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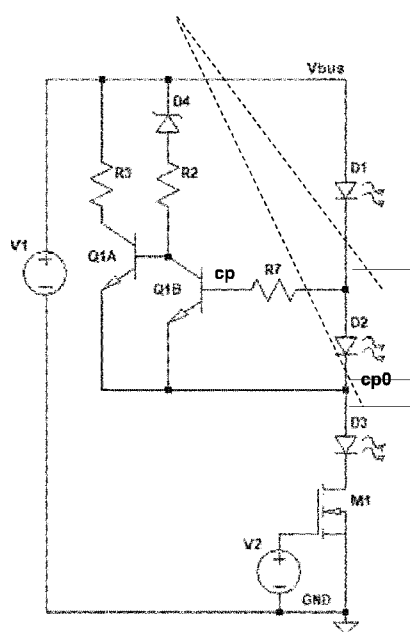


FIG. 2

(57) Abstract: It is proposed a LED light strip comprising a series arrangement of LEDs (D1, D2, and D3), wherein the series arrangement of LEDs is distributed along the length direction of the LED light strip, a conduction circuit connected between a positive input (Vbus) and remaining LED (D3) of the LEDs, and a control circuit comprising a sensing terminal (cp) connected to an intermediate interconnection in the series arrangement of LEDs, and adapted to sense a voltage originating from the positive input (Vbus) and via a first LED (D1), and the control circuit is adapted to deactivate or activate the conduction circuit according to the sensing terminal's sensing; characterized in that the sensing terminal (cp) is further adapted to sense a time instant of cutting the first LED (D1); and the control circuit is adapted to activate the conduction circuit when the sensing terminal (cp) has sensed the time instant of cutting the first LED (D1). The early activation of the conduction circuit prevents an interruption of the current and an abrupt response of any driver due to the interruption, and thus prevents a transient/surge current to the remaining LED caused by the abrupt response of the driver.

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LED LIGHTING CIRCUIT AND CUTTABLE LED LIGHT STRIP COMPRISING THE SAME

FIELD OF THE INVENTION

This invention relates to LED lighting circuit. In particular it relates to a LED lighting circuit with a failure-tolerated circuit, and a cuttable LED light strip comprising the same.

5 BACKGROUND OF THE INVENTION

LED strips become quite popular in replacing the traditional light strip, thanks to its small size or footprint, power efficiency, etc. The LED strip comes in a form of a strip comprising multiple LEDs connected in series and placed along a length of the strip. The LED strip could be made very long in the factory, and is cut by the user on site. Due to cost
10 limit, the LED strip is not cuttable at every connection position between every two neighboring LEDs. Several LEDs are placed in series with one current regulator, and they form an uncuttable cell or unit. Multiple of such cells are connected in parallel and are connected to a power supply such as a voltage source. The cells are placed one to one along the length of the strip. The cutting of the LED strip is done cell by cell, meaning that the LED
15 strip is designed to be cut at the connection of the cells such that the remaining cell after cutting is still a whole and can emit light. If cut at a random position of a cell, namely cut at a random LED of the series LED in that cell, the remaining LED in that cell can not emit light and is thus wasted.

US20190032870A1, as shown in fig. 1 of the drawings of this application,
20 discloses a cuttable LED strip with series LEDs between a bus voltage and ground, wherein there is one conduction circuit for each LED to allow a random cut. Each conduction circuit is connected between the bus voltage and one respective LED, and has a sensing leg 640 connected also to the bus voltage. The conduction circuit is open by default. The cutting cuts off the sensing leg, and a loss of the bus voltage on the sensing leg would trigger the
25 conduction circuit to become close to conduct current from the bus to the remaining LEDs. In this way, the LED strip is cuttable in a random position.

SUMMARY OF THE INVENTION

It is an insight of the inventors that the cuttable LED strip in the mentioned prior art can not tolerate a failure or open of a LED, such as the LED at the beginning of the series connection. When such LED is open, the whole series connection of LEDs is open and no current can flow through; the conduction circuit, since its sensing leg's connection to the bus voltage is still intact, is also not activated and open. The remaining LED after the failed/open LED would not receive current and not emit light, and the whole LED light strip is black out. Another potential risk of the prior art is in hot cut, meaning the lighting strip is cut when it is powered on. The user's scissor may short circuit point N4 and GND, after it cuts line 640. The switch Q2 is already made conductive and is directly between the positive line PWR and the negative or zero line GND, and the switch Q2 may be overheated and break down.

It is a concept of the invention to use the upstream LED's voltage conduction for the input supply as a metric to determine whether the series arrangement of LEDs, more specifically, the upstream LED, is intact and is turned on. Here, whether the series arrangement of LEDs is intact covers situations including whether at least the upstream LED is cut away, whether the upstream LED fails and becomes open, etc.. Therefore, besides providing a cuttable series arrangement of LEDs, the concept of the invention also provides operability for at least some remaining LEDs in case that the upstream LED becomes open, so the series arrangement of LED would not go dark completely. This provides extra robustness of the LED lighting circuit and a better user experience. Note that the first LED could comprises a plurality of LED units.

EP2187705B1 discloses a LED circuit of a series connection of a first LED 402A and a second LED 402N, wherein a voltage sensing circuit 440 is adapted to sense a potential across the first LED 402A and to generate a signal indicating whether a fault (e.g., failure) has occurred in the first LED 402A based on the sensed potential. And the controller 408 receives the signal generated by the voltage sensing circuit 440 and activates the first switch Q21 to still conduct current to the second LED 402N when the sensed voltage is indicative of a fault occurrence. This prior art does not disclose using this circuit in a light strip.

The inventors find that a problem with this prior art when using it in the light strip. The light strip is often hot cut, meaning that the light strip is cut when it is already powered by the power supply. If hot cut the first LED 402A in this prior art, the proper cut position should be between the cathode of the first LED 402A and the interconnection point

of the first LED 402A and the second LED 402N. The moment the scissor touches the cut position, the voltage sensing circuit still senses the voltage from the first LED 402A; and the voltage sensing circuit only sense the absence of the voltage after that cut position was cut off, and the voltage sensing circuit starts to activate the switch Q21. However, the moment the cut position was cut off, the current through the LEDs was already disrupted, and the driver's output current control loop may respond to this disrupted current, such as taking this as insufficient output current and thus would try increase its output current. Given the driver's output current being increased, the moment the switch Q21 is activated, an increased transient output current may be conducted by the switch Q21 to the second LED 402N. This may damage the second LED 402N, such as decreasing its lifetime. In short, if the prior art EP2187705B1 is used in hot-cutable light strip, there would probably be an asynchronization between the activation of the switch Q21 and the driver's output control due to the hot cut, and this may lead to transient current through the LEDs.

A first aspect of the invention provides a LED light strip comprising a LED lighting circuit comprising: a positive input and a negative input; a series arrangement of LEDs connected between the positive input and the negative input, comprising a first LED whose anode is coupled to the positive input and a remaining LED whose cathode is coupled to the negative input and a conduction circuit connected between the positive input and an anode of the remaining LED; a control circuit, comprising a sensing terminal connected to an intermediate interconnection in the series arrangement of LEDs, and adapted to sense a voltage originating from the positive input and via the first LED, and the control circuit is adapted to deactivate or activate the conduction circuit according to the sensing terminal's sensing; characterized in that the sensing terminal is further adapted to sense a time instant of cutting the first LED; and the control circuit is adapted to activate the conduction circuit at the sensed time instant of cutting the first LED.

In this aspect, the sensing terminal senses a voltage that is derived via the first LED, thus whether the first LED (including the LED itself as well as its connection pads) is intact is detected and the conduction circuit is controlled accordingly. The proposed LED lighting circuit has more robustness against an incompleteness of the first LED. For example, if the first LED is removed or become open due to failure, the first LED is considered as incomplete.

More importantly, in case of hot cut when the light strip is powered, since the sensing terminal is also adapted to sense a time instant of cutting and the conduction circuit is activated at the sensed time instant, the current through the light strip is continuous, without

being interrupted. This power supply to the LEDs will not create, in response to an interrupted current, an abruptly changed output of the power supply. Thus when the LED is cut away completely, the conduction circuit would not conduct the abruptly changed output to the remaining LED and prevents the remaining LEDs from being influenced, damaged etc., by the abruptly changed output. The lifetime of the LED strip is guaranteed. To be noted, the term “time instant of cutting” means the action of cutting is happening, for example the user is cutting the light strip, and it does not mean that a part of the light strip has been cut away.

In an embodiment, the control circuit is adapted to deactivate the conduction circuit when the voltage is sensed; otherwise activate the conduction circuit when the voltage is not sensed.

In this embodiment, if there is an open in the first LED, the first LED would not conduct a voltage from the input thus there would be no voltage sensed by the sensing terminal, and the conduction circuit would be activated and try to conduct current to the remaining LED even the complete series arrangement can not conduct current. This provides more robustness.

In an embodiment, the control circuit is adapted to activate the conduction circuit to conduct a current from the positive input, through the remaining LED and to the negative input to light on the remaining LED.

In this embodiment, the remaining LED is still operable. The conduction circuit is able to provide current to the remaining LED and a complete black out of the light circuit is avoided when the first LED is open. This provides more robustness and a better user experience.

In an embodiment, the control circuit comprising a further sensing terminal, the sensing terminal and the further sensing terminal are adapted to together sense the time instant of cutting the first LED. Sensing the cutting via two terminals provides accuracy.

In an embodiment, the LED strip comprising a cut line cross both of the sensing terminal and the further sensing terminal, wherein the sensing terminal and the further sensing terminal are adapted to be short circuited by a cutting tool cutting along the cutting line. Inherently, if using a metal cutting tool such as a scissor or a knife, the cutting along the defined cut line will probably electrically connect the sensing terminal and the further sensing terminal, thus a short circuit/zero voltage across the two terminals may be used for detecting the cutting. This embodiment is accurate and low cost.

In an embodiment, the sensing terminal is connected to any interconnection

between a cathode of first LED and an anode of an upstream LED connected to the anode of the remaining LED.

In this embodiment, the sensing terminal would still keep a low voltage to maintain the conduction circuit being activated to power the remaining LED, since the sensing terminal would not receive a voltage because the any upstream LEDs are not conducting a voltage to the sensing terminal. Alternatively, the sensing terminal can also be connected to the remaining LED to activate the conduction circuit, and a latch circuit may have to be provided to latch the conduction circuit on afterwards, since the sensing terminal's voltage would change high by the conduction of the remaining LED.

In an embodiment, the control circuit comprises a second switch with a control terminal connected to the sensing terminal, said second switch is adapted to be close so as to deactivate the conduction path, when the voltage on the sensing terminal is high; otherwise be open so as to activate the conduction path, thereby conducting a current from the positive input (Vbus), through the remaining LED and to the negative input, when the voltage on the sensing terminal is low; and the second switch is connected to the further sensing terminal at the current flowing-out and adapted to be open when a voltage between the sensing terminal and the further sensing terminal is zero.

In this embodiment, a second switch is connected to the sensing terminal and the further sensing terminals, thus a voltage across the two terminals can be used for biasing/driving the second switch. The second switch automatically switches off when there is no voltage between the sensing terminal and the further sensing terminal in the moment of cutting, thus the response of the second switch is very quick.

In an embodiment, the remaining LED comprises a plurality of preferably series connected LEDs, and the first LED also comprises a plurality of preferably series connected LED units.

In this embodiment, any one of the LED unit in the first LED becoming open can be detected, and the remaining LED can have plurality of LED units to keep on emitting light. Optionally, the number of LED units in the first LED and that in the remaining LED are comparable, preferably the same substantially. The LED lighting circuit can tolerate a fair percentage of potential failure of the LED units in the whole LED lighting circuit, and still emit a fair percentage of light output.

In an embodiment, the conduction circuit comprises a first switch with a control terminal connected to a high bias voltage, optionally coupled to the positive input, and the second switch is connected to the control terminal of the first switch and with a

control terminal connected to the sensing terminal, said second switch is adapted to be closed so as to pull the control terminal of the first switch low and open the first switch, when the voltage on the sensing terminal is high; otherwise be opened so as to allow the high bias voltage to apply to the control terminal and close the first switch, when the voltage on the sensing terminal is low.

This embodiment provides a bridge implementation of the conduction circuit and the control circuit. More specifically, the switches can be implemented by bi-polar transistors or MOSFETs. The bridge implantation is quick and reliable.

In a further embodiment, the conduction circuit further comprises a current limiting component between the positive input and the first switch.

Since the LEDs before the remaining LED is switched out of the power loop, an excessive power is taken by the current limiting component to avoid an overcurrent or overpower on the remaining LEDs, and this protects the conduction circuit, the remaining LEDs (and optionally the current regulator mentioned below). Even further, in hot cutting, even if the first switch is short circuited to the ground by the scissor, the current limiting component between the first switch and the positive input can still limit a current through the first switch and protect the first switch.

In a further embodiment, the positive input and the negative input are adapted to receive a voltage supply, and the LED lighting circuit comprises a current regulator in series with the remaining LED and the negative input.

In this embodiment, the current regulator acts to convert the voltage supply into a desired current to drive the LED and emit light accurately since LED's light output is highly dependent on the current. The current regulator still works for the remaining LEDs after the first LED becomes incomplete and switched out of the power loop. Such a current regulator is widely used in light strip. As discussed above, the current regulator may respond abruptly to an interrupted current if without the present innovation. For example, when the LED is interrupted, the current regulator may switch into a saturation region from a linear amplification region in order to increase the current, in such a saturation region, the current regulator may not limit current. The moment the conduction circuit is activated, the power supply will be applied to the remaining LED without an effective regulation by the current regulator and a transient/surge to the LED may happen. With the present innovation, the conduction circuit is activated and the current through the LEDs and the current regulator is not interrupted, the current regulator would not take abrupt response during the cutting, and the current to the remaining LED is more stable.

The LED light strip comprising: a cuttable-away portion comprising at least the first LED, said cuttable-away portion is adapted to be cut away and create an open circuit in the series arrangement, and a remaining portion comprising the positive input, the conduction circuit, the remaining LED, the negative input, and the control circuit, said control circuit is adapted to activate the conduction circuit when the cuttable-away portion is cut away.

In this aspect, the first LED is intentionally made open by cutting away an upstream portion, of the series arrangement of the LEDs, including the first LED, and the remaining LEDs can still be powered by the conduction circuit. This enables an intermediate cuttable position in the LED light strip, and provides more flexibility in obtaining a desired length of the light strip.

In a further embodiment, the LED light strip comprises a plurality of the LED lighting circuits, colors of the LED in series arrangement of LEDs of the different LED lighting circuit are different, and the respective LEDs of the different LED lighting circuits are aggregated in proximity with each other so as to mix their light; and the cuttable-away portions of the different LED lighting circuits are aligned, and the remaining portions of the different LED lighting circuits are also aligned.

This provides a cuttable LED light strip with different colored LED to mix their light and provide adjust color output. The cuttable-away portion and remaining portion are aligned so the light output of different colors is still unified.

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:

Fig. 1 shows a circuit of a cuttable light strip in a prior art; and

Fig. 2 shows a LED lighting circuit according to an embodiment of the invention, and a schematic cutting of a LED light strip comprising the LED light circuit.

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.

The description will explain the embodiment of the invention in the sense of cutting the series arrangement of LEDs to create an open circuit of at least the first LED, and how the control circuit and the conduction circuit would operate to power the remaining or uncut LEDs. This is preferably implemented in a LED light strip wherein it is preferred to allow the remaining portion to keep operating after cutting the LED light strip into a desired length. It should be understood that in case that the first LED fails and opens due to aging, heating, etc., making the series arrangement to be interrupted, the control circuit and the conduction circuit will operate to power the remaining LEDs in a similar manner.

Figure 2 shows one cell or unit of the LED lighting circuit. The cell or unit is also in a strip form with a length, and the LEDs of the cell are distributed along the length. The LED light strip comprises a plurality of the cells, electrically connected in parallel and between a power supply, often a voltage supply. The cells are also placed, one by one, along a length of the whole LED light strip. The user may cut the LED light strip at a minimum of one cell or unit. The remaining cell or unit is still complete in terms of its series arrangement of the LED and is powered by the power supply. If the user does not need a full length of one cell or unit, the user would like to cut at somewhere within the cell and still hopes that the remaining portion of that cell can still emit light.

Figure 2 shows a circuit of one cell or unit of the LED lighting circuit, preferably placed in the LED light strip, according to an embodiment of the invention. The dash lines indicate how the LED light strip is designed to be cut.

The LED lighting circuit has a positive input V_{bus} and a negative input GND. In this example, positive means that the current flows to the LED lighting circuit through this positive input V_{bus} and negative means the current flows out of the LED lighting circuit through this negative input GND. Those two inputs are connected to the power supply V1 and deliver power for the LEDs. The power supply V1 is preferably a voltage source which regulates the voltage across V_{bus} and GND. Of course, the power supply could also limit the

output current below an upper limit to avoid overpower.

A series arrangement of LEDs, a first LED D1, a second LED D2 and a third LED D3 are connected between the positive input Vbus and the negative input GND. The first LED D1 is coupled with its anode to the positive input Vbus. The second LED D2 is coupled with its anode to the cathode of the first LED D1. The third LED D3 is coupled with its anode to the cathode of the second diode D2 and with its cathode to the negative input GND. In this example, only three LEDs are shown but it is to be understood that each of the first LED D1 and the third LED D3 could stand for a plurality of LED units coupled in series, so could the second LED D2.

If the LED light strip is not cut, the series arrangement of LEDs is intact and all LEDs in the series arrangement emit light.

The LED lighting circuit further comprises a conduction circuit connected between the positive input Vbus and the anode of the third LED D3. This conduction circuit is for providing a second power path for the third (remaining) LED D3, if the upstream LEDs between the remaining LED D3 and the positive input, become open. This open circuit may be caused either by cutting the first LED D1 of the LED strip away, or due to internal failure of the upstream LED due to aging or overcurrent, etc. Here the terms upstream and downstream are named in terms of the direction of the current flow; in other words, the term upstream means that the LED is closer to the positive input, and downstream means that the LED is closer to the negative input.

The most substantial innovation proposed by the invention is how to control the conduction circuit. The LED lighting circuit further comprises a control circuit, coupled to a sensing terminal cp connected to an intermediate interconnection between the first LED D1 and the second LED D2. The control circuit is adapted to deactivate or activate the conduction circuit according to the sensing terminal's sensing.

In one embodiment, whether the voltage is sensed (meaning non-zero) or not (meaning substantially zero) can be indicative of whether the series arrangement is intact or is open, more specifically, whether the first LED D1 is intact or is cut away/open. Since it is a series arrangement of LEDs, the sensing terminal's sensing voltage would be close to be zero or zero when the first LED D1 is open.

Preferably, the conduction circuit comprises a first switch, BJT, Q1A with a control terminal connected to a high bias voltage, optionally coupled to the positive input Vbus, preferably via a voltage lifting circuit such as a resistor R2 and preferably a Zener diode D4. Here voltage lifting means lift the base voltage of the first switch Q1A approach

the Vbus voltage. The resistor R2 also limits the current into the base of the BJT Q1A. The control circuit comprises a second switch, BJT, Q1B whose base is connected to the sensing terminal cp and collector is connected to the control terminal of the first switch Q1A. Said second switch Q1B is adapted to be closed so as to pull the control terminal of the first switch Q1A to a low voltage and open the first switch Q1A when the voltage on the sensing terminal cp is high. If the sense voltage at the sensing terminal cp is high/not zero, meaning the series arrangement, more specifically the first LED D1, is intact, the first switch Q1A would not become conductive and the power still flows through the first LED D1 and through whole series arrangement of LEDs.

If the series arrangement is incomplete, such as that the first LED D1 has been cut away, the supply voltage would not be conducted by the first LED D1 to the sensing terminal cp, the second switch Q1B is open and allows the high bias voltage to apply to the control terminal of the first switch Q1A and close the first switch Q1A. The first switch Q1A would conduct a power from the positive input to the third/remaining LED D3.

In an alternative embodiment, a latch circuit can be introduced to latch the first switch Q1A to be on after it has been turned on.

In the examples provided above, in a lighting module, when the LED components, soldering, or wires in the first LED D1 becomes an open connection due to aging, overcurrent, overheating, etc., the conduction circuit Q1A would kick in to power the remaining third LED D3. This allows the lighting module to still emit some light, instead of a complete black out. This is extra beneficial if the third LED D3 has more than one LED units connected in series. This provides a fault-tolerance and increases user's experience.

In a light strip cell or unit, for the convenience of obtaining a universally proper length of the remaining portion, it may be good to define the cut position in the middle of the cell or unit. Therefore, it is preferred to have the third LED D3 start at relatively from the middle of the series arrangement. For example, the third LED D3 has same number of LED units as that of the first LED D1 plus the second LED D2.

The power supply connected to the positive input and the negative input is often a voltage supply, a current regulator, MOSFET, M1 is provided to regulate the current to control LED light output more accurately. A stable voltage supply V2 is applied to the gate of the MOSFET to generate a stable current.

When the conduction circuit is activated, in some sense, it bypasses the upstream LEDs such as first LED D1. And the LEDs actually powered by the supply voltage, which is mostly unchanged, is less. Simply say, the power supply maintains but the load

become lighter, and there is a risk of overpower. More specifically, with the above mentioned current regulator M1, the current through the LED may still be controlled as before but the current regulator needs to take a lot of voltage on it; if without the current regulator M1, the current through the LED may be controlled by the conduction circuit, if it is capable, but this makes the conduction circuit take a lot of voltage; otherwise if the conduction circuit is not capable of controlling the current, the current may become so high that the brightness of remaining LED becomes high and not be desired by the user, or damages the remaining LED. In whatever case, there is risk in the remaining circuit. Thus, the embodiment of the invention proposes a current limiting component R3, in the conduction circuit, between the positive input Vbus and the first switch Q1A to limit current, alternatively speaking, to balance a voltage difference between the positive input Vbus and the forward voltage of the remaining LED D3. The current limiting component can facilitate the current control of the remaining LED. The current limiting component can be implemented by resistors which is simple and low cost. Alternatively, some diodes can also be used.

The LED lighting circuit is to be used for facilitating cutting of the series arrangement, therefore it is provided a LED light strip comprising the LED lighting circuit, wherein the series arrangement of LEDs is distributed along the length direction of the LED light strip, the LED light strip comprising: a cuttable-away portion comprising the first LED D1 between the positive input Vbus and the remaining LED D3, said cuttable-away portion is adapted to be cut away and create an open circuit of the series arrangement/first LED D1. In the embodiment shown in figure 2, the cuttable-away portion may further comprise the LED D2 upstream to the remaining LED D3.

The LED light strip also comprises a remaining portion comprising the positive input Vbus, the conduction circuit, the remaining LED D3, the control circuit, and the negative input GND. Said control circuit Q1B is adapted to activate the conduction circuit when the above cuttable-way portion is cut away.

In an implementation of colorful light strip, there should be multiple LED lighting circuit with LEDs of different colors, and respective one LED of different colors are aggregated in the same spot or proximity to mix their light as one pixel. The different lighting circuit can be controlled and the current to each color can be set separately, therefore their mixed light can be adjusted. One light strip cell or unit has multiplex pixels along the length of the strip.

For the ease of cutting, the cuttable-away portions of the different LED lighting circuits are aligned, and the remaining portions of the different LED lighting circuits

are also aligned.

Most notably, as shown by figure 2 and discussed in the summary of the invention, the dashed cut line is cross a sensing terminal cp and a further sensing terminal cp0. The terminal cp is essentially connecting to the base of the second switch Q1B, and the further sensing terminal cp0 is essentially connecting to the emitter of the second switch Q1B. The moment the cutting tool cuts the light strip along the cut line, the cutting tool short circuits the sensing terminal cp and the further sensing terminal cp0, making the base-emitter voltage of the second switch Q1B to zero. The second switch Q1B will be quickly turned off, and the first switch Q1A/conduction circuit is turned on quickly. After D2 is cut off from D3, the conduction circuit is already conducting thus a current through D3 as well as the current regulator M1 is continuous, and the current regulator M1 is always regulating the current without an abrupt response to a zero current, and the current to the remaining LED D3 will be more stable.

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. 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".

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

CLAIMS:

1. A LED light strip comprising
a LED lighting circuit comprising:
a positive input (Vbus) and a negative input (GND);
a series arrangement of LEDs (D1, D2, and D3) connected between the
5 positive input (Vbus) and the negative input (GND), comprising a first LED (D1) whose
anode is coupled to the positive input (Vbus) and a remaining LED (D3) whose cathode is
coupled to the negative input (GND), wherein the series arrangement of LEDs is distributed
along the length direction of the LED light strip;
a conduction circuit connected between the positive input (Vbus) and an anode
10 of the remaining LED (D3);
a control circuit, comprising
a sensing terminal (cp) connected to an intermediate interconnection in
the series arrangement of LEDs, and adapted to sense a voltage originating from the positive
input (Vbus) and via the first LED (D1),
15 and the control circuit is adapted to deactivate or activate the conduction
circuit according to the sensing terminal's sensing;
characterized in that
the sensing terminal (cp) is further adapted to sense a time instant of cutting
the first LED (D1); and
20 the control circuit is adapted to activate the conduction circuit at the sensed
time instant of cutting the first LED (D1).
2. The LED light strip according to claim 1, wherein the control circuit is
adapted to deactivate the conduction circuit when the voltage is sensed; otherwise to activate
25 the conduction circuit when the voltage is not sensed; and
the control circuit comprising a further sensing terminal (cp0), the sensing
terminal (cp) and the further sensing terminal (cp0) are adapted to together sense the time
instant of cutting the first LED (D1).

3. The LED light strip according to claim 2, wherein the control circuit is adapted to activate the conduction circuit to conduct a current from the positive input (Vbus), through the remaining LED (D3) and to the negative input (GND) to light on the remaining LED (D3), and

5 wherein the LED strip comprising a cut line cross both of the sensing terminal (cp) and the further sensing terminal (cp0) such that the sensing terminal (cp) and the further sensing terminal (cp0) are adapted to be short circuited by a cutting tool cutting along the cutting line.

10 4. The LED light strip according to claim 3, wherein the sensing terminal (cp) is connected to any one interconnection between a cathode of first LED (D1) and an anode of an upstream LED (D2) connected to the anode of the remaining LED (D3), and

the control circuit comprises a second switch (Q1B) with a control terminal connected to the sensing terminal (cp), said second switch (Q1B) is adapted to

15 be close so as to deactivate the conduction path, when the voltage on the sensing terminal (cp) is high;

otherwise be open so as to activate the conduction path, thereby conducting a current from the positive input (Vbus), through the remaining LED (D3) and to the negative input (GND), when the voltage on the sensing terminal (cp) is low; and

20 the second switch (Q1B) is connected to the further sensing terminal (cp0) at the current flowing-out terminal and adapted to be open when a voltage between the sensing terminal (cp) and the further sensing terminal (cp0) is zero.

5. The LED light strip according to claim 4, wherein the remaining LED (D3)

25 comprises a plurality of preferably series connected LED units, and the first LED (D1) comprises a plurality of preferably series connected LED units,

optionally the number of LED units in the first LED and that in the remaining LED are comparable, preferably the same substantially.

30 6. The LED light strip according to claim 4, wherein the conduction circuit comprises a first switch (Q1A) with a control terminal connected to a high bias voltage, optionally coupled to the positive input (Vbus) via a voltage lifting circuit (D4, R2), and

the second switch (Q1B) is connected to the control terminal of the first switch (Q1A), said second switch (Q1B) is adapted to

be close so as to pull the control terminal of the first switch (Q1A) low and open the first switch (Q1A), when the voltage on the sensing terminal (cp) is high;

otherwise be open so as to allow the high bias voltage to apply to the control terminal of the first switch (Q1A) and close the first switch (Q1A), thereby conducting a current from the positive input (Vbus), through the remaining LED (D3) and to the negative input (GND), when the voltage on the sensing terminal (cp) is low.

The LED light strip according to claim 6, wherein the conduction circuit further comprises a current limiting component (R3) in series with the positive input (Vbus) and the first switch (Q1A), and the second switch (Q1B) is connected to the further sensing terminal at the current flowing-out terminal second switch (Q1B).

The LED light strip according to any one of claims 1 to 4, wherein the positive input (Vbus) and the negative input (GND) are adapted to receive a voltage supply (V1), and the LED lighting circuit further comprises a current regulator (M1) in series with the remaining LED (D3) and the negative input (GND).

The LED light strip according to claim 1, the LED light strip comprising: a cuttable-away portion comprising at least the first LED (D1), said cuttable-away portion is adapted to be cut away and create an open circuit of the first LED (D1), and a remaining portion comprising the positive input (Vbus), the conduction circuit, the remaining LED (D3), the control circuit, and the negative input (GND), wherein said control circuit is adapted to activate the conduction circuit when the cuttable-way portion is cut away.

The LED light strip according to claim 1, comprising a plurality of the LED lighting circuits, light characteristic of the LED in series arrangement of LEDs of the different LED lighting circuit are different, and the respective LEDs of the different LED lighting circuits are placed in proximity with each other so as to mix their light; and the cuttable-away portions of the different LED lighting circuits are aligned, and the remaining portions of the different LED lighting circuits are also aligned.

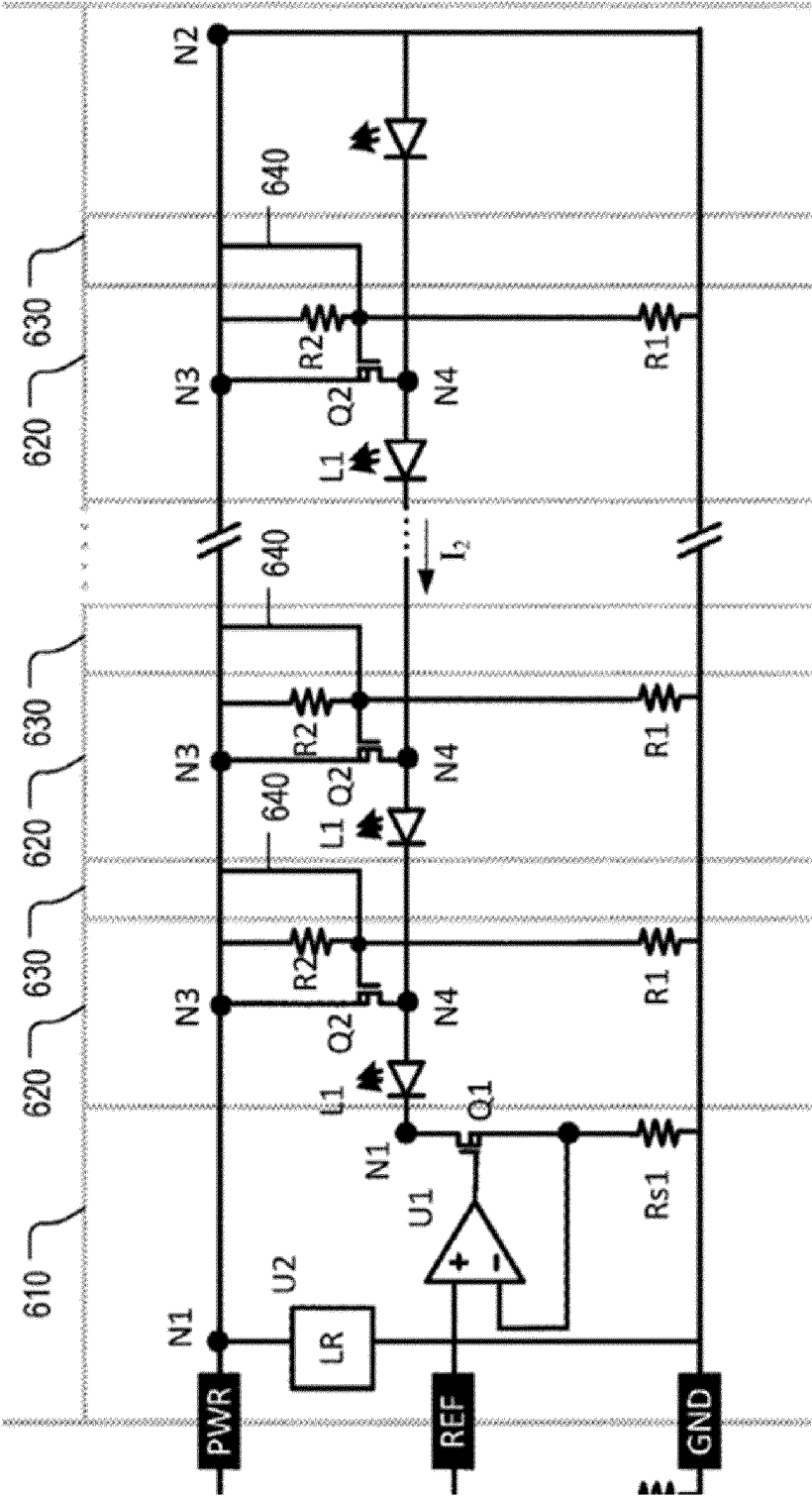


FIG. 1

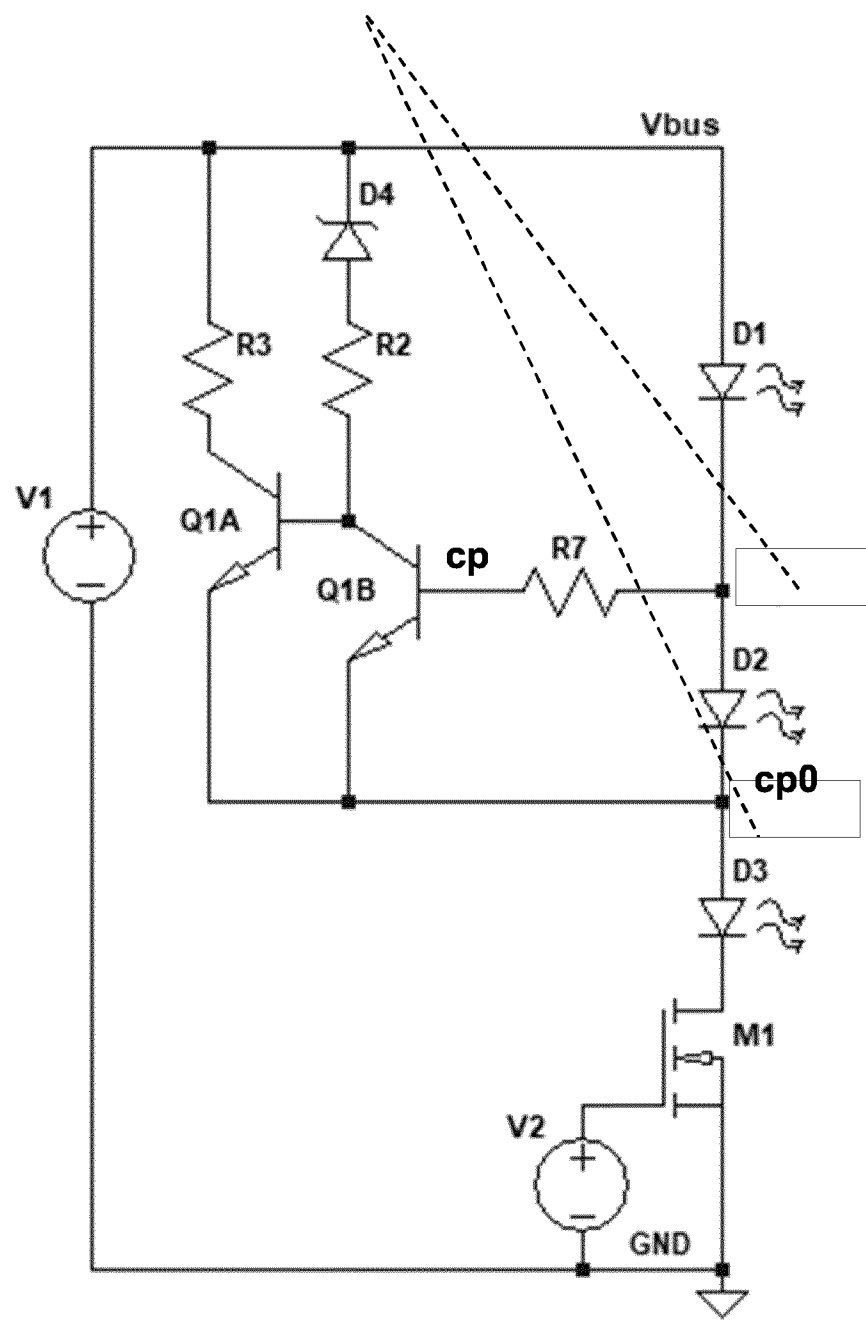


FIG. 2

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2022/052257

A. CLASSIFICATION OF SUBJECT MATTER INV. H05B45/54 H05B45/14 H05B47/23 F21S4/00 H05B45/48 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 F21V F21S		
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.
X	US 2015/092413 A1 (LI MING [US] ET AL)	1-3, 8-10
A	2 April 2015 (2015-04-02)	4-7
	paragraph [0050] - paragraph [0054];	
	figures 6-8	

A	FR 3 048 056 A1 (LUMILA [FR])	1-10
	25 August 2017 (2017-08-25)	
	page 5 - page 10; figures 1-5	

A	US 10 897 802 B1 (AVERY JR WILLIAM H [US])	1-10
	19 January 2021 (2021-01-19)	
	column 6, line 51 - column 8, line 26;	
	figure 4	

☐ 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
16 May 2022		25/05/2022
Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016		Authorized officer Beaugrand, Francois

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2022/052257

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		EP 3182804 A1	21-06-2017
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