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(54) **ORGANIC LIGHT EMITTING DISPLAY AND METHOD OF COMPENSATING FOR MOBILITY THEREOF**

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(57)

**ABSTRACT**

An organic light emitting display can include a display panel including a plurality of pixels of a source following manner, in which a source voltage of a driving thin film transistor (TFT) is changed according to a current flowing between a drain electrode and a source electrode of the driving TFT, a gate driving circuit for generating a mobility sensing gate pulse for operating the pixel in the source following manner, a data driving circuit for detecting a sensing voltage corresponding to mobility of the driving TFT from the pixel in response to the mobility sensing gate pulse, and a timing controller for setting a mobility sensing period in a period, in which a gate-source voltage of the driving TFT is greater than a threshold voltage of the driving TFT.

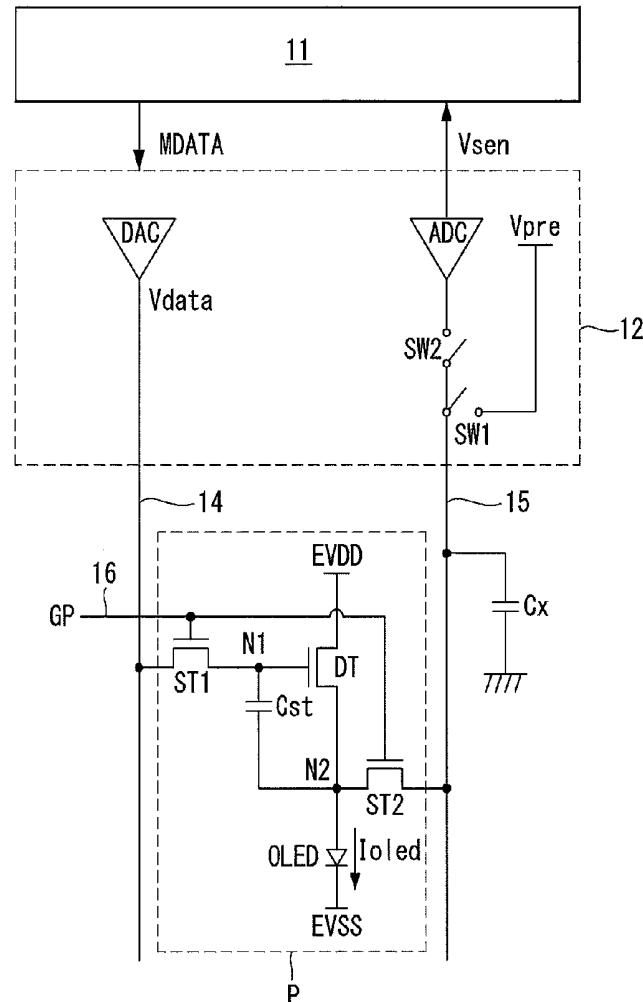


FIG. 1

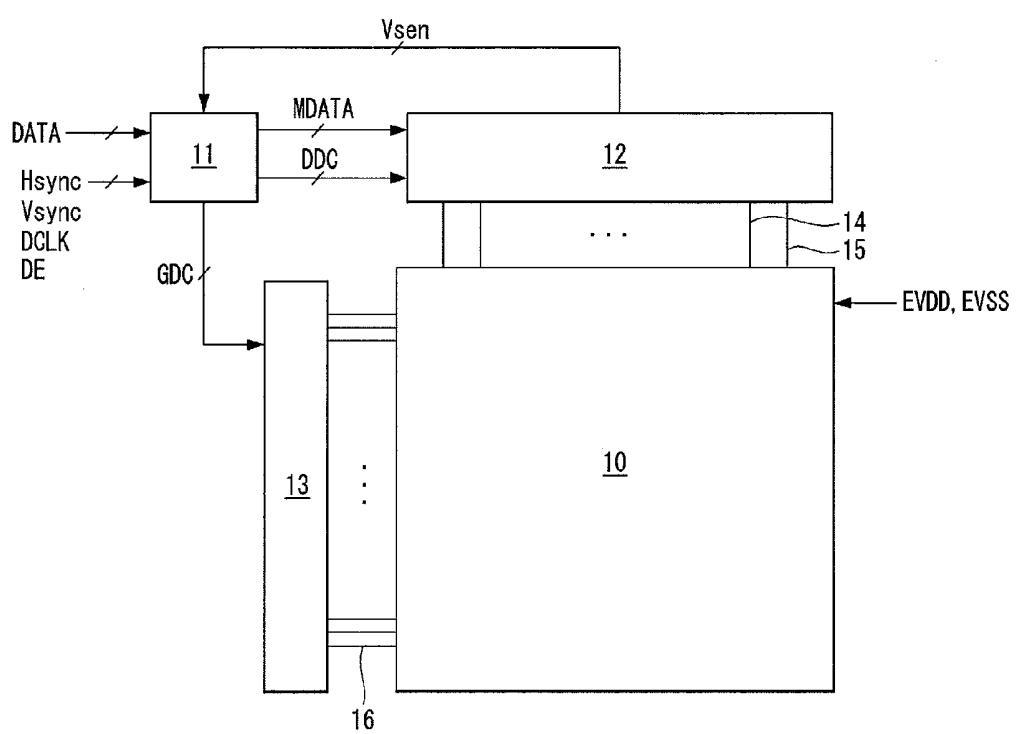


FIG. 2

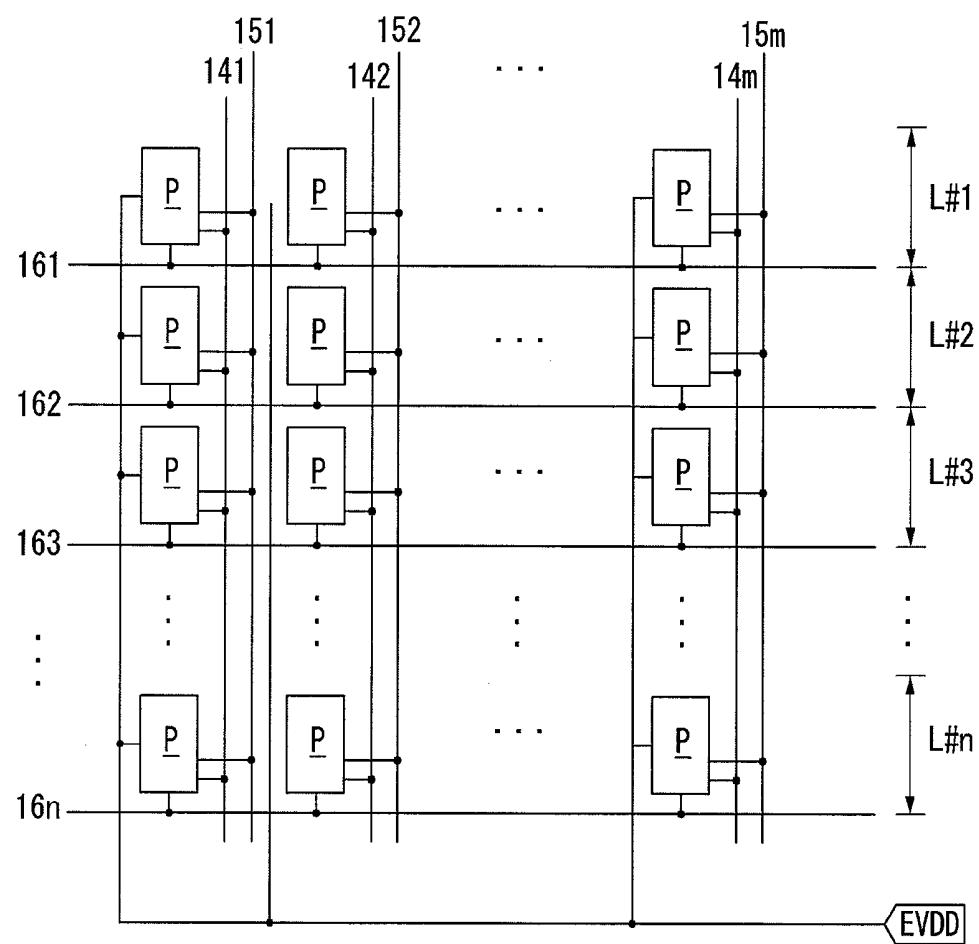


FIG. 3

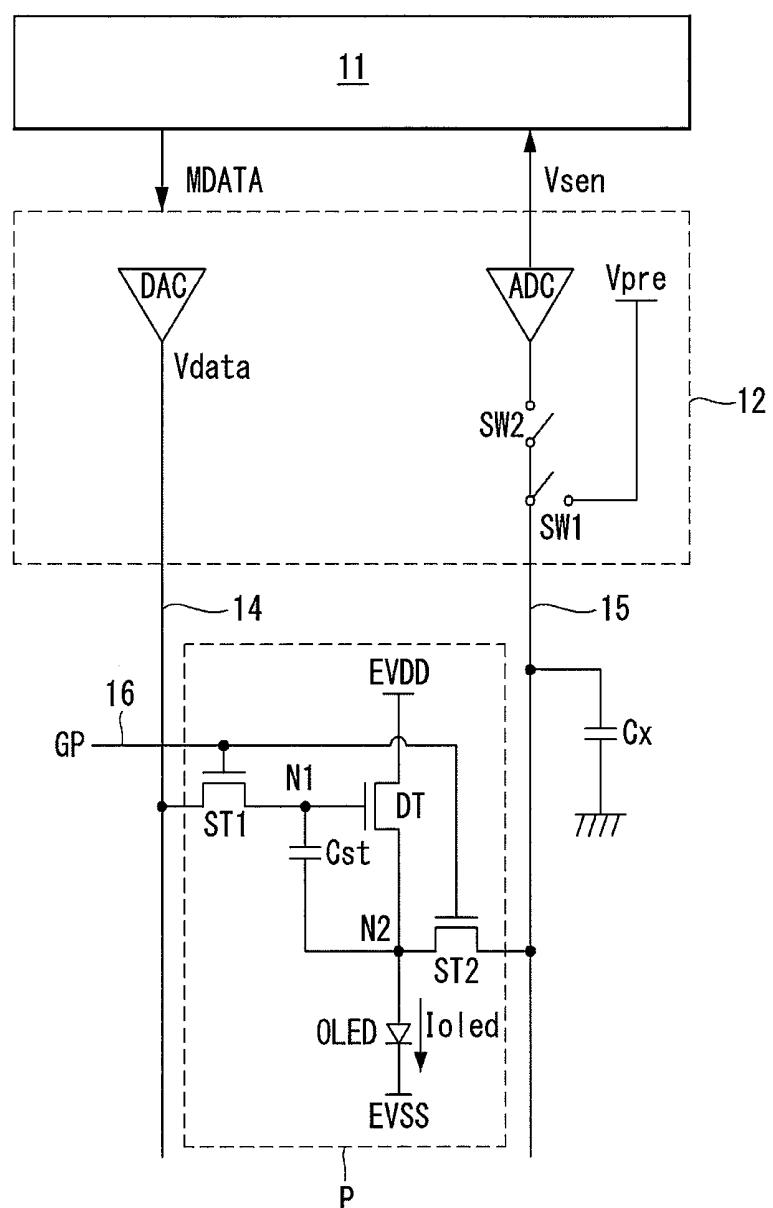
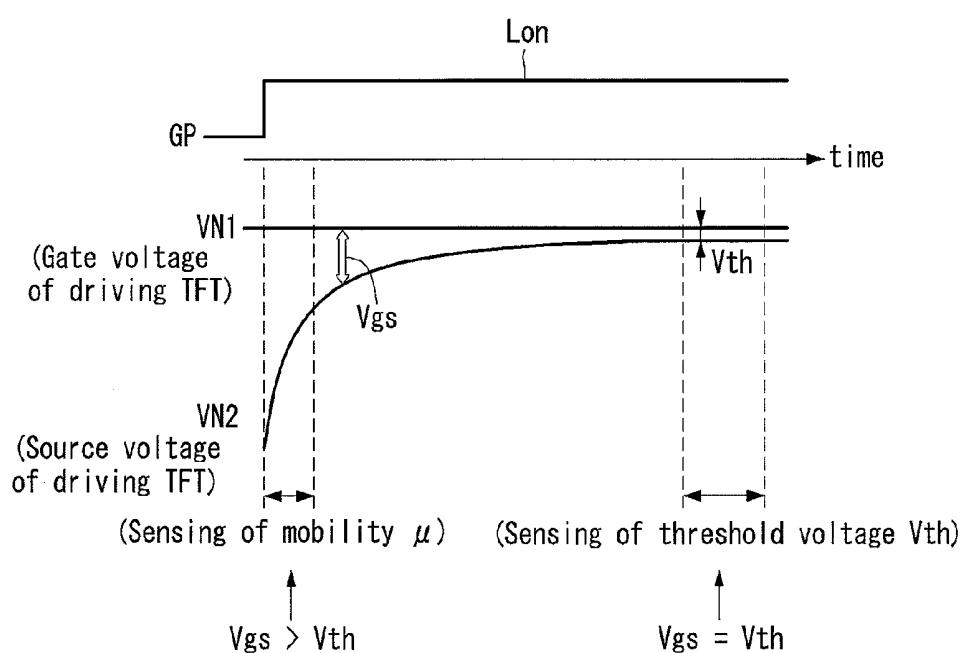
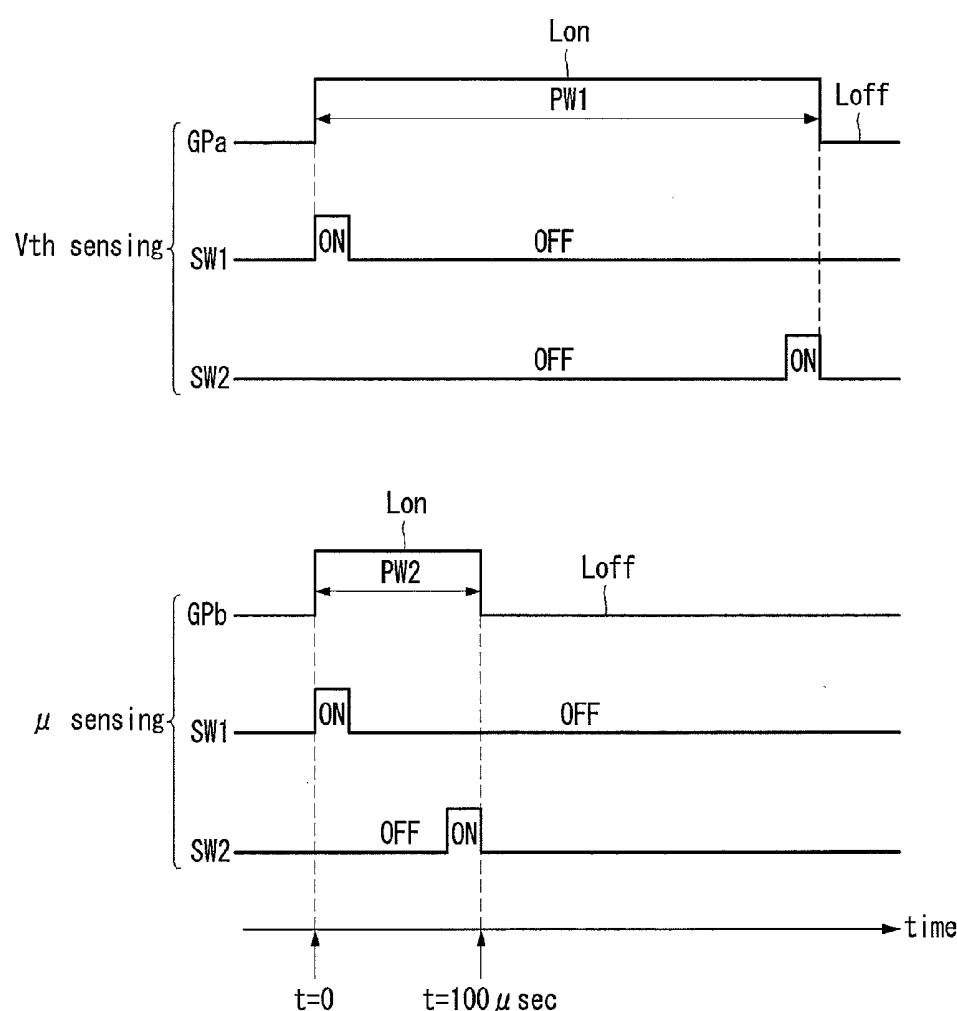
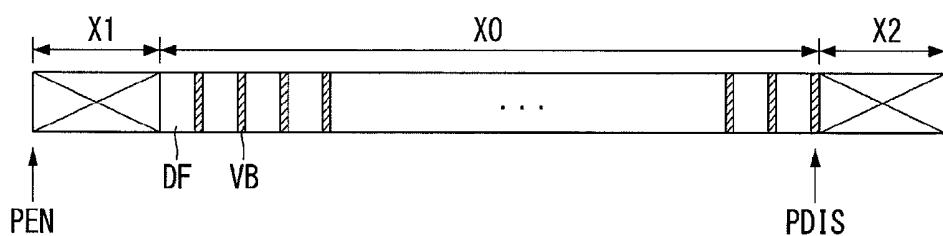
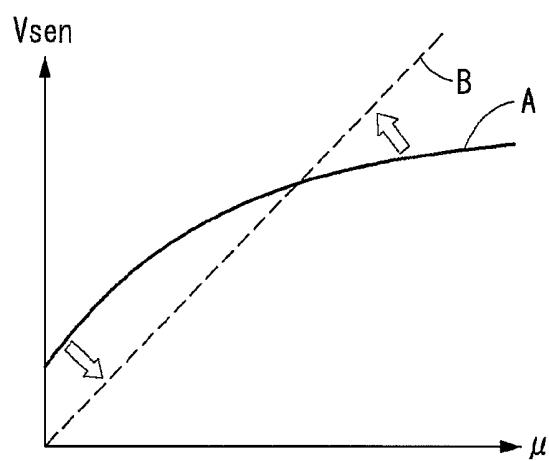
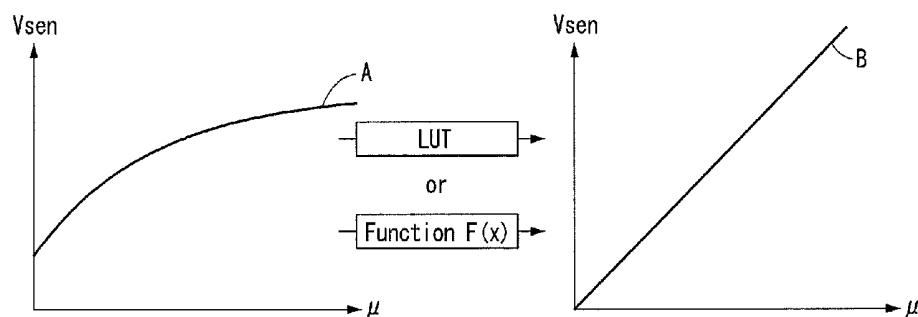
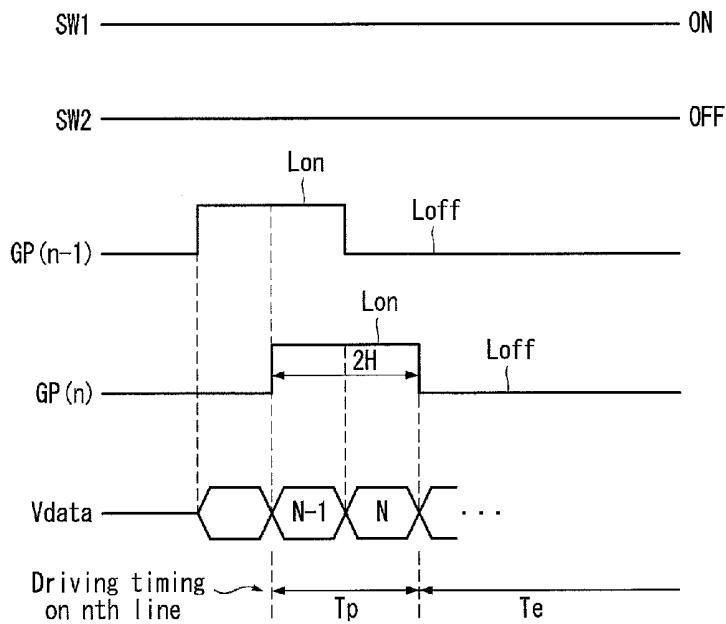


FIG. 4



**FIG. 5**

**FIG. 6****FIG. 7**

**FIG. 8****FIG. 9**

## ORGANIC LIGHT EMITTING DISPLAY AND METHOD OF COMPENSATING FOR MOBILITY THEREOF

[0001] This application claims the benefit of Patent Application No. 10-2013-0134256 filed on Nov. 6, 2013 in the Republic of Korea, which is incorporated herein by reference for all purposes as if fully set forth herein.

### BACKGROUND OF THE INVENTION

#### [0002] 1. Field of the Invention

[0003] Embodiments of the invention relate to an active matrix organic light emitting display, and more particularly to an organic light emitting display and a method of compensating for mobility thereof.

#### [0004] 2. Discussion of the Related Art

[0005] An active matrix organic light emitting display includes organic light emitting diodes (hereinafter, abbreviated to "OLEDs") capable of emitting light by itself and has advantages of a fast response time, a high light emitting efficiency, a high luminance, a wide viewing angle, and the like.

[0006] The OLED serving as a self-emitting element includes an anode electrode, a cathode electrode, and an organic compound layer formed between the anode electrode and the cathode electrode. The organic compound layer includes a hole injection layer HIL, a hole transport layer HTL, a light emitting layer EML, an electron transport layer ETL, and an electron injection layer EIL. When a driving voltage is applied to the anode electrode and the cathode electrode, holes passing through the hole transport layer HTL and electrons passing through the electron transport layer ETL move to the light emitting layer EML and form excitons. As a result, the light emitting layer EML generates visible light.

[0007] The organic light emitting display arranges pixels each including the OLED in a matrix form and adjusts a luminance of the pixels depending on a gray scale of video data. Each pixel includes a driving thin film transistor (TFT) for controlling a driving current flowing in the OLED. It is preferable that electrical characteristics (including a threshold voltage, a mobility, etc.) of the driving TFT are equally designed in all of the pixels. However, in practice, the electrical characteristics of the driving TFTs of the pixels are not uniform due to various causes. A deviation between the electrical characteristics of the driving TFTs results in a luminance deviation between the pixels.

[0008] Various compensation methods of compensating for the deviation between the electrical characteristics of the driving TFTs are known. The compensation methods are classified into an internal compensation method and an external compensation method. The internal compensation method automatically compensates for a deviation between the threshold voltages of the driving TFTs inside circuits of the pixels. A driving current flowing in the OLED has to be determined irrespective of the threshold voltage of the driving TFT, so as to perform the internal compensation method. Therefore, configuration of the pixel circuit is very complex. Furthermore, the internal compensation method is not suitable to compensate for a deviation between mobilities of the driving TFTs.

[0009] The external compensation method measures sensing voltages corresponding to the threshold voltages (or mobilities) of the driving TFTs and modulates video data

through an external circuit based on the sensing voltages, thereby compensating for a deviation between the threshold voltages (or mobilities). In the external compensation method, in general, after the deviation between the threshold voltages is compensated, the deviation between the mobilities is compensated. However, in recent, as a resolution of a display panel gradually increases, improving process capability and mass production, etc. are becoming issues. For these reasons, a simpler configuration of the pixel circuit is desired. Hence, the configuration of the pixel circuit applied to the external compensation method needs to be simpler.

### SUMMARY OF THE INVENTION

[0010] Embodiments of the invention provide an organic light emitting display and a method of compensating for mobility thereof capable of compensating for a deviation between electrical characteristics of driving thin film transistors (TFTs) using an external compensation method with a pixel circuit that has a simpler structure.

[0011] Embodiments of the invention also provide an organic light emitting display and a method of compensating for mobility thereof capable of increasing a compensation capability.

[0012] In one aspect, there is an organic light emitting display comprising a display panel including a plurality of pixels, each pixel using a source following manner, in which a source voltage of a driving thin film transistor (TFT) is changed according to a current flowing between a drain electrode and a source electrode of the driving TFT, a gate driving circuit is configured to generate a mobility sensing gate pulse for operating the pixel in the source following manner, a data driving circuit is configured to detect a sensing voltage corresponding to a mobility of the driving TFT from the pixel in response to the mobility sensing gate pulse, and a timing controller is configured to set a mobility sensing period for detecting the sensing voltage in a period, in which a gate-source voltage of the driving TFT is greater than a threshold voltage of the driving TFT, wherein the mobility sensing period is included in a period in which the mobility sensing gate pulse is generated at an on-level, wherein the sensing voltage is detected in a predetermined period, which ranges from a start time point of the on-level of the mobility sensing gate pulse to a time point corresponding to 2% of one frame period.

### BRIEF DESCRIPTION OF THE DRAWINGS

[0013] The accompanying drawings, which are included to provide a further understanding of the invention and are incorporated in and constitute a part of this specification, illustrate embodiments of the invention and together with the description serve to explain the principles of the invention. In the drawings:

[0014] FIG. 1 is a block diagram of an organic light emitting display according to an exemplary embodiment of the invention;

[0015] FIG. 2 shows a pixel array of a display panel according to an embodiment of the invention;

[0016] FIG. 3 illustrates a connection structure of a timing controller, a data driving circuit, and pixels along with a detailed configuration of an external compensation pixel according to an embodiment of the invention;

[0017] FIG. 4 shows a change in potential for a gate voltage and a source voltage of a driving thin film transistor (TFT)

when sensing electrical characteristics of the driving TFT according to an embodiment of the invention;

[0018] FIG. 5 shows a comparison between a mobility sensing gate pulse, a mobility sensing period, a threshold voltage sensing gate pulse and a threshold voltage sensing period according to an embodiment of the invention;

[0019] FIG. 6 shows an image display period and non-display periods before and after the image display period according to an embodiment of the invention;

[0020] FIGS. 7 and 8 illustrate a method for providing additional improvements to compensation capability and a result thereof according to an embodiment of the invention; and

[0021] FIG. 9 shows a timing diagram of an image display gate pulse for an image display drive, a data voltage, etc. according to an embodiment of the invention.

#### DETAILED DESCRIPTION OF THE ILLUSTRATED EMBODIMENTS

[0022] Reference will now be made in detail to embodiments of the invention, examples of which are illustrated in the accompanying drawings. Wherever possible, the same reference numbers will be used throughout the drawings to refer to the same or like parts. It will be paid attention that detailed description of known arts will be omitted if it is determined that the arts can mislead the embodiments of the invention.

[0023] Exemplary embodiments of the invention will be described with reference to FIGS. 1 to 9.

[0024] FIG. 1 is a block diagram of an organic light emitting display according to an exemplary embodiment of the invention. FIG. 2 shows a pixel array of a display panel.

[0025] As shown in FIGS. 1 and 2, the organic light emitting display according to an embodiment of the invention includes a display panel 10, a data driving circuit 12, a gate driving circuit 13, and a timing controller 11.

[0026] The display panel 10 includes a plurality of data lines 14 and sensing lines 15, a plurality of gate lines 16 crossing the data lines 14 and the sensing lines 15, and a plurality of pixels P respectively arranged at crossings of the data lines 14, the sensing lines 15, and the gate lines 16 in a matrix form.

[0027] Each pixel P is connected to one of data lines 141 to 14m, one of sensing lines 151 to 15m, and one of gate lines 161 to 16n. Each pixel P receives a data voltage through the data line, receives a gate pulse through the gate line, and outputs a sensing voltage through the sensing line. Namely, in a pixel array shown in FIG. 2, the pixels P sequentially operate based on each of horizontal lines L#1 to L#n in response to the gate pulse, which is received from the gate lines 161 to 16n in a line sequential manner. The pixels P on the same horizontal line, on which an operation is activated, receive the data voltage from the data lines 141 to 14m and output the sensing voltage to the sensing lines 151 to 15m.

[0028] Each pixel P receives a high potential driving voltage EVDD and a low potential driving voltage EVSS from a power generator (not shown). Each pixel P includes an organic light emitting diode (OLED), a driving thin film transistor (TFT), first and second switch TFTs, and a storage capacitor for the external compensation. Each pixel P is characterized in that the first and second switch TFTs are simultaneously turned on in response to the same gate pulse, so as to reduce the number of signal lines. The TFTs constituting the pixel P may be implemented as a p-type or an n-type.

Further, semiconductor layers of the TFTs constituting the pixel P may contain amorphous silicon, polycrystalline silicon, or oxide.

[0029] In a sensing drive for sensing electrical characteristics (including a threshold voltage, a mobility, etc.) of the driving TFT, the data driving circuit 12 converts the sensing voltages received from the display panel 10 through the sensing lines 15 into digital values and supplies the digital sensing voltages to the timing controller 11. In an image display drive for the image display, the data driving circuit 12 converts digital compensation data MDATA received from the timing controller 11 into the analog data voltage based on a data control signal DDC and supplies the analog data voltage to the data lines 14.

[0030] The gate driving circuit 13 generates the gate pulse based on a gate control signal GDC. The gate pulse includes a threshold voltage sensing gate pulse, a mobility sensing gate pulse, and an image display gate pulse, each of which has a different width. A width of the mobility sensing gate pulse may be much less than a width of the threshold voltage sensing gate pulse. The gate driving circuit 13 may supply the threshold voltage sensing gate pulse to the gate lines 16 in the line sequential manner in the sensing drive of the threshold voltage, and may supply the mobility sensing gate pulse to the gate lines 16 in the line sequential manner in the sensing drive of the mobility. Further, in the image display drive, the gate driving circuit 13 may supply the image display gate pulse to the gate lines 16 in the line sequential manner. The gate driving circuit 13 may be directly formed on the display panel 10 through a gate driver-in panel (GIP) process.

[0031] The timing controller 11 generates the data control signal DDC for controlling operation timing of the data driving circuit 12 and the gate control signal GDC for controlling operation timing of the gate driving circuit 13 based on timing signals, such as a vertical sync signal Vsync, a horizontal sync signal Hsync, a data enable signal DE, and a dot clock DCLK. Further, the timing controller 11 modulates input digital video data DATA based on the digital sensing voltage values received from the data driving circuit 12 and generates the digital compensation data MDATA for compensating for a deviation between the electrical characteristics of the driving TFT.

[0032] The timing controller 11, according to an embodiment of the invention, sets a mobility sensing period for detecting the sensing voltage in a period, in which a gate-source voltage of the driving TFT is greater than the threshold voltage of the driving TFT, so as to increase a compensation capability of the mobility when sensing the mobility. Further, the timing controller 11 may set the mobility sensing period, so that the sensing voltage is detected in a predetermined period, starting from a time point, at which the mobility sensing gate pulse is generated at an on-level, to a time point corresponding to 2% of one frame period. Namely, when a source voltage of the driving TFT is changed to a gate voltage of the driving TFT through a source following manner shown in FIG. 4 in the sensing drive of the mobility, the timing controller 11 controls the width of the mobility sensing gate pulse and also controls operation timing of an internal switch SW2 (refer to FIG. 3) of the data driving circuit 12, so that the sensing voltage is detected in an initial change period. In other words, the driving TFT is configured as a source follower amplifier (e.g., common-drain amplifier).

[0033] The timing controller 11, according to an embodiment of the invention, calculates a gain value through using a

compensation function, in which a physical proportional constant  $K$  of the driving TFT is applied, and the input digital video data  $DATA$  is multiplied by the gain value to generate the digital compensation data  $MDATA$ , in which a mobility deviation between the driving TFTs is compensated, so as to further increase the compensation capability of the mobility during sensing of the mobility.

[0034] FIG. 3 illustrates a connection structure of the timing controller, the data driving circuit, and the pixels along with a detailed configuration of an external compensation pixel. FIG. 4 shows a change in a potential of each of a gate voltage and a source voltage of the driving TFT in the sensing drive for sensing the electrical characteristics of the driving TFT. FIG. 5 shows a comparison between the mobility sensing gate pulse, a mobility sensing period, the threshold voltage sensing gate pulse and a threshold voltage sensing period. FIG. 6 shows an image display period and non-display periods before and after the image display period.

[0035] As shown in FIG. 3, the pixel  $P$  may include an OLED, a driving TFT  $DT$ , a storage capacitor  $Cst$ , a first switch TFT  $ST1$ , and a second switch TFT  $ST2$ .

[0036] The OLED includes an anode electrode connected to a second node  $N2$ , a cathode electrode connected to an input terminal of a low potential driving voltage  $EVSS$ , and an organic compound layer positioned between the anode electrode and the cathode electrode.

[0037] The driving TFT  $DT$  controls a driving current  $Ioled$  flowing in the OLED depending on a gate-source voltage  $Vgs$  of the driving TFT  $DT$ . The driving TFT  $DT$  includes a gate electrode connected to a first node  $N1$ , a drain electrode connected to an input terminal of a high potential driving voltage  $EVDD$ , and a source electrode connected to the second node  $N2$ .

[0038] The storage capacitor  $Cst$  is connected between the first node  $N1$  and the second node  $N2$ .

[0039] The first switch TFT  $ST1$  applies a data voltage  $Vdata$  on the data line  $14$  to the first node  $N1$  in response to a gate pulse  $GP$ . The first switch TFT  $ST1$  includes a gate electrode connected to the gate line  $16$ , a drain electrode connected to the data line  $14$ , and a source electrode connected to the first node  $N1$ .

[0040] The second switch TFT  $ST2$  turns on a current flow between the second node  $N2$  and the sensing line  $15$  in response to the gate pulse  $GP$ . Hence, the second switch TFT  $ST2$  stores a source voltage of the second node  $N2$  in a sensing capacitor  $Cx$  on the sensing line  $15$ , which is changed by following a gate voltage of the first node  $N1$  in the source following manner. A gate electrode of the second switch TFT  $ST2$  is commonly connected to the gate electrode of the first switch TFT  $ST1$  and the gate line  $16$ , a drain electrode of the second switch TFT  $ST2$  is connected to the second node  $N2$ , and a source electrode of the second switch TFT  $ST2$  is connected to the sensing line  $15$ .

[0041] The data driving circuit  $12$  is connected to the pixel  $P$  through the data line  $14$  and the sensing line  $15$ . The sensing capacitor  $Cx$ , which stores the source voltage of the second node  $N2$  as a sensing voltage  $Vsen$ , is formed on the sensing line  $15$ . The data driving circuit  $12$  includes a digital-to-analog converter (DAC), an analog-to-digital converter (ADC), a first switch  $SW1$ , and a second switch  $SW2$ .

[0042] The DAC converts digital data received from the timing controller  $11$  into the analog data voltage  $Vdata$  and outputs the analog data voltage  $Vdata$  to the data line  $14$ . The first switch  $SW1$  turns on a current flow between an input

terminal of an initialization voltage  $Vpre$  and the sensing line  $15$ . The second switch  $SW2$  turns on a current flow between the sensing line  $15$  and the ADC. The ADC converts the analog sensing voltage  $Vsen$  stored in the sensing capacitor  $Cx$  into a digital value and supplies the digital sensing voltage  $Vsen$  to the timing controller  $11$ .

[0043] A process for detecting the sensing voltage  $Vsen$  corresponding to a mobility of the driving TFT  $DT$  from each pixel  $P$  is additionally described below with reference to FIGS. 4 and 5.

[0044] The sensing voltage  $Vsen$  detected from each pixel  $P$  corresponds to mobility  $\mu$  of the driving TFT  $DT$ . The embodiment of the invention applies the data voltage  $Vdata$ , in which a threshold voltage  $Vth$  of the driving TFT  $DT$  is compensated, to each pixel  $P$  through the DAC of the data driving circuit  $12$ , before detecting the sensing voltage  $Vsen$ .

[0045] When a mobility sensing gate pulse  $GPb$  of an on-level  $Lon$  is applied to the pixel  $P$  for sensing the mobility, the first switch TFT  $ST1$  and the second switch TFT  $ST2$  are simultaneously turned on. In this instance, the first switch  $SW1$  inside the data driving circuit  $12$  is turned on. When the first switch  $SW1$  is turned on, the data voltage  $Vdata$ , in which the threshold voltage  $Vth$  of the driving TFT  $DT$  is compensated, is supplied to the first node  $N1$ . When the first switch  $SW1$  and the second switch  $SW2$  are turned on, the initialization voltage  $Vpre$  is supplied to the second node  $N2$ . In this instance, because the gate-source voltage  $Vgs$  of the driving TFT  $DT$  is greater than the threshold voltage  $Vth$  of the driving TFT  $DT$ , the driving current  $Ioled$  flows between the drain electrode and the source electrode of the driving TFT  $DT$ . A source voltage  $VN2$  of the driving TFT  $DT$  charged by the second node  $N2$  gradually increases due to the driving current  $Ioled$ . Hence, until the gate-source voltage  $Vgs$  of the driving TFT  $DT$  becomes the threshold voltage  $Vth$  of the driving TFT  $DT$ , the source voltage  $VN2$  of the driving TFT  $DT$  follows a gate voltage  $VN1$  of the driving TFT  $DT$ .

[0046] The source voltage  $VN2$  of the driving TFT  $DT$  charged by the second node  $N2$  is stored in the sensing capacitor  $Cx$  formed on the sensing line  $15$ , as the sensing voltage  $Vsen$ , via the second switch TFT  $ST2$ . When the first switch  $SW1$  inside the data driving circuit  $12$  is turned off, and at the same time, the second switch  $SW2$  is turned on, the sensing voltage  $Vsen$  is detected in a period, in which the mobility sensing gate pulse  $GPb$  is maintained at the on-level  $Lon$ , and is supplied to the ADC.

[0047] The source following manner has an advantage when used with the simple configuration of the pixel because the first and second switch TFTs  $ST1$  and  $ST2$  may be commonly connected to one gate line  $16$ . However, because the gate-source voltage  $Vgs$  of the driving TFT  $DT$  is continuously reduced during sensing of the mobility the compensation capability of the mobility  $\mu$  is reduced.

[0048] In an embodiment, a width  $PW2$  of the mobility sensing gate pulse  $GPb$  is set to be less than a width  $PW1$  of a threshold voltage sensing gate pulse  $GPa$ , so as to minimize a reduction in the compensation capability of the mobility  $\mu$ . Further, a mobility sensing period can be set, so that sensing of the mobility  $\mu$  is performed in a period, in which the gate-source voltage  $Vgs$  of the driving TFT  $DT$  is greater than the threshold voltage  $Vth$  of the driving TFT  $DT$ . As a result, after a first time passed from a start time point ( $t=0$ ) of the on-level  $Lon$  during the threshold voltage sensing gate pulse  $GPa$ , sensing of the threshold voltage  $Vth$  is performed. On the other hand, sensing of the mobility  $\mu$  is performed after a

second time much shorter than the first time passed from a start time point ( $t=0$ ) of the on-level  $L_{on}$  of the mobility sensing gate pulse  $GP_b$ . For example, when one frame period is 8.3 ms, the second time may be, for example, about 100  $\mu$ s.

[0049] In other words, a measurement of the mobility  $\mu$  is performed during a shorter period than a measurement of the threshold voltage  $V_{th}$ . An embodiment of the invention can be characterized in that the sensing voltage  $V_{sen}$  for the compensation of the mobility  $\mu$  is detected in a predetermined period, which starts from a generation time point of the on-level  $L_{on}$  of the mobility sensing gate pulse  $GP_b$  to a time point corresponding to 2% of one frame period.

[0050] As shown in FIG. 6, the mobility sensing period may belong to at least one of vertical blank periods  $VB$  in an image display period  $X_0$ , a first non-display period  $X_1$  can be arranged prior to the image display period  $X_0$ , and a second non-display period  $X_2$  can be arranged after the image display period  $X_0$ . The vertical blank periods  $VB$  are defined as periods between adjacent display frames  $DF$ . The first non-display period  $X_1$  may be defined as a period of several tens to several hundreds of frames having passed from an application time point of a driving power enable signal  $PEN$ . The second non-display period  $X_2$  may be defined as a period of several tens to several hundreds of frames having passed from an application time point of a driving power disable signal  $PDIS$ .

[0051] A threshold voltage sensing period may be included in the first non-display period  $X_1$ , the vertical blank periods  $VB$ , and the second non-display period  $X_2$ . Because a relatively long time is required to sense the threshold voltage  $V_{th}$ , it is preferable that the threshold voltages  $V_{th}$  of the driving TFTs of all of the pixels be measured in the first non-display period  $X_1$  and/or the second non-display period  $X_2$ . Further, it is advantageous for the compensation capability to sense the mobility  $\mu$  for a relatively short amount of time. Therefore, it is preferable that the mobilities  $\mu$  of the predetermined number of pixels are sensed in each vertical blank period  $VB$ .

[0052] FIGS. 7 and 8 illustrate a method for improving the additional compensation capability and a result thereof.

[0053] More specifically, FIGS. 7 and 8 show a graph showing a relationship between the mobility  $\mu$  and the sensing voltage  $V_{sen}$ . The compensation capability of the mobility  $\mu$  indicates the accuracy of the compensation. As indicated by a graph B of FIGS. 7 and 8, the compensation capability of the mobility  $\mu$  is best when the mobility  $\mu$  and the sensing voltage  $V_{sen}$  are directly proportional to each other. The directly proportional relationship indicated by the graph B is obtained when the gate-source voltage  $V_{gs}$  of the driving TFT DT is held constant throughout the sensing period.

[0054] Because the embodiment of the invention uses the source following manner for a pixel with a simple circuit structure, the gate-source voltage  $V_{gs}$  of the driving TFT DT continuously varies during the sensing period. Thus, as described above, even if the sensing time of the mobility  $\mu$  is set to be much shorter than the sensing time of the threshold voltages  $V_{th}$ , the relationship between the mobility  $\mu$  and the sensing voltage  $V_{sen}$  has a parabola shape as indicated by graph A in FIGS. 7 and 8. As a result, there is somewhat of a limit for increasing the compensation capability.

[0055] In an embodiment, the relationship between the mobility  $\mu$  and the sensing voltage  $V_{sen}$  is corrected from graph A to graph B, so as to further increase the compensation capability of the mobility  $\mu$ . For this, the timing controller 11 can linearly correct a slope indicating a ratio of a change of

the sensing voltage  $V_{sen}$  to a change of the mobility  $\mu$  and also corrects the sensing voltage  $V_{sen}$  through a lookup table or a compensation function to increase the slope.

[0056] The compensation function may be expressed by the following Equation 1.

$$G = \sqrt{\frac{V_{sen\_ave}}{V_{sen} + (V_{sen} - V_{sen\_ave}) \times K}} \quad [\text{Equation 1}]$$

[0057] The timing controller 11 may calculate a gain value  $G$  using the above Equation 1, in which the sensing voltage  $V_{sen}$  is received from the data driving circuit 12, and an average sensing voltage  $V_{sen\_ave}$  and the physical proportional constant  $K$  of the driving TFT are applied. In an embodiment, the average sensing voltage  $V_{sen\_ave}$  can correspond to an average of the sensing voltages  $V_{sen}$  extracted from the pixels. The average sensing voltage  $V_{sen\_ave}$  may be obtained through a real time calculation and may also be previously set to an initial value that is stored when the display panels are shipped. The physical proportional constant  $K$  is determined by a channel capacity including a channel width and a channel length of the driving TFT, the mobility  $\mu$  of the driving TFT, and a parasitic capacitance between the electrodes of the driving TFT. The timing controller 11 may multiply the input digital video data by the gain value  $G$  and may generate the digital compensation data for compensating for the mobility deviation.

[0058] FIG. 9 shows a timing diagram of the image display gate pulse for driving the image display, the data voltage, etc.

[0059] The image display drive of a predetermined pixel  $P$  on an  $n$ th line is described below with reference to FIGS. 3 and 9.

[0060] The image display drive is divided into a programming period  $T_p$  and an emission period  $T_e$ . Operations performed in the two periods are repeated in each frame period. In the image display drive, the first switch  $SW1$  of the data driving circuit 12 is continuously maintained in a turn-on state, and the second switch  $SW2$  of the data driving circuit 12 is continuously maintained in a turn-off state.

[0061] In the programming period  $T_p$ , the first and second switch TFTs  $ST1$  and  $ST2$  are simultaneously turned on, in response to an image display gate pulse  $GP_n$ . Hence, the gate-source voltage  $V_{gs}$  of the driving TFT DT can be programmed at a desired level (e.g., a difference between the  $N$ th data voltage and the initialization voltage  $V_{pre}$ ).

[0062] In the emission period  $T_e$ , the first and second switch TFTs  $ST1$  and  $ST2$  are simultaneously turned on, in response to the image display gate pulse  $GP_n$ , and the driving TFT DT generates the driving current  $I_{oled}$  based on the programmed level of the gate-source voltage  $V_{gs}$  and applies the driving current  $I_{oled}$  to the OLED. The OLED emits light at brightness corresponding to the driving current  $I_{oled}$  and represents gray scale.

[0063] The adjacent image display gate pulses  $GP_n$  and  $GP_{n-1}$  may overlap for a predetermined period in order to secure a sufficient scan period.

[0064] As described above, the embodiments of the invention compensate for the deviation between the electrical characteristics of the driving TFTs using the external compensation method and reduces the number of gate lines assigned to each pixel using the source following manner, thereby simplifying the configuration of the gate driving circuit and

increasing the aperture ratio of the pixel array. Hence, the image quality of the organic light emitting display can be improved, and the process capability and the mass production can be greatly increased.

[0065] Furthermore, according to the embodiments of the invention, the mobility sensing time can be set much shorter than the time for sensing the threshold voltage in the source following manner, thereby increasing the compensation capability of the mobility.

[0066] Furthermore, according to the embodiments, the invention can linearly correct a slope indicating a ratio of a change of the sensing voltage to a change of the mobility and also correct the sensing voltage though a lookup table or a compensation function to increase the slope. Hence, the compensation capability of the mobility may be further increased.

[0067] Although embodiments of the invention have been described with reference to a number of illustrative embodiments thereof, it should be understood that numerous other modifications and embodiments can be devised by those skilled in the art that will fall within the scope of the principles of this disclosure. More particularly, various variations and modifications are possible in the component parts and/or arrangements of the subject combination arrangement within the scope of the disclosure, the drawings and the appended claims. In addition to variations and modifications in the component parts and/or arrangements, alternative uses will also be apparent to those skilled in the art.

What is claimed is:

1. An organic light emitting display comprising:  
a display panel including a plurality of pixels, each pixel using a source following manner, in which a source voltage of a driving thin film transistor (TFT) is changed according to a current flowing between a drain electrode and a source electrode of the driving TFT;  
a gate driving circuit configured to generate a mobility sensing gate pulse for operating the pixel in the source following manner;  
a data driving circuit configured to detect a sensing voltage corresponding to a mobility of the driving TFT from the pixel in response to the mobility sensing gate pulse; and  
a timing controller configured to set a mobility sensing period for detecting the sensing voltage in a period, in which a gate-source voltage of the driving TFT is greater than a threshold voltage of the driving TFT,  
wherein the mobility sensing period is included in a period in which the mobility sensing gate pulse is generated at an on-level,  
wherein the sensing voltage is detected in a predetermined period, which ranges from a start time point of the on-level of the mobility sensing gate pulse to a time point corresponding to a portion of one frame period.

2. The organic light emitting display of claim 1, wherein each pixel includes:

- the driving TFT including a gate electrode connected to a first node, the source electrode connected to a second node, and the drain electrode connected to an input terminal of a high potential driving voltage;
- an organic light emitting diode (OLED) connected between the second node and an input terminal of a low potential driving voltage;
- a storage capacitor connected between the first node and the second node;

a first switch TFT connected between a data line charged to a threshold voltage compensation data voltage and the first node; and

a second switch TFT connected between a sensing line charged to the sensing voltage and the second node, wherein the first and second switch TFTs are simultaneously turned on in response to the mobility sensing gate pulse.

3. The organic light emitting display of claim 1, wherein the mobility sensing period belongs to at least one of a plurality of vertical blank periods during an image display period, a first non-display period arranged prior to the image display period, and a second non-display period arranged after the image display period.

4. The organic light emitting display of claim 1, wherein the timing controller linearly corrects a slope indicating a ratio of a change amount of the sensing voltage to a change amount of the mobility and corrects the sensing voltage using a lookup table or a compensation function to increase the slope.

5. The organic light emitting display of claim 4, wherein the compensation function is expressed by the following Equation:

$$G = \sqrt{\frac{V_{sen\_ave}}{V_{sen} + (V_{sen} - V_{sen\_ave}) \times K}},$$

wherein the timing controller calculates a gain value G using the Equation, in which a sensing voltage V<sub>sen</sub> is received from the data driving circuit and an average sensing voltage V<sub>sen\_ave</sub> and a physical proportional constant K of the driving TFT are applied to the Equation, multiplies digital video data by the gain value G, to be input to the pixel, and generates digital compensation data for compensating for a deviation between the mobilities of the driving TFTs.

6. The organic light emitting display of claim 1, wherein the portion of one frame period corresponds to 2% of one frame period.

7. A method of compensating for mobility of an organic light emitting display including a display panel including a plurality of pixels of a source following manner, in which a source voltage of a driving thin film transistor (TFT) is changed according to a current flowing between a drain electrode and a source electrode of the driving TFT, the method comprising:

generating a mobility sensing gate pulse for operating a pixel in the source following manner;

detecting a sensing voltage corresponding to mobility of the driving TFT from the pixel in response to the mobility sensing gate pulse; and

setting a mobility sensing period for detecting the sensing voltage in a period, in which a gate-source voltage of the driving TFT is greater than a threshold voltage of the driving TFT,

wherein the mobility sensing period is included in a period in which the mobility sensing gate pulse is generated at an on-level, and

wherein the sensing voltage is detected in a predetermined period, which ranges from a start time point of the on-level of the mobility sensing gate pulse to a time point corresponding to a portion of one frame period.

**8.** The method of claim 7, wherein the mobility sensing period belongs to at least one of a plurality of vertical blank periods during an image display period, a first non-display period arranged prior to the image display period, and a second non-display period arranged after the image display period.

**9.** The method of claim 7, further comprising linearly correcting a slope indicating a ratio of a change amount of the sensing voltage to a change amount of the mobility and correcting the sensing voltage using a lookup table or a compensation function to increase the slope.

**10.** The method of claim 9, wherein the compensation function is expressed by the following Equation:

$$G = \sqrt{\frac{V_{sen\_ave}}{V_{sen} + (V_{sen} - V_{sen\_ave}) \times K}},$$

wherein the method further comprises calculating a gain value G using the Equation, in which a sensing voltage V<sub>sen</sub>, an average sensing voltage V<sub>sen\_ave</sub>, and a physical proportional constant K of the driving TFT are applied to the Equation, multiplying digital video data by the gain value G, to be input to the pixel, and generating digital compensation data for compensating for a deviation between the mobilities of the driving TFTs.

**11.** The method of claim 7, wherein the portion of one frame period corresponds to 2% of one frame period.

\* \* \* \* \*

专利名称(译)	有机发光显示器和补偿其迁移率的方法		
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### 摘要(译)

有机发光显示器可包括显示面板，该显示面板包括源极跟随方式的多个像素，其中驱动薄膜晶体管(TFT)的源极电压根据在漏极电极和源极电极之间流动的电流而改变。驱动TFT，用于产生用于以源跟随方式操作像素的迁移率感测栅极脉冲的栅极驱动电路，用于响应于移动性检测与来自像素的驱动TFT的迁移率对应的感测电压的数据驱动电路感测栅极脉冲和用于在一段时间内设置迁移率感测时段的时序控制器，其中驱动TFT的栅极-源极电压大于驱动TFT的阈值电压。

