allows the connector module to be angled through the front panel at an angle other than a 90 degree angle (i.e., perpendicular). A 90 degree angle decreases a density of connector modules that can be mounted on a given circuit board, increases manufacturing and repair costs of the devices, and decreases overall functionality.

[0018] An example embodiment of the present invention is an apparatus and corresponding method for providing optical indications about a state of a circuit on a circuit board. A connector component is positioned at a non-perpendicular first angle relative to an edge of the circuit board and configured to accept a mating component. The example apparatus includes an optical light transmission element with at least three mounting features. The mounting features allow the transmission element to be secured to the circuit board at a straight or angled position relative to the connector component. The transmission element further includes a light-receiving end that accepts light projected by an optical light-generating device, such as a light-emitting diode (LED). The light-generating device itself is configured to illuminate as a function of a state of a circuit. The light transmission element also includes a light propagation region configured to support propagation of the light for a given length. The transmission element also has a light-emitting end to output the light at a location near where the connector component accepts the mating component. The light is outputted at a second angle relative to the edge of the circuit board, the second angle being different from the first angle of the connector component relative to the edge of the circuit board. The light-emitting end thereby associates the light output by the transmission element with the state of the circuit on the circuit board associated with the connector component.

[0019] The mounting features may be configured to be press-fitted into the circuit board, which allows the light-receiving end to be positioned above a surface-mounted LED, for example. The LED may be a multi-colored LED.

[0020] The light propagation region may include at least one geometric structure supporting propagation of the light. Further, there may be multiple geometric structures configured to be parallel to each other with at least one support connecting the parallel geometric structures to provide structural stiffness of the geometric structure. The geometric structure(s) may cause the light to be redirected along a path substantially offset from, and along, a longitudinal axis of a surface plane of the circuit board. The light propagation region may be constructed of clear plastic.

[0021] The connector component may include a standard Small Form-Factor Pluggable (SFP) cage. The SFP cage may be mounted to the circuit board. In order to increase the density connector components on the circuit board, the SFP cage may be arranged in angled rows with transceiver module cages plugged into the receptacle SFP cages.

[0022] The light-emitting end may include a textured surface through which the light is outputted to ensure visibility from a broad range of viewing angles. The light-emitting end may be configured to output light through a front panel housing the circuit board. The outputted light may provide optical indications of the state of the circuit connected to the SFP cage as a function of light generated by the LED.

[0023] The light transmission element may be attached to the circuit board without modification. An example embodiment of the invention includes a single-piece structure that eliminates need for a separate clip, increases stability, reduces costs, and permits increased transceiver module connector density compared to conventional light guides.

[0024] FIG. **1** is a diagram of an apparatus including an electronics rack **100**, such as a network system with multiple shelves of circuit boards **105**, utilizing an example embodiment of the present invention. For purposes of describing the electronics rack **100** in a context of a network, the electronics rack **100** may interchangeably be referred to herein as a network system **100** or network interface. The network system **100** includes the circuit boards **105**, fiber optic cables **107** connected to circuit board connectors **108** to establish network connections, and power supplies **110**. The network system **100** further includes light-emitting ends **115** of optical light transmission elements (not shown) adjacent to front panels **118** of the circuit boards **105**. The light-emitting ends **115** output LED-emitted light **116**, thereby indicating the state of a fiber optic interface circuit (not shown) established inside the network system **100**. In this example embodiment, the light-emitting ends **115** are more stably aligned or angled with the front panel as compared to conventional methods understood in the art. Furthermore, in the example embodiment, the fiber optic cables **107** can be integrated into the circuit boards **105** at a greater density compared to the conventional methods understood in the art because of the angle of the circuit board connectors.

[0025] FIG. **2** is a mechanical diagram of a circuit board assembly **200** within the network system **100** of FIG. **1**. In the example embodiment of FIG. **2**, the circuit board assembly **200** may include a circuit board **220**. Connector components **212** protrude through a front panel **202** of the network system. The connector components **212** accept mating components of fiber optic cables, for example a state of a circuit responsive to the connection is relayed to respective LEDs positioned behind the connector components **212**. The connector components **212** in this example embodiment can be positioned at a non-perpendicular first angle **208** such that available surface area is maximized for the placement of additional connector components and, secondarily, for strain relief purposes to reduce bending on the cables plugged into the connector components **212**. The optical light transmission elements **215** may be positioned above the LEDs and behind the connector components. In this position, the light transmission elements may redirect light emitted by the LED to a location outside the circuit board assembly **200** near the connector components **208** positions on the front panel **202**.

[0026] The optical light transmission elements **215** may include at least three mounting features to secure it soundly to a circuit board for ease of assembly with a front panel. Assembly through a front panel is facilitated by maintaining the ends of multiple light transmission elements **215** in alignment relative to each other. Enhanced stability allows multiple light guides to be packaged in closer proximity and presented at an angle. The example embodiment reduces the cost of assembling electronic equipment and further permits a reduction in size of the equipment. The optical light transmission elements **215** are mechanically independent from connector components **312**.

[0027] FIG. **3**A is a close-up view of a mechanical diagram of a circuit board assembly **300** with SFP cage connector components **312** positioned at a non-perpendicular first angle relative to an edge **306** of the circuit board **320** and protruding through a front panel **302** of the circuit board assembly **300**. In this example embodiment, optical light transmission elements **315** may be defined by positioning at a second angle