A system for increasing heat dissipation of LED displays uses the current PCB packaging, e.g. heat-sink pad 25, mounted to a LCD panel support structure thereby eliminating the need for a metal core PCB. Reverse mounted LEDs having heat dissipation pads are used to optimize heat transfer to a metal layer (Fig 6; 63) which is then placed in contact with the LCD support structure (61).
LED MOUNTING ASSEMBLY

[0001] The need for LEDs having high power (increased brightness) is increasing. As power increases, so does the need for heat dissipation since if the heat generated by the LED junction is not dissipated effectively the brightness of the LED is diminished.

[0002] Currently LEDs are produced in surface-mounted LED packages which are mounted to aluminum metal core PCBs. The metal core PCBs act as direct heat-sinks drawing the heat away from the LEDs. Using metal core PCBs is relatively expensive since the cost of the material for a metal core PCB is high.

[0003] There is disclosed a system and method for increasing heat dissipation of LED displays by using the current PCB packaging mounted to a LCD panel support structure thereby eliminating the need for a metal core PCB. In one embodiment, reverse mounted LEDs having heat dissipation pads are used to optimize heat transfer to a metal layer which is then placed in contact with the LCD support structure.

[0004] For a more complete understanding of the present invention, reference is now made to the following descriptions taken in conjunction with the accompanying drawing, in which:

[0005] FIGURE 1 shows a perspective view of one embodiment of a single LED and dome package;

[0006] FIGURE 2 shows one embodiment of the LED package of FIGURE 1 with the LED removed;

[0007] FIGURES 3A and 3B show embodiments of side views of the single LED package of FIGURE 1 taken along section line 3A–3A of FIGURE 2;

[0008] FIGURES 4 and 5 show top and side views, respectively, of a multiple LED package; and
FIGURES 6 and 7 show a display using LED strips constructed in accordance with the teachings of this disclosure.

FIGURE 1 shows a perspective view of one embodiment of single LED package 10 consisting of PCB substrate 22 mated to heat-sink pad 25. Optical dome 12 is constructed, by molding or otherwise, above surface 11 which in turn is mated to substrate 22. Contact strips 23 and 24 are constructed on the surface of substrate 22 and are used as discussed in more detail hereinafter.

FIGURE 2 shows package 10 with the LED and optical dome 12 removed. An LED chip (or other light emitting source) would be physically attached to heat-sink pad 25 inside reflector cup 21 by a terminally conductive bonding agent, or by other fastener means. The LED would then be wire bond connected to pads 23-1 and 24-1 of contact strips 23 and 24, respectively, for subsequent connection to an external electrical path. The heat path from the LED is through heat-sink pad 25 which can be, for example, copper. Note that the heat path from the LED is pad 25 and is separate from the electrical path to optimize the heat dissipation from the die to the back structure. The LED is mounted to pad 25 using a thermally conductive (but non-electrically conductive) adhesive dielectric. The heat dissipation is better than in prior art metal core PCBs because the pad has a wider surface area.

Figure 21 is constructed having an optimum angle for reflecting LED side light to the top of the package. The reflector cup is formed, for example, using bright color opaque material. Once the LED is mated with pad 25, transparent material is poured around the LED to encapsulate the LED and wire bond to form complete LED package 10.

Optical dome 12 (FIGURE 1) is constructed to direct the light from the LED source in a desired direction. The light output of the LED can be changed, as desired, to applications simply by redesigning the dome shape.

FIGURE 3A shows a sectional cut-away side view of LED package 10 taken along section line 3A–3A of FIGURE 2 having light source, such as LED 31, physically bonded to heat dissipation pad 25 by bonding material 302. Bond wire 32
connects one terminal of LED 31 to contact pad 24-1 of contact strip 24 (FIGURE 1). The second electrical terminal of LED 31 is connected to contact pad 23-1 by path 33. Any electrical contact system can be used to connect LED 31 to respective contacts external to dome 12. In the embodiment shown, there are two such leads but there could be three or more, if desired.

[0015] FIGURE 3B shows in a cut-away view how external power is connected via contacts 52 and 53 to contact area 23-2 and 24-2. The position of contact areas 23-1, 23-2, 24-1, and 24-2 is shown in FIGURE 2. Note that these contacts can be any place along contact strip 23, 24 so long as they do not interfere with the wire bonds to the LED. FIGURE 4 shows display 40 having a plurality of LED packages 10-1 through 10-N, each with an LED 12-1 to 12-N. Surrounding each LED package is a opening, such as opening 42-1 through 42-N formed in structure 42 to allow light from the respective LED to pass through.

[0016] FIGURE 5 is a cross-section of display 40 taken a long line 5-5 of FIGURE 4 showing three LEDs 12-1, 12-2, 12-3 mounted to mounting plate 61. (Mounting plate 61 will be described more fully with respect to FIGURE 6.) Shown in FIGURE 5 are contacts 52 and 53 which are formed beneath the surface of structure 41 for the purpose of providing control and power to the respective LEDs. This then allows for the contact surface to be on the top side of the LED device and away from heat pad 25 for better electrical and heat separation.

[0017] FIGURE 6 shows system 60 which has a plurality of LED strips 40 mounted to heat dissipation bar 63 which in turn is connected to back mounting plate 61. If desired, cover 62 can be added. Cover 62 could have opaque areas for allowing the LED light to be seen externally.

[0018] FIGURE 7 shows a cross-section of structure 60 taken along section line 7-7 of FIGURE 6. In FIGURE 7 light diffusers and other elements 72, 73 are shown for diffusing, or otherwise controlling the light. Such control can be on an individual basis, if desired.

[0019] FIGURE 8 shows one alternate embodiment 80 of a device using light source 92 having both bond wires on the top of the light source. This is possible because of
the horizontal structure of light source 92 as shown in FIGURE 9B. In this embodiment adhesive (or other bonding agent) 802 can be both heat conductive as well as electrically conductive. This then allows for the use of solder as the bonding agent which could, in some situations, be more effective than simply being heat conductive.

[0020] FIGURE 9A shows a diagram of vertical structure light source 91 having its electrical connections at the top and at the bottom of the device.

[0021] FIGURE 9B shows a diagram of horizontal structure light source 92 having both its electrical connections at the top of the device. Note that while only two electrical connections are shown, any number can be used and the concepts discussed herein could work with conductors coming from the sides of the device if desired.

[0022] Although the present invention and its advantages have been described in detail, it should be understood that various changes, substitutions and alterations can be made herein without departing from the scope of the invention as defined by the appended claims. Moreover, the scope of the present application is not intended to be limited to the particular embodiments of the process, machine, manufacture, composition of matter, means, methods and steps described in the specification. As one of ordinary skill in the art will readily appreciate from the disclosure of the present invention, processes, machines, manufacture, compositions of matter, means, methods, or steps, presently existing or later to be developed that perform substantially the same function or achieve substantially the same result as the corresponding embodiments described herein may be utilized according to the present invention. Accordingly, the appended claims are intended to include within their scope such processes, machines, manufacture, compositions of matter, means, methods, or steps.

[0023] The disclosures in United States patent application no. 09/643,982, from which this application claims priority, and in the abstract accompanying this application are incorporated herein by reference.
CLAIMS

1. An LED assembly comprising:
   a substrate having a heat-sink pad forming a bottom surface thereof;
   an LED mounted at least partially on said substrate and having a portion of said LED
   in contact with said heat sink pad; and
   wire bond pads on a top surface of said substrate, said wire bond pads electrically
   connected to said LED.

2. The assembly of claim 1 further comprising:
   a reflector cup constructed within said substrate, said LED positioned within said
   reflector cup.

3. The assembly of claim 2 wherein said portion of said LED in contact with said
   heat-sink pad is a portion designed for the dissipation of heat from said LED.

4. The assembly of claim 2 further comprising:
   an optical dome covering said LED and said reflector cup.

5. The assembly of claim 4 wherein said optical dome is part of a substrate
   positioned to cover said top surface.

6. The assembly of claim 3 further comprising:
   a separate substrate positioned over said substrate, said separate substrate having
   electrical contacts for making electrical contact with at least a portion of said wire bond pads;
   and
   wherein said separate substrate has constructed therein provision for allowing light
   from said LED to be visible to an observer.

7. The assembly of claim 6 further comprising:
   a support structure connected to said heat-sink pad.

8. The assembly of claim 7 wherein said PCB substrate contains a plurality of
   said LEDs all in contact with said heat-sink and wherein said heat-sink is in contact with said
   support structure.
9. The assembly of claim 8 wherein said separate substrate has constructed therein provision allowing light from said plurality of LEDs to be visible to an observer.

10. An array of LEDs, said array comprising:
a first substrate having reflector cups constructed therein, said reflector cups for mounting said LEDs therein; said first substrate having attached thereto a heat conducting layer in contact with a first surface of mounted ones of said LEDs; said first substrate comprising:
   electrical pads for connecting to mounted ones of said LEDs, said electrical pads positioned so as to communicate electrical control signals from a mating substrate, said mating substrate having constructed therein control circuitry for controlling said LEDs;
   said LED array further comprising:
a heat conducting support structure in non-electrical contact with said heat conducting layer so as to transfer away heat generate from the operation of mounted ones of said LEDs.

11. The array of claim 10 wherein said mating substrate comprises:
a plurality of optical domes for allowing light from mounted ones of said LEDs to be radiated away from said mating substrate, said light radiating from a second surface of said LEDs.

12. The array of claim 10 wherein said heat conducting layer is a metal layer.

13. The array of claim 10 wherein said heat conducting support structure is a metal structure.

14. The array of claim 10 wherein said heat conducting support structure is mated to said heat conducting layer with a thermally conductive, non-electrically conductive dielectric.

15. The method of constructing an LED array, said method comprising:
constructing in a first substrate a reflector area for mounting an LED therein, said reflector area containing a heat transfer material in contact with a bottom surface of said first substrate; and
constructing on a top surface of said first substrate contact pads for connecting with
electrical contacts of a mounted LED, said contact pads also having area for making electrical contact with electrical contacts on a second substrate in contact with said top surface of said first substrate.

16. The method of claim 15 further comprising: positioning an LED within said reflector area with a bottom surface of said LED in heat transferring relationship with said heat transfer material.

17. The method of claim 16 further comprising: positioning a light dome over said reflector area to disperse light from a mounted LED.

18. The method of claim 17 further comprising: constructing a plurality of said reflector areas of said first substrate.

19. The method of claim 18 further comprising: mounting a plurality of said first substrates, each with a plurality of reflector areas upon a support structure to form a matrix array of LEDs.

20. The method of claim 17 further comprising: mounting a plurality of said first substrates on a support structure to form an array of LEDs, said array being controlled from said second substrate.

21. An assembly substantially as herein described with reference to each of the accompanying drawings.

22. An array substantially as herein described with reference to each of the accompanying drawings.

23. A method substantially as herein described with reference to each of the accompanying drawings.
**Patents Act 1977: Search Report under Section 17**

**Documents considered to be relevant:**

<table>
<thead>
<tr>
<th>Category</th>
<th>Relevant to claims</th>
<th>Identity of document and passage or figure of particular relevance</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>1-5</td>
<td>US2003/189830 A (MATSUSHITA ELECTRIC) figs 1a, 11, 17, 18, 25</td>
</tr>
<tr>
<td>X</td>
<td>1-3</td>
<td>US2004/264195 A (CHANG) fig 3</td>
</tr>
<tr>
<td>X</td>
<td>1</td>
<td>GB2406969 A (AGILENT TECHNOLOGIES) figs 3b, 4, 5, 7</td>
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<tr>
<td>X</td>
<td>1</td>
<td>US2005/023537 A (SALAM) figs 13, paragraphs 111-126</td>
</tr>
<tr>
<td>X</td>
<td>1-4</td>
<td>JP2002043632 A (CITIZEN ELECTRONICS) English language abstract, figs 1, 4</td>
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<tr>
<td>X</td>
<td>1</td>
<td>JP05211374 A (NIPPON ELECTRIC) English language abstract, fig 1</td>
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**Categories:**

- X Document indicating lack of novelty or inventive step
- Y Document indicating lack of inventive step if combined with one or more other documents of same category
- & Member of the same patent family
- A Document indicating technological background and/or state of the art.
- P Document published on or after the declared priority date but before the filing date of this invention.
- E Patent document published on or after, but with priority date earlier than, the filing date of this application.

**Field of Search:**

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC™:

- H1K
- H01L

Worldwide search of patent documents classified in the following areas of the IPC:

The following online and other databases have been used in the preparation of this search report:

EPODOC, WPI