

### Embedded LEDs

In the last 10 years there has been a significant trend to embed LEDs within the membrane switch for the purposes of backlighting. Typically embedded LEDs are used for small indicator windows or to illuminate very small areas outside the contact areas of a membrane switch.

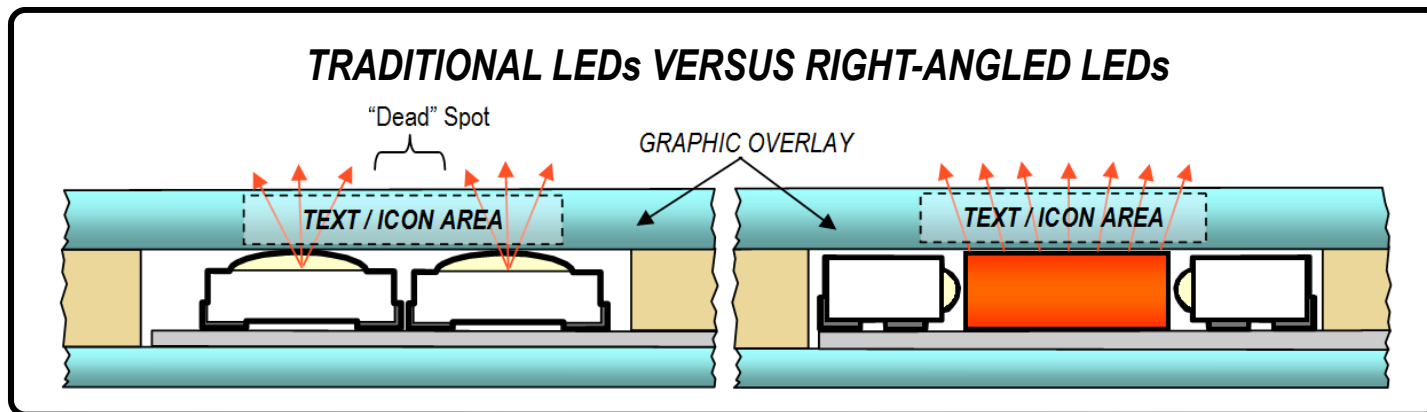
Recently, however, SSI has been incorporating right-angle ("side-fired") LEDs to address some of the many shortcomings of the embedded LED. By using right-angle LEDs and a diffuser, these discrete LEDs are able to be used to light broader areas than otherwise possible. Though this method provides a slightly muted brightness, both hot spots and dead spots are more easily avoided.

**Advantages:**

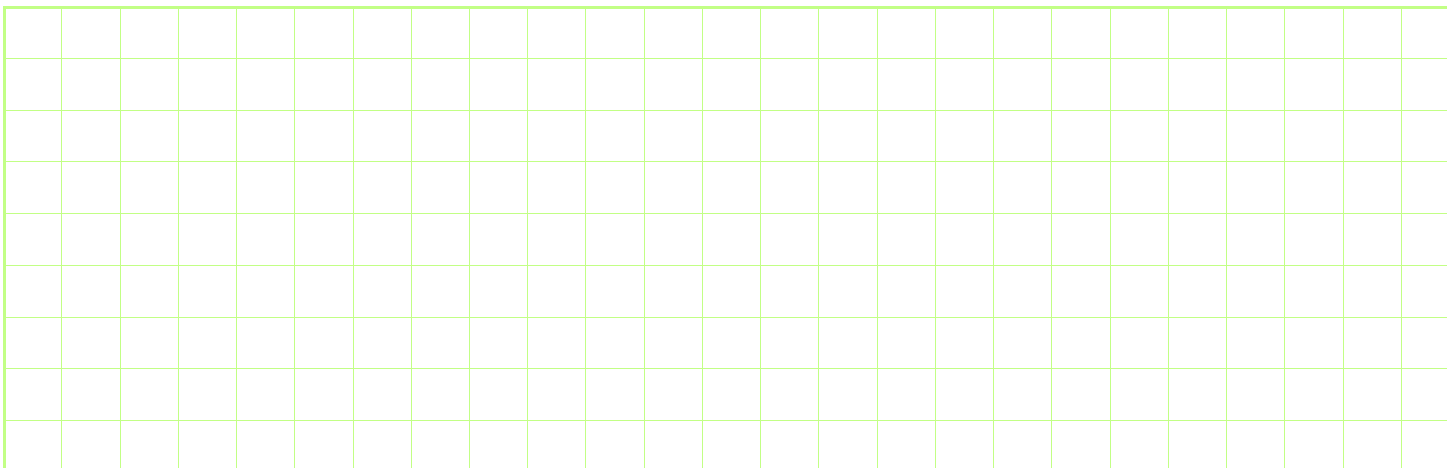
- This method can be a very cost effective means to backlight small indicator windows, small icons or isolated areas by embedding LEDs on the flexible circuit of the membrane switch.

**Disadvantages:**

- Because of the proximity of the LED to the graphic overlay, it can be challenging and/or costly to backlight broad areas. Right-angled LEDs address this disadvantage.



**Sketch/Notes:**

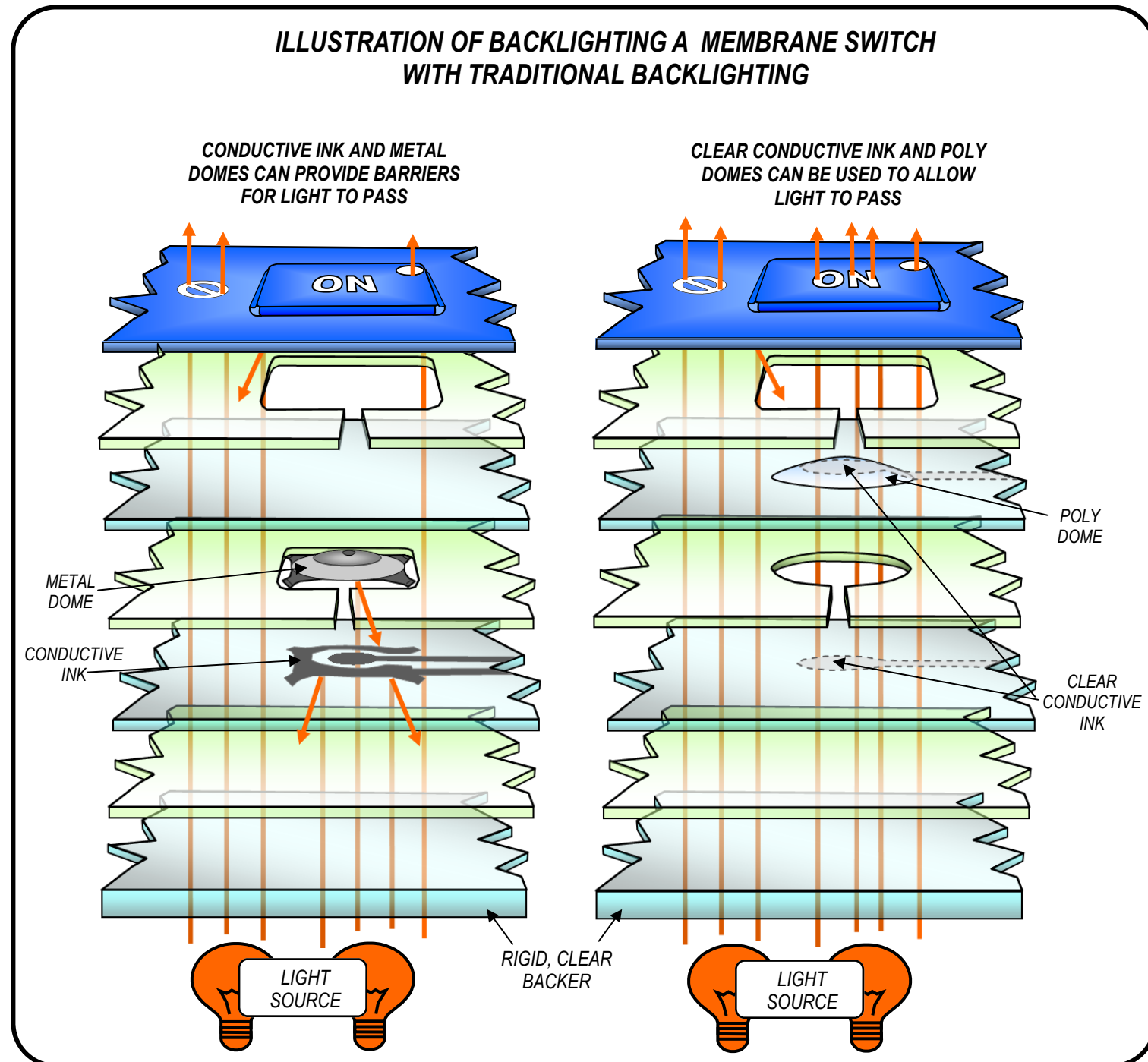


## BACKLIGHTING: A Guideline to Integrating Backlighting into Membrane Switches and Keypads

There are many ways in which to integrate backlighting into your membrane switch and keypad applications. Each method has its own set of advantages and disadvantages. Consider the following guidelines to determine the method that provides the best fit for your application.

### Traditional

This backlighting method utilizes incandescent or LED lights on a plane behind the membrane switch. Often these light sources are assembled on a PCB or attached to a subpanel. Depending on how much of the membrane switch needs to be backlit, the membrane switch is then assembled to a clear backer or to a panel with cutouts. The lighting shines through the clear panel or cutouts and illuminates various entities of the membrane switch.



## Phosphorescence

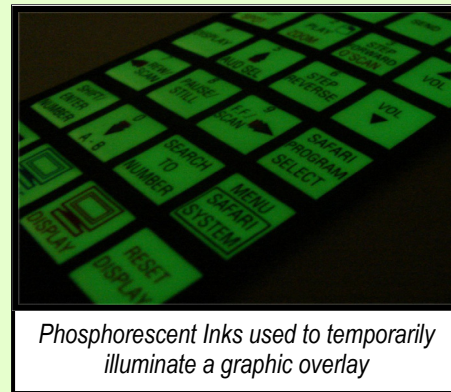
Most people have seen or used products that incorporate glow-in-the-dark materials. Phosphorescent inks have been developed to allow SSI to incorporate this low cost means of backlighting into the graphics we use for our membrane switches.

### Advantages:

- Utilizing phosphorescent inks provide a very low cost option to highlight certain graphical entities in a low light environment.

### Disadvantages:

- Phosphorescent inks fade quickly and require "charging" by being exposed to light.
- This method is effective for applications where the environment is dark for short periods of time.
- Backlit colors are typically limited to greens and yellows.



Phosphorescent Inks used to temporarily illuminate a graphic overlay

## Estimated Fade Chart

Time	% Fade
1 minute	15%
2 minutes	30%
5 minutes	50%
10 minutes	75%
20 minutes	90%

## Electroluminescence

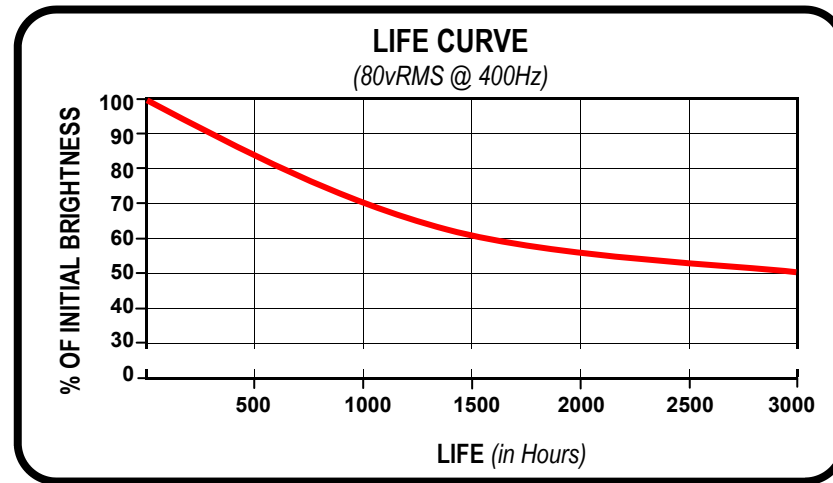
Timex's Indigo® watch is perhaps the most well-known user of electroluminescence backlighting. This technology is tailor-made for the membrane switch industry as it can be applied to thin films which easily integrate into a membrane switch design. More specifically, the electroluminescent layer can be positioned under the graphic yet above the circuit layers circumventing the challenges of backlighting the keypad areas as discussed earlier.

### Advantages:

- The backlighting produced by electroluminescence is extremely even and is well suited for backlighting very broad areas.
- Electroluminescence can be selectively applied allowing for good design flexibility.

### Disadvantages:

- Implementation of electroluminescence can often double the cost of the membrane switch.
- Colors are limited to white, blue and green/yellow.
- The life of a electroluminescence panel is limited. "Half life", the time in which the panel gets to be half as bright as it was new, is around 3,000 hours.



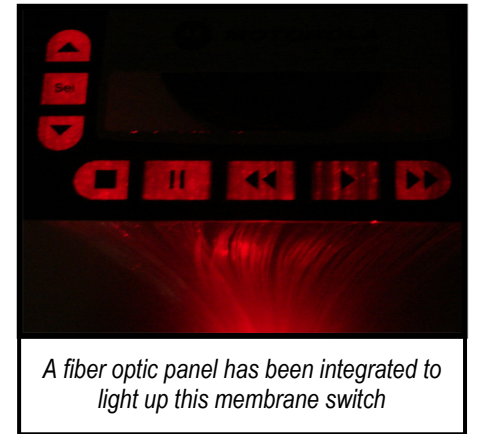
## FIBEROPTICS CONTINUED...

### Advantages:

- The life of a fiber optic backlighting layer is nearly endless. This method utilizes long-lasting LEDs positioned inside the final product's enclosure. In the event an LED burns out, it can often be easily replaced.

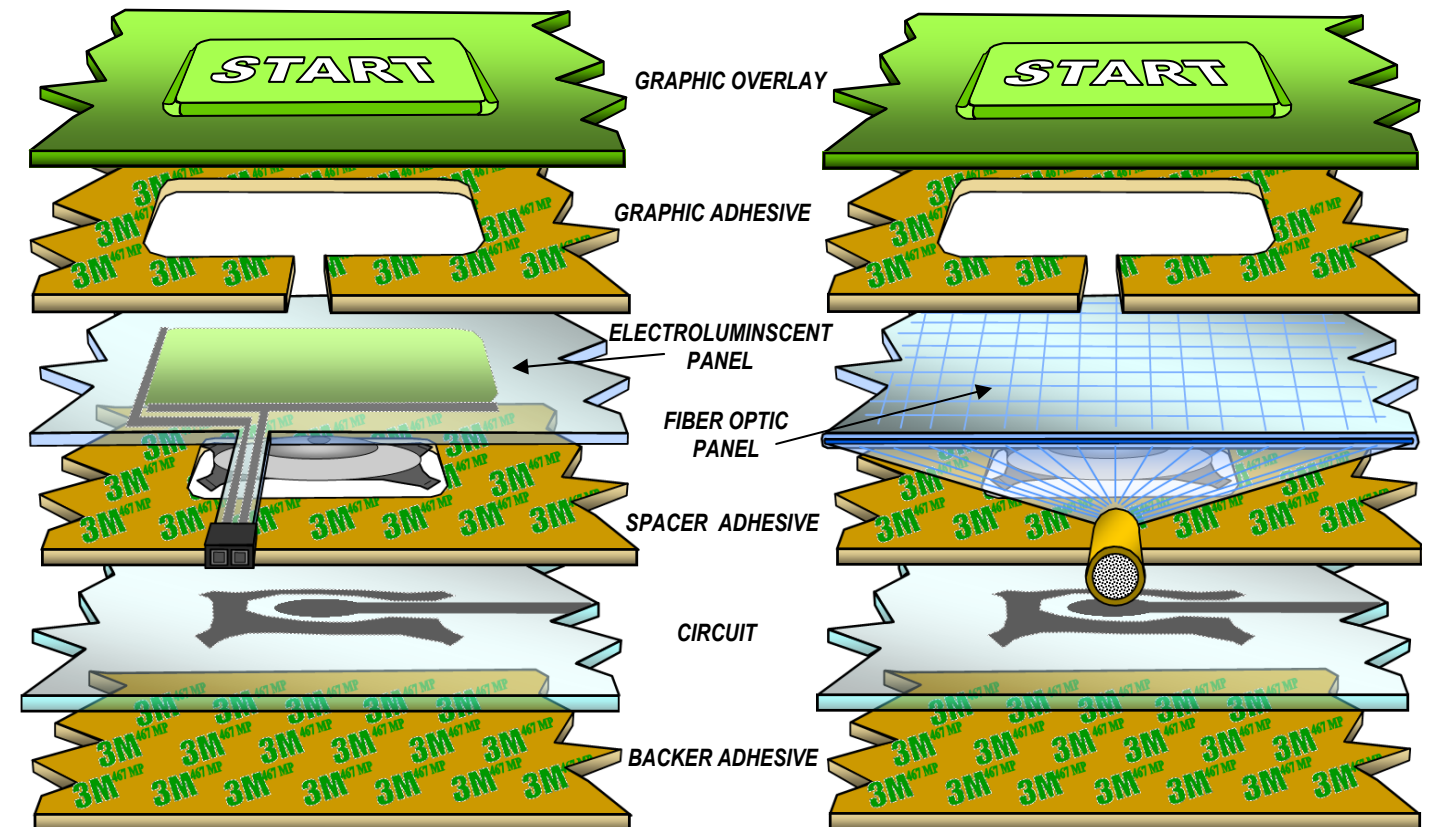
### Disadvantages:

- The cost of fiber optic backlighting often doubles the cost of the membrane switch.
- Although often acceptable for many users, this type of backlighting can create fine "hot spots" which can be noticeable when backlighting certain colors.
- Since the light of the fibers flow in a linear path, lighting around windows and other cutouts can be challenging (see previous illustration).



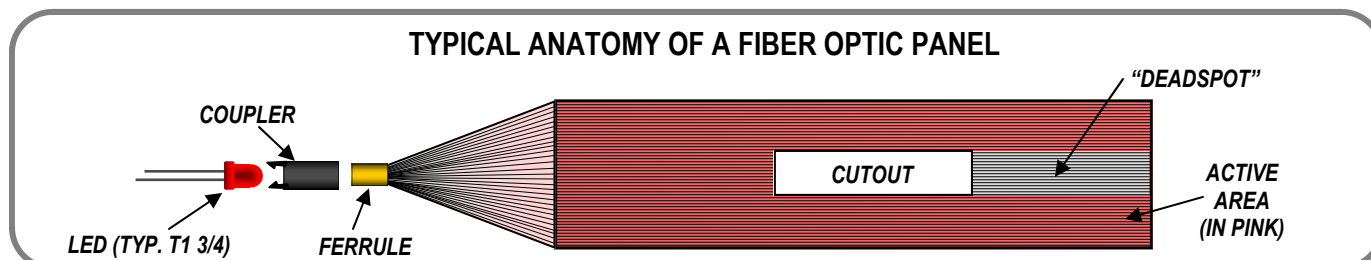
A fiber optic panel has been integrated to light up this membrane switch

## ILLUSTRATION OF HOW ELECTROLUMINESCENCE AND FIBER OPTICS ARE INTEGRATED INTO MEMBRANE SWITCH CONSTRUCTION



## Fiber Optics

Like electroluminescence, fiber optics provide a flexible backlighting layer that can be incorporated between the graphic overlay and the circuit layer allowing nearly the entire surface area of the membrane switch to be backlit. Fiber optic panels comprise thin plastic optical fibers that are oriented in a linear fashion. These fibers are then terminated with a brass ferrule allowing the attachment of a light source. These thin panels are ideal for assembling within the membrane switch construction.



## FIBER OPTICS VERSUS ELECTROLUMINESCENCE

FACTOR	FIBER OPTICS	ELECTROLUMINESCENCE
RESISTANCE TO MOISTURE	EXCELLENT	GOOD
COST	LESS PER ACTIVE AREA	LESS, IF SELECTIVELY REQUIRED
ELECTROMAGNETIC INTERFERENCE	NONE	SOME
LIGHT CONSISTENCY	GOOD	EXCELLENT
MAINTENANCE	REPLACE LIGHT SOURCE	REPLACE ENTIRE PART
INVERTER REQUIRED?	NO	YES
LIFE OF BULB	EXCELLENT (LED LIFE)	MODERATE (1K-4K HRS. HALF LIFE)