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(54) **BACKLIGHT DRIVING APPARATUS AND LIQUID CRYSTAL DISPLAY DEVICE USING THE SAME**

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USPC **345/690**; 315/186; 345/102

(57) **ABSTRACT**

Disclosed is a backlight driving apparatus. The backlight driving apparatus includes a light source configured to include at least one LED, a DC-DC converter configured to generate a driving voltage according to a turn-on of a switching element and supply the driving voltage to the light source, a feedback circuit configured to generate a feedback voltage corresponding to a voltage level of the driving voltage supplied from light source, a duty controller connected to the light source, and configured to control a turn-on period of the LED according to an LED duty signal corresponding to a backlight dimming signal, and a switching controller configured to generate a PWM signal for controlling the turn-on of the switching element according to the feedback signal, generate a switching control signal corresponding to the PWM signal according to the LED duty signal, and selectively control the turn-on of the switching element.

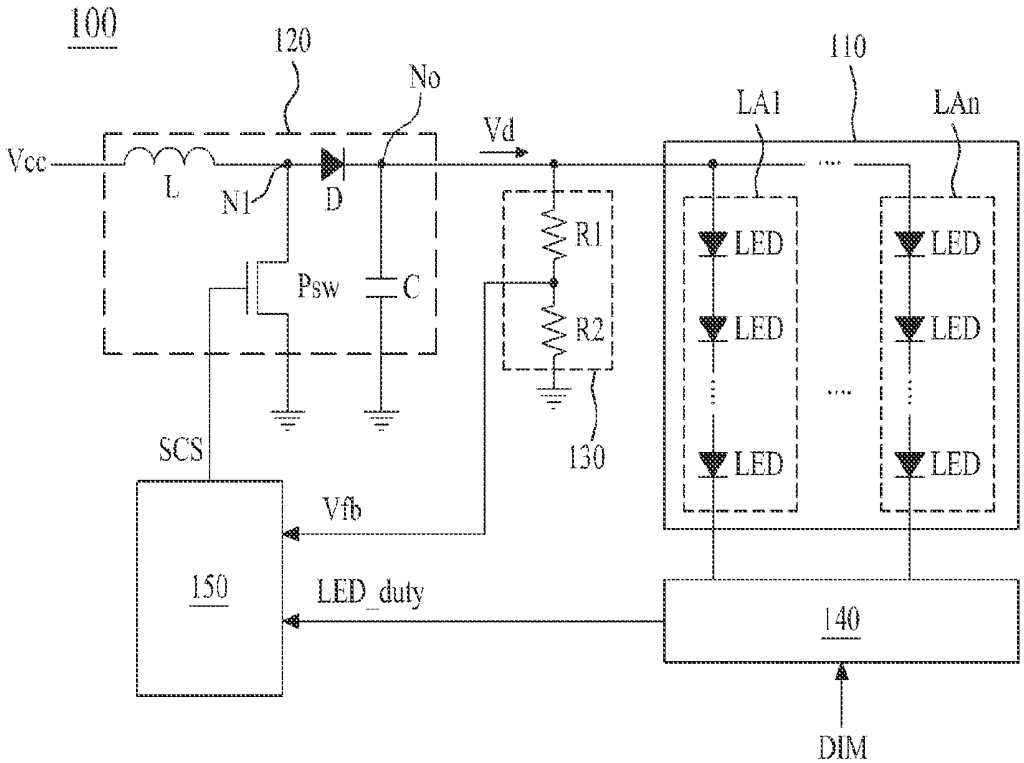


FIG. 1

Related Art

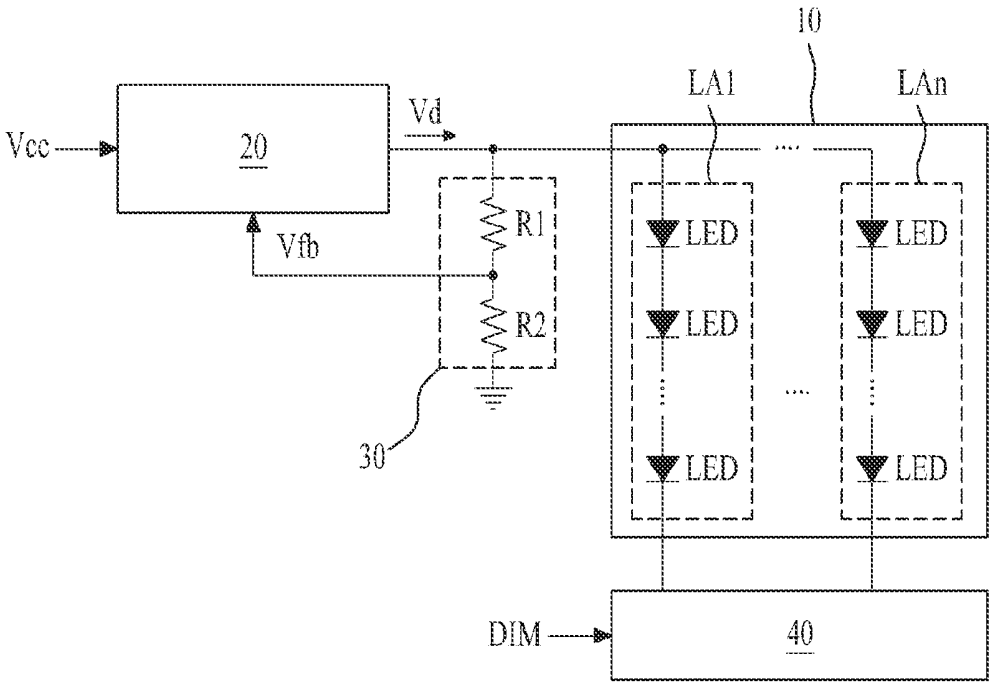


FIG. 2

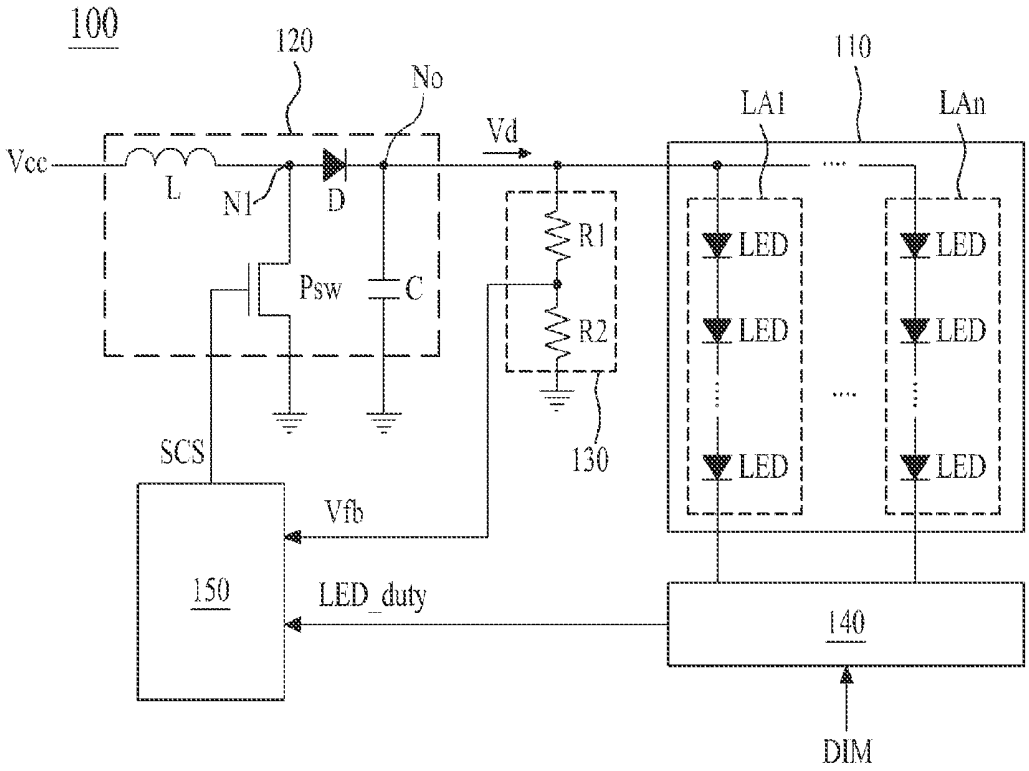

100
120
No
110
LA1
LAn
Vcc
L
N1
D
Vd
R1
R2
Psw
C
LED
SCS
130
Vfb
150
LED_duty
140
DIM

FIG. 3

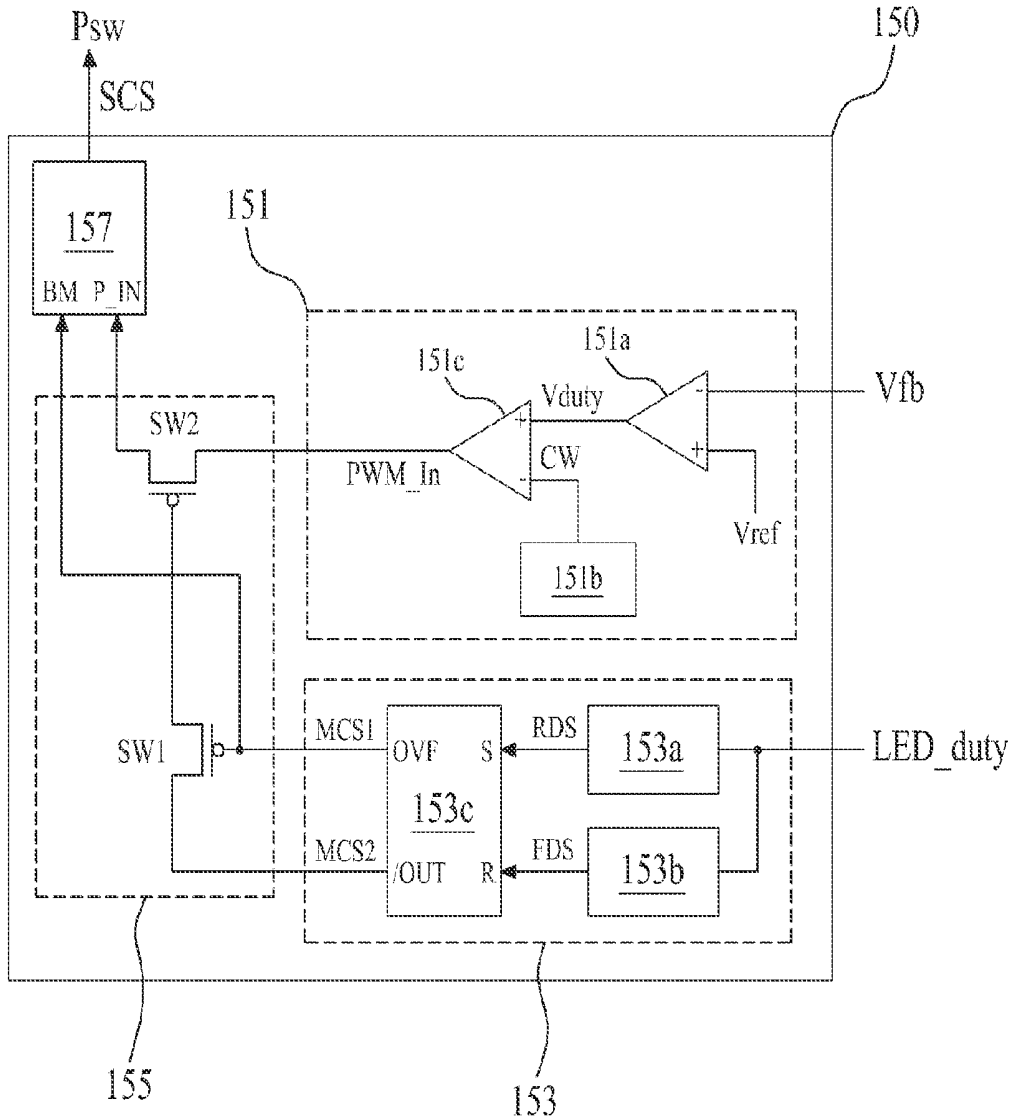

Psw
SCS
150
157
BM_P_IN
151
151a
151c
Vduty
Vfb
SW2
PWM_In
CW
Vref
151b
SW1
MCS1
OVF
S
RDS
153a
LED_duty
153c
MCS2
/OUT
R
FDS
153b
155
153

FIG. 4

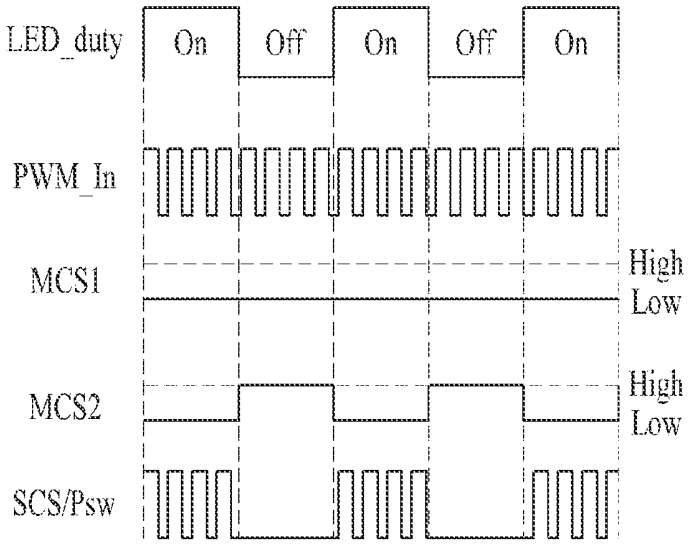

LED_duty
On
Off
On
Off
On
PWM_In
MCS1
High
Low
MCS2
High
Low
SCS/Psw

FIG. 5

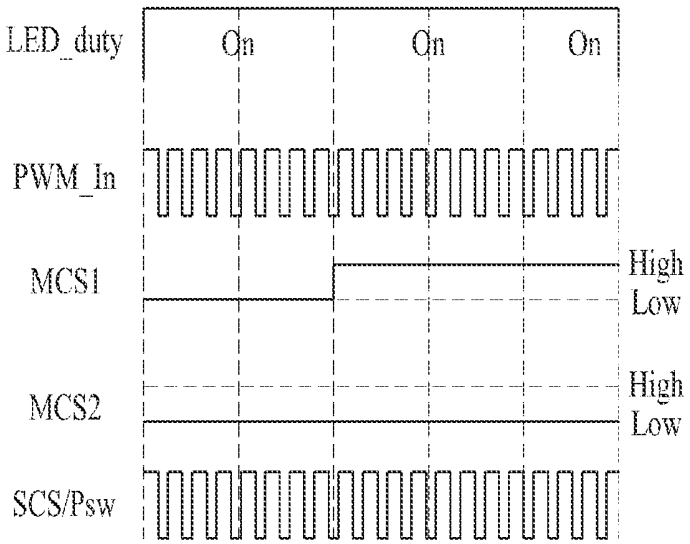

LED_duty
On
On
On
PWM_In
MCS1
High
Low
MCS2
High
Low
SCS/Psw

FIG. 6

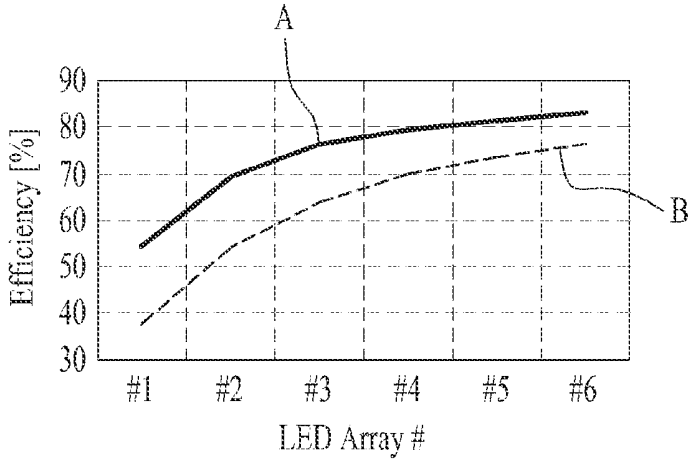
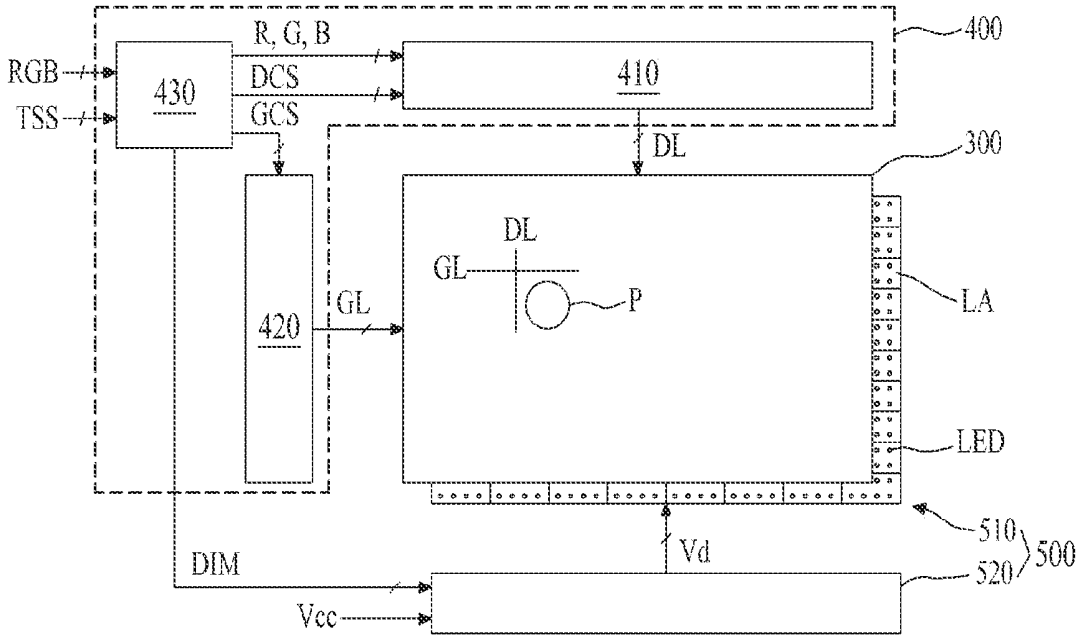

A
B
90
80
70
60
50
40
30
Efficiency [%]
#1
#2
#3
#4
#5
#6
LED Array #

FIG. 7


400
R, G, B
RGB
TSS
430
DCS
GCS
410
DL
300
DL
GL
P
LA
420
GL
LED
510
500
Vd
DIM
520
Vcc

BACKLIGHT DRIVING APPARATUS AND LIQUID CRYSTAL DISPLAY DEVICE USING THE SAME

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of the Korean Patent Application No. 10-2012-0153461 filed on Dec. 26, 2012, which is hereby incorporated by reference as if fully set forth herein.

BACKGROUND

[0002] 1. Field of the Invention

[0003] The present invention relates to a backlight driving apparatus and a liquid crystal display (LCD) device using the same, and more particularly, to a backlight driving apparatus and an LCD device using the same, which can minimize a loss of power to enhance power conversion efficiency.

[0004] 2. Discussion of the Related Art

[0005] Backlights are devices that irradiate light on a display panel, and use a cold cathode fluorescent lamp (CCFL) as a light source. However, when the CCFL is used, a harmful environment is caused by mercury, a response time to an applied signal is slowed by about 15 ms, and a color reproducibility is lower by about 75% with respect to standards published by the National Television Standard Committee (NTSC). Also, the CCFL causes other problems such as predetermined white light being emitted. For this reason, recently, light emitting diodes (LEDs) are drawing much attraction as a light source.

[0006] In comparison with CCFLs, LEDs are eco-friendly, are quick to respond with a response time of several nano seconds, are driven with an impulse, and have a color reproducibility of 80% to 100%. Also, in backlights using the LEDs, a luminance and a color temperature can be arbitrarily adjusted by adjusting an amount of light.

[0007] FIG. **1** is a diagram for describing a general backlight driving apparatus.

[0008] As illustrated in FIG. **1**, the general backlight driving apparatus includes a DC-DC converter **20** that supplies a driving voltage Vd to a light source **10**, a feedback circuit **30** that detects a voltage level of the driving voltage Vd to feed back the detected voltage level to the DC-DC converter **20**, and a duty controller **40** that controls a turn-on/off of the light source **10** according to a backlight dimming signal DIM supplied from the outside.

[0009] The light source **10** includes a plurality of LED arrays LA**1** to LAn in which a plurality of LEDs are serially connected to each other. Each of the plurality of LED arrays LA**1** to LAn emits light with a current which flows according to the driving voltage Vd supplied from the DC-DC converter **20**.

[0010] The DC-DC converter **20** generates the driving voltage Vd on the basis of an input voltage Vcc supplied from the outside, and supplies the driving voltage Vd to the plurality of LED arrays LA**1** to LAn, thereby emitting light from the LEDs of each of the plurality of LED arrays LA**1** to LAn.

[0011] The feedback circuit **30** voltage-divides the driving voltage Vd outputted from the DC-DC converter **20** to generate a feedback voltage Vfb by using first and second resistors R**1** and R**2** which are serially connected to each other, and feeds back the generated feedback voltage Vfb to the DC-DC converter **20**. Thus, the DC-DC converter **20** generates a pulse width modulation (PWM) signal corresponding to the feedback voltage Vfb supplied from the feedback circuit **30**, and turns on a switching element according to the PWM signal to output the driving voltage Vd which has a voltage level equal to or higher than a certain voltage level with respect to the input voltage Vcc.

[0012] The duty controller **40** is connected to the light source **10**, namely, the plurality of LED arrays LA**1** to LAn, and controls a turn-on/off period of the plurality of LED arrays LA**1** to LAn according to the backlight dimming signal DIM to adjust a brightness of the light source **10**. Therefore, the plurality of LED arrays LA**1** to LAn emit light during a duty-on section of the backlight dimming signal DIM.

[0013] However, the general backlight driving apparatus has the following problems.

[0014] First, since the switching element of the DC-DC converter **20** is turned on even during a duty-off section of the light source **10**, a loss of power such as a switching loss of the switching element occurs, causing a reduction in power conversion efficiency.

[0015] Second, the plurality of LED arrays LA**1** to LAn are repeatedly turned on/off by the backlight dimming signal DIM to continuously change a load condition of the DC-DC converter **20**, and a load condition of the turn-on period of the LED arrays LA**1** to LAn differs from that of the turn-off period of the LED arrays LA**1** to LAn. For this reason, it is difficult to maintain a constant power conversion efficiency of the DC-DC converter **20**.

SUMMARY

[0016] Accordingly, the present invention is directed to provide a backlight driving apparatus and an LCD device using the backlight driving apparatus that substantially obviates one or more problems due to limitations and disadvantages of the related art.

[0017] An aspect of the present invention is directed to provide a backlight driving apparatus and an LCD device, which can minimize a loss of power to enhance power conversion efficiency.

[0018] In addition to the aforesaid objects of the present invention, other features and advantages of the present invention will be described below, but will be clearly understood by those skilled in the art from descriptions below.

[0019] Additional advantages and features of the invention will be set forth in part in the description which follows and in part will become apparent to those having ordinary skill in the art upon examination of the following or may be learned from practice of the invention. The objectives and other advantages of the invention may be realized and attained by the structure particularly pointed out in the written description and claims hereof as well as the appended drawings.

[0020] To achieve these and other advantages and in accordance with the purpose of the invention, as embodied and broadly described herein, there is provided a backlight driving apparatus including: a light source configured to include at least one light emitting diode (LED); a DC-DC converter configured to generate a driving voltage according to a turn-on of a switching element, and supply the driving voltage to the light source; a feedback circuit configured to generate a feedback voltage corresponding to a voltage level of the driving voltage supplied from light source; a duty controller connected to the light source, and configured to control a turn-on period of the LED according to an LED duty signal corresponding to a backlight dimming signal; and a switching

controller configured to generate a pulse width modulation (PWM) signal for controlling the turn-on of the switching element according to the feedback signal, generate a switching control signal corresponding to the PWM signal according to the LED duty signal, and selectively control the turn-on of the switching element.

[0021] In another aspect of the present invention, there is provided a liquid crystal display (LCD) device including: a display panel configured to include a plurality of liquid crystal cells that are respectively formed in a plurality of areas defined by intersections between a plurality of gate lines and a plurality of data lines; a panel driver configured to display an image, corresponding to external input data, in the display panel; and a backlight unit configured to irradiate light on the display panel, wherein the backlight unit includes the backlight driving apparatus.

[0022] It is to be understood that both the foregoing general description and the following detailed description of the present invention are exemplary and explanatory and are intended to provide further explanation of the invention as claimed.

BRIEF DESCRIPTION OF THE DRAWINGS

[0023] The accompanying drawings, which are included to provide a further understanding of the invention and are incorporated in and constitute a part of this application, illustrate embodiments of the invention and together with the description serve to explain the principle of the invention. In the drawings:

[0024] FIG. **1** is a diagram for describing a general backlight driving apparatus;

[0025] FIG. **2** is a diagram for describing a backlight driving apparatus according to an embodiment of the present invention;

[0026] FIG. **3** is a diagram for describing a configuration of a switching controller according to an embodiment of the present invention;

[0027] FIG. **4** is a waveform diagram showing driving waveforms of the switching controller based on a burst mode;

[0028] FIG. **5** is a waveform diagram showing driving waveforms of the switching controller based on a normal mode;

[0029] FIG. **6** is a graph that compares an efficiency of the backlight driving apparatus of the present invention with an efficiency of the related art backlight driving apparatus; and

[0030] FIG. **7** is a diagram for describing an LCD device according to an embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0031] The terms described in the specification should be understood as follows.

[0032] As used herein, the singular forms "a", "an" and "the" are intended to include the plural forms as well, unless the context clearly indicates otherwise. The terms "first" and "second" are for differentiating one element from the other element, and these elements should not be limited by these terms.

[0033] It will be further understood that the terms "comprises", "comprising,", "has", "having", "includes" and/or "including", when used herein, specify the presence of stated features, integers, steps, operations, elements, and/or components, but do not preclude the presence or addition of one or more other features, integers, steps, operations, elements, components, and/or groups thereof.

[0034] The term "at least one" should be understood as including any and all combinations of one or more of the associated listed items. For example, the meaning of "at least one of a first item, a second item, and a third item" denotes the combination of all items proposed from two or more of the first item, the second item, and the third item as well as the first item, the second item, or the third item.

[0035] Hereinafter, embodiments of the present invention will be described in detail with reference to the accompanying drawings.

[0036] FIG. **2** is a diagram for describing a backlight driving apparatus according to an embodiment of the present invention.

[0037] As illustrated in FIG. **2**, a backlight driving apparatus **200** according to an embodiment of the present invention includes a DC-DC converter **120** that supplies a driving voltage Vd to a light source **110**, a feedback circuit **130** that generates a feedback voltage corresponding to a voltage level of the driving voltage Vd, a duty controller **140** that controls a turn-on/ff period of the light source **110** according to an LED duty signal based on a backlight dimming signal supplied from the outside, and a switching controller **150** that controls the DC-DC converter **120** on the basis of the LED duty signal and the feedback voltage Vfb.

[0038] The light source **110** includes a plurality of LED arrays LA**1** to LAn in which a plurality of LEDs are serially connected to each other. Each of the plurality of LED arrays LA**1** to LAn emits light with a current which flows according to the driving voltage Vd supplied from the DC-DC converter **120**.

[0039] The DC-DC converter **120** generates the driving voltage Vd according to switching control by the switching controller **150** on the basis of an input voltage Vcc supplied from the outside, and supplies the driving voltage Vd to the plurality of LED arrays LA**1** to LAn, thereby emitting light from the LEDs of each of the plurality of LED arrays LA**1** to LAn. For example, the DC-DC converter **120** includes a booster inductor L, a diode D, a capacitor C, and a switching element Psw. The DC-DC converter **120** outputs energy stored in the booster inductor L through the diode D according to a turn-on of the switching element Psw, and boosts the energy through the capacitor C to generate the driving voltage Vd.

[0040] The inductor L is connected between an input voltage Vcc line and a first node N**1**, and stores a voltage corresponding to a change amount of current due to the input voltage Vcc. The diode D is connected between the first node N**1** and an output node NO, and rectifies and outputs a voltage supplied from the inductor L according to the turn-on of the switching element Psw. Here, the diode D is a backflow prevention diode, and allows the voltage supplied from the inductor L to be supplied to an output node NO. The capacitor C is charged with the voltage supplied from the inductor L through the diode D according to the turn-on of the switching element Psw, and outputs the charged voltage as the driving voltage Vd to the output node NO.

[0041] The feedback circuit **130** generates the feedback voltage Vfb corresponding to the driving voltage Vd outputted from the DC-DC converter **120** according to voltage division by first and second resistors R**1** and R**2** which are serially connected between the output node NO of the DC-DC converter **120** and ground, and feeds back the generated feedback

voltage Vfb to the switching controller **150**. Here, each of the first and second resistors R**1** and R**2** may be replaced with an impedance element such as an inductor or a capacitor.

[0042] The duty controller **140** is connected to the light source **110**, namely, the plurality of LED arrays LA**1** to LAn, and controls a turn-on/off period of the plurality of LED arrays LA**1** to LAn according to the backlight dimming signal DIM to adjust a brightness of the light source **110**. That is, the duty controller **140** allows a current to flow from the plurality of LED arrays LA**1** to LAn to the ground during a duty-on section of a backlight dimming signal DIM, thereby emitting light from the plurality of LED arrays LA**1** to LAn. On the other hand, the duty controller **140** prevents a current from flowing from the plurality of LED arrays LA**1** to LAn to the ground during a duty-off section of the backlight dimming signal DIM, thereby turning off the plurality of LED arrays LA**1** to LAn.

[0043] Moreover, the duty controller **140** may receive the feedback voltage Vfb from the feedback circuit **130** to additionally control the turn-on/off of the plurality of LED arrays LA**1** to LAn. Also, the duty controller **140** supplies the backlight dimming signal DIM as an LED duty signal to the switching controller **150**.

[0044] The switching controller **150** generates a switching control signal (SCS) on the basis of the feedback voltage Vfb supplied from the feedback circuit **130** and the LED duty signal supplied from the duty controller **140** to control the turn-on/off of the switching element Psw of the DC-DC converter **120**.

[0045] Specifically, the switching controller **150** generates a PWM signal according to the feedback voltage Vfb, sets a normal mode or a burst mode according to the LED duty signal, and generates the switching control signal SCS corresponding to the PWM signal or the switching control signal SCS having a switching-off voltage level according to the set mode, thereby controlling the DC-DC converter **120**. That is, when a duty-on section of the LED duty signal LED_duty is less than a predetermined reference value, the switching controller **150** sets the burst mode, and generates the switching control signal SCS corresponding to the PWM signal to repeatedly turn on the switching element Psw of the DC-DC converter **120** during only the duty-on section of the LED duty signal LED_duty, or generates the switching control signal SCS having the switching-off voltage level to fully turn off the switching element Psw of the DC-DC converter **120** during only the duty-off section of the LED duty signal LED_duty. On the other hand, when the duty-on section of the LED duty signal LED_duty is held for equal to or longer than the predetermined reference value, the switching controller **150** sets the normal mode, and generates the switching control signal SCS corresponding to the PWM signal to repeatedly turn on the switching element Psw of the DC-DC converter **120**.

[0046] Therefore, the switching controller **150** turns off the switching element Psw of the DC-DC converter **120** during the duty-off section of the LED duty signal LED_duty in the burst mode, and thus prevents a reduction in power conversion efficiency such as a switching loss due to the unnecessary turn-on of the switching element Psw during the duty-off section of the light source **110**.

[0047] FIG. **3** is a diagram for describing a configuration of a switching controller according to an embodiment of the present invention, FIG. **4** is a waveform diagram showing driving waveforms of the switching controller based on a burst mode, and FIG. **5** is a waveform diagram showing driving waveforms of the switching controller based on a normal mode.

[0048] As shown in FIGS. **3** to **5**, the switching controller **150** includes a PWM signal generating unit **151**, a mode setting unit **153**, a switching unit **155**, and a switching control signal generating unit **157**.

[0049] The PWM signal generating unit **151** generates the PWM signal PWM_In according to the feedback voltage Vfb supplied from the feedback circuit **130**, and supplies the PWM signal PWM_In to the switching unit **155**.

[0050] The PWM signal generating unit **151** according to an embodiment of the present invention includes a first comparator **151***a*, a chopping wave generator **151***b*, and a second comparator **151***c*.

[0051] The first comparator **151***a* is an operational amplifier (OP-AMP), and compares a reference voltage Vref and the feedback voltage Vfb to output a duty variable voltage Vduty.

[0052] The chopping wave generator **151***b* generates a chopping wave CW having a constant frequency, and supplies the chopping wave CW to the second comparator **151***c*.

[0053] The second comparator **151***c* generates the PWM signal PWM_In having a duty-on section and a duty-off section based on the duty variable voltage Vduty with respect to the chopping wave CW, and supplies the PWM signal PWM_In to the switching unit **155**.

[0054] The mode setting unit **153** generates first and second mode control signals MCS**1** and MCS**2** for mode control on the basis of the duty-on section and duty-off section of the LED duty signal supplied from the duty controller **140**. That is, when the duty-on section of the LED duty signal LED_duty is less than the predetermined reference value, the mode setting unit **153** generates the first and second mode control signals MCS **1** and MCS**2** for the burst mode to control the turn-on of the switching unit **155**, and when the duty-on section of the LED duty signal LED_duty is equal to or greater than the predetermined reference value, the mode setting unit **153** generates the first and second mode control signals MCS**1** and MCS**2** for the normal mode to control the turn-on of the switching unit **155**.

[0055] The mode setting unit **153** according to an embodiment of the present invention includes first and second detectors **153***a* and **153***b* and a timer **153***c*.

[0056] The first detector **153***a* detects a rising edge trigger of the LED duty signal LED_duty, and supplies a high level of rising detection signal RDS to the timer **153***c*.

[0057] The second detector **153***b* detects a falling edge trigger of the LED duty signal LED_duty, and supplies a high level of falling detection signal FDS to the timer **153***c*.

[0058] The timer **153***c* generates the first and second mode control signals MCS**1** and MCS**2** according to the rising detection signal RDS and the falling detection signal FDS, and supplies the first and second mode control signals MCS**1** and MCS**2** to the switching unit **155**, thereby allowing the switching unit **155** to be turned on according to the normal mode or the burst mode.

[0059] The timer **153***c* includes a start terminal S receiving the rising detection signal RDS, a reset terminal R receiving the falling detection signal FDS, an overflow output terminal OVF for outputting the first mode control signal MCS**1**, and an inverting output terminal /OUT for outputting the second mode control signal MCS**2**. The timer **153***c* starts to operate according to the falling detection signal FDS having a high

level, and stops an operation according to the falling detection signal FDS having a high level.

[0060] In detail, the timer **153***c* outputs the first mode control signal MCS**1** having a low level through the overflow output terminal OVF and simultaneously outputs the second mode control signal MCS**2** having a low level through the inverting output terminal /OUT, during the duty-on section of the LED duty signal LED_duty for which the falling detection signal FDS having a high level is supplied to the start terminal S and the falling detection signal FDS having a low level is supplied to the reset terminal R.

[0061] Moreover, the timer **153***c* outputs the first mode control signal MCS**1** having a low level through the overflow output terminal OVF and simultaneously outputs the second mode control signal MCS**2** having a high level through the inverting output terminal /OUT, during the duty-off section of the LED duty signal LED_duty for which the falling detection signal FDS having a high level is supplied to the reset terminal R.

[0062] In addition, when the falling detection signal FDS having a high level is not supplied to the reset terminal R for a predetermined reference time after the falling detection signal FDS having a high level is supplied to the start terminal S, the timer **153***c* outputs the first mode control signal MCS**1** having a high level through the overflow output terminal OVF and simultaneously outputs the second mode control signal MCS**2** having a low level through the inverting output terminal /OUT.

[0063] The switching unit **155** supplies the first mode control signal MCS**1**, supplied from the timer **153***c* of the mode setting unit **153**, to the switching control signal generating unit **157**, and selectively supplies the PWM signal PWM_In, supplied from the PWM signal generating unit **151**, to the switching control signal generating unit **157** according to the first and second mode control signals MCS**1** and MCS**2**.

[0064] The switching unit **155** according to an embodiment of the present invention includes first and second switch transistors SW**1** and SW**2**.

[0065] The first switch transistor SW**1** is a P-type transistor, and includes a gate receiving the first mode control signal MCS**1**, a first terminal receiving the second mode control signal MCS**2**, and a second terminal connected to a gate of the second switch transistor SW**2**. The first switch transistor SW**1** is turned on according to the first mode control signal MCS**1** to supply the second mode control signal MCS**2**, supplied from the timer **153***c*, to the second switch transistor SW**2**. At this time, the gate of the first switch transistor SW**1** is connected to a PWM input terminal PIN of the switching control signal generating unit **157**.

[0066] The second switch transistor SW**2** is a P-type transistor, and includes the gate connected to the second terminal of the first switch transistor SW**1**, a first terminal receiving the PWM signal PWM_In, and a second terminal connected to a burst-mode input terminal BM of the switching control signal generating unit **157**. The second switch transistor SW**2** is turned on according to the second mode control signal MCS**2** supplied through the turned-on first switch transistor SW**1** to selectively supply the PWM signal PWM_In to the switching control signal generating unit **157**. Here, since the second switching transistor SW**2** is the P-type transistor, the second switch transistor SW**2** is turned on according to the second mode control signal MCS**2** having a low level supplied through the first switch transistor SW**1**, or turned on when the second mode control signal MCS**2** is not supplied thereto because the first switch transistor SW**1** is turned off. That is, the second switch transistor SW**2** is turned off only when the second mode control signal MCS**2** having a high level is supplied thereto through the turned-on first switching transistor SW**1**.

[0067] The first and second switch transistors SW**1** and SW**2** are all turned on in response to the first mode control signal MCS**1** having a low level and the second mode control signal MCS**2** having a low level which are supplied from the timer **153***c* according to the duty-on section of the LED duty signal LED_duty, and thus, the switching unit **155** supplies the PWM signal PWM_In to the PWM input terminal PIN of the switching control signal generating unit **157**. Also, the first switch transistor SW**1** is turned on and the second switch transistor SW**2** is turned off, in response to the first mode control signal MCS **1** having a low level and the second mode control signal MCS**2** having a high level which are supplied from the timer **153***c* according to the duty-off section of the LED duty signal LED_duty, and thus, the switching unit **155** prevents the PWM signal PWM_In from being supplied to the PWM input terminal PIN of the switching control signal generating unit **157**. In addition, the first switch transistor SW**1** is turned off in response to the first mode control signal MCS **1** having a high level and the second mode control signal MCS**2** having a low level which are supplied from the timer **153***c* according to the LED duty signal LED_duty having the duty-off section of 100%, and thus, the second switch transistor SW**2** is turned on, whereby the switching unit **155** supplies the PWM signal PWM_In to the PWM input terminal P_IN of the switching control signal generating unit **157**.

[0068] The switching control signal generating unit **157** generates the switching control signal SCS, whose a switching-on/off voltage level corresponding to the PWM signal PWM_In selectively supplied from the switching unit **155** to the PWM signal PWM_In is alternately changed, or the switching control signal SCS holding the switching-off voltage level to control the switching element Psw of the DC-DC converter **120** on the basis of the first mode control signal MCS**1** supplied to the burst-mode input terminal BM through the switching unit **155**.

[0069] Specifically, when the first mode control signal MCS**1** having a low level is supplied to the burst-mode input terminal BM, the switching control signal generating unit **157** generates the switching control signal SCS corresponding to the PWM signal PWM_In to repeatedly turn on the switching element Psw during only a section in which the PWM signal PWM_In is supplied to the PWM input terminal P_IN, and the switching control signal generating unit **157** generates the switching control signal SCS having the switching-off voltage level to fully turn off the switching element Psw during a section in which the PWM signal PWM_In is not supplied to the PWM input terminal P_IN. That is, when the first mode control signal MCS**1** having a low level is supplied to the burst-mode input terminal BM, as shown in FIG. **4**, the switching control signal generating unit **157** switches the switching element Psw to the burst mode, namely, the switching control signal generating unit **157** generates and outputs the switching control signal SCS corresponding to the PWM signal PWM_In supplied from the switching unit **155** to the PWM input terminal P_IN according to the duty-on section of the LED duty signal LED_duty, and the switching control signal generating unit **157** generates and outputs the switching control signal SCS having the switching-off voltage level during a section in which the PWM signal PWM_In is not

supplied from the switching unit **155** to the PWM input terminal P_IN according to the duty-off section of the LED duty signal LED_duty.

[0070] On the other hand, when the first mode control signal MCS**1** having a high level is supplied to the burst-mode input terminal BM, the switching control signal generating unit **157** generates the switching control signal SCS corresponding to the PWM signal PWM_In supplied to the PWM input terminal P_IN to repeatedly turn on the switching element Psw. That is, when the first mode control signal MCS **1** having a high level is supplied to the burst-mode input terminal BM, the switching control signal generating unit **157** switches the switching element Psw to the normal mode, namely, the switching control signal generating unit **157** generates and outputs the switching control signal SCS corresponding to the PWM signal PWM_In supplied from the switching unit **155** to the PWM input terminal P_IN according to the duty-on section of the LED duty signal LED_duty.

[0071] FIG. **6** is a graph that compares an efficiency of the backlight driving apparatus of the present invention with an efficiency of the related art backlight driving apparatus.

[0072] In FIG. **6**, an A graph indicates an efficiency of each of first to sixth LED arrays according to the present invention, and a B graph indicates an efficiency of each of first to sixth LED arrays of the related art. As seen in FIG. **6**, it can be seen that the efficiency of the first to sixth LED arrays according to the present invention is higher than the first to sixth LED arrays of the related art.

[0073] Therefore, in the backlight driving apparatus **100** according to the present invention, the switching element of the DC-DC converter is fully turned off during the duty-off section of the LED duty signal, thus preventing a power conversion efficiency from being reduced by a switching loss of the switching element which occurs during the duty-off section. Also, despite that the LED arrays LA**1** to LAn are repeatedly turned on/off by the backlight dimming signal, a constant power conversion efficiency of the DC-DC converter can be maintained.

[0074] FIG. **7** is a diagram for describing an LCD device according to an embodiment of the present invention.

[0075] Referring to FIG. **7**, the LCD device according to an embodiment of the present invention includes a display panel **300**, a panel driver **400**, and a backlight unit **500**.

[0076] The display panel **300** includes a plurality of pixels P that are respectively formed in a plurality of areas defined by intersections between a plurality of gate lines GL and a plurality of data lines DL.

[0077] Each of the plurality of pixels P includes a thin film transistor (TFT, not shown) connected to a corresponding gate line GL and a corresponding data line DL and a liquid crystal cell connected to the TFT.

[0078] The display panel **300** generates an electric field in the liquid crystal cell according to a data voltage supplied to each pixel P to adjust a transmittance of light irradiated from the backlight unit **500**, thereby displaying a certain image.

[0079] The panel driver **400** includes a data driving circuit unit **410**, a gate driving circuit unit **420**, and a timing controller **430**.

[0080] The data driving circuit unit **410** latches data signals R, G and B inputted from the timing controller **430** according to a data control signal DCS supplied from the timing controller **430**, converts the latched data signals into positive/negative analog pixel voltages by using positive/negative analog gamma voltages, generates pixel voltages having a polarity corresponding to a polarity control signal, and supplies the pixel voltages to the respective data lines DL.

[0081] The gate driving circuit unit **420** generates a gate pulse according to a gate control signal GCS supplied from the timing controller **430**, and sequentially supplies the gate pulse to the gate lines GL. Here, the gate driving circuit unit **420** may be provided on a substrate when the TFTs are being formed.

[0082] The timing controller **430** aligns input data RGB inputted from the outside so as to properly match a pixel structure of the display panel **200**, and supplies the aligned data RGB to the data driving circuit unit **410**.

[0083] Moreover, the timing controller **400** generates a data control signal DCS for controlling an operation timing of the data driving circuit unit **410** and a gate control signal GCS for controlling an operation timing of the gate driving circuit unit **420** by using a timing synch signal TSS inputted thereto. Here, the timing sync signal TSS may include a vertical sync signal (Vsync), a horizontal sync signal (Hsync), a data enable signal (DE), and a dot clock (DCLK). The data control signal DCS may include a source start pulse (SSP), a source sampling clock (SSC), a source output enable signal (SOE), and the polarity control signal (POL). The gate control signal GCS may include a gate start pulse (GSP), a gate shift clock (GCLK), a gate shift clock (GSC), and a gate output enable signal (GOE).

[0084] In addition, the timing controller **430** generates the backlight dimming signal DIM for controlling a luminance of the backlight unit **500** according to a brightness of an image corresponding to one frame, and supplies the backlight dimming signal DIM to the backlight unit **500**. Here, the timing controller **430** analyzes input data RGB of the one frame to calculate an average image level, and generates the backlight dimming signal DIM based on the calculated average image level. For example, when the image corresponding to the one frame is determined as a relatively bright image according to the average image level, the timing controller **430** may generate the backlight dimming signal DIM for reducing a luminance of the backlight unit **500**, but when the image corresponding to the one frame is determined as a relatively dark image according to the average image level, the timing controller **430** may generate the backlight dimming signal DIM for increasing a luminance of the backlight unit **500**.

[0085] The backlight unit **500** emits light from a plurality of LEDs to irradiate the light on the display panel **300**. The backlight unit **500** includes a light source **510**, including a plurality of LED arrays LA configured with the plurality of LEDs which are serially connected to each other, and a backlight driver **520**. Here, the backlight unit **500** is configured identically to the backlight driving apparatus **100** according to an embodiment of the present invention described above with reference to FIGS. **2** to **5**, and thus, a repetitive description is not provided.

[0086] The backlight unit **500** may further include an optical sheet member (not shown) that enhances a luminance characteristic of light incident from the light source **500** to irradiate the luminance-enhanced light on the display panel **300**.

[0087] As described above, the switching element of the DC-DC converter is fully turned off during the duty-off section of the LED duty signal, thus preventing power conversion efficiency from being reduced by a switching loss of the switching element which occurs during the duty-off section.

[0088] Moreover, despite that the LED arrays are repeatedly turned on/off by the backlight dimming signal, a constant power conversion efficiency of the DC-DC converter can be maintained.

[0089] It will be apparent to those skilled in the art that various modifications and variations can be made in the present invention without departing from the spirit or scope of the inventions. Thus, it is intended that the present invention covers the modifications and variations of this invention provided they come within the scope of the appended claims and their equivalents.

What is claimed is:

1. A backlight driving apparatus comprising:

a light source configured to comprise at least one light emitting diode (LED);

a DC-DC converter configured to generate a driving voltage according to a turn-on of a switching element, and supply the driving voltage to the light source;

a feedback circuit configured to generate a feedback voltage corresponding to a voltage level of the driving voltage supplied from light source;

a duty controller connected to the light source, and configured to control a turn-on period of the LED according to an LED duty signal corresponding to a backlight dimming signal; and

a switching controller configured to generate a pulse width modulation (PWM) signal for controlling the turn-on of the switching element according to the feedback signal, generate a switching control signal corresponding to the PWM signal according to the LED duty signal, and selectively control the turn-on of the switching element.

2. The backlight driving apparatus of claim **1**, wherein:

the switching controller generates the switching control signal corresponding to the PWM signal during a duty-on section of the LED duty signal to turn on the switching element; and

the switching controller generates the switching control signal having a switching-off voltage level during a duty-off section of the LED duty signal to turn off the switching element.

3. The backlight driving apparatus of claim **2**, wherein the switching controller comprises:

a PWM signal generating unit configured to generate the PWM signal according to the feedback signal;

a mode setting unit configured to generate a mode control signal based on the duty-on section and duty-off section of the LED duty signal;

a switching unit configured to selectively output the PWM signal according to the mode control signal; and

a switching control signal generating unit configured to generate the switching control signal which corresponds to the mode control signal and the PWM signal supplied from the switching unit, or generate the switching control signal having the switching-off voltage level.

4. The backlight driving apparatus of claim **3**, wherein the mode setting unit comprises:

a first detector configured to detect a rising edge trigger of the LED duty signal to output a rising detection signal;

a second detector configured to detect a falling edge trigger of the LED duty signal to output a falling detection signal; and

a timer configured to generate a first mode control signal and a second mode control signal according to the rising detection signal and the falling detection signal, and supply the first and second mode control signals to the switching unit.

5. The backlight driving apparatus of claim **4**, wherein:

when the rising detection signal is less than a predetermined reference value, the timer generates the first and the second mode control signals having a first logic level during the duty-on section of the LED duty signal, and during the duty-off section of the LED duty signal, the timer generates the first mode control signal having the first logic level and generates the second mode control signal having a second logic level; and

when the rising detection signal is equal to or greater than the predetermined reference value, the timer generates the first mode control signal having the second logic level and generates the second mode control signal having the first logic level.

6. The backlight driving apparatus of claim **5**, wherein the switching unit comprises:

a first switch transistor configured to output the second mode control signal according to the first mode control signal; and

a second switch transistor configured to supply the PWM signal, supplied from the PWM signal generating unit, to the switching control signal generating unit according to the second mode control signal supplied through the first switch transistor.

7. The backlight driving apparatus of claim **6**, wherein the second switch transistor is turned off only when the second mode control signal having the second logic level is supplied through the first switch transistor.

8. The backlight driving apparatus of claim **5**, wherein:

the switching control signal generating unit generates the switching control signal corresponding to the PWM signal supplied from the switching unit according to the first mode control signal having the first logic level to turn on the switching element, and generates the switching control signal having the switching-off voltage level to turn off the switching element; and

the switching control signal generating unit generates the switching control signal corresponding to the PWM signal supplied from the switching unit according to the first mode control signal having the second logic level to turn on the switching element.

9. A liquid crystal display (LCD) device comprising:

a display panel configured to comprise a plurality of liquid crystal cells that are respectively formed in a plurality of areas defined by intersections between a plurality of gate lines and a plurality of data lines;

a panel driver configured to display an image, corresponding to external input data, in the display panel; and

a backlight unit configured to irradiate light on the display panel,

wherein the backlight unit comprises a backlight driving apparatus of claim **1**.

10. The LCD of claim **9**, wherein:

the switching controller generates the switching control signal corresponding to the PWM signal during a duty-on section of the LED duty signal to turn on the switching element; and

the switching controller generates the switching control signal having a switching-off voltage level during a duty-off section of the LED duty signal to turn off the switching element.

11. The LCD of claim **10**, wherein the switching controller comprises:

a PWM signal generating unit configured to generate the PWM signal according to the feedback signal;

a mode setting unit configured to generate a mode control signal based on the duty-on section and duty-off section of the LED duty signal;

a switching unit configured to selectively output the PWM signal according to the mode control signal; and

a switching control signal generating unit configured to generate the switching control signal which corresponds to the mode control signal and the PWM signal supplied from the switching unit, or generate the switching control signal having the switching-off voltage level.

12. The LCD of claim **11**, wherein the mode setting unit comprises:

a first detector configured to detect a rising edge trigger of the LED duty signal to output a rising detection signal;

a second detector configured to detect a falling edge trigger of the LED duty signal to output a falling detection signal; and

a timer configured to generate a first mode control signal and a second mode control signal according to the rising detection signal and the falling detection signal, and supply the first and second mode control signals to the switching unit.

13. The LCD of **12**, wherein:

when the rising detection signal is less than a predetermined reference value, the timer generates the first and the second mode control signals having a first logic level during the duty-on section of the LED duty signal, and during the duty-off section of the LED duty signal, the timer generates the first mode control signal having the first logic level and generates the second mode control signal having a second logic level; and

when the rising detection signal is equal to or greater than the predetermined reference value, the timer generates the first mode control signal having the second logic level and generates the second mode control signal having the first logic level.

14. The LCD of claim **13**, wherein the switching unit comprises:

a first switch transistor configured to output the second mode control signal according to the first mode control signal; and

a second switch transistor configured to supply the PWM signal, supplied from the PWM signal generating unit, to the switching control signal generating unit according to the second mode control signal supplied through the first switch transistor.

15. The LCD of claim **14**, wherein the second switch transistor is turned off only when the second mode control signal having the second logic level is supplied through the first switch transistor.

16. The LCD of claim **13**, wherein:

the switching control signal generating unit generates the switching control signal corresponding to the PWM signal supplied from the switching unit according to the first mode control signal having the first logic level to turn on the switching element, and generates the switching control signal having the switching-off voltage level to turn off the switching element; and

the switching control signal generating unit generates the switching control signal corresponding to the PWM signal supplied from the switching unit according to the first mode control signal having the second logic level to turn on the switching element.

17. The LCD of claim **9**, wherein the panel driver comprises a timing controller configured to analyze input data of one frame to generate a backlight dimming signal for controlling a luminance of the backlight unit, and supply the backlight dimming signal to the backlight unit.

* * * * *

专利名称(译)	背光驱动装置和使用该装置的液晶显示装置		
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[标]申请(专利权)人(译)	乐金显示有限公司		
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摘要(译)

公开了一种背光驱动装置。该背光驱动装置包括：光源，被配置为包括至少一个LED; DC-DC转换器，被配置为根据开关元件的接通产生驱动电压并将驱动电压提供给光源，反馈电路被配置为产生与从光源提供的驱动电压的电压电平相对应的反馈电压，连接到光源的占空控制器，并且被配置为根据与a对应的LED占空比信号来控制LED的导通时段。背光调光信号，以及切换控制器，用于根据反馈信号产生用于控制开关元件导通的PWM信号，根据LED占空信号产生与PWM信号对应的开关控制信号，并选择性地控制开关元件的接通。