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(54) **LED DIMMING CIRCUIT, DIMMING APPARATUS AND DIMMING METHOD FOR REDUCING HARMONIC DISTORTION**

(57) Disclosed in the present invention are an LED dimming circuit, dimming apparatus and dimming method for reducing harmonic distortion. The LED dimming circuit for reducing harmonic distortion comprises a voltage division module, a multipath selection module, a dimming decoding module, and a constant current source module. After a line voltage is divided by the voltage division module, corresponding amplitudes of voltage signals are output to the multipath selection module by different taps; the dimming decoding module performs decoding according to a received dimming input signal and outputs brightness data to the multipath selection module; the multipath selection module outputs, according to the brightness data, the voltage signals output from the corresponding taps of the voltage division module to the constant current source module; and the constant current source module controls, according to the currently received voltage signals, current passing through an LED light string. The present invention can meet the requirements of both dimming and low harmonic distortion, so that higher harmonics are not introduced while dimming is performed, thereby reducing power grid interference and improving the working stability of a product.

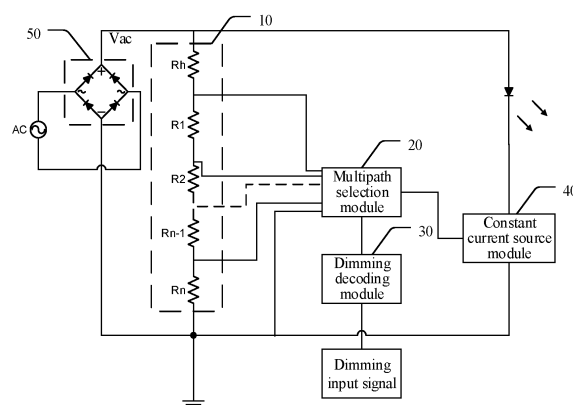


FIG. 2

**Description**FIELD OF THE INVENTION

5     **[0001]** The present disclosure relates to the technical field of LED, more particularly, to an LED dimming circuit, a dimming apparatus and a dimming method for reducing harmonic distortion.

BACKGROUND

10    **[0002]** A linear constant current driving LED light, although a current passing through the LED light is constant, which is caused by a rectifier bridge converting a negative half cycle of an alternating current into a positive voltage, however if there is a current on a neutral line or a live line, it may be found that the current may turn from a positive current into a negative current, thus a higher harmonics of the current may be introduced, and interfered with a power grid.

15    **[0003]** As shown in FIG. 1, generally, a linear LED driving method needs to meet a specification of a plurality of various harmonic distortions, and a dimming circuit is required to apply a partial voltage of the alternating current as a dimming reference voltage to realize a synchronous change between the current and an alternating voltage, without a step jump between the positive current and the negative current occurring, thus no higher harmonics will be introduced. However, a dimming circuit is thus occupied, making either dimming possible, but the harmonic distortion is high; or dimming impossible, but the harmonic distortion is low.

20    **[0004]** Therefore, the current technology needs to be improved and developed.

BRIEF SUMMARY OF THE DISCLOSURE

25    **[0005]** According to the above described defects, the purpose of the present disclosure is providing an LED dimming circuit, a dimming apparatus and a dimming method for reducing harmonic distortion, being able to meet a requirement of both dimming and low harmonic distortion, reducing a grid interference and improving a working stability of product.

**[0006]** A technical solution of the present disclosure to solve the technical problems is as follows:

30    **[0007]** an LED dimming circuit for reducing harmonic distortion, wherein comprising a voltage division module, a multipath selection module, a dimming decoding module and a constant current source module; after the voltage division module dividing a line voltage, a plurality of voltage signals with corresponding amplitudes are output to the multipath selection module through different taps; the dimming decoding module decodes and outputs a brightness data to the multipath selection module according to a dimming input signal received; the multipath selection module outputs the voltage signal output through a plurality of corresponding taps of the voltage division module to the constant current source module according to the brightness data, the constant current source module controls a current passing through  
35    an LED light string according to the voltage signal currently received.

**[0008]** The LED dimming circuit for reducing harmonic distortion, wherein the voltage division module comprises a resistor string, the resistor string comprises a plurality of voltage division resistors connected in series, an upper end of the resistor string connects to a line voltage output terminal, a lower end of the resistor string is grounded; a lower tap of each voltage division resistor extends to connect with the multipath selection module.

40    **[0009]** The LED dimming circuit for reducing harmonic distortion, wherein the dimming decoding module is applied to performing an analog-to-digital conversion on an analog dimming signal received before outputting a digital signal to the multipath selection module.

**[0010]** The LED dimming circuit for reducing harmonic distortion, wherein the dimming decoding module is applied to judging a duty cycle of a PWM signal received, and outputting a duty cycle data obtained to the multipath selection module.

45    **[0011]** The LED dimming circuit for reducing harmonic distortion, wherein the dimming decoding module is applied to receiving the brightness data through a wire or wireless communication directly, before outputting the brightness data to the multipath selection module.

**[0012]** The LED dimming circuit for reducing harmonic distortion, wherein the multipath selection module comprises a plurality of switches corresponding to the voltage division resistors, one end of each switch connects correspondingly to the lower tap of a voltage division resistor, another end of each switch connects to the constant current source module, a control end of each switch connects to the dimming decoding module.

**[0013]** The LED dimming circuit for reducing harmonic distortion, wherein the multipath selection module further comprises an encoder, an input end of the encoder connects to the dimming decoding module, a plurality of output ends of the encoder connect to the control end of each switch accordingly.

55    **[0014]** The LED dimming circuit for reducing harmonic distortion, wherein the constant current source module comprises an operational amplifier, a first MOS transistor and a sampling resistor; a non-inverting input terminal of the operational amplifier is a control end of the constant current source module, connecting to the multipath selection module, an inverting input terminal of the operational amplifier connects to a source of the first MOS transistor and one end of

the sampling resistor, an output terminal of the operational amplifier connects to a gate of the first MOS transistor; a drain of the first MOS transistor connects to a negative electrode of the LED light string; another end of the sampling resistor is grounded.

**[0015]** An LED dimming method for reducing harmonic distortion, wherein comprising following steps:

performing a voltage division through a voltage division module to a line voltage before outputting a voltage signal with a corresponding amplitude to a multiplier module through different taps;  
decoding and outputting a brightness data through a dimming decoding module to the multipath selection module according to a dimming input signal received;  
outputting the voltage signal output from the corresponding taps of the voltage division module through the multipath selection module to a constant current source module according to the brightness data;  
controlling a current passing through an LED light string by the constant current source module according to the voltage signal currently received.

**[0016]** An LED dimming apparatus, wherein comprising a shell, the shell has a PCB board arranged inside, the PCB board is equipped with the LED dimming circuit for reducing harmonic distortion as described above.

**[0017]** Comparing to the prior art, the present disclosure provides an LED dimming circuit, dimming apparatus and dimming method for reducing harmonic distortion, wherein the LED dimming circuit for reducing the harmonic distortion comprises a voltage division module, a multipath selection module, a dimming decoding module and a constant current source module; after the voltage division module dividing a line voltage, a plurality of voltage signals with a plurality of corresponding amplitudes are output to the multipath selection module through different taps; the dimming decoding module decodes and outputs a brightness data to the multipath selection module according to a dimming input signal received; the multipath selection module outputs the voltage signal output through a plurality of corresponding taps of the voltage division module to the constant current source module according to the brightness data, the constant current source module controls a current passing through an LED light string according to the voltage signal currently received. The present disclosure is able to meet the requirement of both dimming and low harmonic distortion, reducing the grid interference and improving the working stability of product.

#### BRIEF DESCRIPTION OF THE DRAWINGS

**[0018]**

FIG. 1 illustrates a circuit diagram on a linear LED driving in the prior art;  
FIG. 2 illustrates a structural block diagram on the LED dimming circuit for reducing the harmonic distortion provided by the present disclosure;  
FIG. 3 illustrates a circuit diagram on a first embodiment of the LED dimming circuit for reducing the harmonic distortion provided by the present disclosure;  
FIG. 4 illustrates a circuit diagram on a second embodiment of the LED dimming circuit for reducing the harmonic distortion provided by the present disclosure;  
FIG. 5 illustrates a circuit diagram on a third embodiment of the LED dimming circuit for reducing the harmonic distortion provided by the present disclosure;  
FIG. 6 illustrates a flow chart on an LED dimming method for reducing the harmonic distortion provided by the present disclosure.

#### DETAILED DESCRIPTION OF EMBODIMENTS

**[0019]** According to a plurality of defects in the prior art that, a linear LED driving is unable to meet the requirement of both dimming and low harmonic distortion at a same time, the purpose of the present disclosure is providing an LED dimming circuit, a dimming apparatus and a dimming method for reducing harmonic distortion, being able to meet the requirement of both dimming and low harmonic distortion, reducing a grid interference and improving a working stability of product.

**[0020]** In order to make the purpose, technical solution and the advantages of the present disclosure clearer and more explicit, further detailed descriptions of the present disclosure are stated here, referencing to the attached drawings and some embodiments of the present disclosure. It should be understood that the detailed embodiments of the disclosure described here are used to explain the present disclosure only, instead of limiting the present disclosure.

**[0021]** Referencing to FIG. 2, the LED dimming circuit for reducing the harmonic distortion provided by the present disclosure connects to an LED light string, comprising a rectifying module 50, a voltage division module 10, a multipath selection module 20, a dimming decoding module 30 and a constant current source module 40, an input end of the

rectifying module 50 is supplied with an alternating current (AC), an output end of the rectifying module 50 connects to the voltage division module 10 and a positive electrode of an LED light string, the voltage division module 10 has a plurality of taps extending out and connecting with the multipath selection module 20, the multipath selection module 20 further connects to a control end of the constant current source module 40 and the dimming decoding module 30.

**[0022]** The present invention rectifies an input AC power before outputting a line voltage through the rectifying module 50, divides the line voltage through the voltage division module 10, before outputting a plurality of voltage signals with a plurality of corresponding amplitudes to the multipath selection module 20 through different taps; receiving the dimming input signal through the dimming decoding module 30, decoding and outputting a brightness data to the multipath selection module 20 according to the dimming input signal; the multipath selection module 20 outputs the voltage signal output through a plurality of corresponding taps of the voltage division module 10 to the constant current source module 40 according to the brightness data, the constant current source module 40 controls a current passing through an LED light string according to the voltage signal currently received, that is, each tap of the voltage division module 10 will output a voltage signal with a different amplitude, and a periodic phase of each voltage signal is as same as a line voltage Vac. During dimming, a multiplexer selects the voltage of one of the taps before outputting to the constant current source module 40 and acting as a reference voltage of dimming, according to the brightness data output by the dimming decoding module 30, thus being able to meet a requirement of both dimming and low harmonic distortion, reducing the grid interference and improving the working stability of a product.

**[0023]** The voltage division module 10 comprises a resistor string, the resistor string comprises a plurality of voltage division resistors connected in series, shown as  $R_h$ ,  $R_1$ ,  $R_2$ , ...,  $R_{n-1}$ ,  $R_n$ , a specific number of the voltage division resistors may be selected according to an actual dimming requirement, and there is no restrictions herein. An upper end of the resistor string connects to a line voltage output terminal, a lower end of the resistor string gets grounded; a lower tap of each voltage division resistor extends to connect with the multipath selection module 20, that is, the present disclosure divides the line voltage through a plurality of voltage division resistors, a lower tap of each voltage division resistor will output a voltage signal of different amplitude, the multiplexer selects the voltage signal output to the constant current source module 40 by controlling an on and off of each tap, before further realizing a dimming control, also, since the voltage signal obtained in a voltage division process has a same cycle phase as the line voltage, thus the current passing through the LED light string will not contain any of other frequencies, being able to meet a requirement of both dimming and low harmonic distortion, reducing effectively the power grid interference during the work process of the LED.

**[0024]** The dimming input signal may have a plurality of options, such as an analog dimming signal, including analog voltage and analog current, a PWM signal, and a wired or a wireless signal including SPI, I2C, UART, WiFi, Bluetooth and more, which may be selected according to specific product requirements. According to different dimming input signals, the LED dimming circuit for reducing the harmonic distortion provided by the present disclosure, wherein the dimming decoding module 30 also has a plurality of implementation methods.

**[0025]** Referencing to FIG. 3, a first embodiment of the present disclosure, wherein the dimming input signal is an analog dimming signal. It should be noted that in the present embodiment, only 5 voltage dividers are used to achieve a 5-level brightness adjustment for an explanation. Of course, in other embodiments, the number of the voltage division resistors may be adjusted as required. In the present embodiment, the dimming decoding module 30 may be implemented by an analog-to-digital converter, which is applied to performing an analog-to-digital conversion on an analog dimming signal received before outputting a digital signal to the multipath selection module 20, that is, outputting a digital signal obtained after the analog-to-digital conversion to the multipath selection module 20 as the brightness data, the multipath selection module 20 selects one of the taps to be turned on according to the digital signal, and outputs a corresponding voltage signal to the constant current source module 40.

**[0026]** Further, the multipath selection module 20 in the present embodiment comprises a plurality of switches corresponding to the voltage division resistors, shown as  $K_1$  to  $K_5$  in FIG. 3, one end of each switch corresponds to the lower tap of a voltage division resistor, another end of each switch connects to the constant current source module 40, the control end of each switch connects to the dimming decoding module 30. The switch may be achieved by a relay, a triode, an MOSFET, a transmission gate, and more.

**[0027]** The multipath selection module 20 further comprises an encoder 21, an input end of the encoder 21 connects to the dimming decoding module 30, a plurality of output ends of the encoder 21 connect correspondingly to the control end of each switch, that is, after receiving the brightness data output by the dimming decoding module 30, the encoder 21 encodes the brightness data to control on and off of each switch separately to realize the dimming.

**[0028]** Furthermore, the constant current source module 40 in the present embodiment comprises an operational amplifier A1, a first MOS transistor Q1 and a sampling resistor  $R_{cs}$ ; a non-inverting input terminal of the operational amplifier A1 is the control end of the constant current source module 40, connecting to the multipath selection module 20, the inverting input terminal of the operational amplifier A1 connects to a source of the first MOS transistor Q1 and one end of the sampling resistor  $R_{cs}$ , an output terminal of the operational amplifier A1 connects to a gate of the first MOS transistor Q1; a drain of the first MOS transistor Q1 connects to a negative electrode of the LED light string; the other end of the sampling resistor  $R_{cs}$  is grounded. The encoder 21 controls the on and off of each switch and outputs

a corresponding voltage signal to the non-inverting input terminal of the operational amplifier A1, acting as the reference voltage Vref of the constant current source module 40 to achieve an adjustment to an LED drive current.

**[0029]** In a specific implementation, the resistor strings Rh, R1~ R4 in the voltage division module 10 of the present embodiment, divide the line voltage Vac to obtain five voltage signals respectively, namely V1~ V5, wherein:

$$V1 = (R1 + R2 + R3 + R4) / (Rh + R1 + R2 + R3 + R4) * Vac;$$

$$V2 = (R2 + R3 + R4) / (Rh + R1 + R2 + R3 + R4) * Vac;$$

$$V3 = (R3 + R4) / (Rh + R1 + R2 + R3 + R4) * Vac;$$

$$V4 = (R4) / (Rh + R1 + R2 + R3 + R4) * Vac;$$

$$V5 = 0 / (Rh + R1 + R2 + R3 + R4) * Vac = 0V;$$

wherein Vac= |Vmax\*sinωt|, Vmax is a peak voltage, ω is an angular frequency, t is time.

**[0030]** Assuming that the analog-to-digital converter in the present embodiment is a 3-bit analog-to-digital conversion, with a measurement range of 0V~Vfs, converting the analog dimming signal Vdim into a plurality of binary numbers including 000, 001,..., 111, before transmitting to the multiplex module 20, while the multiplex module 20 is composed of five switches and an encoder 21, the encoder 21 encodes the 3-bit digital signal received before converting into a 5-bit one-hot code, and each bit controls a switch respectively. Adopting a one-hot encoding, such as, encoding 000 into 00001; encoding both 001 and 010 into 00010; encoding both 011 and 100 into 00100; encoding both 101 and 110 into 01000; and encoding 111 into 10000.

**[0031]** At the same time, an output current of the constant current source module 40 is Iled=Vref/Rcs, assuming a current input Vdim=0.4Vfs, then an output of an ADC is 011, the encoder 21 of one-hot code outputs 00100, and K3 is turned on, while other switches are turned off, then Vref=V3, Iled=V3/Rcs= (R3+R4)/(Rh+R1+R2+R3+R4)|Vmax\*sinωt|. It can be seen that the current of the LED light string contains no component of other frequencies, thus there is no harmonic distortion; when the input Vdim=0V, the output of the ADC is 000, and the encoder 21 of one-hot code outputs 00001, and K5 is turned on, while other switches are turned off, then Vref=V5, Iled=V5/Rcs=0. It can be seen that the LED has no current, thus there is no harmonic distortion. By analogy, as long as changing the input voltage of the analog dimming signal Vdim, an effective value of the current passing through the LED light string can be changed, so as to meet the requirement of both dimming and low harmonic distortion, reducing a grid interference and improving a working stability of a product.

**[0032]** Further, referencing to FIG. 4, a second embodiment of the present disclosure, wherein the dimming input signal is an analog dimming signal, comparing to the first embodiment, a difference is that the dimming decoding module 30 in the present embodiment is achieved by a duty cycle detector, which is applied to determining a duty cycle of the PWM signal received, and output the duty cycle data obtained to the multipath selection module 20, that is, a duty cycle data of a PWM signal is output as the brightness output to the multipath selection module 20 to achieve a dimming control. In a specific implementation, the duty cycle detector is composed of a sampling clock and a counter. Assuming that the PWM signal is sampled N times in one cycle, the counter counts a number of the PWM signal being sampled in one cycle as a high level, then the duty cycle of the current PWM signal can be obtained as the brightness data, and after the brightness data being transmitted to the encoder 21 in the multipath selection module 20 for encoding, it is possible to select a corresponding voltage division signal as the reference voltage Vref of the constant current source module 40. A specific coding rule is similar to that in the first embodiment, and no more descriptions are stated herein in details. It is also possible to realize meeting the requirement of both dimming and low harmonic distortion.

**[0033]** Furthermore, referencing to FIG. 5, a third embodiment of the present disclosure, wherein the dimming input signal is a wired or wireless signal, comparing to the first embodiment, a difference is that the dimming decoding module 30 is achieved through a plurality of serial ports including a Bluetooth module, a WiFi module, an SPI and more, it is applied to receiving directly the brightness data through a wired or wireless communication, before outputting to the multipath selection module 20. The present embodiment is explained by taking a Bluetooth signal for an example, the brightness data sent by the external Bluetooth controller is directly received through the Bluetooth module, and the data is transmitted to the multiple selection module 20, the multipath selection module 20 selects a plurality of responding resistors before dividing and outputting to the control end of the constant current source module 40 as the referencing

voltage  $V_{ref}$  thereof, thus achieving a control to the LED light string. Since when the Bluetooth is sending a data, it is possible to send the one-hot code directly as the brightness data, thus the multipath selection module 20 in the present disclosure may need no encoder 21 arranged.

**[0034]** In addition, the constant current source module 40 in the present embodiment may also be implemented by a current mirror, wherein comprising a second MOS transistor Q2 and a third MOS transistor Q3. A drain of the second MOS transistor Q2 is the control end of the constant voltage source module, connecting to a gate of the second MOS transistor Q2 and a gate of the third MOS transistor Q3, a source of the second MOS transistor Q2 and a source of the third MOS transistor Q3 are both grounded, a drain of the third MOS Q3 connects to a negative end of the LED light string.

**[0035]** Correspondingly, the present disclosure further provides an LED dimming method for reducing the harmonic distortion. Shown as FIG. 6, the LED dimming method for reducing the harmonic distortion comprises the following steps:

S100, the voltage division module performs a voltage division to the line voltage before outputting the voltage signals with the corresponding amplitudes to the multiplier module through different taps;

S200, the dimming decoding module decodes and outputs the brightness data to the multipath selection module according to the dimming input signal received;

S300, the multipath selection module outputs the voltage signal output through the corresponding taps of the voltage division module to the constant current source module according to the brightness data;

S400, the constant current source module controls the current passing through the LED light string according to the voltage signal currently received.

**[0036]** The present disclosure further provides an LED dimming apparatus, wherein comprising a shell, the shell has a PCB board arranged inside, the PCB board is equipped with the LED dimming circuit for reducing the harmonic distortion as described above. Since the LED dimming circuit for reducing the harmonic distortion has been described in details above, no more descriptions are made herein.

**[0037]** All above, the present disclosure provides an LED dimming circuit, a dimming apparatus and a dimming method for reducing harmonic distortion, wherein the LED dimming circuit for reducing the harmonic distortion comprises a voltage division module, a multipath selection module, a dimming decoding module and a constant current source module; after the voltage division module dividing a line voltage, a plurality of voltage signals with a plurality of corresponding amplitudes are output to the multipath selection module through different taps; the dimming decoding module decodes and outputs a brightness data to the multipath selection module according to a dimming input signal received; the multipath selection module outputs the voltage signal output through a plurality of corresponding taps of the voltage division module to the constant current source module according to the brightness data, the constant current source module controls a current passing through an LED light string according to the voltage signal currently received. The present disclosure is able to meet a requirement of both dimming and low harmonic distortion, reducing the grid interference and improving the working stability of a product.

**[0038]** It should be understood that, the application of the present disclosure is not limited to the above examples listed. Ordinary technical personnel in this field can improve or change the applications according to the above descriptions, all of these improvements and transforms should belong to the scope of protection in the appended claims of the present disclosure.

## Claims

1. An LED dimming circuit for reducing harmonic distortion, wherein comprising a voltage division module, a multipath selection module, a dimming decoding module and a constant current source module; after the voltage division module dividing a line voltage, a plurality of voltage signals with corresponding amplitudes are output to the multipath selection module through different taps; the dimming decoding module decodes and outputs a brightness data to the multipath selection module according to a dimming input signal received; the multipath selection module outputs the voltage signal output through a plurality of corresponding taps of the voltage division module to the constant current source module according to the brightness data, the constant current source module controls a current passing through an LED light string according to the voltage signal currently received.
2. The LED dimming circuit for reducing harmonic distortion according to claim 1, wherein the voltage division module comprises a resistor string, the resistor string comprises a plurality of voltage division resistors connected in series, an upper end of the resistor string connects to a line voltage output terminal, a lower end of the resistor string is grounded; a lower tap of each voltage division resistor extends to connect with the multipath selection module.
3. The LED dimming circuit for reducing harmonic distortion according to claim 1, wherein the dimming decoding

module is applied to performing an analog-to-digital conversion on an analog dimming signal received before outputting a digital signal to the multipath selection module.

4. The LED dimming circuit for reducing harmonic distortion according to claim 1, wherein the dimming decoding module is applied to judging a duty cycle of a PWM signal received, and outputting a duty cycle data obtained to the multipath selection module.

5. The LED dimming circuit for reducing harmonic distortion according to claim 1, wherein the dimming decoding module is applied to receiving the brightness data through a wire or wireless communication directly, before outputting the brightness data to the multipath selection module.

6. The LED dimming circuit for reducing harmonic distortion according to claim 2, wherein the multipath selection module comprises a plurality of switches corresponding to the voltage division resistors, one end of each switch connects correspondingly to the lower tap of the voltage division resistor, another end of each switch connects to the constant current source module, a control end of each switch connects to the dimming decoding module.

7. The LED dimming circuit for reducing harmonic distortion according to claim 6, wherein the multipath selection module further comprises an encoder, an input end of the encoder connects to the dimming decoding module, a plurality of output ends of the encoder connect to the control end of each switch accordingly.

8. The LED dimming circuit for reducing harmonic distortion according to claim 1, wherein the constant current source module comprises an operational amplifier, a first MOS transistor and a sampling resistor; a non-inverting input terminal of the operational amplifier is a control end of the constant current source module, connecting to the multipath selection module, an inverting input terminal of the operational amplifier connects to a source of the first MOS transistor and one end of the sampling resistor, an output terminal of the operational amplifier connects to a gate of the first MOS transistor; a drain of the first MOS transistor connects to a negative electrode of the LED light string; another end of the sampling resistor is grounded.

9. An LED dimming method for reducing harmonic distortion, wherein comprising following steps:

performing a voltage division through a voltage division module to a line voltage before outputting a voltage signal with a corresponding amplitude to a multiplier module through different taps;  
decoding and outputting a brightness data through a dimming decoding module to the multipath selection module according to a dimming input signal received;  
outputting the voltage signal output from the corresponding taps of the voltage division module through the multipath selection module to a constant current source module according to the brightness data;  
controlling a current passing through an LED light string by the constant current source module according to the voltage signal currently received.

10. An LED dimming apparatus, wherein comprising a shell, the shell has a PCB board arranged inside, the PCB board is equipped with the LED dimming circuit for reducing harmonic distortion according to any one of claims 1-8.

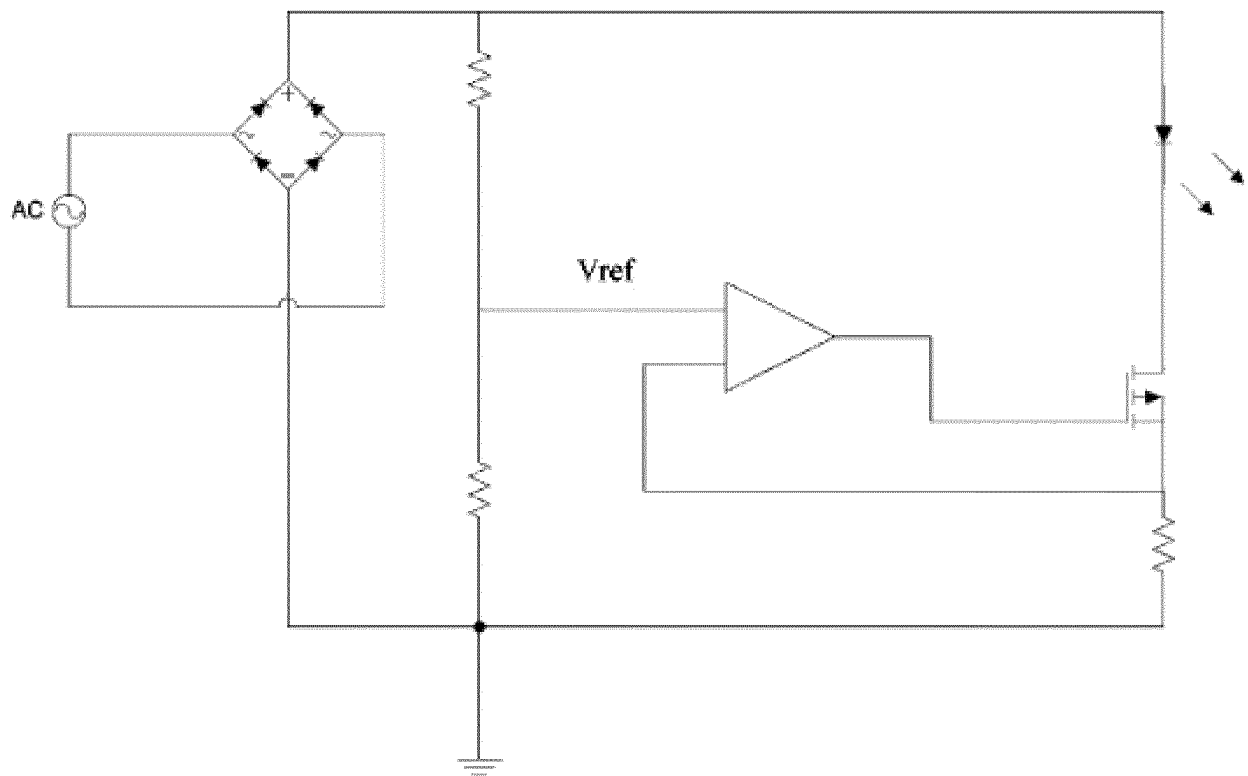


FIG. 1



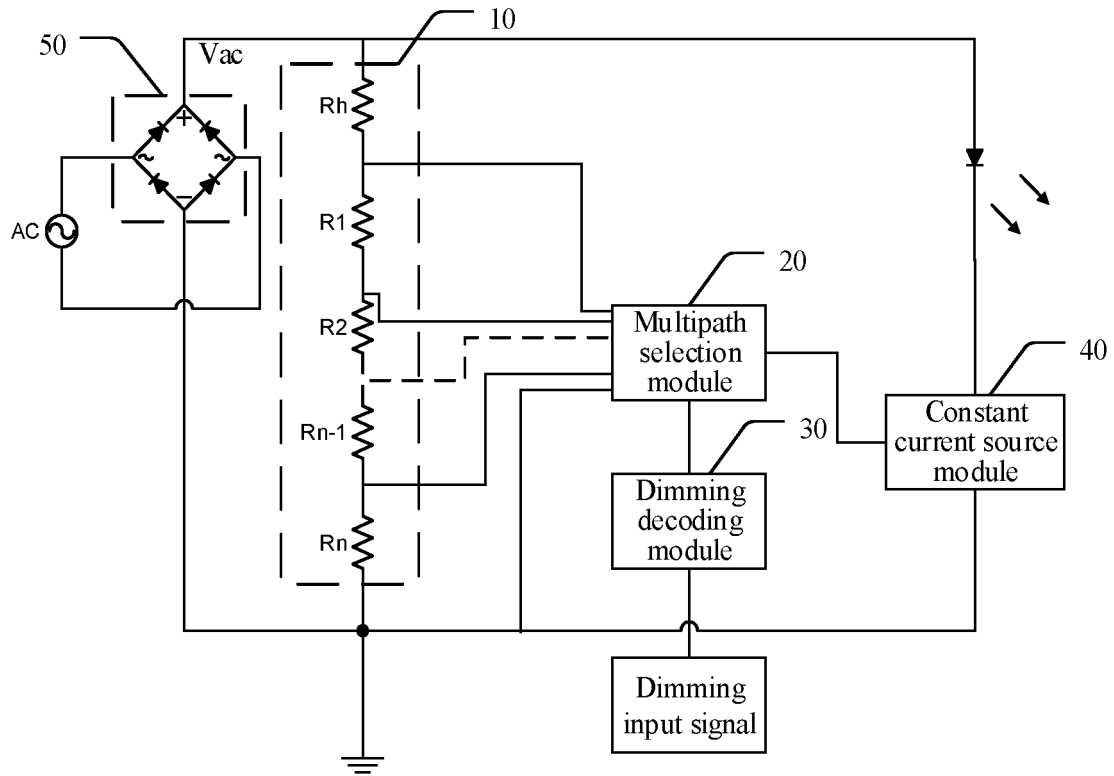


FIG. 2

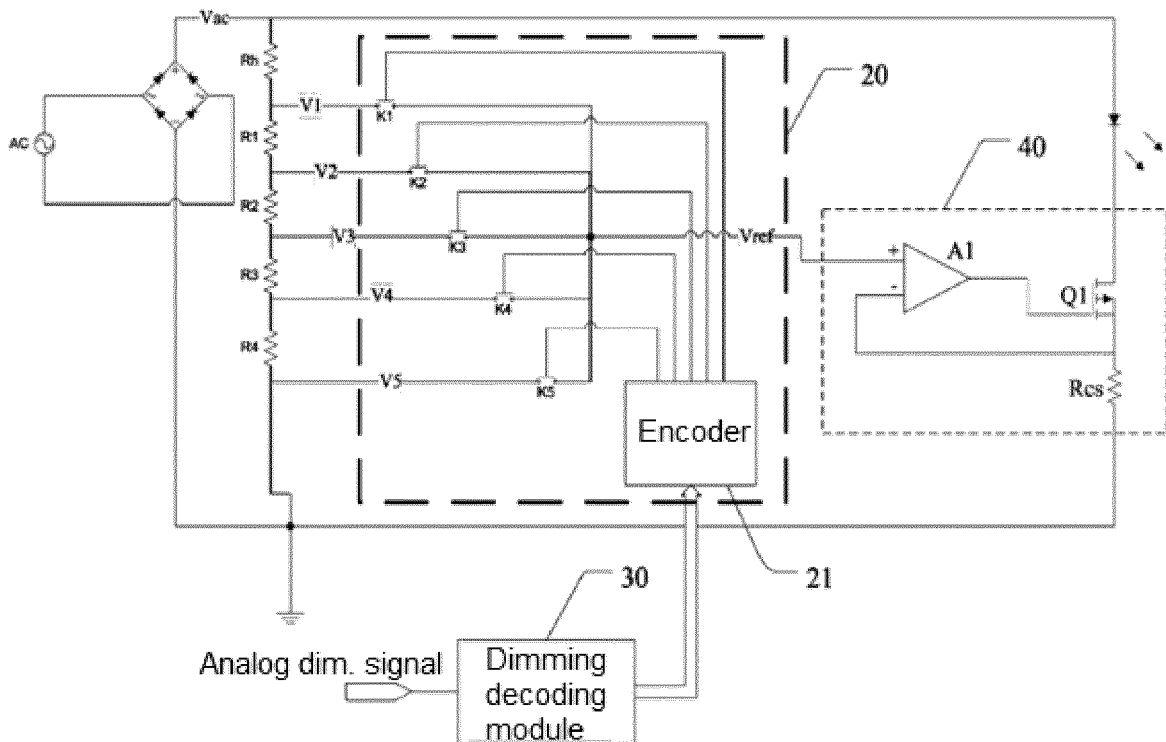


FIG. 3

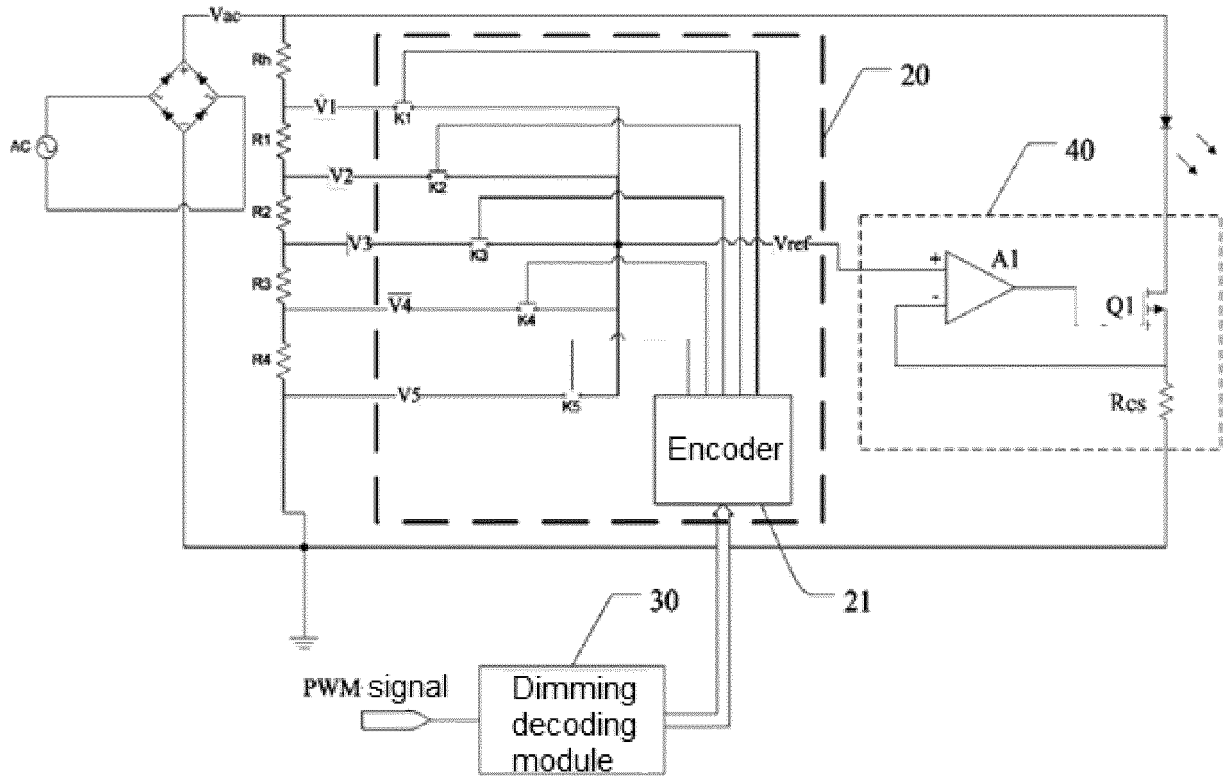


FIG. 4

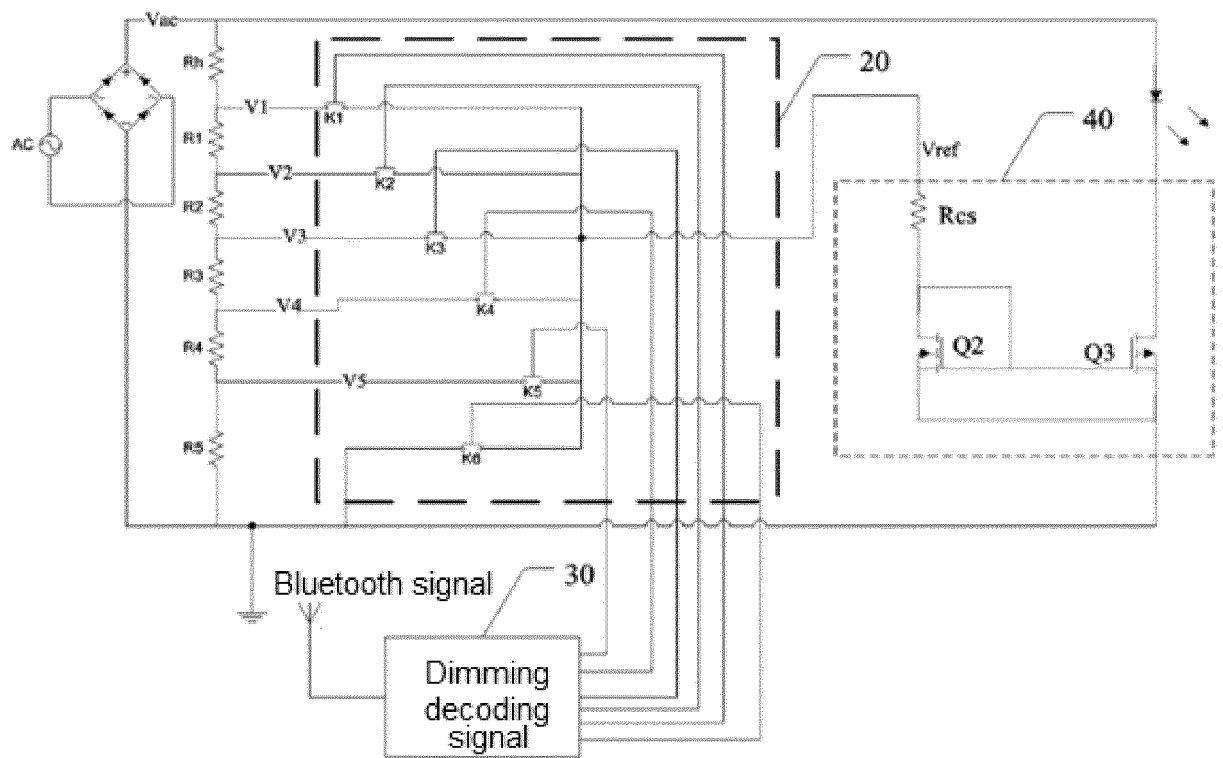


FIG. 5

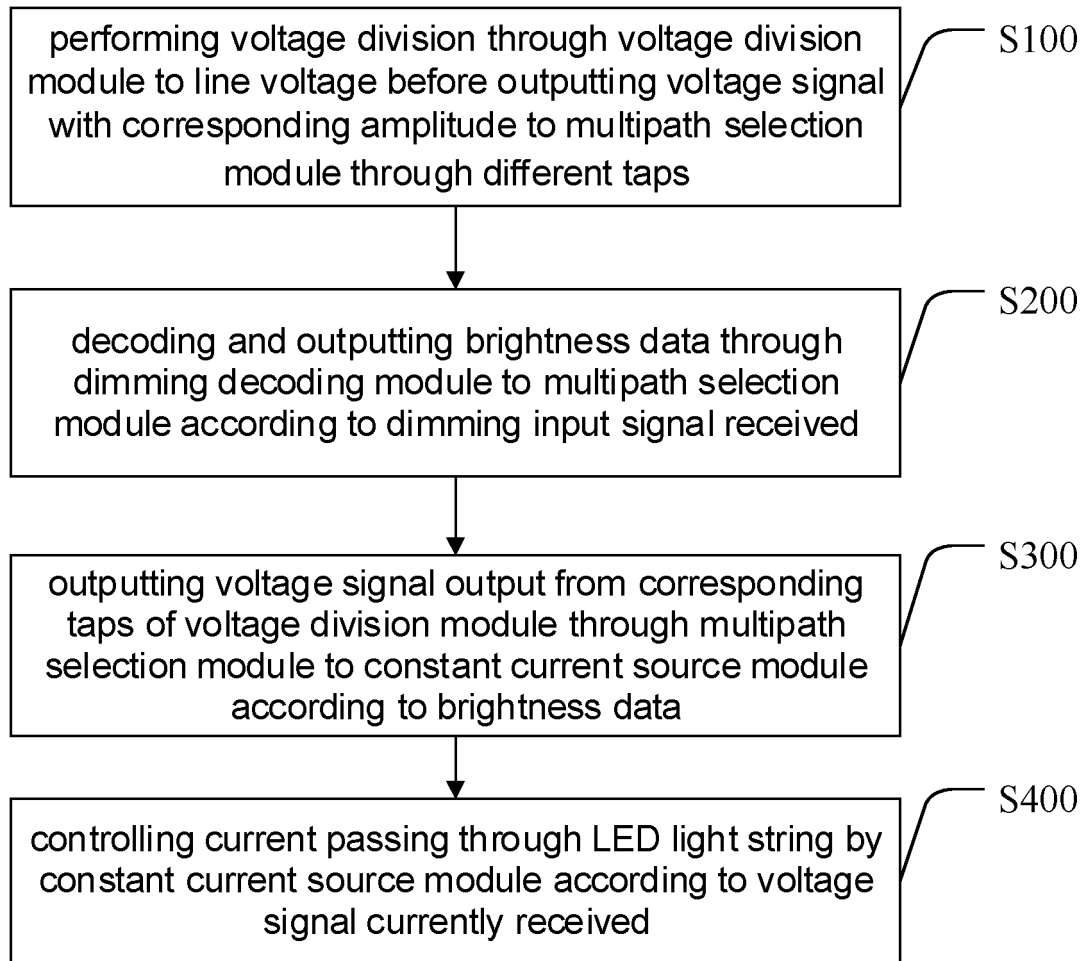


FIG. 6

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2019/077115

5	<b>A. CLASSIFICATION OF SUBJECT MATTER</b>	
	H05B 33/08(2006.01)i	
	According to International Patent Classification (IPC) or to both national classification and IPC	
	<b>B. FIELDS SEARCHED</b>	
10	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	
15	Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)	
	VEN; CNABS; CNTXT; CNKI: 发光二极管, 发光二极管, LED, 调光, 亮度, 调节, 调整, 分压, 电阻串, 多路, 多段, 多通道, 开关, 选择, 译码, 编码, light emitting diode, dim, brightness, intensity, adjust, voltage, pressure, divide, resistor string, multi, path, channel, section, switch, select, decode	
	<b>C. DOCUMENTS CONSIDERED TO BE RELEVANT</b>	
20	Category*	Citation of document, with indication, where appropriate, of the relevant passages
	Y	CN 103025031 A (SHANGHAI AUSTAR LIGHTING ELECTRICAL INDUSTRY CO., LTD.) 03 April 2013 (2013-04-03) description, paragraphs [0025]-[0044], and figure 2
25	Y	CN 101730335 A (GREEN SOLUTION TECHNOLOGY CO., LTD.) 09 June 2010 (2010-06-09) description, paragraph [0034], and figure 2
	Y	CN 103124459 A (ANTEYA TECHNOLOGY CORPORATON ET AL.) 29 May 2013 (2013-05-29) description, paragraphs [0065]-[0072], and figures 2 and 5
30	PX	CN 108495419 A (SHENZHEN SANDISK SEMICONDUCTOR CO., LTD.) 04 September 2018 (2018-09-04) claims 1-10, description, paragraphs [0025]-[0040], and figures 1-6
35	PX	CN 208094850 U (SHENZHEN SANDISK SEMICONDUCTOR CO., LTD.) 13 November 2018 (2018-11-13) claims 1-9, description, paragraphs [0030]-[0055], and figures 1-6
	<input type="checkbox"/> Further documents are listed in the continuation of Box C. <input checked="" type="checkbox"/> See patent family annex.	
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