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(19) **United States**(12) **Patent Application Publication**  
**Huang et al.**(10) **Pub. No.: US 2009/0085860 A1**(43) **Pub. Date: Apr. 2, 2009**(54) **LIQUID CRYSTAL DISPLAY AND DRIVING METHOD THEREOF**(30) **Foreign Application Priority Data**

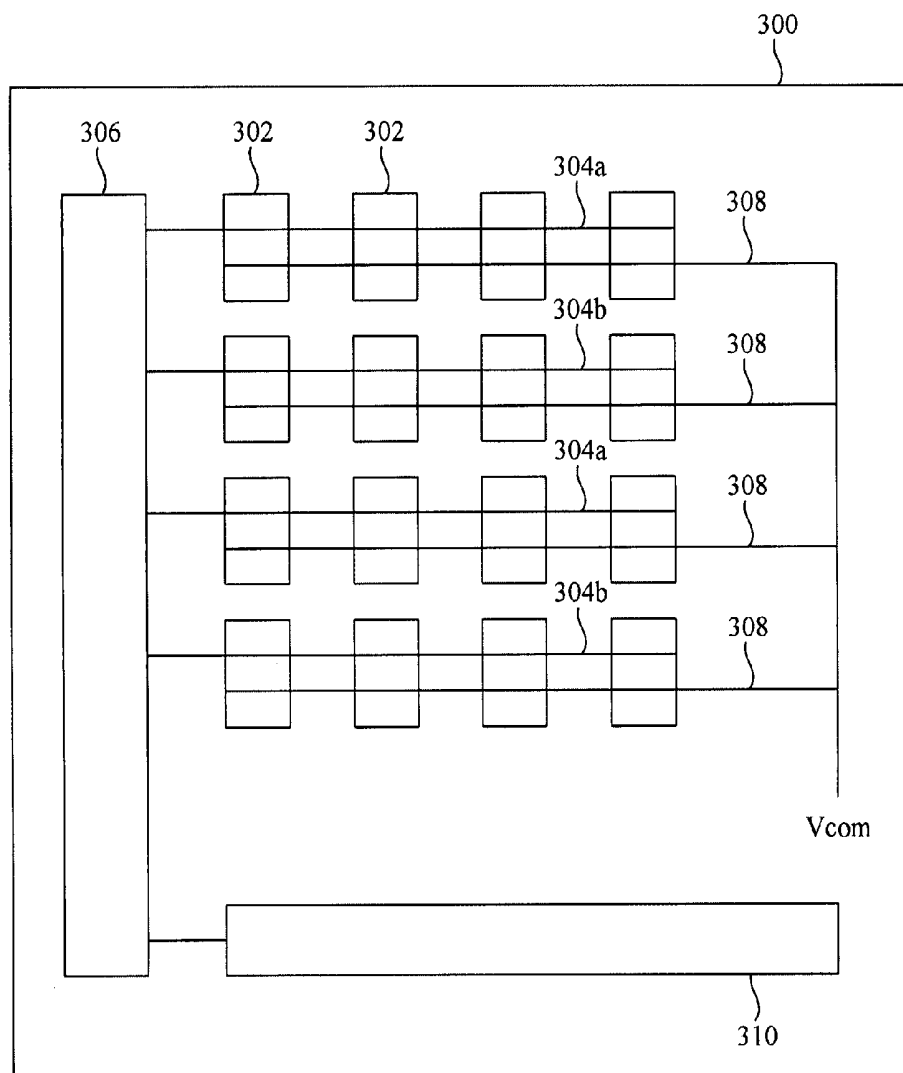
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Hsin-Chu (TW)**Publication Classification**(51) **Int. Cl.**  
**G09G 3/36** (2006.01)(52) **U.S. Cl.** ..... **345/102; 345/87**(57) **ABSTRACT**

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In a method for driving a liquid crystal display, a plurality of first enabling pulses are transmitted to a first group of scan lines in a first period of a predetermined time, respectively. A plurality of second enabling pulses are transmitted to a second group of scan lines in a second period of the predetermined time, respectively. The pixel voltages of pixel units, which are connected to the scan lines of the first and second group, are different in their polarities. During the predetermined time, a common voltage signal, which has different levels in the first and second period, is transmitted to the common line. A liquid crystal display applying the above driving method is also disclosed.

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Hsin-Chu (TW)(21) Appl. No.: **12/149,705**(22) Filed: **May 7, 2008**

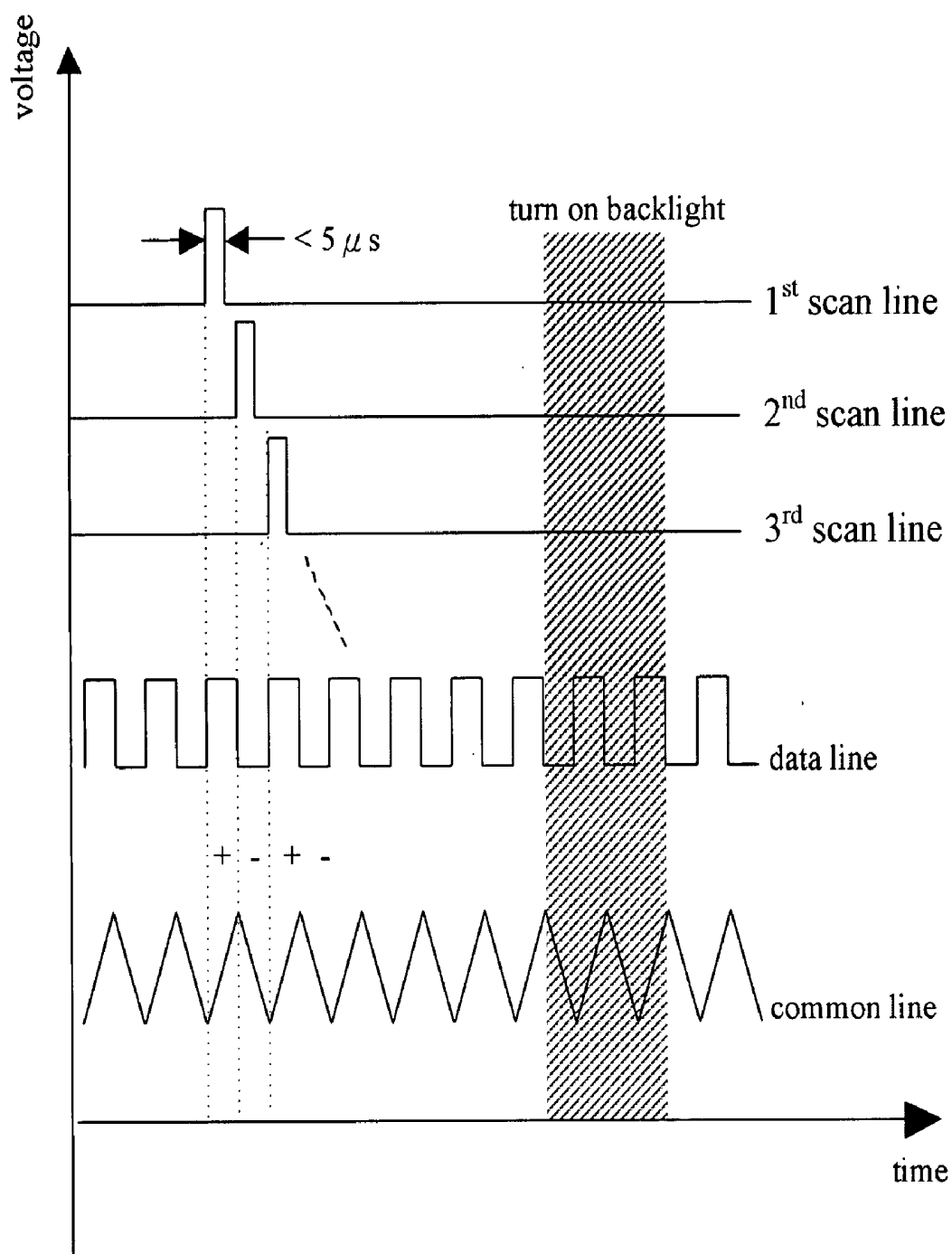


Figure 1 (Prior Art)

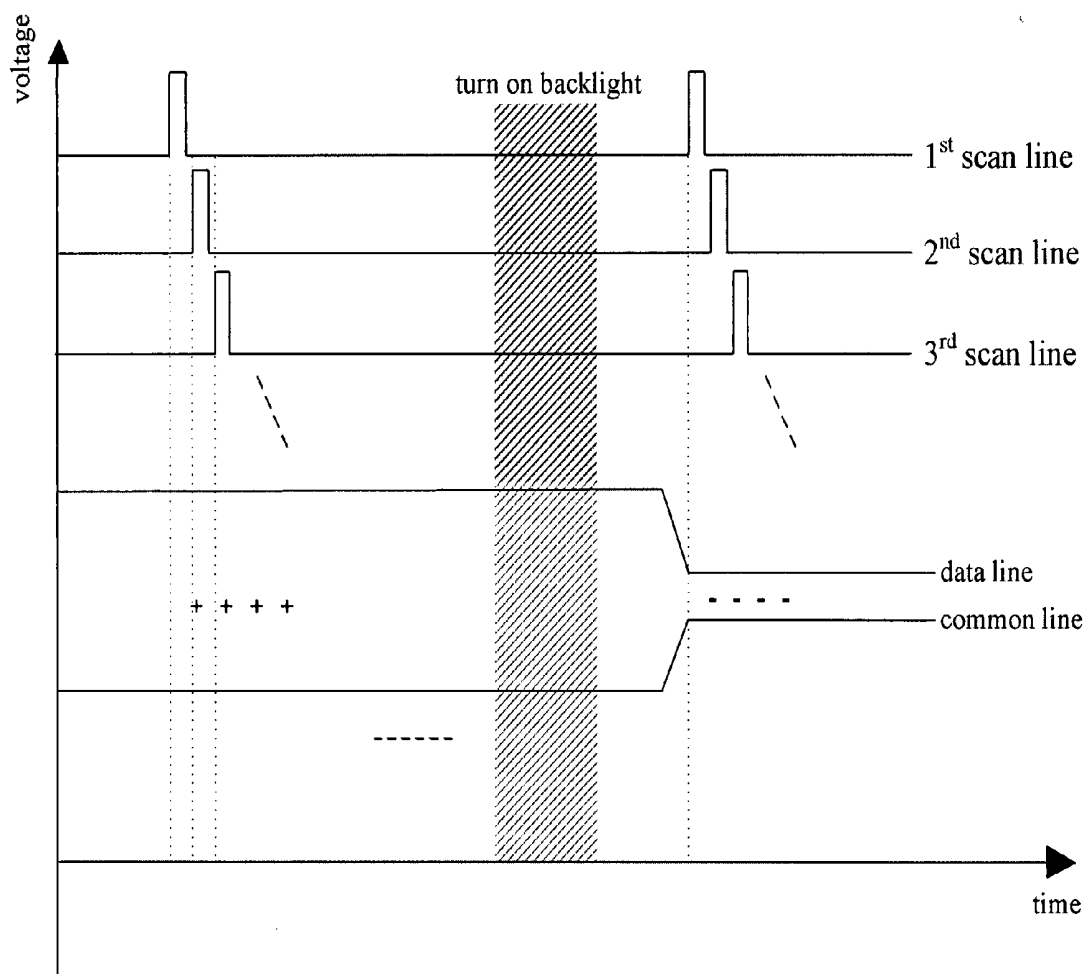


Figure 2 (Prior Art)

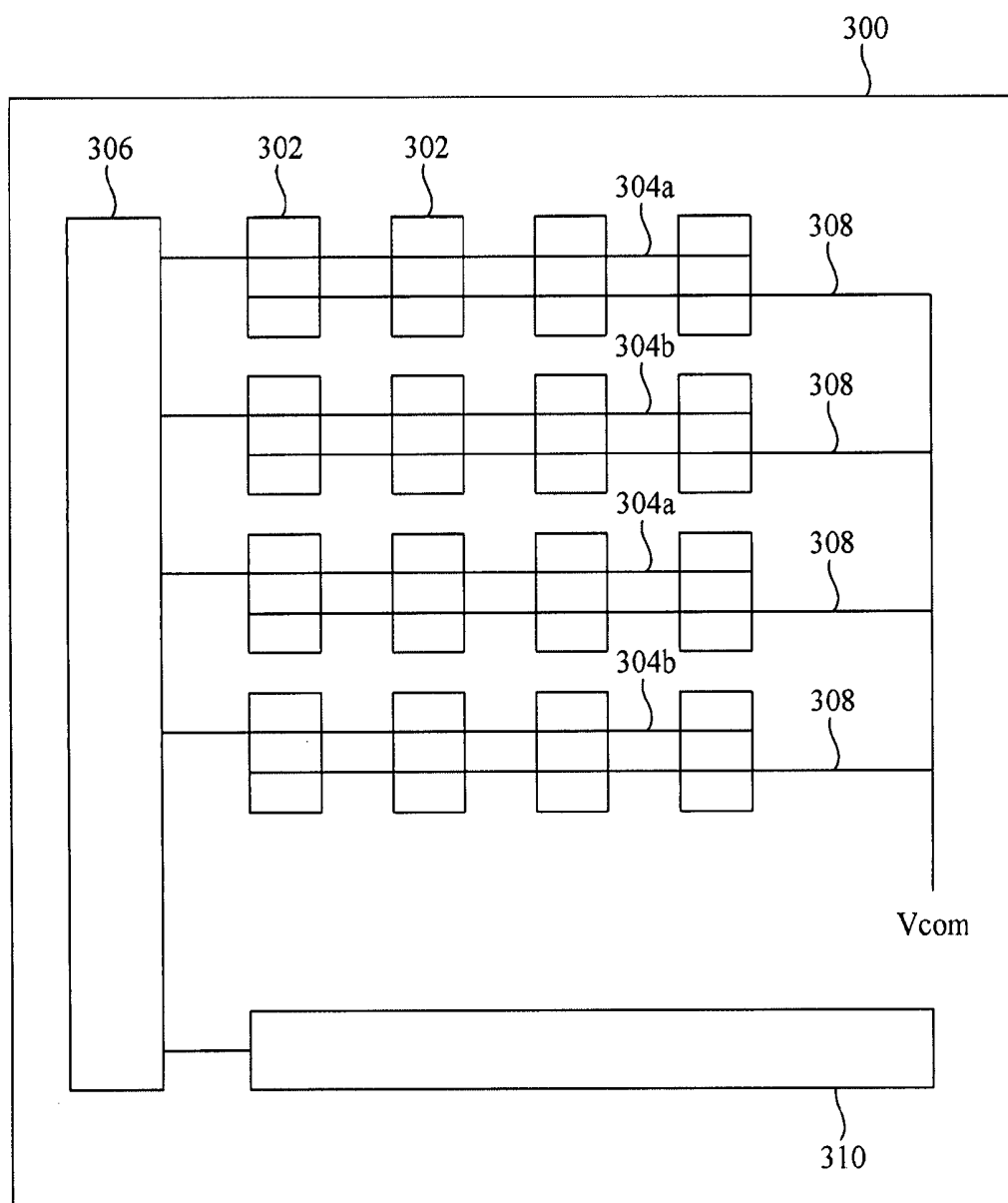


Figure 3

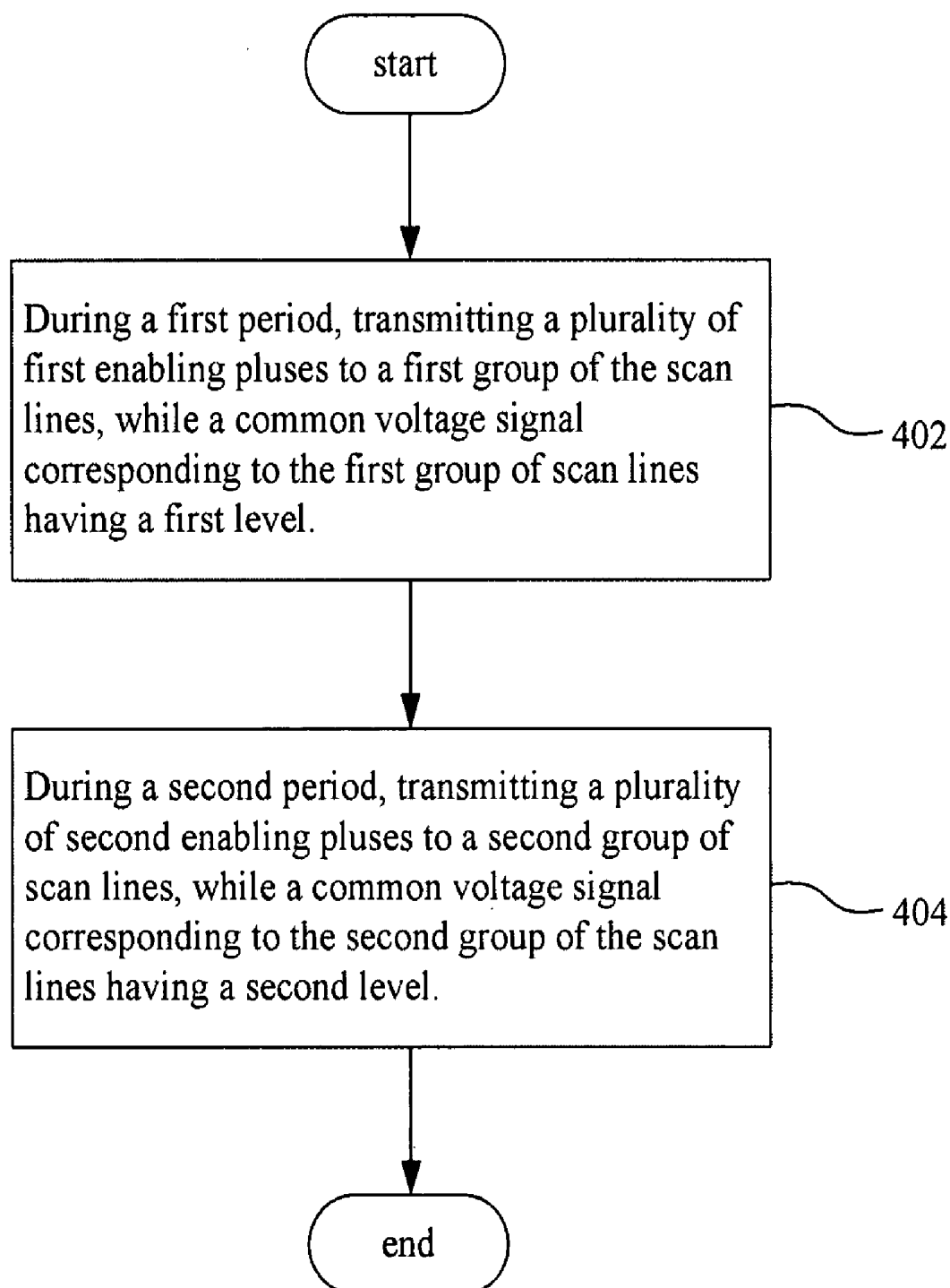


Figure 4

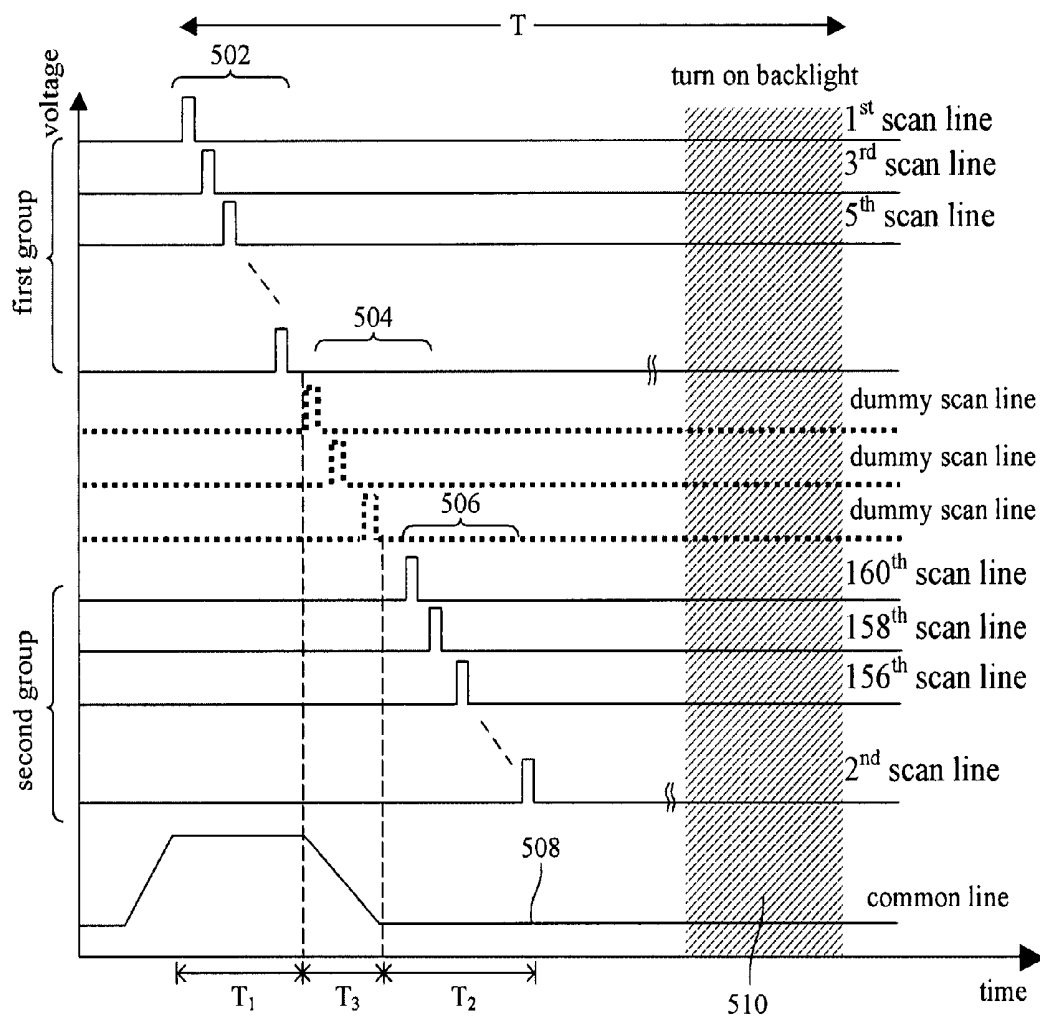


Figure 5



Figure 6

## LIQUID CRYSTAL DISPLAY AND DRIVING METHOD THEREOF

### RELATED APPLICATIONS

[0001] This application claims priority to Taiwan Patent Application Serial Number 96136401, filed Sep. 28, 2007, which is herein incorporated by reference.

### FIELD OF THE INVENTION

[0002] The invention is related to a display and a driving method thereof, more particularly, to a LCD display and a driving method thereof.

### BACKGROUND OF THE INVENTION

[0003] FIG. 1 is a timing chart of signals for the line inversion method adopted by the conventional liquid crystal display. FIG. 1 shows that, for all the scan lines, the polarities of voltages applied to the data lines and the common lines are repeatedly inverted with time in the liquid crystal display driven by a color sequential method. In the color sequential method, sub-frames of three primary colors, e.g., red, green, and blue, are configured to constitute a complete frame, and thus the driving frequency of each sub-frame is 180 Hz. However, the scan lines on the panel of the LCD display are switched in only a small portion of a sub-frame time ( $<5 \mu\text{s}$ ), and the other portion of the sub-frame time is configured to rotate the liquid crystal molecules in specific positions to turn on a backlight. Moreover, a scan time of a scan line needs to be shortened in order to reduce the possibility of the liquid crystal molecules reacting synchronically as a result of differences between the scan times of different scan lines, which leads to the degradation of brightness of the display panel driven by a line-sequential mode. Therefore, the scan time for each scan line must be shortened.

[0004] In the condition that the above scanning method is adopted by a driving configuration of the common line voltage swing shown in FIG. 1, and the LCD display is operated by a line inversion method, a common voltage on the common lines may be incapable of inverting with time and thus resulting in the problem of unstable charging of a pixel unit.

[0005] For solving the aforesaid problems, in general, the LCD display in FIG. 1 is substituted by an LCD adopted with a frame inversion method. FIG. 2 is a timing chart of the signals of the frame inversion method adopted by a conventional LCD. FIG. 2 shows when the LCD is driven by the color sequential method, the voltages on the scan lines, data lines, and common lines vary with time. As shown in FIG. 2, in the frame inversion method, the polarity of a common line voltage inverses once between two consecutive frames such that the common line voltage reaches a stable value before the scan line start being switched on, and thus the stability of charging state of the pixel unit is ensured.

[0006] However, compared with other LCDs, the flicker problem of the LCD with the frame inversion method is more serious. The LCD implementing a frequency of up to 300 Hz may mitigate the flicker problem. If the reaction time of the liquid crystal molecules can't keep up with the frequency, brightness degradation is inevitable.

[0007] For solving the aforesaid problem, an LCD and a driving method thereof are provided.

### SUMMARY OF THE INVENTION

[0008] One aspect of the invention is to provide a driving method for the LCD. In a first period of a predetermined time, a plurality of first enabling pulses are transmitted to a first group of scan lines during a first period of a predetermined time, respectively. A plurality of second enabling pulses are transmitted to a second group of scan lines during a second period of the predetermined time, respectively. The pixel voltages of pixel units, which are connected to the scan lines of the first and second groups, are different in their polarities. During the predetermined time, a common voltage signal, which has different levels in the first and second period, is transmitted to the common line.

[0009] Another aspect of the invention is to provide an LCD, which includes a plurality of pixel units, a plurality of scan lines, at least one scan driver and a plurality of common lines. Each of scan lines is respectively connected to one of terminals of a row of pixel units. The scan lines are divided into a first group and a second group. The pixel voltages of the pixels, which separately connected to the first and second groups, are different in their polarities. In a first period of a predetermined time, a plurality of first enabling pulses are transmitted to a first group of scan lines in a first period of a predetermined time, respectively. A plurality of second enabling pulses are transmitted to a second group of scan lines in a second period of the predetermined time, respectively. Each common line is respectively connected to other terminals of the row of the pixels. Also, a common voltage signal on a common line is different in polarity during the first and second period.

### BRIEF DESCRIPTION OF THE DRAWINGS

[0010] FIG. 1 is a timing chart of signals of a conventional LCD with a line inversion method.

[0011] FIG. 2 is a timing chart of signals of a conventional LCD with a frame inversion method.

[0012] FIG. 3 is a schematic diagram illustrating an LCD according to an embodiment of the invention.

[0013] FIG. 4 is a flow chart of the driving method of an LCD according to an embodiment of the invention.

[0014] FIG. 5 is a timing chart of signals on the scan lines and common lines of the LCD according to an embodiment of the invention.

[0015] FIG. 6 is a timing chart of signals of an LCD with both the driving method and black insertion method according to an embodiment of the invention.

### DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0016] FIG. 3 is a schematic diagram illustrating an LCD according to an embodiment of the invention. LCD 300 includes a plurality of pixel units 302, a plurality of scan lines 304a and 304b, at least one scan driver 306 and a plurality of common lines. Each of scan lines 304a or 304b is respectively connected to a terminal of a row of pixel units. The pixel voltages of the pixel unit 302 connected to first group of scan lines 304a, and the pixel voltages the pixel unit 302 connected to the second group of scan lines 304b are different in their polarities.

[0017] The scan driver 306 is configured to output a plurality of first enabling pluses to the first group of scan lines in a first period of a predetermined time, and output a plurality of second enabling pluses to the second group of scan lines



**304b**. A common voltage signal on each of the common lines **308** is different in polarity during the first and second period.

[0018] Moreover, a driving method for LCD is described in other embodiments of the invention, and an exemplary flow chart is shown in FIG. 4. FIG. 5 is a timing chart of signals on the scan lines and common lines of the LCD according to said embodiment of the invention. Please refer to FIG. 3, FIG. 4 and FIG. 5 with the following description.

[0019] During the first period of the predetermined time T, a plurality of first enabling pluses are sequentially transmitted to the first group of scan lines **304a** (step **402**). During the second period T2 of the predetermined time T, a plurality of second enabling pluses are transmitted to the second group of scan lines **304b** (step **404**). Pixel voltages of the pixel units, which connect to the first and second group of scan lines **304a**, **304b**, are different in their polarities. In the predetermined time T, a common voltage signal (Vcom) is transmitted to common lines **308**, wherein the common voltage signal **508** has different levels during the first period T1 and the second period T2. For example, during the first period T1, the common voltage **508** is at a first level (such as a high level), and during the second period T2, the common voltage **508** is at a second level (such as a low level).

[0020] According to the embodiment of the invention, the said predetermined time is a frame time or a sub-frame time. For example, when LCD **300** is driven by the color sequential method, i.e., a complete frame of the LCD **300** is composed of three sub-frames respectively associated with each of three primary colors, the predetermined time is meant to be one sub-frame time, where each sub-frame time is respectively associated with one backlight color. Besides, when LCD **300** is driven with a generally method, e.g., the LCD implements a white light source as backlight, the predetermined time T can directly mean to be a frame time.

[0021] Further, the LCD **300** in FIG. 3 can include at least one dummy scan line **310**, which is configured to receive at least a dummy enabling pulse **504** (shown on FIG. 5) from the scan driver **306** during the level inversion period T3 of the common voltage signal **508**. Also, the level inversion period T3 of the common voltage signal **508** is generally between the first period T1 and the second period T2. Thus, in the polarity inversion period of the pixel voltage of each row of the pixel units **302**, one or a plurality of dummy scan lines is configured to receive enabling pluses (i.e. dummy pluses **504**) from the scan driver **306**. After the voltage of the common voltage signal is stable, other enabling pluses (e.g. second enabling pluses **506**) begin to be transmitted to the corresponding scan lines.

[0022] According to other embodiments of the invention, the dummy enabling pulse **504** is not necessarily sent to the panel on the layout design, and only needs the a designer of the scan driver **306** to design the drive timing to include the level inversion period T3. Therefore, it is not necessary to implement a physical electronic element (such as the dummy scan line **310**). The dummy scan line **310** can be one single scan line or a plurality of scan lines.

[0023] If the first group of scan lines **304a** and the second group of scan lines **304b** are driven in different timings, the scan driver **306** can be deposited in the middle of the display, and the scan lines **304a** and **304b** are connected to the scan driver respectively by the right side and the left side of the scan driver. It should be noted that each element shown in FIG. 3 is meant to illustrate connections between each ele-

ment for describing characteristics of transmissions of signals, without limiting the physical layout position of each element on the substrate.

[0024] In the embodiment shown in FIG. 3, odd scan lines **304a** are classified as the first group, and even scan lines **304b** are classified as a second group. Meanwhile, pixel voltages of the pixel units **302**, which connect to the first group of scan lines **304a** have one polarity, and pixel voltages of the pixel units **302**, which connect to the second group of scan lines **304b** have the another polarity. In other embodiments of the invention, it is not necessarily to divide scan lines according to number characteristics (odd or even) of scan lines, such as if pixel voltages of pixel units connected to two adjacent scan line has the same polarity, scan lines are divided according to the polarity of pixel voltages of the pixel units.

[0025] As shown in FIG. 5, in the embodiment, the enabling pluses are sequentially transmitted to the first and second groups of scan lines **304a**, **304b** with different scan directions. More specifically, the odd scan lines **304a** of the first group sequentially receive enabling pluses **502** with the order of the first scan line, the third scan line and the fifth scan etc. Also, the even scan lines **304b** for the second group sequentially receive enabling pluses **502** with the order of the 160th scan line, the 158th scan line and the 156th scan line etc. In such way, the scan sequence of the enabling pulses begins from up to down and then from down to up in the view of a physical configuration, therefore, the scan sequence of the two groups of scan lines are different. However, according to other embodiments of the invention, the enabling pulses sequentially transmitted to the first and second groups of scan lines **304a**, **304b** with the same scan direction, i.e., scan sequences of both the first and second group of scan lines begin from up to down or down to up, thus the scope of the invention is not limited to the aforesaid exemplary.

[0026] In addition, after transmissions for both the first and second enabling pulses **502**, **504** are finished, a backlight source of the LCD **300** (not shown in FIG. 3) is switched on during the switch-on period of the backlight source **510**, such as turning on a primary color or a white light backlight source.

[0027] The driving method as described in said embodiments can be executed with a black insertion signal, for example, inserting a black frame with a once-insertion or sequential-insertion method, to enhance the visual performance of the LCD.

[0028] FIG. 6 is a timing chart of signals of LCD with both the driving method and black insertion method according to an embodiment of the invention. As shown in FIG. 6, each frame time is composed of three sub-frames time T, each sub-frame time corresponds to a backlight color, i.e., only a backlight source of a color is switched on in one sub-frame time T. Each sub-frame time includes a first period T1 and second period T2. It should be noted that the dummy enabling pulse time is obviated for the sake of clarity. However, the obviated dummy enabling pulse time is also referred to the level inversion period T3, which is shown in FIG. 5. The level inversion period T3, during which a voltage level of a common electrode is being inverted, is generally between the first and second period T1, T2. Also, the scope of the invention should not be limited to the embodiments described above.

[0029] During the first period T1, a plurality of first enabling pulses are transmitted to the first group of scan lines, and a plurality of second enabling pulses are transmitted to the second group of scan lines during the second period. The pixel voltages of the pixel units connected to the first and

second groups of scan lines are different in their polarities, and a common voltage signal 604 have different voltage levels in the first and second period. After the backlight source is switch on, during the first black insertion period T3, a plurality of black insertion signals are sequentially transmitted to pixel units connected to the first group of scan lines. Later, during the second insertion period T4, a plurality of other black insertion signals are sequentially transmitted to pixel units connected to the second group of scan lines, i.e., before pixel units connected to the second group of scan lines begin to receive black insertion signals, pixel units connected to the first group of scan lines sequentially receive black insertion signals to display a black frame.

[0030] Beside, in other embodiments of the invention, the black insertion signals are sequentially transmitted to the pixel units connected to the scan lines. For example, in accordance with a scan sequence beginning from up to down, the black insertion signals are sequentially received by pixel units connected to the scan lines, i.e., inserting a black frame.

[0031] While the present invention has been described with respect to preferred embodiments thereof, it will be apparent to those skilled in the art that the disclosed invention may be modified in numerous ways and may assume many embodiments other than those specifically described above. Accordingly, it is intended by the appended claims to cover all modifications of the invention that fall within the true spirit and scope of the invention.

What is claimed is:

1. A method of driving a liquid crystal display, comprising: transmitting a plurality of first enabling pluses respectively to a first group of scan lines in a first period of a predetermined time; transmitting a plurality of second enabling pluses respectively to a second group of scan lines in a second period of the predetermined time; and transmitting a common voltage signal to a common line, wherein, polarities of pixel voltages of pixel units connected to the scan lines of the first and second group are different, and levels of the common voltage signal in the first and second period are different.
2. The method of the claim 1, wherein the predetermined time is a frame time or a sub-frame time.
3. The method of the claim 1, wherein the predetermined time is a sub-frame time associated with a backlight color.
4. The method of the claim 1, further comprising transmitting at least one dummy enabling pulse to at least one dummy scan line during the inversion period of the common voltage signal.
5. The method of the claim 4, wherein the inversion period of the common voltage signal is between the first period and the second period.
6. The method of the claim 1, wherein at least one dummy enabling pulse is provided during an inversion period of the common voltage signal.
7. The method of the claim 1, wherein the first and second enabling pluses are sequentially transmitted to the first and second groups of scan lines respectively with the same or different scan directions.
8. The method of the claim 1, further comprising switching on a backlight source after transmitting the first and second enabling pulses.

9. The method of the claim 8, further comprising transmitting a plurality of black insertion signals to the pixel units connected to the first group of scan lines after switching on the backlight, then transmitting other insertion signals to the pixel units connected to the second group of scan lines.

10. The method of the claim 8, further comprising sequentially transmitting black insertion signals to the pixel units connected to the scan lines after switching on the backlight.

11. A liquid crystal display, comprising:

a plurality of pixel units;

a plurality of scan lines, each of scan lines is respectively connected to one terminal of each row of the pixel units, wherein the scan lines are divided into a first group and a second group, and pixel voltages of the pixel units, which connected to the first and second groups of scan lines, are different in their polarities;

at least one scan driver configured to transmit a plurality of first enabling pulses to the first group of scan lines in a first period of the predetermined time, and transmitting a plurality of second enabling pulses to the second group of scan lines in a second period of the predetermined time; and

a plurality of common lines, each of the common lines is respectively connected to another terminal of each row of the pixel units, and common voltage signals on the common lines are different in polarity during the first and second period.

12. The liquid crystal display of the claim 11, wherein the predetermined time is a frame time or a sub-frame time.

13. The liquid crystal display of the claim 11, wherein if the LCD is driven by the color sequential method, the predetermined time is a sub-frame time, which is associated with a backlight color.

14. The liquid crystal display of the claim 11, further comprising at least a dummy scan line, during the inversion period of the common voltage signal, the dummy enabling pulse is transmitted to the dummy scan line.

15. The liquid crystal display of the claim 14, wherein the inversion period of the common voltage signal is between the first period and the second period.

16. The liquid crystal display of the claim 11, wherein the scan driver is configured to output at least one dummy enabling pulse during an inversion period of the common voltage signal.

17. The liquid crystal display of the claim 11, wherein the scan driver is configured to sequentially output the first and second enabling pluses to the first and second group of scan lines respectively with the same or different scan directions.

18. The liquid crystal display of the claim 11, further comprising a backlight source configured to be switched on after transmitting the first and second enabling pulses.

19. The liquid crystal display of the claim 18, wherein the scan driver is configured to output a plurality of black insertion signals to the pixel units connected to the first group of scan lines, then output other black insertion signals to the pixel units connected to the second group of scan lines.

20. The liquid crystal display of the claim 18, wherein the scan driver is configured to sequentially output a plurality of black insertion signals to the pixel units connected to the scan lines.

|                |                                                                                                   |         |            |
|----------------|---------------------------------------------------------------------------------------------------|---------|------------|
| 专利名称(译)        | 液晶显示器及其驱动方法                                                                                       |         |            |
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#### 摘要(译)

在用于驱动液晶显示器的方法中，多个第一使能脉冲分别在预定时间的第一周期中被发送到第一组扫描线。在预定时间的第二周期中，分别将多个第二使能脉冲发送到第二组扫描线。连接到第一和第二组扫描线的像素单元的像素电压的极性不同。在预定时间期间，在第一和第二周期中具有不同电平的公共电压信号被发送到公共线。还公开了应用上述驱动方法的液晶显示器。

