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Kim et al.

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[54] **LIQUID CRYSTAL DISPLAY DEVICE**

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[30] **Foreign Application Priority Data**

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[51] **Int. Cl.**[6] **G09G 3/30**

[52] **U.S. Cl.** **345/96**; 345/92

[58] **Field of Search** 345/50, 54, 55, 345/58, 87, 89, 94, 96, 93, 100, 103, 92

[56] **References Cited**

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Primary Examiner—Matthew Luu
Attorney, Agent, or Firm—Cushman Darby&Cushman IP Group of Pillsbury Madison & Sutro LLP

[57] **ABSTRACT**

A liquid crystal display device includes a plurality of pixels arrayed in a matrix, and a plurality of data drivers for transmitting a video signal to the pixels. Pixels in the same row receive the video signal from one of the data drivers, while pixels in the adjacent row receive the signal having an opposite data polarity with respect to the same gray level from a different data driver.

3 Claims, 3 Drawing Sheets

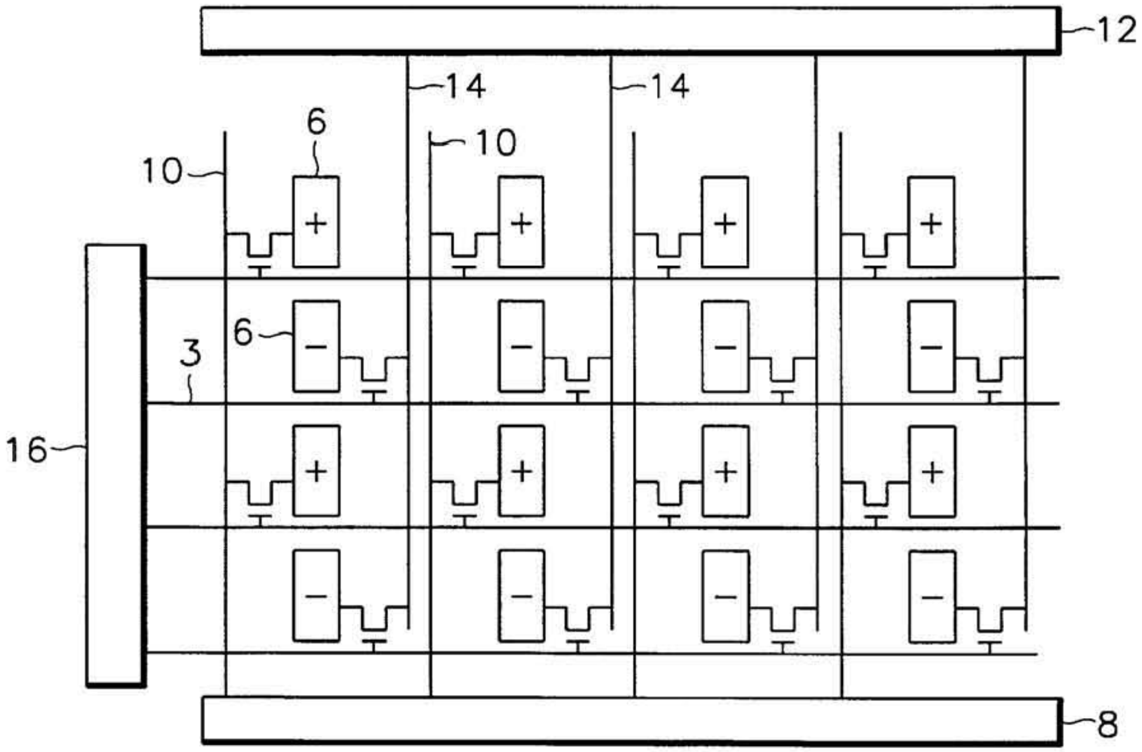


FIG. 1 (Prior Art)

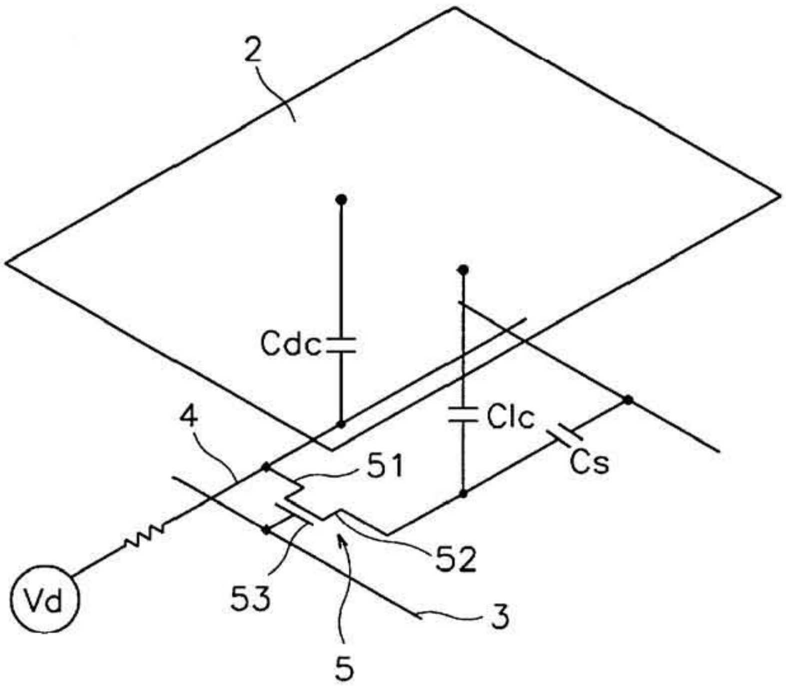


FIG. 2 (Prior Art)

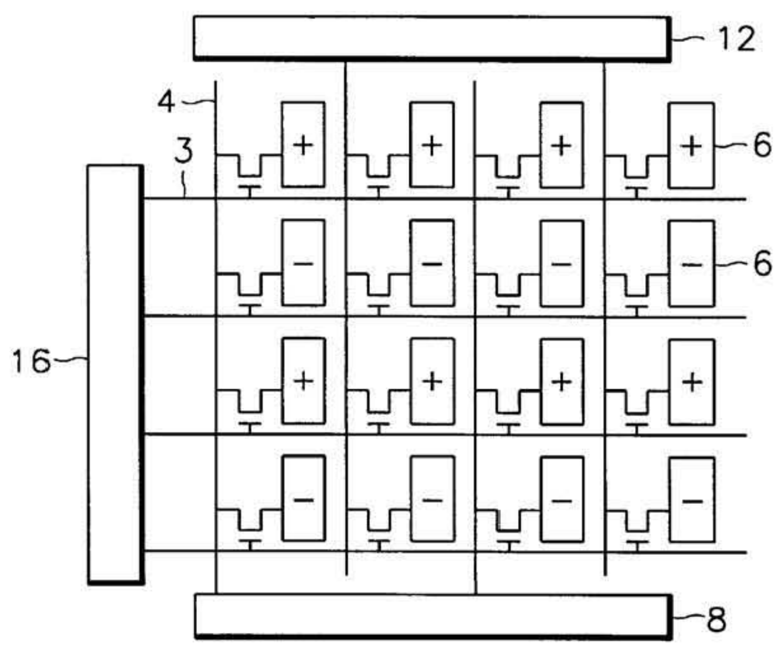


FIG.3 (Prior Art)

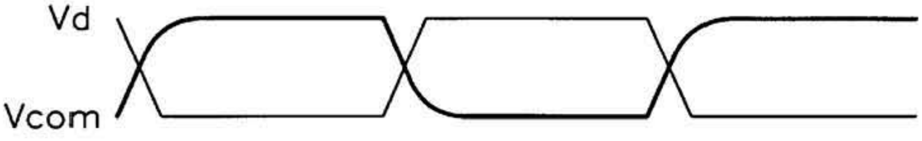


FIG.4 (Prior Art)

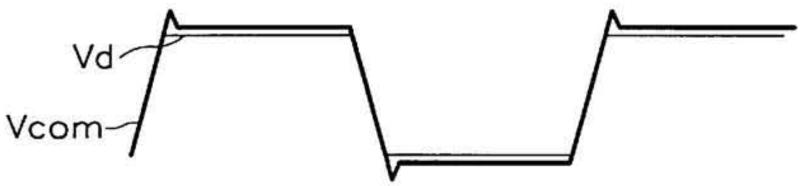


FIG.5

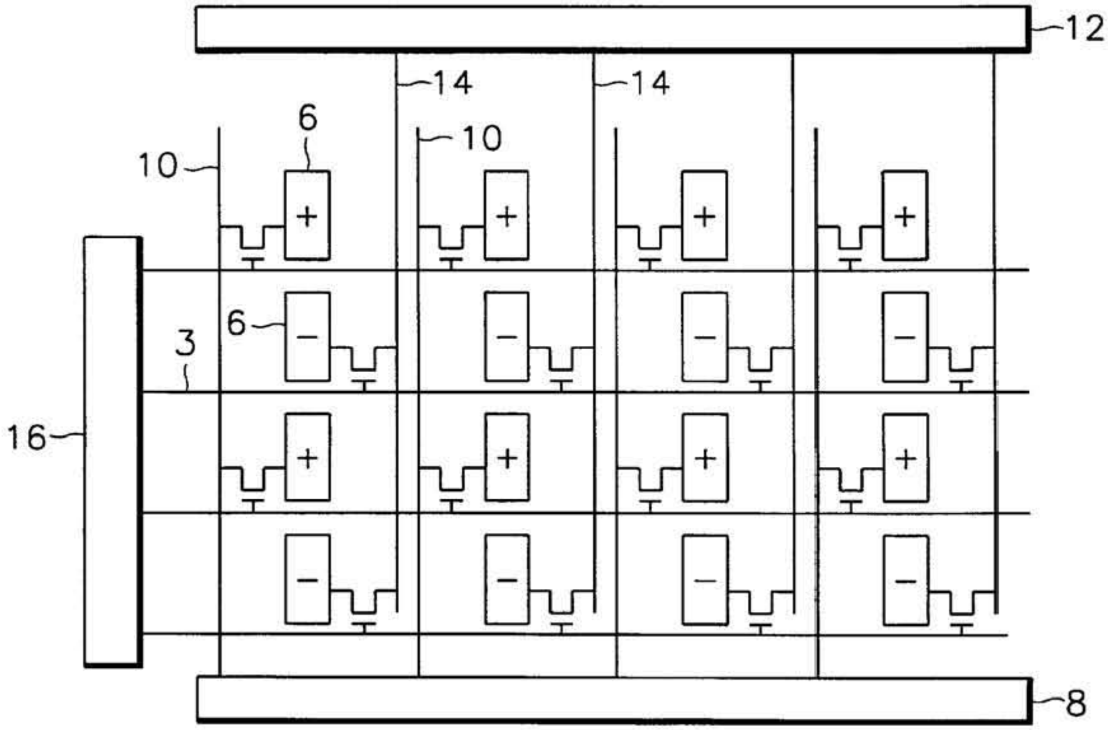


FIG.6

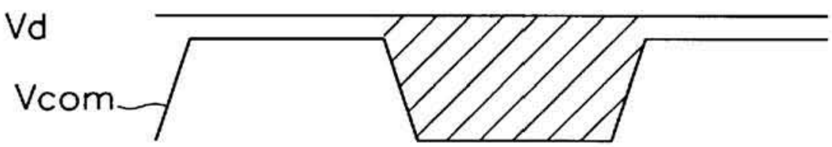


FIG.7

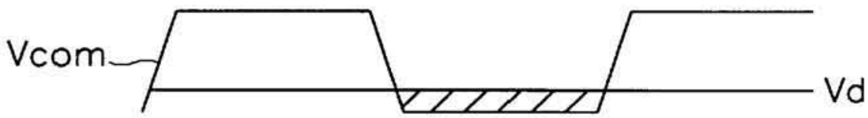


FIG.8

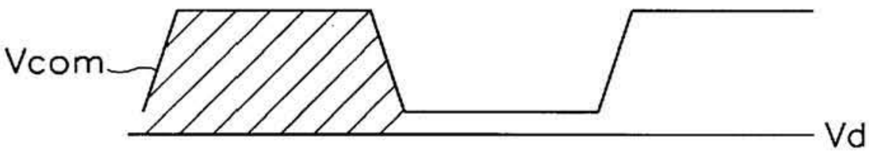
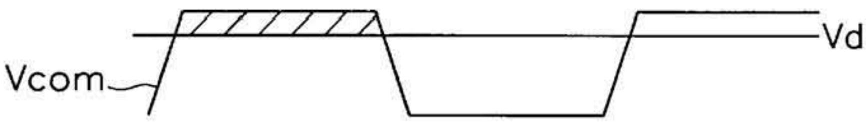


FIG.9



LIQUID CRYSTAL DISPLAY DEVICE

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a liquid crystal display (LCD) device, and more particularly, to a liquid crystal display using a gate line inversion driving technique which reduces horizontal crosstalk and power consumption.

2. Description of the Related Art

Many devices use liquid crystal displays, such as portable personal computers. These devices optimally include components which consume as little power as possible, so that they can be used as long as possible per battery charge.

Conventional liquid crystal displays commonly require high voltage drive ICs, which in turn require high power consumption. This inhibits their use in such devices as portable computers, because of their drawback in causing a short duration of usage per battery charge. Therefore, it is desirable to use low voltage ICs in the range of 5 V or less in liquid crystal displays. These components also enjoy other advantages such as easier fabrication and lower price as compared to high voltage drive ICs.

A conventional liquid crystal display, in general, includes: a thin-film transistor (TFT) board, wherein a plurality of pixel units, each including a thin-film transistor, a pixel electrode, and storage capacitors, are arrayed in matrix form, and wherein gate lines and data lines are respectively provided along each row and column of pixels; a color filter plate formed by a color filter and a common electrode; and liquid crystal material which is infused into the space between the thin-film transistor board and the color filter plate.

FIG. **1** illustrates an equivalent circuit diagram of one pixel according to a conventional liquid crystal display. As shown, a liquid crystal capacitor (C_{lc}) is formed by a common electrode **2** of a color filter plate, a pixel electrode of a thin-film transistor **5**, and the liquid crystal material (not shown) infused into the space therebetween.

The liquid crystal capacitor (C_{lc}) is connected between a drain electrode **52** of thin-film transistor **5** and the common electrode **2**. Source electrode **51** of thin-film transistor **5** is connected with data line **4** and gate electrode **53** is connected with gate line **3**.

One end of a storage capacitor (C_s) is connected to a drain electrode **52** of the thin-film transistor **5**. Furthermore, a capacitor (C_{dc}) is formed between the common electrode **2** of the color filter and the data line **4** of the thin-film transistor **5** having liquid crystal as a medium therebetween.

In a conventional LCD as illustrated in FIG. **2**, pixels **6** in the same row are commonly connected with a gate driver **16** through gate line **3**, while pixels **6** in the same column are commonly connected with data drivers **8** and **12** through data line **4**. The two data drivers **8** and **12**, however, are oppositely arranged such that the first data driver **8** is connected with the pixels of each jth (j=1, 3, 5, . . .) column and the second data driver **12** is connected with the pixels of each (j+1)th column.

The conventional LCD device described above operates as follows, with reference to FIG. **3** and FIG. **4**.

A gate driver **16** transmits gate voltage to each gate line **3** in a consecutive manner such that a data voltage can be selectively applied to each of the pixels **6** in each row one by one in order. Then, the data drivers **8** and **12** transmit the data voltage to the pixels **6** in each row in accordance to the operation of the gate driver **16**.

In this conventional drive method, the polarity of the data voltage (Vd) supplied to each adjacent row of pixels **6** should be opposite. That is, the polarity of the data voltages corresponding to black and white data is reversed for each adjacent row of pixels **6**. Therefore, as shown in FIG. **3**, according to a conventional operation, the common electrode voltage (Vcom) supplied to common electrode has an inverse waveform to that of the data voltage (Vd) representing black data supplied to a column of pixels.

This gate line inversion drive operation is more commonly used than a frame inversion drive operation because it causes less flickering of the display. However, the conventional drive method described above suffers from the following problems.

As illustrated in FIG. **3**, the common electrode voltage (Vcom) swings in opposite direction of the data voltage (Vd) when the data voltage (Vd) applied by the data drivers **8** and **12** is black data. However, the common electrode voltage (Vcom) is deflected toward the data voltage (Vd) due to the effects of the data voltage (Vd) and capacitive coupling, thereby generating an RC-type delay in the common electrode voltage (Vcom).

Meanwhile, when the data voltage (Vd) of the data drivers **8** and **12** represents white data, as illustrated in FIG. **4**, the common electrode voltage (Vcom) swings correspondingly the data voltage (Vd). In this case, the common electrode voltage (Vcom) is deflected toward the data voltage (Vd) due to the effect of the data voltage (Vd) and the capacitive coupling, thereby generating a resistance delay in the common electrode voltage (Vcom).

Moreover, the relative dielectric constant of the liquid crystal material increases in proportion to the voltage difference between data voltage (Vd) and common electrode voltage (Vcom), thereby resulting in a difference in capacitive coupling between that arising from the transmission of black data and that from white data. This is the major cause of horizontal crosstalk occurring during the inversion drive of the gate lines.

SUMMARY OF THE INVENTION

It is, therefore, an object of the present invention to provide a liquid crystal display device that can eliminate horizontal crosstalk in a display using a gate-line inversion drive technique.

It is a further object of the present invention to provide a liquid crystal device which requires a driving voltage lower than 5 V to effect a reduced power consumption.

In order to achieve these and other objects, an embodiment according to the present invention includes a plurality of pixels arrayed in a matrix, and a plurality of data drivers for transmitting a video signal to the pixels, wherein pixels in the same row receive the video signal from one of the data drivers, while pixels in the adjacent row receive the signal from a different data driver.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other advantages of the present invention will become better understood by the following detailed description taken in conjunction with the accompanying drawings in which:

FIG. **1** shows an equivalent circuit diagram of one pixel in a conventional liquid crystal display device;

FIG. **2** is a circuit diagram illustrating an array of pixels in a conventional liquid crystal display device;

FIG. **3** illustrates a data voltage waveform representing black data applied in the conventional device illustrated in FIG. **2**;

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