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(54) **DIRECT TYPE LED BACKLIGHT AND LIQUID CRYSTAL DISPLAY THEREOF**

(71) Applicants: **Wei Chen**, Shenzhen (CN); **Xinhong Chen**, Shenzhen City (CN); **Hua Zhang**, Shenzhen City (CN)

(72) Inventors: **Wei Chen**, Shenzhen (CN); **Xinhong Chen**, Shenzhen City (CN); **Hua Zhang**, Shenzhen City (CN)

(73) Assignee: **Shenzhen China Star Optoelectronics Technology Co., Ltd**, Shenzhen, Guangdong (CN)

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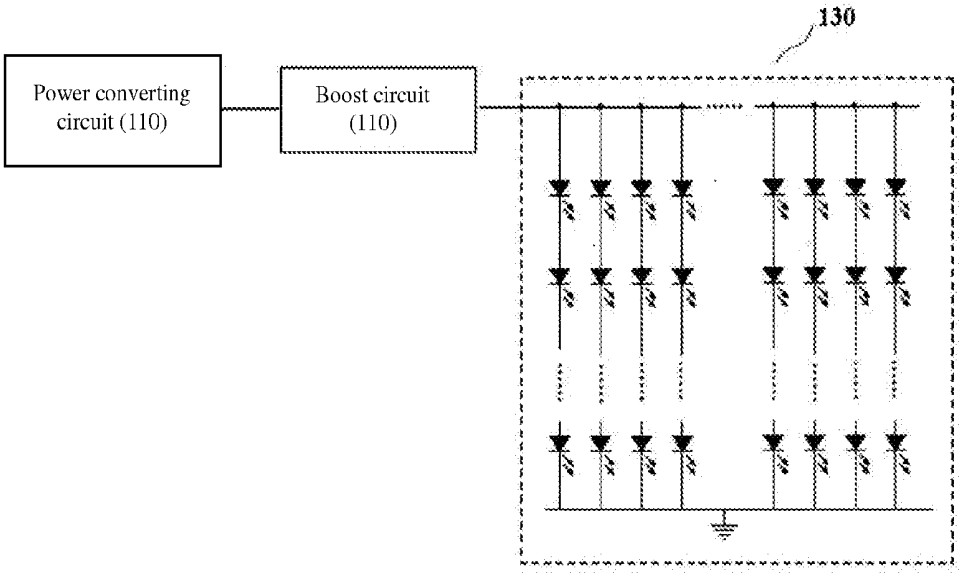
USPC **315/186**

(57) **ABSTRACT**

The present invention provides a direct type LED backlight and a liquid crystal display thereof. The direct type LED backlight comprises a power converting circuit, which transfers an alternating current voltage generated from an external liquid crystal display into direct an current voltage and outputs it; multiple LED strings connected in parallel, wherein each LED string comprises a predetermined amount of LED connected in parallel, which receives a direct current from the power converting circuit; wherein, the predetermined amount is limited to that the direct current of the LED string emitting light normally is smaller than or equal to the direct current output from the power converting circuit. According to the direct type LED backlight of the present invention, it can avoid using a boost circuit in order to decrease circuit complexity and save costs.



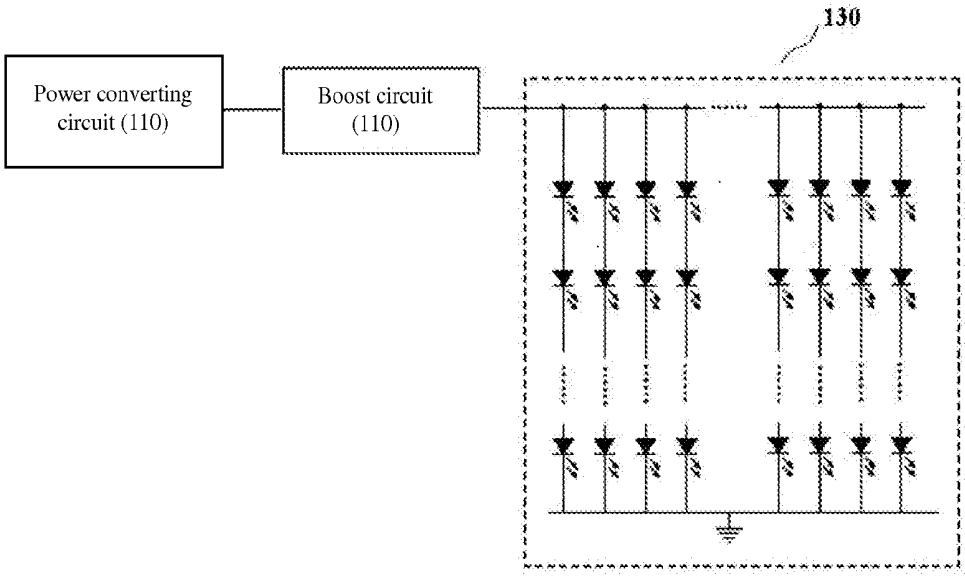


Figure 1

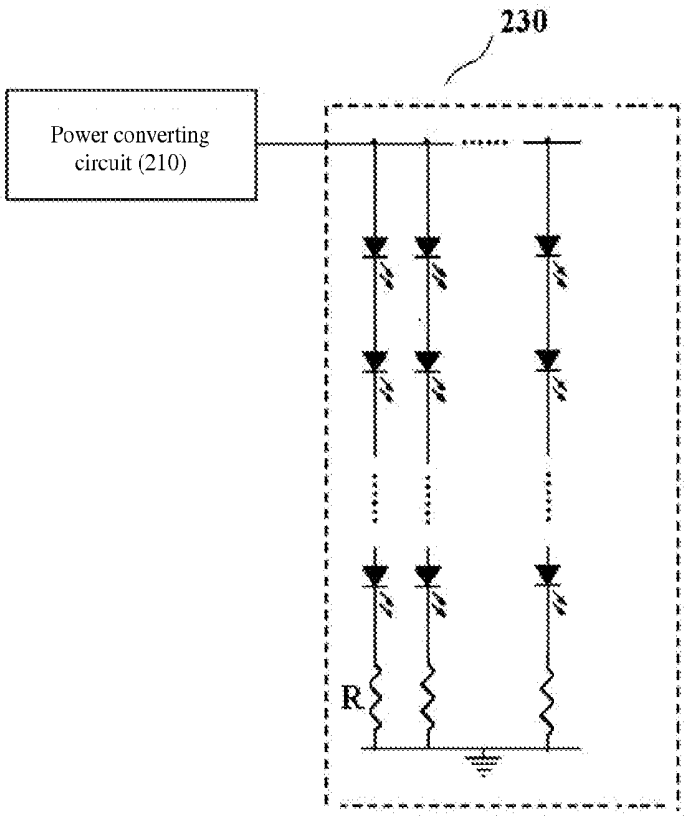


Figure 2

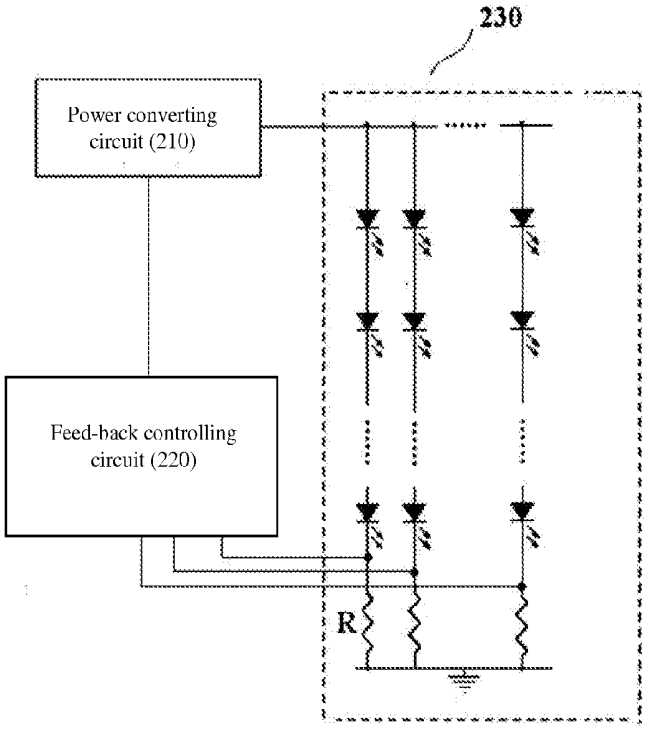


Figure 3

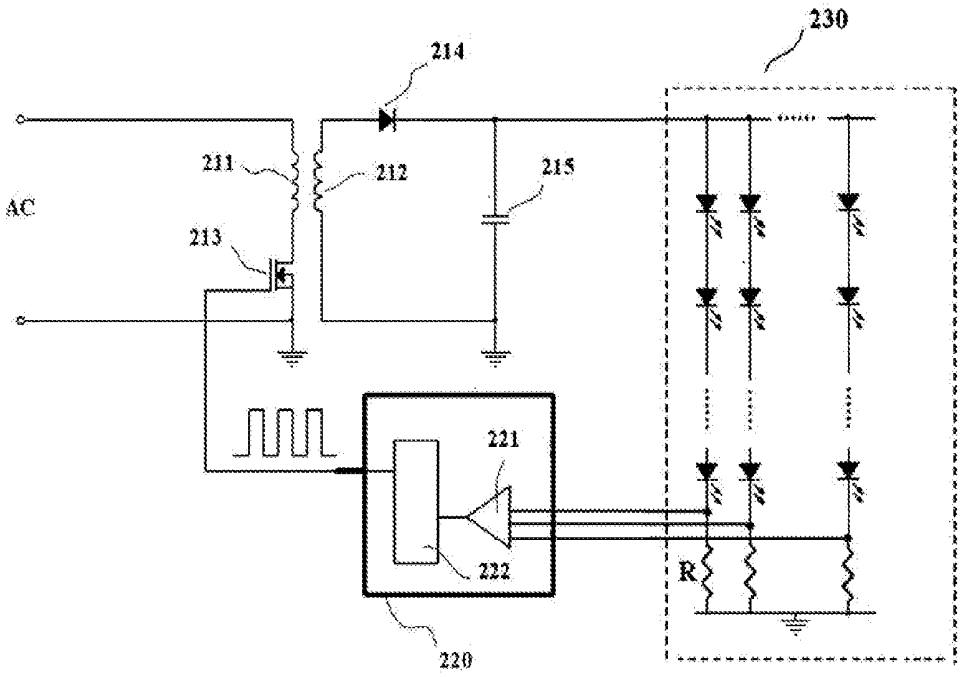


Figure 4

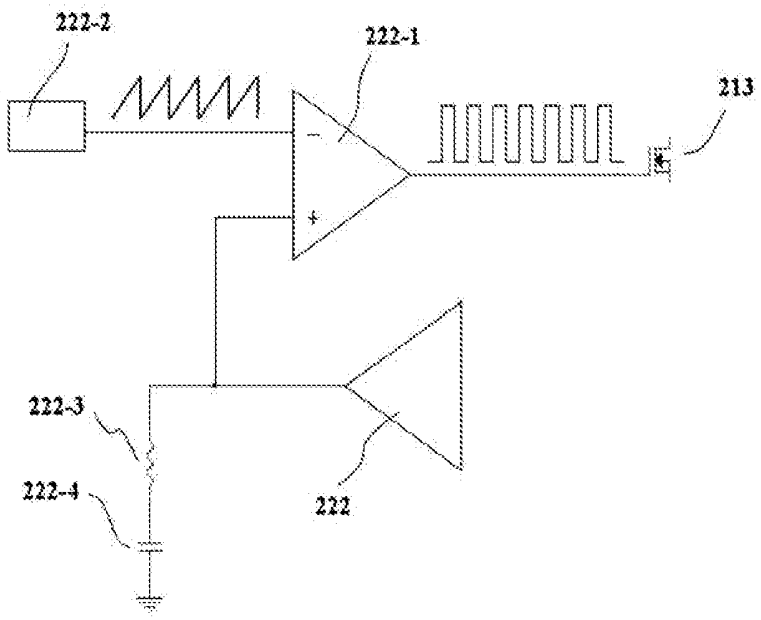


Figure 5

DIRECT TYPE LED BACKLIGHT AND LIQUID CRYSTAL DISPLAY THEREOF

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] The present invention relates to the field of liquid crystal display, and in particular to a direct type LED backlight and a liquid crystal display thereof.

[0003] 2. The Related Arts

[0004] With the continuous improvement of technology, the backlight technology of liquid crystal display is improved continuously. A traditional backlight of the liquid crystal display uses a cold cathode fluorescent lamp (CCFL). But CCFL backlight has some disadvantages of worse color reproduction, poor luminous efficiency, high discharge voltage, bad discharge feature at low temperature and taking long time to heat to achieve stable grayscale. At present, it has been developed using LED backlight technology.

[0005] LED backlight is mainly divided into direct type and edge type.

[0006] The direct type LED backlight denotes that LED is arranged at the back of the liquid crystal panel as backlight. The edge type LED backlight denotes that LED is arranged around the edge of the liquid crystal panel, in which the LED emits light through the light guide plate and to the entire display panel from the edge of the screen.

[0007] In the direct type LED backlight, multiple LED strings are arranged at the back of the liquid crystal panel, wherein, each LED string comprises multiple LEDs connected in series. In order to drive each LED string, it needs a specific drive circuit to offer drive voltage to each LED string.

[0008] FIG. **1** is a schematic view illustrating a direct type LED backlight according to the known technology. As shown in FIG. **1**, the driving circuit of the backlight comprises a power converting circuit **110**, a boost circuit **120**, and multiple LED strings **130**.

[0009] The power converting circuit **110** is used to convert an AC voltage (such as 110 V or 220 V) into a DC voltage (such as 5 V, 12 V, or 24 V). Generally, there is only one power converting circuit **110** used for AC-DC conversion in a liquid crystal display, which is used as a DC power source for the various electrical components in the liquid crystal display.

[0010] The boost circuit **120** is used to boost the DC voltage output from the power converting circuit **110**, to satisfy the need of driving each LED string **130**. In the present technology, the needed voltage for each LED string **130** is higher than the DC voltage output from the power converting circuit **110**, which needs the specific boost circuit **120** to boost. Because of the presence of the boost circuit **120**, the circuits of the entire liquid crystal display become complicate, and the costs increase.

[0011] Therefore, a direct type LED backlight with simple and low-cost circuit structure is needed.

SUMMARY OF THE INVENTION

[0012] The purpose of the present invention is to provide a direct type LED backlight which is used in a liquid crystal display.

[0013] According to the present invention, it provides a direct type LED backlight, comprising: a power converting circuit, which transfers an alternating current voltage generated from an external liquid crystal display device into direct an current voltage and outputs it; multiple LED strings connected in parallel, wherein each LED string comprises a predetermined amount of LED connected in parallel, which receives a direct current from the power converting circuit; wherein, the predetermined amount is limited to that the direct current voltage of the LED string emitting light normally is smaller than or equal to the direct current voltage output from the power converting circuit.

[0014] Moreover, the predetermined amount of LED is connected in series to a first resistor within each LED string.

[0015] Moreover, the direct type LED backlight further comprises: a feed-back controlling circuit, which controls the power converting circuit to control the intensity of output direct current voltage according to the voltage across the first resistor.

[0016] Moreover, the feed-back controlling circuit controls the power converting circuit to increase the output voltage when the voltage across the first resistor in one of the multiple LED strings is smaller than a predetermined voltage threshold; the feed-back controlling circuit controls the power converting circuit to decrease the output voltage when the voltage across the first resistor in each LED string is larger than the predetermined voltage threshold.

[0017] Moreover, the predetermined voltage threshold is the voltage across the first resistor when the LED string emits light normally.

[0018] Moreover, no boost circuit exists in the direct type LED backlight.

[0019] Moreover, the power converting circuit comprises a primary coil, a secondary coil, a MOS transistor, a rectifying diode, and a first capacitor; wherein, the primary coil is connected in series to the MOS transistor, one end of the secondary coil is connected to the anode of the rectifying diode, the first capacitor is connected between the cathode of the rectifying diode and the other end of the secondary coil, and the gate of the MOS transistor is connected to the feed-back controlling circuit.

[0020] Moreover, the feed-back controlling circuit comprises: a first comparator, which compares the voltage across the first resistor of the multiple LED strings with the predetermined voltage threshold; a square-wave generator, which generates a square-wave signal; wherein, output a first level signal when the voltage across the first resistor of each LED string is larger than the predetermined voltage threshold; output a second level signal when the voltage across the first resistor in one of the multiple LED strings is smaller than the predetermined voltage threshold; wherein, a square-wave generator reduces the duty cycle of the square wave signal in response to the first level signal, the square-wave generator increases the duty cycle of the square-wave signal in response to the second level signal.

[0021] Moreover, the square-wave generator comprises: a second comparator, a triangular-wave generator, a second resistor, and a second capacitor, wherein, a first input terminal of the second comparator receives a triangular-wave signal from the triangular-wave generator, a second input terminal of the second comparator is connected to an output terminal of the first comparator, and the second resistor and the second capacitor connected in series to each other are connected to the second input terminal of the second comparator.

[0022] Moreover, the first level signal is a low level signal, and the second level signal is a high level signal.

[0023] According to the present invention, it further provides a liquid crystal display device, comprising a direct type LED backlight, wherein, the direct type LED backlight com-

prises: a power converting circuit, which transfers an alternating current voltage generated from an external liquid crystal display device into direct an current voltage and outputs it; multiple LED strings connected in parallel, wherein each LED string comprises a predetermined amount of LED connected in parallel, which receives a direct current from the power converting circuit; wherein, the predetermined amount is limited to that the direct current of the LED string emitting light normally is smaller than or equal to the direct current output from the power converting circuit; wherein the predetermined amount of LED is connected in series to a first resistor within each LED string; a feed-back controlling circuit, which controls the power converting circuit to control the intensity of output direct current voltage according to the voltage across the first resistor; wherein, the feed-back controlling circuit controls the power converting circuit to increase the output voltage when the voltage across the first resistor in one of the multiple LED strings is smaller than a predetermined voltage threshold; the feed-back controlling circuit controls the power converting circuit to decrease the output voltage when the voltage across the first resistor in each LED string is larger than the predetermined voltage threshold.

[0024] Moreover, the predetermined voltage threshold is the voltage across the first resistor when the LED string emits light normally.

[0025] Moreover, no boost circuit exists in the direct type LED backlight.

[0026] Moreover, the power converting circuit comprises a primary coil, a secondary coil, a MOS transistor, a rectifying diode, and a first capacitor; wherein, the primary coil is connected in series to the MOS transistor, one end of the secondary coil is connected to the anode of the rectifying diode, the first capacitor is connected between the cathode of the rectifying diode and the other end of the secondary coil, and the gate of the MOS transistor is connected to the feed-back controlling circuit.

[0027] Moreover, the feed-back controlling circuit comprises: a first comparator, which compares the voltage across the first resistor of the multiple LED strings with the predetermined voltage threshold; a square-wave generator, which generates a square-wave signal; wherein, output a first level signal when the voltage across the first resistor of each LED string is larger than the predetermined voltage threshold; output a second level signal when the voltage across the first resistor in one of the multiple LED strings is smaller than the predetermined voltage threshold; wherein, a square-wave generator reduces the duty cycle of the square wave signal in response to the first level signal, the square-wave generator increases the duty cycle of the square-wave signal in response to the second level signal.

[0028] Moreover, the square-wave generator comprises: a second comparator, a triangular-wave generator, a second resistor, and a second capacitor, wherein, a first input terminal of the second comparator receives a triangular-wave signal from the triangular-wave generator, a second input terminal of the second comparator is connected to an output terminal of the first comparator, and the second resistor and the second capacitor connected in series to each other are connected to the second input terminal of the second comparator.

[0029] Moreover, the first level signal is a low level signal, and the second level signal is a high level signal.

[0030] The direct type LED backlight according to the present invention can avoid using a boost circuit in order to decrease circuit complexity and save costs.

[0031] Additional aspects and/or advantages of the present invention are illustrated in the following description, and the part of the description will also be illustrated or learned by the embodiment of the present invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0032] By illustrating the accompanying drawings and the detailed descriptions as follows, the objects, the features and the advantages of the present invention will become more apparent, wherein:

[0033] FIG. **1** is a schematic view illustrating a direct type LED backlight according to the known technology;

[0034] FIG. **2** is a schematic view illustrating a direct type LED backlight according to the embodiment of the present invention;

[0035] FIG. **3** is a schematic view illustrating a direct type LED backlight according to another embodiment of the present invention;

[0036] FIG. **4** is a schematic view illustrating a power converting circuit and a feed-back controlling circuit of the direct type LED backlight according to the embodiment of the present invention; and

[0037] FIG. **5** is a schematic view illustrating a square-wave generator according to the embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0038] Now, the various exemplary embodiments are fully described referring to the accompanying drawings, wherein some of the exemplary embodiments are shown in the accompanying drawings.

[0039] FIG. **2** is a schematic view illustrating a direct type LED backlight according to the embodiment of the present invention.

[0040] As shown in FIG. **2**, a direct type LED backlight according to the embodiment of the present invention comprises: a power converting circuit **210** and multiple LED strings **230**.

[0041] The power converting circuit **210** converts AC voltage (such as 110 V or 220 V) into DC voltage (such as 24 V). Here, the power converting circuit **210** is an AC-DC converting circuit used to supply DC voltage to all DC components in the liquid crystal display.

[0042] The multiple LED strings **230** are provided at the back of the liquid crystal panel of the liquid crystal display as a backlight, wherein each LED string comprises multiple LEDs connected in series and a resistor R. The multiple LED strings **230** receive the direct current voltage from the power converting circuit **110**. The amount N (N is integer and larger than zero.) of LEDs in each LED string **230** is defined by the following an equation:

$$N \times Vd \leq Vs,$$

wherein, Vd is the light-emitting voltage of each LED, Vs is the output voltage of the power converting circuit **110**.

[0043] For example, when Vd is 6.5 V and Vs is equal to 24 V, N is less or equal to 3.

[0044] Moreover, when the power converting circuit **110** can output multiple DC voltages (such as 5 V, 12 V or 24 V at the same time), Vs is preferably the maximum DC voltage

(such as 24 V) within the multiple DC voltages output from the power conversion circuit **110**.

[0045] In addition, the amount of the LEDs in each LED string is preferably the same.

[0046] Alternatively, each LED string may not comprise the resistor R.

[0047] FIG. **3** is a schematic view illustrating a direct type LED backlight according to another embodiment of the present invention.

[0048] As shown in FIG. **3**, the embodiment of the direct type LED backlight according to the present invention comprises: a power converting circuit **210**, a feed-back controlling circuit **220** and multiple LED strings **230**.

[0049] Comparing with the embodiment in FIG. **2**, the embodiment in FIG. **3** further provides a feed-back controlling circuit **220**. The feed-back controlling circuit **220** controls the output voltage of the power converting circuit **110** according to the feed-back voltage of the LED string to stabilize the power for the LED string.

[0050] The feed-back voltage of the LED string is the voltage across the resistor R in each LED string. The feed-back controlling circuit **220** compares the minimal feed-back voltage within the feed-back voltages of the multiple LED strings **230** with the predetermined voltage threshold Va. The predetermined voltage threshold Va is the voltage across the resistor R when the LED string emits light normally, which is provided inside the feed-back controlling circuit **220**. When the minimal feed-back voltage is smaller than the predetermined voltage, the feed-back controlling circuit **220** outputs a controlling signal to control the power converting circuit **210** to increase the output voltage. When the minimal feed-back controlling voltage is larger than the predetermined voltage, the feed-back controlling circuit **220** outputs a controlling signal to control the power converting circuit **210** to decrease the output voltage. It can be understood that when the minimal feed-back controlling voltage is equal to the predetermined voltage, the feed-back controlling circuit **220** does not control the voltage output of the power converting circuit **210** (ex. not output the controlling signal) or controls the power converting circuit **210** to maintain the present voltage output.

[0051] The AC-DC converting circuit of the present technology and the feed-back controlling circuit thereof can be used to realize the power converting circuit **210** and the feed-back controlling circuit **220** in the prevent invention.

[0052] The power converting circuit **210** and the feed-back controlling circuit **220** according to one embodiment of the prevent invention referring to FIG. **4** are as follow.

[0053] FIG. **4** is a schematic view illustrating the power converting circuit **210** and the feed-back controlling circuit **220** of the direct type LED backlight according to the embodiment of the present invention.

[0054] As shown in FIG. **4**, the power converting circuit **210** according to the present invention comprises a primary coil **211**, a secondary coil **212**, a metal oxide semiconductor (MOS) transistor **213**, a rectifying diode **214** and a capacitor **215**.

[0055] The primary coil **211** and the MOS transistor **213** are connected in series. One end of the secondary coil **212** is connected to the anode of the rectifying diode **214**, and the capacitor **215** is connected between the cathode of the rectifying diode **214** and the other end of the secondary coil **212**.

[0056] By controlling the gate of the MOS transistor **212** connected in series to the primary coil **211**, it can control the intensity of output voltage generated from the power converting circuit **210**.

[0057] The feed-back controlling circuit **220** according to the present invention comprises a comparator **221** and a square-wave generator **222**.

[0058] The comparator **221** compares the feed-back voltage of the multiple LED strings **230** with the predetermined voltage threshold Va. When the feed-back voltages of the multiple LED strings **230** are larger than the predetermined voltage threshold Va, output a first level signal; when one of the feed-back voltages of the multiple LED strings **230** is smaller than the predetermined voltage threshold Va, output a second level signal. The square-wave generator **222** can reduce the duty cycle of the square wave signal in response to the first level signal output from the comparator **221**, so that the output voltage of the power converting circuit **210** is decreased. Moreover, the square-wave generator **222** increases the duty cycle of the square-wave signal in response to the second level signal output from the comparator **221**, so that the output voltage of the power converting circuit **210** is boosted.

[0059] It can be understood that the first level signal can be a low level signal; the second level signal can be a high level signal; or the first level signal can be a high level signal; the second level signal can be a low level signal.

[0060] FIG. **5** is a schematic view illustrating a square-wave generator **222** according to the embodiment of the present invention.

[0061] As shown in FIG. **5**, the square-wave generator **222** comprises: a comparator **222-1**, a triangular-wave generator **222-2**, a resistor **222-3**, and a capacitor **222-4**.

[0062] Wherein, a first input terminal (such as a negative input terminal) of the comparator **222-1** receives a triangular-wave signal from the triangular-wave generator **222-2**; a second input (such as a positive input terminal) of the comparator **222-1** is connected to an output terminal of the comparator **221**; and the resistor **222-3** and the capacitor **222-4** connected in series to each other are connected to the second input terminal of the comparator **222-1**.

[0063] When the comparator **221** outputs the second level signal with high voltage, the resistor **222-3** and the capacitor **222-4** are charged. The input voltage of the second input terminal of the comparator **222-1** is gradually increased. Because the gradually increased input voltage in the comparator **222-1** is tangent to the triangular-wave signal output from the triangular-wave generator **222-2**, the comparator **222-1** outputs the square-wave signal with a gradually increased duty cycle. Meanwhile, the duty cycle of the square-wave signal is gradually increased, so that the output voltage of the power converting circuit **210** is gradually increased accordingly.

[0064] When the comparator **221** outputs the second level signal with low voltage, the input voltage of the second input terminal of the comparator **222-1** is gradually decreased. Because the gradually decreased input voltage in the comparator **222-1** is tangent to a triangular-wave signal output from the triangular-wave generator **222-2**, the comparator **222-1** outputs the square-wave signal with a gradually decreased duty cycle. Meanwhile, the duty cycle of the square-wave signal is gradually decreased, so that the output voltage of the power converting circuit **210** is gradually decreased accordingly.

[0065] Although FIG. **5** shows the square-wave generator **222** according to an embodiment of the present invention, the present invention is not limited thereto. We also can use the square-wave generator with the duty cycle of the other output square-wave signal.

[0066] The direct type LED backlight according to the present invention can avoid using the boost circuit in order to decrease circuit complexity and save costs.

[0067] The present invention referring to the exemplary embodiment is specifically described and illuminated, but those having ordinary skills in the art should understand that it can changed in various forms and details without departing from the spirit and scope of the claim defined by the present invention.

What is claimed is:

1. A direct type LED backlight, comprising:

a power converting circuit, which transfers an alternating current voltage generated from an external liquid crystal display into direct an current voltage and outputs it;

multiple LED strings connected in parallel, wherein each LED string comprises a predetermined amount of LED connected in parallel, which receives a direct current from the power converting circuit;

wherein, the predetermined amount is limited to that the direct current voltage of the LED string emitting light normally is smaller than or equal to the direct current voltage output from the power converting circuit.

2. The direct type LED backlight as claimed in claim **1**, wherein the predetermined amount of LED is connected in series to a first resistor within each LED string.

3. The direct type LED backlight as claimed in claim **2**, wherein, it further comprises:

a feed-back controlling circuit, which controls the power converting circuit to control the intensity of output direct current voltage according to the voltage across the first resistor.

4. The direct type LED backlight as claimed in claim **3**, wherein the feed-back controlling circuit controls the power converting circuit to increase the output voltage when the voltage across the first resistor in one of the multiple LED strings is smaller than a predetermined voltage threshold; the feed-back controlling circuit controls the power converting circuit to decrease the output voltage when the voltage across the first resistor in each LED string is larger than the predetermined voltage threshold.

5. The direct type LED backlight as claimed in claim **4**, wherein the predetermined voltage threshold is the voltage across the first resistor when the LED string emits light normally.

6. The direct type LED backlight as claimed in claim **1**, wherein no boost circuit exists in the direct type LED backlight.

7. The direct type LED backlight as claimed in claim **3**, wherein the power converting circuit comprises a primary coil, a secondary coil, a MOS transistor, a rectifying diode, and a first capacitor; wherein, the primary coil is connected in series to the MOS transistor, one end of the secondary coil is connected to the anode of the rectifying diode, the first capacitor is connected between the cathode of the rectifying diode and the other end of the secondary coil, and the gate of the MOS transistor is connected to the feed-back controlling circuit.

8. The direct type LED backlight as claimed in claim **3**, wherein the feed-back controlling circuit comprises:

a first comparator, which compares the voltage across the first resistor of the multiple LED strings with the predetermined voltage threshold;

a square-wave generator, which generates a square-wave signal;

wherein, output a first level signal when the voltage across the first resistor of each LED string is larger than the predetermined voltage threshold;

output a second level signal when the voltage across the first resistor in one of the multiple LED strings is smaller than the predetermined voltage threshold;

wherein, the square-wave generator reduces the duty cycle of the square wave signal in response to the first level signal, the square-wave generator increases the duty cycle of the square-wave signal in response to the second level signal.

9. The direct type LED backlight as claimed in claim **8**, wherein the square-wave generator comprises: a second comparator, a triangular-wave generator, a second resistor, and a second capacitor, wherein, a first input terminal of the second comparator receives a triangular-wave signal from the triangular-wave generator, a second input terminal of the second comparator is connected to an output terminal of the first comparator, and the second resistor and the second capacitor connected in series to each other are connected to the second input terminal of the second comparator.

10. The direct type LED backlight as claimed in claim **8**, wherein the first level signal is a low level signal, and the second level signal is a high level signal.

11. A liquid crystal display, comprising a direct type LED backlight, wherein, the direct type LED backlight comprises:

a power converting circuit, which transfers an alternating current voltage generated from an external liquid crystal display into direct an current voltage and outputs it;

multiple LED strings connected in parallel, wherein each LED string comprises a predetermined amount of LED connected in parallel, which receives a direct current from the power converting circuit; wherein, the predetermined amount is limited to that the direct current voltage of the LED string emitting light normally is smaller than or equal to the direct current voltage output from the power converting circuit; wherein the predetermined amount of LED is connected in series to a first resistor within each LED string;

a feed-back controlling circuit, which controls the power converting circuit to control the intensity of output direct current voltage according to the voltage across the first resistor;

wherein, the feed-back controlling circuit controls the power converting circuit to increase the output voltage when the voltage across the first resistor in one of the multiple LED strings is smaller than a predetermined voltage threshold; the feed-back controlling circuit controls the power converting circuit to decrease the output voltage when the voltage across the first resistor in each LED string is larger than the predetermined voltage threshold.

12. The liquid crystal display as claimed in claim **11**, wherein the predetermined voltage threshold is the voltage across the first resistor when the LED string emits light normally.

13. The liquid crystal display as claimed in claim **11**, wherein no boost circuit exists in the direct type LED backlight.

14. The liquid crystal display as claimed in claim **11**, wherein the power converting circuit comprises a primary coil, a secondary coil, a MOS transistor, a rectifying diode, and a first capacitor; wherein, the primary coil is connected in series to the MOS transistor, one end of the secondary coil is connected to the anode of the rectifying diode, the first capacitor is connected between the cathode of the rectifying diode and the other end of the secondary coil, and the gate of the MOS transistor is connected to the feed-back controlling circuit.

15. The liquid crystal display as claimed in claim **11**, wherein the feed-back controlling circuit comprises:

a first comparator, which compares the voltage across the first resistor of the multiple LED strings with the predetermined voltage threshold;

a square-wave generator, which generates a square-wave signal;

wherein, output a first level signal when the voltage across the first resistor of each LED string is larger than the predetermined voltage threshold;

output a second level signal when the voltage across the first resistor in one of the multiple LED strings is smaller than the predetermined voltage threshold;

wherein, the square-wave generator reduces the duty cycle of the square wave signal in response to the first level signal, the square-wave generator increases the duty cycle of the square-wave signal in response to the second level signal.

16. The liquid crystal display as claimed in claim **15**, wherein the square-wave generator comprises: a second comparator, a triangular-wave generator, a second resistor, and a second capacitor, wherein, a first input terminal of the second comparator receives a triangular-wave signal from the triangular-wave generator, a second input terminal of the second comparator is connected to an output terminal of the first comparator, and the second resistor and the second capacitor connected in series to each other are connected to the second input terminal of the second comparator.

17. The liquid crystal display as claimed in claim **15**, wherein the first level signal is a low level signal, and the second level signal is a high level signal.

* * * * *

专利名称(译)	直下式LED背光及其液晶显示器		
公开(公告)号	US20140167629A1	公开(公告)日	2014-06-19
申请号	US13/811404	申请日	2012-12-21
[标]申请(专利权)人(译)	陈伟 陈信宏 张华		
申请(专利权)人(译)	陈韦 陈，新红 张，华		
当前申请(专利权)人(译)	深圳市中国星光电科技有限公司		
[标]发明人	CHEN WEI CHEN XINHONG ZHANG HUA		
发明人	CHEN, WEI CHEN, XINHONG ZHANG, HUA		
IPC分类号	G02F1/1335 H05B33/08		
CPC分类号	H05B33/0827 G02F1/133603 G02F2001/133612 H05B45/20 H05B45/37		
优先权	201210540550.3 2012-12-14 CN		
其他公开文献	US9024532		
外部链接	Espacenet USPTO		

摘要(译)

本发明提供一种直下式LED背光及其液晶显示器。直下式LED背光源包括电源转换电路，该电源转换电路将外部液晶显示器产生的交流电压转换为直流电流并输出;多个LED串并联连接，其中每个LED串包括并联连接的预定量的LED，其接收来自电源转换电路的直流电;其中，预定量限于发光的LED串的直流电流通常小于或等于从电源转换电路输出的直流电流。根据本发明的直下式LED背光源，可以避免使用升压电路以降低电路复杂性并节省成本。