US 20150008839A1

(19) **United States**

(12) **Patent Application Publication**

(10) **Pub. No.: US 2015/0008839 A1**

(43) **Pub. Date: Jan. 8, 2015**

Zhang

(54) **LED BACKLIGHT DRIVING CIRCUIT, LCD DEVICE, AND METHOD FOR DRIVING THE LED BACKLIGHT DRIVING CIRCUIT**

(71) Applicant: **SHENZHEN CHINA STAR OPTOELECTRONICS TECHNOLOGY CO., LTD**, Shenzhen (CN)

(72) Inventor: **Hua Zhang**, Shenzhen (CN)

(73) Assignee: **SHENZHEN CHINA STAR OPTOELECTRONICS TECHNOLOGY CO., LTD.**, Shenzhen, Guangdong (CN)

(21) Appl. No.: **13/985,575**

(22) PCT Filed: **Jul. 5, 2013**

(86) PCT No.: **PCT/CN2013/078912**

§ 371 (c)(1),
(2) Date: **Aug. 15, 2013**

(30) **Foreign Application Priority Data**

Jul. 2, 2013 (CN) 201310274509.0

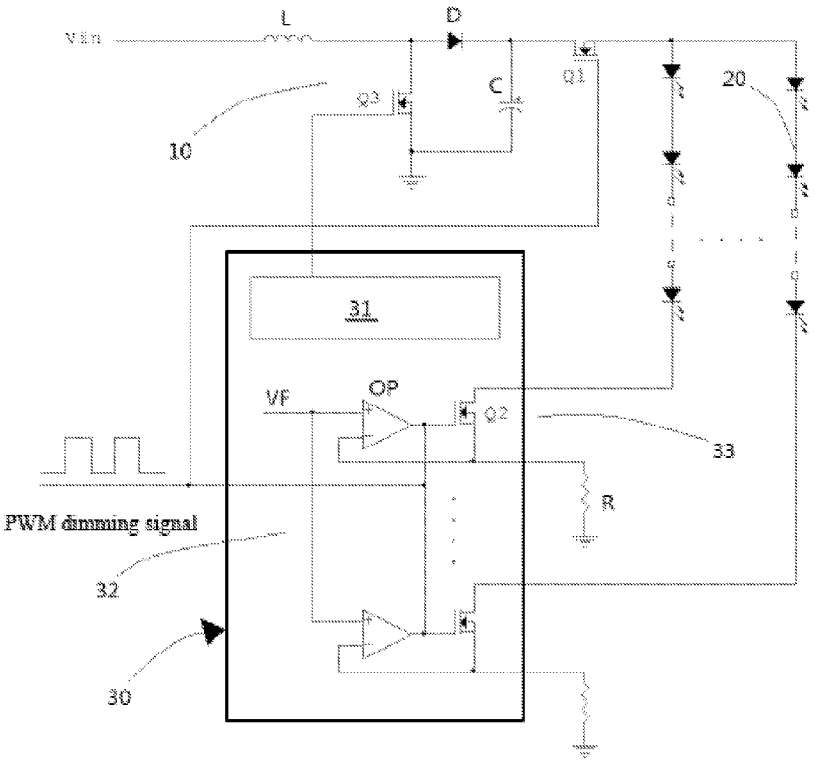
Publication Classification

(51) **Int. Cl.**
G09G 3/34 (2006.01)
H05B 33/08 (2006.01)

(52) **U.S. Cl.**
CPC ***G09G 3/3406*** (2013.01); ***H05B 33/0845*** (2013.01)
USPC **315/210**; 315/224

(57) **ABSTRACT**

A light emitting diode (LED) backlight driving circuit includes a power supply, an LED lightbar coupled to the power supply, and a constant current driving chip coupled to a control end of the power supply and coupled to a cathode of the LED lightbar. The constant current driving chip includes an adjusting dimming unit coupled to the cathode of the LED lightbar, and the adjusting dimming unit adjusts an external pulse-width modulation (PWM) dimming signal. A controllable switch unit is connected in series between an output end of the power supply and the constant current driving chip, and logical operation of the controllable switch unit is relative to logical operation of the adjusting dimming unit. The controllable switch unit turns off when the adjusting dimming unit turns off or before the adjusting dimming unit turns off, and the controllable switch unit turns on when the adjusting dimming unit turns on or after the adjusting dimming unit turns on.



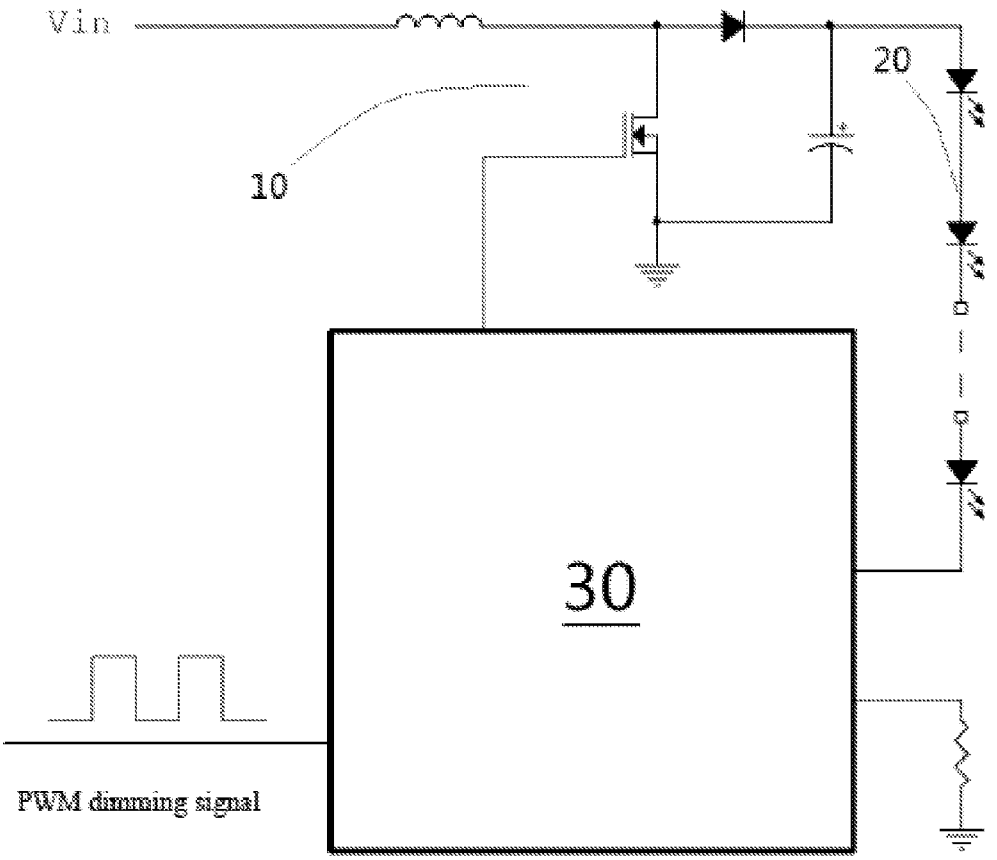


FIG. 1

(PRIOR ART)

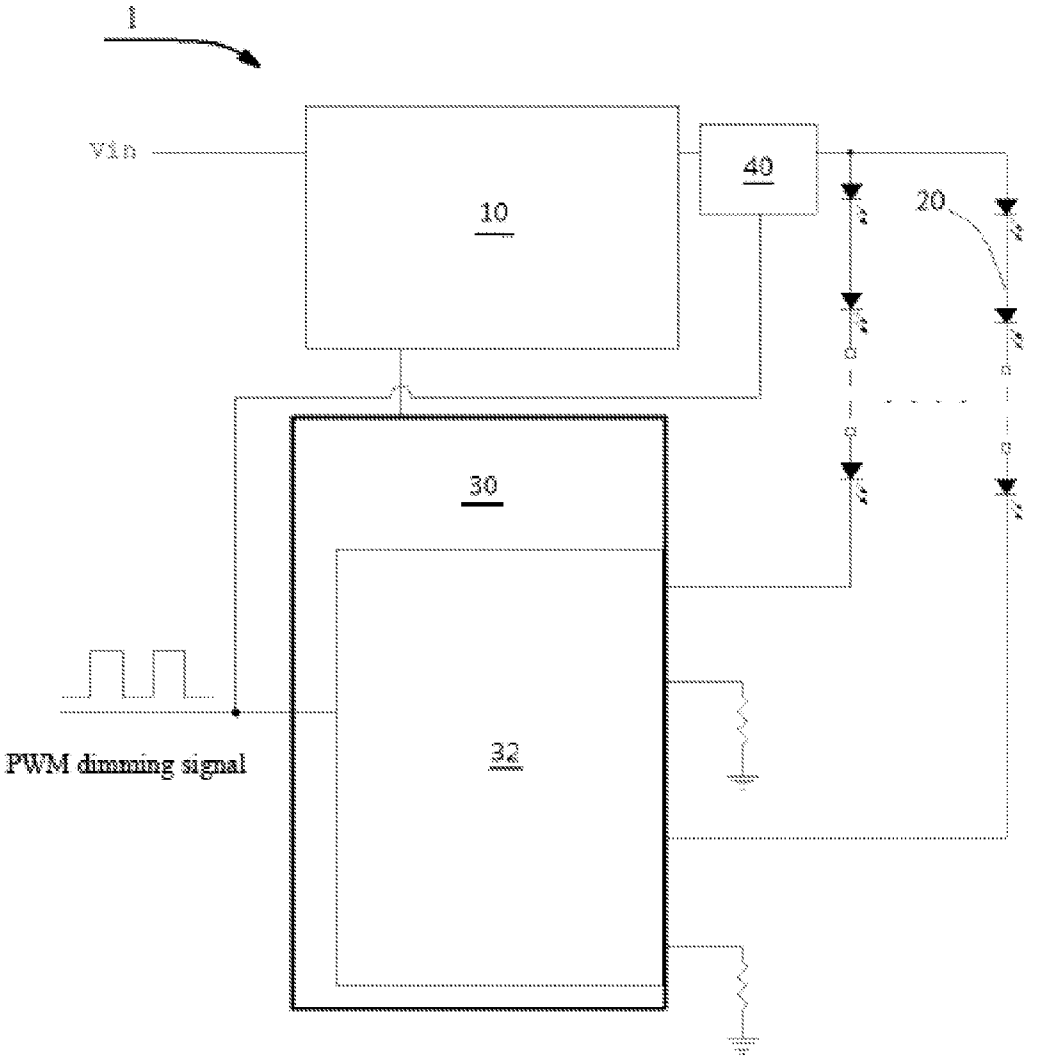


FIG. 2

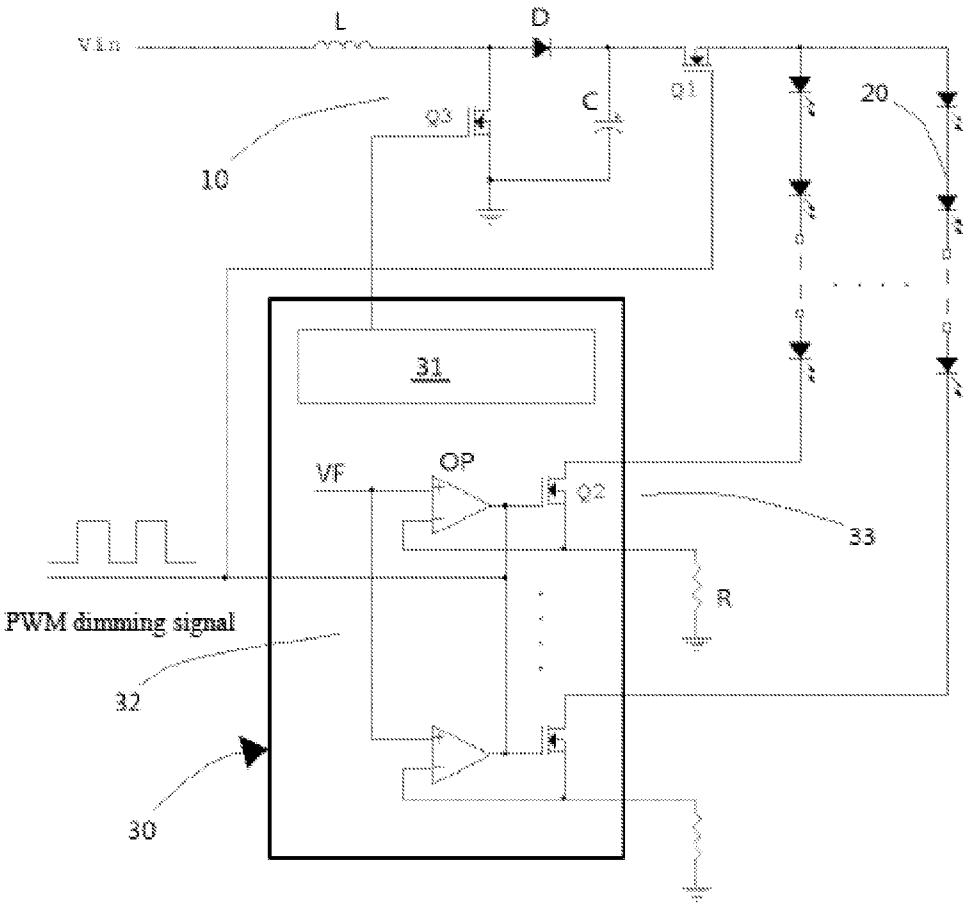


FIG. 3

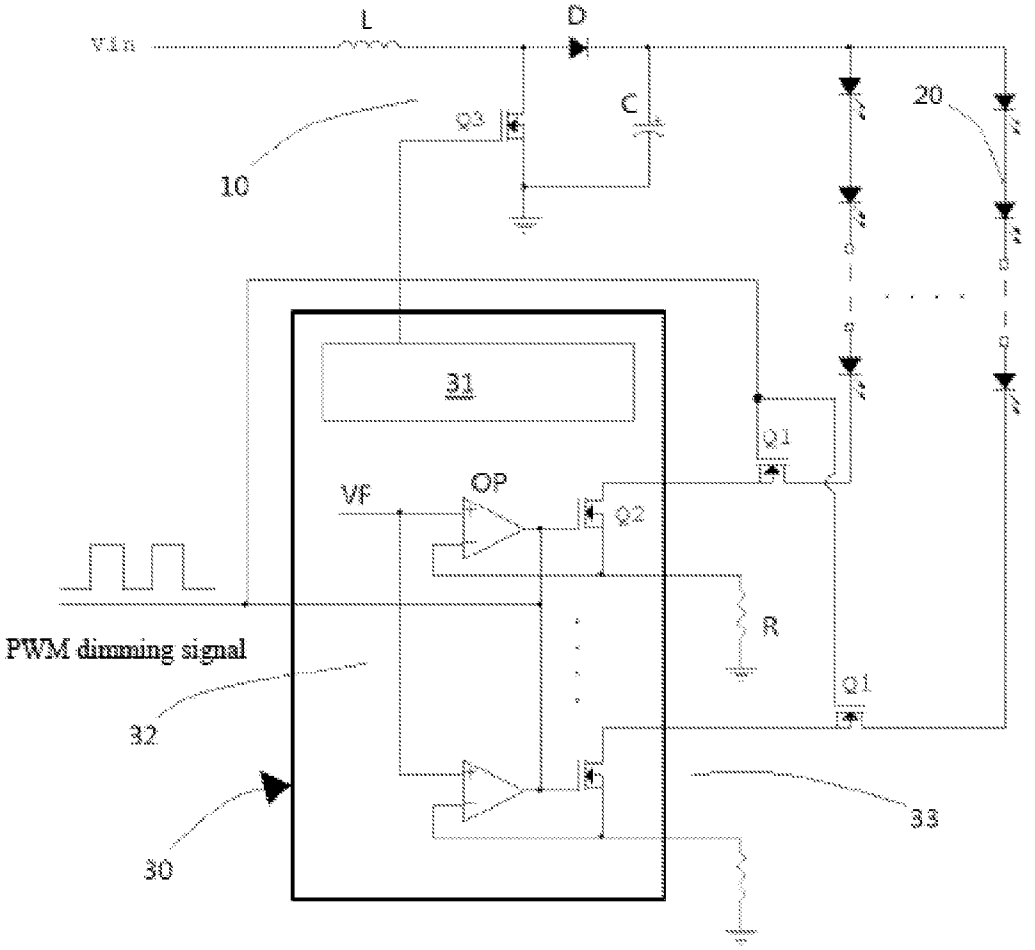


FIG. 4

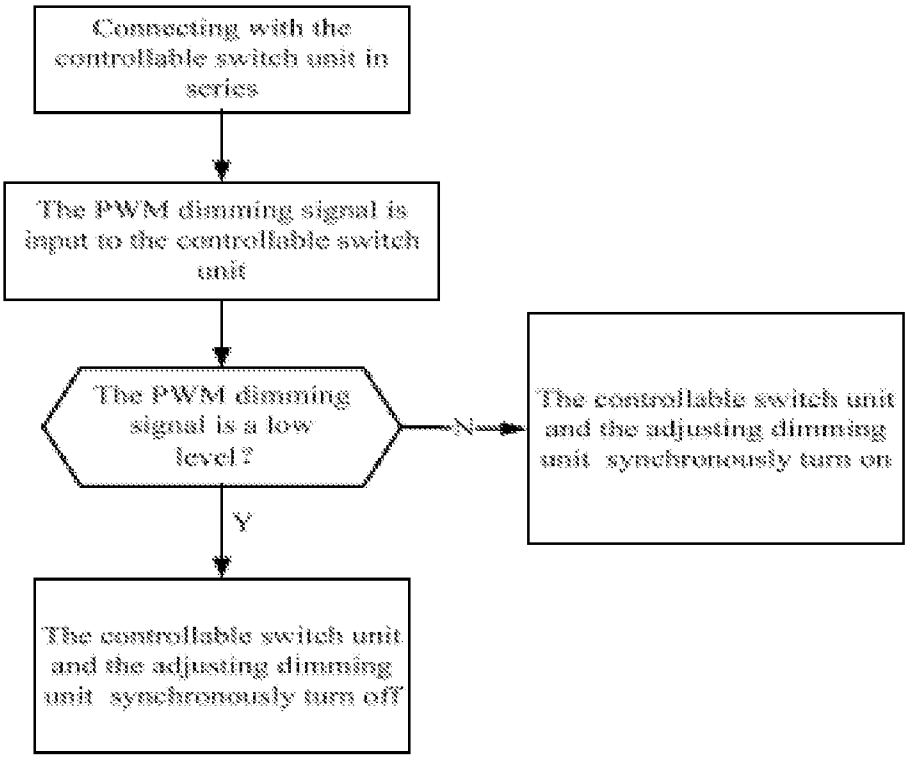

Connecting with the controllable switch unit in series
The PWM dimming signal is input to the controllable switch unit
The PWM dimming signal is a low level?
N
The controllable switch unit and the adjusting dimming unit synchronously turn on
Y
The controllable switch unit and the adjusting dimming unit synchronously turn off

FIG. 5

LED BACKLIGHT DRIVING CIRCUIT, LCD DEVICE, AND METHOD FOR DRIVING THE LED BACKLIGHT DRIVING CIRCUIT

TECHNICAL FIELD

[0001] The present disclosure relates to the field of liquid crystal displays (LCDs), and more particularly to a light emitting diode (LED) backlight driving circuit, an LCD device, and a method for driving the LED backlight driving circuit.

BACKGROUND

[0002] As shown in FIG. **1**, a light emitting diode (LED) backlight driving circuit of a liquid crystal display (LCD) device includes a power supply **10**, and an LED lightbar **20** coupled to the power supply **10**. A constant current driving chip **30** is used to control brightness of the LED lightbar **20**, and an external pulse-width modulation (PWM) dimming signal is sent to the constant current driving chip **30**. When the PWM dimming signal is at a high level, current flows through the LED lightbar **20**, and when the PWM dimming signal is at a low level, current does not flow through the LED lightbar **20**. An average value of the current flowing through the LED lightbar **20** is controlled by adjusting a duty cycle of the PWM dimming signal, thus the brightness of the LED lightbar **20** may be adjusted. A typical PWM dimming method may damage the constant current driving chip **30**.

SUMMARY

[0003] As shown in FIG. **1**, a light emitting diode (LED) backlight driving circuit of a liquid crystal display (LCD) device includes a power supply **10**, and an LED lightbar **20** coupled to the power supply **10**. A constant current driving chip **30** is used to control brightness of the LED lightbar **20**, and an external pulse-width modulation (PWM) dimming signal is sent to the constant current driving chip **30**. When the PWM dimming signal is at a high level, current flows through the LED lightbar **20**, and when the PWM dimming signal is at a low level, current does not flow through the LED lightbar **20**. An average value of the current flowing through the LED lightbar **20** is controlled by adjusting a duty cycle of the PWM dimming signal, thus the brightness of the LED lightbar **20** may be adjusted. A typical PWM dimming method may damage the constant current driving chip **30**.

BRIEF DESCRIPTION OF FIGURES

[0004] FIG. **1** is a schematic diagram of a typical light emitting diode (LED) backlight driving circuit;

[0005] FIG. **2** is a schematic diagram of a light emitting diode (LED) backlight driving circuit of the present disclosure;

[0006] FIG. **3** is a schematic diagram of a light emitting diode (LED) backlight driving circuit of a first example of the present disclosure;

[0007] FIG. **4** is a schematic diagram of a light emitting diode (LED) backlight driving circuit of a second example of the present disclosure; and

[0008] FIG. **5** is a flowchart of a method for driving a light emitting diode (LED) backlight driving circuit of a third example of the present disclosure.

DETAILED DESCRIPTION

[0009] The present disclosure provides a liquid crystal display (LCD) device comprising a light emitting diode (LED) backlight driving circuit **1**. As shown in FIG. **2**, the LED backlight driving circuit **1** comprises a power supply **10**, an LED lightbar **20** coupled to the power supply **10**, and a constant current driving chip **30** coupled to a control end of the power supply **10** and coupled to a cathode of the LED lightbar **20**. The constant current driving chip **30** comprises an adjusting dimming unit **32** coupled to the cathode of the LED lightbar **20**, and the adjusting dimming unit **32** adjusts an external pulse-width modulation (PWM) dimming signal. The LED lightbar **20** is connected in series with a controllable switch unit **40**, and logical operation of the controllable switch unit **40** is relative to logical operation of the adjusting dimming unit **32**. The controllable switch unit **40** turns off when the adjusting dimming unit **32** turns off or before the adjusting dimming unit **32** turns off. The controllable switch unit **40** turns on when the adjusting dimming unit **32** turns on or after the adjusting dimming unit **32** turns on.

[0010] The external pulse-width modulation (PWM) dimming signal may be used to control the controllable switch unit **40** and the adjusting dimming unit **32** to synchronously turn on/off. It also should be considered that the controllable switch unit **40** and the adjusting dimming unit **32** are separately controlled.

[0011] When the PWM dimming signal is at a low level (logic 0), current does not flow through the LED lightbar **20**, thus a voltage drop of the LED lightbar **20** decreases. But the power supply **10** continually outputs a large voltage, so a voltage of the cathode of the LED lightbar **20** is correspondingly great, which damages the constant current driving chip **30**. In the present disclosure, the controllable switch unit **40** is connected in series between an output end of the power supply **10** and the constant current driving chip **30**, and the logical operation of the controllable switch unit **40** is relative to the logical operation of the adjusting dimming unit **32**, where the controllable switch unit **40** turns off when the adjusting dimming unit **32** turns off or before the adjusting dimming unit **32** turns off. Thus, the controllable switch unit **40** turns off before the adjusting dimming unit **32** turns off, and the LED lightbar **20** cannot receive the large voltage output by the power supply **40**, the voltage of the cathode of the LED lightbars **20** is correspondingly low, therefore, the constant current driving chip **30** does not receive the large voltage, which avoids the constant current driving chip **30** from being damaged by the large voltage, and improves reliability and working life of the LED backlight driving circuit.

[0012] The present disclosure is further described in detail in accordance with the figures and the exemplary examples.

Example 1

[0013] As shown in FIG. **3**, a backlight driving circuit **1** of a first example comprises a power supply **10**, an LED lightbar **20** coupled to the power supply **10**, and a constant current driving chip **30** coupled to a control end of the power supply **10** and coupled to a cathode of the LED lightbar **20**. The constant current driving chip **30** comprises an adjusting dimming unit **32** coupled to the cathode of the LED lightbar **20**, and the adjusting dimming unit **32** adjusts a PWM dimming signal. The LED lightbar **20** is connected in series with a

controllable switch unit **40**, and logical operation of the controllable switch unit **40** is relative to logical operation of the adjusting dimming unit **32**.

[0014] The controllable switch unit **40** comprises a first metal-oxide-semiconductor field-effect transistor (MOSFET) Q1. A number of the LED lightbar **20** is at least two, and each of the LED lightbars **20** is connected with each other in parallel. An anode of each of the LED lightbars **20** is coupled to the power supply **10**. The adjusting dimming unit **32** comprises dimming channels **33**. The dimming channels **33** are corresponding to the cathodes of the LED lightbars **20** one by one. A number of the first MOSFET Q1 is one, and the first MOSFET Q1 is connected in series between the power supply **10** and the anode of the LED lightbars **20**. A same external PWM dimming signal is sent to the controllable switch unit **40** and the adjusting dimming unit **32** to control the controllable switch unit **40** and the adjusting dimming unit **32** to synchronously turn on/off, which simplifies control method, shortens development time, and lowers production cost. It should be considered that the controllable switch unit **40** and the adjusting dimming unit **32** may be separately controlled. Regardless of using any one of the two control methods, the first MOSFET Q1 turns off before the adjusting dimming unit **32** turns off or when the adjusting dimming unit **32** turns off, and the first MOSFET Q1 turns on when the adjusting dimming unit **32** turns on or after the adjusting dimming unit **32** turns on.

[0015] The LED backlight driving circuit **1** comprises a resistor R. Each of the dimming channels **33** of the adjusting dimming unit **32** comprises a comparator OP and a second MOSFET Q2. The LED lightbars **20** are connected with a ground terminal of the LED backlight driving circuit **1** through the second MOSFET Q2 and the resistor R. The external PWM dimming signal is sent to a control end of the second MOSFET Q2, and the control end of the second MOSFET Q2 is coupled to an output end of the comparator OP. A reference voltage VF is input to a non-inverting end of the comparator OP, and an inverting end of the comparator OP is coupled to an end of the second MOSFET Q2 that is adjacent to the resistor R.

[0016] The power supply **10** comprises an inductor L, a diode D, a third MOSFET Q3, and a capacitor C. A first end of the inductor L is coupled to an input end of the power supply **10**, a second end of the inductor L is coupled to an anode of the diode D, and the second end of the inductor L is coupled to the ground terminal of the LED backlight driving circuit **1** through the third MOSFET Q3. A cathode of the diode D is coupled to an anode of the LED lightbars **20**, and the cathode of the diode D is coupled to the ground terminal of the LED backlight driving circuit **1** through the capacitor C. The constant current driving chip **30** further comprises a control unit **31** coupled to a control end of the third MOSFET Q3.

[0017] The first example provides a circuit structure of a plurality of LED lightbars connected with each other in parallel and the controllable switch unit comprising the MOSFET. Because the plurality of LED lightbars is connected with each other in parallel, all LED lightbars are controlled to turn on/off by only one controllable switch unit, which lowers cost.

Example 2

[0018] The first MOSFET Q1 is connected in series with the anode of the LED lightbars, and it should be considered that the first MOSFET Q1 is also connected in series with the cathode of the LED lightbars. As shown in FIG. **4**, a number of the first MOSFET Q1 is same as a number of the LED lightbars, and each of the LED lightbars **20** is correspondingly coupled to one dimming channel **33** through one first MOSFET Q1. Each of the LED lightbars **20** is independently connected in series with one controllable switch unit, thus, each of the controllable switch units only loads one LED lightbar **20**, which decreases power loss of each of the controllable switch units and improves working life of the controllable switch units.

Example 3

[0019] As shown in FIG. **5**, the present disclosure provides a method for driving an LED backlight driving circuit **1**, the backlight driving circuit comprises an LED lightbar **20**, and an adjusting dimming unit **32** connected in series with a cathode of the LED lightbar **20**. The adjusting dimming unit **32** adjusts a PWM dimming signal. And the method comprises:

[0020] A: connecting a controllable switch unit **40** with the cathode or an anode of the LED lightbar **20**; and

[0021] B: turning off the controllable switch unit **40** when the adjusting dimming unit **32** turns off or before the adjusting dimming unit **32** turns off, and turning on the controllable switch unit **40** when the adjusting dimming unit **32** turns on or after the adjusting dimming unit **32** turns on.

[0022] Specifically, in the step B, a same external PWM dimming signal is sent to the controllable switch unit **40** and the adjusting dimming unit **32**. When the PWM dimming signal is at a low level, the controllable switch unit **40** and the adjusting dimming unit **32** synchronously turn off. When the PWM dimming signal is at a high level (logic 1), the controllable switch unit **40** and the adjusting dimming unit **32** synchronously turn on. Thus, synchronous operation of the controllable switch unit **40** and the adjusting dimming unit **32** is obtained, which simplifies control method, shortens development time, and lowers production cost. It should be considered that the controllable switch unit **40** and the adjusting dimming unit **32** are also separately controlled.

[0023] The present disclosure is described in detail in accordance with the above contents with the specific exemplary examples. However, this present disclosure is not limited to the specific examples. For the ordinary technical personnel of the technical field of the present disclosure, on the premise of keeping the conception of the present disclosure, the technical personnel can also make simple deductions or replacements, and all of which should be considered to belong to the protection scope of the present disclosure.

We claim:

1. A light emitting diode (LED) backlight driving circuit, comprising:

a power supply;

an LED lightbar coupled to the power supply; and

a constant current driving chip coupled to a control end of the power supply and coupled to a cathode of the LED lightbar;

wherein the constant current driving chip comprises an adjusting dimming unit coupled to the cathode of the LED lightbar, and the adjusting dimming unit adjusts an external pulse-width modulation (PWM) dimming signal; a controllable switch unit is connected in series between an output end of the power supply and the constant current driving chip, and logical operation of

the controllable switch unit is relative to logical operation of the adjusting dimming unit;

the controllable switch unit turns off when the adjusting dimming unit turns off or before the adjusting dimming unit turns off, and the controllable switch unit turns on when the adjusting dimming unit turns on or after the adjusting dimming unit turns on.

2. The LED backlight driving circuit of claim **1**, wherein a same external PWM dimming signal is sent to the controllable switch unit and the adjusting dimming unit.

3. The LED backlight driving circuit of claim **1**, wherein a number of the LED lightbar is at least two, and each of the LED lightbars is connected in parallel with each other; an anode of each of the LED lightbars is coupled to the power supply; the adjusting dimming unit comprises dimming channels, the dimming channels are corresponding to the cathodes of the LED lightbars one by one.

4. The LED backlight driving circuit of claim **3**, wherein a same external PWM dimming signal is sent to the controllable switch unit and the adjusting dimming unit.

5. The LED backlight driving circuit of claim **3**, wherein a number of the controllable switch unit is one, and the controllable switch unit is connected in series between the power supply and the anode of the LED lightbars.

6. The LED backlight driving circuit of claim **5**, wherein a same external PWM dimming signal is sent to the controllable switch unit and the adjusting dimming unit.

7. The LED backlight driving circuit of claim **3**, wherein a number of the controllable switch unit is same as a number of the LED lightbars, each of the LED lightbars is correspondingly coupled to one dimming channel through one controllable switch unit.

8. The LED backlight driving circuit of claim **7**, wherein a same external PWM dimming signal is sent to the controllable switch unit and the adjusting dimming unit.

9. The LED backlight driving circuit of claim **1**, wherein the controllable switch unit comprises a first metal-oxide-semiconductor field-effect transistor (MOSFET); a number of the LED lightbars is at least two, and each of the LED lightbars is connected in parallel with each other; an anode of each of the LED lightbars is coupled to the power supply;

the adjusting dimming unit comprises dimming channels; the dimming channels are corresponding to the cathodes of the LED lightbars one by one; a number of the first MOSFET is one, and the first MOSFET is connected in series between the power supply and the anode of the LED lightbars; a same external PWM dimming signal is sent to the first MOSFET and the adjusting dimming unit.

10. The LED backlight driving circuit of claim **9**, further comprising a resistor; wherein each of the dimming channels of the adjusting dimming unit comprises a comparator and a second MOSFET; the LED lightbars are connected with a ground terminal of the LED backlight driving circuit through the second MOSFET and the resistor; a control end of the second MOSFET is coupled to an output end of the comparator, and the external PWM dimming signal is sent to the control end of the second MOSFET; a reference voltage is input to a a non-inverting end of the comparator, and an inverting end of the comparator is coupled to an end of the second MOSFET that is adjacent to the resistor.

11. The LED backlight driving circuit of claim **10**, wherein the power supply comprises an inductor, a diode, a third MOSFET, and a capacitor; a first end of the inductor is coupled to an input end of the power supply, a second end of the inductor is coupled to an anode of the diode, and the second end of the inductor is coupled to the ground terminal of the LED backlight driving circuit through the third MOSFET; a cathode of the diode is coupled to the anode of the LED lightbars, and the cathode of the diode is coupled to the ground terminal of the LED backlight driving circuit through the capacitor; the constant current driving chip further comprises a control unit coupled to a control end of the third MOSFET.

12. A method for driving a light emitting diode (LED) backlight driving circuit, the backlight driving circuit comprising an LED lightbar and an adjusting dimming unit connected in series with a cathode of the LED lightbar; the method comprising:

A: connecting a controllable switch unit with the cathode or an anode of the LED lightbar; and

B: turning off the controllable switch unit when the adjusting dimming unit turns off or before the adjusting dimming unit turns off, and turning on the controllable switch unit when the adjusting dimming unit turns on or after the adjusting dimming unit turns on.

13. A light crystal display (LCD) device, comprising:

a light emitting diode (LED) backlight driving circuit;

wherein the LED backlight driving circuit comprises a power supply, an LED lightbar coupled to the power supply, and a constant current driving chip coupled to a control end of the power supply and coupled to a cathode of the LED lightbar;

the constant current driving chip comprises and adjusting dimming unit coupled to the cathode of the LED lightbar, and the adjusting dimming unit adjusts an external pulse-width modulation (PWM) dimming signal; a controllable switch unit is connected in series between an output end of the power supply and the constant current driving chip, and logical operation of the controllable switch unit is relative to logical operation of the adjusting dimming unit;

the controllable switch unit turns off when the adjusting dimming unit turns off or before the adjusting dimming unit turns off, and the controllable switch unit turns on when the adjusting dimming unit turns on or after the adjusting dimming unit turns on.

14. The LCD device of claim **13**, wherein a same external PWM dimming signal is sent to the controllable switch unit and the adjusting dimming unit.

15. The LCD device of claim **13**, wherein a number of the LED lightbar is at least two, and each of the LED lightbars is connected in parallel with each other; an anode of each of the LED lightbars is coupled to the power supply, the adjusting dimming unit comprises dimming channels; the dimming channels are corresponding to the cathodes of the LED lightbars one by one.

16. The LCD device of claim **15**, wherein a number of the controllable switch unit is one, and the controllable switch unit is connected in series between the power supply and the anode of the LED lightbars.

17. The LCD device of claim **15**, wherein a number of the controllable switch unit is same as a number of the LED lightbars, each of the LED lightbars is correspondingly coupled to one dimming channel through one controllable switch unit.

18. The LCD device of claim **13**, wherein the controllable switch unit comprises a first metal-oxide-semiconductor

field-effect transistor (MOSFET); a number of the LED lightbars is at least two, and each of the LED lightbars is connected in parallel with each other; an anode of each of the LED lightbars is coupled to the power supply;

the adjusting dimming unit comprises dimming channels; the dimming channels are corresponding to the cathodes of the LED lightbars one by one; a number of the first MOSFET is one, and the first MOSFET is connected in series between the power supply and the anode of the LED lightbars; a same external PWM dimming signal is sent to the first MOSFET and the adjusting dimming unit.

19. The LCD device of claim **18**, wherein the LED backlight driving circuit comprises a resistor; wherein each of the dimming channels of the adjusting dimming unit comprises a comparator and a second MOSFET; the LED lightbars are connected with a ground terminal of the LED backlight driving circuit through the second MOSFET and the resistor; a control end of the second MOSFET is coupled to an output end of the comparator, and the external PWM dimming signal is sent to the control end of the second MOSFET; a reference voltage is input to a non-inverting end of the comparator, and an inverting end of the comparator is coupled to an end of the second MOSFET that is adjacent to the resistor.

20. The LCD device of claim **19**, wherein the power supply comprises an inductor, a diode, a third MOSFET, and a capacitor; a first end of the inductor is coupled to an input end of the power supply, a second end of the inductor is coupled to an anode of the diode, and the second end of the inductor is coupled to the ground terminal of the LED backlight driving circuit through the third MOSFET; a cathode of the diode is coupled to the anode of the LED lightbars, and the cathode of the diode is coupled to the ground terminal of the LED backlight driving circuit through the capacitor; the constant current driving chip further comprises a control unit coupled to a control end of the third MOSFET.

* * * * *