BIVAR

White Paper

Flexible Light Pipes Address Key LED Design Concerns

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Inserting fiber optics into your chassis can increase real estate behind your panel face, reduce noise naturally, and guide the brightness of an LED around obstacles without “bleeding” unwanted light into other areas.

Today, we are inundated with LEDs. Many of our electronics have LEDs meant for status indication–but light up a bedroom enough to read a book at night. For the average consumer, it’s an irritation. But for medical, military, industrial, and aerospace applications, excess light from one status LED could bleed excess light into a different indicator lens, leading to confusion. In a panicked situation at a nuclear plant, the wrong color that bleeds over can get read as a different signal. As an example, picture a fighter pilot’s cockpit with light bleeding into an incorrect indicator -- a dark cockpit should only draw attention to failures. There are situations where excess LED light is not only annoying and unwanted, but dangerous.

Human factors engineers optimize performance in designs where humans must interact with systems. For example, in critical conditions, people must be able to quickly interpret a status on the control panels in a nuclear power plant. Designing for human factors is also practiced in automotive dashboards, life-saving medical equipment, and thoughtfully designed consumer electronics to increase human health, safety, and productivity.

Options for managing LED status lights in electronics equipment may be as simple as reducing brightness by choosing another LED or by reducing current flow through the LED. Another option is to add a photocell to correlate brightness with the ambient light that is competing with LED brightness levels. However, even a dim LED can bleed into unwanted areas. Human interpretation of status is difficult and prone to mistakes if one LED lights up two indication areas.

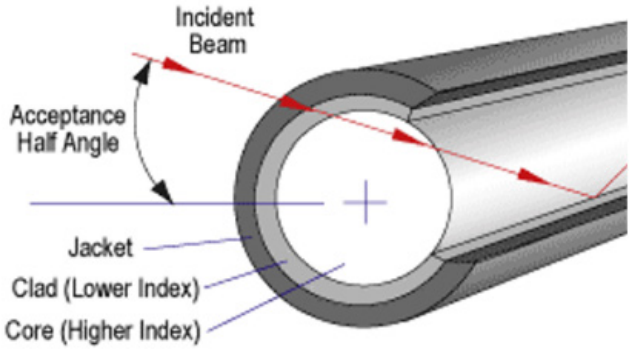

Figure 1: Light travels down the fiber core and is contained within by the cladding (Fluorinated Polymer TFE).

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Another LED brightness solution is to use light pipes, guides, or tubes to solve the problem of light bleed. When operator action is critical, light pipes can reduce or eliminate light bleed by channeling light from one place to another. Flexible light pipes, like some rigid light pipes, refractively propagate light, moving it from one end of the fiber to the other.

Flush mounting a light pipe assembly to a Printed Circuit Board (PCB) prevents LED light from bleeding into the outside environment. A light pipe also improves LED output efficiency, enabling designers to squeeze a bit more in energy savings at the LED as the light source is focused on the lens for maximum brightness.

Bivar invented the flexible light pipe and holds US patents on the technology. Bivar's flexible series of light pipes consist of an LED light source (built-in or standalone), an adapter, Plastic Optical Fiber (POF), and a flat or domed lens cap. A proprietary process bonds the POF to the lens cap. Bivar's Zero Light Bleed (ZLB) SZ series is offered as an assembly so parts don't need to be size-matched or assembled before installation and assures uniformity from one flexible light pipe to another.

The Advantages of Flexible Light Pipes

Flexible light pipes make it easy to add additional indicators or replace a damaged assembly because the LED itself can be placed anywhere within 330 feet (in Bivar SZ series assembly). The light pipe and lens need far less room near the panel face in a repair. If a human factors engineer finds another indicator is necessary and space is an issue, a large redesign can be avoided by adding the indicator with a flexible ZLB. The coupling of design time and design space radically improve cost concerns in a variety of industries and applications. Five different colors of POF jackets improve installation and visual identification in the field by technicians, as well as clarify references in user manuals.

Power Savings and Noise Immunity

Sometimes a designer must look for every bit of power that can be saved. A flexible light pipe can eliminate the need for a more powerful LED driver to accommodate long distances, improving efficiency in power use and mounting in tight conditions. ZLB flex pipes do not introduce signal transmission noise or Electrostatic Discharge (ESD) and are immune to any electrical noise through which an indication signal must travel.

It is important to note that not all light pipes are created equal. Some offer "light protection," which does not eliminate light bleed like Bivar's ZLB pipes. The SZ series of ZLB flexible light pipes can also withstand high levels of vibration (as an option) making it ideal for harsh conditions.

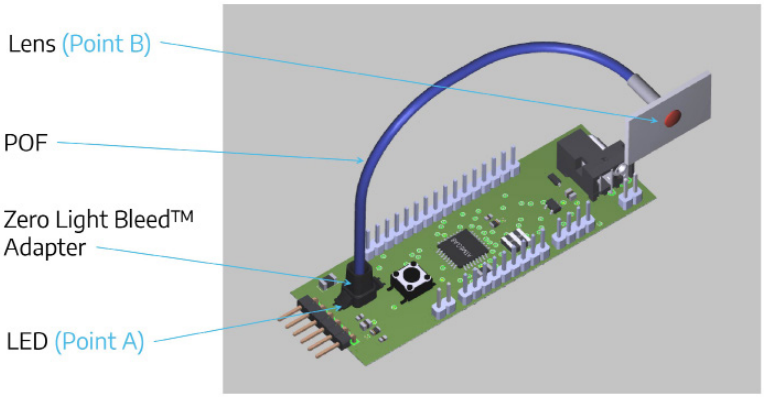

Figure 2: A flexible light pipe transmits light from point A to point B, up to 330 feet away. Bivar's bonding process for joining the POF to the LED lens cap provides greater durability. Bivar board mounting light pipes are available in 1mm and 2mm diameters.

As attractive as LED light pipes might be, they can also be confusing to order if you have to order separate components. Size-matching the LED, lens, and the fiber pipe would be tedious, so Bivar light pipes are offered as a complete assembly. A complete assembly avoids confusion in both ordering and any painstaking assembly during installation. The Bivar SZ series of flexible ZLB pipes offers the option to order a complete assembly over a wide range of options for the type of lens, fiber color, length, and whether the LED is included or used with another LED to accommodate existing designs.

Just How Flexible Can a Light Pipe Be?

Bivar's flexible light pipes can bend to a radius that is 10 times the diameter of the light pipe. For example, a 2mm diameter light pipe has a bend radius of 20mm. Bivar's flexible light pipes are made of POF which consists of three layers: fiber core, fiber cladding, and a fiber jacket.