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Wen et al.

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(54) **LIQUID CRYSTAL DISPLAY WITH DATA COMPENSATION FUNCTION AND METHOD FOR COMPENSATING DATA UTILIZING ISOLATED COUPLING LINES**

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G09G 3/36 (2006.01)
G06F 3/038 (2006.01)

(52) **U.S. Cl.** **345/96**; 345/209; 345/93

(58) **Field of Classification Search** 345/87, 345/90, 93–96, 103, 204–206, 208–215
See application file for complete search history.

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Primary Examiner — Bipin Shalwala

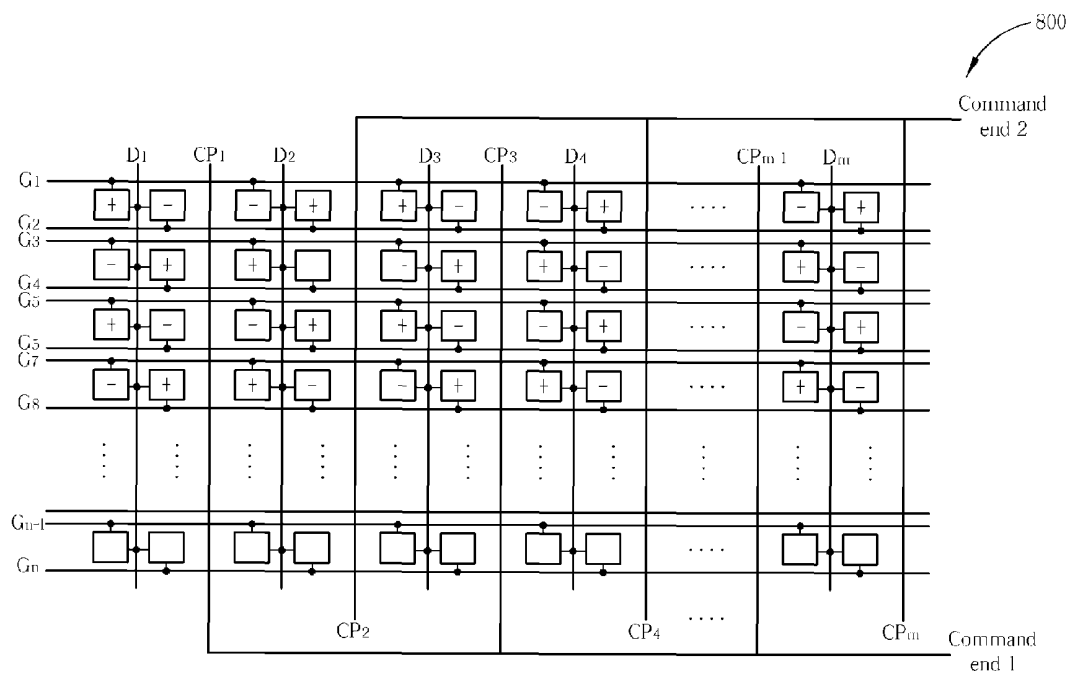
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(57) **ABSTRACT**

An liquid crystal display with data compensating function includes a plurality of gate lines, a plurality of first data lines, a plurality of second data lines, a pixel array, a first common end, a second common end, a plurality of first coupling lines, and a plurality of second coupling lines. The first coupling lines are disposed correspondingly near the first data lines, and are coupled to the first common end. The second coupling lines are disposed correspondingly near the second data lines, and are coupled to the second common end. The first common end carries voltages having same polarity as those of the first data lines for driving the first coupling lines. The second common end carries voltages having same polarity as those of the second data lines for driving the second coupling lines. The first common end is isolated from the second common end.

11 Claims, 13 Drawing Sheets



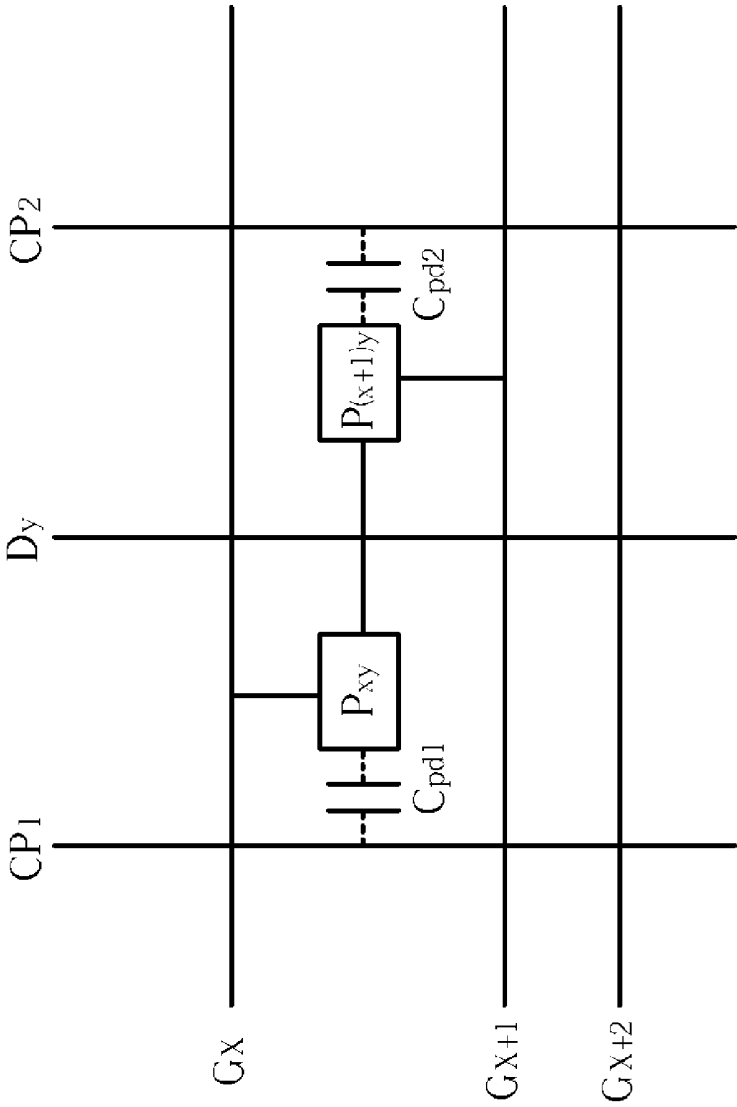


FIG. 1 PRIOR ART

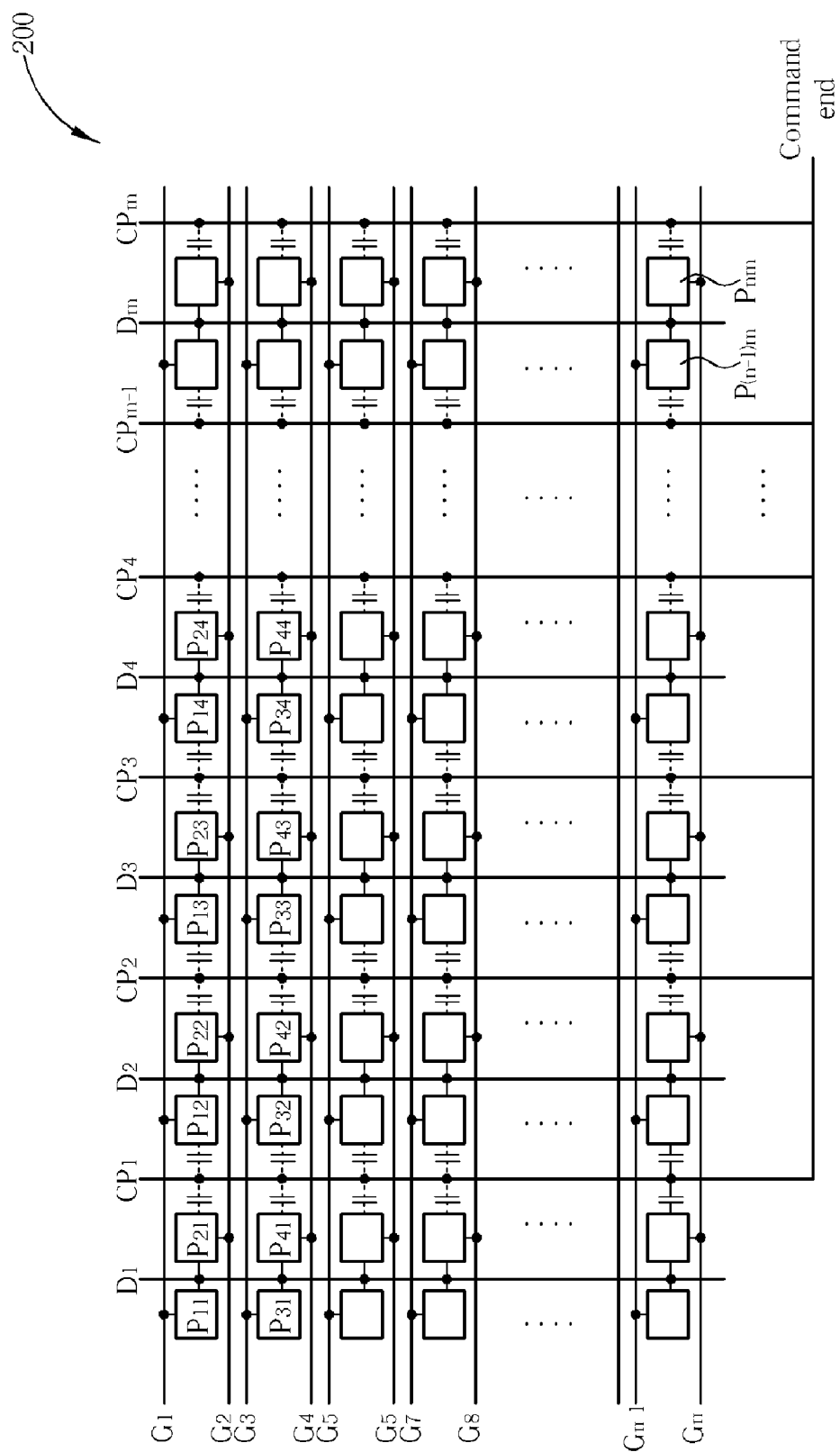


FIG. 2 PRIOR ART

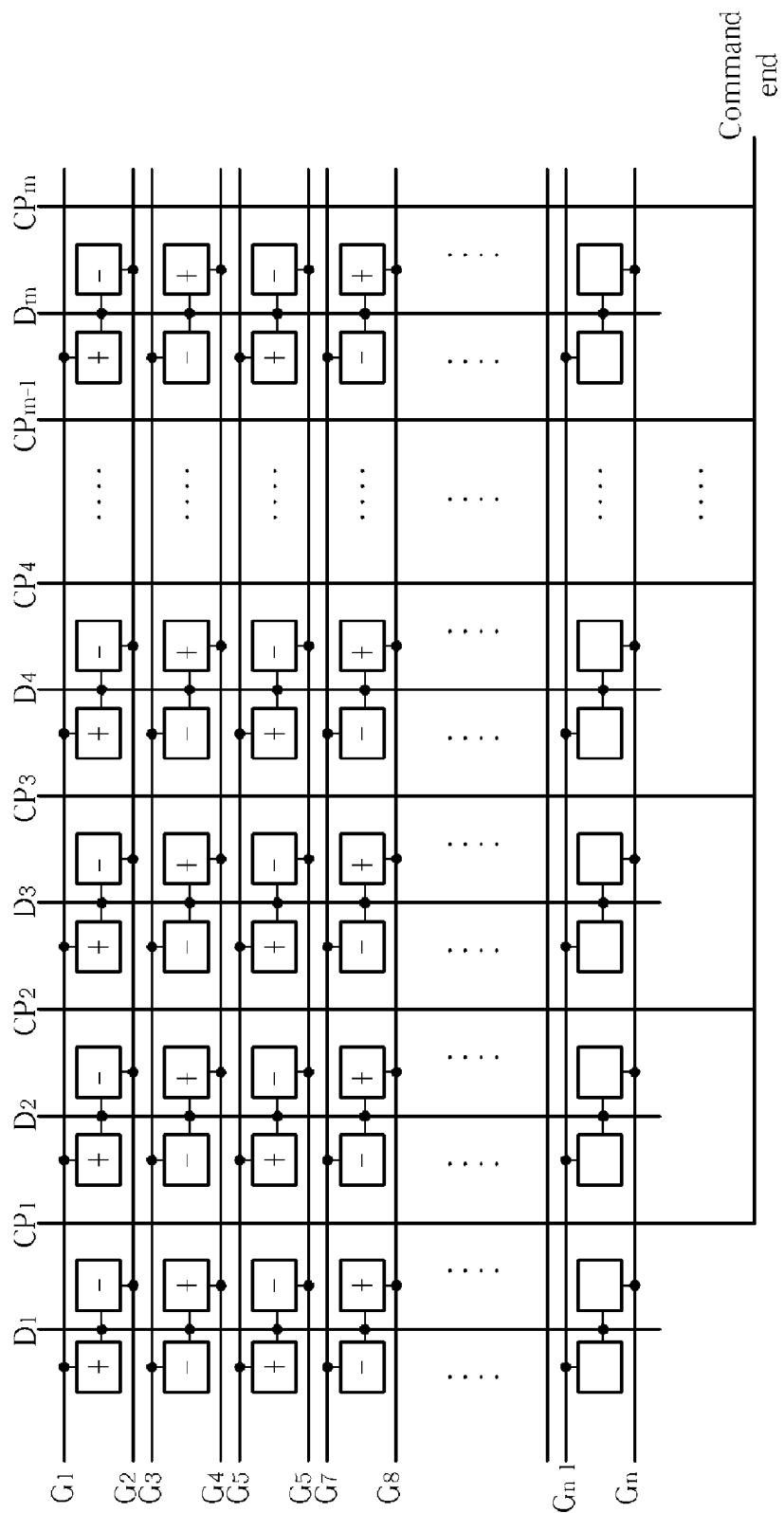


FIG. 3 PRIOR ART

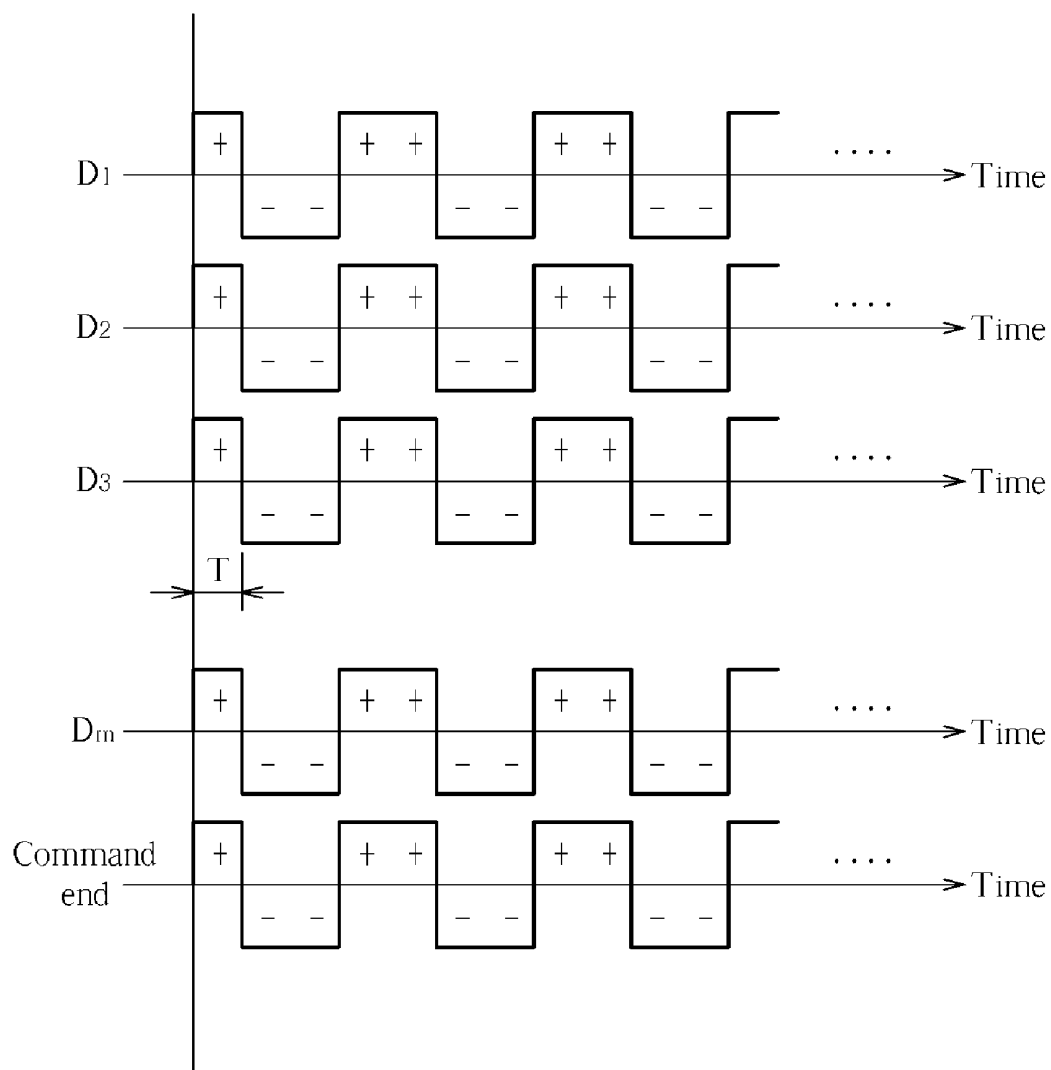


FIG. 4 PRIOR ART

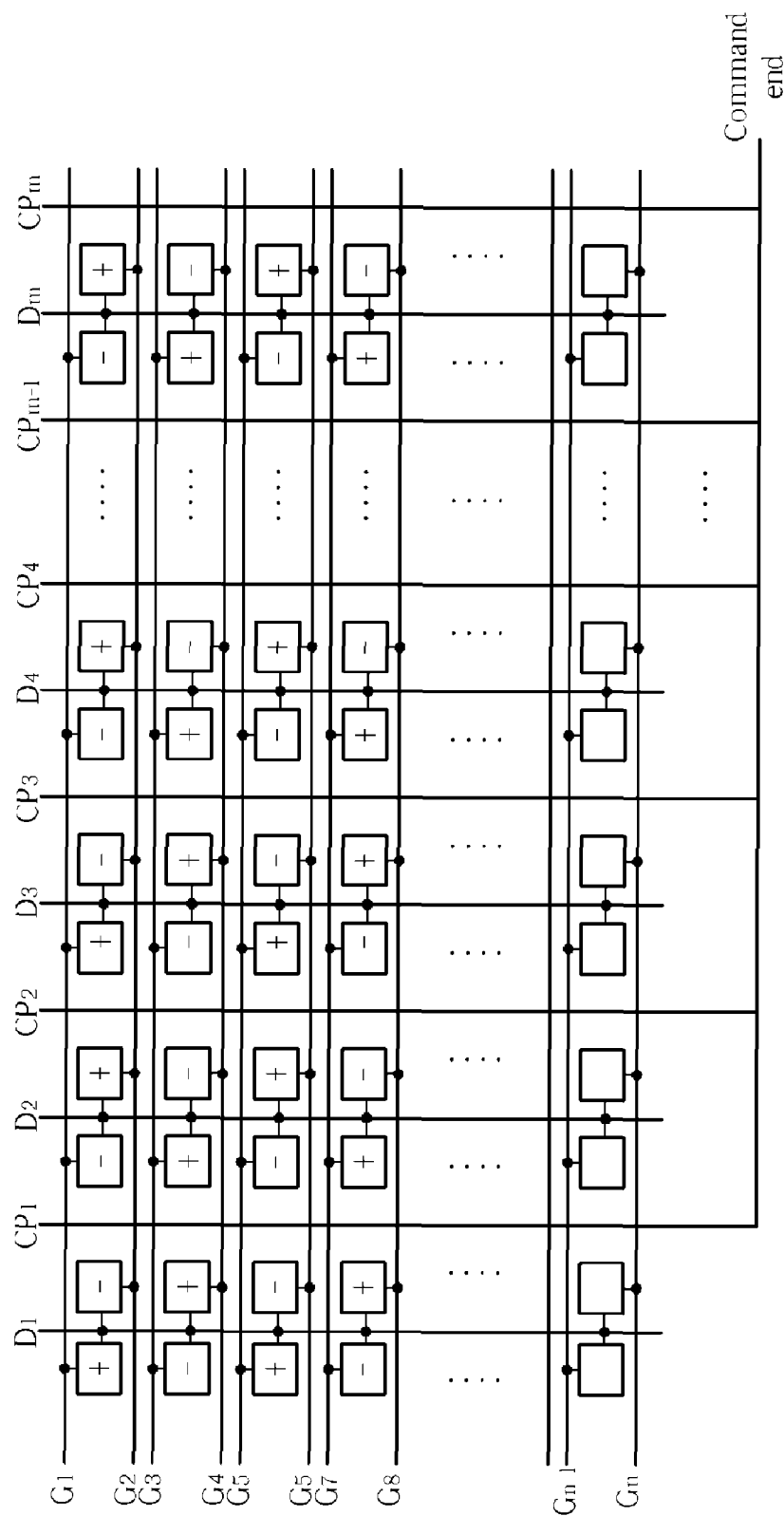


FIG. 5 PRIOR ART

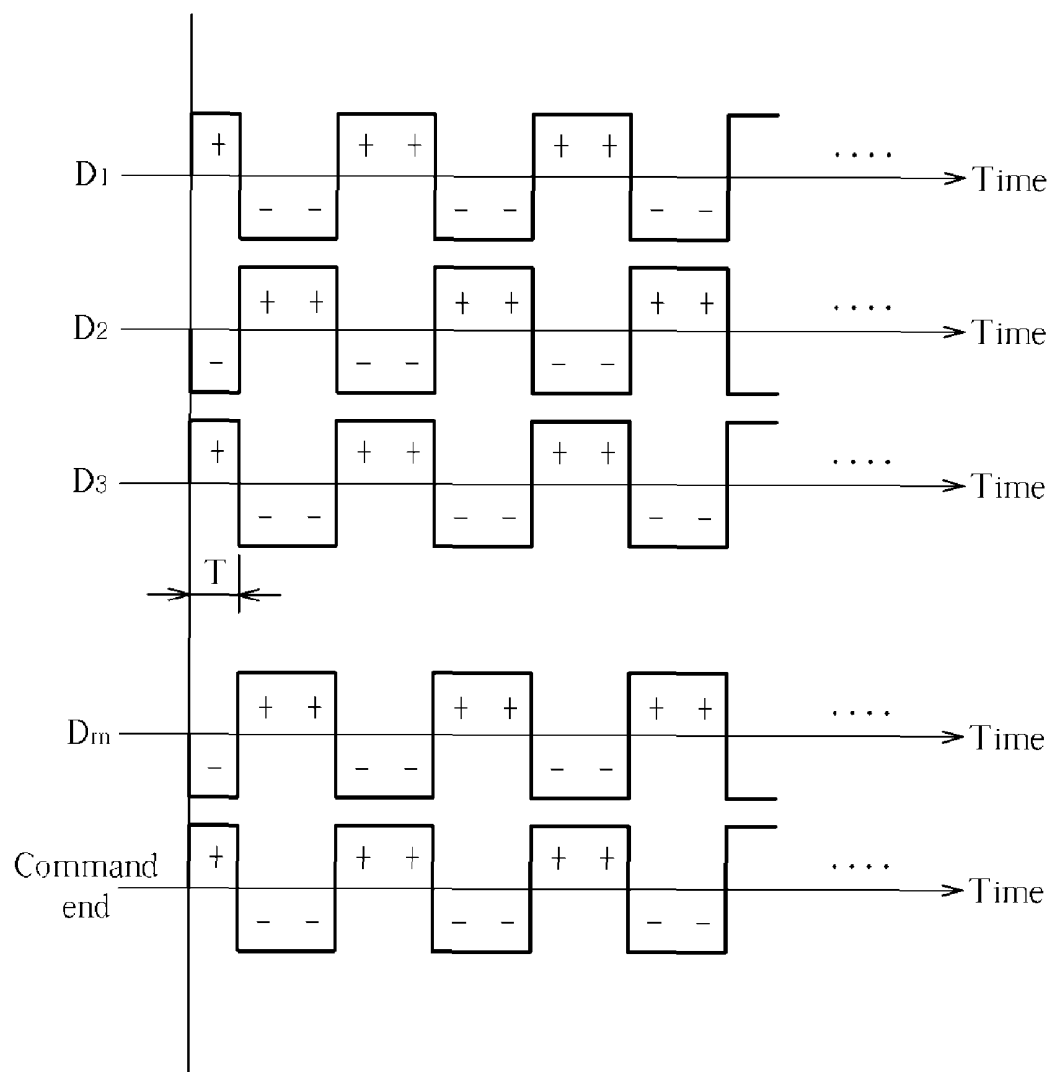


FIG. 6 PRIOR ART

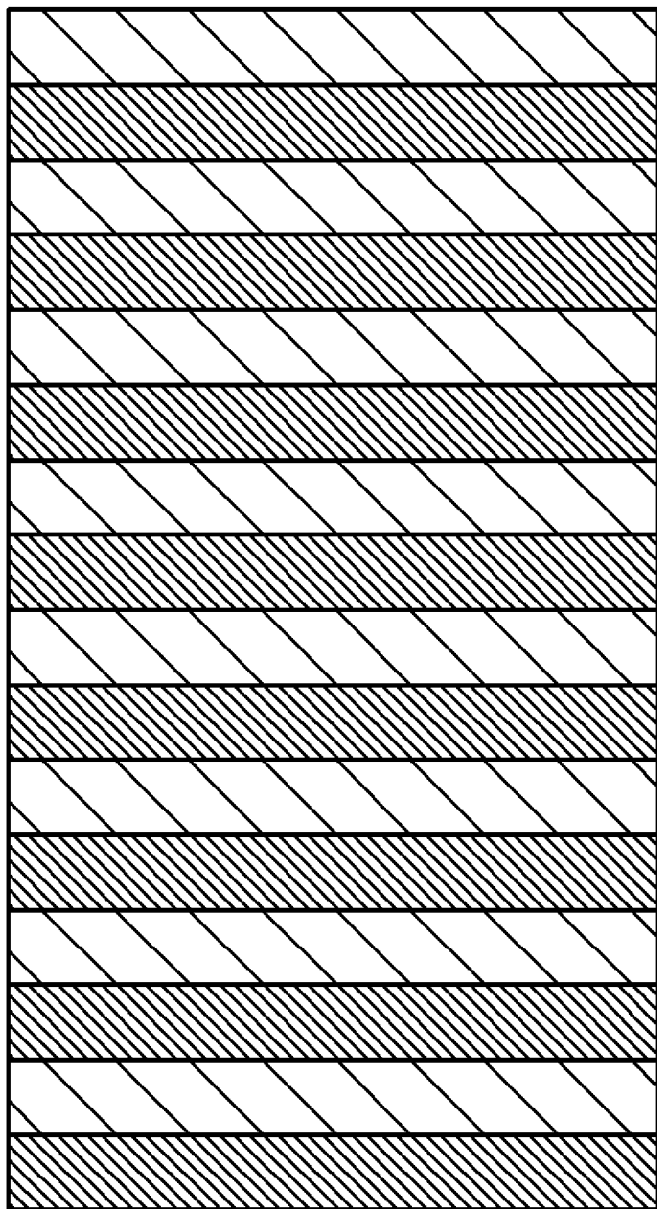


FIG. 7 PRIOR ART

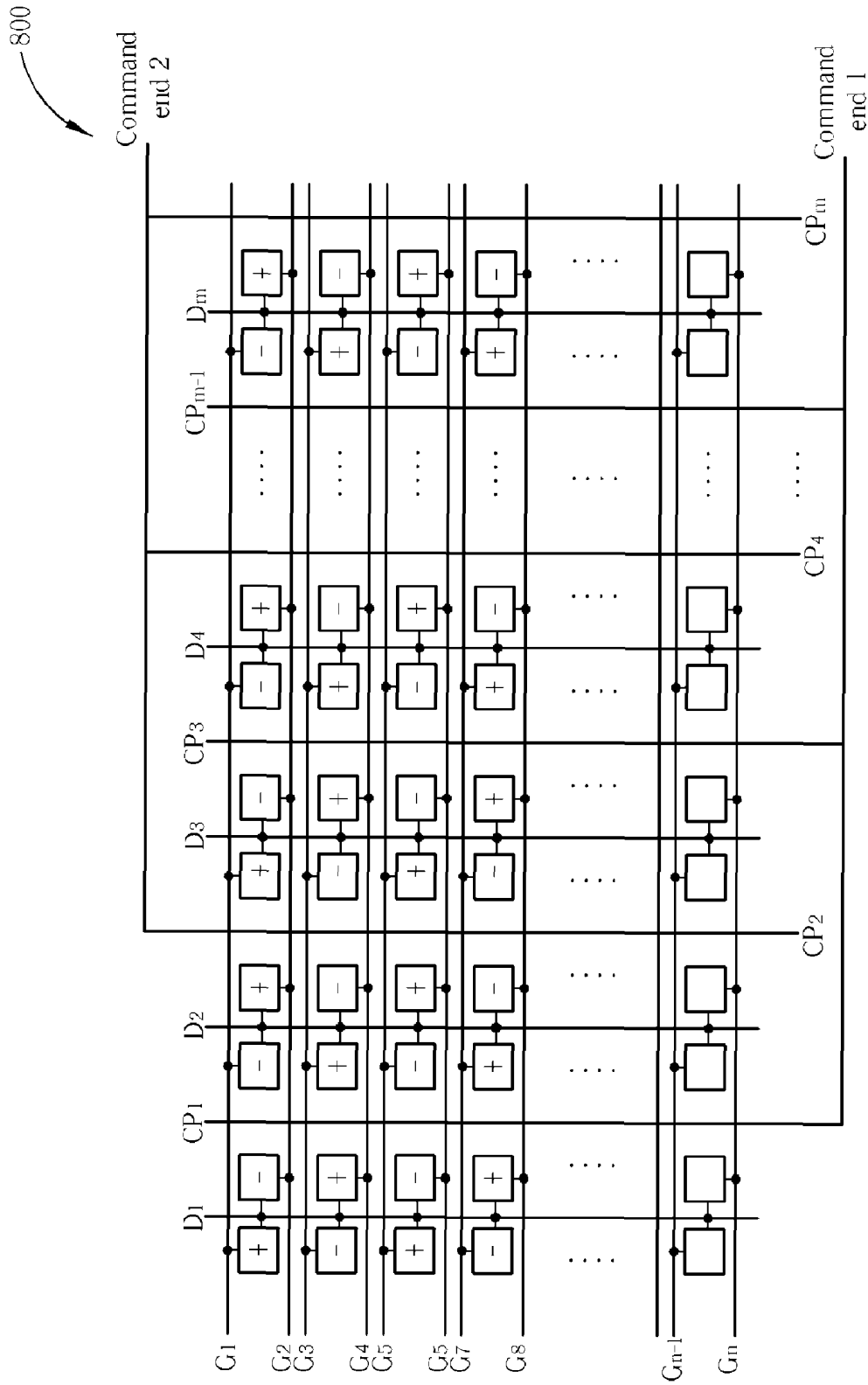


FIG. 8

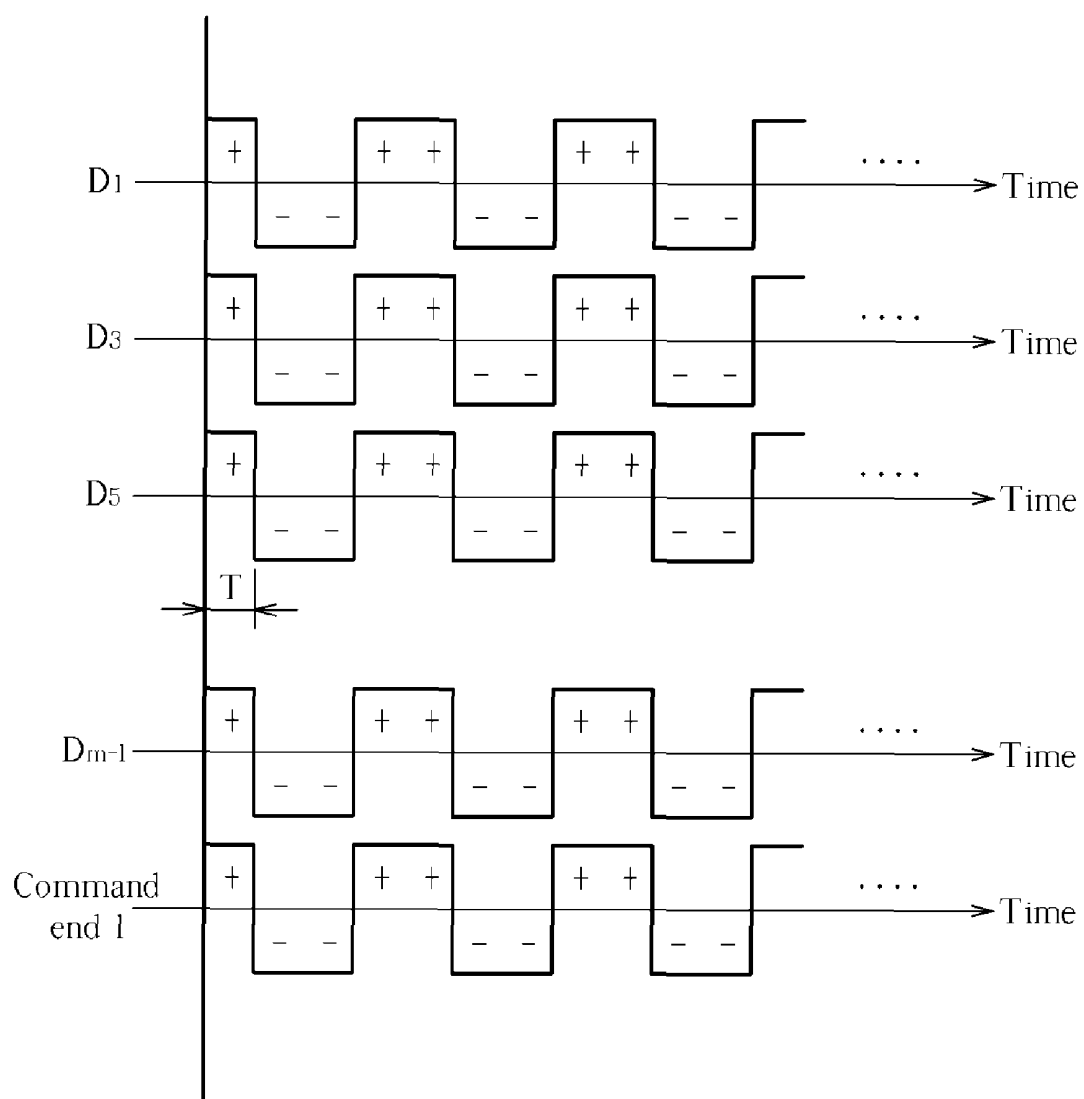


FIG. 9

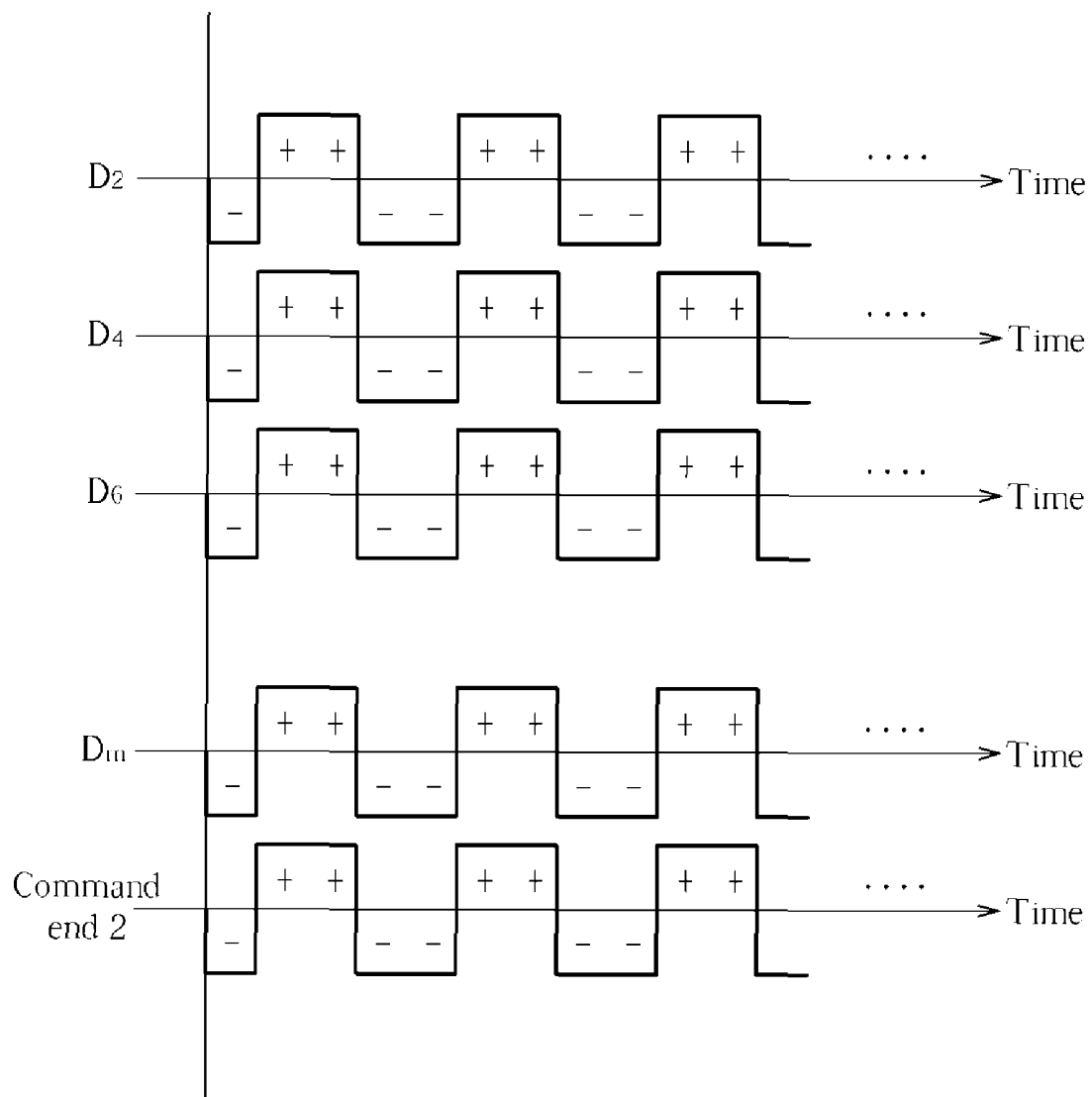


FIG. 10

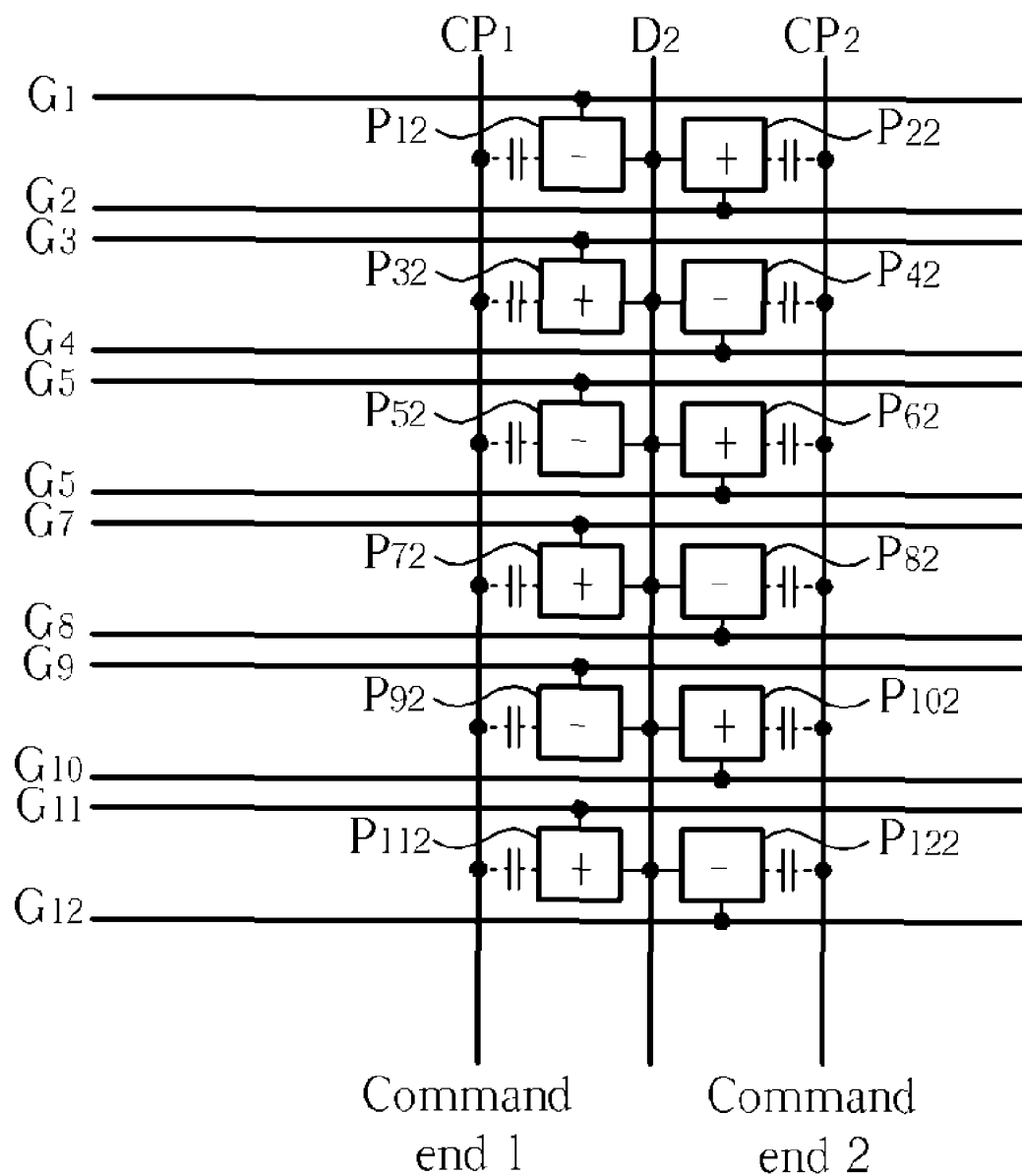


FIG. 11

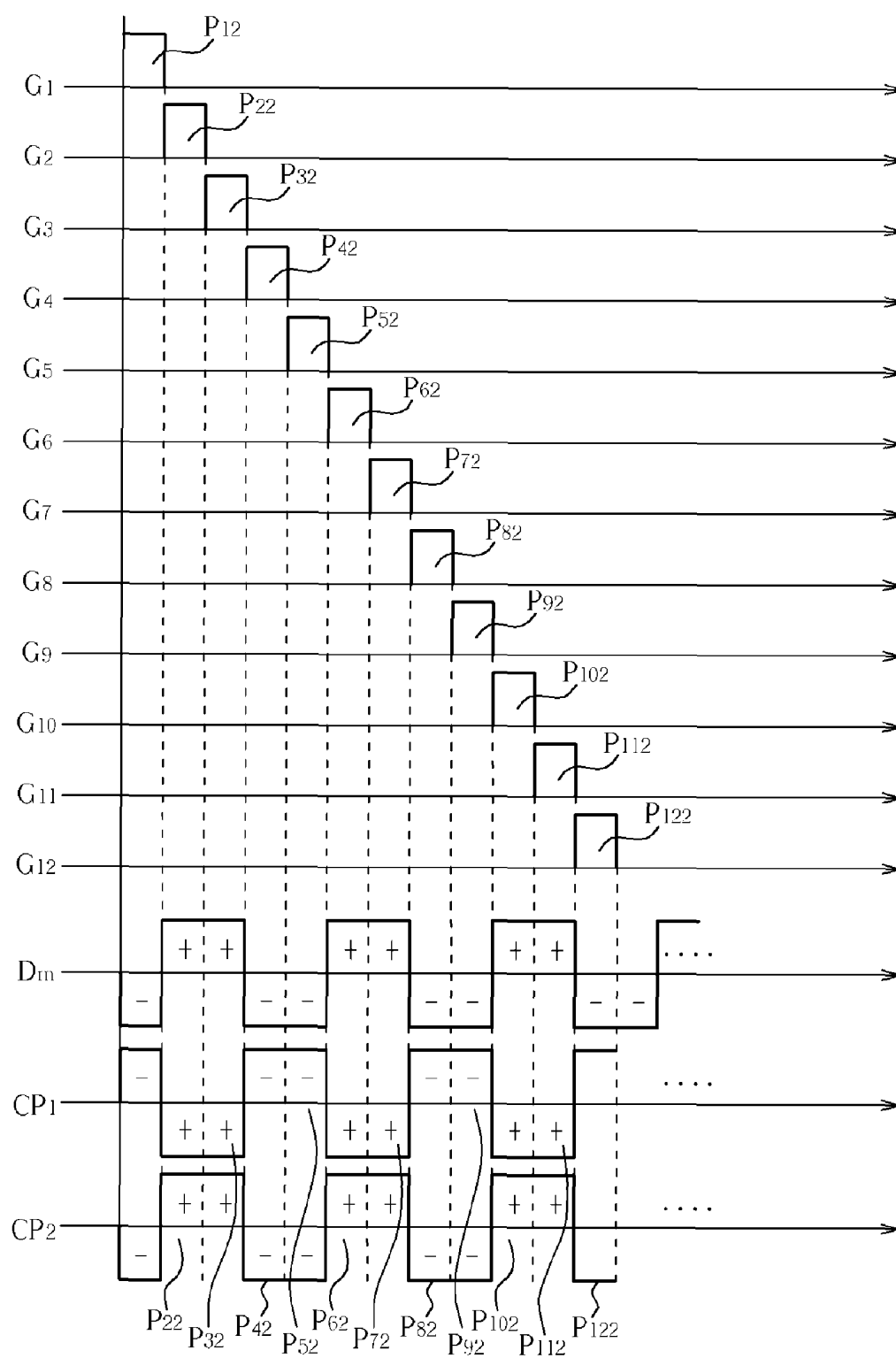


FIG. 12

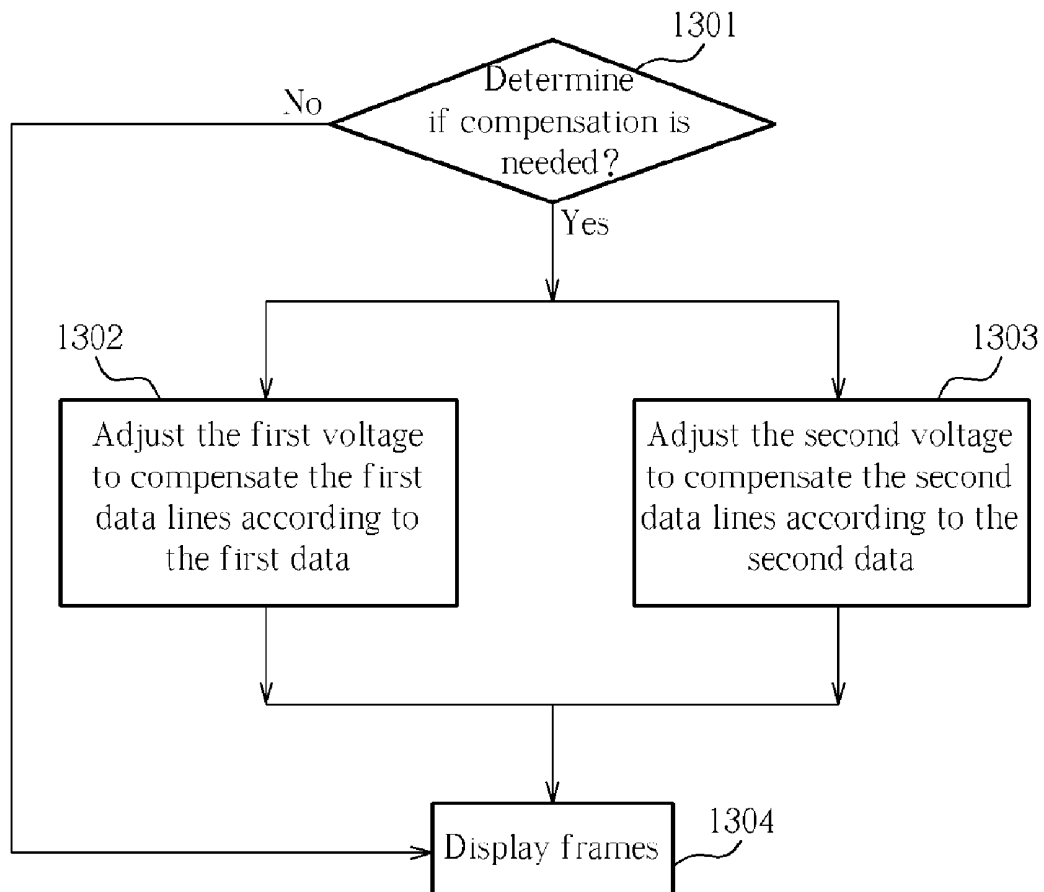


FIG. 13

LIQUID CRYSTAL DISPLAY WITH DATA COMPENSATION FUNCTION AND METHOD FOR COMPENSATING DATA UTILIZING ISOLATED COUPLING LINES

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a liquid crystal display (LCD), and more particularly, to an LCD with data compensation function.

2. Description of the Prior Art

In an LCD, the cost of the source driver is much higher than the gate driver. In order to reduce the total cost of the LCD, the structure of pixels sharing data lines is generated. In the structure of pixels sharing data lines, the data lines are reduced by half; in this way, the amount of source drivers is reduced, which will lower the total cost. However, due to this structure, the amount of the gate drivers will be doubled and the frequency of the gate driving signals also has to be doubled for keeping the same frame rate. In other words, the turning-on period of a gate is reduced by half. Under such conditions, the data lines cannot be fully charged or discharged to the predetermined voltage levels. Therefore, in the prior art, coupling lines are disposed near the data lines to increase driving abilities of the data lines.

FIG. 1 is a diagram illustrating coupling lines of a conventional LCD. As shown in FIG. 1, the pixel P_{xy} is coupled to the data line D_x and the gate line G_x , and the pixel $P_{(x+1)y}$ is coupled to the data line D_y and the gate line $G_{(x+1)y}$. The left side of the pixel P_{xy} is disposed with a coupling line CP_1 , which is a metal line. In this way, a parasitic capacitor C_{pd1} is formed between the coupling line CP_1 and the pixel P_{xy} . The right side of the pixel $P_{(x+1)y}$ is disposed with a coupling line CP_2 , which is also a metal line. In this way, a parasitic capacitor C_{pd2} is formed between the coupling line CP_2 and the pixel $P_{(x+1)y}$. The voltages on the pixels P_{xy} and $P_{(x+1)y}$ are affected by the voltages of the coupling lines CP_1 and CP_2 . Therefore, the voltages on the pixels P_{xy} and $P_{(x+1)y}$ can be adjusted by controlling the voltages of the coupling lines CP_1 and CP_2 ; consequently, the driving ability of the data line D_y is improved.

FIG. 2 is a diagram illustrating a conventional LCD with data compensation function. As shown in FIG. 2, a coupling line is disposed between every two data lines. For example, the coupling line CP_1 is disposed between the data lines D_1 and D_2 , the coupling line CP_2 is disposed between the data lines D_2 and D_3 , the coupling line CP_n is disposed between the data lines D_n and $D_{(n+1)}$, and so on. The coupling line CP_1 is disposed between the data lines D_1 and D_2 , and thus the pixels which are affected by the coupling line CP_1 comprise pixels P_{21} , P_{12} , P_{41} , P_{32} , and so on. The coupling line CP_2 is disposed between the data lines D_2 and D_3 , and thus the pixels which are affected by the coupling line CP_2 comprise pixels P_{22} , P_{13} , P_{42} , P_{33} , and so on. All the coupling lines $CP_1 \sim CP_m$ are coupled to one common end. In this way, the voltages of all the coupling lines $CP_1 \sim CP_m$ are controlled by controlling the voltage of the common end, and thus the voltages of all pixels in the LCD 200 will be affected by the coupling lines.

Referring to FIGS. 3 and 4, FIG. 3 is a diagram illustrating the LCD 200 adopting two-line inversion driving method, while FIG. 4 is a timing diagram illustrating the common end of the LCD 200 with coupling lines adopting two-line inversion method. In FIG. 4, T represents a period of time with a gate being turned on and the vertical axis represents a voltage level. The polarity of the voltage on the common end (compared to a common voltage level) changes in the same way as

the data lines change. For example, when the polarity of the voltages of the data lines $D_1 \sim D_m$ is negative (compared to the common voltage level), the polarity of the voltage on the common end is also negative, and when the polarity of the voltages of the data lines $D_1 \sim D_m$ is positive (compared to the common voltage level), the polarity of the voltage on the common end is also positive.

Referring to FIGS. 5 and 6, FIG. 5 is a diagram illustrating the LCD 200 adopting two-line-dot inversion driving method, while FIG. 6 is a timing diagram illustrating the common end of the LCD 200 with coupling lines adopting two-line-dot inversion driving method. In FIG. 6, T represents a period of time with a gate being turned on and the vertical axis represents a voltage level. The polarity of the voltage on the common end (compared to a common voltage level) changes in the same way as a part of the data lines changes. When the two-line-dot inversion is adopted, the data lines are divided into two groups, each group having different polarity relative to the other. However, due to the couple lines connected to the common end, the polarity of the voltage on the common end only changes according to one of the two groups. For example, when the polarity of the voltages of the odd data lines $D_1, D_3, D_5 \dots D_{m-1}$ (assuming m is an even number) is negative (compared to the common voltage level), the polarity of the voltage on the common end is negative, and when the polarity of the voltages of the odd data lines $D_1, D_3, D_5 \dots D_{m-1}$ is positive (compared to the common voltage level), the polarity of the voltage on the common end is positive. In this way, the polarity of the voltage on the common end is not the same as the polarity of the even data lines $D_2, D_4, D_6 \dots D_m$. Consequently, the driving ability of the odd data lines is enhanced, but the even data lines is reduced. This causes non-uniformity on the LCD 200, as shown in FIG. 7, and color difference in stripe shape is generated. Therefore, the conventional LCD 200 cannot adopt the two-line-dot inversion driving method.

SUMMARY OF THE INVENTION

The present invention provides an LCD with data compensation function. The LCD comprises a plurality of gate lines, a plurality of first data lines for transmitting first data, a plurality of second data lines for transmitting second data, a pixel array comprising a plurality of pixels wherein the plurality of the pixels are interwoven by the gate lines, the plurality of the first data lines, and the plurality of the second data lines, a first common end carrying a first voltage, a second common end carrying a second voltage, a plurality of first coupling lines near the plurality of the first data lines coupled to the first common end, and a plurality of second coupling lines near the plurality of the second data lines coupled to the second common end, wherein the first and the second common ends are electrically isolated, and one coupling line of the first or the second coupling lines is disposed between two adjacent data lines of the first or the second data lines.

The present invention further provides a method for compensating data of an LCD. The LCD comprises a plurality of gate lines, a plurality of first data lines, a plurality of second data lines, a pixel array, a first common end, a second common end, a plurality of first coupling lines, and a plurality of second coupling lines, the plurality of the first data lines transmitting first data, the plurality of the second data lines transmitting second data, the pixel array comprising a plurality of pixels, wherein the plurality of pixels are interwoven by the plurality of the gate lines, the plurality of the first data lines, and the plurality of the second data lines, the first coupling lines coupled to the first common end near the

plurality of the first data lines, the second coupling lines coupled to the second common end near the plurality of the second data lines, the first common end carrying a first voltage, the second common end carrying a second voltage, the first common end electrically isolated from the second common end. The method comprises adjusting the first voltage to compensate the plurality of the first data lines according to the first data, and adjusting the second voltage to compensate the plurality of the second data lines according to the first data.

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 illustrating coupling lines of a conventional LCD.

FIG. 2 is a diagram illustrating a conventional LCD with data compensation function.

FIG. 3 is a diagram illustrating the conventional LCD with coupling lines adopting two-line inversion.

FIG. 4 is a timing diagram illustrating the common end of the conventional LCD with coupling lines adopting two-line inversion.

FIG. 5 is a diagram illustrating the conventional LCD with couple lines adopting two-line-dot inversion.

FIG. 6 is a timing diagram illustrating the common end of the conventional LCD with couple lines adopting two-line-dot inversion.

FIG. 7 is a diagram illustrating frames displayed by the conventional LCD under the two-line-dot inversion.

FIG. 8 is a diagram illustrating an LCD with data compensation function of the present invention.

FIG. 9 is a timing diagram illustrating one common end of the LCD, according to the present invention, for driving the coupling lines according to the characteristic of the odd data lines.

FIG. 10 is a timing diagram illustrating another common end of the LCD, according to the present invention, for driving the coupling lines according to the characteristic of the even data lines.

FIG. 11 is a diagram illustrating the coupling lines disposed at sides of the data line for data compensating, according to the present invention.

FIG. 12 is a timing diagram illustrating voltages on the coupling lines, according to the present invention.

FIG. 13 is a flowchart illustrating the method of displaying frames according to the LCD with data compensation function of the present invention.

DETAILED DESCRIPTION

FIG. 8 is a diagram illustrating an LCD with data compensation function of the present invention. As shown in FIG. 8, the coupling lines $CP_1 \sim CP_m$ are divided into two groups. The odd coupling lines $CP_1, CP_3, CP_5 \dots CP_{m-1}$ are coupled to the common end 1, and the even coupling lines $CP_2, CP_4, CP_6 \dots CP_m$ are coupled to the common end 2. In this way, when the LCD 800 adopts two-line inversion driving method, the polarity of the common end 1 and the polarity of the common end 2 change the same way as all the data lines $D_1 \sim D_m$. Thus the coupling lines $CP_1 \sim CP_{m-1}$ change the same way as all the data lines $D_1 \sim D_m$ and help the data lines $D_1 \sim D_m$ to drive pixels. When the LCD 800 adopts two-line-dot inversion, the polarity of the common end 1 changes the same way

as the odd data lines $D_1, D_3, D_5 \dots D_{m-1}$ and the polarity of the common end 2 changes the same way as the even data lines $D_2, D_4, D_6 \dots D_m$. Thus the coupling lines $CP_1, CP_3, CP_5 \dots CP_{m-1}$ change the same way as the odd data lines $D_1, D_3, D_5 \dots D_{m-1}$ and help the odd data lines $D_1, D_3, D_5 \dots D_{m-1}$ to drive pixels, and the coupling lines $CP_2, CP_4, CP_6 \dots CP_m$ change the same way as the even data lines $D_2, D_4, D_6 \dots D_m$ and help the even data lines $D_2, D_4, D_6 \dots D_m$ to drive pixels. Therefore, all the driving abilities of the data lines are enhanced, and the color difference in stripe shape is solved.

Referring to FIGS. 9 and 10, FIG. 9 is a timing diagram illustrating the common end 1 of the LCD 800 of the present invention driving the coupling lines $CP_1, CP_3, CP_5 \dots CP_{m-1}$ according to the characteristic of the odd data lines $D_1, D_3, D_5 \dots D_{m-1}$, while FIG. 10 is a timing diagram illustrating the common end 2 of the LCD 800 of the present invention driving the coupling lines $CP_2, CP_4, CP_6 \dots CP_m$ according to the characteristic of the even data lines $D_2, D_4, D_6 \dots D_m$. As shown in FIG. 9, the polarity of the voltage on the common end 1 (compared to the common voltage level) changes the same way as the odd data lines $D_1, D_3, D_5 \dots D_m$ change. When the polarities of the voltages on the odd data lines $D_1, D_3, D_5 \dots D_{m-1}$ are positive (compared to the common voltage level), the polarity of the voltage on the common end 1 is positive, and when the polarities of the voltages on the odd data lines $D_1, D_3, D_5 \dots D_{m-1}$ are negative (compared to the common voltage level), the polarity of the voltage on the common end 1 is negative. As shown in FIG. 10, the polarity of the voltage on the common end 2 (compared to the common voltage level) changes the same way as the even data lines $D_2, D_4, D_6 \dots D_m$ change. When the polarities of the voltages on the even data lines $D_2, D_4, D_6 \dots D_m$ are positive (compared to the common voltage level), the polarity of the voltage on the common end 2 is positive, and when the polarities of the voltages on the even data lines $D_2, D_4, D_6 \dots D_m$ are negative (compared to the common voltage level), the polarity of the voltage on the common end 2 is negative.

Referring to FIGS. 11 and 12, FIG. 11 is a diagram illustrating the coupling lines CP_1 and CP_2 disposed at sides of the data line D_2 for data compensating, while FIG. 12 is a timing diagram illustrating voltages on the coupling lines CP_1 and CP_2 . As shown in FIG. 11, the parasitic capacitors generated by the coupling line CP_1 respectively affect the pixels $P_{12}, P_{32}, P_{52}, P_{72}, P_{92}, P_{112} \dots$ and so on, and the parasitic capacitors generated by the coupling line CP_2 respectively affect the pixels $P_{22}, P_{42}, P_{62}, P_{82}, P_{102}, P_{122} \dots$ and so on. As shown in FIG. 12, when the gate driving signal on the gate line G_2 is turned on, the pixel P_{22} is coupled to the data line D_2 for transmitting the data on the data line D_2 to the pixel P_{22} . Meanwhile, the voltage on the data line D_2 is changing from negative to positive (as shown in FIG. 11, the voltage on the data line D_2 is negative at the period when the gate driving signal on the gate line G_1 is turned on). Therefore, the voltage on the coupling line CP_2 is also positive to help the data line D_2 so as to hurry the pixel P_{22} to the predetermined voltage level. When the gate driving signal on the gate line G_3 is turned on, the pixel P_{32} is coupled to the data line D_2 for transmitting the data on the data line D_2 to the pixel P_{32} . Meanwhile, the voltage on the data line D_2 is changing from positive to positive (as shown in FIG. 11, the voltage on the data line D_2 is positive at the period when the gate driving signal on the gate line G_2 is turned on). Therefore, the voltage on the coupling line CP_1 is negative to help the data line D_2 so as to avoid the pixel P_{32} exceeding the predetermined voltage level. When the gate driving signal on the gate line G_4 is turned on, the pixel P_{42} is coupled to the data line D_2 for transmitting the data on the data line D_2 to the pixel P_{42} .

Meanwhile, the voltage on the data line D_2 is changing from positive to negative (as shown in FIG. 11, the voltage on the data line D_2 is positive at the period when the gate driving signal on the gate line G_3 is turned on). Therefore, the voltage on the coupling line CP_2 is negative so that the data line D_2 may accelerate the pixel P_{42} to reach the predetermined voltage level. When the gate driving signal on the gate line G_5 is turned on, the pixel P_{52} is coupled to the data line D_2 for transmitting the data on the data line D_2 to the pixel P_{52} . Meanwhile, the voltage on the data line D_2 is changing from negative to negative (as shown in FIG. 11, the voltage on the data line D_2 is negative at the period when the gate driving signal on the gate line G_4 is turned on). Therefore, the voltage on the coupling line CP_1 is positive to help the data line D_2 so as to avoid the pixel P_{52} exceeding the predetermined voltage level. The operations of the rest of the pixels can be inferred by the described above. It is known by the description above that the driving characteristics of the coupling line CP_1 is same as that of the data line D_1 , and the driving characteristics of the coupling line CP_2 is same as that of the data line D_2 . It is further explained that the coupling lines $CP_1, CP_3, CP_5 \dots CP_{m-1}$ are disposed near the odd data lines $D_1, D_3, D_5 \dots D_{m-1}$ and the coupling lines $CP_1, CP_3, CP_5 \dots CP_{m-1}$ are coupled to a common end 1 having same driving characteristics as the odd data lines $D_1, D_3, D_5 \dots D_{m-1}$, and the coupling lines $CP_2, CP_4, CP_6 \dots CP_m$ are disposed near the even data lines $D_2, D_4, D_6 \dots D_m$ and the coupling lines $CP_2, CP_4, CP_6 \dots CP_m$ are coupled to a common end 2 having same driving characteristics as the even data lines $D_2, D_4, D_6 \dots D_m$. In this way, driving ability of each data line is efficiently enhanced and the LCD 800 has better data compensating function, which improves the problem of color difference in strip shape.

FIG. 13 is a flowchart illustrating the method of displaying frames according to the LCD with data compensation function of the present invention. The step 1301 determines if the compensation is needed. If not, the frame is directly displayed (step 1304). If so, the step 1302 is executed onto the plurality of first data lines and the step 1303 is executed onto the plurality of second data lines. In step 1302, a first voltage is adjusted according to the first data, thus the common end 1 carries the first voltage, and then the first voltage is transmitted to the coupling lines ($CP_1, CP_3, CP_5 \dots CP_{m-1}$) corresponding to the plurality of the first data lines so that the corresponding coupling lines carry the first voltage and generate capacitor coupling effect for compensating the plurality of the first data lines. In step 1303, a second voltage is adjusted according to the second data, thus the common end 2 carries the second voltage, and then the second voltage is transmitted to the coupling lines ($CP_2, CP_4, CP_6 \dots CP_m$) corresponding to the plurality of the second data lines so that the corresponding coupling lines carry the second voltage and generate capacitor coupling effect for compensating the plurality of the second data lines. After finishing the steps 1302 and 1303, the compensated frame is displayed (step 1304). Additionally, the step 1302 comprises adjusting the first voltage to be higher/lower than a predetermined voltage level when the first data is higher/lower than the predetermined voltage level so as to compensate the first data lines, and the step 1303 comprises adjusting the second voltage to be higher/lower than a predetermined voltage level when the second data is higher/lower than the predetermined voltage level so as to compensate the second data lines.

While the invention has been described by way of example and in terms of the preferred embodiment, it is to be understood that the invention is not limited to the disclosed embodiments. To the contrary, it is intended to cover various modi-

fications and similar arrangements as would be apparent to those skilled in the art. Therefore, the scope of the appended claims should be accorded the broadest interpretation so as to encompass all such modifications and similar arrangements.

What is claimed is:

1. A liquid crystal display (LCD) with data compensating function comprising:

- a plurality of gate lines;
- a plurality of first data lines for transmitting first data;
- a plurality of second data lines for transmitting second data;
- a pixel array comprising a plurality of pixels wherein the plurality of the pixels are interwoven by the gate lines, the plurality of the first data lines, and the plurality of the second data lines;
- a first common end carrying a first voltage;
- a second common end carrying a second voltage;
- a plurality of first coupling lines near the plurality of the first data lines coupled to the first common end, for transmitting a first compensation data with a first polarity disposed between the first data lines and the second data lines and arranged along the first data lines; and
- a plurality of second coupling lines near the plurality of the second data lines coupled to the second common end, for transmitting a second compensation data with a second polarity disposed between the second data lines and the first data lines and arranged along the second data lines; wherein the first and second coupling lines are electrically isolated from the pluralities of first and second data lines at all time and the first compensation data and the second compensation data have different polarity.

2. The LCD of claim 1, wherein one of the first data lines is coupled to at least one column of pixels of the pixel array, and one of the second data lines is coupled to at least one column of pixels of the pixel array.

3. The LCD of claim 2, wherein when a first data voltage is higher than a predetermined voltage level, the first voltage is adjusted to be higher than the predetermined voltage level to compensate the plurality of the first data lines.

4. The LCD of claim 2, wherein when the first data voltage is lower than a predetermined voltage level, the first voltage is adjusted to be lower than the predetermined voltage level to compensate the plurality of the first data lines.

5. A method for compensating data of an LCD, the LCD comprising a plurality of gate lines, a plurality of first data lines, a plurality of second data lines, a pixel array, a first common end, a second common end, a plurality of first coupling lines, and a plurality of second coupling lines, the plurality of the first data lines transmitting first data, the plurality of the second data lines transmitting second data, the pixel array comprising a plurality of pixels, wherein the plurality of pixels are interwoven by the plurality of the gate lines, the plurality of the first data lines, and the plurality of the second data lines, the first coupling lines coupled to the first common end near the plurality of the first data lines, the second coupling lines coupled to the second common end near the plurality of the second data lines, the first and second coupling lines electrically isolated from the pluralities of first and second data lines at all time, the first common end carrying a first voltage, the second common end carrying a second voltage, the first common end electrically isolated to the second common end at all time, the method comprising:

- transmitting a first compensation data with a first polarity disposed between the first data lines and the second data lines;
- adjusting the first voltage to compensate the plurality of the first data lines according to the first data;

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transmitting a second compensation data with a second polarity disposed between the second data lines and the first data lines and arrange along the second data lines; and

adjusting the second voltage to compensate the plurality of the second data lines according to the second data; wherein the first compensation data and the second compensation data have different polarity.

6. The method of claim 5, wherein adjusting the first voltage to compensate the plurality of the first data lines according to the first data comprises when a first data voltage is higher than a predetermined voltage level, adjusting the first voltage to be higher than the predetermined voltage level to compensate the plurality of the first data lines.

7. The method of claim 5, wherein adjusting the first voltage to compensate the plurality of the first data lines according to the first data comprises when a first data voltage is lower than a predetermined voltage level, adjusting the first voltage to be lower than the predetermined voltage level to compensate the plurality of the first data lines.

8. The method of claim 5, wherein adjusting the second voltage to compensate the plurality of the second data lines

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according to the second data comprises when a second data voltage is higher than a predetermined voltage level, adjusting the second voltage to be higher than the predetermined voltage level to compensate the plurality of the second data lines.

9. The method of claim 5, wherein adjusting the second voltage to compensate the plurality of the second data lines according to the second data comprises when a second data voltage is lower than a predetermined voltage level, adjusting the second voltage to be lower than the predetermined voltage level to compensate the plurality of the second data lines.

10. The LCD of claim 1, wherein the first data and the second data have different polarity, the first data lines and the first compensation data have same polarity, and the second data lines and the second compensation data have same polarity.

11. The method of claim 5, wherein the first data and the second data have different polarity, the first data lines and the first compensation data have same polarity, and the second data lines and the second compensation data have same polarity.

* * * * *

专利名称(译)	具有数据补偿功能的液晶显示器和利用隔离耦合线补偿数据的方法		
公开(公告)号	US8217882	公开(公告)日	2012-07-10
申请号	US11/954241	申请日	2007-12-12
[标]申请(专利权)人(译)	闻一CHIEN 洪智MAO		
申请(专利权)人(译)	闻一CHIEN 洪智, 毛		
当前申请(专利权)人(译)	友达光电.		
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摘要(译)

一种具有数据补偿功能的液晶显示器，包括多条栅极线，多条第一数据线，多条第二数据线，像素阵列，第一公共端，第二公共端，多条第一耦合线，和多个第二连接线。第一耦合线对应地设置在第一数据线附近，并且耦合到第一公共端。第二耦合线对应地设置在第二数据线附近，并且耦合到第二公共端。第一公共端承载与用于驱动第一耦合线的第一数据线具有相同极性的电压。第二公共端承载与第二数据线的极性相同的电压，用于驱动第二耦合线。第一公共端与第二公共端隔离。

