(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
19 December 2024 (19.12.2024)

WIPO | PCT

(10) International Publication Number
WO 2024/256212 A1

(51) International Patent Classification:
H05B 45/375 (2020.01)

(21) International Application Number:
PCT/EP2024/065296

(22) International Filing Date:
04 June 2024 (04.06.2024)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
PCT/CN2023/099604 12 June 2023 (12.06.2023) CN
23181959.0 28 June 2023 (28.06.2023) EP

(71) Applicant: **SIGNIFY HOLDING B.V.** [NL/NL]; High Tech Campus 48, 5656 AE Eindhoven (NL).

(72) Inventors: **ZOU, Rui**; c/o High Tech Campus 7, 5656 AE Eindhoven (NL). **WANG, Qing, Xue**; c/o High Tech Campus 7, 5656 AE Eindhoven (NL).

(74) Agent: **VAN EEUWIJK, Alexander, Henricus, Waltherus** et al.; High Tech Campus 7, 5656 AE Eindhoven (NL).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CV, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IQ, IR, IS, IT, JM, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, MG, MK, MN, MU, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, WS, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, CV, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SC, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, ME, MK, MT, NL, NO, PL, PT, RO, RS, SE,

(54) **Title:** A LED LIGHTING CIRCUIT AND A LED LIGHTING DEVICE

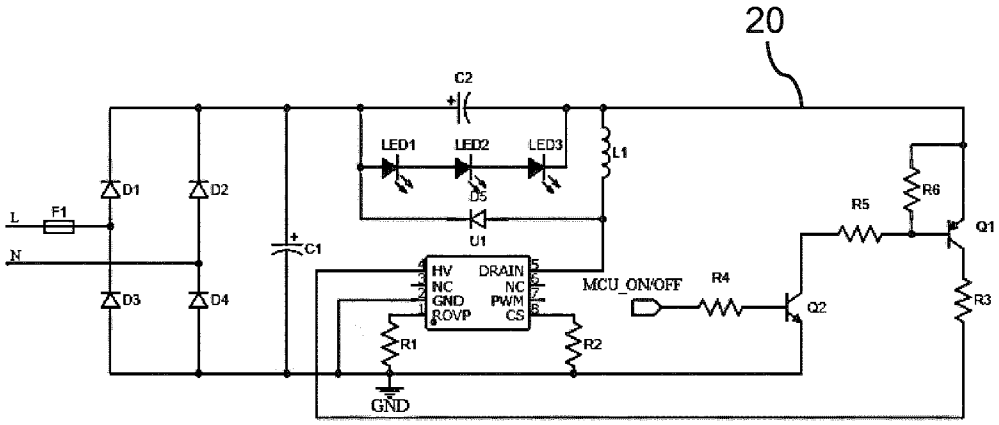

FIG. 3

(57) **Abstract:** Provided a LED lighting circuit comprising a LED string (LED1, LED2, LED3) comprising at least one LED (LED3); an input interface adapted to connect and receive an input power; an output interface connecting to the LED string (LED1, LED2, LED3) and outputting an output power; a controller circuit (U1) adapted to control the LED lighting circuit, and comprising a supply terminal (HV) to receive a supply voltage; and a connection circuit (20) connecting said supply terminal to a cathode of one LED (LED3) in the LED string such that the supply voltage is retrieved in sequence of from the input interface, via an anode of the LED, the LED (LED3), the cathode of the LED and to the supply terminal, characterized in that further comprising; a controlling interface to receive a command to instruct said LED lighting circuit to switch into a non-light-emitting mode; and a switching circuit adapted to manipulate said connection circuit (20) so that the supply voltage is decoupled from going through the LED (LED3) via the anode and cathode of the LED when in the non-light-emitting mode. Glow and power loss on the LED in the non-light-emitting mode are prevented.

WO 2024/256212 A1

[Continued on next page]

SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

— *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*

Published:

— *with international search report (Art. 21(3))*

— *in black and white; the international application as filed contained color or greyscale and is available for download from PATENTSCOPE*

A Led Lighting Circuit And A Led Lighting Device

FIELD OF THE INVENTION

The present invention relates to the field of LED lighting, and in particular to a circuit used for powering the LED.

BACKGROUND OF THE INVENTION

At present, with the overall downward pressure on the global economy accumulating, affected by factors such as poor global supply chain and international conflicts, the shortage of natural gas, electricity and oil products in the world is getting worse and worse and global energy prices are soaring, which has deepened the concerns of countries all over the world about energy security. As lighting is a major energy consumer, improving the utilization rate of energy has become an important goal of major companies. The applicant has introduced products with energy efficiency as high as 210lm/W (called as class A) to adapt to the market.

Figure 1 shows a typical schematic for class A bulb. Usually, L and N are the input interface to receive an input AC mains voltage. F1 is a fuse. Diodes D1 to D4 form a rectifier bridge. Capacitor C1 is a bulk/Vbus capacitor to smooth the power provided by the rectifier bridge. Inductor L1, diode D5, and IC chip U1 form a buck converter. The output of the buck converter is connected to a LED string of LED1, LED2 and LED3, with an output capacitor C2 connected in parallel with the LED string. The power supply terminal HV of the IC chip is connected to the positive output of the rectifier/ anode terminal of the capacitors C1/C2. Under the input of 230V rms AC, the highest voltage of the anode terminal of the capacitor C1/C2 reaches 325V. The working current of the IC chip could be chosen as 400uA, and therefore the power consumption of the IC chip is 130mW. For a 4.3W class A bulb, there will be 3% efficiency loss, which is obviously needs to be reduced.

US2022240356A1 dislcoses a LED control device with a controller. The controller is connected to a + voltage of a driving power via a power supply, and is connected to a – voltage of the driving power.

SUMMARY OF THE INVENTION

Fig. 2 shows an improved schematic for class A bulb. Components that are similar as those in figure 1 would not be described again. The significant difference is the supply terminal HV of the IC chip is connected to the cathode of the last LED, in a direction of anode to cathode, in the LED string via a connection circuit 20. The LED string has a substantial forward voltage such as 200V in one typical product, and the supply voltage of the IC chip is clamped down from the peak voltage of the rectifier output by 200V, and is only around 125V. And the power consumption of the IC chip will be reduced to 50mW, the efficiency will only be lost by 1.2% whereas and the efficiency will be improved by 1.8%.

WO2011027299 discloses a relevant circuit.

The inventors finds that the circuit in fig. 2 has some side effect. When the user commands the lamp into OFF/standby state such as via APP or light control system, the IC chip works in standby, and the working current of the IC chip still flow/leak through the LED string and will make the LED string slightly bright/glow. Not only the glow may annoy user especially in the night, but also the leakage current through the LED string causes power loss on the LED string regardless of whether visible glow is generated or not. Thus it is needed to avoid the leakage current through the LED string. This problem does not only relate to a driver IC that controls a switched mode power supply in the lighting circuit, but also applies for other controller integrated circuits such as MCU if other controller integrated circuits also tap the supply voltage via the LED: the operation of MCU in standby also produce a small current leakage through the LEDs to emit glow and cause power loss on the LEDs.

A basic idea of the present invention is to manipulate, in a non-light-emitting mode of the LED lighting circuit, the abovementioned circuit for the supply voltage in such a way that the supply voltage to the controller integrated circuit is decoupled from going through the LEDs.

In a first aspect of the invention, it is provided a LED lighting circuit comprising a LED string comprising at least one LED; an input interface adapted to connect and receive an input power; an output interface connecting to the LED string and outputting an output power; a controller circuit adapted to control the LED lighting circuit, and comprising a supply terminal to receive a supply voltage; and a connection circuit connecting said supply terminal to a cathode of one LED in the LED string such that the supply voltage is retrieved in sequence of from the input interface, via an anode of the LED, the LED, the cathode of the LED and to the supply terminal characterized in that further comprising; a controlling interface to receive a command to instruct said LED lighting circuit to switch into a non-light-emitting mode; and a switching circuit adapted to manipulate said connection circuit so that the supply voltage is

decoupled from going through the LED via the anode and cathode of the LED when in the non-light-emitting mode.

In this aspect, the connection circuit is manipulated so that the supply voltage is decoupled from going through the LED when in the non-light-emitting mode. Thus the LEDs would not glow and annoy the user. Even more, the removal of glow also reduces the power loss on the LED in the non-light-emitting mode.

In one embodiment, the switching circuit is adapted to cut off the supply connection. In this embodiment, the connection circuit is cut off thus prevent any current flowing through the LED string.

In one embodiment, the supply terminal is adapted to receive a positive voltage.

In an alternative embodiment, said LED driving circuit further comprises a switchable second supply connection in parallel with said LED string, and the switching circuit is adapted to conduct the switchable second supply connection thereby bypassing the LED string in the non-light-emitting mode, and cut off said second switchable second supply connection otherwise.

In an even alternative embodiment, said LED driving circuit further comprises a third supply connection electrically connecting the supply terminal and the input interface without passing through the LED string, and the switching circuit is adapted to enable said third supply connection and connect the supply terminal to the input interface thereby bypassing the connection circuit in the non-light-emitting mode, and to disable said third supply connection otherwise.

In those two alternative embodiments, the supply voltage comes from a different location without passing through the LEDs thus prevents glow and power loss on the LEDs, meanwhile the controller circuit is still operable for providing standby functions such as fast wake up etc..

In one embodiment, the switching circuit further comprises a voltage detector adapted to detect a voltage across the LED string, and the switching circuit is adapted to manipulate said connection circuit according to a detected voltage across the LED string.

In this embodiment, the switching circuit can determine whether the LED string has been turned off via the voltage across the LED string by itself, without needing a dedicated signal from another controlling device such MCU. The complexity of circuit is low.

In one embodiment, the LED is any one between the middle and the last LED in the string starting in a direction of forward bias. Preferably it is the last LED because the power loss on the controller circuit would be less. If the controller integrated requires a higher

supply voltage, the LED from which the supply voltage is tapped could also either be one in the last few LEDs, or the middle LED, and the power loss is also acceptable.

In one embodiment, said input interface is adapted to connect to either a rectified AC mains voltage; or an AC-DC converted voltage.

The input power to the input interface can either be unconverted AC voltage or an already converted DC voltage.

In one embodiment, said output interface comprises a positive terminal and a negative terminal, said LED string is connected to the positive terminal of the output interface via the anode of the LED string and to the negative terminal of the output interface via the cathode of the LED string, and said positive terminal of the output interface is electrically connected to a positive terminal of the input interface, thereby the supply voltage is clamped lower than a voltage on the positive terminal of the input interface by the LED.

In this embodiment, the supply voltage is the voltage on the input interface subtracted by the forward voltage of LEDs thus the supply voltage may be significantly lower than the voltage on the input interface, and the power loss on the controller circuit can be substantially reduced.

In one embodiment, the LED lighting circuit further comprises a switched mode power supply between the input interface and the output interface, and the controller circuit comprises a driver control IC adapted to control the switched mode power supply.

In another embodiment, the controller circuit comprises a micro controller unit (MCU), a sensor module or a RF communication module.

In one embodiment, said switched mode power supply comprises a buck converter wherein the LED string is connected to a positive terminal of the input interface and an inductor of the buck converter is connected to a negative terminal of the input interface. The embodiment of the invention is suitable for buck converter topology. Please note that other type of converter may also be applicable.

In a second aspect of the invention, it is provided a LED lighting device comprising the LED lighting circuit of the first aspect.

These and other aspects of the invention will be apparent from and elucidated with reference to the embodiment(s) described hereinafter.

BRIEF DESCRIPTION OF THE DRAWINGS

For a better understanding of the invention, and to show more clearly how it may be carried into effect, reference will now be made, by way of example only, to the

accompanying drawings, in which:

Figure 1 shows typical circuit schematic for class A bulb;

Figure 2 shows an improved circuit schematic for class A bulb;

Figure 3 shows a schematic of a LED lighting circuit according to an embodiment of the invention;

Figure 4 shows a schematic of a LED lighting circuit according to another embodiment of the invention; and

Figure 5 shows a schematic of a LED lighting circuit according to yet another embodiment of the invention.

DETAILED DESCRIPTION OF THE EMBODIMENTS

The invention will be described with reference to the Figures.

It should be understood that the detailed description and specific examples, while indicating exemplary embodiments of the apparatus, systems and methods, are intended for purposes of illustration only and are not intended to limit the scope of the invention. These and other features, aspects, and advantages of the apparatus, systems and methods of the present invention will become better understood from the following description, appended claims, and accompanying drawings. It should be understood that the Figures are merely schematic and are not drawn to scale. It should also be understood that the same reference numerals are used throughout the Figures to indicate the same or similar parts.

Figure 3 to figure 5 shows several embodiments of the invention. In figure 3, similar as figures 1 and 2, L and N are the input interface to receive an input AC mains voltage. F1 is a fuse. Diodes D1 to D4 form a rectifier bridge. Capacitor C1 is a bulk capacitor to smooth the voltage/power proved by the rectifier bridge. Inductor L1, diode D5, and IC chip U1 form a buck converter. The output of the buck converter is connected to a LED string of LED1, LED2 and LED3, with an output capacitor C2 connected in parallel with the LED string. The power supply terminal HV of the IC chip is connected to the cathode of the last LED LED3 in the LED string via a connection circuit 20.

The switching circuit in the embodiment in figure 3 comprises a switch Q1 and peripheral circuits including resistor R4, switch Q2, resistors R5, R6, and R3. The switch Q1 is implemented by a NPN transistor, and the switch Q2 is implemented by a PNP transistor.

When the user or the light control system commands the lamp in ON state, the LED lighting circuit has a control interface to receive a command sent by the user or the light control system, and the MCU of the LED lighting circuits outputs a high level, makes the

transistor Q2 on and the transistor Q1 ON, and the connection circuit 20 is close to supply power to the supply terminal HV of IC chip U1 through R3.

When the user or the light control system commands the lamp in a non-light-emitting/OFF/standby state, MCU outputs a low level to cut OFF the transistor Q2 and the transistor Q1, thus the connection circuit 20 is open, so as to prevent any current of the chip from flowing through the LED to make the LED emit light. The IC chip U1 stops working,

In some cases, the IC chip U1 needs work in the non-light-emitting mode, for example maintaining a voltage on the output capacitor C2 so as to provide a fast start up function. Or the controller circuit is MCU, sensor module or RF module that needs to keep operation in the non-light-emitting mode, the embodiments in figures 4 and 5 can be used.

More specifically, on top of the connection circuit 20, the LED lighting circuit further comprises another supply connection circuit to provide the supply voltage to the controller integrated circuit in standby mode, without passing the supply voltage through the LEDs.

In the embodiment in figure 4, the LED lighting circuit comprises a switchable second supply connection 40 in parallel with said LED string LED1, LED2 and LED3, and the switching circuit Q1 is adapted to conduct the switchable second supply connection 40 thereby bypassing the LED string in the non-light-emitting mode, and cut off said second switchable second supply connection 40 otherwise. The second supply connection 40 is connected to the positive output of the rectifier bridge and the supply terminal HV, in figure 4 it connects to the supply terminal HV via the connection circuit 20.

More specifically, when buck converter is operating to drive the LED string and the LED string is in the ON state, the voltage at both ends of the LED string, detected by the voltage detector R6 and R7 is high for example is higher than 200V. The output voltage of the voltage detector is high and turns on the transistor Q2, and turns off the MOSFET Q1, and the second supply connection 40 is cut off, and power supply current of the IC chip U1 flows into the supply terminal HV from the LED string through the original connection circuit 20.

When the buck converter is commanded by the MCU into standby mode, its output power does not drive the LED but only maintain a voltage across the capacitor C2 smaller than the forward voltage of the LED, and the LED is in OFF state. The voltage at both ends of the LED string drops to for example less than 170V. The output voltage of the voltage detector R6 and R7 is low, and the transistor Q2 is cut OFF. The MOSFET Q1 is in ON state, and the second supply connection 40 becomes close/conductive, and power supply current of the IC chip flows into the IC from the resistor R5 and the MOSFET Q1. The LED string is

substantially open thus would not conduct the supply current, and would not glow or generate power loss.

Fig. 5 shows an embodiment modified from the embodiment in fig. 4. There is a third supply connection 50 connecting the positive output of the rectifier bridge and the supply terminal HV directly, without passing through the connection circuit 20.

More specifically, when buck converter is operating to drive the LED string and the LED string is in the ON state, the voltage at both ends of the LED string, detected by the voltage detector R6 and R7 is high for example is higher than 200V. The output voltage of the voltage detector R6 and R7 is high and turns off the MOSFET Q1 via a certain MOSFET driving circuit such as Q2 in fig. 4, and the third supply connection 50 is cut off, and power supply current of the IC chip U1 flows into the supply terminal HV from the LED string through the original connection circuit 20.

When the buck converter is commanded by the MCU into standby mode, its output power does not drive the LED but only maintain a voltage across the capacitor C2 smaller than the forward voltage of the LED, and the LED is in OFF state. The voltage at both ends of the LED string drops to for example less than 170V. The output voltage of the voltage detector is low and turn on the MOSFET Q1, and the third supply connection 50 becomes close/conductive, and power supply current of the IC chip flows into the IC directly from the positive output of the rectifier bridge. The LED string is substantially open thus would not conduct the supply current, and would not glow or generate power loss.

Variations to the disclosed embodiments can be understood and effected by those skilled in the art in practicing the claimed invention, from a study of the drawings, the disclosure and the appended claims. For example, the cool white LED channel and the warm white LED channel can also be replaced by or added with red, green and blue LED channels.

In the claims, the word "comprising" does not exclude other elements or steps, and the indefinite article "a" or "an" does not exclude a plurality.

The mere fact that certain measures are recited in mutually different dependent claims does not indicate that a combination of these measures cannot be used to advantage.

If the term "adapted to" is used in the claims or description, it is noted the term "adapted to" is intended to be equivalent to the term "configured to". If the term "arrangement" is used in the claims or description, it is noted the term "arrangement" is intended to be equivalent to the term "system", and vice versa.

Any reference signs in the claims should not be construed as limiting the scope.

CLAIMS:

1. A LED lighting circuit comprising

a LED string (LED1, LED2, LED3) comprising at least one LED (LED3);

an input interface adapted to connect and receive an input power;

an output interface connecting to the LED string (LED1, LED2, LED3) and outputting an output power;

a controller circuit (U1) adapted to control the LED lighting circuit, and comprising a supply terminal (HV) to receive a supply voltage; and

a connection circuit (20) connecting said supply terminal to a cathode of one LED (LED3) in the LED string such that the supply voltage is retrieved in sequence of from the input interface, via an anode of the LED, the LED (LED3), the cathode of the LED and to the supply terminal,

characterized in that further comprising;

a controlling interface to receive a command to instruct said LED lighting circuit to switch into a non-light-emitting mode; and

a switching circuit adapted to manipulate said connection circuit (20) so that the supply voltage is decoupled from going through the LED (LED3) via the anode and cathode of the LED when in the non-light-emitting mode.

2. The LED driving circuit according to claim 1, wherein said switching circuit (Q1) is adapted to cut off the connection circuit (20), and the supply terminal is adapted to receive a positive voltage.

3. The LED driving circuit according to claim 1, wherein said LED driving circuit further comprises a switchable second supply connection (40) in parallel with said LED string, and the switching circuit (Q1) is adapted to

conduct the switchable second supply connection (40) thereby bypassing the LED string in the non-light-emitting mode, and

cut off said second switchable second supply connection (40) otherwise.

4. The LED driving circuit according to claim 1, wherein said LED driving circuit further comprises a third supply connection (50) electrically connecting the supply terminal (HV) and the input interface without passing through the LED string, and the switching circuit (Q1) is adapted to

enable said third supply connection (50) and connect the supply terminal (HV) to the input interface thereby bypassing the connection circuit (20) in the non-light-emitting mode, and

to disable said third supply connection (50) otherwise.

5. The LED lighting circuit of claim 3 or 4, wherein the switching circuit further comprises a voltage detector adapted to detect a voltage across the LED string (LED1, LED2, LED3), and the switching circuit is adapted to manipulate said connection circuit (20) according to a detected voltage across the LED string (LED1, LED2, LED3).

6. The LED lighting circuit of claim 1, wherein the LED is any one LED between a middle LED to the last LED in the LED string starting in a direction of forward bias, preferably the last LED.

7. The LED lighting circuit of claim 1, wherein said input interface is adapted to connect to either

A rectified AC mains voltage; or

An AC-DC converted voltage.

8. The LED lighting circuit of claim 7, wherein said output interface comprises a positive terminal and a negative terminal, said LED string is connected to the positive terminal of the output interface via the anode of the LED string and to the negative terminal of the output interface via the cathode of the LED string, and

said positive terminal of the output interface is electrically connected to a positive terminal of the input interface, thereby the supply voltage is clamped lower than a voltage on the positive terminal of the input interface by the LED.

9. The LED lighting circuit of claim 1, further comprises a switched mode power supply between the input interface and the output interface, and

the controller circuit (U1) comprises

a driver control IC adapted to control the switched mode power supply,

a micro controller unit; and/or

a sensor module or a RF communication module.

10. The LED lighting circuit of claim 1, wherein said switched mode power supply comprises a buck converter wherein the LED string is connected to a positive terminal of the input interface and an inductor (L1) of the buck converter is connected to a negative terminal of the input interface.

11. A LED lighting device comprising the LED lighting circuit of any of claims 1 to 10.

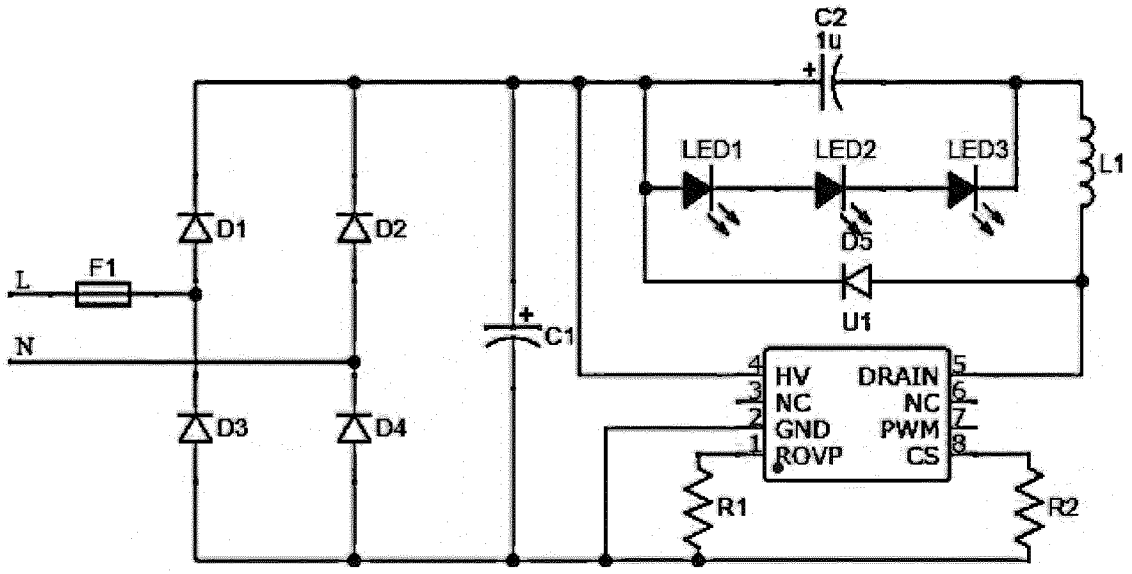
C2
1u
LED1
LED2
LED3
L1
D1
D2
L
F1
N
D5
U1
C1
HV
NC
GND
ROVP
DRAIN
NC
PWM
CS
D3
D4
R1
R2

FIG. 1

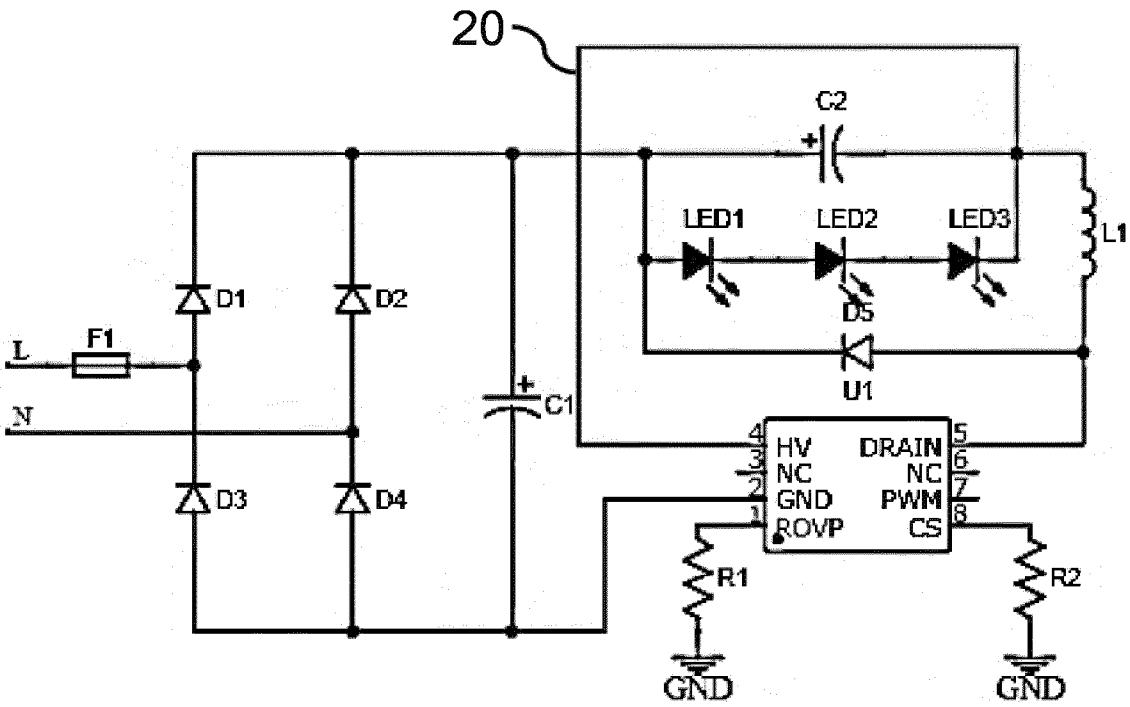
20
C2
LED1
LED2
LED3
L1
D1
D2
L
F1
N
D5
U1
C1
HV
NC
GND
ROVP
DRAIN
NC
PWM
CS
D3
D4
R1
R2
GND
GND

FIG. 2

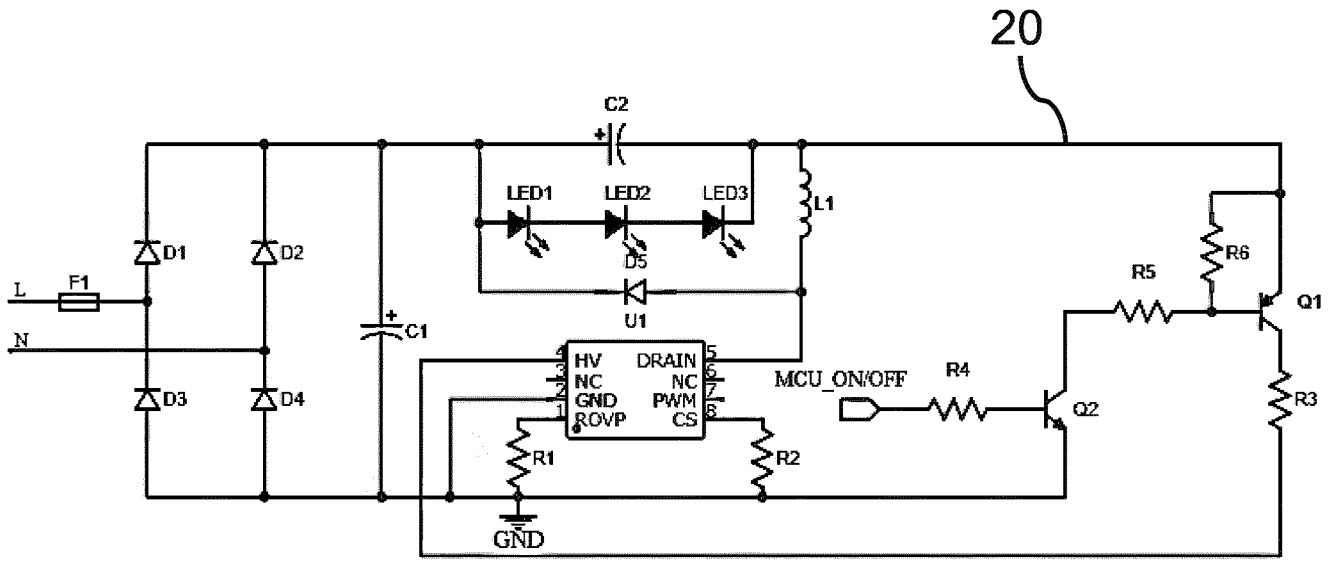
20
C2
LED1
LED2
LED3
L1
D5
U1
L
F1
N
D1
D2
D3
D4
C1
HV
NC
GND
ROVP
DRAIN
NC
PWM
CS
R1
R2
GND
MCU_ON/OFF
R4
Q2
R5
R6
Q1
R3

FIG. 3

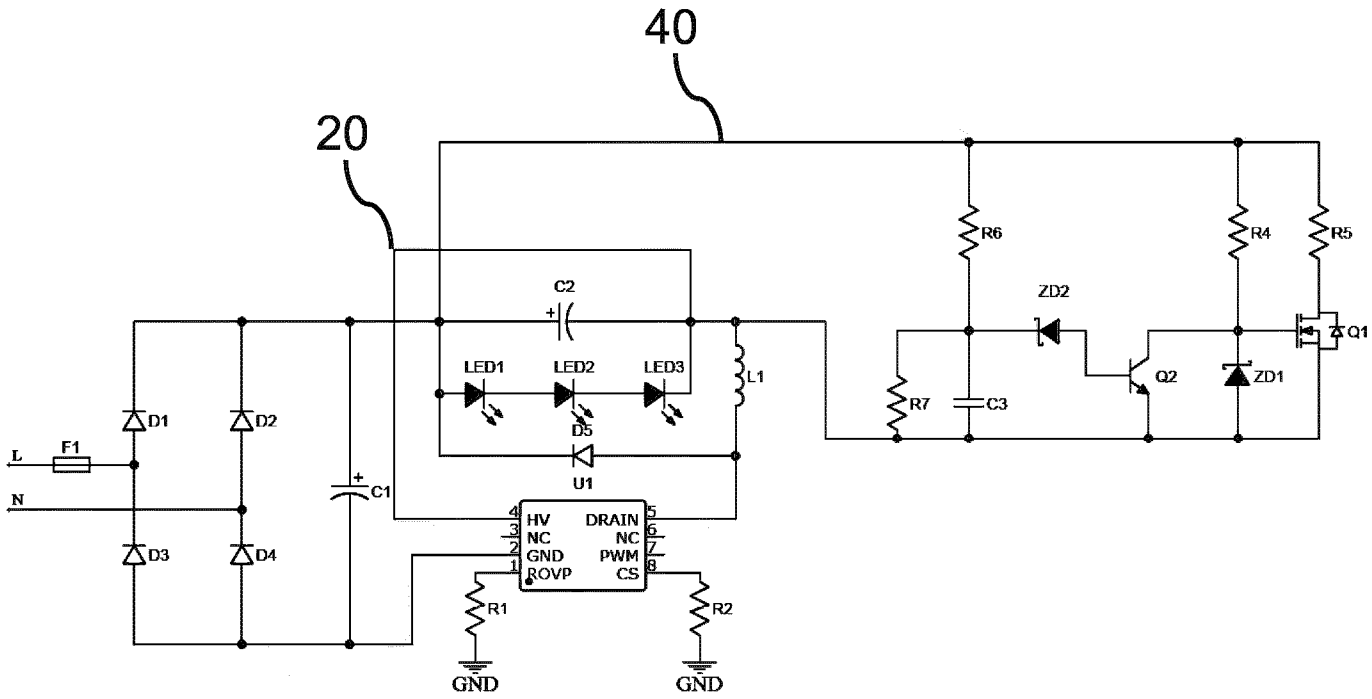
40
20
C2
LED1
LED2
LED3
L1
D5
U1
L
F1
N
D1
D2
D3
D4
C1
HV
NC
GND
ROVP
DRAIN
NC
PWM
CS
R1
R2
GND
GND
R6
ZD2
R4
R5
Q1
Q2
ZD1
R7
C3

FIG. 4

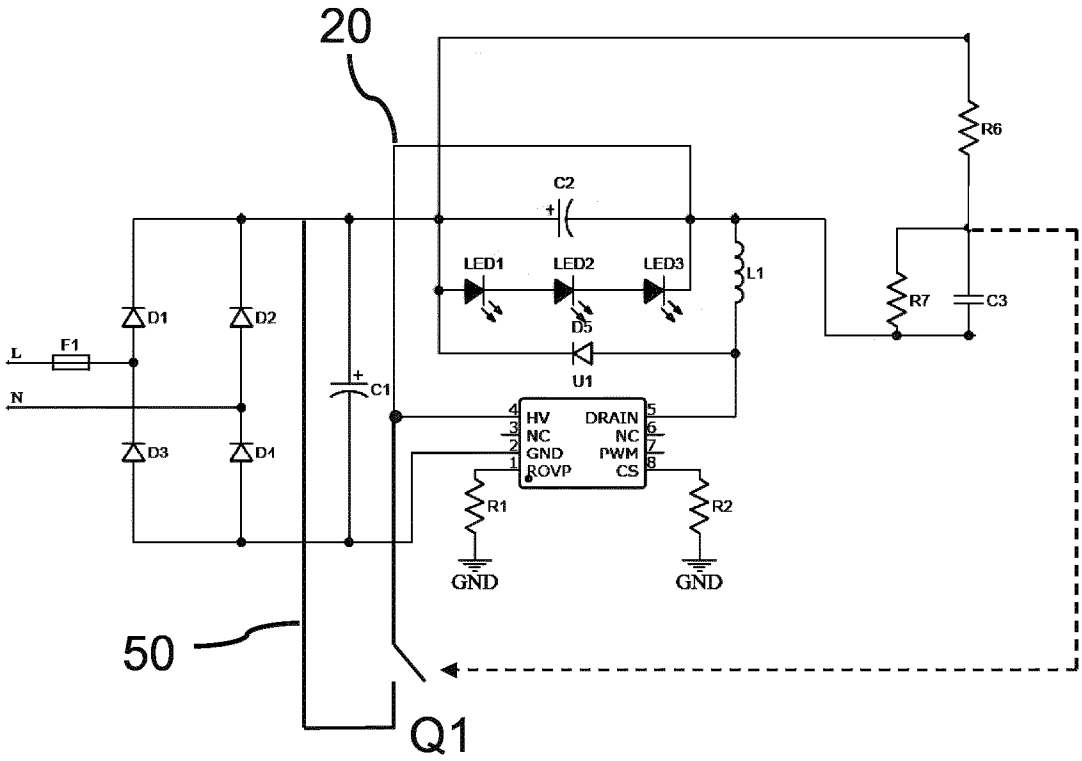
20
R6
C2
LED1
LED2
LED3
L1
R7
C3
D5
U1
D1
D2
L
F1
N
C1
D3
D4
HV
NC
GND
ROVP
DRAIN
NC
PWM
CS
R1
R2
GND
GND
50
Q1

FIG. 5

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2024/065296

A. CLASSIFICATION OF SUBJECT MATTER
INV. H05B45/375
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
H05B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2022/240356 A1 (LEE BONGJIN [KR] ET AL) 28 July 2022 (2022-07-28) paragraphs [0005] - [0063]; claim 15; figures 5,6	1-11
A	WO 2009/013676 A2 (NXP BV [NL]; HOOGZAAD GIAN [NL]) 29 January 2009 (2009-01-29) page 5, lines 11-16; figures 1-8	1,3,5,9, 10
A	US 2019/268984 A1 (SONG ZHI HUA [US] ET AL) 29 August 2019 (2019-08-29) paragraph [0030]; figure 1	1,4,5,10

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance;; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance;; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
3 September 2024	17/09/2024

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Henderson, Richard

Form PCT/ISA/210 (second sheet) (April 2005)

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2024/065296

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2022240356 A1	28-07-2022	CN 114900915 A	12-08-2022
		DE 102021134022 A1	28-07-2022
		KR 20220107485 A	02-08-2022
		US 2022240356 A1	28-07-2022
WO 2009013676 A2	29-01-2009	CN 101779522 A	14-07-2010
		EP 2177080 A2	21-04-2010
		US 2010194274 A1	05-08-2010
		WO 2009013676 A2	29-01-2009
US 2019268984 A1	29-08-2019	TW 201941662 A	16-10-2019
		US 2019268984 A1	29-08-2019
		WO 2019169014 A1	06-09-2019