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(54) **Light-emitting semiconductor device with open-bypass function**

(57) This invention discloses a light-emitting semiconductor device with open-bypass function, which comprises two terminals providing a current, at least one LED unit and a bypass switch. Electrodes of the LED unit and the bypass switch are properly connected to the terminals, so that the bypass switch will provide an alternative path for current flowing through if the circuit of the LEDs unit between two terminals is open.

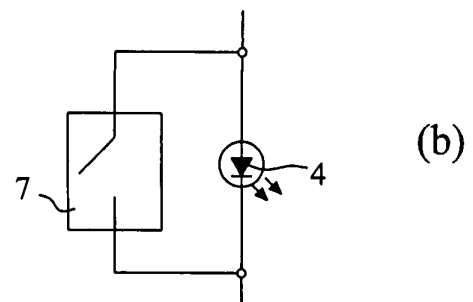
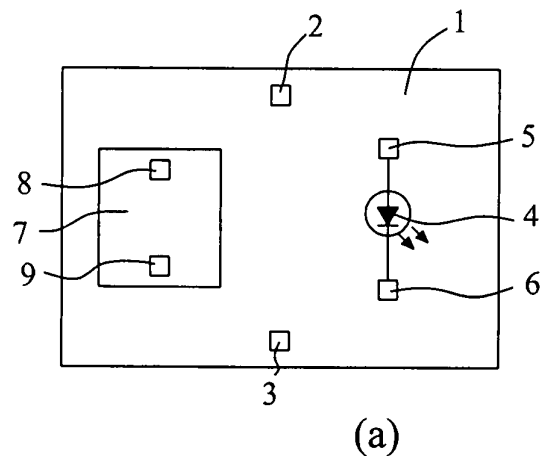


FIG. 1

Description

FIGs. 7 and 8 respectively show the series and the parallel circuits.

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] This invention relates to a light-emitting semiconductor device with open-bypass function.

2. Related Prior Arts

[0002] For serial or parallel LEDs, open or short circuit may cause the LED unable to be lit. The open circuit results in all LEDs serially connected to this circuit ineffective; and the short circuit makes one or more LEDs being "omitted".

[0003] Therefore, this invention provides a bypass switch in the LED circuit.

SUMMARY OF THE INVENTION

[0004] The light-emitting semiconductor device with open-bypass function comprises a first terminal, a second terminal, at least one LED unit and a bypass switch. Each LED unit composed of one or more LED die has a first electrode and a second electrode respectively connected to the first terminal and the second terminal. The bypass switch also has a first electrode and a second electrode respectively connected to the first terminal and the second terminal of the light-emitting semiconductor device.

[0005] In a normal condition, a current applied to the first and the second terminals can be conducted through the LED unit for lighting it, and the switch is in an "Off" state without current flowing through. If the circuit of the LEDs unit between two terminals is open and the current can not be conducted through, the bypass switch will be in an "On" state for conducting the current.

[0006] Accordingly, the first and the second terminals of the light-emitting semiconductor device can be always electrically conductible.

[0007] This invention also comprises a series or parallel circuit comprising several devices and a current source.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008]

FIG. 1 shows the light-emitting semiconductor device of this invention

FIGs. 2 and 3 respectively show the LED unit and the bypass switch.

FIGs. 4 and 5 respectively show the ways current flowing when the switch is in the "On" and "Off" states.

FIG 6 shows the electrical connection of this invention

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0009] FIG 1 (a) shows a light-emitting semiconductor device 1 comprising two terminals defined as a first terminal 2 and a second terminal 3, an LED unit 4 and a switch 7 for bypassing. The LED unit 4 includes several LED dice 10 as shown in FIG. 2, and has a first electrode 5 and a second electrode 6 respectively connected to the first terminal 2 and the second terminal 3. In a normal condition, the circuit involving the LED unit 4 is electrically connected well and the LED dice can be lit by applying a current to the terminals 2 and 3. However, if the circuit is open, the LED unit 4 can't be lit.

[0010] The switch 7 is made with an integrated circuit and also has a first electrode 8 and a second electrode 9 respectively connected to the terminals 2 and 3. The switch 7 includes a voltage detection circuit 11 and a switch circuit 12, as shown in FIG. 3. The switch 7 is electrically unconductible in an "Off" state, but conductible in an "On" state when triggered by a first signal received from the electrodes 8 and 9. This first signal is a voltage equal to or higher than a predetermined value and generated when the circuit involving the LED unit 4 is open.

[0011] FIG 1(b) shows the LED unit 4 connected to the switch 7 through a common contact and thus controlled by the switch 7.

[0012] The voltage detection circuit 1 has an anode, a cathode and a gate, wherein the anode and the cathode are respectively connected to the electrodes 8 and 9. The switch circuit 12 also has an anode, a cathode and a gate, wherein the anode and the cathode are also respectively connected to the electrodes 8 and 9. The gates of the circuits 11 and 12 are connected to each other. By detecting voltage of the circuit, the circuit 11 can generate a second signal to drive the gate of the switch circuit 12 through the gate of the voltage detection circuit 11. Then the switch circuit 12 enters into the "On" state.

[0013] In this invention, the switch circuit can be designed as follows:

(1) One PNP thyristor having a P anode and an N cathode respectively connected to the anode and cathode of the switch circuit.

(2) Two bipolar junction transistors

The first bipolar junction transistor has a first emitter, a first base and a first collector; the second bipolar junction transistor has a second emitter, a second base and a second collector. The first emitter and the second emitter are respectively connected to the anode and the cathode of the switch circuit. The first base is connected to the second collector. The first collector is connected to the second base.

(3) Two MOSFETs

The first MOSFET has a first source, a first gate and a first drain; the second MOSFET has a second source, a second gate and a second drain. The first source and the second source are respectively connected to the anode and the cathode of the switch circuit. The first gate is connected to the second drain. The first drain is connected to the second gate.
(4) One bipolar junction transistor and one MOSFET

[0014] The bipolar junction transistor has an emitter, a base and a collector; the MOSFET has a source, a gate and a drain. The emitter and the source are respectively connected to the anode (or the cathode) and the cathode (or the anode) of the switch circuit. The base is connected to the drain. The collector is connected to the gate.

[0015] The light-emitting semiconductor device 1 is conducted as follows:

(1) If electrical connection of the LED unit 4 is abnormally open, the current can not be conducted through the LED unit 4; and the switch 7 will be in the "On" state and enable the current to flow through, as shown in FIG 4.

(2) If electrical connection of the LED unit 4 is normal, a current can be conducted through the LED unit 4 for lighting it; and the switch 7 is in the "Off" state without current flowing through, as shown in FIG 5.

[0016] FIG 6 shows the electrical connection of the device. The electrode 5 of the LED unit 4 and the electrode 8 of the switch 7 are commonly connected to the first terminal 2 of the device 1. The electrode 6 of the LED unit 4 and the electrode 9 of the switch 7 are commonly connected to the second terminal 3 of the device 1.

[0017] The terminals of the light-emitting semiconductor device can be attached to a substrate by wire bonding and surface mount technology.

[0018] FIG 7 shows a series circuit. The terminal 3 of the device 1 is connected to the terminal 2' of the device 1'; and the terminal 2 of the device 1 and the terminal 3' of the device 1' are individually connected to a current source 13. FIG 8 shows a parallel circuit. The terminal 2 of the device 1 and the terminal 2' of the device 1' are commonly connected to a current source; and the terminal 3 of the device 1 and the terminal 3' of the device 1' are commonly connected to the current source. That is, the devices and the current source can form a series or parallel circuit always conductible by providing the bypass switch.

Claims

1. A light-emitting semiconductor device with open-bypass function, comprising:

a first terminal;
a second terminal;

at least one LED unit each comprising one or more LED die, a first electrode and a second electrode respectively connected to the first and the second terminals; and

a bypass switch comprising a first electrode and a second electrode respectively connected to the first and the second terminals;

wherein

the bypass switch will be in an "Off" state without current flowing through if the LED unit can be lit by applying a current to the first and second terminals; or

the bypass switch will be in an "On" state for conducting the current if the LED unit is in an open circuit.

2. The light-emitting semiconductor device of claim 1, wherein the first and the second terminals are attached to a substrate by wire bonding and surface mount technology.

3. The light-emitting semiconductor device of claim 1, wherein the LED unit will generate a first signal delivered to the first and the second electrodes of the bypass switch as being in an open circuit; and the bypass switch will be in the "Off" state if the first signal is lower than a predetermined voltage; or the bypass switch will be triggered to enter into the "On" state if the first signal is equal to or higher than the predetermined voltage.

4. The light-emitting semiconductor device of claim 1, wherein the bypass switch is formed as an integrated circuit and comprises:

a voltage detection circuit with an anode, a cathode and a gate, wherein the anode and the cathode are respectively connected to the first and the second electrodes of the bypass switch; and a switch circuit with an anode, a cathode and a gate, wherein the anode and the cathode are respectively connected to the first and the second electrodes of the bypass switch, and the gate is connected to the gate of the voltage detection circuit;

wherein the voltage detection circuit can generate a second signal according to the detected voltage and the second signal will drive the gate of the switch circuit through the gate of the voltage detection circuit and therefore turn on the switch circuit into the "On" state.

5. The light-emitting semiconductor device of claim 4, wherein the switch circuit comprises a PNP thyristor with a P anode and an N cathode respectively connected to the anode and the cathode of the switch circuit.

6. The light-emitting semiconductor device of claim 4, wherein the switch circuit comprises a first bipolar junction transistor with a first emitter, a first base and a first collector and a second bipolar junction transistor with a second emitter, a second base and a second collector; wherein: 5

the first emitter and the second emitter are respectively connected to the anode and the cathode of the switch circuit; 10
the first base is connected to the second collector; and
the first collector is connected to the second base. 15

7. The light-emitting semiconductor device of claim 4, wherein the switch circuit comprises a first MOSFET with a first source, a first gate and a first drain and a second MOSFET with a second source, a second gate and a second drain; wherein: 20

the first source and the second source are respectively connected to the anode and the cathode of the switch circuit; 25
the first gate is connected to the second drain; and
the first drain is connected to the second gate.

8. The light-emitting semiconductor device of claim 4, wherein the switch circuit comprises a bipolar junction transistor with an emitter, a base and a collector and a MOSFET with a source, a gate and a drain; wherein: 30

the emitter or the source is connected to the anode or the cathode of the switch circuit; 35
the base is connected to the drain;
the collector is connected to the gate.

9. A light-emitting semiconductor apparatus, comprising a plurality of the light-emitting semiconductor devices of claim 1 and a current source to construct a series or parallel circuit. 40

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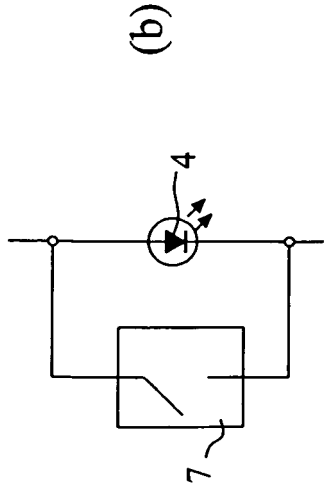
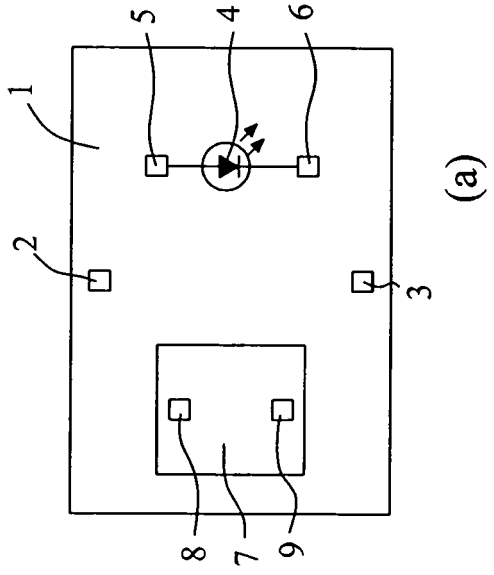
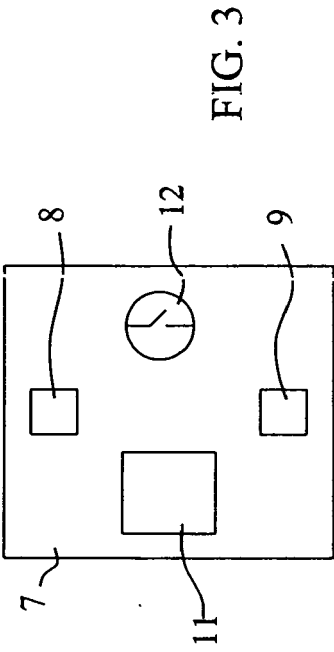
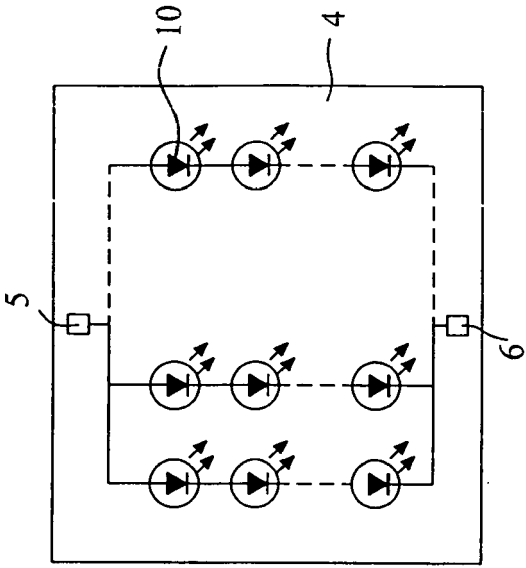


FIG. 1

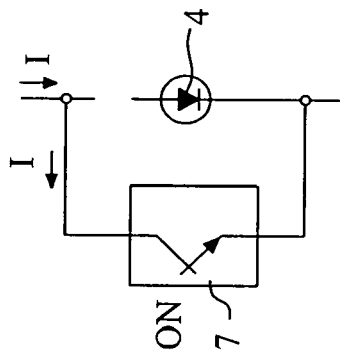


FIG. 4

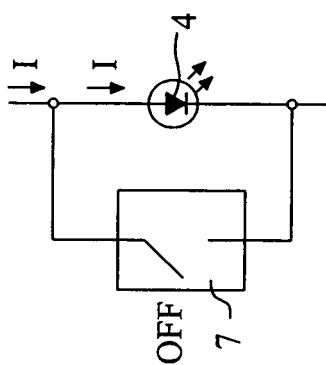


FIG. 5

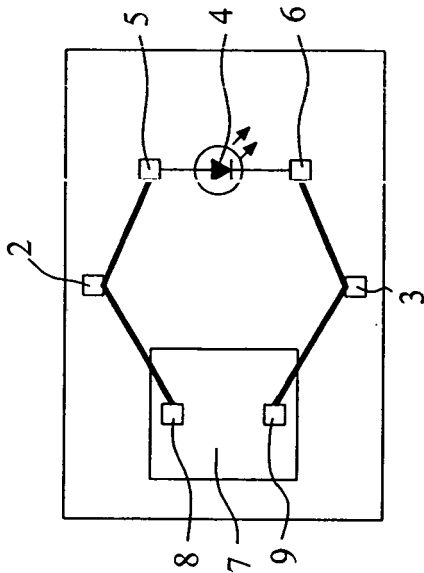


FIG. 6

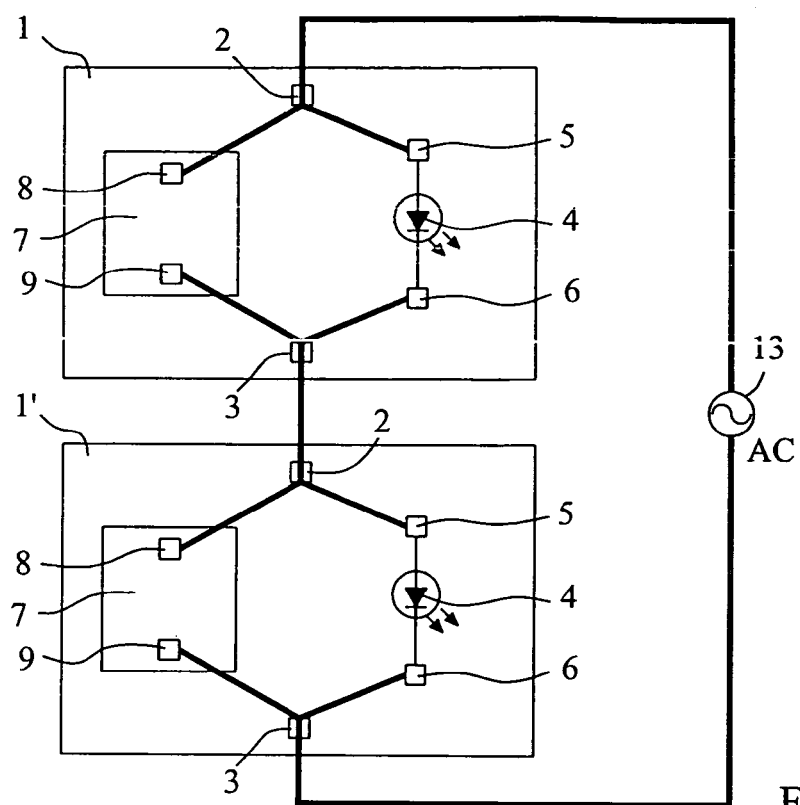


FIG. 7

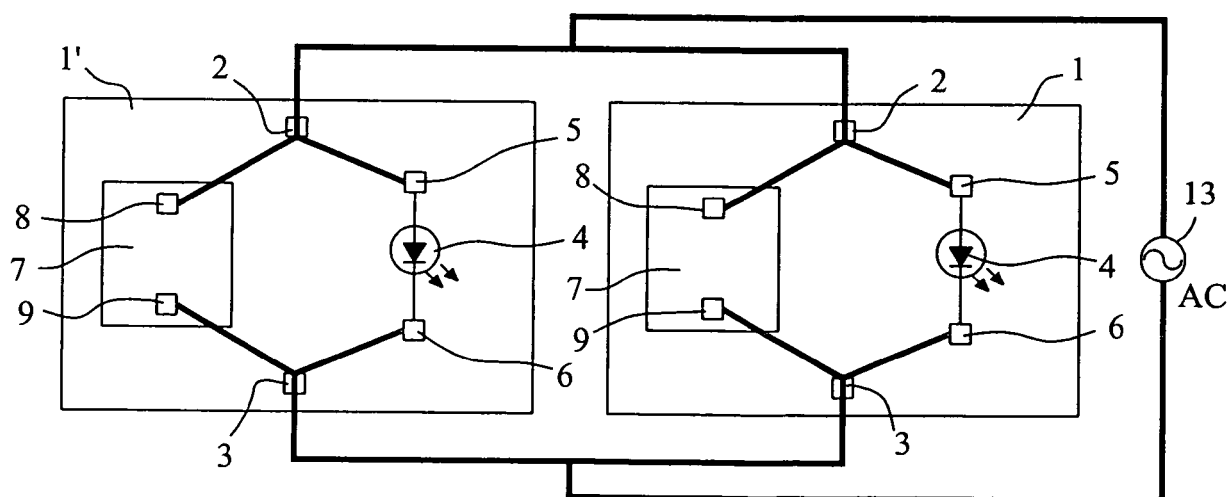


FIG. 8



European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 06 00 7984

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 2002/043943 A1 (MENZER RANDY L [US] ET AL) 18 April 2002 (2002-04-18)	1,3,9	INV. H05B33/08
Y	* page 1, paragraph 1; figures 4,5,6b,7,11 *	2,4,5	
	* page 2, paragraph 14-16 *		
	* page 3, paragraphs 20,26,30 *		
	* page 5, paragraph 59 - page 6, paragraph 64 *		
	* page 7, paragraphs 70,73 - page 8, paragraph 76 *		

X	EP 1 589 519 A (SONY CORP [JP]) 26 October 2005 (2005-10-26)	1,4	
Y	* column 1, paragraph 1; figures 15-17 *	2,5	
	* column 12, paragraph 72 - column 14, paragraph 83 *		

Y	US 2004/248332 A1 (YOON JOON HO [KR]) 9 December 2004 (2004-12-09)	2	
	* page 1, paragraph 2; figure 5 *		
	* page 2, paragraph 16 *		
	* page 3, paragraphs 45,46 *		

Y	JP 11 178243 A (MITSUBISHI ELECTRIC CORP) 2 July 1999 (1999-07-02)	5	
	* abstract *		

Y	JP 63 018967 A (TOKYO SHIBAURA ELECTRIC CO) 26 January 1988 (1988-01-26)	4,5	
	* abstract; figure 1 *		

A	US 2005/057179 A1 (MADHANI VIPIN [US] ET AL) 17 March 2005 (2005-03-17)	1-9	
	* page 1, paragraphs 3,9,14 - page 2, paragraph 15; figures 1,2 *		

The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 15 May 2007	Examiner Brosa, Anna-Maria
CATEGORY OF CITED DOCUMENTS		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	
X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document			

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EPO FORM 1503 03/82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 06 00 7984

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15-05-2007

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2002043943 A1	18-04-2002	AU 3040302 A WO 0233799 A1	29-04-2002 25-04-2002
EP 1589519 A	26-10-2005	CN 1691126 A JP 2005310998 A KR 20060045573 A US 2005231459 A1	02-11-2005 04-11-2005 17-05-2006 20-10-2005
US 2004248332 A1	09-12-2004	JP 2004363533 A KR 20040104178 A	24-12-2004 10-12-2004
JP 11178243 A	02-07-1999	NONE	
JP 63018967 A	26-01-1988	NONE	
US 2005057179 A1	17-03-2005	NONE	