SideLight Cable
Applications notes

How far can you go?
The most common question asked about SideLight cable is, "How far can the light be transmitted?" For side-lighting applications, the loss percentage of a given fiber remains the same along the length of the run, but the light inside the fiber decreases along the way (due to emission and internal losses). Human factors testing shows that a two-to one ratio of luminous intensity creates a perceived brightness difference. Thus, the total proportion of light lost along the fiber should not exceed 50%. At 20-30 ft the luminosity of the light guide is generally about half that at the start, producing a perceptible difference. This rule of perception holds no matter how much light you pump into the light guide; i.e., the ratio of light is independent of lumen input. Half as bright is equally noticeable whether you begin with 100 lumens or 1,000 lumens.

To extend a run over a longer distance, look for a light guide with a lower loss rate. Another solution is to cap the distant end of the fiber with a small reflector. “Looped runs”, where both ends of the light guide are drive by the same or separate Light Engines, can often double the recommended run length.

End-light cable applications act completely the opposite. Increasing the amount of light input to the light guide will proportionately increase the output at the end. Micro-cracks and impurities in glass and plastic can scatter light, increasing side-lighting losses, or even absorb light.

Color attenuation
In the visible spectrum, solid-core fibers attenuate shorter wavelengths (blues) faster than longer wavelengths (reds), so at the end of a certain length run, a larger proportion of longer wavelengths will remain. The end result after a very long run is that the fiber itself and the light it emits appear yellow. As "white" light passes through a material, the wavelengths, or colors, will spread, as in a prism.

Consequently, attenuation per foot (or meter) is higher for certain wavelengths, with the color shift becoming increasingly apparent over the length of a run. The result can be an unpleasant yellow- or green-tinged output, which is particularly problematic in end-light applications. Absorption and spreading characteristics are dependent upon the chemical composition and quality of the light guide material and vary greatly among the different optical fibers on the market. When white light is desired, the maximum recommended run is 20-30 ft.

The color of the light out of the light guide, of course, depends on the color of the light into the light guide. With a correlated color temperature of 3000-3200 degrees Kelvin (K), it is virtually impossible to make a halogen-driven remote source lighting system look bluish-white. Metal halide lamps at 4000 or 5600 degrees K are much more likely to achieve that effect. Conversely, a halogen lamp system is better at producing reds.

UV and IR
Infrared wavelengths from incandescent lamp Light Engines should be properly filtered, as both UV and IR wavelengths are almost immediately absorbed into the core of the light guide. Visible light can also create excessive heat if it's not transmitted efficiently.
Bend radius
The recommended bend radius is commonly 8 times the optical core diameter. This radius can retain up to 90% of straight-line transmission without color change. Making looser turns than the recommended minimum will result in smoother light flow and brighter end lighting. The minimum bend radius is 4 times the core diameter, which will cause a significant light loss but will prevent cracking.

If a fiber is bent too sharply, losses will increase because more light will strike the core-cladding interface at angles larger than the critical angle. Tiny cracks may appear at the bend, or worse, the fiber could break causing substantial light loss.

SideLight Cable - Solid-Core, Plastic Fiber
CML’s SideLight Cable offers improved optical clarity and durability to ensure optimal light transmission over the long-term. Moisture resistance prevents whitening during long-term water submersion. Greater flexibility inhibits hardening and possible breakage over time. SideLight Cable accommodates easy routing and cutting in the field. The greatest advantage is efficiency - SideLight Cables do not require bundling, which eliminates the light wasted into dead spaces between smaller fibers.

Solid-core polymer fibers are available in several diameters from CML. For side lighting, the monofilament light guide is clad in PTFE, and then sometimes sheathed in a flexible translucent jacket for protection against abuse, exposure to ultraviolet light, and moisture. End-lighting fibers may use also have an opaque sheath, usually polyethylene.

Both types have numerical apertures of 0.6 to 0.66. Solid-core fibers have light losses as low as 2% per foot (approximately 6% per meter), in some cases slightly higher for smaller-diameter fibers. To avoid a perceptible brightness difference in side-lighting applications the maximum recommended run is 20-30 ft. If the fiber is looped, or double-ended, runs can double that length. Underwater lighting requires even shorter runs, usually 15 ft (single-end lighted), for good brightness.

SideLight Cable
CML sells the unique SIDELIGHT CABLE Light Emitting Fiber specifically for side-lighting applications. Ordinarily, shorter runs of 15 ft (single-ended) are recommended. The law of diminishing returns is illustrated well by SIDELIGHT CABLE. A higher rate of losses reduces the possible run length.

If you inject, 100 lumens (lm) into a fiber with 2% losses per foot, the fiber will be transmitting only 98 lm after the first foot (100’0 x .98), 96 lm after the second foot (98 x 0.98), 94 lumens after the third foot (96 x 0.98), etc. At the end of 5 ft, the light guide will have lost only 10% of its lumens; therefore the 2% side lighting being emitted will be proportionately 10% less than at the beginning. Now inject that same 100 lm into a theoretical ultra-bright side-lighting light guide losing a consistent 15% per foot. After 5 ft, the luminance of the fiber will be well below 50% of the luminance at the beginning, a noticeable difference.

Environmental properties and limitations
For maximum performance, UV light below 400 nm and IR above 700 nm should be filtered out before the light enters the fiber (not an issue if an LED Light Engine is used). Because polymers stiffen and become more brittle at lower temperatures, installing cable should not be done when ambient temperatures drop below 1 degree C. In addition, the interface temperature inside the Light Engine should not exceed 85 degrees C.
Plastic optical fibers, in general, are less durable than glass. Some competitor’s brands of plastic fibers may yellow over time, affecting the color characteristics of the transmitted light. These fibers may become fairly brittle after a number of years and may break if flexed.

Applications
Solid-core plastic is particularly suited to smooth side-lighting applications, due to its relatively high losses and efficiency in accepting light at the harness face. Because it is not stranded, the applicability of solid-core fiber is less flexible, but offers unobstructed, efficient side lighting.

Because of their remote sources and light guide flexibility, fiber-optic lighting systems run the gamut of application possibilities:
- Low-profile accent and task lighting
- Step lights
- Landscape lighting
- Aquarium, fountain, pool, and spa lighting
- Hazardous environments
- Architectural cove lighting
- Museums
- Hospitals
- Retail display cases
- Refrigerated and frozen food cases
- Path of egress
- Medical and dental lighting
- Edge-lighting for etched glass and acrylic, signs or art glass
- Highway and road signs
- Industrial and clean room lighting
- Automotive and aviation vehicles
- Advertising signage
- Glass block

Sidelight Brightness
Unfortunately, there is no reliable way to calculate the numerical brightness of side-lighting fiber. Though losses are given, there is little published data on what percentage is absorbed and what is transmitted out the side. In an average side-lighting light guide, 2% losses per foot can be portioned into approximately 1.75% emitted luminance and 0.25% absorbed.

Recommended run lengths are based on rules of thumb.

Double-ended runs
Side-lighting fiber has an advantage over end-lit in that runs can be looped. That is, both ends of a light guide can be inserted into a Light Engine. Or even better, two illuminators feed the light guide at each end. Ultimately, illuminators can be daisy-chained, performing well with only small interruptions over long distances. To achieve maximum sidelight brightness, double-ended runs should be kept very short. Because the illuminators reinforce each other, the fiber can be run to the point where, if single-ended the side lighting would be weak and the light stream inside the light guide virtually depleted. At the midpoint of the light guide, the confluence of the opposite light streams produces sidelight equal to that emitted at the ends. If properly configured, the result is even brightness along the entire length.
Operating and Maintenance Budget

Often the best selling point for a remote source system is long-term cost. By valuating with an appropriate remote source lighting system up against a traditional electric lighting scheme -equipment and installation costs, typical energy usage, re-lamping and other maintenance cost -often the remote source system can prove to pay for itself. The line-by-line breakout of capital and operating expenses can be formulated to give a simple payback: the time it will take for the ongoing savings to pay back the higher initial cost. Only through long-term cost analysis can the truly economical alternative be determined. Several examples of simple payback calculations are included.

Cutting and Terminating Fiber

Connecting the fibers to the illuminator is a critical process. If not done correctly, poor transmission of light into the fiber will result. Proper cutting tools must be used to make clean perpendicular cuts on the ends of plastic fibers. PTFE-coated razor blades are recommended for cutting and stripping solid-core fiber, and PTFE spray can be helpful. Termination kits for solid-core fiber are required for termination.

Solid-core fibers

When porting solid-core light guides into a CML Light Engine, first cut the fiber to the desired length and then re-cut each end of the fiber using the proper diameter hole in the fiber-optic cutter. The termination process is critical and needs to be precise. Polishing plastic fibers is not recommended. With the fiber faces flush with the end of the harness, tighten the compression ring to secure the fibers in place.

Installing Fibers

Fiber is generally pulled from the fixture or mounting position toward the Light Engine. The face of the fiber to be harnessed into the Light Engine needs to be treated with care. It must be protected from dust, dirt, moisture, and damage on the job site. It is a good idea to allow 2 ft or more extra fiber in a service loop if an end is damaged and needs to be re-terminated.

Sidelight fibers

Because side-lighting fibers are visually exposed, careful mounting will lead to an attractive, efficient installation. Straight lines are virtually impossible to achieve without tracking. Corners must be taken broadly to prevent a noticeable increase in brightness there. The simplest mounting devices are clear P-clips that encircle the fiber and then are screwed in firmly, flush against the wall. With flexible U-channel tracking, the fiber simply snaps in and stays in place (at times glue or silicone is recommended). The contractor drives the mounting screws right through the plastic. Standoff mountings hold the fiber away from the surface, like neon, for maximum exposure. Standoffs are used more for curved runs with swirled or irregular shapes.
Specifications:
- Temperature range: 0 degrees C to 85 degrees C
- Flammability: flame resistant (PTFE jacket)
- Bend radius: 6x to 8x the diameter
- Cable runs
  - 2% side light cable:
    - 30 ft / 9 m single end light, 50 ft / 15 m double end light (~ 50% light reduction)
  - 15% side light cable:
    - 6 ft / 2 m single end, 12 ft / 3 m (~ 50% light reduction)
  - 1% end light cable
    - 50 ft / 15 m (~ 50% light reduction)

Light Engines / Drivers:
LEDs -
- Single Color LEDs
  - RED
  - Green
  - Blue
  - Yellow
  - White
- Multiple LED colors
  - Red/Green/Blue
  - Red/Cyan
  - Blue/Yellow
  - Red/Green
  - Custom upon request

Incandescent Lamps –
- Metal Halide
- Xenon

Applications:
- Museum and art display cases
- Point of Sale displays
- Architectural lighting
- Stair and pathway lighting
- Decorative Lighting
- Automotive interior accent lighting
- Commercial / Hospital night lights
- Casino / Gaming accent lights
- Refrigerated display cases
- Solar light conduit for interior illumination
EndLight Cable available with white or black PVC Poly Jacket.

Clear PTFE outer layer standard

Super SideLight Cable