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Chen(10) **Pub. No.: US 2003/0214472 A1**(43) **Pub. Date: Nov. 20, 2003**(54) **DISPLAY CIRCUIT STRUCTURE FOR
LIQUID CRYSTAL DISPLAY****Publication Classification**(75) **Inventor: Hsin-Ming Chen, Hsinchu (TW)**(51) **Int. Cl.⁷ G09G 3/36**(52) **U.S. Cl. 345/87**

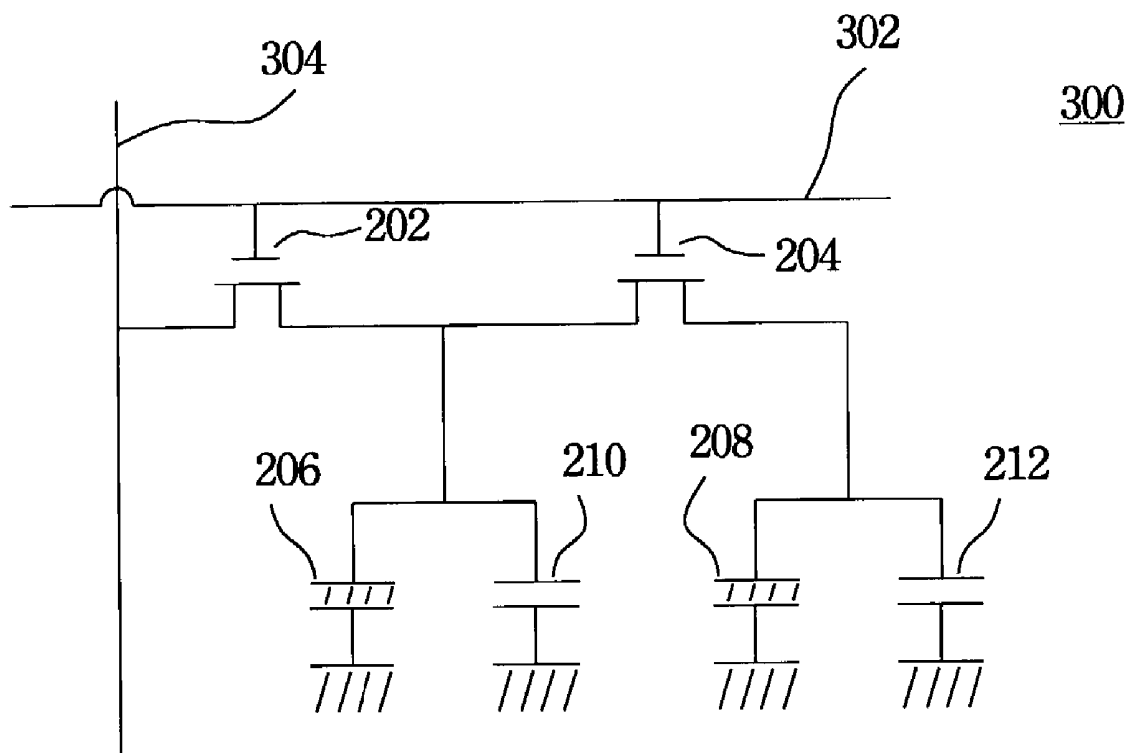
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CORP.**(21) **Appl. No.: 10/235,726**(22) **Filed: Sep. 6, 2002**(30) **Foreign Application Priority Data**

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(57) **ABSTRACT**

A scan line is used to control two thin film transistors and a video data line is used to transmit video signal to pixel capacitors and maintenance capacitors. When the thin film transistors are selected by the selection signal, the video signal stored therein charges the pixel capacitors and maintenance capacitors. When the selection signal is removed, the charge in the pixel capacitors is preserved until the next repetition when that scan line is again selected by a selection signal and new voltages are stored therein. Thus a picture is displayed on the matrix display by the charges stored in the pixel capacitors.



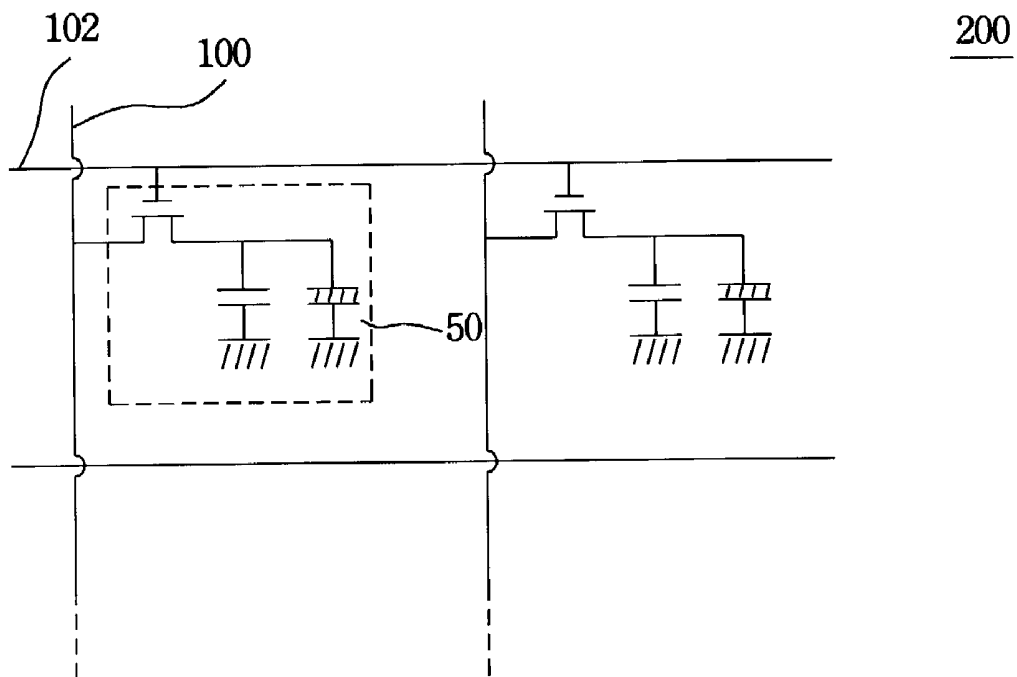


Fig. 1A (Prior Art)

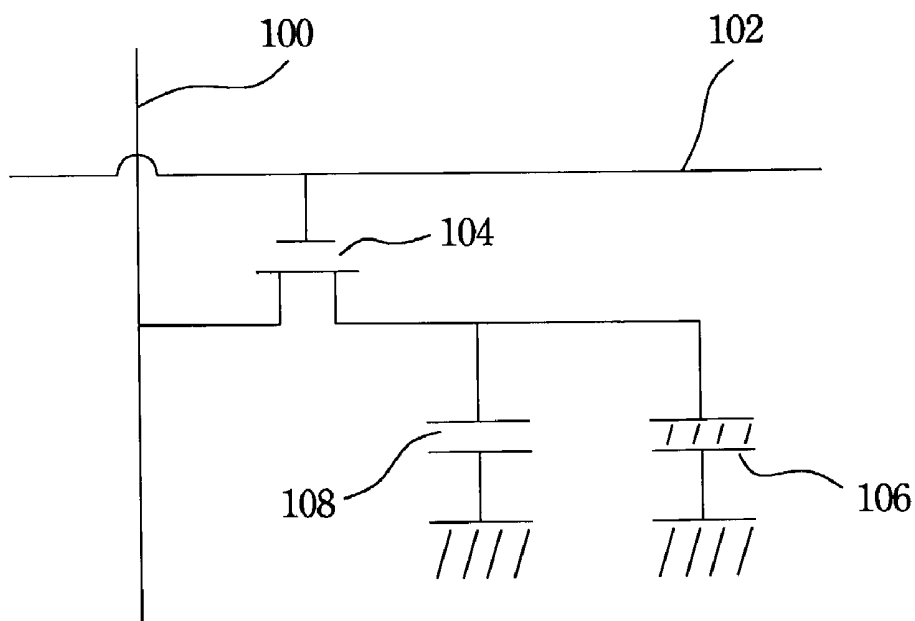


Fig. 1B (Prior Art)

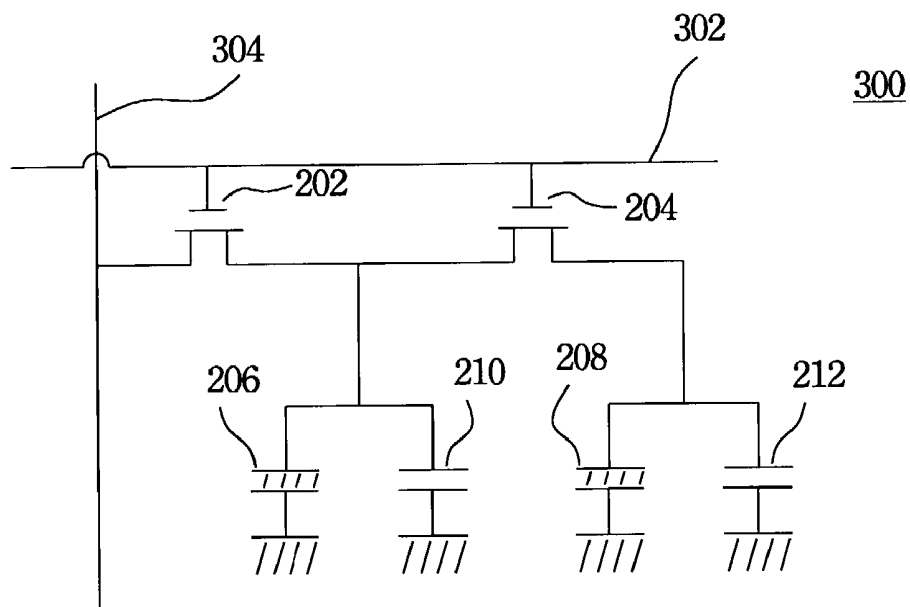


Fig. 2

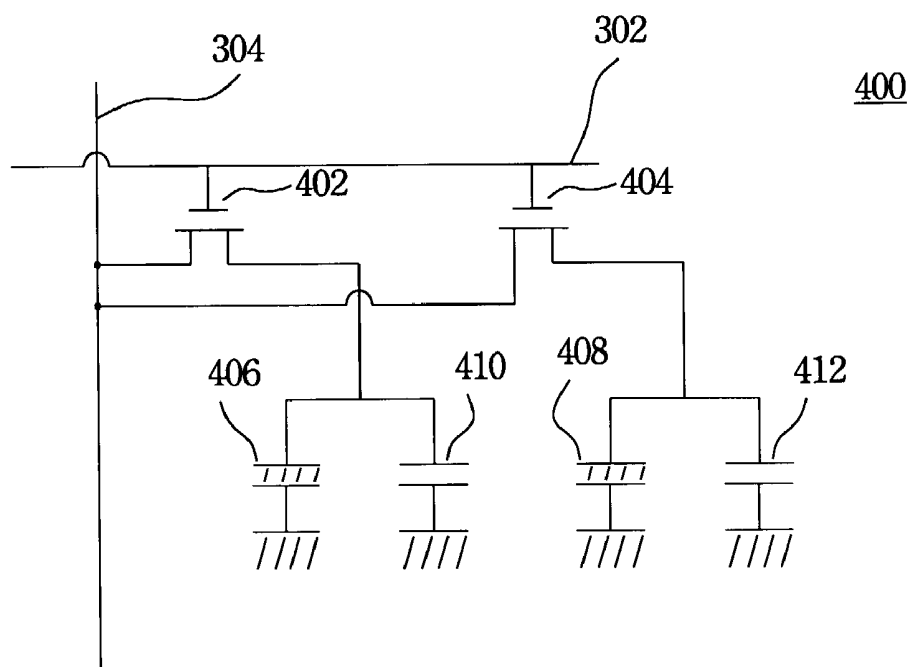


Fig. 3

DISPLAY CIRCUIT STRUCTURE FOR LIQUID CRYSTAL DISPLAY

FIELD OF THE INVENTION

[0001] The present invention relates to a display circuit structure for a liquid crystal display (LCD), and more particularly to a display circuit structure for a liquid crystal display (LCD) having reflection and transmission regions.

BACKGROUND OF THE INVENTION

[0002] Liquid crystal displays (LCD) have been widely applied in electrical products, such as digital watches, calculator, etc. for a long time. Moreover, with the advance of techniques for manufacture and design, thin film transistor-liquid crystal display (TFT-LCD) has been introduced into portable computers, personal digital assistants, and color televisions, as well as gradually replacing the CRT used for conventional display. The demands of TFT-LCD tend to be large scale.

[0003] In general, a typical circuit of a liquid crystal display having both reflection and transmission regions is illustrated in FIG. 1A, in which the LCD matrix display device commonly comprises a LCD display array 200 that further includes a plurality of display elements 50, whose enlarged diagram is shown in the FIG. 1B, arranged in a matrix of rows and columns. Switching devices (not shown in this figure) are coupled with display elements 50 to control the application of video signals thereto. Each display element 50 acts as a switching device that includes a pixel capacitor 106 and a maintenance capacitor 108 driven by a switching transistor 104, referring to FIG. 1B.

[0004] FIG. 1B is an enlarged schematic diagram of a circuit of a liquid crystal display having both reflection and transmission regions according to one preferred embodiment of the present invention. The switching transistor 104 is usually a thin-film transistor (TFT) that is deposited on a transparent substrate such as glass. The switching transistor 104 is deposited on the glass on the same side of the display matrix as the switching transistor and has its source/drain electrode respectively connected to the capacitor electrodes of the pixel capacitor 106 and the maintenance capacitor 108. The source/drain electrode of the switching transistor 104 is connected to a column data driver (not shown in this figure) through the video data line 100 to which video signals are applied. The gate electrodes of the switching transistor 104 is coupled to a row select driver (not shown in this figure) through a scan line 102, and a scan signal is applied to turn on the switching transistor 104.

[0005] By scanning the scan lines 102 and in accordance with the scan signals, all of the switching transistors 104 in a given scan line 102 are turned on. At the same time, video signals are provided in the video data lines synchronously with the selected scan line 102. When the switching transistors 104 in a given scan line 102 are selected by the scan signals, the video signals supplied to the switching transistors 104 charge the pixel capacitors 106 and the maintenance capacitor 108 to a voltage value corresponding to the video signal on the video data line. Thus each pixel capacitor 106 with its electrodes on opposite sides of the matrix display acts as a capacitor. When a signal for a selected scan line 102 is removed, the charge in the pixel capacitor 106 is preserved until the next repetition when that scan line is again selected

by a scan signal and new voltages are stored therein. Thus a picture is displayed on the matrix display by the charges stored in the pixel capacitors 106.

[0006] However, for a liquid crystal display having both reflection and transmission regions, the pixel capacitor 106 crosses both regions. Once the switching transistor 104 or the pixel capacitor 106 is broken, the display element 50 fails.

[0007] On the other hand, the main function of the maintenance capacitor 108 is to maintain the constancy of the voltage value applied to the pixel capacitor 106. That is, before the data stored in the pixel capacitor 106 is refreshed, the voltage applied to the pixel capacitor 106 is maintained by the maintenance capacitor 108. However, with regard to the conventional liquid crystal display having both reflection and transmission regions, the pixel capacitor 106 crosses both regions; therefore, the maintenance capacitor 108 needs to simultaneously maintain the voltage applied to the reflection and transmission regions. The capacitor value of the maintenance capacitor 108 needs to be enlarged to avoid electric charge leakage which would result in a sharp decrease of the voltage applied therein. Accordingly, the enlarged capacitor value of the maintenance capacitor 108 requires a larger current to drive the refresh data process so as to finish this refresh process in the same time. However, this increases the difficulties of circuit design.

SUMMARY OF THE INVENTION

[0008] According to the above descriptions, with regard to the conventional liquid crystal display having reflection and transmission regions, each display element 50 comprises a pixel capacitor 106 and a maintenance capacitor 108 both driven by a switching transistor 104. Therefore, once one of them is broken, the whole display element fails.

[0009] On the other hand, the pixel capacitor 106 crosses both regions. Therefore, the maintenance capacitor 108 needs to simultaneously maintain the voltage applied to the reflection and transmission regions. The capacitor value of the maintenance capacitor needs to be enlarged to avoid electric charge leakage which would result in a sharp decrease of the voltage applied therein. The enlarged capacitor value of the maintenance capacitor 108 requires a larger current to drive the refresh data process so as to finish this refresh process in the same time. This increases the difficulties of circuit design. Therefore, the present invention provides a circuit structure to solve the above problems.

[0010] The primary object of the present invention is to provide a circuit for liquid crystal displays with reduced power consumption.

[0011] Another object of the present invention is to provide a circuit for liquid crystal displays with reduced drive current in the refresh process.

[0012] A further object of the present invention is to provide a circuit for liquid crystal displays in which each display element comprises a plurality of pixel capacitors, a plurality of maintenance capacitors and a plurality of switching transistors and those capacitors and transistors are isolated from each other. Such a structure avoids failure of the entire display element when one capacitor or transistor breaks. The present invention provides a circuit for liquid crystal displays having reflection and transmission regions.

In accordance with the present invention, each display element comprises a plurality of pixel capacitors, a plurality of maintenance capacitors and a plurality of switching transistors. The reflection and transmission regions respectively comprise a pixel capacitor, a maintenance capacitor and a switching transistor. Therefore, the two regions are isolated from each other. That is, a breakage in the reflection region does not affect the transmission region work, and vice versa. Furthermore, in accordance with the circuit structure of the present invention, because each maintenance capacitor only needs to maintain the voltage applied the pixel capacitor of the reflection or transmission region, the capacitor value does not require enlargement. Therefore, the charge current may be decreased.

[0013] In accordance with the structure of the present invention, a scan line is used to control two thin film transistors and a video data line is used to transmit a video signal to pixel capacitors and maintenance capacitors. When the thin film transistors are selected by the selection signal, the video signal stored therein charges the pixel capacitors and maintenance capacitors. When selection signal is removed, the charge in the pixel capacitors is preserved until the next repetition when that scan line is again selected by a selection signal and new voltages are stored therein. Thus a picture is displayed on the matrix display by the charges stored in the pixel capacitors.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] The foregoing aspects and many of the attendant advantages of this invention will become more readily appreciated as the same becomes better understood by reference to the following detailed description, when taken in conjunction with the accompanying drawings, wherein:

[0015] **FIG. 1A** is a schematic diagram of a display circuit structure of the liquid crystal display in accordance with the conventional invention;

[0016] **FIG. 1B** is an enlarged schematic diagram of a display circuit structure of the liquid crystal display in accordance with the conventional invention;

[0017] **FIG. 2** is a schematic diagram of a display circuit structure of the liquid crystal display in accordance with the first embodiment of the present invention; and

[0018] **FIG. 3** is a schematic diagram of a display circuit structure of the liquid crystal display in accordance with the second embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0019] Without limiting the spirit and scope of the present invention, the circuit structure in a liquid crystal display (LCD) proposed in the present invention is illustrated with one preferred embodiment. Skilled artisans, upon acknowledging the embodiments, can apply the circuit design of the present invention to any kind of liquid crystal display to form a display circuit structure. In accordance with the circuit structure of the present invention, the present invention avoids the drawback existing in the conventional liquid crystal display circuit structure having display elements composed only of a pixel capacitor, a maintenance capacitor and a switching transistor. However, this kind of conventional circuit structure may result in total display element

failure once one of the three devices breaks. The structure of the present invention uses display elements comprising plurality of pixel capacitors, a plurality of maintenance capacitors and a plurality of switching transistors; therefore, when one, the devices can replace it to make the whole display element keep working.

[0020] On the other hand, the circuit structure of the present invention also avoids the drawback of the conventional circuit design in which only one maintenance capacitor having a larger capacitor value is used to maintain the voltage applied to the reflection and transmission region. In accordance with this conventional structure, the enlarged capacitor value of the maintenance capacitor requires a larger current to drive the refresh data process, which increases the power consumption. The application of the present invention is not limited by the following description.

[0021] The present invention provides a circuit structure for liquid crystal displays having reflection and transmission regions. In accordance with the present invention, each display element comprises a plurality of pixel capacitors, a plurality of maintenance capacitors and a plurality of switching transistors. The reflection and transmission regions respectively comprise a pixel capacitor, a maintenance capacitor and a switching transistor. Therefore, the two regions are isolated from each other. That is, breakage in the reflection region does not affect the transmission region work, and vice versa. Furthermore, in accordance with the circuit structure of the present invention, because each maintenance capacitor only needs to maintain the voltage applied the pixel capacitor of the reflection or transmission region, the capacitor value does not require enlargement. Therefore, the charge current may be decreased. The detailed description of the present invention is as follows.

[0022] **FIG. 2** is a schematic diagram of a display circuit structure **300** of a liquid crystal display in accordance with the first embodiment of the present invention. This circuit structure **300** is used in a thin film transistor liquid crystal display (TFT-LCD) having reflection and transmission regions therein. In this circuit structure, each display element comprises two pixel capacitors **206** and **208**, two maintenance capacitors **210** and **212** and two switching transistors **202** and **204**. The pixel capacitors **206**, maintenance capacitor **210** and switching transistor **202** are used to control the reflection region in the thin film transistor liquid crystal display. The pixel capacitors **208**, maintenance capacitor **212** and switching transistor **204** are used to control the transmission region in the thin film transistor liquid crystal display.

[0023] The gate electrodes of the switching transistors **202** and **204** are both coupled with a scan line **302**. The scan line **302** is used to control the turning on/off of the switching transistors **202** and **204**. The source/drain electrode of the switching transistors **202** is coupled with the video data line that is used to transmit the video signal. The video data line **304** and the scan line **302** work simultaneously to select a display element from a display element array (not shown in this figure). The other source/drain electrode of the switching transistor **202** is respectively coupled with the electrodes of the pixel capacitor **206** and the maintenance capacitor **210**, and is also coupled with the source/drain electrode of the other switching transistor **204**. The other source/drain electrode of the switching transistors **204** is respectively

coupled with the electrodes of the pixel capacitor **208** and the maintenance capacitor **212**.

[0024] When operation, a selection signals is transmitted to the scan line **302**; that is, a high voltage is applied to the scan line **302** to turn on the switching transistors **202** and **204**. At the same time, video signals are transmitted from the video data line **304** to the source/drain electrode of the switching transistor **202**. Then, the video signal transmits to the pixel capacitor **206** and the maintenance capacitor **210** through the channel of the switching transistor **202**, and also transmits to the pixel capacitor **208** and the maintenance capacitor **212** through the channel of the switching transistor **204**. The video signals may respectively charge the pixel capacitor **206** and **208** and the maintenance capacitor **210** and **212** to the corresponding voltage value applied to the video data line to drive the liquid crystal in the reflection and transmission regions.

[0025] When the selection signals in the scan line **302** are removed and another selection signals are not transmitted to the scan line **302** yet, the switching transistors **202** and **204** are turned off. The charge still retained in the pixel capacitor **206** and **208** and the maintenance capacitor **210** and **212**. Therefore, a picture is displayed on the display by the charges stored in the pixel capacitors **206** and **208**.

[0026] In accordance with the structure described in the above, the reflection and transmission regions respectively comprise a pixel capacitor, a maintenance capacitor and a switching transistor. Therefore, the two regions are isolated from each other. That is, the break in the reflection region does not affect the transmission region work, and vice versa. For example, if the pixel capacitor **206** breaks, it only affects the reflection region of the circuit structure **300**. The transmission region of the circuit structure **300** still works well.

[0027] Furthermore, in accordance with the circuit structure of the present invention, the voltage applied to the pixel capacitors **206** and **208** are respectively maintained by the maintenance capacitors **210** and **212**. Therefore, the capacitor value does not require enlargement. The charge current can be decreased. In other words, the circuit structure of the present invention uses two pixel capacitors and maintenance capacitors to control respectively the reflection and transmission regions, which is different from the conventional structure using only one pixel capacitor and maintenance capacitor to control the reflection and transmission regions. Therefore, the electric charge leakage ratio in a constant time of the present invention structure is lower than the conventional structure. In other words, because each maintenance capacitor only needs to maintain the voltage applied the pixel capacitor in the reflection or transmission region, the capacitor value does not require enlargement. Therefore, the charge current is decreased when a refresh process is conducted.

[0028] FIG. 3 is a schematic diagram of a display circuit structure **400** of the liquid crystal display in accordance with the second embodiment of the present invention. This circuit structure **400** is also used in a thin film transistor liquid crystal display (TFT-LCD) having reflection and transmission regions therein. In this circuit structure, each display element comprises two pixel capacitors **406** and **408**, two maintenance capacitors **410** and **412** and two switching transistors **402** and **404**. The pixel capacitors **406**, maintenance capacitor **410** and switching transistor **402** are used to

control the reflection region in the thin film transistor liquid crystal display. The pixel capacitors **408**, maintenance capacitor **412** and switching transistor **404** are used to control the transmission region in the thin film transistor liquid crystal display.

[0029] The gate electrodes of the switching transistors **402** and **404** are both coupled with a scan line **302**. The scan line **302** is used to control the turning on/off of the switching transistors **402** and **404**. The source/drain electrode of the switching transistors **402** is coupled with the video data line that is used to transmit the video signal. The video data line **304** and the scan line **302** can work simultaneously to select a display element from a display element array (not shown in this figure). The other source/drain electrode of the switching transistor **402** is respectively coupled with the electrodes of the pixel capacitor **406** and the maintenance capacitor **410**. The source/drain electrode of the switching transistors **404** is respectively coupled with the electrodes of the pixel capacitor **408** and the maintenance capacitor **412**, and the other source/drain electrode of the switching transistors **404** is also coupled with the video data line **304**.

[0030] During operation, a selection signal is transmitted to the scan line **302**; that is, a high voltage is applied to the scan line **302** to turn on the switching transistors **402** and **404**. At the same time, video signals are transmitted from the video data line **304** to the source/drain electrode of the switching transistors **402** and **404**. Then, the video signal is transmitted to the pixel capacitor **406** and **408** and the maintenance capacitor **410** and **412** respectively through the channel of the switching transistor **402** and **404**. The video signals respectively charge the pixel capacitors **406** and **408** and the maintenance capacitor **410** and **412** to the corresponding voltage value applied to the video data line so as to drive the liquid crystal in the reflection and transmission regions.

[0031] When the selection signals in the scan line **302** are removed and another selection signal is not transmitted to the scan line **302** yet, the switching transistor **402** and **504** is turned off. The charge is still retained in the pixel capacitor **406** and **408** and the maintenance capacitor **410** and **412**. Therefore, a picture is displayed on the display by the charges stored in the pixel capacitors **406** and **408**.

[0032] In accordance with the structure described in the above, the reflection and transmission regions are respectively composed of a pixel capacitor, a maintenance capacitor and a switching transistor. Therefore, the two regions are isolated from each other. That is, the break in the reflection region does not affect the transmission region work, and vice versa. For example, if the pixel capacitor **406** breaks, it only affects the reflection region of the circuit structure **400**. The transmission region of the circuit structure **400** still works well.

[0033] Furthermore, in accordance with the circuit structure of the present invention, the voltage applied to the pixel capacitors **406** and **408** are respectively maintained by the maintenance capacitors **410** and **412**. Therefore, the capacitor value does not require enlargement. The charge current can be decreased. In other words, the circuit structure of the present invention uses two pixel capacitors and maintenance capacitors to control respectively the reflection and transmission regions, which is different from the conventional structure using only one pixel capacitor and maintenance

capacitor to control the reflection and transmission regions. Therefore, the electric charge leakage ratio in a constant time of the present invention structure is lower than the conventional structure. In other words, because each maintenance capacitor only needs to maintain the voltage applied the pixel capacitor in the reflection or transmission region, the capacitor value does not require enlargement. Therefore, the charge current can be decreased when a refresh process is operated.

[0034] As is understood by a person skilled in the art, the foregoing preferred embodiments of the present invention are illustrative of the present invention rather than limiting of the present invention. They are intended to cover various modifications and similar arrangements included within the spirit and scope of the appended claims, the scope of which should be accorded the broadest interpretation so as to encompass all such modifications and similar structure.

What is claimed is:

1. A display circuit structure of the liquid crystal display having reflection and transmission regions, said circuit structure comprising:

first and second data lines;

a plurality of transistors, wherein said transistors are connected in series to couple with said first data line and a gate electrode of each transistor is coupled with said second data line; and

a plurality of capacitor pairs, wherein each capacitor pair comprises a pixel capacitor and a maintenance capacitor connected in parallel and each capacitor pair is coupled to a source/drain electrode of one corresponding transistor of said plurality of series connection transistors.

2. The circuit structure according to claim 1, wherein said second data line is used to control the turning on/off of said plurality of transistors.

3. The circuit structure according to claim 1, wherein said plurality of capacitor pairs is charged when said plurality of transistors is turned on.

4. A display circuit structure of the liquid crystal display having reflection and transmission regions, said circuit structure comprising:

a first data line;

a second data line crossing said first data line;

a first transistor, wherein a source/drain electrode is coupled with said first data line and a gate electrode of said first transistor is coupled with said second data line;

a first pixel capacitor, wherein said first pixel capacitor is coupled with said first data line through a channel of said first transistor;

a first maintenance capacitor, wherein said first maintenance capacitor is coupled with said first data line through the channel of said first transistor;

second transistor, wherein said second transistor is coupled with said first data line through the channel of said first transistor and a gate electrode of said second transistor is coupled with said second data line;

a second pixel capacitor, wherein said second pixel capacitor is coupled with said first data line through channels of said first and second transistors; and

second maintaining capacitor, wherein said second maintenance capacitor is coupled with said first data line through the channels of said first and second transistors.

5. The circuit structure according to claim 4, wherein said second data line is used to control turning on/off of said first and second transistors.

6. The circuit structure according to claim 4, wherein said first and second pixel capacitors and maintenance capacitors is charged when said first and second transistors are turned on.

7. The circuit structure according to claim 4, wherein said first transistor, first pixel capacitor and first maintenance capacitor are used to control a reflection region, and said second transistor, second pixel capacitor and second maintenance capacitor are used to control a transmission region.

8. The circuit structure according to claim 4, wherein said first transistor, first pixel capacitor and first maintenance capacitor are used to control a transmission region, and said second transistor, second pixel capacitor and second maintenance capacitor are used to control a reflection region.

9. A display circuit structure of the liquid crystal display having reflection and transmission regions, said circuit structure comprising:

first and second data lines;

a plurality of transistors, wherein a source/drain electrode of each transistor is coupled with said first data line and a gate electrode of each transistor is coupled with said second data line; and

a plurality of capacitor pairs, wherein each capacitor pair comprises a pixel capacitor and a maintenance capacitor connected in parallel and each capacitor pair is coupled to said first data line through a channel of a corresponding transistor of said plurality of transistors.

10. The circuit structure according to claim 9, wherein said second data line is used to control turning on/off of said plurality of transistors.

11. The circuit structure according to claim 9, wherein said plurality of capacitor pairs is charged when said plurality of transistors is turned on.

12. A display circuit structure of the liquid crystal display having reflection and transmission regions, said circuit structure comprising:

a first data line;

a second data line crossing said first data line;

first transistor, wherein a source/drain electrode is coupled with said first data line and a gate electrode of said first transistor is coupled with said second data line;

first pixel capacitor, wherein said first pixel capacitor is coupled with said first data line through a channel of said first transistor;

first maintenance capacitor, wherein said first maintenance capacitor is coupled with said first data line through the channel of said first transistor;

a second transistor, wherein the source/drain electrode is coupled with said first data line and the gate electrode of said first transistor is coupled with said second data line;

a second pixel capacitor, wherein said second pixel capacitor is coupled with said first data line through a channel of said second transistor; and

a second maintenance capacitor, wherein said second maintenance capacitor is coupled with said first data line through the channel of said second transistor.

13. The circuit structure according to claim 12, wherein said second data line is used to control turning on/off of said first and second transistors.

14. The circuit structure according to claim 12, wherein said first and second pixel capacitors and maintenance capacitors are charged when said first and second transistors are turned on.

15. The circuit structure according to claim 12, wherein said first transistor, first pixel capacitor and first maintenance capacitor are used to control the reflection region, and said second transistor, second pixel capacitor and second maintenance capacitor are used to control the transmission region.

16. The circuit structure according to claim 12, wherein said first transistor, first pixel capacitor and first maintenance capacitor are used to control the transmission region, and said second transistor, second pixel capacitor and second maintenance capacitor are used to control the reflection region.

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专利名称(译)	用于液晶显示器的显示电路结构		
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摘要(译)

扫描线用于控制两个薄膜晶体管，视频数据线用于将视频信号传输到像素电容器和维护电容器。当通过选择信号选择薄膜晶体管时，存储在其中的视频信号对像素电容器和维护电容器充电。当去除选择信号时，像素电容器中的电荷被保留直到下一次重复，此时该选择信号再次选择该扫描线并且在其中存储新电压。因此，通过存储在像素电容器中的电荷在矩阵显示器上显示图像。

