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(54) **DRIVING CIRCUIT FOR UNIT PIXEL OF ORGANIC LIGHT EMITTING DISPLAYS**

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(58) **Field of Search** 315/169.1–169.3; 345/92, 204, 36, 45, 46, 76, 82, 214

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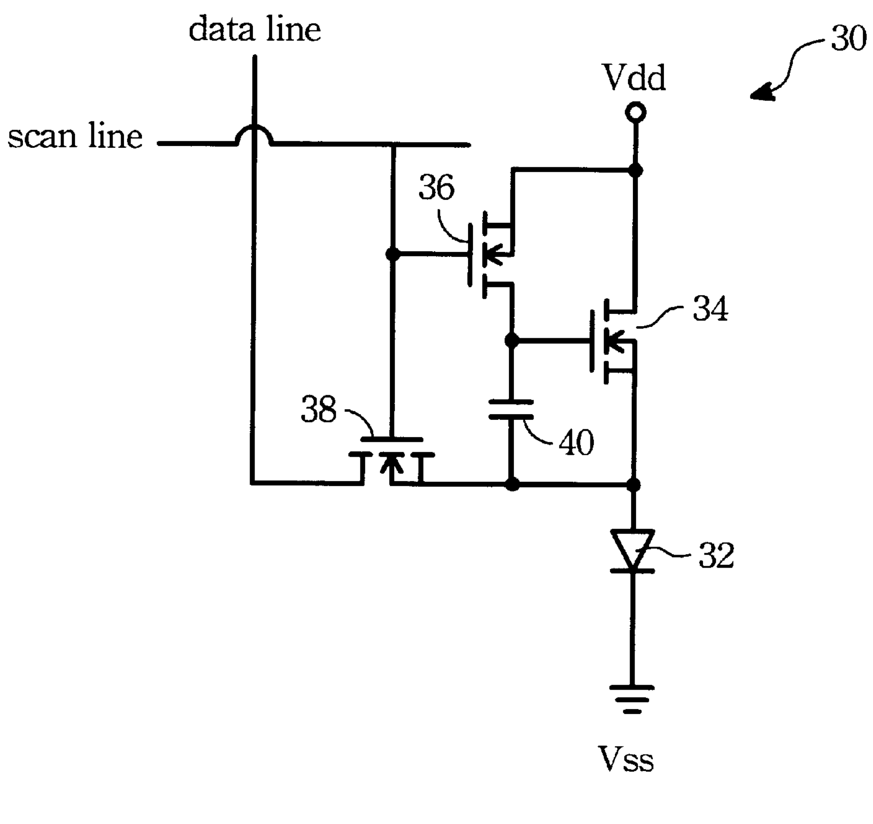
(57) **ABSTRACT**

A driving circuit for an organic light emitting diode comprises the following elements. A driving transistor has a control terminal, a first electrode and a second electrode, wherein the first electrode and the second electrode are connected to a power line and the organic light emitting diode. A first switch device can be turned on by a scan signal to electrically conduct the power line and the control terminal of the driving transistor for maintaining the control terminal at the voltage level of the scan signal. And a second switch device can be turned on by the scan signal to electrically conduct a data line and the second electrode of the driving transistor for transferring the data signal to the second electrode and maintaining the second electrode at the voltage level of the data signal. Thus, by maintaining the control terminal of the driving transistor and the second electrode at the certain levels the operation current of the driving transistor will not affected by the voltage difference between two electrodes of the organic light emitting diode.

12 Claims, 1 Drawing Sheet



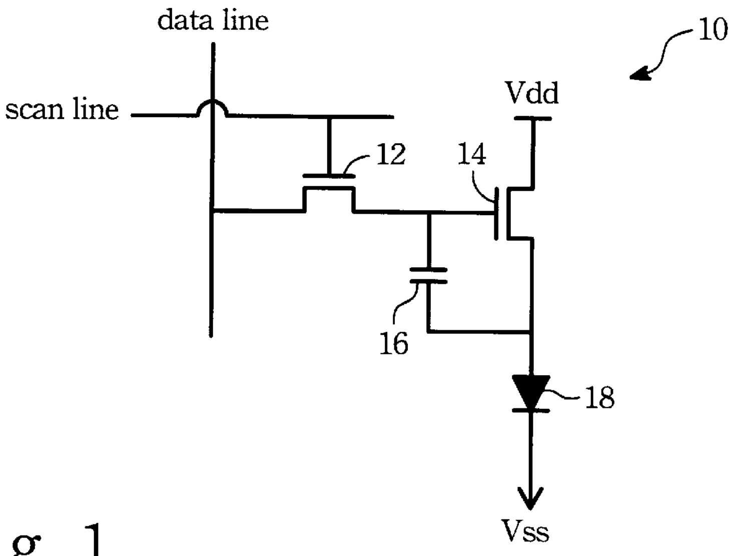


Fig. 1
(Prior Art)

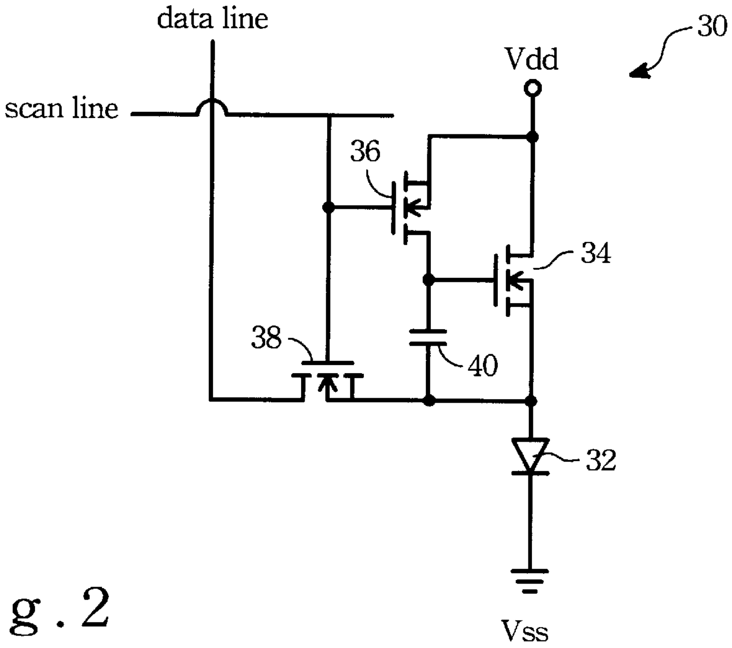


Fig. 2

DRIVING CIRCUIT FOR UNIT PIXEL OF ORGANIC LIGHT EMITTING DISPLAYS

FIELD OF THE INVENTION

The present invention relates to a driving circuit for organic light emitting displays (OLEDs), and more specifically, to a driving circuit applied to drive organic light emitting diodes and amorphous silicon thin film transistors (a-Si TFT) in a unit pixel to prolong lifetime of the OLEDs.

BACKGROUND OF THE INVENTION

With the advance of techniques for manufacturing integrated circuits, the development and progress of electronic science cause various electronic products fabricated with digital and complicated designs. And for the conveniences of portability and utility, these electronic products are designed with smaller appearances, multiple functions and rapid processing rates. Thus, the products of new generation are easy to carry and fit modern life. Especially because the powerful processing ability of multimedia products can handle easily the audio, visual and graphical digital data, the visual displays are widely researched and developed. No matter what kind of electronics, such as PDAs, laptops, walkmans, digital cameras or mobile phones, all need the display panels for viewing and browsing.

In conventional manufacturing processes of displays, because the techniques of thin film transistors are mature, the liquid crystal displays with the advantages of lightweight, lower consumption and non-irradiation are favored and widely used by consumers. However, with the research and development of organic light emitting diodes, the new generation of organic light emitting displays have further advantages of high light-emitting efficiency, high responding rate, power saving, no limitation of viewing angle, lightweight, thinness, brightness and all colors. And by applying the OLEDs the portable electronic products are manufactured with smaller sizes and finest graphic displaying effects.

Please refer to FIG. **1**, a circuit **10** of unit pixel for OLEDs in the prior art is illustrated. The circuit **10** is defined on an amorphous silicon substrate and has two thin film transistors **12**, **14** and a storage capacitor **16** so as to drive an organic light emitting diode **18**. The transistor **12** is briefly served as a switch device of which a drain electrode is connected to a data line, a gate electrode is connected to a scan line and a source electrode is connected to both one terminal of the storage capacitor **16** and the gate electrode. On the other hand, a drain electrode of the transistor **14** is connected to a power line (Vdd). And a source electrode of the transistor **14** and another terminal of the storage capacitor **16** are both connected to a positive terminal of the organic light emitting diode **18**. With regard to a negative terminal of the organic light emitting diode **18** is connected to a power line (Vss).

Thus, the signal from the scan line can turn the transistor **12** on to transfer image data of the data line to the unit pixel. When the transistor **12** is turned on, the data signal on the data line can transfer to the gate of the transistor **14** and be stored in the capacitor **16**. This data signal can also turn the transistor **14** on to transfer the voltage signal of the power line (Vdd) to the positive terminal of the organic light emitting diode **18** for luminescence. The data voltage stored in the capacitor **16** can be applied to keep the transistor **14** turned on while the signal on the scan line turns the transistor **12** off so as to maintain the organic light emitting diode **18** at a certain current level.

However, it is noted that in the above circuit design, the voltage difference V_{OLED} between two terminals of the organic light emitting diode **18** will affect the gate-to-source voltage (Vgs) and the drain current (Id) of the transistor **14** due to the organic light emitting diode **18** is connected directly to the source electrode of the transistor **14**. The current formula is shown as follows:

$$\begin{aligned} Id &= \frac{1}{2} * K(Vgs - Vth)^2 \\ &= \frac{1}{2} * K[Vdata - (V_{OLED} - V_{SS}) - Vth]^2, \end{aligned}$$

In above formula, K is a constant, Vdata is the voltage signal on the data line, and Vth is the threshold voltage of the transistor **14**. After a long time of operation, the voltage difference V_{OLED} between two terminals of the organic light emitting diode **18** will increase so as to reduce the drain current (Id), to decrease the lightness of the organic light emitting diode and to shorten the lifetime of the displays.

SUMMARY OF THE INVENTION

A purpose of the present invention is to provide a unit pixel circuit for OLEDs to prevent the voltage difference between two terminals of the organic light emitting diode from varying and to avoid of reducing the operating current of the driving transistor.

Another purpose of the present invention is to provide a circuit design to prevent from reducing the brightness of the OLEDs and to prolong the lifetime of the displays.

The present invention discloses a driving circuit of an organic light emitting diode. The driving circuit comprises the components as follows. A driving transistor has a gate, a source and a drain, wherein the drain is connected to a power line and the source is connected to the organic light emitting diode. A first switch transistor has a first gate, a first drain and a first source, wherein the first gate is connected to a scan line, the first source is connected to the power line, and the first drain is connected to the gate of the driving transistor. When the first switch transistor is turned on by the scan signal on the scan line, the voltage signal on the power line will turn the driving transistor on. A second switch transistor has a second gate, a second drain and a second source, wherein the second gate is connected to the scan line, the second drain is connected to a data line and the second source is connected to the source of the driving transistor. When the scan signal on the scan line turn the second switch transistor on, the data signal on the data line can transfer to the source of the driving transistor.

BRIEF DESCRIPTION OF THE DRAWINGS

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:

FIG. **1** illustrate the unit pixel circuit structure of the OLEDs according to the prior art; and

FIG. **2** illustrate the unit pixel circuit structure of the OLEDs according to the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

The present invention provides a unit pixel circuit structure for active matrix organic light emitting diodes (OLEDs) with amorphous silicon TFTs and organic light emitting diodes. Two switch transistors are provided to turn a driving transistor on or off and to maintain the gate-to-source voltage at a certain level. Thus, the voltage difference V_{OLED} between two electrodes of the organic light emitting diode will not affect the operating current of the driving transistor. And after a long time of operation, even though the voltage difference V_{OLED} increases, the operating current of the driving transistor can be maintained at a certain level. So the brightness of the organic light emitting diode will not decrease and the lifetime of the displays can be prolonged effectively. The detailed description is as follows.

Please refer to FIG. **2**, an unit pixel circuit **30** for OLEDS provided by the present invention is illustrated. As well know in the prior art, thin film transistors and interconnections are defined on a glass substrate firstly. These interconnections comprises scan lines and data lines which are arranged in a crisscross pattern to connect each unit pixel for sending scan signals and data signals. And each unit pixel **30** comprises an organic light emitting diode **32**, a driving transistor **34** and two switch transistors **36** and **38**.

The organic light emitting diode **32** has a positive terminal and a negative terminal, wherein the negative terminal is connected to a ground line Vss, and the positive terminal is connected through a driving transistor **34** to a power line Vdd. The driving transistor **34** has three electrodes of a gate, a drain and a source, wherein the gate is served as a control terminal. The gate of the driving transistor **34** is connected to the scan line. So the scan signals of the scan line can be applied to turn the driving transistor **34** on or off. And the drain and source of the driving transistor **34** are connected respectively to the power line Vdd and the positive terminal of the organic light emitting diode **32** to transfer the voltage signal of the power line Vdd to the organic light emitting diode **32** for luminescence.

Notedly, in the present invention, for the purpose of preventing the voltage difference between two terminals of the organic light emitting diode from affecting the drain current of the driving transistor **34** two transistors are introduced to turn the driving transistor **34** on or off and to maintain the gate-to-source voltage at a certain level. A gate of the switch transistor **36** is connected to the scan line, and a source thereof is connected to the power line Vdd, and a drain thereof is connected to the gate of the driving transistor **34**. When the switch transistor **36** is turned on by the scan signal on the scan line, the voltage signal on the power line Vdd will be transferred to the gate of driving transistor **34** for turning it on. In the mean, while, the voltage level of the gate of the driving transistor **34** is maintained at the level of the scan signal.

As to another switch transistor **38** of which a gate is connected to the scan line, a drain is connected to the data line, and a source is connected to the drain of the driving transistor **34**. When the switch transistor **38** is turned on by the scan signal, the data signal of the data line can be transferred to the source of the driving transistor **34** to maintain it at the voltage level of the data signal.

It is noted that the unit pixel circuit in the present invention also has a storage capacitor **40**. One terminal of the storage capacitor **40** is connected to both the gate of the driving transistor **34** and the source of the switch transistor **36**. As to another terminal of the storage capacitor **40** is connected to both the source of the driving transistor **34** and the source of the switch transistor **38**. Therefore, when the switch transistor **36** is turned on, the storage capacitor **40** is charged. And after that, when the switch transistor **36** is turned off, the storage capacitor **40** can applied to maintain the gate of the driving transistor **34** at a certain voltage level. Thus, in the time interval of turning the switch transistor **36** on and off, the current of the organic light emitting diode can be kept at a certain current level.

The voltage level of the gate of the driving transistor **34** is equal to that of the power line Vdd by introducing the switch transistor **36** in the present invention. And by applying the switch transistor **38**, the voltage level of the source of the driving transistor **34** is equal to that of the data signal. So the gate-to-source voltage (Vgs) can be kept at a certain level, and the drain current (Id) thereof will not be affected by the voltage difference V_{OLED}. The current formula is as follows:

$$\begin{aligned} Id &= \frac{1}{2} * K(Vgs - Vth)^2 \\ &= \frac{1}{2} * K[(Vdd - Vdata) - Vth]^2 \end{aligned}$$

In above formulas, K is a constant, Vdata is voltage signal on the data line, and Vth is the threshold voltage of the driving transistor **34**. Apparently, from the formulas, after a long time of operation the drain current (Id) of driving transistor **34** will not be affected even though the voltage difference V_{OLED} increases.

The unit pixel circuit of the OLEDs provided by the present invention has some advantages as follows:

(1) Because the drain current of the driving transistor is unconcerned with the voltage difference between two terminals of the organic light emitting diode, the operating current of the driving transistor will not decrease with voltage varying of the organic light emitting diodes while the display is operated a long time.

(2) Because the drain current is kept at a certain value, the brightness of the organic light emitting diodes will not decrease. Thus, the image quality of the displays can be promoted and the lifetime thereof can be prolonged effectively.

While the preferred embodiment of the invention has been illustrated and described, it will be appreciated that various changes can be made therein without departing from the spirit and scope of the invention. For example, in above embodiments, NMOS transistors are applied to serve as the switch devices, wherein a first switch device is used for turning the driving transistor on or off and maintaining the gate thereof at a certain voltage level, and a second switch device is used for controlling the source of the driving transistor at a certain voltage level. To those people skilled in the art, it is easy to be understood some other electronic devices can be chosen to replace the NMOS transistors for the identical functions.

What is claimed:

1. A driving circuit for an organic light emitting diode, said driving circuit comprises:

a driving transistor having a control terminal, a first electrode and a second electrode, wherein said first electrode and said second electrode are connected respectively to a power line and an organic light emitting diode;

a first switch device responsive to a scan signal from a scan line to electrically conduct said power line and said control terminal of said driving transistor to maintain said control terminal at a certain voltage level equal to that of said power line; and

a second switch device responsive to said scan signal from said scan line to electrically conduct a data line and said second electrode of said driving transistor and to transfer a data signal of said data line to said second electrode for maintaining said second electrode at a certain voltage level equal to that of said data signal;

wherein said control terminal and said second electrode are maintained respectively at certain voltage levels to prevent an operating current of said driving transistor from affection of a voltage difference between two terminals of said organic light emitting diode.

2. The driving circuit of claim **1**, wherein said first switch device is a transistor of which a gate is connected to a scan line, a source and a drain are connected respectively to said power line and said control terminal of said driving transistor.

3. The driving circuit of claim **1**, wherein said second switch device is a transistor of which a gate is connected to a scan line, a drain and a source are connected respectively to said data line and said second electrode of said driving transistor.

4. The driving circuit of claim **1**, wherein said control terminal of said driving transistor is a gate, said first electrode is a drain and said second electrode is a source.

5. The driving circuit of claim **1**, further comprises a storage capacitor of which two terminals are respectively connected to said gate and said source of said driving transistor.

6. A driving circuit for an organic light emitting diode, said driving circuit comprises:

a driving transistor having a gate, a source and a drain, wherein said drain is connected to a power line and said source is connected to said organic light emitting diode;

a first switch transistor has a first gate, a first drain and a first source, wherein said first gate is connected to a scan line, said first source is connected to said power line and said first drain is connected to said gate of said driving transistor, when said first switch transistor is turned on by said scan signal from said scan line, a voltage signal of said power line can turn said driving transistor on; and

a second switch transistor has a second gate, a second drain and a second source, wherein said second gate is connected to said scan line, said second drain is connected to a data line, and said second source is connected to said source of said driving transistor, when said second switch transistor is turned on by said scan signal from said scan line, a data signal of said data line is applied to said drain of said driving transistor.

7. The driving circuit of claim **6**, further comprises a storage capacitor of which two terminals are respectively

connected to said first drain of said first switch transistor and said second source of said second switch transistor.

8. An unit pixel circuit for an organic light emitting display comprises:

a scan line for transferring a scan signal to said unit pixel circuit;

a data line for transferring a data signal to said unit pixel circuit;

an organic light emitting diode has a positive terminal and a negative terminal, wherein said negative terminal is connected to a ground terminal;

a driving transistor has a control terminal, a first electrode and a second electrode, wherein said first electrode and said second electrode are respectively connected to a power line and said positive terminal of said organic light emitting diode;

a first switch transistor responsive to said scan signal of said scan line to electrically conduct said power line and said control terminal of said driving transistor for maintaining said control terminal at the voltage level of said scan signal; and

a second switch transistor responsive to said scan signal of said scan line to electrically conduct said data line and said second electrode of said driving transistor for maintaining said second electrode at the voltage level of said data signal;

when said first switch transistor and said second switch transistor are turned on by said scan signal, said first electrode and said second electrode of said driving transistor are conducted to transfer said data signal of said data line to said source of said driving transistor.

9. The circuit of claim **8**, wherein a gate of said first switch transistor is connected to said scan line, and a source and a drain thereof are respectively connected to said power line and said control terminal of said driving transistor.

10. The circuit of claim **8**, wherein a gate of said second switch transistor is connected to said scan line, a drain and a source thereof are connected respectively to said data line and said second electrode of said driving transistor.

11. The circuit of claim **8**, wherein said control terminal of said driving transistor is a gate, said first electrode is a drain and said second electrode is a source.

12. The circuit of claim **8**, further comprises a storage capacitor of which two terminals are connected respectively to said gate and said source of said driving transistor.

* * * * *

patsnap

专利名称(译)	用于有机发光显示器的单位像素的驱动电路		
公开(公告)号	US6756741	公开(公告)日	2004-06-29
申请号	US10/396780	申请日	2003-03-26
[标]申请(专利权)人(译)	友达光电股份有限公司		
申请(专利权)人(译)	友达光电.		
当前申请(专利权)人(译)	友达光电.		
[标]发明人	LI CHUN HUAI		
发明人	LI, CHUN-HUAI		
IPC分类号	G09G3/04 G09G3/10 G09G3/00		
CPC分类号	G09G3/3233 G09G2300/0842 G09G2320/0233 G09G2320/043		
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其他公开文献	US20040007989A1		
外部链接	Espacenet USPTO		

摘要(译)

用于有机发光二极管的驱动电路包括以下元件。驱动晶体管具有控制端子，第一电极和第二电极，其中第一电极和第二电极连接到电源线和有机发光二极管。可以通过扫描信号接通第一开关装置，以电导电源线和驱动晶体管的控制端子，以将控制端子保持在扫描信号的电压电平。并且可以通过扫描信号接通第二开关器件以导电数据线和驱动晶体管的第二电极，以将数据信号传输到第二电极并将第二电极保持在数据信号的电压电平。因此，通过将驱动晶体管和第二电极的控制端保持在一定水平，驱动晶体管的工作电流不会受到有机发光二极管的两个电极之间的电压差的影响。