**Light emitting module for use in configurable large-screen display application**

A light emitting module comprises a casing (18) made of light transmitting material, said casing (18) having two ends, an axis of symmetry going through said ends, and an axial hole-through (28) along said axis of symmetry; a printed circuit board (30) mounted in casing (18); at least one light emitting element (32) mounted in casing (18); a control circuitry (34) disposed on and electrically connected to printed circuit board (30); two end covers (24, 26) removably attached to the ends of casing (18) for closing casing (18); two connectors (20, 22) electrically connected to printed circuit board (30), said printed circuit board (30) is mounted substantially along said axis of symmetry, said light emitting element (32) is disposed on and electrically connected to printed circuit board (30), said connectors (20, 22) are connected to opposite ends of printed circuit board (30). A string assembly of "daisy-chained" light emitting modules and a display comprising a plurality of string assemblies are provided.

**Fig. 5**
Description

TECHNICAL FIELD OF INVENTION

[0001] The present invention relates to a light emitting module for use in a configurable modular display, particularly to a light emitting module for large-screen display applications, and more particularly to such light emitting module that incorporate, light emitting diodes (LEDs) as a light source.

BACKGROUND OF INVENTION

[0002] The full-color LED displays have been widely used for displaying pictures and information in sports fields, recreation grounds, in outdoor and indoor advertisements, and in area of events and shows. The present invention is particularly to a light emitting module for large-scale displays, but also for more complex three-dimensional displays, especially for stage and architectural applications.

[0003] An example of a LED pixel module that is used to display a pixel on a large-scale display is described in U.S. patent 5,410,328 to Yokesza et al., entitled "Replaceable intelligent pixel module for large-scale LED displays." This patent describes an apparatus that is a detachable LED module which is used to display a pixel on a display. A plurality of LEDs along with a processor with input and output capabilities are contained within the LED module. The input and output capabilities of the processors allow modules to be "daisy-chained" together with data intended for a single module to be passed through a succession of modules.

[0004] Although the apparatus of U.S. patent 5,410,328 is capable of use in a configurable modular display, this apparatus emits lights in one direction only.

[0005] Another prior art is a plastic-encased LED spherical module called "MISPHERE" from Barco Media and Entertainment of Belgium. A MISpHERE consists of four full-color high performance LEDs that reside inside an opaque, light-defusing capsule. This module has 360-degree viewing angles and ability to play both full video and data. Individual MISpHERES are "daisy-chained" into a string, with several strings in turn forming a 3-D visualization curtain.

[0006] Barco brochure does not disclose internal construction of MISpHERE, however, its light emission is not even, it is clearly seen that the surface of a diffusive bulb has shadows caused by mechanical construction. It is also quite large in size and weight. The diameter of one module is 60 mm and the weight is 142 g.

[0007] U.S. patent 6,536,915 to Chang discloses a lamp string comprising a plurality of serially connected lamp units having a 360-degree illumination effect. Each lamp unit comprises a casing having two ends, two base plates respectively mounted in two ends of the casing, an illuminating member mounted in the casing between the base plates, two end covers removably attached to the ends of the casing for closing the casing, a wire electrically connected to the illuminating member, and electric elements for controlling the lighting effect placed on one of the base plates.

[0008] A lamp described in U.S. patent 6,536,915 with two printed circuit boards and a light emitting source between the circuit boards has too complex and, therefore, unreliable and difficult to assemble construction. Further this patent does not mention the use of LED in the illuminating member.

[0009] An object of the present invention is to provide a light emitting module with a 360-degree viewable angle for large-scale display applications which is relatively simple in structure and, therefore, easily to assemble and relatively small, light and reliable. It is a further object of the invention to provide a module that is uniformly illuminated and emits lights of different colors.

[0010] Further objects and advantages of the present invention will become apparent from consideration of the drawings and ensuing description.

SUMMARY OF INVENTION

[0011] In accordance with still further aspects of the present invention a light emitting module comprises a casing made of light transmitting material, said casing having two ends, an axis of symmetry going through said ends, and an axial hole-through along said axis of symmetry, a printed circuit board mounted in said casing, at least one light emitting element mounted in said casing, a control circuitry disposed on and electrically connected to said printed circuit board (PCB), two end covers removably attached to the ends of said casing for closing said casing, two connectors electrically connected to said printed circuit board, characterized in that said printed circuit board is mounted substantially along said axis of symmetry, said light emitting element is disposed on and electrically connected to said printed circuit board, said connectors are connected to opposite ends of said printed circuit board.

[0012] In accordance with still further aspects of the present invention a light emitting module has a substantially spherical or ball-shaped casing made of light diffusing material and having a drilled hole-through, wherein the hole-through, preferably, has a screw thread inside to hold said end covers having corresponding screw thread.

[0013] In accordance with still further aspects of the present invention said light emitting element comprises light emitting diodes (LEDs) of three primary colors or RGB type, these LEDs are of surface mounted type and are side-view LEDs which emit lights substantially in the direction parallel to the LED mounting surface.

[0014] In accordance with still further aspects of the present invention said plurality of light emitting modules are
assembled into light emitting assemblies or strings and these strings are assembled into a large-screen display.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] Fig. 1 is a perspective view of a light emitting module of the present invention.

Fig. 2 is a perspective view of a light emitting module without a casing.

Fig. 3 is a perspective exploded view of a light emitting module.

Fig. 4 is an enlarged section view of an end cover comprising a cable gland.

Fig. 5 is a perspective view of a semi-assembled module with PCB not installed into casing.

Fig. 6a is a sectional view of a casing.

Fig. 6b is a pole perspective view of a casing.

Fig. 7 is a perspective view of a PCB with mounted light emitting elements and a control circuitry.

Fig. 8 is a circuit diagram of a module.

Fig. 9a is a perspective view of an alternative embodiment with one cable connector and one socket connector.

Fig. 9b is a perspective view of a semi-assembled module with one cable connector and one socket connector.

Fig. 10 is a perspective view of an embodiment with additional male socket on one of the connectors.

Fig. 11a shows an embodiment with alternative constructions of PCB.

Fig. 11b shows another embodiments with alternative constructions of PCB.

Fig. 12 shows a string assembly.

Fig. 13 shows a display.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENT

[0017] A preferred embodiment of the light emitting module of the present invention is illustrated in Fig. 1 showing perspective view of the module, Fig. 2 showing perspective view without a casing and Fig. 3 showing perspective exploded view. Further details of the preferred embodiments are illustrated in Fig. 4 showing section view of an end cover, Fig. 5 showing a semi-assembled module, Fig. 6a (perspective view) and Fig. 6b (sectional view) showing a bulb casing, Fig. 7 showing perspective view of a PCB with light emitting elements and a control circuitry mounted on it, and Fig. 8 showing a circuit diagram of the preferred embodiment.

End covers and connectors; cable glands

[0019] As shown in Fig. 4, an end cover 24 (26) comprises a cable gland to removably attach cover 24 (26) to connector 20 (22). An end cover 24 (26) also has a threaded part 40 to removably attach it to casing 18 by screwing it into axial hole 28 having corresponding inside thread.

[0020] Referring to Fig. 5, the module is assembled in the following way: first connector 20 is passed through first end cover 24 and is soldered to printed circuit board 30; then circuit board 30 together with first connector 20 is passed through casing 18, second connector 22 is passed through second end cover 26 and is soldered to printed circuit board 30; after that first end cover 24 is screwed into casing 18, the printed circuit board together with soldered to it connector 20 is moved into predetermined position inside casing 18 and end cover 24 is fixed on first connector 20 by tightening a cable gland; finally, the second end cover 26 is screwed into casing 18 and fixed on second connector 22 by tightening a cable gland.

[0021] Those having ordinary skill in the art will appreciate that although in the preferred embodiment the first and second end covers 24, 26 are attached to connectors 20, 22 preferably by means of cable glands, the invention is not so limited, and that end covers may be attached to connectors by any other means known in the art, for example, by latch, elastic insert, or the like. Alternatively, an end cover and a connector may be made as one inseparable unit, for example, in one of the embodiments an end cover may be a female socket soldered to PCB 30 and screwed in into casing 18.

[0022] In the preferred embodiment end covers 24, 26 are removably attached to casing 18 by means of a screw thread. However, those having ordinary skill in the art will appreciate that the invention is not so limited, and that the covers may be attached to casing 18 by any other means known in the art, for example, by friction, by latch, by bayonet connection, or the like. Preferably, end cover 24, 26 is disposed partially in hole 28, a part of end cover 24, 26 is relatively tight inserted into the casing 18 and fixed inside hole 28 thus enhancing mechanical strength.
of the connection.

Casing

[0023] Fig. 6a (perspective view) and Fig. 6b (sectional view) show a casing 18 of the preferred embodiment.

[0024] Casing 18 has two ends or poles, an axis of symmetry going through these poles and an axial hole 28 going along this axis from one pole to the other.

[0025] In the preferred embodiment, casing 18 is of a substantially spherical shape, however, the invention is not so limited and the casing of any other substantially axially symmetrical shape may be used, for example, the casing may comprise an elliptical shape, a lenticular shape, a convex shape, a concave shape, a conical shape, a hyperbolic shape, a parabolic shape, in addition to any other shapes known in the art.

[0026] In the preferred embodiment, casing 18 is made from monolith spherical piece of light diffusing material, for example, opaline acryl ("Diffuser opal #432") from Sing Mas Enterprise of Taiwan. Hole-through 28, preferably is drilled through the monolith material of casing 18. However, those having ordinary skill in the art will appreciate that the invention is not so limited, and that other materials and methods of manufacture may be used.

[0027] Preferably, casing 18 has an antiglare matt finished surface or has an antiglare covering to avoid reflection of ambient light from the surface of casing 18.

[0028] The hole 28 further comprises thread 38 on its inside surface. Preferably, the thread has a step from 1 to 3 mm, in the preferred embodiment the step is 1.6 mm. The thread is used as a light dispersing or light refracting surface to enhance the uniform 360-degree illumination effect. The same thread is also used to hold two cable glands or end covers 24, 26. Alternatively, the internal surface of hole 28 may comprise a wavy surface, a triangular surface, or any other surface to additionally disperse lights emitted by light emitting element 32.

PCB

[0029] Fig. 7 shows PCB 30 together with two light emitting elements 32 disposed on and electrically connected to the PCB 30 and control circuitry 34 disposed on and electrically connected to the PCB 30.

[0030] In the preferred embodiments PCB 30 is a flat substantially rectangular printed circuit board, made from monolith piece of fiberglass material, preferably of FR4 type.

[0031] As shown in Fig. 7, PCB 30 has contacts or solder pads 46 to which connectors 20, 22 (not shown) are connected, preferably by soldering. Preferably, PCB 30 also comprises at least one opening 36, a size of the opening is large enough to enable lights emitted from a light emitting element 32 disposed on one planar surface of the PCB 30 to illuminate through the opening 36 the opposite inner side of the casing 18 to enhance the uniform 360-degree illumination effect. Additional advantage of opening 36 is that the module comprising only one light emitting element 32 may enable a 360-degree viewable angle. To improve the uniformity of module illumination the PCB 30 may have a reflective covering.

[0032] The width of remaining parts 31 of printed circuit board 30 is sufficient to provide current flow for the transmission of the necessary data and power signals for the plurality of “daisy-chained” light emitting modules, but remains relatively thin to impede a minimum amount of light emitting from light emitting elements 32.

Control circuitry

[0033] Fig. 8 illustrates the circuit or electrical schematic diagram of a light emitting module of the preferred embodiment. Electrical schematic diagram shows a voltage converter 56, a controlling driver 54, a current setting resistors 50, voltage drop resistors 52, and LEDs 51. All elements with the exception of input and output connectors are disposed on and electrically connected to the printed circuit board 30. Voltage converter 56 transforms 15V DC power to 5V DC power, and 5V DC power is then delivered to controlling driver 54.

[0034] Controlling driver 54 is an integrated microprocessor and constant current source device such as, for example, DM412 from Silicon Touch Technology of Taiwan.

[0035] Controlling driver manages and distributes video data by receiving and parsing the DAI and CKI signals and facilitates the process of identifying the portion of the signal that belongs to its physical portion of the larger display system. Controlling driver 54 manages the pulse width modulation associated with driving light emitting diodes 51 and supplying a constant current, typically in the range of 5 to 50 mA, to the LEDs.

[0036] Constant current, supplied to light emitting diodes 51 by the controlling driver 54, is set up using current setting resistors 50.

[0037] Light emitting diodes 51 of the same color are connected in sequence to each other and sequentially with voltage drop resistors 52.

[0038] Those having ordinary skill in the art will appreciate that the electrical configuration of the preferred embodiment is only an example and other configurations are possible.

Light emitting elements

[0039] Preferably, light emitting elements 32 comprise light emitting diodes (LEDs) 51, more preferably three color RGB LEDs in a single package, still more preferably of surface mounting type. It is advantageous to use side-emitting type LEDs, for example, NSMM038AT manufactured by Nichia of Japan.

[0040] Preferably, LEDs are disposed at the positions in close vicinity to the end of the casing 18 and emit lights towards the inside of the casing 18 to enhance the uniform 360-degree illumination effect. It is further advanta-
gerous to locate earlier-mentioned opening 36 in the PCB 30 in close vicinity to the light emitting side of the LEDs.

[0041] Those having ordinary skill in the art will appreciate that, although, the preferred embodiment disclosed herein is only shown with two light emitting elements 32 disposed on and electrically connected to the PCB 30, the invention is not so limited. In other embodiments only one light emitting element or multiple light emitting elements may be used.

Connectors

[0042] In the preferred embodiment, each of connectors 20, 22 has four copper conductors, the connectors deliver power via two conductors and data and/or control signals via other two conductors. Preferably, the conductors are connected directly to the printed circuit board 30 via solder pads 46. Those having ordinary skill in the art will appreciate that other configuration is possible, for example, connectors may have three conductors, one for power, one for data and control signals and one common conductor, or connectors may have six conductors - one pair for power, one pair for data and one pair for control signals, etc.

[0043] Additional embodiments are shown in Figs. 9, 10, and 11.

[0044] In Fig. 9a (perspective view) and Fig. 9b (semi-assembled view) a light emitting module 16 has first end cover 24 with cable connector 20 and second end cover 44 with female socket connector made as an integral part of the cover. In the light emitting module shown in Fig. 10 cable connector 20 further has an additional male socket 45 complimentary to the female socket in the opposite end cover, thus allowing to easily connect one module to another and to connect plurality of modules 16 in a "daisy-chained" string.

[0045] In Fig. 11a printed circuit board 30a has two light emitting elements 32 disposed on each planar surface and has no openings. In Fig. 11b printed circuit board 30b has four light emitting elements 32 disposed on each planar surface.

[0046] There are various possibilities with regard to the combination of different connectors and with regard to the number and relative disposition of the light emitting elements, thus, the scope of the invention should not be limited by the examples given.

[0047] In Fig. 12 light emitting string assembly 62 comprising a plurality of light emitting modules 16 is shown. Modules 16 are "daisy-chained" together into a string assembly 62 with data intended for a single module to be passed through a succession of modules. Such string assembly may be used as a separate lightening device producing various lightening effects or a plurality of string assemblies may be further combined to form a large-screen video display.

[0048] Fig. 13 illustrates a practical application of light emitting modules of the present invention in such large-screen video display assembled of a plurality of string assemblies 62. A plurality of sequential strings 62 of light emitting modules 16 are connected to the bottom of control unit 66 suspended on conventional truss 68.

[0049] Thus, the present invention provides a light emitting module with a 360-degree viewable angle for large-scale display applications which is relatively simple in structure and, therefore, easily to assemble and relatively small, light and reliable. Also the provided light emitting module is uniformly illuminated and emits lights of different colors.

[0050] The present invention is in no way limited to the form of the embodiments described by way of example and represented in the figures; however, such light emitting module for use in a configurable large-screen display application, as well as such string assembly and display can be realized in various forms without leaving the scope of the invention.

Claims

1. A light emitting module comprising:
   a casing (18) made of light transmitting material, said casing (18) having two ends, an axis of symmetry going through said ends, and an axial hole-through (28) along said axis of symmetry; a printed circuit board (30) mounted in said casing (18);
   at least one light emitting element (32) mounted in said casing (18);
   a control circuitry (34) disposed on and electrically connected to said printed circuit board (30);
   two end covers (24, 26) removably attached to said casing (18) for closing said casing (18);
   two connectors (20, 22) electrically connected to said printed circuit board (30), characterized in that said printed circuit board (30) is mounted substantially along said axis of symmetry, said light emitting element (32) is disposed on and electrically connected to said printed circuit board (30), said connectors (20, 22) are connected to opposite ends of said printed circuit board (30).

2. A light emitting module of claim 1, characterized in that said casing (18) has a substantially spherical shape.

3. A light emitting module of claim 1, characterized in that said casing (18) is made of light diffusing material.

4. A light emitting module of claim 1, characterized in that said axial hole-through (28) is a drilled hole.

5. A light emitting module of claim 1, characterized in
that at least part of said hole-through (28) has a screw thread inside and said end covers (24, 26) have corresponding outside thread.

6. A light emitting module of claim 1, characterized in that said light emitting element (32) comprises a light emitting diode.

7. A light emitting module of claim 1, characterized in that said light emitting element (32) comprises light emitting diodes of three primary colors.

8. A light emitting module of claim 6 or 7, characterized in that said light emitting diode is of surface mounting type.

9. A light emitting module of claim 6, 7 or 8, characterized in that said light emitting diode is of side-view type.

10. A light emitting module of claim 1, characterized in that said light emitting element (32) emits lights substantially towards the center of the casing (18).

11. A light emitting module of claim 1, characterized in that said printed circuit board (30) has an opening (36) large enough to enable lights emitted from a light emitting element (32) disposed on one planar surface of said printed circuit board (30) to illuminate through the opening (36) the opposite inner side of the casing (18).

12. A light emitting module of claim 1, characterized in that said light emitting element (32) is disposed near an edge of the opening (36) and emits lights towards said opening (36).

13. A light emitting module of claim 1, characterized in that said printed circuit board (30) has a reflective covering.

14. A light emitting module of claim 1, characterized in that at least one of said end covers (24, 26) comprises a cable gland removably attached to said connector (20, 22).

15. A light emitting module of claim 1, characterized in that said end covers (24, 26) are partly disposed inside said axial hole-through (28).

16. A light emitting assembly comprising a plurality of "daisy-chained" light emitting modules (16) of claim 1.

17. A display comprising a plurality of light emitting assemblies (62) of claim 16.
Fig. 11a

Fig. 11b
### DOCUMENTS CONSIDERED TO BE RELEVANT

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<tr>
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The present search report has been drawn up for all claims

Munich  5 February 2008  Chaloupy, Marc

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Date of completion of the search: 5 February 2008
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