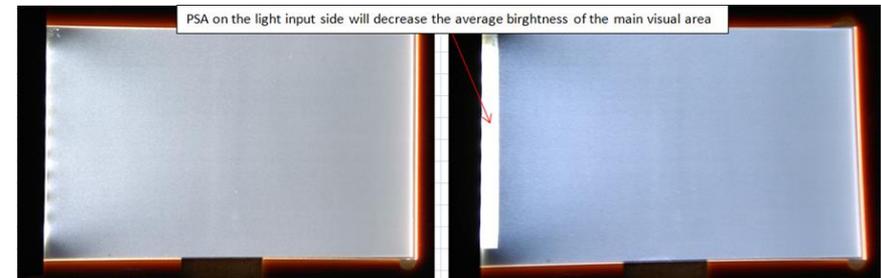
### Adhesive

- Adhesives are used to mount components in place.
- It is important to not place adhesives over optical patterns due to adhesives absorbing light causing inefficiencies and hot spots.



### Pressure Sensitive Adhesive Impact

- Pressure Sensitive Adhesive will absorb/extract the light from lightguide, its effect is much bigger than optical pattern.
- Avoid Pressure Sensitive Adhesive locations on the light path or the main visual area.
- Decreases brightness
- Causes uniformity to become very difficult to control.





## PCBA/FPCA: LED

### LED

- LED – Light Emitting Diode is a semiconductor device that emits visible light when an electric current passes through.
- **Top Fire LED**
  - High direct light distribution
  - High power efficiencies due to LED chip positioned closely to LGP
  - Large design. Is not applicable for thin designs.



- **Side Fire LED**

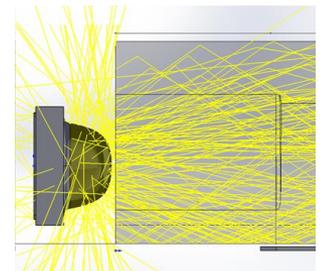
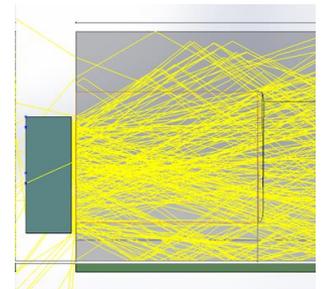
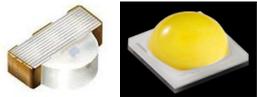
#### Flat LED

- High direct light distribution
- LED chip is positioned closely to LGP
- Flat LED is the best option for LGP applications due to high power and size efficiencies.



#### Dome LED

- Higher spread light distribution
- LED chip rests further way from LGP than flat LED.



### Comparison of Flat and Dome Input Luminous Flux

Model with Flat LED	Model with Dome LED	Flat LEDs are more efficient than Dome. Efficiency is 58% of Flat.
280	163	

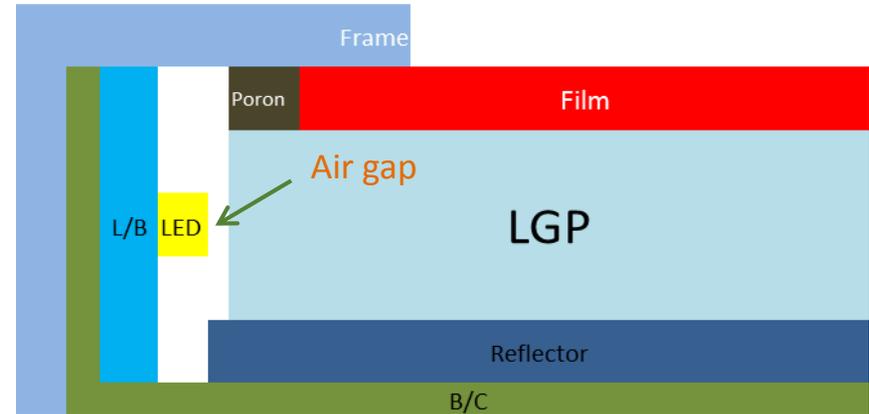
## PCBA/FPCA: LED Placement

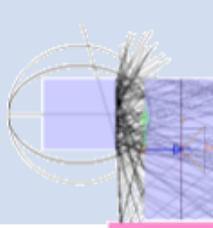
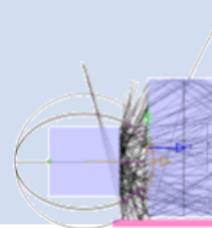
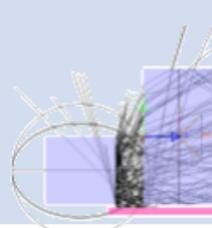
### How to Mount LEDs

- Air gap between LED and LGP affects efficiency
  - GLT recommends an air gap of 0.2mm.

Comparison of Different Air Gap			
Air gap(mm)	0.4	0.5	0.6
Light loss	6%	13%	20%

- LED height position also affects efficiency
  - GLT recommends to position LEDs in a Medium to Low height.



Comparison of different LED position			
LED position	High	Medium	Low
Light loss	17%	6%	9%
Image			

## Assembly Configuration

### Backlight

- A backlight is a form of illumination used in liquid crystal displays (LCDs). As LCDs do not produce light by themselves, they need illumination to produce a visible image. Backlights illuminate the LCD from the side or back of the display panel. Backlights are often used in small displays to increase readability in low light conditions such as in wristwatches, and are used in smart phones, computer displays and LCD television.

### Frontlight

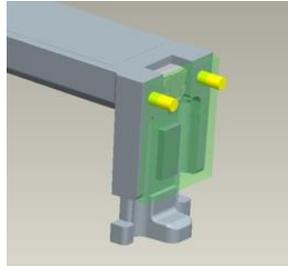
- A frontlight is similar to a backlight, however, instead of illuminating the LCD from the side or back of the display panel, it do so in the front of the LCD. An LCD presents an image by absorbing some light passing through it. When an electric field is applied across the crystal, it changes the passing light so it will not pass through a polarization filter. This allows LCDs to operate at low power, as no energy needs to be spent generating light. Many battery-operated electronic devices, including most calculators and other devices use unilluminated LCDs.



## How to Mount a Lightguide

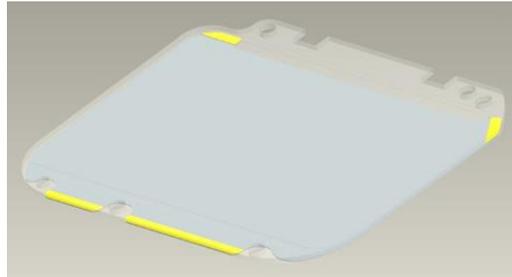
### Heat Stake

- Mount PCB or FPC



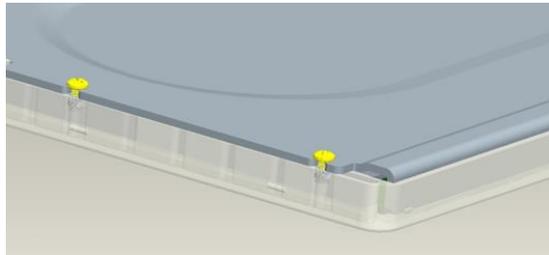
### Adhesive

- Mount reflector and diffuser



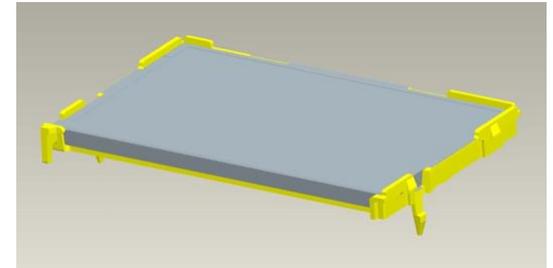
### Screw

- Mount plastic and metal housing



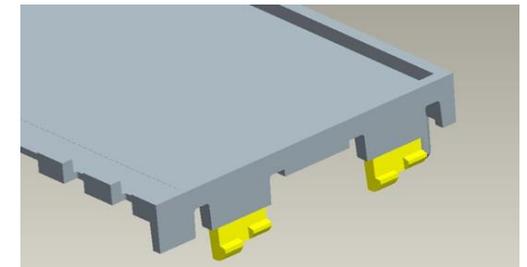
### Housing

- Mount lightguide and optical films



### Snap Feature

- Mount PCB



For optimal performance, LGP material needs to typically be polycarbonate in order to maintain durability.

# How to Assemble Our Lightguide

## Environment

- Open in clean room only (the minimum class of clean room is 10000 class, the working table with 100 class is suggested), if lower than this specification, we will not accept the surface dust.
- Cleaning fingers/gloves are needed.

## Device

- ESD – Electrostatic Discharge protection is required when handling trays/parts. (Product may include LED's or other electronic devices which are ESD sensitive).
- If any dust needs to be cleaned, the dust removing roller must be used, alcohol is forbidden.



## SOP for Assembling Lightguides

- Use the lint remover to clean the reflector (A side).
- Remove the release liner (A side) from lightguide with ESD blower, and assemble onto the reflector.
- Remove the release liner (B side) from lightguide with ESD blower, and assemble top films onto lightguide.
- Appearance inspection in light up condition, use the lint remover/cleaning stick to remove dust if needed.

Note: Remove the release liner of LGP from the corner at the light output side (high pattern density) will be easier due to the lower adhesion force.

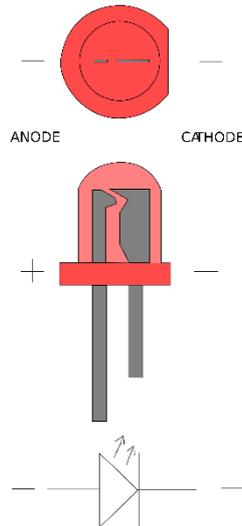
# How to Power an LED Assembly

## Standard Operating Device

- Use a Current Limiting Device rather than a Voltage Limiting Device.
  - When using a voltage limiting device the risk of burning out the LED increases.

## Polarity

- Polarity indicates whether a circuit component is symmetric or not.
  - Diodes only allow current to flow in one direction, and they're always polarized.
  - If there is no current-flow, no light.
  - A diode has two terminals. The positive side is called the anode, and the negative one is called the cathode.

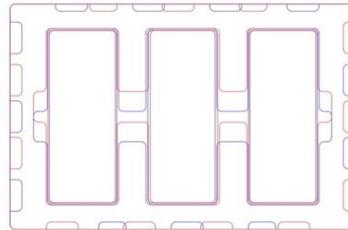


## How to Store Our Lightguide & Things to Avoid

### Tray Stacking

- Trays must be stacked in alternating directions.

Notes: Because different products will have different stacking reel stacking of trays please see the mark on the tray. The image below displays tray differences as seen by the blue and pink markings.



### Storage Condition

- Storage environment must be kept at 30°C, 70% RH in order to maintain proper functionality of parts, within six months from the date of shipment based on the above described storage conditions, to ensure its proper functionality.

### Conditions to Avoid when Handling Lightguides

- Direct touch is not allowed, latex gloves are required.
- Avoid using lightguide as A-surface in assemblies.
- Avoid wetted contact like glues or bonding agents directly on the lightguide.
  - **Do not use solvents or swelling agents on the parts.**

