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H04B 10/04

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H4B BK4

(56) Documents Cited
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US 5742133 A
JP 030034477 A
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(58) Field of Search
UK CL (Edition V) H4B
INT CL^7 H04B
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(54) Abstract Title
Infrared LED driver for a remote control transmitter

(57) The invention provides a simple and stable infrared light emitting diode (LED) drive circuit for preventing an LED from emitting a continuous intense infrared light when a fault occurs. The driver circuit comprises a voltage source 2, a first transistor 5 connected in series with an LED 4, a second transistor 7 connected in parallel with the LED and a set of operation keys 8 for generating pulse signals. During normal operation when any of the operation keys are pressed a pulse is applied to the base of the series transmitter resulting in current flowing to the LED. If the emitter and collector of the series transistor are short circuited however, the parallel transistor becomes active to prevent current flowing to the LED when operation keys are not pressed. Application is to a remote control transmitter or other communication appliance such as an electronic notebook or personal digital assistant.

Fig. 1

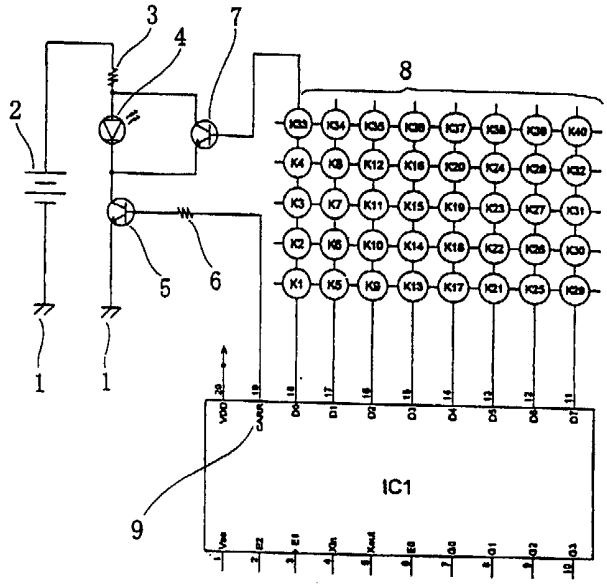

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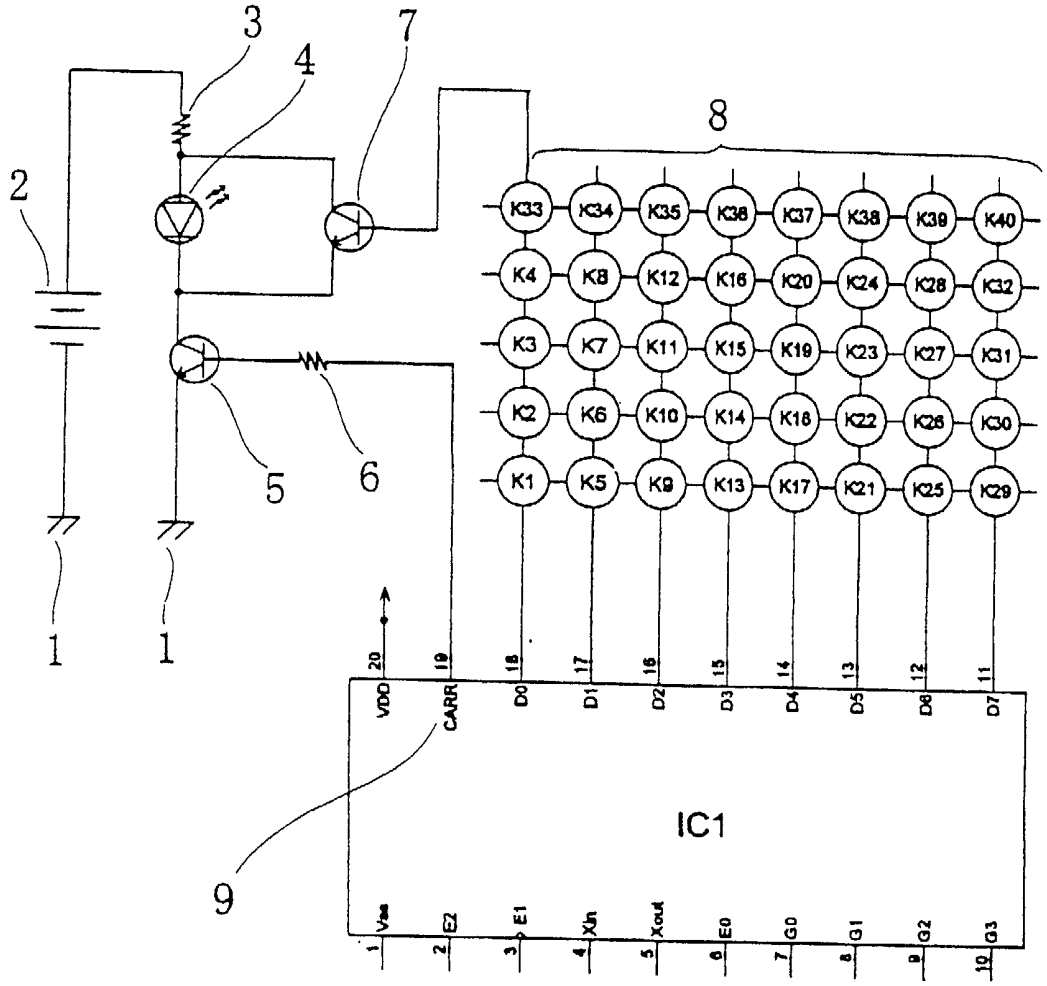
Fig. 1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K2 K6 K10 K14 K18 K22 K26 K30
K1 K5 K9 K13 K17 K21 K25 K29
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1
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20 19 18 17 16 15 14 13 12 11
VDD CARR D0 D1 D2 D3 D4 D5 D6 D7
IC1
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1 Vss 2 E2 3 E1 4 Xin 5 Xout 6 E0 7 G0 8 G1 9 G2 10 G3

Fig. 2

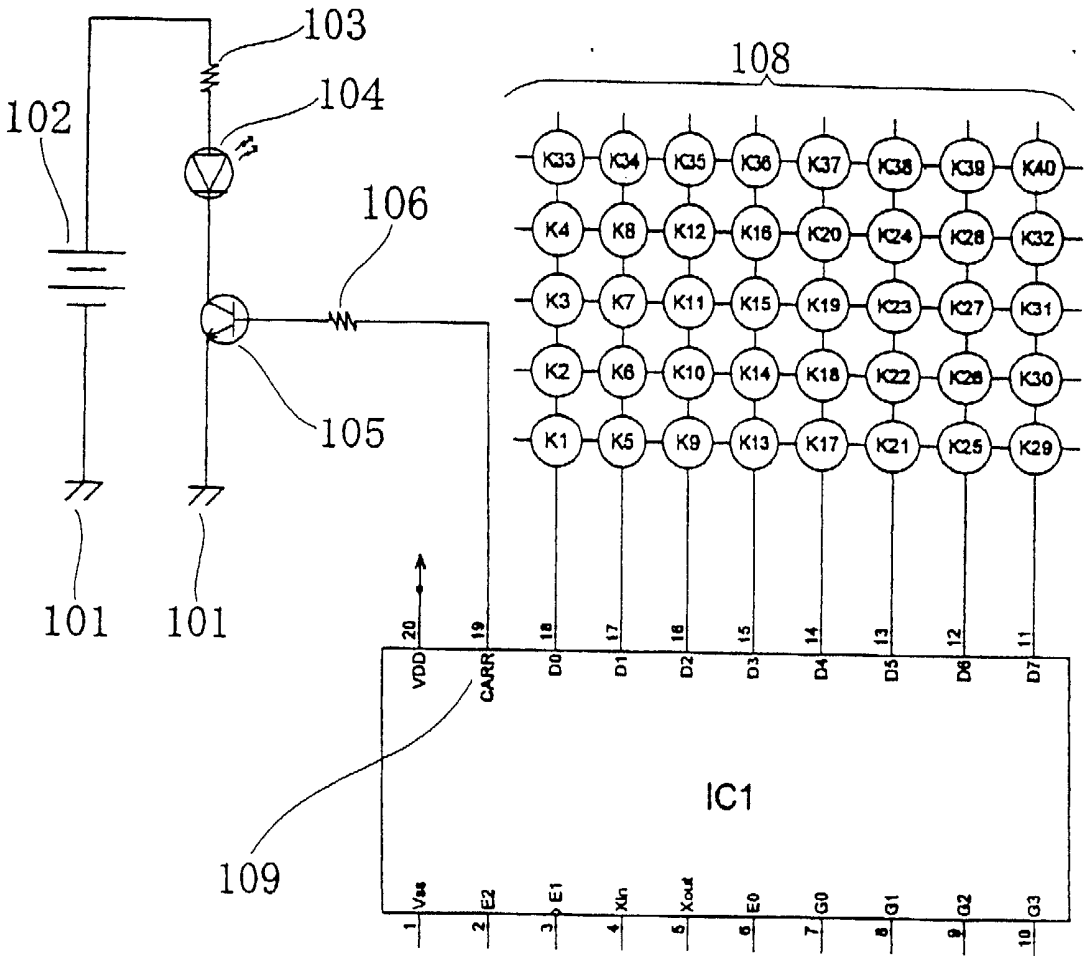
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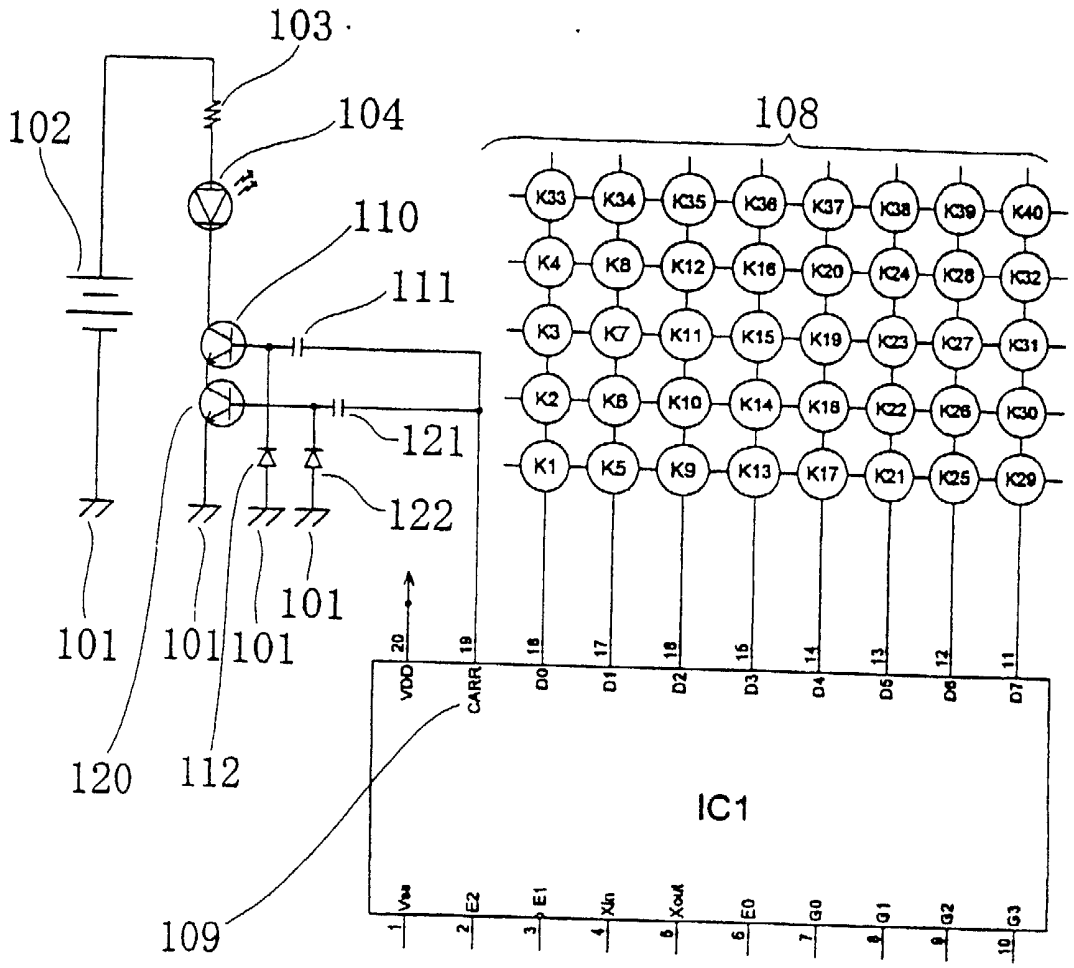
Fig. 3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INFRARED LED DRIVER FOR REMOTE CONTROL TRANSMITTER

The present invention relates to a driving circuit for an infrared light emitting diode used in a remote control transmitter for remotely controlling various electric appliances such as a television receiver, air conditioner and audio system.

Users of the remote control transmitter for the above-mentioned electric appliances press the key pads to generate a pulse signal modulated by a transmission data corresponding to the pressed keys, thereby driving an infrared light emitting diode (infrared LED).

The electric appliance receives the infrared light signal by using a sensor such as a photodiode.

One of the conventional driving circuit for the infrared LED used in the remote control transmitter is shown in Figure 2.

The cathode of battery 102 is grounded at GND 101, while the battery anode is connected with resistance 103 which is connected in series with the anode of the infrared LED.

Further, the cathode of the infrared LED is connected with the collector of transistor 105 of which emitter is grounded at GND 101.

The base of transistor 105 is connected with pulse signal output terminal 109, through resistance 106 if necessary.

Infrared LED 104 emits infrared light, in accordance with the pulse signal.

Operation key 108 is also shown in Figure 1.

However, the above-explained conventional infrared LED driver has a disadvantage that an intense infrared light is continuously

emitted by a continuous current in the infrared LED, when transistor 105 has a trouble such as a short circuit between the emitter and the collector, or when transmission pulse signal output terminal (CAAR) 109 becomes at a continuous high level due to some trouble.

Further, an accidental exposure of a human eye to an intense infrared light becomes an issue of safety recently.

Accordingly, a protection circuit as shown in Figure 3 is designed in order to solve those disadvantages.

Transistor 120 is connected in series with transistor 110 in such a manner that infrared LED 104 does not emit light, even when transistor 110 has a trouble. Further, direct current cut condensers 111, 121 as well as counter electromotive force protection diodes 112, 122 are provided in order to suppress base currents of transistor 110,120, respectively, even when transmission pulse signal output terminal (CAAR) 109 becomes at a continuous high level due to some trouble.

However, the above-explained protection circuit has a disadvantage that additional electric parts are required, the current in the infrared LED is lowered by an increased collector to emitter voltage due to the additional transistor connected in series, and a waveform of the pulse signal passing through the dc cut condensers 111,112 is distorted by charge and discharge in the condensers, when the remote controller is operated.

It would be desirable to be able to provide a simple and stable infrared LED driver for preventing the LED from emitting a continuous intense infrared light, when there occurs a single trouble mode defined by only one trouble in one of active elements in the

infrared LED driver in the remote control transmitter.

The infrared LED driver of the present invention comprises: a first NPN transistor connected with the infrared LED connected in a forward direction with a voltage source power; and a second NPN transistor of which collector is connected with the anode of the LED and of which emitter is connected with the cathode of the LED. The second NPN transistor is connected in parallel with the LED. Here, the base of the first transistor is connected with the pulse signal output terminal.

The second NPN transistor bypasses the current which might pass through the LED, if the first NPN transistor has a trouble. Thus, the LED is not allowed to emit infrared light.

The first and/or second transistors may be of PNP type, so as to operate the base at low level. Further, the first and/or second transistors may be a P channel or N channel MOSFET. Further, the first transistor may be a NPN transistor, while the second transistor may be P channel FET, and so on. There is no limitation of selecting transistors for first and second transistor, as far as the transistors can be turned on and off.

Furthermore, in the present invention, the second transistor is in active state by activating its base, for example, by raising the base of the NPN transistor at high level, when the remote controller does not transmit a pulse output signal, or the remote controller is in a standby state.

According to the present invention, the infrared LED is not allowed to emit infrared light by activating, during the time when the remote controller does not transmit the pulse signal, the second transistor connected in parallel with the infrared LED. Therefore, the infrared LED does not emit infrared light, even when the first

transistor has a trouble such as a short circuit.

Further, the infrared LED does not emit infrared light, at any case of single trouble mode when the first transistor has a trouble in a turned-off mode, when the second transistor has a trouble in a turned-off or short circuit mode, when the CARR terminal has a trouble in a turned-off mode, or when the infrared LED has a trouble in a turned-off or short circuit mode.

Thus, the infrared LED driver of the present invention is a simple and stable driver, due to a fewer electronic parts compared with the conventional driver. Further, the infrared LED driver of the present invention does not distort the pulse waveform.

By way of example only, the invention will now be described in greater detail with reference to the accompanying drawings of which:

Figure 1 is an exemplary circuit diagram of the infrared LED driver of the present invention.

Figure 2 is a circuit diagram of one of the conventional infrared LED driver.

Figure 3 is a circuit diagram of one of the conventional infrared LED driver with elements for circuit protection.

Preferred embodiment of the present invention is explained, referring to Figure 1.

The cathode of power source (battery) 2 is grounded at GND 1, while the anode is connected, through resistance 3, with infrared LED 4 in a forward direction.

The cathode of infrared LED 4 is connected with the collector of first transistor 5 and its emitter is grounded at GND 1.

The base of transistor 5 is connected, through resistance 6, with

pulse signal output terminal (CARR) 9 of an integrated circuit.

Infrared LED is connected in parallel with second NPN transistor 7 in such a manner that the collector of the NPN transistor 7 is connected with the anode of infrared LED 4 and the emitter of the NPN transistor 7 is connected with the cathode of infrared LED 4. Further, the base of transistor 7 is connected with terminals D0 of the IC, through an operation key 8. The transistor 7 is turned on, or in other words, the base of the NPN transistor 7 is made high (if the second transistor is of PNP in place of NPN transistor, the base of the PNP transistor is made low), when the pulse signal is not outputted, or in other words, when any one of operation keys in any row not pressed.

When the emitter and collector of first transistor 5 are short-circuited due to a trouble, the battery current flows in second transistor 7, thereby inhibiting infrared LED 4 from emitting infrared light, because the anode to cathode voltage becomes lower than a forward direction threshold voltage for emitting infrared light.

Second transistor 7 is made active except the case when the pulse signal is outputted. Therefore, the battery current bypasses transistor 7. Accordingly, infrared LED does not emit infrared light, in a troubled state wherein the pulse signal output terminal (CARR) is made normally high, resulting in a normally on state of first transistor 5.

On the other hand, when operation key 8 is pressed for remote control signal transmission, the base voltage of second transistor 7 is made low, thereby tuning off second transistor 7 in order to allow infrared LED to emit infrared light in accordance with the pulse signal applied to the base of first transistor 5. In this case, the anode

to cathode voltage of said infrared LED is greater than a forward direction threshold voltage for emitting infrared light, when said second transistor is turned off when any one of said set of operation keys in any row is not pressed.

The infrared LED driver of the present invention may be applied to any appliances relating the infrared communication wherein infrared light is emitted by a pulse signal, such as electronic pocket notebook, portable digital assistant, code-less headphone, or infrared communication between audio visual systems.

CLAIMS

1. An infrared LED driver for an infrared communication appliance which comprises:

a voltage source;

a set of operation keys for generating a pulse signal;

a pulse signal output terminal for outputting said pulse signal;

an infrared LED connected with said voltage source in a forward direction;

a first transistor connected in series with said infrared LED; and

a second transistor connected in parallel with said infrared LED, wherein:

the base of said first transistor is connected with said pulse signal output terminal; and

the base of said second transistor is connected with said set of operation keys.

2. The infrared LED driver according to claim 1, wherein said infrared communication appliance is a remote control transmitter, electronic pocket notebook, personal digital assistance, code-less headphone, or audio visual appliance for communicating with another audio visual appliance.

3. The infrared LED driver according to claim 1 or claim 2, wherein said second transistor is turned on, when said pulse signal output terminal does not output any pulse signal, while said second transistor is turned off, when said pulse signal output terminal outputs a pulse signal.

4. The infrared LED driver according to any one of claims 1 to 3, wherein said first transistor is a PNP or NPN transistor, while said second transistor is a PNP or NPN transistor.

5. The infrared LED driver according to any one of claims 1 to 4,

wherein said first transistor is a P channel or N channel MOSFET, while said second transistor is a P channel or N channel MOSFET.

6. The infrared LED driver according to any one of claims 1 to 3, wherein either of said first or said second transistor is a NPN or PNP transistor, while the other of said first or said second transistor is a P channel or N channel MOSFET.

7. The infrared LED driver according to claim 3, wherein the anode to cathode voltage of said infrared LED is lower than a forward direction threshold voltage for emitting infrared light, when said second transistor is turned on when any one of said set of operation keys in any row is not pressed.

8. The infrared LED driver according to claim 3, wherein the anode to cathode voltage of said infrared LED is greater than a forward direction threshold voltage for emitting infrared light, when said second transistor is turned off when any one of said set of operation keys in any row is not pressed.

9. An infrared LED driver for an infrared communication appliance substantially as described with reference to and as illustrated by Fig. 1 of the accompanying drawings.

Application No:	GB 0301134.3	**Examiner:**	Matthew Nelson
Claims searched:	1-9	**Date of search:**	10 June 2003

Patents Act 1977 : Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance	
A		US 5742133	(WILHELM et al) See the abstract and figure 1.
A		US 5140175	(YAGI et al) See the abstract and figure 1.
A		JP 110008588 A	(FURUKAWA ELECTRIC) See online abstract.
A		JP 030034477 A	(SONY & MITSUBISHI) See online abstract and figure 1.
A		JP 020305296 A	(SANYO) See online abstract and figure 1.
A		JP 020128533 A	(TOSHIBA) See online abstract and figures 1 and 2.

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	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[V]:

H4B

Worldwide search of patent documents classified in the following areas of the IPC[7]:

H04B

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

WPI, EPODOC, JAPIO