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(54) LIQUID CRYSTAL DISPLAY DEVICE AND DRIVING METHOD THEREOF

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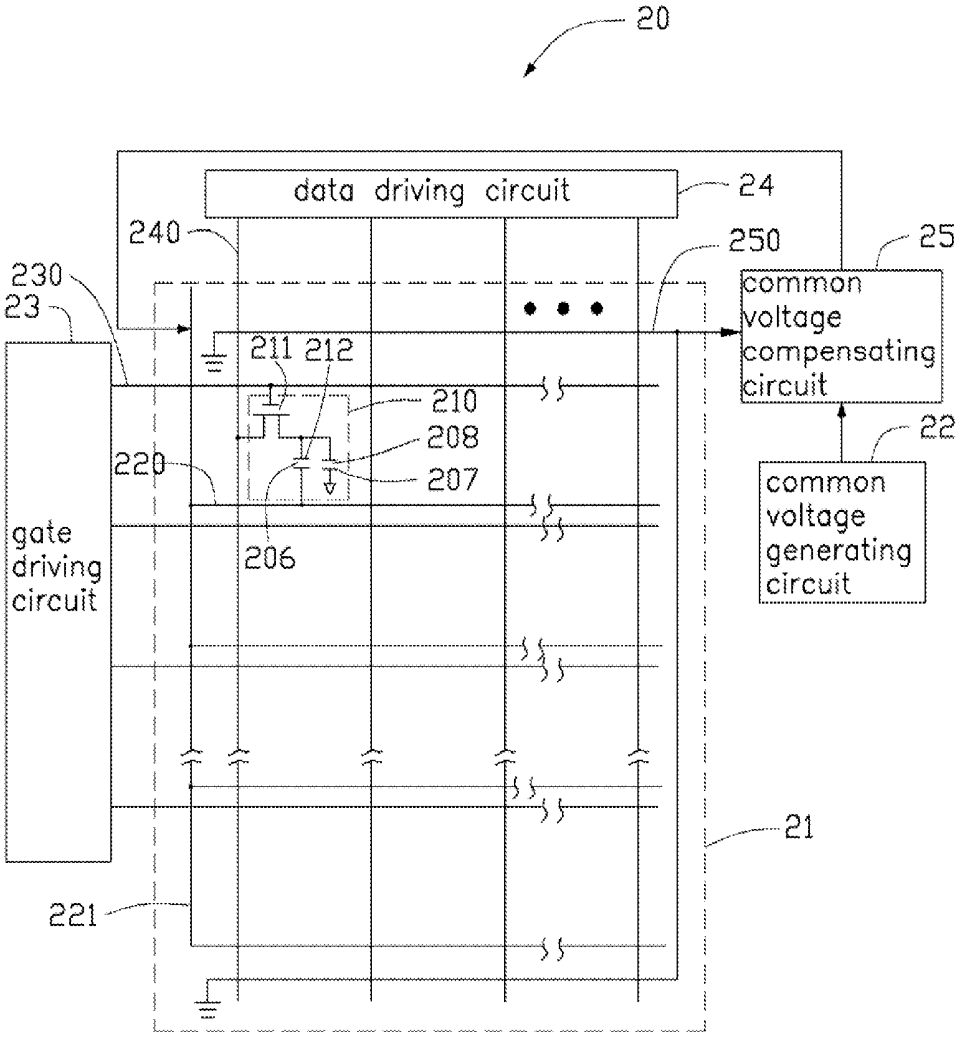
(52) U.S. Cl. 345/211; 345/98

(57) ABSTRACT

A liquid crystal display (LCD) device includes a common voltage generating circuit, a common voltage compensating circuit, and a liquid crystal panel. The liquid crystal panel includes gate lines parallel to each other, data lines isolated from and intersecting with the gate lines, common voltage lines parallel to the gate lines, and a coupling line isolated from and intersecting with the data lines. A method for driving the LCD device includes the common voltage compensating circuit generating and providing an original common voltage and the coupling line generating a feedback signal when data signals on the plurality of data lines change. The common voltage compensating circuit generates a compensating signal according to the feedback signal and compensates the original common voltage, and outputs a compensated common voltage to the common voltage lines.



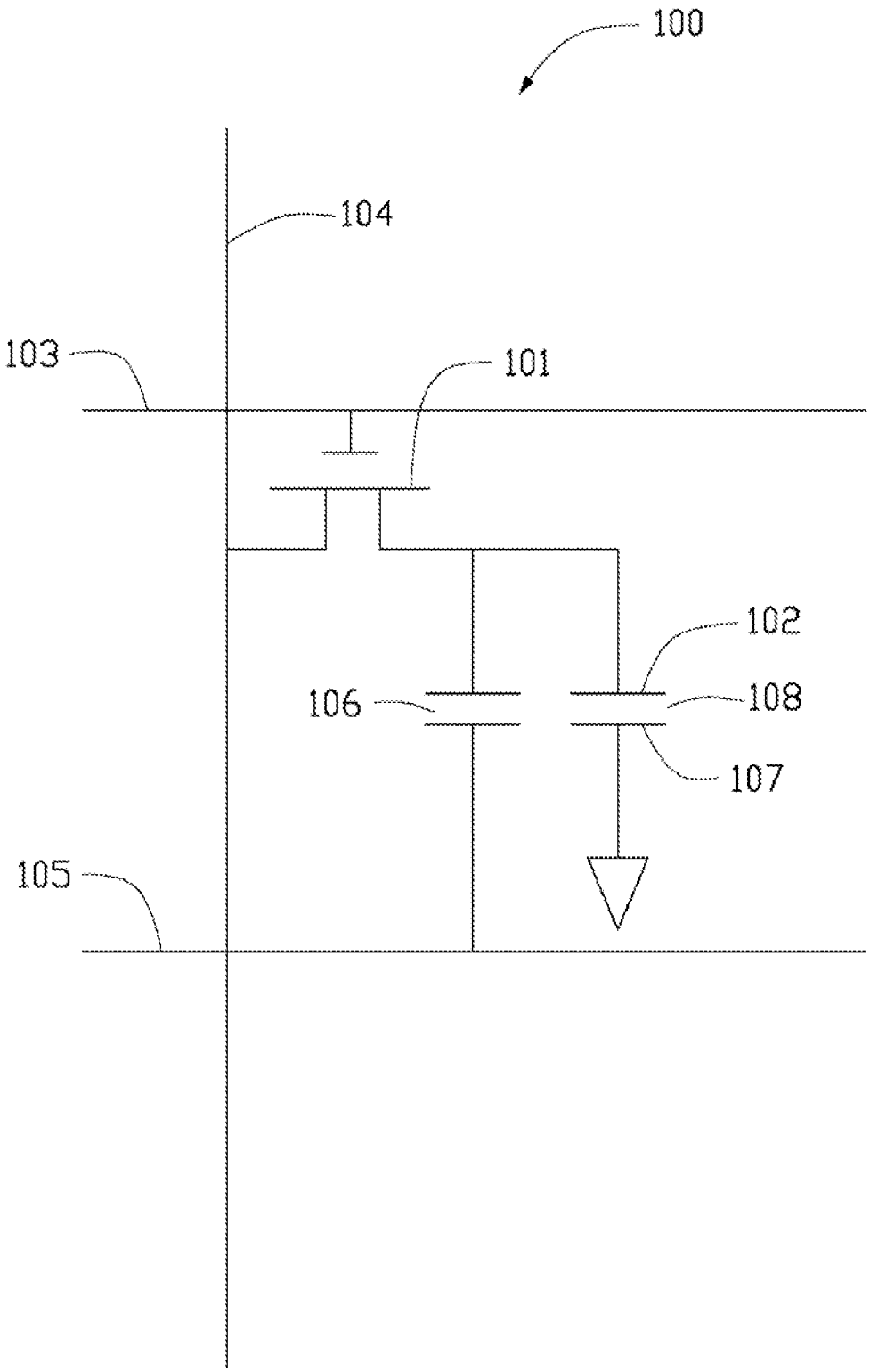


FIG. 1
(RELATED ART)

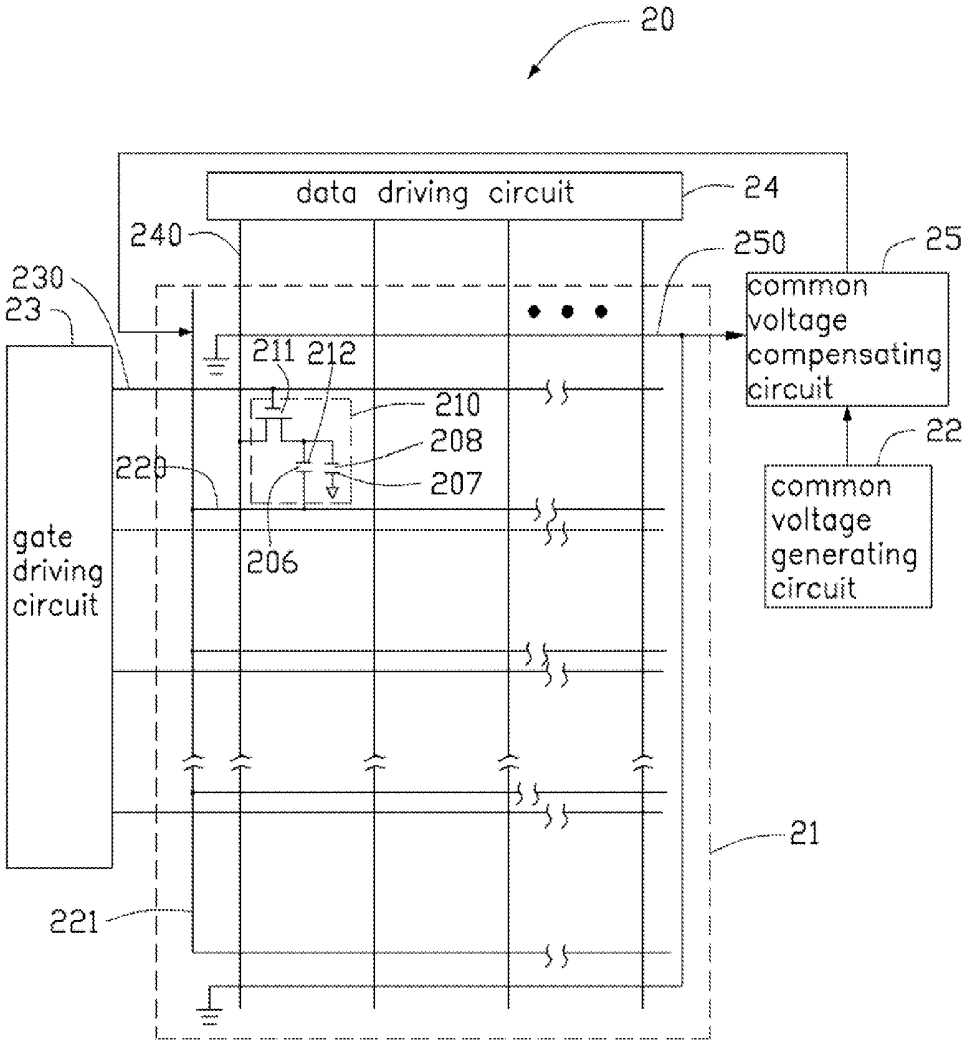

20
data driving circuit
24
240
250
25
230
23
common voltage compensating circuit
211 212
210
208
207
220
22
common voltage generating circuit
gate driving circuit
206
21
221

FIG. 2

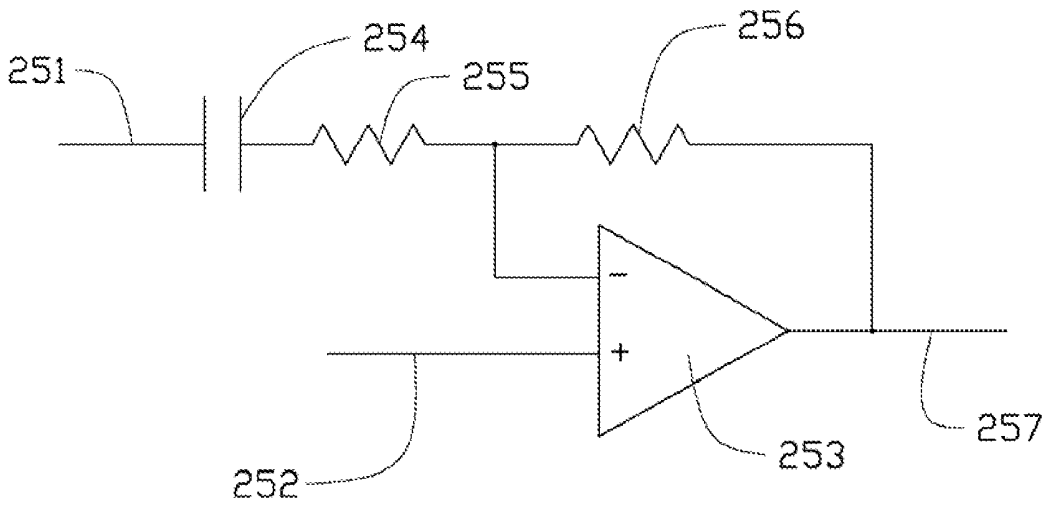


FIG. 3

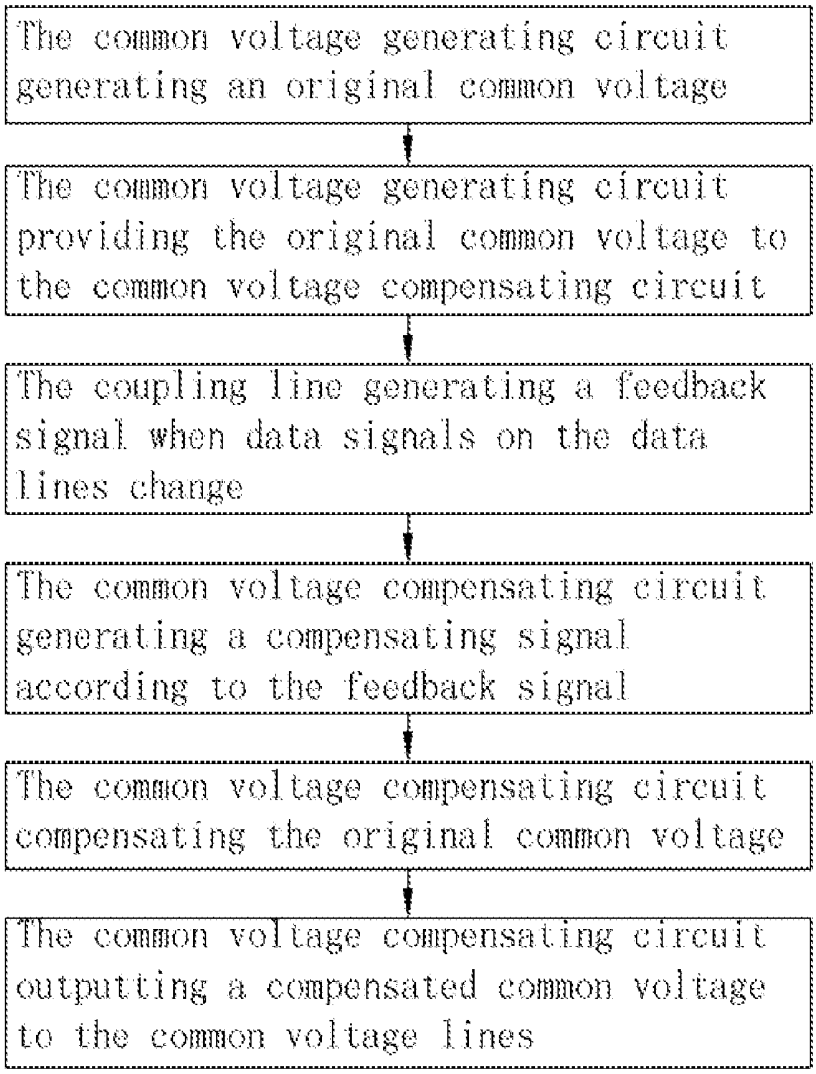

The common voltage generating circuit generating an original common voltage
The common voltage generating circuit providing the original common voltage to the common voltage compensating circuit
The coupling line generating a feedback signal when data signals on the data lines change
The common voltage compensating circuit generating a compensating signal according to the feedback signal
The common voltage compensating circuit compensating the original common voltage
The common voltage compensating circuit outputting a compensated common voltage to the common voltage lines

FIG. 4

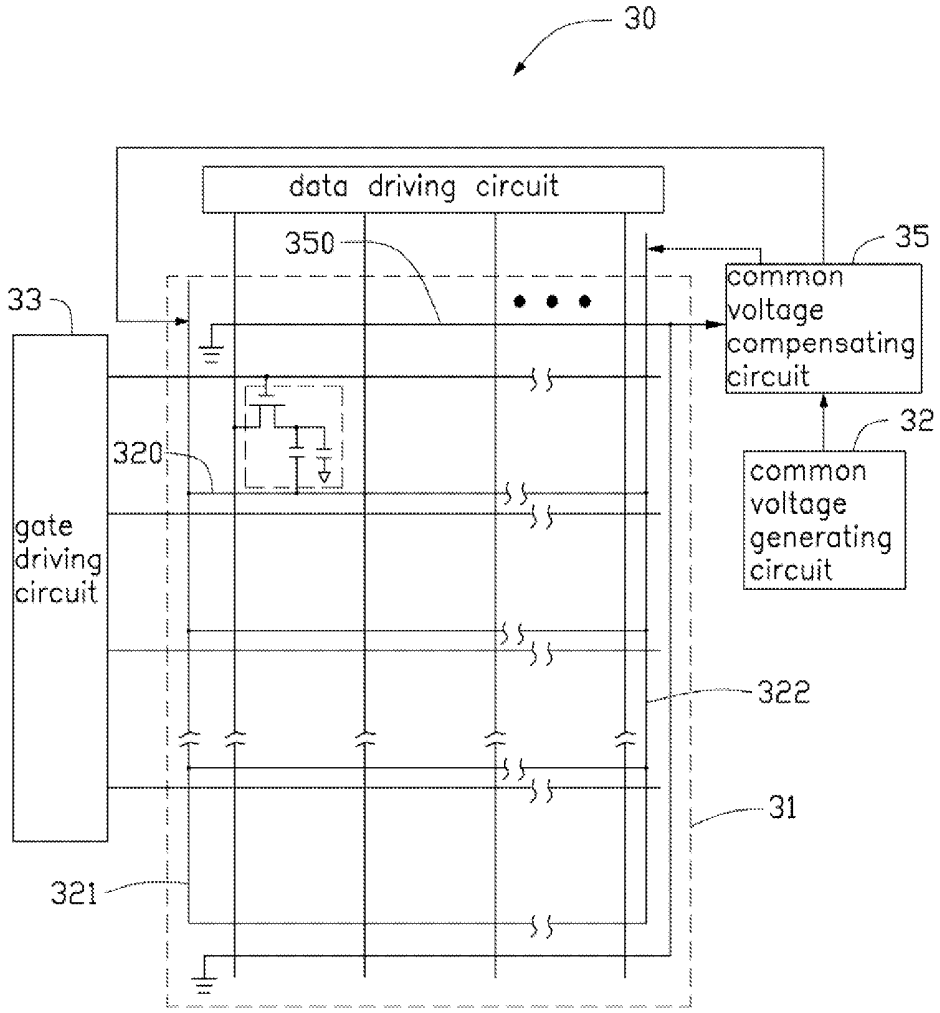

30
data driving circuit
350
35
common voltage compensating circuit
33
32
common voltage generating circuit
320
gate driving circuit
322
31
321

FIG. 5

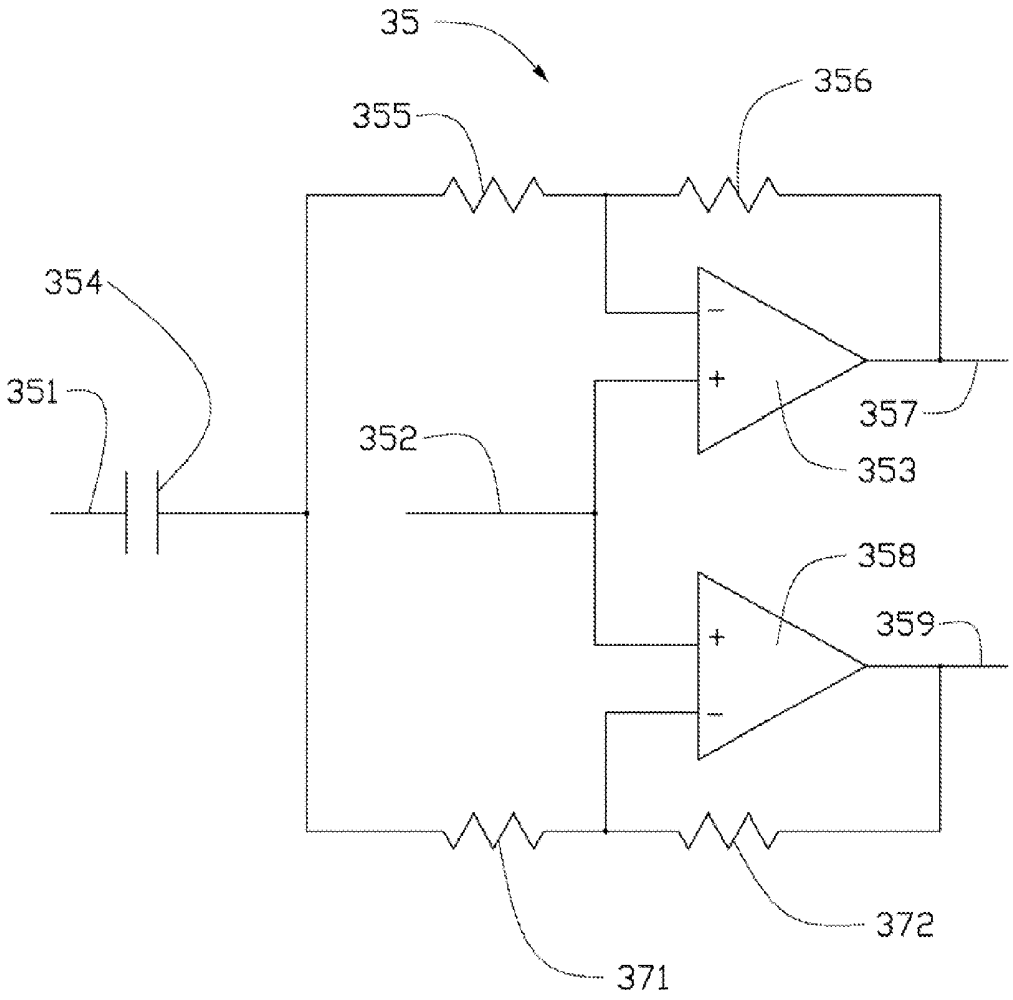


FIG. 6

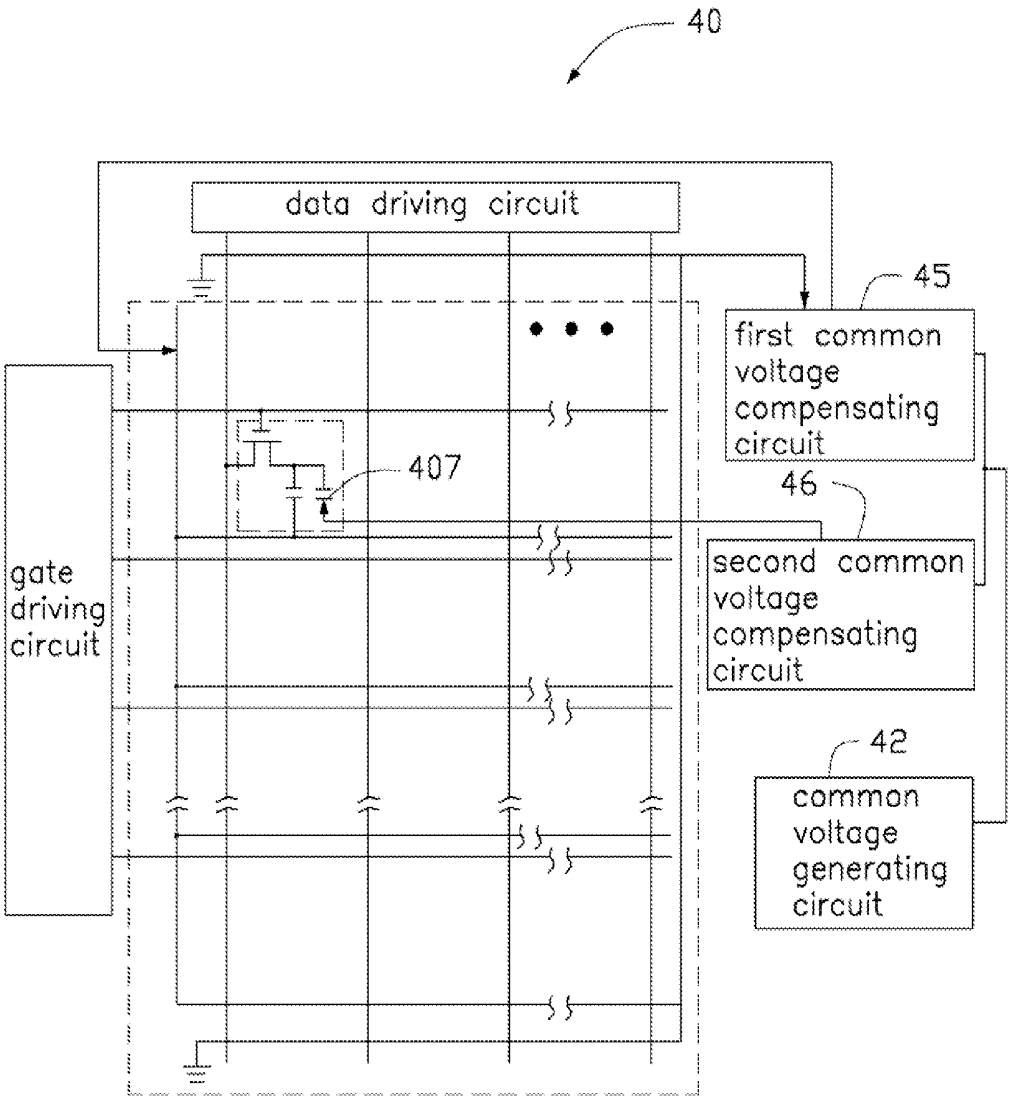

40
data driving circuit
45
first common voltage compensating circuit
407
46
second common voltage compensating circuit
gate driving circuit
42
common voltage generating circuit

FIG. 7

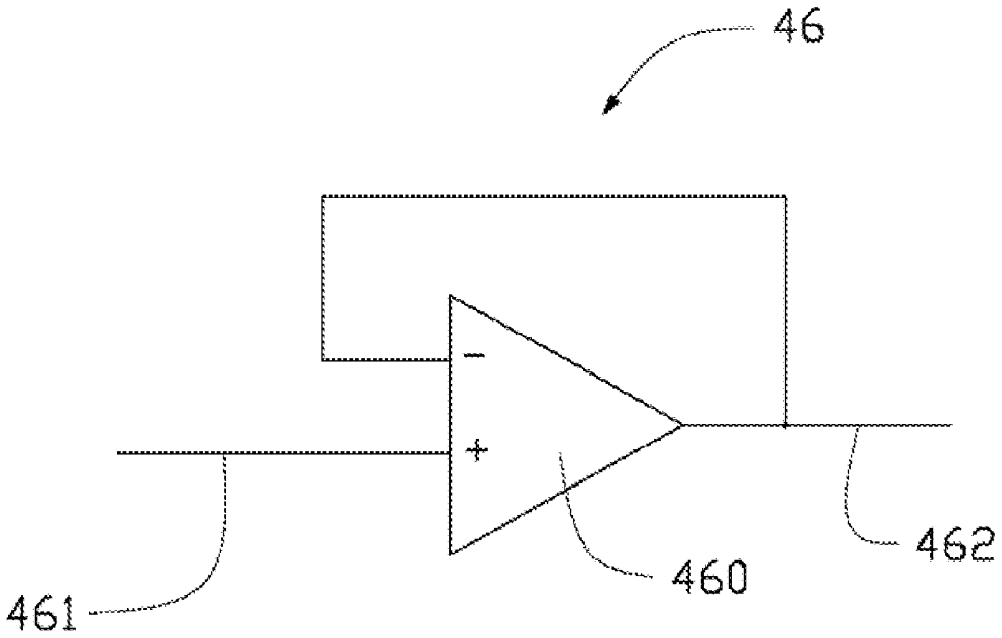


FIG. 8

LIQUID CRYSTAL DISPLAY DEVICE AND DRIVING METHOD THEREOF

BACKGROUND

[0001] 1. Technical Field

[0002] The present disclosure generally relates to display devices, and particularly to a liquid crystal display (LCD) device and a driving method for the LCD device.

[0003] 2. Description of Related Art

[0004] Commonly used LCD devices have the advantages of portability, low power consumption, and low radiation, and are widely used in various electronic devices such as notebooks, personal digital assistants (PDAs), video cameras, televisions, and others. Usually, an LCD device includes a liquid crystal panel to display images. The liquid crystal panel includes a plurality of common voltage lines, a plurality of gate lines, a plurality of data lines, and a plurality of pixel units defined by the gate lines and the data lines.

[0005] Referring to FIG. **1**, a schematic circuit diagram of a pixel unit of a typical LCD device is shown. The pixel unit **100** includes a thin film transistor (TFT) **101** and a pixel electrode **102**. A gate electrode of the TFT **101** is connected to a corresponding gate line **103**, a source electrode of the TFT **101** is connected to a corresponding data line **104**, and a drain electrode of the TFT **101** is connected to the pixel electrode **102**. The pixel electrode **102**, a common voltage line **105** corresponding to the pixel unit **100**, and an insulating layer (not labeled) therebetween cooperatively form a storage capacitor **106**. The pixel electrode **102**, a common electrode **107**, and a liquid crystal layer (not labeled) therebetween cooperatively form a liquid crystal capacitor **108**.

[0006] When the LCD device displays a frame of image, a common voltage is provided to the common electrode **107** and the common voltage line **105**. When a gate signal is provided to the gate line **103** to turn on the TFT **101**, a data signal is provided to the pixel electrode **102** via the data line **104** and the activated TFT **101**, and the liquid crystal capacitor **108** and the storage capacitor **106** charge. After the liquid crystal capacitor **108** and the storage capacitor **106** are charged, a gray voltage is held between the common electrode **107** and the pixel electrode **102** until another gate signal is provided in a successive frame. In an electric field generated by the gray voltage, liquid crystal molecules of the liquid crystal layer twist to control a transmissive amount of light beams to display the image.

[0007] However, the common voltage line **105** and the gate line **103** are usually formed on the same layer during manufacture of the LCD device, and the insulating layer is formed between the layer of the common voltage line **105** and a layer of the data line **104**. A parasitic capacitor is formed by the common voltage line **105**, the data line **104**, and the insulating layer therebetween. When the data signal changes on the data line **104**, the common voltage on the common voltage line **105** can be disturbed due to the parasitic capacitor. Therefore, crosstalk is generated, distorting the image displayed on the LCD device.

[0008] What is needed, therefore, is an LCD device and a driving method thereof which can overcome the described limitations.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] The components in the drawings are not necessarily drawn to scale, the emphasis instead being placed upon clearly illustrating the principles of the present disclosure. Moreover, in the drawings, like reference numerals designate corresponding parts throughout the several views, and all the views are schematic.

[0010] FIG. **1** is a schematic circuit diagram of a pixel unit of a commonly used LCD device.

[0011] FIG. **2** is a schematic circuit diagram of a first embodiment of an LCD device, the LCD device including a common voltage compensating circuit.

[0012] FIG. **3** is a schematic circuit diagram of the common voltage compensating circuit of FIG. **2**.

[0013] FIG. **4** is a flow chart of a method for driving the LCD device of FIG. **2**.

[0014] FIG. **5** is a schematic circuit diagram of a second embodiment of an LCD device, the LCD device including a common voltage compensating circuit.

[0015] FIG. **6** is a schematic circuit diagram of the common voltage compensating circuit of FIG. **5**.

[0016] FIG. **7** is a schematic circuit diagram of a third embodiment of an LCD device, the LCD device including a second common voltage compensating circuit.

[0017] FIG. **8** is a schematic circuit diagram of the second common voltage compensating circuit of FIG. **7**.

DETAILED DESCRIPTION

[0018] Reference will now be made to the drawings to describe various embodiments in detail.

[0019] Referring to FIG. **2**, a schematic circuit diagram of a first embodiment of an LCD device **20** is shown. The LCD device **20** includes a liquid crystal panel **21**, a common voltage generating circuit **22**, a gate driving circuit **23**, a data driving circuit **24**, and a common voltage compensating circuit **25**.

[0020] The liquid crystal panel **21** includes a plurality of gate lines **230** parallel to each other, a plurality of data lines **240** isolated from and intersecting with the gate lines **230**, a plurality of pixel units **210** defined by the gate lines **230** and the data lines **240**, a plurality of common voltage lines **220** alternately disposed with and parallel to the gate lines **230**, a common voltage supply line **221**, and a coupling line **250**.

[0021] Each pixel unit **210** includes a TFT **211** and a pixel electrode **212**. A gate electrode of the TFT **211** is connected to a corresponding gate line **230**, a source electrode of the TFT **211** is connected to a corresponding data line **240**, and a drain electrode of the TFT **211** is connected to the pixel electrode **212**. The pixel electrode **212**, a corresponding common voltage line **220**, and an insulating layer (not labeled) therebetween cooperatively form a storage capacitor **206**. The pixel electrode **212**, a common electrode **207**, and a liquid crystal layer (not labeled) therebetween cooperatively form a liquid crystal capacitor **208**.

[0022] The gate lines **230** are connected to the gate driving circuit **23** to receive gate signals output therefrom. The data lines **240** are connected to the data driving circuit **24** to receive data signals output therefrom. The common voltage supply line **221** is connected to the common voltage generating circuit **22** via the common voltage compensating circuit **25**. The common voltage supply line **221** receives a common voltage output from the common voltage generating circuit **22** and compensated by the common voltage compensating circuit **25**, and provides the common voltage to the common voltage lines **220**. The common voltage supply line **221** may be disposed on a side of the liquid crystal panel **21** and parallel to the data lines **240**. The coupling line **250** is disposed at a

side of the data driving circuit **24** adjacent to the gate lines **230**, and is isolated from and intersects with the data lines **240**. One terminal of the coupling line **250** is connected to the common voltage compensating circuit **25**, and the other terminal of the coupling line **250** is grounded. The other terminal of the coupling line **250** also may be chosen to be floated or connected to a constant voltage source. Coupling capacitors (not shown) are formed between the coupling line **250** and the data lines **240**. When the data signals output from the data driving circuit **24** change, the coupling line **250** provides a feedback signal to the common voltage compensating circuit **25** by utilizing the coupling capacitors.

[0023] Referring also to FIG. **3**, a schematic circuit diagram of the common voltage compensating circuit **25** is shown. The common voltage compensating circuit **25** includes a first input terminal **251**, a second input terminal **252**, an operational amplifier **253**, a capacitor **254**, a first resistor **255**, a second resistor **256**, and an output terminal **257**. An inverting terminal of the operational amplifier **253** is connected to the first input terminal **251** via the first resistor **255** and the capacitor **254** in that order, and is also connected to the output terminal **257** via the second resistor **256**. A non-inverting terminal of the operational amplifier **253** is connected to the second input terminal **252**. An output of the operational amplifier **253** is connected to the output terminal **257**. The first input terminal **251** is connected to the coupling line **250** to receive the feedback signal generated by the coupling line **250**. The second input terminal **252** is connected to the common voltage generating circuit **22** to receive an original common voltage generated by the common voltage generating circuit **22**. The output terminal **257** outputs the common voltage compensated by the common voltage compensating circuit **25** to the common voltage supply line **221**.

[0024] Referring to FIG. **4**, a method for driving the LCD **20** is shown. The method includes: the common voltage generating circuit **22** generating an original common voltage; the common voltage generating circuit **22** providing the original common voltage to the common voltage compensating circuit **25**; the coupling line **250** generating a feedback signal when data signals on the data lines **240** change; the common voltage compensating circuit **25** generating a compensating signal according to the feedback signal; the common voltage compensating circuit **25** compensating the original common voltage; and the common voltage compensating circuit **25** outputting a compensated common voltage to the common voltage lines **220**.

[0025] That is, when the LCD device **20** displays an image, the gate driving circuit **23** generates a plurality of gate signals, and successively provides the gate signals to the gate lines **230**. When a gate line **230** receives a corresponding gate signal, a row of TFTs **211** connected to the gate line **230** is turned on. The data driving circuit **24** provides a data signal to a corresponding pixel unit **212** via a corresponding data line **240** and the corresponding activated TFT **211**. The common voltage generating circuit **22** generates the original common voltage and outputs the original common voltage to the common voltage compensating circuit **25**. The coupling line **250** reflects information of the data signal via the coupling capacitors, and generates and outputs the feedback signal to the common voltage compensating circuit **25**. The feedback signal is provided to the inverting terminal of the operational amplifier **253** via the capacitor **254** and the first resistor **255**, and is modulated to a compensating signal by the first resistor **255**, the second resistor **256**, and the operational amplifier **253**. The compensating signal is loaded on the original common voltage to compensate the original common voltage.

[0026] Then the output terminal **257** of the common voltage compensating circuit **25** outputs the compensated common voltage to the common voltage lines **220** via the common voltage supply line **221**.

[0027] Even though the common voltage on the common voltage lines **220** is affected by parasitic capacitors between the common voltage lines **220** and the data lines **240**, the common voltage is compensated prior thereto by the common voltage compensating circuit **25**. Therefore, the affect of the parasitic capacitors between the common voltage lines **220** and the data lines **240** can be counteracted by the compensating signal according to the feedback signal from the coupling capacitors. Thus, the crosstalk can be eliminated, and the display of the LCD device **20** is unaffected.

[0028] In an alternative embodiment, two or more coupling lines **250** isolated from and intersecting with the data lines **240** can be disposed on the liquid crystal panel **21**. One terminal of the coupling lines **250** is connected to the first input terminal **251** of the common voltage compensating circuit **25**, and the other terminals of the coupling lines **250** are grounded. The other terminals of the coupling lines **250** also may be chosen to be floated or connected to a constant voltage source.

[0029] Referring to FIG. **5**, a schematic circuit diagram of a second embodiment of an LCD device **30** is shown. The LCD device **30** is similar to the LCD device **20**, but includes a first common voltage supply line **321** and a second common voltage supply line **322**. The first common voltage supply line **321** is disposed on a side of the liquid crystal panel **31** adjacent to the gate driving circuit **33**. The second common voltage supply line **322** is disposed on the other side of the liquid crystal panel **31** far away from the gate driving circuit **33**. Two terminals of a plurality of common voltage lines **320** are respectively connected to the first and the second common voltage supply lines **321**, **322**.

[0030] Referring also to FIG. **6**, a schematic circuit diagram of a common voltage compensating circuit **35** of the LCD device **30** is shown. The common voltage compensating circuit **35** includes a first input terminal **351**, a second input terminal **352**, a first operational amplifier **353**, a second operational amplifier **358**, a capacitor **354**, a first resistor **355**, a second resistor **356**, a third resistor **371**, a fourth resistor **372**, a first output terminal **357**, and a second output terminal **359**. An inverting terminal of the first operational amplifier **353** is connected to the first input terminal **351** via the first resistor **355** and the capacitor **354** in that order, and is also connected to the first output terminal **357** via the second resistor **356**. An output of the first operational amplifier **353** is connected to the first output terminal **357**. An inverting terminal of the second operational amplifier **358** is connected to the first input terminal **351** via the third resistor **371** and the capacitor **354** in that order, and is also connected to the second output terminal **359** via the fourth resistor **372**. An output of the second operational amplifier **358** is connected to the second output terminal **359**. Non-inverting terminals of the first and the second operational amplifiers **353**, **358** are connected to the second input terminal **352**. The first input terminal **351** is connected to a coupling line **350** to receive a feedback signal generated by the coupling line **350**. The second input terminal **352** is connected to a common voltage generating circuit **32** to receive an original common voltage generated by the common voltage generating circuit **32**. The first output

terminal **357** outputs a first common voltage compensated by the common voltage compensating circuit **35** to the first common voltage supply line **321**, and the second output terminal **359** outputs a second common voltage compensated by the common voltage compensating circuit **35** to the second common voltage supply line **322**.

[0031] Due to the difference in locations of the first and the second common voltage supply lines **321**, **322** on the liquid crystal panel **31**, common voltages there may also differ. Thus, the resistances of the first, the second, the third, and the fourth resistors **355**, **356**, **371**, **372** can be regulated and preset according to an actual situation, and the common voltages on the first and the second common voltage supply line **321**, **322** can be respectively compensated by the common voltage compensating circuit **35**.

[0032] FIG. **7** is a schematic circuit diagram of a third embodiment of an LCD device **40**, differing from LCD device **20** and LCD device **30** only in the inclusion of a first common voltage compensating circuit **45** and a second common voltage compensating circuit **46**. The first common voltage compensating circuit **45** may be the same as the common voltage compensating circuit **25** of the LCD device **20** or the common voltage compensating circuit **35** of the LCD device **30**.

[0033] Referring also to FIG. **7**, a schematic circuit diagram of the second common voltage compensating circuit **46** is shown. The second common voltage compensating circuit **46** may be a voltage follower, and includes an input terminal **461**, an output terminal **462**, and an operational amplifier **460**. An output of the operational amplifier **460** is connected to the output terminal **462**, and is also connected to an inverting terminal of the operational amplifier **460**. A non-inverting terminal of the operational amplifiers **460** is connected to the input terminal **461** to receive an original common voltage output from a common voltage generator **42**. The second common voltage compensating circuit **46** outputs a steady common voltage to a common electrode **407**.

[0034] It is believed that the present embodiments and their advantages will be understood from the foregoing description, and it will be apparent that various changes may be made thereto without departing from the spirit and scope of the embodiments or sacrificing all of their material advantages.

What is claimed is:

1. A liquid crystal display (LCD) device, comprising:

a common voltage generating circuit to generate an original common voltage;

a first common voltage compensating circuit to compensate the original common voltage; and

a liquid crystal panel, comprising:

a plurality of gate lines parallel to each other;

a plurality of data lines isolated from and intersecting with the plurality of gate lines;

a plurality of common voltage lines parallel to the plurality of gate lines; and

a coupling line isolated from and intersecting with the plurality of data lines to provide a feedback signal to the first common voltage compensating circuit;

wherein the first common voltage compensating circuit receives the feedback signal, generates a compensation signal according to the feedback signal to compensate an original common voltage, and outputs a first compensated common voltage to the plurality of common voltage lines.

2. The LCD device of claim **1**, wherein coupling capacitors are formed between the coupling line and the data lines, and the coupling line provides the feedback signal to the first common voltage compensating circuit when data signals on the plurality of data lines change, the feedback signal reflecting information of the data signals on the plurality of data lines via the coupling capacitors.

3. The LCD device of claim **2**, wherein the coupling capacitors between the coupling line and the data lines generate the feedback signal to the first common voltage compensating circuit, the first common voltage compensating circuit in turn adds the compensation signal to the original common voltage, substantially counteracting an effect of parasitic capacitors between the plurality of common voltage lines and the plurality of data lines on the common voltage.

4. The LCD device of claim **3**, wherein the first common voltage compensating circuit comprises a first input terminal, a second input terminal, an operational amplifier, a first resistor, a second resistor, and an output terminal, wherein an inverting terminal of the operational amplifier is connected to the first input terminal via the first resistor and also to the output terminal via the second resistor, a non-inverting terminal of the operational amplifier is connected to the second input terminal, an output of the operational amplifier is connected to the output terminal, the first input terminal is connected to the coupling line to receive the feedback signal, the second input terminal is connected to the common voltage generating circuit to receive the original common voltage, and the output terminal outputs the first compensated common voltage to the plurality of common voltage lines.

5. The LCD device of claim **4**, wherein the first common voltage compensating circuit further comprises a capacitor connected between the first input terminal and the first resistor.

6. The LCD device of claim **4**, wherein the liquid crystal panel further comprises a common voltage supply line connected to the plurality of common voltage lines, and the first common voltage compensating circuit provides the first compensated common voltage to the plurality of common voltage lines via the common voltage supply line.

7. The LCD device of claim **3**, wherein the liquid crystal panel further comprises a first common voltage supply line and a second common voltage supply line respectively connected to two terminals of the plurality of common voltage lines.

8. The LCD device of claim **7**, wherein the first common voltage compensating circuit comprises a first input terminal, a second input terminal, a first operational amplifier, a second operational amplifier, a first resistor, a second resistor, a third resistor, a fourth resistor, a first output terminal, and a second output terminal, wherein an inverting terminal of the first operational amplifier is connected to the first input terminal via the first resistor and also to the first output terminal via the second resistor, an output of the first operational amplifier is connected to the first output terminal, an inverting terminal of the second operational amplifier is connected to the first input terminal via the third resistor and also to the second output terminal via the fourth resistor, an output of the second operational amplifier is connected to the second output terminal, non-inverting terminals of the first and the second operational amplifiers are connected to the second input terminal, the first input terminal is connected to the coupling line to receive the feedback signal, the second input terminal is connected to the common voltage generating circuit to receive the original common voltage, the first output terminal outputs the first compensated common voltage to the first common voltage

supply line, and the second output terminal outputs a second compensated common voltage to the second common voltage supply line.

9. The LCD device of claim **8**, wherein the first common voltage compensating circuit further comprises a capacitor connected between the first input terminal and the first resistor and also between the first input terminal and the third resistor.

10. The LCD device of claim **3**, wherein the liquid crystal panel further comprises a plurality of pixel units defined by the plurality of the gate lines and the plurality of the date lines, each pixel unit comprising a pixel electrode, and the pixel electrode, a common electrode, and a liquid crystal layer therebetween forming a liquid crystal capacitor.

11. The LCD device of claim **10**, further comprising a second common voltage compensating circuit, wherein the second common voltage compensating circuit comprises an input terminal and an output terminal, the input terminal receiving the original common voltage output from the common voltage generating circuit, and the output terminal outputting a steady common voltage to the common electrode.

12. The LCD device of claim **11**, wherein the second common voltage compensating circuit is a voltage follower.

13. The LCD device of claim **3**, wherein one terminal of the coupling line is connected to the first common voltage compensating circuit, and the other terminal of the coupling line is grounded or floated.

14. The LCD device of claim **3**, wherein one terminal of the coupling line is connected to the first common voltage compensating circuit, and the other terminal of the coupling line is connected to a constant voltage source.

15. The LCD device of claim **3**, wherein the number of coupling line is more than one.

16. A method for driving a liquid crystal display (LCD) device, the LCD device comprising a common voltage generating circuit, a common voltage compensating circuit, and a liquid crystal panel, the liquid crystal panel comprising a plurality of gate lines parallel to each other, a plurality of data lines isolated from and intersecting with the plurality of gate lines, a plurality of common voltage lines parallel to the plurality of gate lines, and a coupling line isolated from and intersecting with the plurality of data lines, the method comprising:

the common voltage generating circuit generating an original common voltage;

the common voltage generating circuit providing the original common voltage to the common voltage compensating circuit;

the coupling line generating a feedback signal when data signals on the plurality of data lines change;

the common voltage compensating circuit generating a compensating signal according to the feedback signal;

the common voltage compensating circuit compensating the original common voltage; and

the common voltage compensating circuit outputting a compensated common voltage to the plurality of common voltage lines.

17. The method of claim **16**, wherein coupling capacitors are formed between the coupling line and the data lines, and the coupling line provides the feedback signal to the common voltage compensating circuit when data signals on the plurality of data lines change, the feedback signal reflecting information of the data signals on the plurality of data lines via the coupling capacitors.

18. The method of claim **17**, wherein the coupling capacitors between the coupling line and the data lines generate the feedback signal to the common voltage compensating circuit, the common voltage compensating circuit in turn adds the compensation signal to the original common voltage, substantially counteracting the effect of parasitic capacitors between the plurality of common voltage lines and the plurality of data lines on the common voltage.

19. The method of claim **18**, wherein one terminal of the coupling line is connected to the common voltage compensating circuit, and the other terminal of the coupling line is grounded or floated.

20. The method of claim **18**, wherein the LCD device further comprises another common voltage compensating circuit, the liquid crystal panel further comprises a common electrode, and the method further comprises:

the common voltage generating circuit providing the original common voltage to the another common voltage compensating circuit; and

the another common voltage compensating circuit outputting a steady common voltage to the common electrode.

* * * * *

专利名称(译)	液晶显示装置及其驱动方法		
公开(公告)号	US20110102401A1	公开(公告)日	2011-05-05
申请号	US12/844805	申请日	2010-07-27
[标]申请(专利权)人(译)	群康科技(深圳)有限公司 群创光电股份有限公司		
申请(专利权)人(译)	INNOCOM科技（深圳）有限公司. 奇美群创光电		
当前申请(专利权)人(译)	群创光电 INNOCOM科技（深圳）有限公司.		
[标]发明人	FENG SHA		
发明人	FENG, SHA		
IPC分类号	G09G3/36 G06F3/038		
CPC分类号	G09G2320/0209 G09G3/3655		
优先权	200910309171.1 2009-10-30 CN		
外部链接	Espacenet USPTO		

摘要(译)

液晶显示（LCD）装置包括公共电压产生电路，公共电压补偿电路和液晶面板。液晶面板包括彼此平行的栅极线，与栅极线隔离并与栅极线交叉的数据线，与栅极线平行的公共电压线，以及与数据线隔离并与数据线交叉的耦合线。一种用于驱动LCD装置的方法包括：公共电压补偿电路，产生并提供原始公共电压;以及耦合线，当多条数据线上的数据信号改变时，产生反馈信号。公共电压补偿电路根据反馈信号产生补偿信号并补偿原始公共电压，并将补偿后的公共电压输出到公共电压线。