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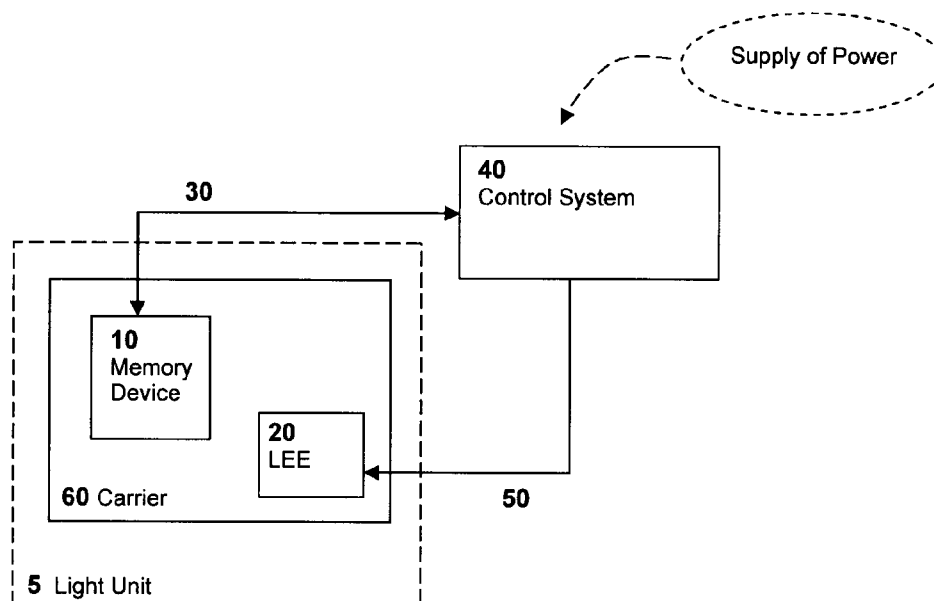
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(54) Title: **LIGHT UNIT**



(57) Abstract: The present invention provides a light unit that is interchangeable within a lighting device. The light unit comprises a carrier to which one or more light-emitting elements are connected. A memory device is further operatively coupled to the carrier, wherein the memory device includes information representative of the operational characteristics of the one or more light-emitting elements associated with the carrier. Upon the operative coupling of the light unit with a lighting device, a control system associated with the lighting device can access the memory device to obtain operational characteristics of the one or more light-emitting elements associated with the carrier. In this manner, the operational characteristics of the light-emitting elements can be immediately available to the control system, without the need for calibration of the lighting device subsequent to the replacement or changing of the light unit with the lighting device.

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LIGHT UNIT

FIELD OF THE INVENTION

[0001] The present invention pertains to the field of lighting and in particular to a light unit designed for ease of replacement within a lighting device.

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BACKGROUND

[0002] Advances in the development and improvements of the luminous flux of light-emitting devices such as solid-state semiconductor and organic light-emitting diodes (LEDs) have made these devices suitable for use in general illumination applications, including architectural, entertainment, and roadway lighting. Light-emitting diodes are becoming increasingly competitive with light sources such as incandescent, fluorescent and high-intensity discharge lamps.

[0003] As is known, LEDs can vary in production. For example, raw light output from a group of LED chips grown on the same wafer manufactured by the same equipment may have as much as about a 3:1 variation in their luminous flux output over the same wafer. This fact gives rise to a binning strategy which is commonly used in the industry, whereby LEDs are individually tested and binned into categories of luminous flux output that represent about 30% intervals. Likewise, forward voltage, dominant wavelength and beam spread may be other factors that are considered during the binning process.

[0004] Furthermore, chromaticity and luminous flux output of LEDs can depend on junction temperature, which can have undesirable effects on the correlated colour temperature (CCT) and more generally the chromaticity of the emitted light. LED junction temperature variations can also cause undesired effects in the spectral power distribution of the resultant output light. Variations in junction temperature not only can reduce the luminous flux output, but can also cause undesirable variations in the CCT of mixed light.

[0005] Based on the inherent emission characteristics of LEDs, a control system associated with a LED based lighting device typically comprises calibration data regarding the LEDs within the lighting device. In this manner the control system is capable of adjusting the operation of the LEDs associated with the lighting device based on their respective predetermined emission characteristics.

[0006] Despite the known extended life expectancy of LEDs, it may be necessary to replace the LEDs in a lighting device. This required replacement may be a result of, for example, failure of an LED, failure of connecting circuitry on a printed circuit board (PCB) carrying the LEDs or other factors as would be readily understood. For example, in a lighting device containing a large number of LEDs, the likelihood of a LED failure increases, and it is typically desirable to replace the failed LED as quickly as possible, in order to correct the potentially resulting undesired changes to the illumination pattern generated by the lighting device. Given the variability in LED output parameters, such as intensity and dominant wavelength, between nominally identical LEDs from the same production batch for example, it is typically desirable to recalibrate a lighting device after every replacement of LEDs. In some lighting devices, particularly those in which the light output from differently coloured LEDs is mixed, the resulting light pattern after replacement of the LEDs can remain incorrect, unbalanced or undesired until the lighting device is recalibrated, which may entail waiting for a service technician.

[0007] United States Patent No. 6,806,659 describes a lighting apparatus comprising a control module and a light module, wherein the light module is interchangeable. The control module comprises a switch, and microcontroller. Memory, which is contained within the microcontroller, is used for storing the level of intensity at which the LED(s) are driven. Therefore, upon replacement of a light module of this lighting apparatus, the control module would require recalibration to account for the emission characteristics of the LEDs associated with the new light module.

[0008] United States Patent No. 6,965,205 discloses a lighting system containing a system memory for controlling a processor, and discloses that the memory may contain calibration data associated with the control signals for driving the LEDs. This memory, however, is configured for use by the system as a whole, and therefore any calibration data relating to a specific LED must be input to the memory in an additional step if a

LED is replaced. Therefore this system requires recalibration after the replacement of one or more LEDs.

[0009] In addition, United States Patent Application Publication No. 2006/0002110 describes lighting units which contain light sources such as LEDs. The lighting units
5 described may also optionally include data storage facilities, which may be used for storing calibration information. The data storage facilities are configured to be accessible by the processors of the lighting units. This configuration of data storage facilities are provided for an entire light system, and therefore upon replacement of one or more light sources, new calibration data is to be input into the data storage facilities
10 for use by the appropriate processor. Therefore this system also requires recalibration after the replacement of one or more light sources.

[0010] Also United States Patent Nos. 6,411,046 and 6,441,558 disclose luminaires in which information for the variation in colour coordinates as a function of temperature are stored in a memory coupled to the control unit. In this configuration of the
15 luminaire, if one or more LEDs are replaced, the recalibration of the luminaire is required, wherein appropriate new calibration information is entered into the memory associated with the control unit.

[0011] Therefore there is a need for a new light unit which can enable ease of replacement and interchangeability of light-emitting elements of a lighting device,
20 without a required recalibration of the lighting device.

[0012] This background information is provided to reveal information believed by the applicant to be of possible relevance to the present invention. No admission is necessarily intended, nor should be construed, that any of the preceding information constitutes prior art against the present invention.

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SUMMARY OF THE INVENTION

[0013] An object of the present invention is to provide a light unit. In accordance with an aspect of the present invention, there is provided a light unit adapted for connection to a lighting device, the lighting device including a control system for controlling activation of one or more light-emitting elements, the control system adapted for

connection to a source of power, the light unit comprising: one or more carriers; one or more light-emitting elements operatively coupled to one or more of the carriers, the one or more light-emitting elements for generating electromagnetic radiation; a memory device operatively coupled to one or more of the carriers, the memory device including
5 information representative of operational characteristics of the one or more light-emitting elements, the memory device adapted for connection to the control system; wherein the control system provides control signals to the one or more light-emitting elements and wherein said control signals are dependent on the operational characteristics.

10 **BRIEF DESCRIPTION OF THE FIGURES**

[0014] Figure 1 illustrates a light unit according to one embodiment of the present invention, wherein the light unit is operatively coupled to a control system of a lighting device.

DETAILED DESCRIPTION OF THE INVENTION

15 *Definitions*

[0015] The term “light-emitting element” is used to define any device that emits radiation in any region or combination of regions of the electromagnetic spectrum for example, the visible region, infrared and/or ultraviolet region, when activated by applying a potential difference across it or passing a current through it, for example.
20 Therefore a light-emitting element can have monochromatic, quasi-monochromatic, polychromatic or broadband spectral emission characteristics. Examples of light-emitting elements include semiconductor, organic, or polymer/polymeric light-emitting diodes, optically pumped phosphor coated light-emitting diodes, optically pumped nanocrystal light-emitting diodes or other similar devices as would be readily understood by a
25 worker skilled in the art.

[0016] As used herein, the term “about” refers to a +/-10% variation from the nominal value. It is to be understood that such a variation is always included in any given value provided herein, whether or not it is specifically referred to.

[0017] Unless defined otherwise, all technical and scientific terms used herein have the same meaning as commonly understood by one of ordinary skill in the art to which this invention belongs.

5 [0018] The present invention provides a light unit that is interchangeable within a lighting device. The light unit comprises a carrier to which one or more light-emitting elements are connected. The light unit further comprises a memory device operatively coupled to the carrier, wherein the memory device includes information representative of the operational characteristics of the one or more light-emitting elements. Upon the operative coupling of the light unit with a lighting device, a control system associated
10 with the lighting device can access the memory device to obtain operational characteristics of the one or more light-emitting elements associated with the carrier. In this manner, the operational characteristics of the light-emitting elements can be immediately available to the control system, without the need for calibration of the lighting device subsequent to the replacement or changing of the light unit with the
15 lighting device.

[0019] Figure 1 illustrates a light unit **5** according to one embodiment of the present invention, wherein the light unit **5** is operatively coupled to the control system of a lighting device. The memory device **10** and the one or more light-emitting elements **20** are mounted on a single carrier **60**. The memory device **10** is configured to carry the
20 operational characteristics of the one or more light-emitting elements **20** mounted on the carrier **60**. The control system **40** of the lighting device to which the light unit **5** is operatively coupled, accesses the memory device in order to extract or write **30** information relating to the operational characteristics of the one or more light-emitting elements **20** or other information on the memory device. In this manner the control
25 system **40** can provide control signals **50** to the one or more light-emitting elements **20** in order that the one or more light emitting elements emit the desired electromagnetic radiation, for example the desired colour of light. The control system **40** is adapted for connection to a source of power thereby enabling desired activation of the one or more light-emitting elements **20**.

30 [0020] In one embodiment of the present invention, other data relating to the one or more light-emitting elements and/or the light unit may be contained on the memory device. For example the memory device may comprise information relating to date of

manufacture, date of calibration, manufacturer's reference information, serial numbers, model numbers, bin information of the light-emitting elements and the like.

5 [0021] In one embodiment of the present invention, operational characteristics can be updated according to the number of hours of operation of the one or more light-emitting elements associated with the light unit. For example, a record of operational history of the one or more light-emitting elements can be useful for the investigation of malfunctioning of the light-emitting elements or deterioration in operating parameters thereof which may provide a means for determining operating conditions under which the light-emitting elements may have the greatest lifetime.

10 *Carrier*

[0022] The carrier provides a support mechanism for the one or more light-emitting elements and/or the memory device.

15 [0023] In one embodiment, a single carrier provides a unitary support to both the one or more light-emitting elements and the memory device, which can provide a means for ease of changability of the light unit.

[0024] In an alternate embodiment of the present invention, a carrier is used as a support mechanism for the one or more light-emitting elements, and a second carrier is used as the support mechanism for the memory device.

20 [0025] In a further embodiment, a particular carrier is used as a support mechanism for a particular format of one or more light-emitting elements. For example, red light-emitting elements are operatively coupled to one carrier, green light-emitting elements are operatively coupled to a second carrier and blue light-emitting elements are operatively coupled to a third carrier.

25 [0026] In one embodiment of the present invention, when the light unit comprises multiple carriers, these multiple carriers can be structurally connected by frame system, in order to produce a unitary carrier component. The configuration of the frame system can be dependent on the configuration of the light unit, the lighting device and the number of carriers within the light unit.

[0027] In one embodiment, the carrier is made from a standard printed circuit board (PCB) type material, for example, an FR4 compound material or other PCB format as would be readily understood by a worker skilled in the art.

5 [0028] In one embodiment the carrier is made of a thermally conductive material, for example, ceramic such as AlN, Al₂O₃, BeO, metal core printed circuit board (MCPCB), direct bond copper (DBC), CVD diamond or other suitable thermally conductive material as would be known to a worker skilled in the art. Furthermore the substrate can be fabricated from a metal, for example Olin 194, Cu, CuW or any other thermally conductive alloy. The substrate may be coated with a dielectric for electrical isolation of
10 one or more light-emitting elements, and/or electrical contacts. In one embodiment, electrical traces can be deposited onto a dielectric coated substrate to allow electrical connectivity.

[0029] In one embodiment, the carrier can be designed such that traces provide electrical connections from the one or more light-emitting elements and the memory device to the
15 control system associated with the lighting device. In one embodiment the traces are formed on one side of the carrier. Alternately the carrier can have electrical connections or traces on both sides thereof. This configuration of the traces can be based on the design of the light-emitting element, the memory device and/or the lighting device.

[0030] In one embodiment, the carrier can be designed to comprise multiple electrically
20 conducting planes in order to reduce the size of the carrier and potentially increase the potential density of devices, for example light-emitting elements, thereon due to the reduction of circuit traces for example.

[0031] In another embodiment of the present invention, the carrier can comprise one or more connectors, plugs or interconnectors which provide for the operative connection
25 between the light unit and the lighting device. A worker skilled in the art would readily understand configuration of plugs which would provide the desired operative connection between the carrier and the lighting device.

[0032] The one or more carriers are electrically configured to operatively connect to the control system of the lighting device which would be readily understood by a worker
30 skilled in the art.

[0033] The carrier can be formed into a variety of desired shapes, for example flat, curved, square, circular, elliptical or other desired shape or other desired shape as would be readily understood. The configuration and shape of the carrier can be dependent on the design of the lighting device, which can determine the shape and size restrictions that may be placed on the carrier.

Memory Device

[0034] The memory device is operatively coupled to a carrier and provides a means for the storing of operational characteristics of the one or more light-emitting elements with which it is associated. In this manner, upon the operational coupling of the light unit to the lighting device, the operational characteristics of each of the one or more light-emitting elements of the lighting unit, are accessible to the control system of the lighting device.

[0035] The operational characteristics of the one or more light-emitting elements can be representative of the wavelength and intensity emission spectrum of the one or more light-emitting elements.

[0036] In one embodiment, the operational characteristics are further representative of the temperature dependence of the wavelength and intensity emission spectrum of the one or more light-emitting elements. As would be known to a worker skilled in the art, different colours of light-emitting elements have varying temperature dependencies and therefore appropriate operational characteristics are required to represent this varying dependency.

[0037] In one embodiment of the present invention, the operational characteristics are polynomial expressions or algorithms for the evaluation of the wavelength and intensity emission spectrum of the one or more light-emitting elements.

[0038] In one embodiment the operational characteristics represent the peak wavelength emission, peak intensity emission and spectral line width of the one or more light-emitting elements as a function of operational temperature of the one or more light-emitting elements. The representation of the spectral output for each of the one or more light-emitting elements can be represented by polynomial expression with predetermined parameters. For example, the operational characteristics stored in the memory device

can be linear or exponential temperature dependent expressions that represent the predetermined parameters of the suitable numerical approximation for the one or more light-emitting elements.

5 [0039] In an alternate embodiment, the operational characteristics are configured in a tabular format, for example in a look-up table configuration.

[0040] The control system can be a computing device or microcontroller having a central processing unit (CPU) and peripheral input/output devices (such as A/D or D/A converters) to monitor parameters from one or more peripheral devices that are operatively coupled to the control system, for example a temperature determination
10 mechanism. The controller can optionally include one or more storage media collectively referred to herein as "memory". The memory can be volatile and non-volatile computer memory such as RAM, PROM, EPROM, and EEPROM, flash, compact disks, optical disks, or the like, wherein control programs (such as software, microcode or firmware) for monitoring or controlling the one or more light-emitting
15 elements and peripheral devices coupled to the control system are stored and executed by the CPU.

[0041] The memory device can be configured as electronically erasable programmable read only memory (EEPROM), electronically programmable read only memory (EPROM), non-volatile random access memory (NVRAM), read-only memory (ROM),
20 programmable read-only memory (PROM), flash memory or other non-volatile memory for storing data as would be readily understood by a worker skilled in the art.

[0042] In one embodiment, the memory device can be configured as a dip-switch package for storing the operational characteristics. The dip-switch package can be set during the calibration stage of the light-emitting elements, for example during the
25 manufacture of the light unit.

[0043] In one embodiment of the present invention, the memory device is configured as an addressable device. The address of the memory device can be stored in a dip-switch package, or can be stored within the memory device for example defined by firmware thereon. Other suitable methods for defining the address of a memory device would be
30 readily understood by a worker skilled in the art.

[0044] It is obvious that the foregoing embodiments of the invention are exemplary and can be varied in many ways. Such present or future variations are not to be regarded as a departure from the spirit and scope of the invention, and all such modifications as would be obvious to one skilled in the art are intended to be included within the scope of

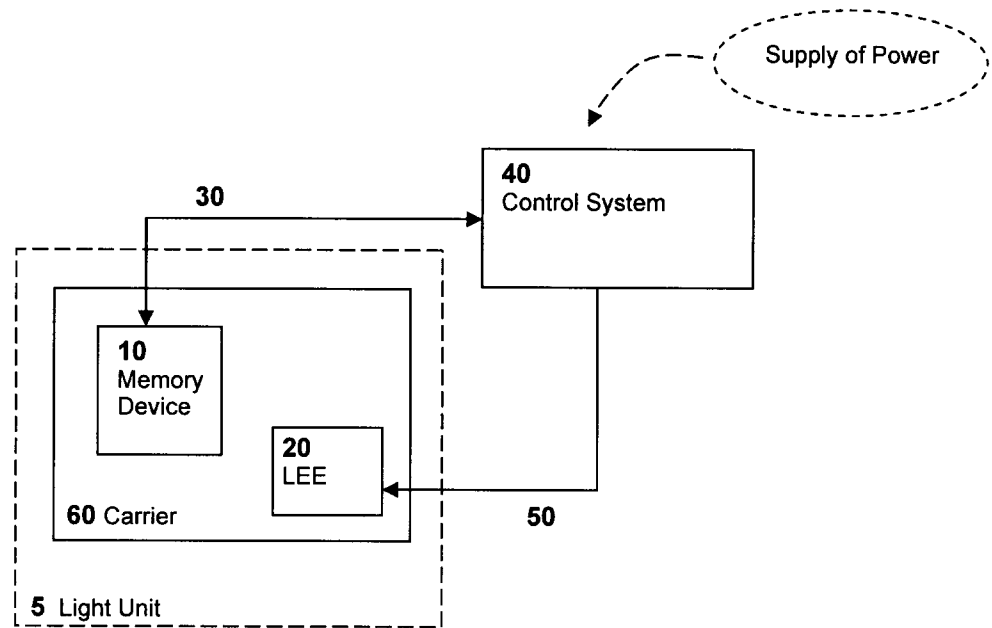
5 the following claims.

WE CLAIM:

1. A light unit adapted for connection to a lighting device, the lighting device including a control system for controlling activation of one or more light-emitting elements, the control system adapted for connection to a source of power, the light unit comprising:
 - a) one or more carriers;
 - b) one or more light-emitting elements operatively coupled to one or more of the carriers, the one or more light-emitting elements for generating electromagnetic radiation;
 - c) a memory device operatively coupled to one or more of the carriers, the memory device including information representative of operational characteristics of the one or more light-emitting elements, the memory device adapted for connection to the control system;wherein the control system provides control signals to the one or more light-emitting elements and wherein said control signals are dependent on the operational characteristics.
2. The light unit according to claim 1, wherein the carrier is a single carrier.
3. The light unit according to claim 1, wherein the memory device is operatively coupled to a first carrier and the one or more light-emitting elements are operatively coupled to a second carrier.
4. The light unit according to claim 1, wherein the memory device is operatively coupled to a first carrier and one or more light-emitting elements of a first colour are operatively coupled to a second carrier and one or more light-emitting elements of a second colour are operatively coupled to a third carrier.
5. The light unit according to claim 3 or 4, wherein the first carrier and second carrier and optionally the third carrier are connected by a frame system thereby forming a unitary carrier component.

6. The light unit according to claim 1, wherein the carrier is a FR4 board, printed circuit board, or formed from a thermally conductive material.
- 5 7. The light unit according to claim 1, wherein the one or more carriers comprise one or more circuit traces or one or more conductive planes.
8. The light unit according to claim 1, wherein the memory unit is selected from the group comprising: electronically erasable programmable read only memory, electronically programmable read only memory, non volatile random access
10 memory, read only memory, programmable read only memory, flash memory and a dip switch package.
9. The light unit according to claim 1, wherein the operational characteristics are representative of wavelength and intensity emission of the one or more light-
15 emitting elements.
10. The light unit according to claim 9, wherein the operational characteristics further comprise representations of temperature dependence of both the wavelength and intensity emission of the one or more light-emitting elements.
20
11. The light unit according to claim 9, wherein the memory device further comprises information relating to features of the one or more light-emitting elements, the features selected from the group comprising: date of manufacture, date of calibration, manufacturer's reference information, serial number, model
25 number and bin information.
12. The light unit according to claim 9, wherein the memory device further comprises information relating to hours of operation of the one or more light-emitting elements.
30
13. The light unit according to claim 9, wherein the operational characteristics are represented by one or more polynomial expressions.

14. The light unit according to claim 9, wherein the operational characteristics are configured as look-up tables.

**FIGURE 1**