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(57) **ABSTRACT**

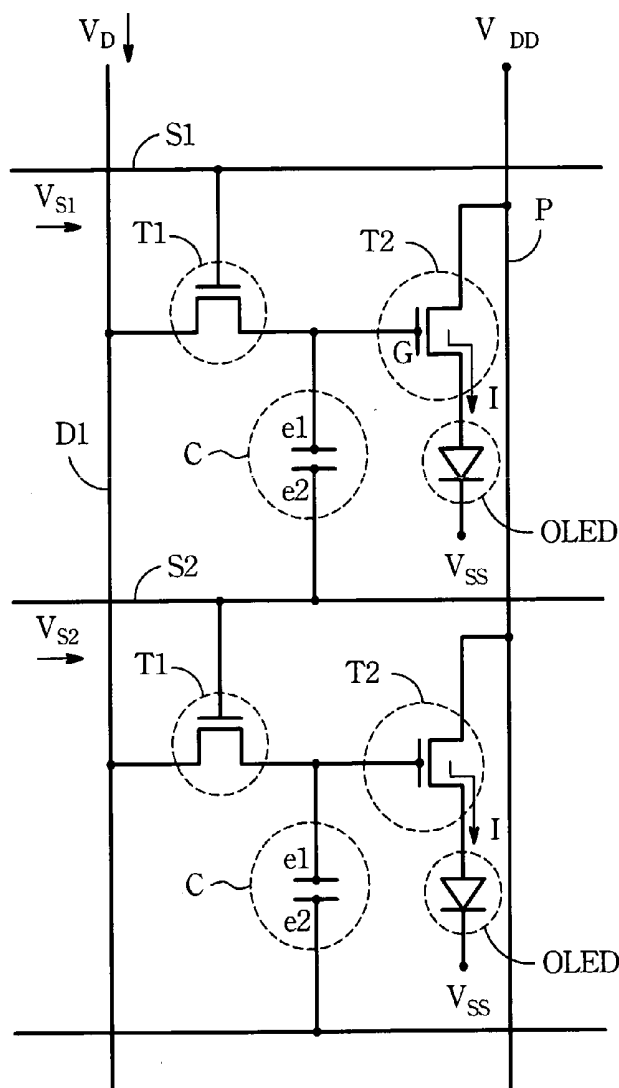
A pixel driving circuit of an active matrix organic light emitted diode display is provided with an input first scanning voltage signal and an input displaying voltage signal. The pixel driving circuit comprises a driving thin film transistor (TFT), an organic light emitted diode (OLED), and a capacitor. The capacitor has a first end connected to a gate electrode of the driving TFT to store a potential respect to the displaying voltage signal and having the driving TFT generate a steady current flowing through the OLED. The capacitor has a second end provided with a second scanning voltage signal, which has a level range larger than that of the displaying voltage signal, partially overlapping with the first scanning voltage signal so as to generate a negative bias in the driving TFT.

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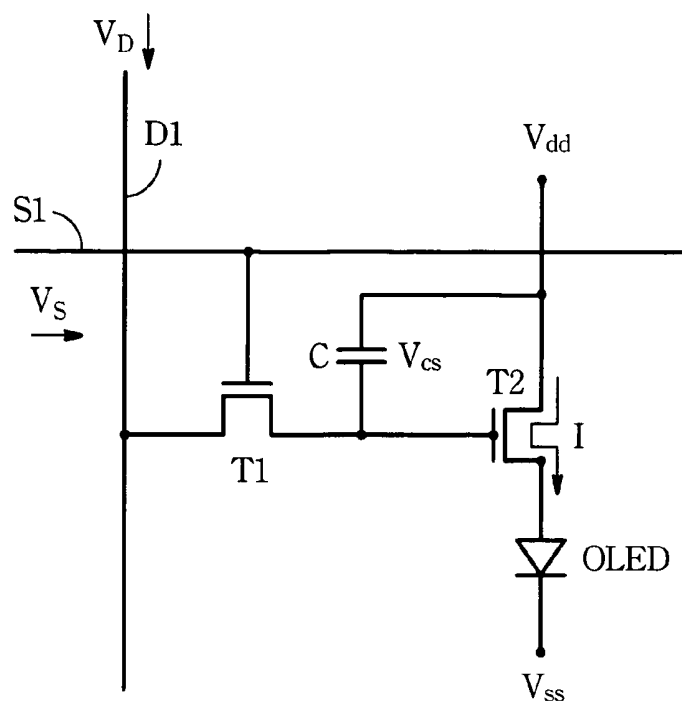


FIG. 1 (Related Art)

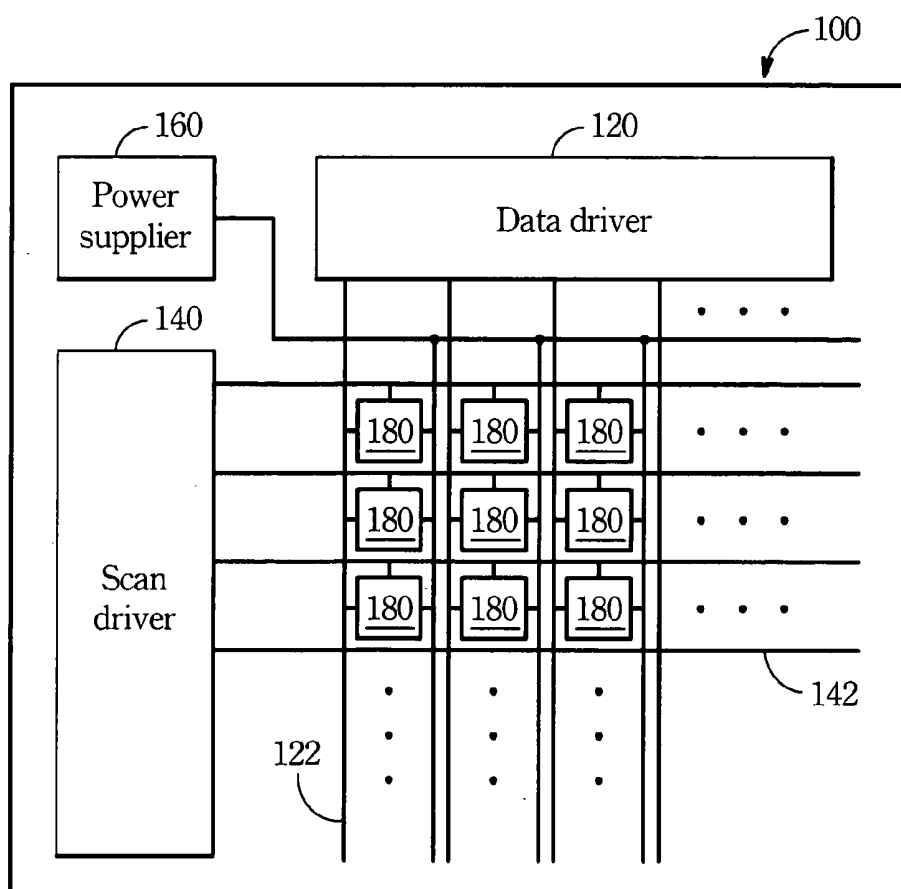


FIG. 2

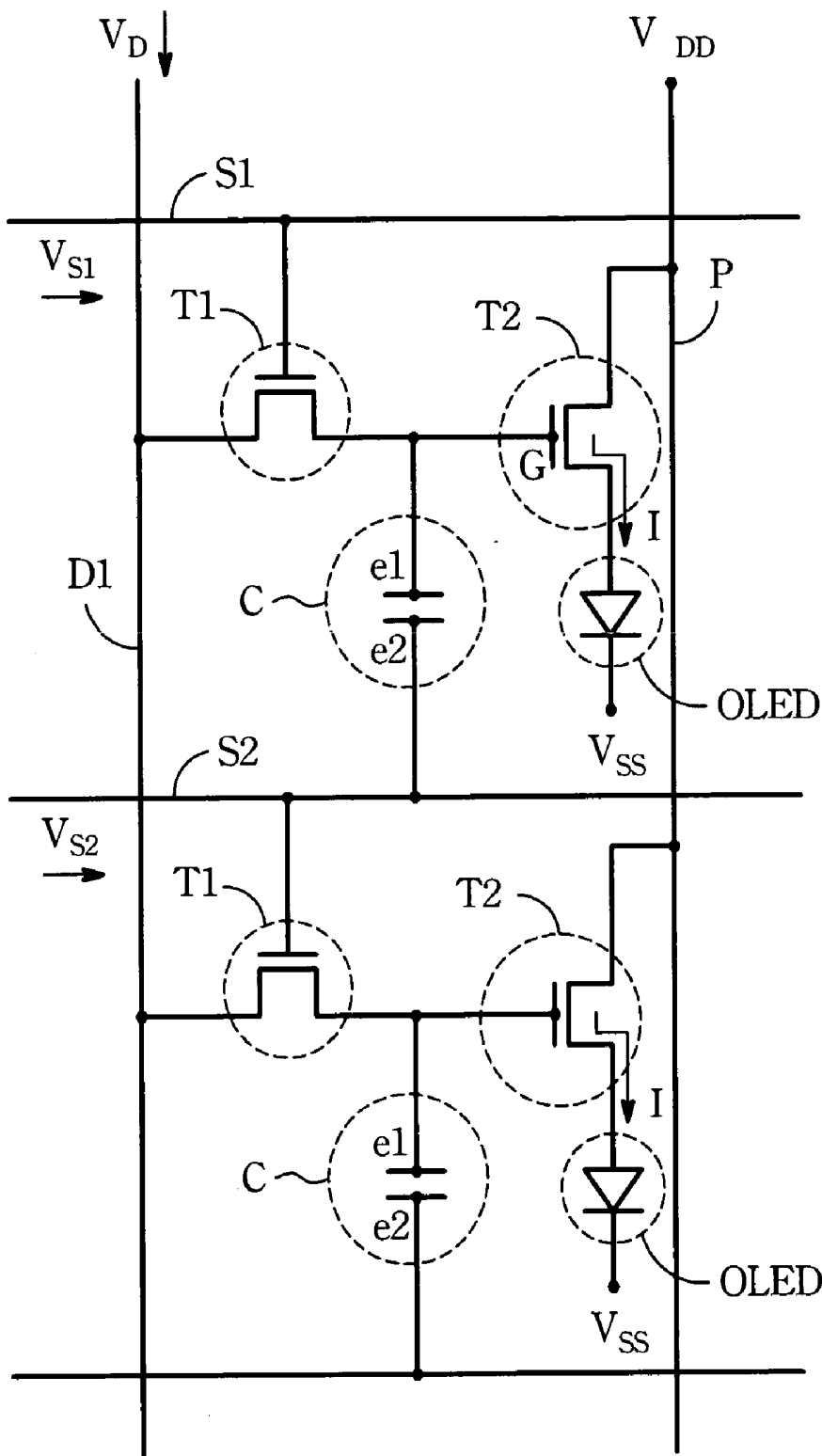


FIG. 3

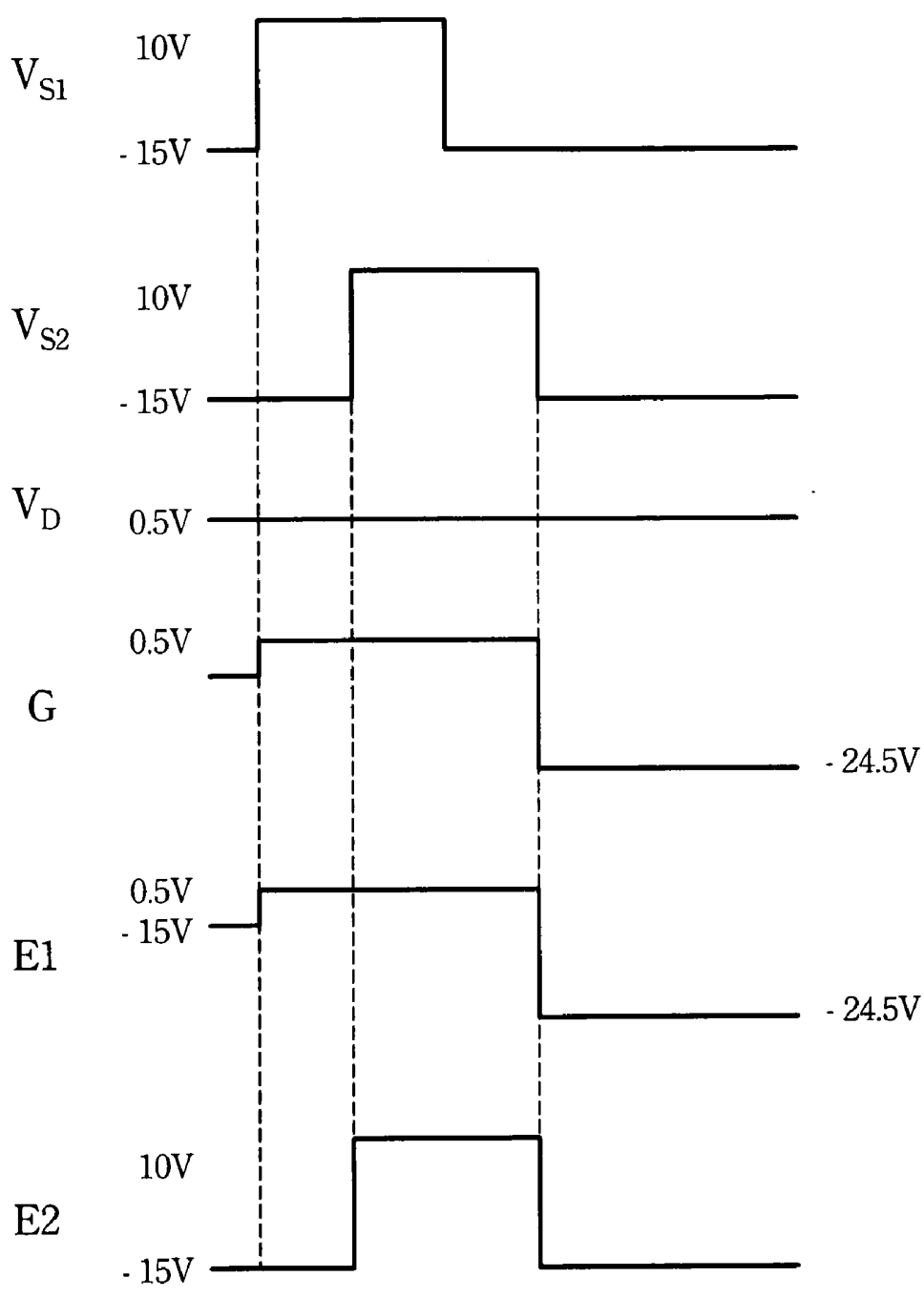


FIG. 4

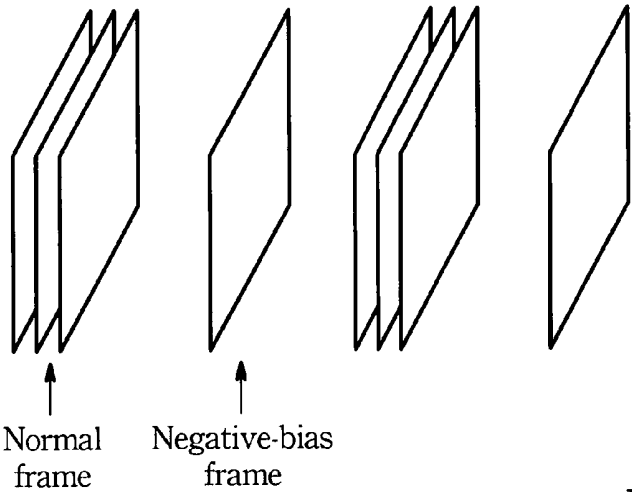


FIG. 5

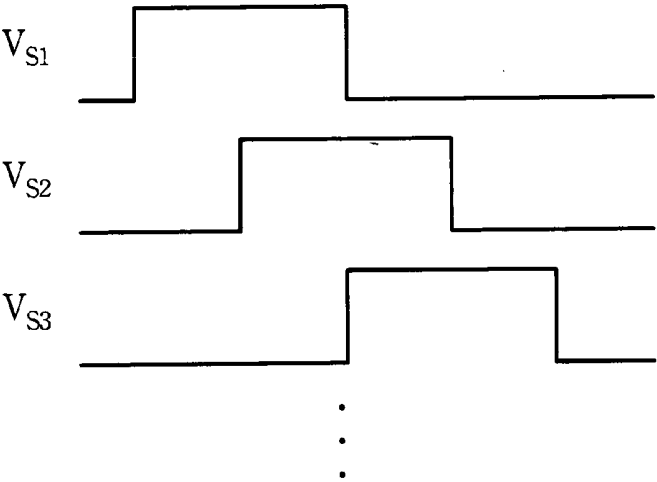


FIG. 6A

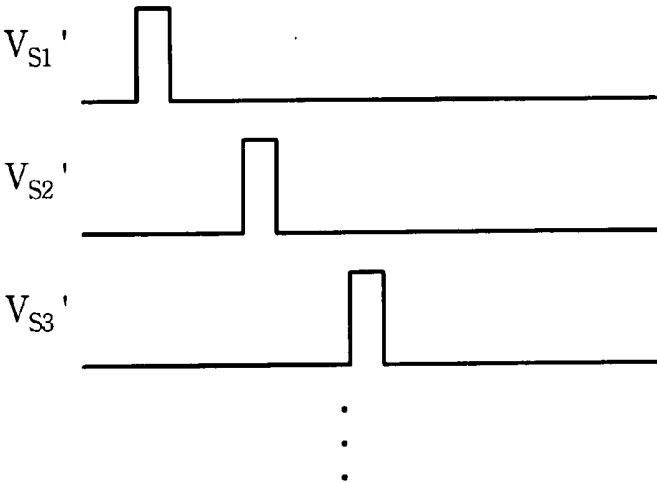


FIG. 6B

ACTIVE MATRIX ORGANIC LIGHT EMITTING DIODE (AMOLED) DISPLAY, A PIXEL DRIVING CIRCUIT, AND A DRIVING METHOD THEREOF

BACKGROUND OF THE INVENTION

[0001] (1) Field of the Invention

[0002] This invention relates to an active matrix organic light emitting diode (AMOLED) display, a pixel driving circuit, and a driving method thereof, and more particularly to a voltage-driven AMOLED display.

[0003] (2) Description of the Related Art

[0004] With the progress in the fabrication technology of organic light emitting diodes (OLEDs), an organic light emitting display with a plurality of OLEDs arranged in matrix has become a popular choice among all the flat panel displays. Based on different driving methods, the organic light emitting display can be sorted into simple matrix system type and active matrix system type. In addition, the active matrix system type is more suitable for large size displays and high resolution usage.

[0005] FIG. 1 shows a circuit diagram of a pixel driving circuit in a traditional voltage-driven active matrix organic light emitting display. The pixel driving circuit includes an OLED, a transistor T1, a transistor T2, and a capacitor C. A source electrode of the transistor T1 is connected to a data line D1 for receiving a driving voltage signal V_D . A gate electrode of the transistor T1 is connected to a scan line S1. A source electrode of the transistor T2 is connected to an anode of the OLED. A drain electrode of the transistor T2 is provided with a potential V_{dd} . A gate electrode of the transistor T2 is connected to a drain electrode of the transistor T1. A cathode of the OLED is provided with a different potential V_{ss} . Both ends of the capacitor C are connected to the gate electrode of the transistor T2 and provided with the potential V_{dd} respectively.

[0006] As to generate a steady current I passing through the OLED to maintain the brightness, a scanning voltage V_S is firstly applied through the scan line S1 to turn on the transistor T1. Then, a driving voltage signal V_D on the data line D1 is able to apply to the gate electrode of the transistor T2 and create a potential V_{cs} stored in the capacitor C. It is understood that the potential V_{cs} equals to a difference of the voltage levels of V_{dd} and the driving voltage signal V_D . Therefore, the gate to source voltage V_{gs} (not shown) of the transistor T2 is determined. Since a difference between the gate to source voltage V_{gs} and the threshold voltage V_t of the transistor T2 determines the value of current I , the brightness of the OLED may be decided by setting the value of the driving voltage signal V_D .

[0007] Although the usage of amorphous silicon thin film transistor (a-Si TFT) can reduce the cost of an organic light emitting display, most of the thin film transistors (TFT) applied for driving OLEDs nowadays are made of low temperature poly-silicon (LTPS) technology due to a major consideration of a shifting threshold voltage V_t of an a-Si TFT during operation. That is, even the gate to source voltage V_{gs} of the transistor remains constant, the value of the current passing through the OLED may be reduced due to the increasing threshold voltage V_t , and a decreasing brightness of the OLED is predictable.

[0008] The total variation of the threshold voltage V_t of the a-Si TFT is equal to a sum of the variations under positive bias and negative bias, which is disclosed in "Threshold Voltage Variation of Amorphous Silicon Thin-Film Transistor During Pulse Operation" of Japanese Journal of Applied Physics Vol. 30, December, 1991, pp. 3719-3723. Furthermore, the variation of the threshold voltage under positive bias is positive, and the variation of the threshold voltage under negative bias is negative, which is disclosed in "Electrical Instability of Hydrogenated Amorphous Silicon Thin-Film Transistors for Active-Matrix Liquid-Crystal Displays" of Japanese Journal of Applied Physics Vol. 37, September, 1998, pp. 4704-4710.

[0009] As mentioned above, the problem of increasing threshold voltage of the a-Si TFT can be effectively resolved by having the a-Si TFT properly supplied with negative bias. Therefore, modifying the pixel driving circuit by providing the TFT with negative bias is quite helpful for the application of a-Si TFT for driving OLEDs.

SUMMARY OF THE INVENTION

[0010] It is a main object of the present invention to generate a negative bias to a driving thin film transistor (TFT) in a pixel driving circuit so as for driving an OLED to overcome the problem of increasing threshold voltage.

[0011] A pixel driving circuit of a voltage-driven active matrix organic light emitting display is provided in the present invention. The pixel driving circuit is applied with a first scanning voltage signal and a displaying voltage signal, and it comprises a driving transistor, an organic light emitting diode (OLED) connected to the driving transistor, and a capacitor having a first end connected to a gate electrode of the driving transistor to store a potential respect to the displaying voltage signal so as to generate a steady current passing through the OLED. A second end of the capacitor is provided with a second scanning voltage signal, which partially overlaps with the first scanning voltage signal and has a level range larger than that of the displaying voltage signal so as to generate a negative bias in the driving transistor.

[0012] By using the above mentioned pixel driving circuit, a method for voltage-driving an organic light emitting display is provided in the present invention. Firstly, the pixel driving circuit is provided with the first scanning voltage signal and the second scanning voltage signal. The scanning voltage signals does not have any overlap so as to operate the pixel driving circuit ordinarily. As a negative bias is desired to be provided in the driving transistor, the first scanning voltage signal and the second scanning voltage signal are overlapped to generate a negative voltage level to the first end of the capacitor for generating the negative bias.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] The present invention will now be specified with reference to its preferred embodiment illustrated in the drawings, in which:

[0014] FIG. 1 is a circuit diagram depicting a traditional pixel driving circuit of a voltage-driven active matrix organic light emitting display;

[0015] FIG. 2 is a functional block diagram depicting a preferred embodiment of an active matrix organic light emitting display in accordance with the present invention;

[0016] FIG. 3 is a circuit diagram depicting a pixel driving circuit shown in FIG. 2;

[0017] FIG. 4 is a timing chart showing the waveforms of the first scanning voltage signal, the second scanning voltage signal, the displaying voltage signal, and the voltage applied on the gate electrode of the driving transistor;

[0018] FIG. 5 shows a schematic drawing of a driving method by using the driving circuit shown in FIG. 2;

[0019] FIG. 6A is a timing chart showing the waveforms of the overlapped first and second scanning voltage signals; and

[0020] FIG. 6B is a timing chart showing the waveforms shows the waveforms of the non-overlapped first and second scanning voltage signals.

DESCRIPTION OF THE PREFERRED EMBODIMENT

[0021] FIG. 2 is a functional block diagram depicting a preferred embodiment of an active matrix organic light emitting display in accordance with the present invention. As shown, the organic light emitting display includes a substrate 100, a data driver 120 arranged on the substrate 100, a scan driver 140 on the substrate 100, a power supplier 160, a plurality of scan lines 122, a plurality of data lines 142 perpendicular to the scan lines 122, and a plurality of pixel driving circuits 180 arranged on the substrate 100 in matrix. The pixel driving circuits 180 of the same column is connected to the data driver 120 through a single data line 122. The pixel driving circuits 180 of the same row is connected to the scan driver 140 through a single scan line 142. The power supplier 160 located on the substrate 100 is utilized for applying power to activate the organic light emitting diodes (OLEDs) of each pixel driving circuits 180.

[0022] FIG. 3 is a circuit diagram depicting a pixel driving circuit 180 of FIG. 2, and two adjacent pixel driving circuits 180 of the same column is shown. As shown in FIG. 3, each pixel driving circuit 180 includes a switching transistor T1, a driving transistor T2, an OLED, and a capacitor C. The switching transistor T1 has a source electrode connected to a data line D1 (identical to the data line 122 of FIG. 2) for receiving a displaying voltage signal V_D , a gate electrode connected to a first scan line S1 (identical to the scan line 142 of FIG. 2) for receiving a first scanning voltage signal V_{S1} , and a drain electrode. The driving transistor T2 has a gate electrode connected to the drain electrode of the switching transistor T1, a drain electrode connected to a power line P for receiving a first voltage level V_{DD} generally ranging from 0 to 12 volts, and a source electrode. The OLED has an anode connected to the source electrode of the driving transistor T2 and a cathode provided with a second voltage level V_{ss} generally ranging from 0 to -12 volts. The capacitor C has a first end e1 connected to both the drain electrode of the switching transistor T1 and the gate electrode of the driving transistor T2, and a second end e2 connected to an adjacent scan line S2 for receiving a second scanning voltage signal V_{S2} .

[0023] As the first scanning voltage signal is at a high level state generally ranging from 0 to 15 volts, the switching transistor T1 is turned on so as to allow the displaying voltage signal V_D generally ranging from 0 to 15 volts passing through the switching transistor T1 and stored in the

capacitor C. As the first scanning voltage signal is at a low level state generally ranging from 0 to -15 volts, the switching transistor T1 is turned off to stop input displaying voltage signal V_D . At the same time, a potential stored in the capacitor C respect to the displaying voltage signal V_D drives the driving transistor T2 to generate a steady current I passing through the OLED to illuminate.

[0024] All the level ranges of the first voltage level V_{dd} , the second voltage level V_{ss} , the first scanning voltage signal V_{S1} , and the second scanning voltage signal V_{S2} are restricted by the allowable loading of the pixel driving circuit 180 and outputs of the data driver 120, the scan driver 140, and the power supplier 160.

[0025] It is noted that a scanning timing of the second scanning voltage signal V_{S2} is right behind that of the first scanning voltage signal V_{S1} . Therefore, the second scan line S2 connected to the second end e2 of the capacitor C can be regarded as a next scan line with respect to the first scan line S1.

[0026] As the first scanning voltage signal V_{S1} does not overlap the second scanning voltage signal V_{S2} , the first end e1 of the capacitor C maintains a voltage level of the displaying voltage signal V_D . The voltage level of the gate electrode of the driving transistor T2 is thus maintained to a value corresponding to the displaying voltage signal V_D to generate a steady current I passing through the OLED normally.

[0027] As the first scanning voltage signal V_{S1} overlaps the second scanning voltage signal V_{S2} and both the first scanning voltage signal V_{S1} and the second scanning voltage signal V_{S2} are in high level state, the first end e1 of the capacitor C has the voltage level of the displaying voltage signal V_D and the second end e2 of the capacitor C has the voltage level of the mentioned high level state. Afterward, as the first scanning voltage signal V_{S1} is switched to the respected low level state but the second scanning voltage signal V_{S2} remains in the high level state, the switching transistor T1 is turned off so as to float the first end e1 of the capacitor C. A difference between the voltage levels of the displaying voltage signal V_D and the high level state generates a potential stored in the capacitor C. Thereafter, as the second scanning voltage signal V_{S2} is further switched to the low level state, the voltage level of the second end e2 of the capacitor C is declined to the voltage level of low level state and leads to a significant decrease of the voltage level of the first end e1 of the capacitor C. It should be noted that the difference between the voltage levels of the high level state and the low level state is usually much greater than the voltage level of the displaying voltage signal V_D . Therefore, the voltage level of the first end e1 of the capacitor C can be decreased to a negative value. The negative voltage level is also applied on the gate electrode of the driving transistor T2 to generate a negative bias.

[0028] For example, as the displaying voltage signal V_D ranges from 0 to 15 volts, the voltage level of the high level state ranges from 0 to 15 volts, and the voltage level of the low level state ranges from 0 to -15 volts, the potential stored in the capacitor C is predictable to have a voltage level ranging from -15 to 15 volts and the difference between the voltage levels of the high and low level states ranging from 0 to 30 volts. It is understood that the difference between the voltage levels of the high and low level

states can be greater than the potential stored in the capacitor C, and thus a negative bias can be generated.

[0029] For a better understanding of the generation of the negative bias, please referring to FIG. 4, which shows a timing chart depicting the waveforms of the first scanning voltage signal V_{S1} , the second scanning voltage signal V_{S2} , the displaying voltage signal V_D , voltage level of the gate electrode G of the driving transistor T2, and voltage levels of the first end e1 (denoted E1) and the second end e2 (denoted E2) of the capacitor C, respectively. It is assumed that the voltage level of the high level state of both the first scanning voltage signal V_{S1} and the second scanning voltage signal V_{S2} is 10 volts, and the respected voltage level of the low level state is -15 volts. It is also assumed that the voltage level of the displaying voltage signal V_D is 0.5 volt.

[0030] In the timing chart shown in FIG. 4, as both the first scanning voltage signal V_{S1} and the second scanning voltage signal V_{S2} are in the high level state of 10 volts, the voltage levels E1 and E2 are 0.5 volts and 10 volts respectively. Then, as the first scanning voltage signal V_{S1} is in the low level state of -15 volts to turn off the switching transistor T1, a potential of -9.5 volts, which is also a difference of voltage levels between the first end e1 and the second end e2, is stored in the capacitor C. Thereafter, as the second scanning voltage signal V_{S2} is at the low level state of -15 volts, the second end e2 of the capacitor C is forced to shift to a voltage level of -15 volts. Since the difference of voltage levels between the first end e1 and the second end e2 is kept constant, the voltage level of the first end e1 of the capacitor is thus reduced to -24.5 volts and applied to the gate electrode G of the driving transistor T2 to generate a negative bias.

[0031] Although the switching transistor T1 and the driving transistor T2 in the pixel driving circuit of FIG. 3 may be polysilicon thin film transistors or amorphous silicon thin film transistors (a-Si TFTs). It is understood that a major objective of the present invention is to generate a negative bias in the driving transistor T2 to extend the expecting life of the driving transistor. Therefore, the pixel driving circuit of the present invention is particularly suitable for using amorphous silicon thin film transistors as the driving transistor T2. Whereas, since the time of applying positive bias on the switching transistor T1 is much shorter than that on the driving transistor T2, the switching transistor T1 in the pixel circuit 180 of the present invention is not limited to use polysilicon thin film transistors.

[0032] FIG. 5 shows a schematic drawing of a voltage-driving method by using the driving circuit 100 shown in FIG. 2. In the present voltage-driving method, the input scanning voltage signals provided by the scan lines 142 can be sorted into the scanning voltage signals with overlapping

V_{S1} , V_{S2} , $V_{S3} \dots$ to generate negative bias in a first cycle, as shown in FIG. 6A, and the scanning voltage signals without overlapping V_{S1}' , V_{S2}' , $V_{S3}' \dots$ to operate the pixel driving circuit ordinary to show normal frames in a second cycle, as shown in FIG. 6B. In FIG. 5, the scanning voltage signals without overlapping and the scanning voltage signals with overlapping are alternatively provided to the driving circuit 100. That is, negative-bias frames formed by applying scanning voltage signals with overlapping are periodically provided to interpose between a predetermined number of the normal frames for adjusting the threshold voltage of the driving transistor in the pixel driving circuits 180. The predetermined number may be reduced to one to help preventing the increasing of threshold voltage.

[0033] While the preferred embodiments of the present invention have been set forth for the purpose of disclosure, modifications of the disclosed embodiments of the present invention as well as other embodiments thereof may occur to those skilled in the art. Accordingly, the appended claims are intended to cover all embodiments which do not depart from the spirit and scope of the present invention.

1. A method for driving an active matrix organic light emitting display having a driving transistor and an organic light emitting diode comprising:

providing, in a first cycle, a first scanning voltage signal of the first cycle and a second scanning voltage signal of the first cycle, wherein the second scanning voltage signal of the first cycle does not overlap the first scanning voltage signal of the first cycle; and

providing, in a second cycle, a first scanning voltage signal of the second cycle and a second scanning voltage signal of the second cycle, wherein the second scanning voltage signal of the second cycle overlaps the first scanning voltage signal of the second cycle to generate a negative bias in the driving transistor for driving the organic light emitting diode.

2. The method according to claim 1, wherein the first scanning voltage signal of the first cycle ranges from about 0 to 30 V.

3. The method according to claim 1, wherein the second scanning voltage signal of the first cycle ranges from about 0 to 30 V.

4. The method according to claim 1, wherein the first scanning voltage signal of the second cycle ranges from about 0 to 30 V.

5. The method according to claim 1, wherein the second scanning voltage signal of the second cycle ranges from about 0 to 30 V.

* * * * *

专利名称(译)	有源矩阵有机发光二极管 (AMOLED) 显示器 , 像素驱动电路及其驱动方法		
公开(公告)号	US20060001616A1	公开(公告)日	2006-01-05
申请号	US11/055686	申请日	2005-02-11
[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	CHANG YI CHENG		
发明人	CHANG, YI-CHENG		
IPC分类号	G09G3/30		
CPC分类号	G09G3/3233 G09G2300/0417 G09G2320/043 G09G2310/0254 G09G2310/0262 G09G2300/0842		
优先权	093119679 2004-06-30 TW		
其他公开文献	US7847774		
外部链接	Espacenet USPTO		

摘要(译)

有源矩阵有机发光二极管显示器的像素驱动电路具有输入的第一扫描电压信号和输入的显示电压信号。像素驱动电路包括驱动薄膜晶体管 (TFT) , 有机发光二极管 (OLED) 和电容器。电容器的第一端连接到驱动TFT的栅极, 以存储相对于显示电压信号的电位, 并使驱动TFT产生流过OLED的稳定电流。电容器的第二端设置有第二扫描电压信号, 其具有大于显示电压信号的电平范围, 与第一扫描电压信号部分重叠, 以在驱动TFT中产生负偏压。

