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(54) **LIQUID CRYSTAL DISPLAY DEVICE CAPABLE OF REDUCING POWER CONSUMPTION BY CHARGE SHARING**

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G09G 3/30 (2006.01)

(52) **U.S. Cl.** **345/92**; 345/93

(58) **Field of Classification Search** 345/92, 345/93, 63, 77, 215

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,867,139	A *	2/1999	Tanaka et al.	345/92
5,877,736	A *	3/1999	Imajo et al.	345/89
5,940,055	A *	8/1999	Lee	345/87
6,130,654	A *	10/2000	Hayashi et al.	345/63
6,891,521	B2 *	5/2005	Park et al.	345/87

* cited by examiner

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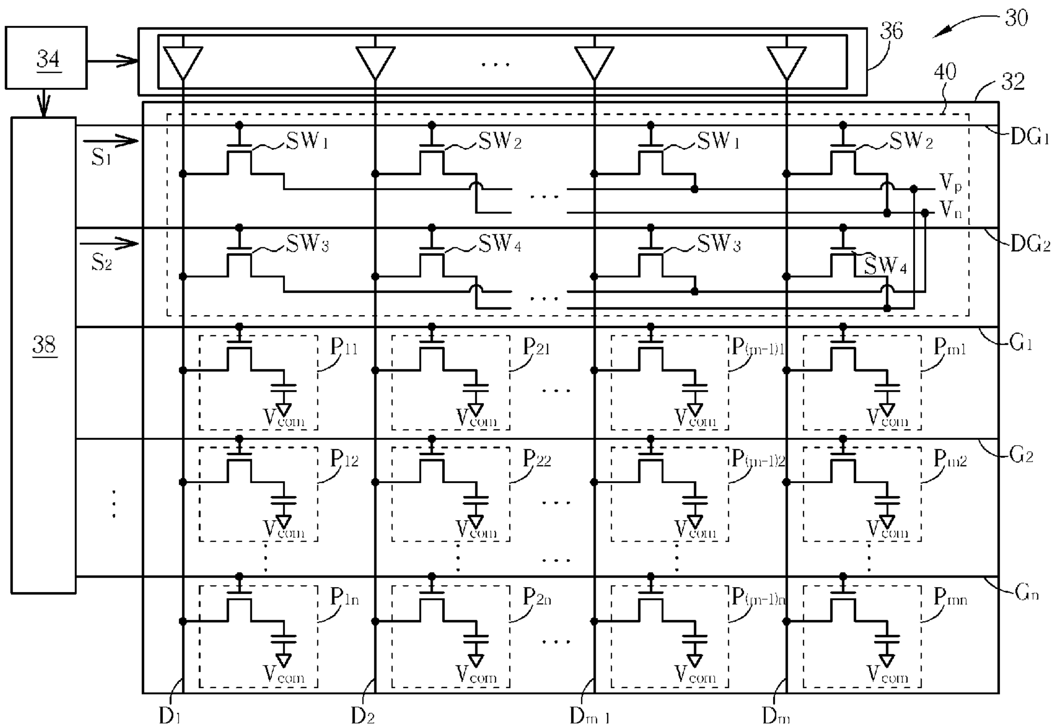
(57) **ABSTRACT**

An LCD device includes a plurality of data lines, a plurality of gate lines, a plurality of display units, two dummy gate lines, and a plurality of dummy switches. When performing charge sharing during a positive driving period, the data lines are coupled to a positive voltage source via a corresponding dummy gate line and corresponding dummy switches. When performing charge sharing during a negative driving period, the data lines are coupled to a negative voltage source via a corresponding dummy gate line and corresponding dummy switches.

11 Claims, 5 Drawing Sheets



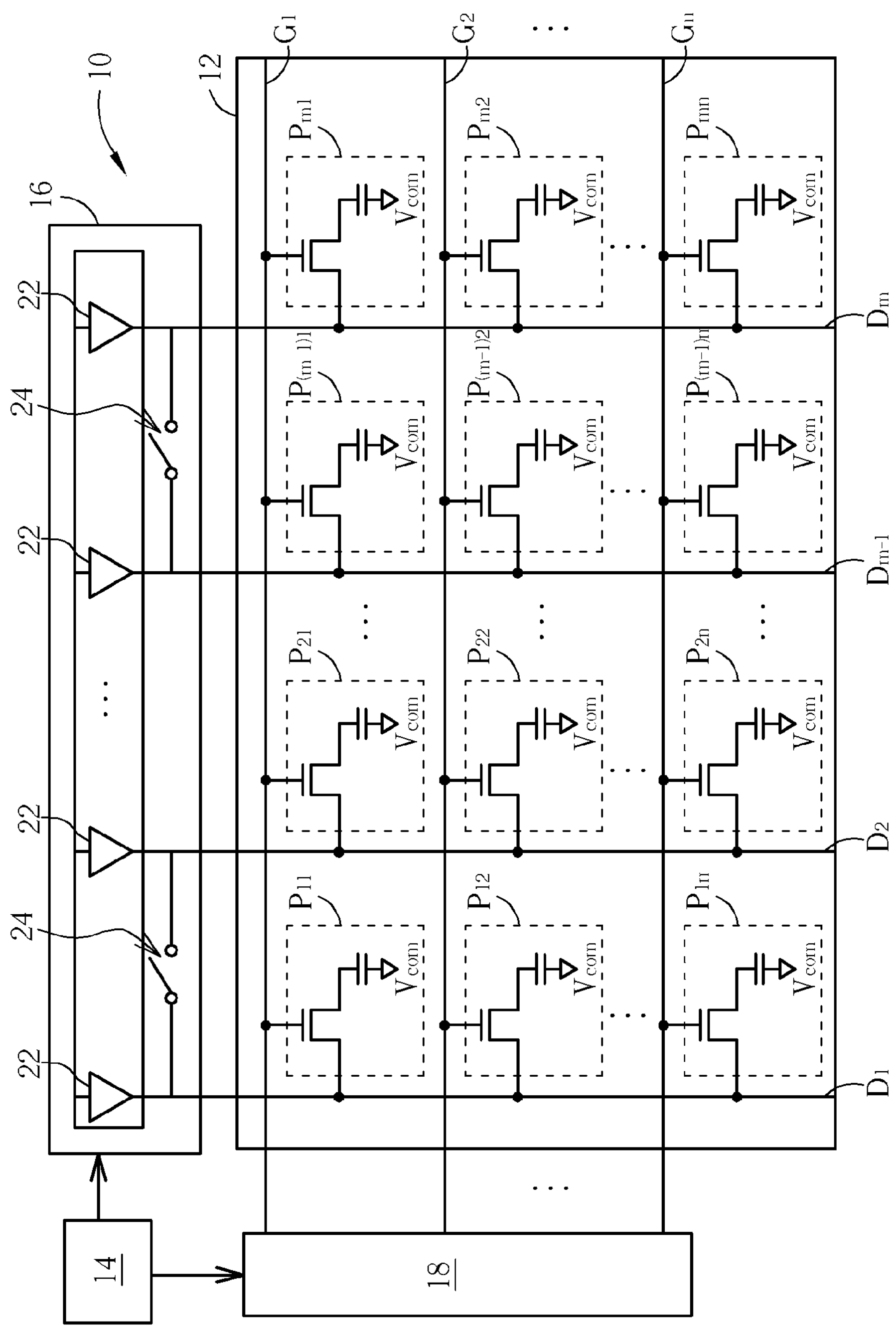


Fig. 1 Prior art

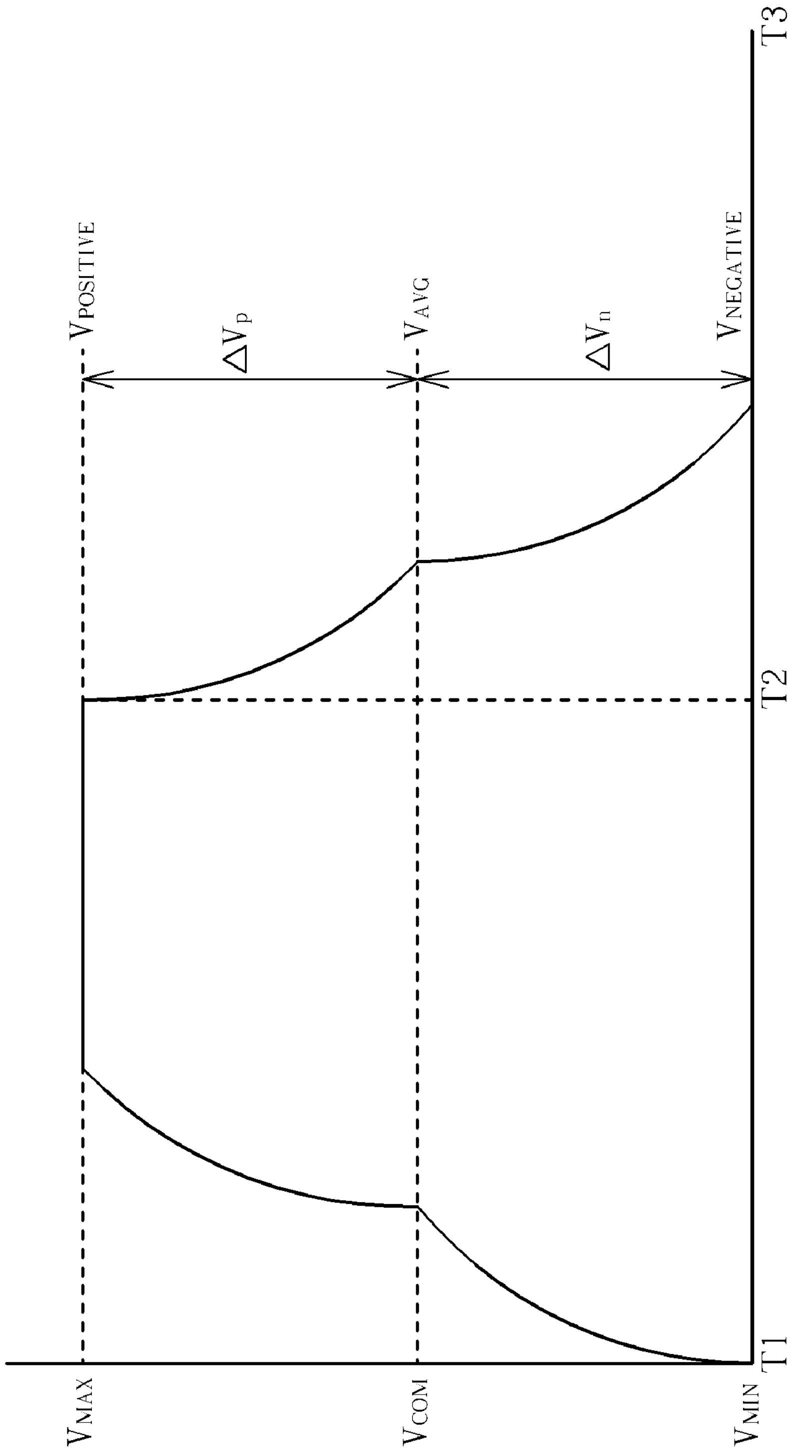
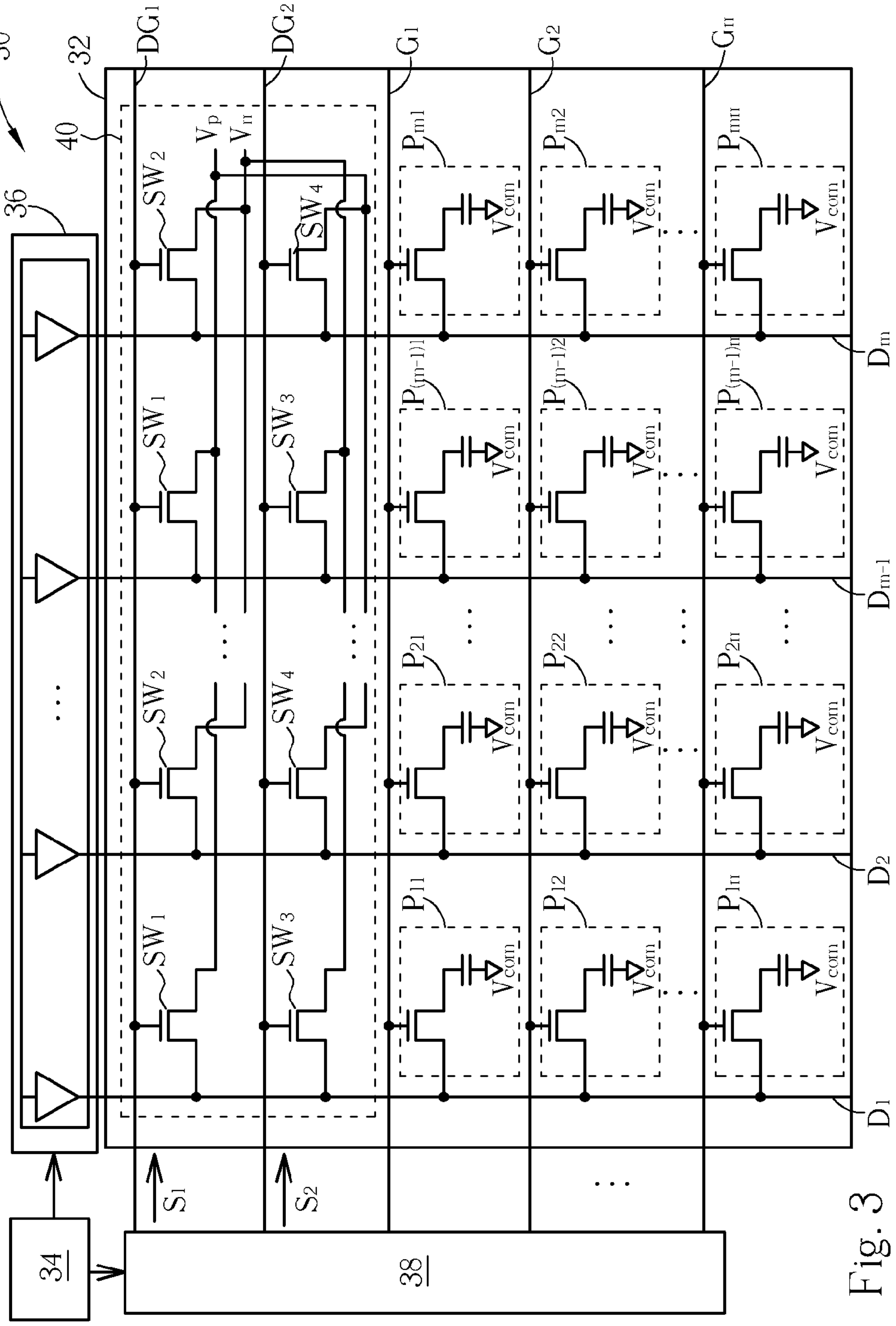


Fig. 2 Prior art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32
34
36
38
40
DG1
DG2
G1
G2
Gn
SW1
SW2
SW3
SW4
Vp
Vn
Vcom
Pm1
Pm2
Pmn
P(m-1)1
P(m-1)2
P(m-1)n
P21
P22
P2n
P11
P12
P1n
D1
D2
Dm-1
Dm
S1
S2

Fig. 3

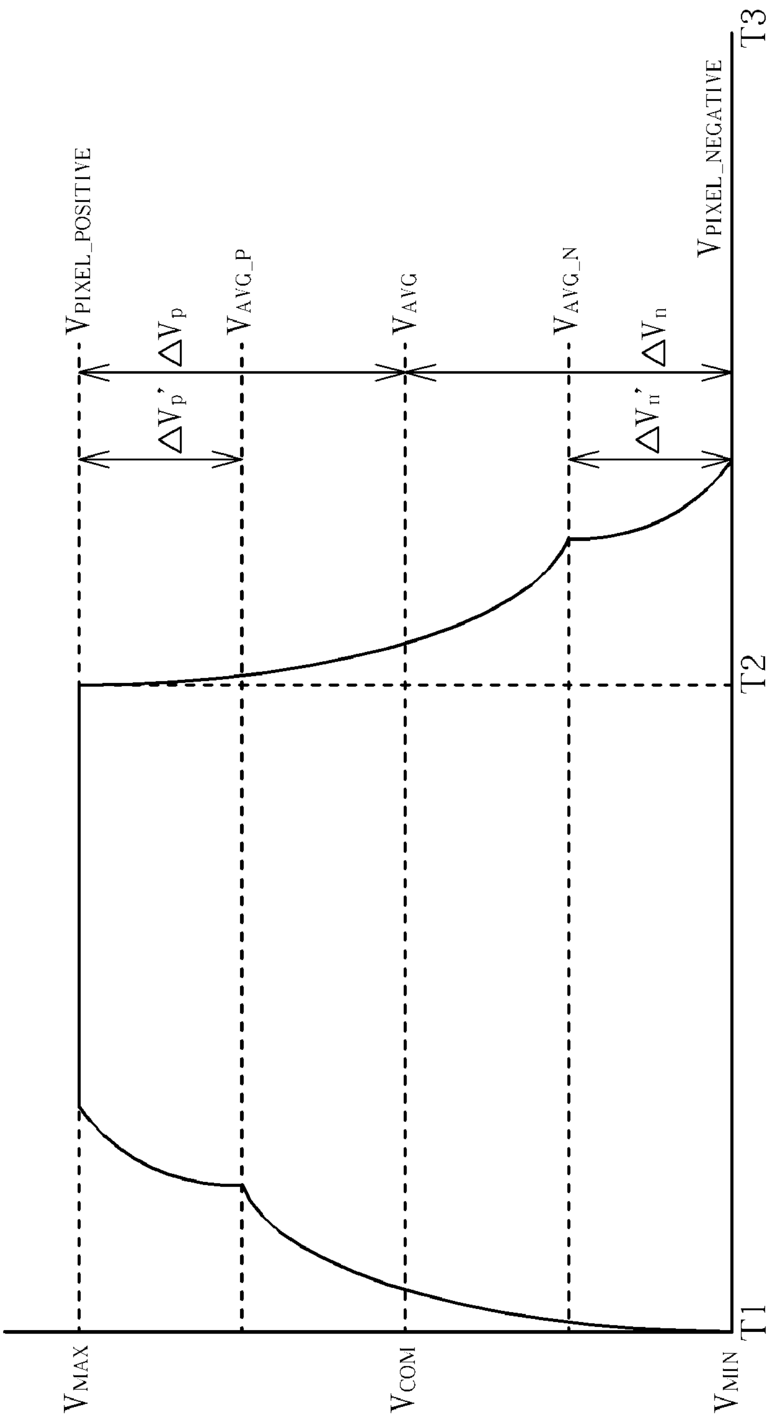
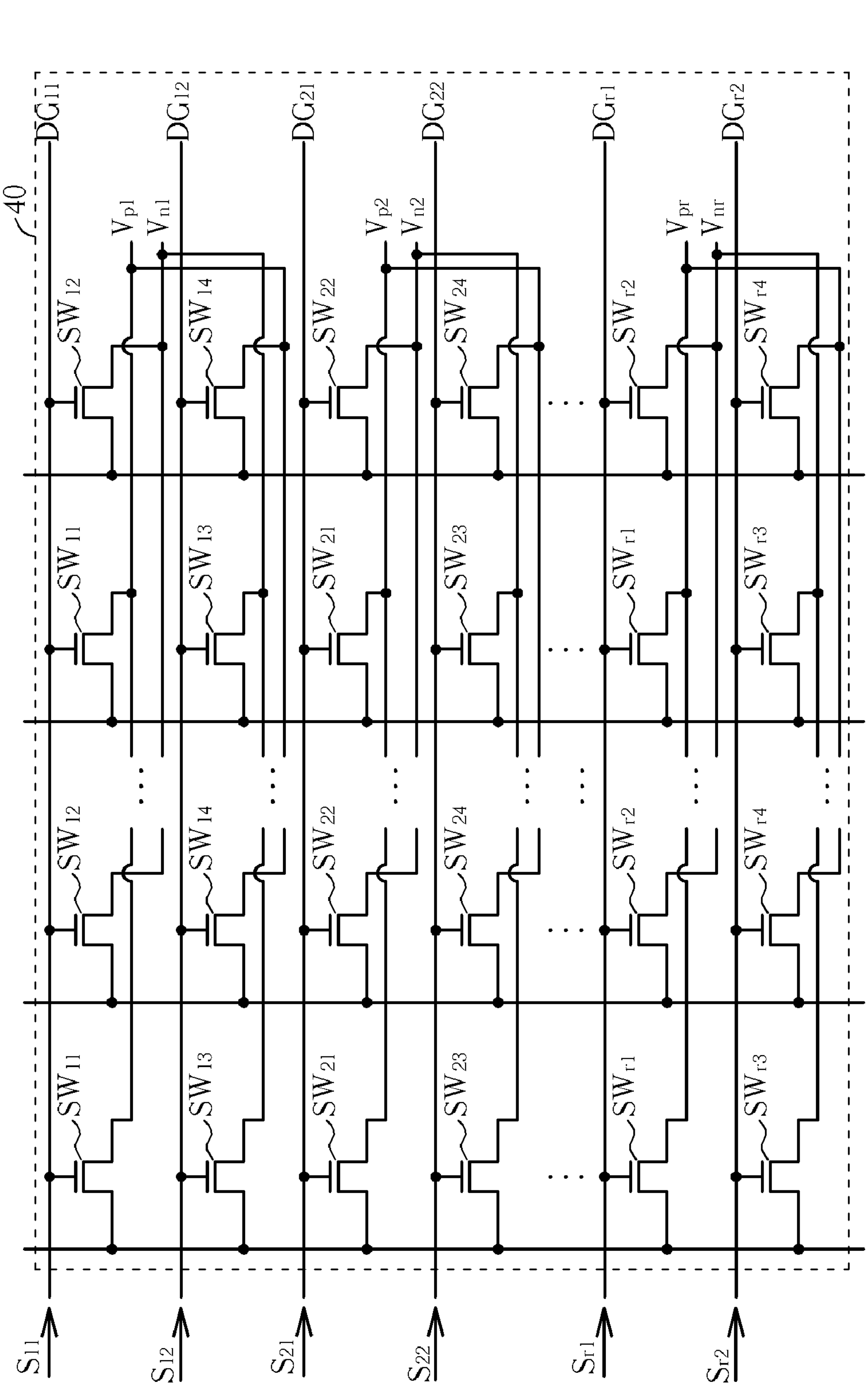

$V_{PIXEL\_POSITIVE}$
V_{AVG_P}
V_{AVG}
V_{AVG_N}
$V_{PIXEL\_NEGATIVE}$
$\Delta V_p'$
ΔV_p
$\Delta V_n'$
ΔV_n
V_{MAX}
V_{COM}
V_{MIN}
T1
T2
T3

Fig. 4


40
DG11
DG12
DG21
DG22
DGr1
DGr2
Vp1
Vn1
Vp2
Vn2
Vpr
Vnr
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SW14
SW22
SW24
SWr2
SWr4
SW11
SW13
SW21
SW23
SWr1
SWr3
D1
D2
Dm-1
Dm
S11
S12
S21
S22
Sr1
Sr2

Fig. 5

LIQUID CRYSTAL DISPLAY DEVICE CAPABLE OF REDUCING POWER CONSUMPTION BY CHARGE SHARING

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention related to a liquid crystal display device, and more particularly, to a liquid crystal display capable of reducing power consumption by charge sharing.

2. Description of the Prior Art

Due to advantages such as low radiation, thin appearance and low power consumption, liquid crystal display (LCD) devices have gradually replaced traditional cathode ray tube (CRT) displays and been widely used in notebook computers, personal digital assistants (PDA), flat panel televisions or mobile phones.

Reference is made to FIG. **1** for a diagram of a prior art LCD device **10**. The LCD device **10** includes an LCD panel **12**, a timing controller **14**, a source driver **16**, and a gate driver **18**. The LCD panel **12** includes a plurality of parallel data lines D_1-D_m, a plurality of parallel gate lines G_1-G_n, and a plurality of display units P_{11}-P_{mn}. The data lines D_1-D_m intersect the gate lines G_1-G_n, and each of the display units P_{11}-P_{mn} is disposed at the intersection of a corresponding data line and a corresponding gate line. The timing controller **14** can generate data signals corresponding display images, as well as control signals and clock signals for driving the LCD panel **12**. Based on signals received from the timing controller **14**, the source driver **16** and the gate driver **18** generate corresponding gate signals and driving signals, respectively. Each display unit of the LCD panel **12** includes a thin film transistor (TFT) switch and an equivalent capacitor. Each equivalent capacitor has an end coupled to a corresponding data line via a corresponding TFT switch, and another end coupled to a common voltage V_{com} (Cs on common). When the TFT switch of a display unit is turned on by a gate signal generated by the gate driver **18**, the equivalent capacitor of the display unit is electrically connected to its corresponding data line and can thus receive a driving voltage from the source driver **16**. Therefore, the display unit can display images of various gray scales by changing the rotation of liquid crystal molecules based on charges stored in the equivalent capacitor.

With increasing demands in large-size applications, the panel loading and dynamic power consumption also increase as the LCD panel becomes larger. As a result, it is a main concern to lower power consumption when designing an LCD device. Generally speaking, in order to avoid permanent polarization of liquid crystal materials, the polarities of voltages applied to both ends of equivalent capacitors have to be reversed periodically. Common methods for driving LCD panels include dot inversion and line inversion. When the driving voltages of an LCD device begin to reverse respective polarities, the LCD device has the largest loading since the source driver consumes the largest amount of current at this point of time.

Charge sharing is normally applied for reducing power consumption in an LCD device. Charge sharing halves the amount of dynamic current by rearranging charges before the source driver outputs driving signals. In the prior art LCD device **10**, the source driver **16** includes a plurality of output buffers **22** and a plurality of charge sharing switches **24**. The source driver **16** can output driving signals to corresponding data lines via the output buffers **22**. The charge sharing switches **24**, each coupled between two neighboring data lines, are used for performing charge sharing. Assuming dot-inversion is used for driving the LCD panel **12** of the LCD device **10**, among the driving voltages outputted by the source driver **16** to the data lines D_1-D_m, half of them are higher than the common voltage V_{com}, while the other half are lower than the common voltage V_{com}. In other words, during positive driving periods, the source driver **16** outputs a driving voltage $V_{PIXEL\_POSITIVE}$ higher than the common voltage V_{com} to odd-numbered date lines D_1-D_{m-1}, and outputs a driving voltage $V_{PIXEL\_NEGATIVE}$ lower than the common voltage V_{com} to even-numbered date lines D_2-D_m; during negative driving periods, the source driver **16** outputs the driving voltage $V_{PIXEL\_NEGATIVE}$ to odd-numbered date lines D_1-D_{m-1}, and outputs the driving voltage $V_{PIXEL\_POSITIVE}$ to even-numbered date lines D_2-D_m. The values of the driving voltages $V_{PIXEL\_POSITIVE}$ and $V_{PIXEL\_NEGATIVE}$ depend on the gray scales of display images,

Before outputting the driving voltages, the prior art LCD device **10** turns on the charge sharing switches **24** in order to neutralize residual charges stored in the data lines at the end of previous driving periods. Reference is made to FIG. **2** for a diagram illustrating the voltage level of a liquid crystal capacitor in the LCD device **10**. In FIG. **2**, the transverse axle represents time, the vertical axle represents voltage level, V_{MAX} and V_{MIN} respectively represent the maximum and the minimum driving voltages outputted to the equivalent capacitor, and V_{AVG} represents the voltage level of each data line after charge sharing. During the positive driving period, the driving voltage $V_{PIXEL\_POSITIVE}$ outputted to the liquid crystal capacitor is between the common voltage V_{com} and the maximum driving voltage V_{MAX}; during the negative driving period, the driving voltage $V_{PIXEL\_NEGATIVE}$ outputted to the equivalent capacitor is between the common voltage V_{com} and the minimum driving voltage V_{MIN}.

Assuming dot-inversion is used for driving the LCD panel **12** of the LCD device **10**, the display units P_{11} and P_{12} are used for illustrations. In FIG. **2**, the equivalent capacitor of the display unit P_{11} has a voltage level $V_{PIXEL\_NEGATIVE}$ equal to the minimum driving voltage V_{MIN} and the equivalent capacitor of the display unit P_{12} has a voltage level $V_{PIXEL\_POSITIVE}$ equal to the maximum driving voltage V_{MAX} at the end of the previous negative driving period (at T**1**). Before outputting driving voltages to the display unit P_{11} during the current positive driving period (between T**1** and T**2**), the prior art LCD device **10** turns on the charge sharing switch **24** coupled between the data lines D_1 and D_2 in order to neutralize residual charges stored in the corresponding data line at the end of the previous negative driving period. Therefore, the voltage level of the equivalent capacitor in the display unit P_{11} is raised from $V_{PIXEL\_NEGATIVE}$ to V_{AVG}. When $V_{PIXEL\_POSITIVE}$ and $V_{PIXEL\_NEGATIVE}$ are respectively equal to the maximum driving voltage V_{MAX} and the minimum driving voltage V_{MIN}, V_{AVG} is equal to the common voltage V_{com}. During the current positive driving period, the prior art LCD device **10** only needs to provide a voltage difference ΔVp to the display unit P_{11}. The value of ΔVp depends on the gray scale of images to be displayed by the display unit P_{11}, and can be represented by the following formula:

$$0 \leqq \Delta Vp = (V_{PIXEL\_POSITIVE} - V_{AVG}) \leqq (V_{MAX} + V_{MIN})/2$$

Similarly, the equivalent capacitor of the display unit P_{11} has a voltage level $V_{PIXEL\_POSITIVE}$ equal to the maximum driving voltage V_{MAX} and the liquid crystal capacitor of the display unit P_{12} has a voltage level $V_{PIXEL\_NEGATIVE}$ equal to the minimum driving voltage V_{MIN} at the end of the previous positive driving period (at T**2**). Before outputting driving voltages to the display unit P_{11} during the current negative driving period (between T**2** and T**3**), the prior art LCD device **10** turns on the charge sharing switch **24** coupled between the data lines D_1 and D_2 in order to neutralize residual charges stored in the corresponding data line at the end of the previous positive driving period. Therefore, the voltage level of the equivalent capacitor in the display unit P_{11} is decreased from $V_{PIXEL\_POSITIVE}$ to V_{AVG}. When $V_{PIXEL\_POSITIVE}$ and $V_{PIXEL\_NEGATIVE}$ are respectively equal to the maximum driving voltage V_{MAX} and the minimum driving voltage V_{MIN}, V_{AVG} is equal to the common voltage V_{com}. During the current negative driving period, the prior art LCD device **10** only needs to provide a voltage difference ΔVn to the display unit P_{11}. The value of ΔVn depends on the gray scale of images to be displayed by the display unit P_{11}, and can be represented by the following formula:

$$0 \leqq \Delta Vn = (V_{AVG} - V_{PIXEL\_NEGATIVE}) \leqq (V_{MAX} + V_{MIN})/2$$

Without charge sharing, the prior art LCD device **10** needs to provide a voltage difference ΔV to a display unit. The value of ΔV can be represented by the following formula:

$$0 \leqq |\Delta V| \leqq (V_{MAX} + V_{MIN})$$

Therefore,

$$\Delta Vp \leqq |\Delta V| \text{ and } \Delta Vn \leqq |\Delta V|$$

The prior art LCD device **10** uses the charge sharing switches **24** for performing charge sharing. The power consumption can be reduced since the LCD device **10** only needs to provide display units with the voltage differences ΔVp and ΔVn, whose absolute values are smaller than that of the voltage difference ΔV. However, the charge sharing switches **24** are disposed on the source driver **16**. Since a large number of charge sharing switches **24** are required in large-size applications and generate a lot of heat during charge sharing, the source driver **16** can encounter difficulties in heat dissipation.

SUMMARY OF THE INVENTION

The present invention provides an LCD device capable of reducing power consumption by charge sharing comprising a plurality of parallel data lines for receiving data signals corresponding to display images; a plurality of parallel gate lines intersecting the plurality of data lines for receiving gate signals; a plurality of storage units for storing data signals received from corresponding data lines; a plurality of data switches; a first dummy gate line parallel to the plurality of gate lines for receiving a first control signal; a plurality of first dummy switches; and a plurality of second dummy switches. The plurality of data switches each comprises a first end coupled to a corresponding storage unit; a second end coupled to a corresponding data line; and a control end coupled to a corresponding gate line, wherein the data switch electrically connects the corresponding storage unit to the corresponding data line or electrically isolates the corresponding storage unit from the corresponding data line based on a gate signal received from the corresponding gate line. The plurality of first dummy switches each comprises a first end coupled to a first power source; a second end coupled to a corresponding odd-numbered data line among the plurality of data lines; and a control end coupled to the first dummy gate line, wherein the first dummy switch electrically connects the first power source to the corresponding odd-numbered data line or electrically isolates the first power source from the corresponding odd-numbered data line based on the first control signal received from the first dummy gate line. The plurality of second dummy switches each comprises a first end coupled to a second power source; a second end coupled to a corresponding even-numbered data line among the plurality of data lines; and a control end coupled to the first dummy gate line, wherein the second dummy switch electrically connects the second power source to the corresponding even-numbered data line or electrically isolates the second power source from the corresponding even-numbered data line based on the first control signal received from the first dummy gate line.

These and other objectives of the present invention will no doubt become obvious to those of ordinary skill in the art after reading the following detailed description of the preferred embodiment that is illustrated in the various figures and drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a diagram of a prior art LCD device.

FIG. **2** is a diagram illustrating the voltage level of an equivalent capacitor in the LCD device of FIG. **1**.

FIG. **3** is a diagram of an LCD device according to a first embodiment of the present invention.

FIG. **4** is a diagram illustrating the voltage level of an equivalent capacitor in the LCD device of FIG. **3**

FIG. **5** is a diagram of a charge sharing circuit according to a second embodiment of the present invention.

DETAILED DESCRIPTION

Reference is made to FIG. **3** for an LCD device **30** according to a first embodiment of the present invention. The LCD device **30** includes an LCD panel **32**, a timing controller **34**, a source driver **36**, and a gate driver **38**. The LCD panel **32** includes a plurality of parallel data lines D_1-D_m, a plurality of parallel gate lines G_1-G_n, a charge sharing circuit **40**, and a plurality of display units P_{11}-P_{mn}. The data lines D_1-D_m intersect the gate lines G_1-G_n, and each of the display units P_{11}-P_{mn} is disposed at the intersection of a corresponding data line and a corresponding gate line. The timing controller **34** can generate data signals corresponding display images, as well as control signals and clock signals for driving the LCD panel **32**. Based on signals received from the timing controller **34**, the source driver **36** and the gate driver **38** can generate corresponding gate signals and driving voltages, respectively. Each display unit of the LCD panel **32** includes a TFT switch and an equivalent capacitor. Each equivalent capacitor has an end coupled to a corresponding data line via a corresponding TFT switch, and another end coupled to a common voltage V_{com}. When the TFT switch of a display unit is turned on by a gate signal generated by the gate driver **38**, the equivalent capacitor of the display unit is electrically connected to its corresponding data line and can thus receive a driving voltage from the source driver **36**. Therefore, the display unit can display images of various gray scales by changing the rotation of liquid crystal molecules based on charges stored in the equivalent capacitor.

The charge sharing circuit **40** is disposed on the LCD panel **32** and includes a first dummy gate line DG_1, a second dummy gate line DG_2, and a plurality of first through fourth dummy switches SW_1-SW_4. The dummy gate lines DG_1 and DG_2, parallel to the gate lines G_1-G_n, can respectively receive a first control signal S_1 and a second control signal S_2 from the gate driver **38**. Each of the first dummy switches SW_1 is coupled between a first power source V_p and a corresponding odd-numbered data line (D_1, D_3, . . . , or D_{m-1}). When the first dummy switches SW_1 are turned on due to the first control signal S_1 applied to respective control ends via the first dummy gate line DG_1, the odd-numbered data lines D_1-D_{m-1} are electrically connected to the first power source V_p. Each of the second dummy switches SW_2 is coupled between a second power source V_n and a corresponding even-numbered data line (D_2, D_4, . . . , or D_m). When the second dummy switches SW_2 are turned on due to the first control signal S_1 applied to respective control ends via the first dummy gate line DG_1, the even-numbered data lines D_2-D_m are electrically connected to the second power source V_n. Each of the third dummy switches SW_3 is coupled between the second power source V_n and a corresponding odd-numbered data line (D_1, D_3, . . . , or D_{m-1}). When the third dummy switches SW_3 are turned on due to the second control signal S_2 applied to respective control ends via the second dummy gate line DG_2, the odd-numbered data lines D_1-D_{m-1} are electrically connected to the second power source V_n. Each of the fourth dummy switches SW_4 is coupled between the first power source V_p and a corresponding even-numbered data line (D_2, D_4, . . . , or D_m). When the fourth dummy switches SW_4 are turned on due to the second control signal S_2 applied to respective control end via the second dummy gate line DG_2, the even-numbered data lines D_2-D_m are electrically connected to the first power source V_P.

The present invention reduces power consumption of a source driver using the charge sharing circuit **40** capable of adjusting the voltage level of each data line before outputting driving voltages to the LCD panel **32**. Reference is made to FIG. **4** for a diagram illustrating the voltage level of an equivalent capacitor in the LCD device **30**. In FIG. **4**, the transverse axle represents time, the vertical axle represents voltage level, V_{MAX} and V_{MIN} respectively represent the maximum and the minimum driving voltages outputted to the liquid crystal capacitor, and V_{AVG} represents the voltage level of each data line after charge sharing. During the positive driving period, the driving voltage $V_{PIXEL\_POSITIVE}$ outputted to the equivalent capacitor is between the common voltage V_{com} and the maximum driving voltage V_{MAX}; during the negative driving period, the driving voltage $V_{PIXEL\_NEGATIVE}$ outputted to the equivalent capacitor is between the common voltage V_{com} and the minimum driving voltage V_{MIN}.

The present invention controls the dummy switches of the charge sharing circuit **40** using the first control signal S_1 and the second control signal S_2. Assuming dot-inversion is used for driving the LCD panel **32** of the LCD device **30**, the display units P_{11} is used for illustrating the present invention. In FIG. **4**, the liquid crystal capacitor of the display unit P_{11} has a voltage level $V_{PIXEL\_NEGATIVE}$ equal to the minimum driving voltage V_{MIN} at the end of the previous negative driving period (at T**1**). Also, during the current positive driving period (between T**1** and T**2**), the driving voltage $V_{PIXEL\_POSITIVE}$ has to be provided to the data line D_1 so that the display unit P_{11} can correctly display images. At this time, the first dummy switch SW**1** coupled to the first dummy gate line DG_1 and the data line D_1 is turned on by applying the first control signal S_1 via the first dummy gate line DG_1, thereby electrically connecting the data line D_1 to the first power source V_p. With charge sharing between the first power source V_p and the data line D_1, the voltage level of the data line D_1 can be raised to a voltage level V_{AVG_P} equal to $(V_{PIXEL\_NEGATIVE}+V_p)/2$. During the current positive driving period, the present LCD device **30** only needs to provide a voltage difference $\Delta Vp'$ to the display unit P_{11}. The value of $\Delta Vp'$ depends on the gray scale of images to be displayed by the display unit P_{11}, and can be represented by the following formula:

$$0 \leqq \Delta Vp' = (V_{PIXEL\_POSITIVE} - V_{AVG\_P}) \leqq \Delta Vp$$

Similarly, the liquid crystal capacitor of the display unit P_{11} has a voltage level $V_{PIXEL\_POSITIVE}$ equal to the maximum driving voltage V_{MAX} at the end of the previous positive driving period (at T**2**). Also, during the current negative driving period (between T**2** and T**3**), the driving voltage $V_{PIXEL\_NEGATIVE}$ has to be provided to the data line D_1 so that the display unit P_{11} can correctly display images. At this time, the third dummy switch SW**3** coupled to the second dummy gate line DG_2 and the data line D_1 is turned on by applying the second control signal S_2 via the second dummy gate line DG_2, thereby electrically connecting the data line D_1 to the second power source V_n. With charge sharing between the second power source V_p and the data line D_1, the voltage level of the data line D_1 can be lowered to a voltage level V_{AVG_N} equal to $(V_{PIXEL\_POSITIVE}+V_n)/2$. During the negative driving period, the present LCD device **30** only needs to provide a voltage difference $\Delta Vn'$ to the display unit P_{11}. The value of $\Delta Vn'$ depends on the gray scale of images to be displayed by the display unit P_{11}, and can be represented by the following formula:

$$0 \leqq \Delta Vn' = (V_{AVG\_N} - V_{PIXEL\_NEGATIVE}) \leqq \Delta Vn$$

In the first embodiment of the present invention, the first power source V_p can be a positive voltage source, and the second power source V_n can be a negative voltage source. During the positive driving periods, the present LCD device **30** performs charge sharing on the display units coupled to the odd-numbered data lines (D_1, D_3, . . . , and D_{m-1}) using the first dummy gate line DG_1, the first dummy switches SW_1 and the first power source V_p, and on the display units coupled to the even-numbered data lines (D_2, D_4, . . . , and D_m) using the second dummy gate line DG_2, the fourth dummy switches SW_4 and the first power source V_p. Therefore, the present invention can neutralize residual charges stored in the liquid crystal capacitors at the end of the previous negative driving period. Since the voltage level of a display unit is raised to V_{AVG_P} after charge sharing, only a smaller voltage difference $\Delta Vp'$ is required for the display unit and the power consumption can thus be reduced. Similarly, during the negative driving periods, the present LCD device **30** performs charge sharing on the display units coupled to the even-numbered data lines using the first dummy gate line DG_1, the second dummy switches SW_2 and the second power source V_n, and on the display units coupled to the odd-numbered data lines using the second dummy gate line DG_2, the third dummy switches SW_3 and the second power source V_n. Therefore, the present invention can neutralize residual charges stored in the data lines at the end of the previous positive driving period. Since the voltage level of a display unit is lowered to V_{AVG_N} after charge sharing, only a smaller voltage difference $\Delta Vn'$ is required for the display unit and the power consumption can thus be reduced from the source driver.

Reference is made to FIG. **5** for a charge sharing circuit **40** according to a second embodiment of the present invention. Compared to the first embodiment, the charge sharing circuit **40** of the second embodiment includes a plurality of dummy gate lines DG_{11}-DG_{r1} and DG_{12}-DG_{r2}, and a plurality of dummy switches SW_{11}-SW_{14} through SW_{r1}-SW_{r4}. The dummy gate lines DG_{11}-DG_{r1} and DG_{12}-DG_{r2} can respectively receive control signals S_{11}-S_{r1} and S_{12}-S_{r2} from the gate driver **38**. Each data line can be coupled to power sources V_{p1}-V_{pr} or V_{n1}-V_{nr} via corresponding dummy gate lines and dummy switches. In the second embodiment of the present invention, the power sources V_{p1}-V_{pr} can be positive voltage sources, and the power sources V_{n1}-V_{nr} can be negative voltage sources. During the positive driving periods, each data line can be coupled to the power sources V_{p1}-V_{pr} having distinct levels, thereby raising a corresponding display unit to various voltage levels V_{AVG_P1}-V_{AVG_Pr}; during the negative driving periods, each data line can be coupled to the power sources V_{n1}-V_{nr} having distinct levels, thereby lowering a corresponding display unit to various voltage levels V_{AVG_N1}-V_{AVG_Nr}. The voltage levels V_{AVG_P1}-V_{AVG_Pr} and V_{AVG_N1}-V_{AVG_Nr} depend on the values of the power sources V_{p1}-V_{pr} and V_{n1}-V_{nr}. Therefore, the charge sharing circuit **40** of the second embodiment of the present invention can reduce power consumption of the source driver, as well as provide more flexible driving methods.

The LCD device **30** of the present invention performs charge sharing using the charge sharing circuit **40**. Power consumption can further be reduced from the source driver by providing display units with a voltage difference ΔVp' whose absolute value is smaller than that of the voltage difference ΔVp, or a voltage difference ΔVn' whose absolute value is smaller than that of the voltage difference ΔVn. Also, the LCD device **30** can be driven flexibly in the present invention by raising a display unit to various voltage levels during the positive driving period, or by lowering a display unit to various voltage levels during the negative driving period. In addition, the charge sharing circuit **40** of the LCD device **30** is disposed on the LCD panel **32** having a larger area. The heat generated during charge sharing can easily be dissipated in large-size applications.

Those skilled in the art will readily observe that numerous modifications and alterations of the device and method may be made while retaining the teachings of the invention. Accordingly, the above disclosure should be construed as limited only by the metes and bounds of the appended claims.

What is claimed is:

1. A liquid crystal display (LCD) device capable of reducing power consumption of a source driver by charge sharing comprising:

a plurality of parallel data lines for receiving data signals corresponding to display images;

a plurality of parallel gate lines intersecting the plurality of data lines for receiving gate signals;

a plurality of storage units for storing data signals received from corresponding data lines;

a plurality of data switches each comprising:

a first end coupled to a corresponding storage unit;

a second end coupled to a corresponding data line; and

a control end coupled to a corresponding gate line, wherein the data switch electrically connects the corresponding storage unit to the corresponding data line or electrically isolates the corresponding storage unit from the corresponding data line based on a gate signal received from the corresponding gate line; and

a first dummy gate line parallel to the plurality of gate lines for receiving a first control signal;

a plurality of first dummy switches each comprising:

a first end coupled to a first power source;

a second end coupled to a corresponding odd-numbered data line among the plurality of data lines; and

a control end coupled to the first dummy gate line, wherein the first dummy switch electrically connects the first power source to the corresponding odd-numbered data line or electrically isolates the first power source from the corresponding odd-numbered data line based on the first control signal received from the first dummy gate line; and

a plurality of second dummy switches each comprising:

a first end coupled to a second power source;

a second end coupled to a corresponding even-numbered data line among the plurality of data lines; and

a control end coupled to the first dummy gate line, wherein the second dummy switch electrically connects the second power source to the corresponding even-numbered data line or electrically isolates the second power source from the corresponding even-numbered data line based on the first control signal received from the first dummy gate line.

2. The LCD device of claim **1** wherein the first power source is a positive voltage source and the second power source is a negative voltage source.

3. The LCD device of claim **1** wherein the first power source is a negative voltage source and the second power source is a positive voltage source.

4. The LCD device of claim **1** further comprising:

a second dummy gate line parallel to the plurality of gate lines for receiving a second control signal;

a plurality of third dummy switches each comprising:

a first end coupled to the second power source;

a second end coupled to a corresponding odd-numbered data line among the plurality of data lines; and

a control end coupled to the second dummy gate line, wherein the third dummy switch electrically connects the second power source to the corresponding odd-numbered data line or electrically isolates the second power source from the corresponding odd-numbered data line based on the second control signal received from the second dummy gate line; and

a plurality of fourth dummy switches each comprising:

a first end coupled to the first power source;

a second end coupled to a corresponding even-numbered data line among the plurality of data lines; and

a control end coupled to the second dummy gate line, wherein the fourth dummy switch electrically connects the first power source to the corresponding even-numbered data line or electrically isolates the first power source from the corresponding even-numbered data line based on the second control signal received from the second dummy gate line.

5. The LCD device of claim **4** wherein the first power source is a positive voltage source and the second power source is a negative voltage source.

6. The LCD device of claim **4** wherein the first power source is a negative voltage source and the second power source is a positive voltage source.

7. The LCD device of claim **4** wherein each dummy switch is a thin film transistor (TFT).

8. The LCD device of claim **1** wherein each data switch is a TFT.

9. The LCD device of claim **1** wherein each dummy switch is a TFT.

10. The LCD device of claim **1** wherein each storage unit includes an equivalent capacitor.

11. The LCD device of claim **1** further comprising:

a source driver for generating the data signals; and

a gate driver for generating the gate signals.

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专利名称(译)	能够通过电荷共享降低功耗的液晶显示装置		
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摘要(译)

LCD装置包括多条数据线，多条栅极线，多个显示单元，两条虚设栅极线和多个虚设开关。当在正驱动时段期间执行电荷共享时，数据线经由对应的虚拟栅极线和对应的虚拟开关耦合到正电压源。当在负驱动时段期间执行电荷共享时，数据线经由对应的虚拟栅极线和对应的虚拟开关耦合到负电压源。