(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 2 782 090 B1

(12) EUROPEAN PATENT SPECIFICATION

(45) Date of publication and mention of the grant of the patent:
21.11.2018 Bulletin 2018/47

(51) Int Cl.:
G09G 3/32 *(2016.01)*

(21) Application number: **14157112.5**

(22) Date of filing: **28.02.2014**

(54) Pixel circuits for amoled displays

Pixelschaltungen für Amoledanzeigen

Circuits de pixels pour écrans AMOLED

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR

(30) Priority: **08.03.2013 US 201313789978**

(43) Date of publication of application:
24.09.2014 Bulletin 2014/39

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Printed by Jouve, 75001 PARIS (FR)

Description

FIELD OF THE INVENTION

[0001] The present disclosure generally relates to circuits for use in displays, and methods of driving, calibrating, and programming displays, particularly displays such as active matrix organic light emitting diode displays.

BACKGROUND

[0002] Displays can be created from an array of light emitting devices each controlled by individual circuits (i.e., pixel circuits) having transistors for selectively controlling the circuits to be programmed with display information and to emit light according to the display information. Thin film transistors ("TFTs") fabricated on a substrate can be incorporated into such displays. TFTs tend to demonstrate non-uniform behavior across display panels and over time as the displays age. Compensation techniques can be applied to such displays to achieve image uniformity across the displays and to account for degradation in the displays as the displays age.

[0003] Some schemes for providing compensation to displays to account for variations across the display panel and over time utilize monitoring systems to measure time dependent parameters associated with the aging (i.e., degradation) of the pixel circuits. The measured information can then be used to inform subsequent programming of the pixel circuits so as to ensure that any measured degradation is accounted for by adjustments made to the programming. Such monitored pixel circuits may require the use of additional transistors and/or lines to selectively couple the pixel circuits to the monitoring systems and provide for reading out information. The incorporation of additional transistors and/or lines may undesirably decrease pixel-pitch (i.e., "pixel density").

[0004] Patent application publication US 2012/299978 A1 describes circuits for programming, monitoring, and driving pixels in a display. Circuits generally include a driving transistor to drive current through a light emitting device according to programming information which is stored on a storage device, such as a capacitor. One or more switching transistors are generally included to select the circuits for programming, monitoring, and/or emission. Circuits incorporate emission transistors to selectively couple the gate and source terminals of a driving transistor to allow programming information to be applied to the driving transistor independently of a resistance of a switching transistor.

[0005] Patent application publication. EP 2 133 860 A1 describes an organic light emitting display that includes: scan lines for applying scan signals; control lines for applying control signals; and data lines for applying data signals. The organic light emitting display further includes: pixels coupled to the scan, control and data lines for displaying an image; power supply lines coupled to the pixels; and a data driver for supplying the data signals of the image to the data lines. The organic light emitting display also includes: a power supply driver for swinging a voltage at the power supply lines between a first level and a second level; a sensing unit including a current sink for sinking a first current from the pixels and a current source for supplying a second current to the pixels; and a switching unit for selectively electrically coupling the pixels to at least one of the data driver, the current source or the current sink.

[0006] Patent application publication US 2009/295423 A1 describes a method of determining characteristics of transistors and electroluminescent devices that includes: providing an electroluminescent display; providing for pairs of electroluminescent devices drive circuits and a single readout line, each drive circuit including a readout transistor electrically connected to the readout line; providing a first voltage source; providing a second voltage source; providing a current source; providing a current sink; providing a test voltage source; providing a voltage measurement circuit; sequentially testing the drive transistors to provide a first signal representative of characteristics of the drive transistor of the first drive circuit and a second signal representative of characteristics of the drive transistor of the second drive circuit, whereby the characteristics of each drive transistor are determined; and simultaneously testing the first and second electroluminescent devices to provide a third signal representative of characteristics of the pair of electroluminescent devices, whereby the characteristics of both electroluminescent devices are determined.

[0007] Patent application publication US 2011/205250 A1 describes an organic light emitting diode (OLED) display that comprises: an OLED; a driving transistor for supplying driving current to the OLED; a data line for transmitting a corresponding data signal to the driving transistor; a first transistor having a first electrode connected to one electrode of the OLED and a second electrode connected to the data line; and a second transistor having a first electrode connected to the data line and a second electrode connected a gate electrode of the driving transistor, wherein the first transistor, the second transistor, and the driving transistor are turned on, a first current and a second current are respectively sunk in a path of driving current from the driving transistor to the OLED through the data line, and a threshold voltage and mobility of the driving transistor are calculated by receiving a first voltage and a second voltage applied to the gate electrode of the driving transistor corresponding to sinking of the first current and the second current through the second transistor and the data line, and the data signal transmitted to the data line is compensated.

[0008] Patent application publication EP 2 383 720 A2 describes a system for a display array including a pixel circuit, the pixel circuit including a driving transistor, at least one switch transistor, a storage capacitor and a light emitting device. The system comprises a monitor for monitoring a current or voltage associated with the pixel circuit, a data process unit for controlling the operation of the display array, the data process unit being configured to extract information indicative of an aging of the pixel circuit, based on the monitored current or voltage and a driver controlled by the data process unit for providing programming and calibration data to the pixel circuit based on the extracted aging information.

[0009] Patent application publication US 2010/103159 A1 describes an electroluminescent (EL) subpixel having a readout transistor is driven by a current source when the drive transistor is non-conducting. This produces an emitter-voltage signal from which an aging signal representing the efficiency of the EL emitter can be computed. The aging signal is used to adjust an input signal to produce a compensated drive signal to compensate for changes in efficiency of the EL emitter.

[0010] Patent application publication US 2010/0103082 A1 describes a method of compensating for differences in characteristics of a plurality of electroluminescent (EL) subpixels having readout transistors, includes providing a first voltage source connected through a first switch to each subpixel's drive transistor and a second voltage source connected through a second switch to each subpixel's EL emitter; providing a current source connected through a third switch, and a current sink connected through a fourth switch, to the readout transistor; providing a test voltage to a subpixel; closing only the first and fourth switches and measuring the readout transistor voltage to provide a first signal representative of characteristics of the drive transistor; closing only the second and third switches and measuring the voltage to provide a second signal representative of characteristics of the EL emitter; repeating for each subpixel; and using the first and second signals for each subpixel to compensate for differences in characteristics of the EL subpixels.

[0011] Patent application publication US 2008/0315788 A1 describes a method of compensating for changes in an OLED drive circuit that includes: providing a drive transistor; providing a first voltage source and a first switch; providing an OLED device connected to the drive transistor. Voltages are measured and used to compensate for changes in the OLED drive transistor.

SUMMARY OF THE INVENTION

[0012] It is an object of the present invention to provide a method and a system that obviate or mitigate at least one of the above disadvantages of the existing prior art.

[0013] This object is solved by the present invention as claimed in the independent claims. Advantageous and preferred embodiments of the invention are defined by the dependent claims.

[0014] In accordance with one illustrative example for understanding the present invention, the OLED voltage of a selected pixel is extracted from the pixel produced when the pixel is programmed so that the pixel current is a function of the OLED voltage. One method for extracting the OLED voltage is to first program the pixel in a way that the current is not a function of OLED voltage, and then in a way that the current is a function of OLED voltage. During the latter stage, the programming voltage is changed so that the pixel current is the same as the pixel current when the pixel was programmed in a way that the current was not a function of OLED voltage. The difference in the two programming voltages is then used to extract the OLED voltage.

[0015] Another method for extracting the OLED voltage is to measure the difference between the current of the pixel when it is programmed with a fixed voltage in both methods (being affected by OLED voltage and not being affected by OLED voltage). This measured difference and the current-voltage characteristics of the pixel are then used to extract the OLED voltage.

[0016] A further method for extracting the shift in the OLED voltage is to program the pixel for a given current at time zero (before usage) in a way that the pixel current is a function of OLED voltage, and save the programming voltage. To extract the OLED voltage shift after some usage time, the pixel is programmed for the given current as was done at time zero. To get the same current as time zero, the programming voltage needs to change. The difference in the two programming voltages is then used to extract the shift in the OLED voltage. Here one needs to remove the effect of TFT aging from the second programming voltage first; this is done by programming the pixel without OLED effect for a given current at time zero and after usage. The difference in the programming voltages in this case is the TFT aging, which is subtracted from the calculated different in the aforementioned case.

[0017] In one implementation, the current effective voltage V_{OLED} of a light-emitting device in a selected pixel is determined by supplying a programming voltage to the drive transistor in the selected pixel to supply a first current to the light-emitting device (the first current being independent of the effective voltage V_{OLED} of the light-emitting device), measuring the first current, supplying a second programming voltage to the drive transistor in the selected pixel to supply a second current to the light-emitting device, the second current being a function of the current effective voltage V_{OLED} of the light-emitting device, measuring the second current and comparing the first and second current measurements, adjusting the second programming voltage to make the second current substantially the same as the first current, and extracting the value of the current effective voltage V_{OLED} of the light-emitting device from the difference between the first and second programming voltages.

[0018] In another implementation, the current effective voltage V_{OLED} of a light-emitting device in a selected pixel is determined by supplying a first programming voltage to the drive transistor in the selected pixel to supply a first current to the light-emitting device in the selected pixel (the first current being independent of the effective voltage V_{OLED} of the light-emitting device), measuring the first current, supplying a second programming voltage to the drive transistor in the selected pixel to supply a second current to the light-emitting device in the selected pixel (the second current being a function of the current effective voltage V_{OLED} of the light-emitting device), measuring the second current, and extracting the value of the current effective voltage V_{OLED} of the light-emitting device from the difference between the first and second current measurements.

[0019] In a modified implementation, the current effective voltage V_{OLED} of a light-emitting device in a selected pixel is determined by supplying a first programming voltage to the drive transistor in the selected pixel to supply a predetermined current to the light-emitting device at a first time (the first current being a function of the effective voltage V_{OLED} of the light-emitting device), supplying a second programming voltage to the drive transistor in the selected pixel to supply the predetermined current to the light-emitting device at a second time following substantial usage of the display, and extracting the value of the current effective voltage V_{OLED} of the light-emitting device from the difference between the first and second programming voltages.

[0020] In another modified implementation, the current effective voltage V_{OLED} of a light-emitting device in a selected pixel is determined by supplying a predetermined programming voltage to the drive transistor in the selected pixel to supply a first current to the light-emitting device (the first current being independent of the effective voltage V_{OLED} of the light-emitting device), measuring the first current, supplying the predetermined programming voltage to the drive transistor in the selected pixel to supply a second current to the light-emitting device (the second current being a function of the current effective voltage V_{OLED} of the light-emitting device), measuring the second current, and extracting the value of the current effective voltage V_{OLED} of the light-emitting device from the difference between the first and second currents and current-voltage characteristics of the selected pixel.

[0021] In a preferred implementation, a system is provided for controlling an array of pixels in a display in which each pixel includes a light-emitting device. Each pixel includes a pixel circuit that comprises the light-emitting device, which emits light when supplied with a voltage V_{OLED}; a drive transistor for driving current through the light-emitting device according to a driving voltage across the drive transistor during an emission cycle, the drive transistor having a gate, a source and a drain and characterized by a threshold voltage; and a storage capacitor coupled across the source and gate of the drive transistor for providing the driving voltage to the drive transistor. A supply voltage source is coupled to the drive transistor for supplying current to the light-emitting device via the drive transistor, the current being controlled by the driving voltage. A monitor line is coupled to a read transistor that controls the coupling of the monitor line to a first node that is common to the source side of the storage capacitor, the source of the drive transistor, and the light-emitting device. A data line is coupled to a switching transistor that controls the coupling of the data line to a second node that is common to the gate side of the storage capacitor and the gate of the drive transistor. A controller coupled to the data and monitor lines and to the switching and read transistors is adapted to:

(1) during a first cycle, turn on the switching and read transistors while delivering a voltage Vb to the monitor line and a voltage Vd1 to the data line, to supply the first node with a voltage that is independent of the voltage across the light-emitting device,
(2) during a second cycle, turn on the read transistor and turn off the switching transistor while delivering a voltage Vref to the monitor line, and read a first sample of the drive current at the first node via the read transistor and the monitor line.
(3) during a third cycle, turn off the read transistor and turn on the switching transistor while delivering a voltage Vd2 to the data line, so that the voltage at the second node is a function of V_{OLED}, and
(4) during a fourth cycle, turn on said read transistor and turn off said switching transistor while delivering a voltage Vref to said monitor line, and read a second sample the drive current at said first node via said read transistor and said monitor line. The first and second samples of the drive current are compared and, if they are different, the first through fourth cycles are repeated using an adjusted value of at least one of the voltages Vd1 and Vd2, until the first and second samples are substantially the same.

[0022] The foregoing and additional aspects and embodiments of the present invention will be apparent to those of ordinary skill in the art in view of the detailed description of various embodiments and/or aspects, which is made with reference to the drawings, a brief description of which is provided next.

BRIEF DESCRIPTION OF THE DRAWINGS

[0023] The foregoing and other advantages of the invention will become apparent upon reading the following detailed description and upon reference to the drawings.

FIG, 1 is a block diagram of an exemplary configuration of a system for driving an OLED display while monitoring the degradation of the individual pixels and providing compensation therefor.
FIG. 2A is a circuit diagram of an exemplary pixel circuit configuration.
FIG. 2B is a timing diagram of first exemplary operation cycles for the pixel shown in FIG. 2A.
FIG. 2C is a timing diagram of second exemplary operation cycles for the pixel shown in FIG. 2A.
FIG. 3 is a circuit diagram of another exemplary pixel circuit configuration.
FIG. 4 is a block diagram of a modified configuration of a system for driving an OLED display using a

shared readout circuit, while monitoring the degradation of the individual pixels and providing compensation therefor.

[0024] While the invention is susceptible to various modifications and alternative forms, specific embodiments have been shown by way of example in the drawings and will be described in detail herein. It should be understood, however, that the invention is not intended to be limited to the particular forms disclosed. Rather, the invention is to cover all modifications, equivalents, and alternatives falling within the spirit and scope of the invention as defined by the appended claims.

DETAILED DESCRIPTION

[0025] FIG. 1 is a diagram of an exemplary display system 50. The display system 50 includes an address driver 8, a data driver 4, a controller 2, a memory storage 6, and display panel 20. The display panel 20 includes an array of pixels 10 arranged in rows and columns. Each of the pixels 10 is individually programmable to emit light with individually programmable luminance values. The controller 2 receives digital data indicative of information to be displayed on the display panel 20. The controller 2 sends signals 32 to the data driver 4 and scheduling signals 34 to the address driver 8 to drive the pixels 10 in the display panel 20 to display the information indicated. The plurality of pixels 10 associated with the display panel 20 thus comprise a display array ("display screen") adapted to dynamically display information according to the input digital data received by the controller 2. The display screen can display, for example, video information from a stream of video data received by the controller 2. The supply voltage 14 can provide a constant power voltage or can be an adjustable voltage supply that is controlled by signals from the controller 2. The display system 50 can also incorporate features from a current source or sink (not shown) to provide biasing currents to the pixels 10 in the display panel 20 to thereby decrease programming time for the pixels 10.

[0026] For illustrative purposes, the display system 50 in FIG. 1 is illustrated with only four pixels 10 in the display panel 20. It is understood that the display system 50 can be implemented with a display screen that includes an array of similar pixels, such as the pixels 10, and that the display screen is not limited to a particular number of rows and columns of pixels. For example, the display system 50 can be implemented with a display screen with a number of rows and columns of pixels commonly available in displays for mobile devices, monitor-based devices, and/or projection-devices.

[0027] The pixel 10 is operated by a driving circuit ("pixel circuit") that generally includes a driving transistor and a light emitting device. Hereinafter the pixel 10 may refer to the pixel circuit. The light emitting device can optionally be an organic light emitting diode, but implementations of the present disclosure apply to pixel circuits having other electroluminescence devices, including current-driven light emitting devices. The driving transistor in the pixel 10 can optionally be an n-type or p-type amorphous silicon thin-film transistor, but implementations of the present disclosure are not limited to pixel circuits having a particular polarity of transistor or only to pixel circuits having thin-film transistors. The pixel circuit 10 can also include a storage capacitor for storing programming information and allowing the pixel circuit 10 to drive the light emitting device after being addressed. Thus, the display panel 20 can be an active matrix display array.

[0028] As illustrated in FIG. 1, the pixel 10 illustrated as the top-left pixel in the display panel 20 is coupled to a select line 24i, a supply line 26i, a data line 22j, and a monitor line 28j. A read line may also be included for controlling connections to the monitor line. In one implementation, the supply voltage 14 can also provide a second supply line to the pixel 10. For example, each pixel can be coupled to a first supply line 26 charged with Vdd and a second supply line 27 coupled with Vss, and the pixel circuits 10 can be situated between the first and second supply lines to facilitate driving current between the two supply lines during an emission phase of the pixel circuit. The top-left pixel 10 in the display panel 20 can correspond a pixel in the display panel in a "ith" row and "jth" column of the display panel 20. Similarly, the top-right pixel 10 in the display panel 20 represents a "jth" row and "mth" column; the bottom-left pixel 10 represents an "nth" row and "jth" column; and the bottom-right pixel 10 represents an "nth" row and "mth" column. Each of the pixels 10 is coupled to appropriate select lines (e.g., the select lines 24i and 24n), supply lines (e.g., the supply lines 26i and 26n), data lines (e.g., the data lines 22j and 22m), and monitor lines (e.g., the monitor lines 28j and 28m). It is noted that aspects of the present disclosure apply to pixels having additional connections, such as connections to additional select lines, and to pixels having fewer connections, such as pixels lacking a connection to a monitoring line.

[0029] With reference to the top-left pixel 10 shown in the display panel 20, the select line 24i is provided by the address driver 8, and can be utilized to enable, for example, a programming operation of the pixel 10 by activating a switch or transistor to allow the data line 22j to program the pixel 10. The data line 22j conveys programming information from the data driver 4 to the pixel 10. For example, the data line 22j can be utilized to apply a programming voltage or a programming current to the pixel 10 in order to program the pixel 10 to emit a desired amount of luminance. The programming voltage (or programming current) supplied by the data driver 4 via the data line 22j is a voltage (or current) appropriate to cause the pixel 10 to emit light with a desired amount of luminance according to the digital data received by the controller 2. The programming voltage (or programming current) can be applied to the pixel 10 during a programming operation of the pixel 10 so as to charge a storage device within the pixel 10, such as a storage capacitor, thereby enabling the pixel 10 to emit light with the desired amount of luminance during an emission operation following the programming operation. For example, the storage device in the pixel 10 can be charged during a programming operation to apply a voltage to one or more of a gate or a source terminal of the driving transistor during the emission operation, thereby causing the driving transistor to convey the driving current through the light emitting device according to the voltage stored on the storage device.

[0030] Generally, in the pixel 10, the driving current that is conveyed through the light emitting device by the driving transistor during the emission operation of the pixel 10 is a current that is supplied by the first supply line 26i and is drained to a second supply line 27i. The first supply line 26i and the second supply line 27i are coupled to the voltage supply 14. The first supply line 26i can provide a positive supply voltage (e.g., the voltage commonly referred to in circuit design as "Vdd") and the second supply line 27i can provide a negative supply voltage (e.g., the voltage commonly referred to in circuit design as "Vss"). Implementations of the present disclosure can be realized where one or the other of the supply lines (e.g., the supply line 27i) is fixed at a ground voltage or at another reference voltage.

[0031] The display system 50 also includes a monitoring system 12. With reference again to the top left pixel 10 in the display panel 20, the monitor line 28j connects the pixel 10 to the monitoring system 12. The monitoring system 12 can be integrated with the data driver 4, or can be a separate stand-alone system. In particular, the monitoring system 12 can optionally be implemented by monitoring the current and/or voltage of the data line 22j during a monitoring operation of the pixel 10, and the monitor line 28j can be entirely omitted. Additionally, the display system 50 can be implemented without the monitoring system 12 or the monitor line 28j. The monitor line 28j allows the monitoring system 12 to measure a current or voltage associated with the pixel 10 and thereby extract information indicative of a degradation of the pixel 10. For example, the monitoring system 12 can extract, via the monitor line 28j, a current flowing through the driving transistor within the pixel 10 and thereby determine, based on the measured current and based on the voltages applied to the driving transistor during the measurement, a threshold voltage of the driving transistor or a shift thereof.

[0032] The monitoring system 12 can also extract an operating voltage of the light emitting device (e.g., a voltage drop across the light emitting device while the light emitting device is operating to emit light). The monitoring system 12 can then communicate signals 32 to the controller 2 and/or the memory 6 to allow the display system 50 to store the extracted degradation information in the memory 6. During subsequent programming and/or emission operations of the pixel 10, the degradation information is retrieved from the memory 6 by the controller 2 via memory signals 36, and the controller 2 then compensates for the extracted degradation information in subsequent programming and/or emission operations of the pixel 10. For example, once the degradation information is extracted, the programming information conveyed to the pixel 10 via the data line 22j can be appropriately adjusted during a subsequent programming operation of the pixel 10 such that the pixel 10 emits light with a desired amount of luminance that is independent of the degradation of the pixel 10. In an example, an increase in the threshold voltage of the driving transistor within the pixel 10 can be compensated for by appropriately increasing the programming voltage applied to the pixel 10.

[0033] FIG. 2A is a circuit diagram of an exemplary driving circuit for a pixel 110. The driving circuit shown in FIG. 2A is utilized to calibrate, program and drive the pixel 110 and includes a drive transistor 112 for conveying a driving current through an organic light emitting diode ("OLED") 114. The OLED 114 emits light according to the current passing through the OLED 114, and can be replaced by any current-driven light emitting device. The OLED 114 has an inherent capacitance C_{OLED}. The pixel 110 can be utilized in the display panel 20 of the display system 50 described in connection with FIG. 1.

[0034] The driving circuit for the pixel 110 also includes a storage capacitor 116 and a switching transistor 118. The pixel 110 is coupled to a select line SEL, a voltage supply line Vdd, a data line Vdata, and a monitor line MON. The driving transistor 112 draws a current from the voltage supply line Vdd according to a gate-source voltage (Vgs) across the gate and source terminals of the drive transistor 112. For example, in a saturation mode of the drive transistor 112, the current passing through the drive transistor 112 can be given by $Ids = \beta(Vgs - Vt)^2$, where β is a parameter that depends on device characteristics of the drive transistor 112, Ids is the current from the drain terminal to the source terminal of the drive transistor 112, and Vt is the threshold voltage of the drive transistor 112.

[0035] in the pixel 110, the storage capacitor 116 is coupled across the gate and source terminals of the drive transistor 112. The storage capacitor 116 has a first terminal, which is referred to for convenience as a gate-side terminal, and a second terminal, which is referred to for convenience as a source-side terminal. The gate-side terminal of the storage capacitor 116 is electrically coupled to the gate terminal of the drive transistor 112. The source-side terminal 116s of the storage capacitor 116 is electrically coupled to the source terminal of the drive transistor 112. Thus, the gate-source voltage Vgs of the drive transistor 112 is also the voltage charged on the storage capacitor 116. As will be explained further below, the storage capacitor 116 can thereby maintain a driving voltage across the drive transistor 112 during an emission phase of the pixel 110.

[0036] The drain terminal of the drive transistor 112 is connected to the voltage supply line Vdd, and the source terminal of the drive transistor 112 is connected to (1) the anode terminal of the OLED 114 and (2) a monitor line MON via a read transistor 119. A cathode terminal of the OLED 114 can be connected to ground or can optionally be connected to a second voltage supply line, such as the supply line Vss shown in FIG. 1. Thus, the OLED 114 is connected in series with the current path of the drive transistor 112. The OLED 114 emits light according to the magnitude of the current passing through the OLED 114, once a voltage drop across the anode and cathode terminals of the OLED achieves an operating voltage (V_{OLED}) of the OLED 114. That is, when the difference between the voltage on the anode terminal and the voltage on the cathode terminal is greater than the operating voltage V_{OLED}, the OLED 114 turns on and emits light. When the anode-to-cathode voltage is less than V_{OLED}, current does not pass through the OLED 114.

[0037] The switching transistor 118 is operated according to the select line SEL (e.g., when the voltage on the select line SEL is at a high level, the switching transistor 118 is turned on, and when the voltage SEL is at a low level, the switching transistor is turned off). When turned on, the switching transistor 118 electrically couples node A (the gate terminal of the driving transistor 112 and the gate-side terminal of the storage capacitor 116) to the data line Vdata.

[0038] The read transistor 119 is operated according to the read line RD (e.g., when the voltage on the read line RD is at a high level, the read transistor 119 is turned on, and when the voltage RD is at a low level, the read transistor 119 is turned off). When turned on, the read transistor 119 electrically couples node B (the source terminal of the driving transistor 112, the source-side terminal of the storage capacitor 116, and the anode of the OLED 114) to the monitor line MON.

[0039] FIG. 2B is a timing diagram of exemplary operation cycles for the pixel 110 shown in FIG. 2A. During a first cycle 150, both the SEL line and the RD line are high, so the corresponding transistors 118 and 119 are turned on. The switching transistor 118 applies a voltage Vd1, which is at a level sufficient to turn on the drive transistor 112, from the data line Vdata to node A. The read transistor 119 applies a monitor-line voltage Vb, which is at a level that turns the OLED 114 off, from the monitor line MON to node B. As a result, the gate-source voltage Vgs is independent of V_{OLED} (Vd1 - Vb - Vds3, where Vds3 is the voltage drop across the read transistor 119). The SEL and RD lines go low at the end of the cycle 150, turning off the transistors 118 and 119.

[0040] During the second cycle 154, the SEL line is low to turn off the switching transistor 118, and the drive transistor 112 is turned on by the charge on the capacitor 116 at node A. The voltage on the read line RD goes high to turn on the read transistor 119 and thereby permit a first sample of the drive transistor current to be taken via the monitor line MON, while the OLED 114 is off. The voltage on the monitor line MON is Vref, which may be at the same level as the voltage Vb in the previous cycle.

[0041] During the third cycle 158, the voltage on the select line SEL is high to turn on the switching transistor 118, and the voltage on the read line RD is low to turn off the read transistor 119. Thus, the gate of the drive transistor 112 is charged to the voltage Vd2 of the data line Vdata, and the source of the drive transistor 112 is set to V_{OLED} by the OLED 114. Consequently, the gate-source voltage Vgs of the drive transistor 112 is a function of V_{LED} ($Vgs = Vd2 - V_{OLED}$).

[0042] During the fourth cycle 162, the voltage on the select line SEL is low to turn off the switching transistor, and the drive transistor 112 is turned on by the charge on the capacitor 116 at node A. The voltage on the read line RD is high to turn on the read transistor 119, and a second sample of the current of‘ the drive transistor 112 is taken via the monitor line MON.

[0043] If the first and second samples of the drive current are not the same, the voltage Vd2 on the Vdata line is adjusted, the programming voltage Vd2 is changed, and the sampling and adjustment operations are repeated until the second sample of the drive current is the same as the first sample. When the two samples of the drive current are the same, the two gate-source voltages should also be the same, which means that:

$$\begin{aligned} V_{OLED} &= Vd2 - Vgs \\ &= Vd2 - (Vd1 - Vb - Vds3) \\ &= Vd2 - Vd1 + Vb + Vds3. \end{aligned}$$

[0044] After some operation time (t), the change in V_{OLED} between time 0 and time t is $\Delta V_{LED} = V_{OLED}(t) - V_{LED}(0) = Vd2(t) - Vd2(0)$. Thus, the difference between the two programming voltages Vd2(t) and Vd2(0) can be used to extract the OLED voltage.

[0045] FIG. 2C is a modified schematic timing diagram of another set of exemplary operation cycles for the pixel 110 shown in FIG. 2A, for taking only a single reading of the drive current and comparing that value with a known reference value. For example, the reference value can be the desired value of the drive current derived by the controller to compensate for degradation of the drive transistor 112 as it ages. The OLED vottage V_{OLED} can be extracted by measuring the difference between the pixel currents when the pixel is programmed with fixed voltages in both methods (being affected by V_{OLED} and not being affected by V_{OLED}). This difference and the current-voltage characteristics of the pixel can then be used to extract V_{OLED}.

[0046] During the first cycle 200 of the exemplary timing diagram in FIG. 2C, the select line SEL is high to turn on the switching transistor 118. and the read line RD is low to turn off the read transistor 118. The data line Vdata supplies a voltage Vd2 to node A via the switching transistor 1 18. During the second cycle 201, SEL is low to turn off the switching transistor 118. and RD is high to turn on the read transistor 119, The monitor line MON supplies a voltage Vref to the node B via the read transistor 118, while a reading of the value of the drive current is taken via the read transistor 119 and the monitor line MON. This read value is compared with the known reference value of the drive current and, if the read value and the reference value of the drive current are different, the cycles 200 and 201 are repeated using an adjusted value of the voltage Vd2. This process is repeated until the read value and the reference value of the drive current are substantially the same, and then the adjusted value of Vd2 can be used to determine V_{OLED}

[0047] FIG. 3 is a circuit diagram of two of the pixels 110a and 110b like those shown in FIG. 2A but modified to share a common monitor line MON, while still permitting independent measurement of the driving current and OLED voltage separately for each pixel. The two pixels 110a and 110b are in the same row but in different columns, and the two columns share the same monitor line MON. Only the pixel selected for measurement is programmed with valid voltages, while the other pixel is programmed to turn off the drive transistor 12 during the measurement cycle. Thus, the drive transistor of one pixel will have no effect on the current measurement in the other pixel.

[0048] FIG. 4 illustrates a modified drive system that utilizes a readout circuit 300 that is shared by multiple columns of pixels while still permitting the measurement of the driving current and OLED voltage independently for each of the individual pixels 10. Although only the number of readout circuits is significantly less than the number of columns. Only the pixel selected for measurement at any given time is programmed with valid voltages, while all the other pixels sharing the same gate signals are programmed with voltages that cause the respective drive transistors to be off. Consequently, the drive transistors of the other pixels will have no effect on the current measurement being taken of the selected pixel. Also, when the driving current in the selected pixel is used to measure the OLED voltage, the measurement of the OLED voltage is also independent of the drive transistors of the other pixels.

[0049] While particular embodiments and applications of the present invention have been illustrated and described, it is to be understood that the invention is not limited to the precise construction and compositions disclosed herein and that various modifications, changes, and variations can be apparent from the foregoing descriptions without departing from the scope of the invention as defined in the appended claims.

Claims

1. A method of determining a current effective voltage, V_{OLED}, of a light-emitting device (114) in a selected pixel (10) in an array (20) of pixels in a display (40) in which each pixel includes a light-emitting device (114) and a drive transistor (112) for supplying current to said light-emitting device (114), the drive transistor (112) being adapted to convey a driving current through the light-emitting device (114) during an emission operation of the pixel, said method comprising applying a first programming voltage to said drive transistor (112) in said selected pixel (10) to supply a first current to a node (B) common to the drive transistor (112) and the light emitting device (114) in said selected pixel (10), while applying a voltage to the node (B) that turns off the light-emitting device (114), wherein said first current is independent of the effective voltage V_{OLED} of said light-emitting device (114);
   measuring said first current;
   said method **characterized in** applying a second programming voltage to said drive transistor (112) in said selected pixel (10) to supply, via said drive transistor (112), a second current to said light-emitting device in said selected pixel (10), said second current being a function of the current effective voltage V_{OLED} of said light-emitting device (114);
   measuring said second current, and comparing said first and second current measurements;
   adjusting said second programming voltage to make the second current substantially the same as said first current; and
   extracting the value of the current effective voltage V_{OLED} of said light-emitting device (114) from the difference between said first and second programming voltages;
   wherein the current effective voltage V_{OLED} is the operating voltage of the light-emitting device (114) at an operation time (t) at which the second programming voltage is applied.

2. The method of claim 1 in which said light-emitting devices (114) are OLEDs.

3. The method of claim 1 in which said current is measured via a read transistor in each pixel.

4. The method claim 3 in which said first current is supplied at a first time, and said second current is supplied at a second time following substantial usage of said display (40).

5. A system for determining a current effective voltage V_{OLED} of a light-emitting device (114) in a selected pixel in an array (20) of pixels in a display (40) in which each pixel includes a light-emitting device (114) that emits light when supplied with a voltage V_{OLED}, and a drive transistor (112) for supplying current to said light-emitting device (114), said system comprising a pixel circuit in each pixel, the pixel circuit including a drive transistor adapted to drive current through the light-emitting device (114) according to a driving voltage across the drive transistor (112) during an emission cycle, and which includes:

a storage capacitor (116) coupled across the source and gate of said drive transistor (112) for providing said driving voltage to said drive transistor (112),
a monitor line (MON) coupled to a read transistor (119) that controls the coupling of said monitor line to a node (B) that is common to the source of said drive transistor (112) and said light-emitting device (114), and
a data line (V_{DATA}) coupled to a switching transistor (118) that controls the
coupling of said data line to the gate of said drive transistor (112); and

a controller coupled to said data and monitor lines and to said switching and read transistors, and adapted to

turn on said switching and read transistors of a selected pixel (10) to apply a first programming voltage to said drive transistor (112) and supply a first current to the node (B) in said selected pixel, while applying a voltage to the node (B) of the selected pixel with a voltage that turns off the light-emitting device (114) of said selected pixel so that said first current is independent of the voltage V_{OLED} of said light-emitting device;
measure the first current flowing through said drive transistor (112);
characterized in that said controller is adapted to turn on said switching and read transistors of the selected pixel (10) to apply a second programming voltage to said drive transistor (112) in said selected pixel (10) and supply, via said drive transistor (112), a second current to said light-emitting device in said selected pixel (10), while supplying said node (B) of said selected pixel (10) with a voltage that is sufficient to turn on said light-emitting device (114) of said selected pixel (10), the current supplied to said light-emitting device (114) being a function of the voltage V_{OLED} of said light-emitting device;
measure the second current flowing through said drive transistor (112) and said light-emitting device of the selected pixel (10);
adjust said second programming voltage to make the second current substantially the same as said first current; and
extract the value of the current effective voltage V_{OLED} of said light-emitting device (114) from the difference between said first and second programming voltages;

wherein the current effective voltage V_{OLED} is the operating voltage of the light-emitting device (114) at an operation time (t) at which the second programming voltage is applied.

6. The system of claim 5, in which
said drive transistor (112) has a gate, a source and a drain and is **characterized by** a threshold voltage, and
said controller is adapted to

during a first cycle (150), turn on said switching and read transistors while delivering a voltage Vb to said monitor line and the first programming voltage Vd1 to said data line, to supply said node (B) with a voltage that is independent of the voltage across said light-emitting device (114),
during a second cycle (154), turn on said read transistor and turn off said switching transistor while delivering a voltage Vref to said monitor line, and read a first sample of the drive current at said node via said read transistor and said monitor line,
during a third cycle (158), turn off said read transistor and turn on said switching transistor while delivering the second programming voltage Vd2 to said data line, so that the voltage at said node is a function of V_{OLED},
during a fourth cycle (162), turn on said read transistor and turn off said switching transistor while delivering a voltage Vref to said monitor line, and read a second sample of the drive current at said node via said read transistor and said monitor line, and
compare said first and second samples and, if said first and second samples are different, repeating said second through fourth cycles using an adjusted value of said second programming voltage Vd2, until said first and second samples are substantially the same.

7. The system of claim 6 in which said pixels are arranged in rows and columns, and said pixel circuits in a plurality of columns share a common monitor line.

8. The system of claim 7 in which said pixel circuits that share a common monitor line are in adjacent columns.

9. The system of claim 7 in which, during said second and fourth cycles, said controller is adapted to turn off all the drive transistors (112) in all of said pixel circuits sharing a common monitor line, except the pixel circuit in which said drive current is being read.

10. The system of claim 9 in which said controller is adapted to determine the current value of V_{OLED} when it has been determined that said first and second samples are substantially the same.

Patentansprüche

1. Verfahren zur Ermittlung einer aktuellen effektiven Spannung, V_{OLED}, einer Leuchteinrichtung (114) in einem ausgewählten Pixel (10) in einem Array (20) aus Pixeln in einer Anzeige (40), in welcher jedes Pixel eine Leuchteinrichtung (114) und einen Ansteuertransistor (112) zum Zuführen von Strom zu der Leuchteinrichtung (114) aufweist, wobei der Ansteuertransistor (112) ausgebildet ist, einen Ansteuerstrom während eines Emissionsvorgangs des Pixels in die Leuchteinrichtung (114) einzuprägen, wobei das Verfahren aufweist
Anlegen einer ersten Programmierspannung an den Ansteuertransistor (112) in dem ausgewählten Pixel (10) zum Zuführen eines ersten Stroms zu einem Knoten (B), der für den Ansteuertransistor (112) und die Leuchteinrichtung (114) in dem ausgewählten Pixel (10) gemeinsam ist, während eine Spannung an den Knoten (B) angelegt wird, die die Leuchteinrichtung (114) ausschaltet, wobei der erste Strom unabhängig von der effektiven Spannung V_{OLED} der Leuchteinrichtung (114) ist;
Messen des ersten Stroms;
wobei das Verfahren gekennzeichnet ist,
Anlegen einer zweiten Programmierspannung an den Ansteuertransistor (112) in dem ausgewählten Pixel (10) zum Zuführen, über den Ansteuertransistor (112), eines zweiten Stroms zu der Leuchteinrichtung in dem ausgewählten Pixel (10), wobei der zweite Strom abhängig ist von der aktuellen effektiven Spannung, V_{OLED}, der Leuchteinrichtung (114);
Messen des zweiten Stroms und Vergleichen der ersten Strommessung mit der zweiten Strommessung;
Einstellen der zweiten Programmierspannung derart, dass der zweite Strom im Wesentlichen gleich dem ersten Strom ist; und
Ermitteln des Wertes der aktuellen effektiven Spannung V_{OLED} der Leuchteinrichtung (114) aus der Differenz zwischen der ersten und der zweiten Programmierspannung;
wobei die aktuelle effektive Spannung V_{OLED} die Betriebsspannung der Leuchteinrichtung (114) zu einem Betriebszeitpunkt (t) ist, an welchem die zweite Programmierspannung angelegt wird.

2. Verfahren nach Anspruch 1, wobei die Leuchteinrichtungen (114) OLEDs sind.

3. Verfahren nach Anspruch 1, wobei der Strom über einen Lesetransistor in jedem Pixel gemessen wird.

4. Verfahren nach Anspruch 3, wobei der erste Strom zu einem ersten Zeitpunkt zugeführt wird und der zweite Strom zu einem zweiten Zeitpunkt, nach welchem eine substantielle Nutzung der Anzeige (40) folgt, zugeführt wird.

5. System zur Ermittlung einer aktuellen effektiven Spannung V_{OLED} einer Leuchteinrichtung (114) in einem ausgewählten Pixel in einem Array (20) aus Pixeln in einer Anzeige (40), in der jedes Pixel eine Leuchteinrichtung (114), die bei Anlegen einer Spannung V_{OLED} Licht aussendet, und einen Ansteuertransistor (112) zum Zuführen von Strom zu der Leuchteinrichtung (114) aufweist,
wobei das System aufweist
eine Pixelschaltung in jedem Pixel, wobei die Pixelschaltung einen Ansteuertransistor aufweist, der ausgebildet ist, Strom in die Leuchteinrichtung (114) gemäß einer Ansteuerspannung an dem Ansteuertransistor (112) während eines Emissionszyklus einzuprägen, und die aufweist:

> einen Speicherkondensator (116), der an Source und Gate des Ansteuertransistors (112) zur Bereitstellung der Ansteuerspannung für den Ansteuertransistor (112) angeschlossen ist,
> eine Überwachungsleitung (MON), die mit einem Lesetransistor (119) verbunden ist, der die Verbindung der Überwachungsleitung zu einem Knoten (B) steuert, der für die Source des Ansteuertransistors (112) und die Leuchteinrichtung (114) gemeinsam ist; und
> eine Datenleitung (V_{DATA}), die mit einem Schalttransistor (118) verbunden ist, der die Verbindung der Datenleitung mit dem Gate des Ansteuertransistors (112) steuert; und
> eine Steuerung, die mit der Datenleitung und der Überwachungsleitung und mit dem Schalttransistor und Lesetransistor verbunden und ausgebildet ist,
> den Schalttransistor und den Lesetransistor eines ausgewählten Pixels (10) einzuschalten, so dass eine erste Programmierspannung an den Ansteuertransistor (112) angelegt wird, und ein erster Strom dem Knoten (B) in dem ausgewählten Pixel zugeführt wird, während eine Spannung an dem Knoten (B) des ausgewählten Pixels mit einer Größe anliegt, die zur Abschaltung der Leuchteinrichtung (114) des ausgewählten Pixels führt derart, dass der erste Strom unabhängig von der Spannung V_{OLED} der Leuchteinrichtung (114) ist;
> den durch den Ansteuertransistor (112) fließenden ersten Strom zu messen;
> **dadurch gekennzeichnet, dass** die Steuerung ausgebildet ist,
> den Schalttransistor und den Lesetransistor des ausgewählten Pixels (10) einzuschalten, so dass eine zweite Programmierspannung an den Ansteuertransistor (112) in dem ausgewählten Pixel (10) angelegt wird und über den Ansteuertransistor (112) der Leuchteinrichtung in dem ausgewählten Pixel (10) ein zweiter Strom zugeführt wird, während der Knoten (B) des aus-

gewählten Pixels (10) mit einer Spannung beaufschlagt ist, die ausreichend ist, die Leuchteinrichtung (114) des ausgewählten Pixels (10) einzuschalten, wobei der der Leuchteinrichtung (114) zugeführte Strom von der Spannung V_{OLED} der Leuchteinrichtung abhängt;
den durch den Ansteuertransistor (112) und die Leuchteinrichtung des ausgewählten Pixels (10) fließenden zweiten Strom zu messen;
die zweite Programmierspannung so einzustellen, dass der zweite Strom im Wesentlichen gleich dem ersten Strom ist; und
den Wert der aktuellen effektiven Spannung V_{OLED} der Leuchteinrichtung (114) aus der Differenz zwischen der ersten und der zweiten Programmierspannung zu ermitteln;
wobei die aktuelle effektive Spannung V_{OLED} die Betriebsspannung der Leuchteinrichtung (114) zu einem Betriebszeitpunkt (t) ist, an welchem die zweite Programmierspannung angelegt ist.

6. System nach Anspruch 5, in welchem
der Ansteuertransistor (112) ein Gate, eine Source und einen Drain hat und durch eine Einsetzspannung gekennzeichnet ist, und
die Steuerung ausgebildet ist,
während eines ersten Zyklus (150) den Schalttransistor und den Lesetransistor einzuschalten, während eine Spannung Vb der Überwachungsleitung und die erste Programmierspannung Vd1 der Datenleitung zugeführt werden, so dass der Knoten (B) mit einer Spannung beaufschlagt ist, die von der Spannung an der Leuchteinrichtung (114) unabhängig ist,
während eines zweiten Zyklus (154) den Lesetransistor einzuschalten und den Schalttransistor auszuschalten, während eine Spannung Vref der Überwachungsleitung zugeführt wird, und einen ersten Abtastwert des Ansteuerstroms an dem Knoten über den Lesetransistor und die Überwachungsleitung auszulesen,
während eines dritten Zyklus (158) den Lesetransistor auszuschalten und den Schalttransistor einzuschalten, während die zweite Programmierspannung Vd2 der Datenleitung zugeführt wird, so dass die Spannung an dem Knoten von V_{OLED} abhängt,
während eines vierten Zyklus (162) den Lesetransistor einzuschalten und den Schalttransistor auszuschalten, während eine Spannung Vref der Überwachungsleitung zugeführt wird, und einen zweiten Abtastwert des Ansteuerstroms an dem Knoten über den Lesetransistor und die Überwachungsleitung auszulesen, und
den ersten und den zweiten Abtastwert miteinander zu vergleichen, und, wenn der erste und der zweite Abtastwert unterschiedlich sind, den zweiten bis vierten Zyklus unter Anwendung eines eingestellten Wertes der zweiten Programmierspannung Vd2 zu wiederholen, bis der erste und der zweite Abtastwert im Wesentlichen gleich sind.

7. System nach Anspruch 6, wobei die Pixel in Reihen und Spalten angeordnet sind und die Pixelschaltungen in mehreren Spalten eine gemeinsame Überwachungsleitung haben.

8. System nach Anspruch 7, wobei die Pixelschaltungen, die eine gemeinsame Überwachungsleitung haben, in benachbarten Spalten liegen.

9. System nach Anspruch 7, wobei während des zweiten und des vierten Zyklus die Steuerung ausgebildet ist, alle Ansteuertransistoren (112) in allen Pixelschaltungen, die eine gemeinsame Überwachungsleitung nutzen, mit Ausnahme der Pixelschaltung abzuschalten, in der der Ansteuerstrom ausgelesen wird.

10. System nach Anspruch 9, wobei die Steuerung ausgebildet ist, den aktuellen Wert von V_{OLED} zu bestimmen, wenn sie ermittelt hat, dass der erste und der zweite Abtastwert im Wesentlichen gleich sind.

Revendications

1. Procédé de détermination d'une tension efficace actuelle, V_{OLED}, d'un dispositif électroluminescent (114) dans un pixel sélectionné (10) dans un réseau (20) de pixels dans un affichage (40) dans lequel chaque pixel comprend un dispositif électroluminescent (114) et un transistor d'attaque (112) pour alimenter du courant audit dispositif électroluminescent (114), le transistor d'attaque (112) étant adapté pour convoyer un courant d'attaque à travers le dispositif électroluminescent (114) durant une opération d'émission du pixel, le procédé comprenant
l'application d'une première tension de programmation audit transistor d'attaque (112) dans ledit pixel sélectionné (10) pour alimenter un premier courant à un noeud (B) commun au transistor d'attaque (112) et au dispositif électroluminescent (114) dans ledit pixel sélectionné (10), tout en appliquant une tension au noeud (B) qui désactive le dispositif électroluminescent (114), dans lequel le premier courant est indépendant de la tension efficace V_{OLED} dudit dispositif électroluminescent (114) ;
la mesure dudit premier courant ;
ledit procédé étant **caractérisé par**
l'application d'une deuxième tension de programmation audit transistor d'attaque (112) dans ledit pixel sélectionné (10) pour alimenter, via ledit transistor d'attaque (112), un deuxième courant audit dispositif électroluminescent dans ledit pixel sélectionné (10), ledit deuxième courant étant une fonction de la tension efficace actuelle V_{OLED} dudit dispositif électro-

luminescent (114) ;
la mesure dudit deuxième courant, et la comparaison desdites première et deuxième mesures de courant ;
l'ajustement de ladite deuxième tension de programmation pour égaler substantiellement le deuxième courant audit premier courant ; et
l'extraction de la valeur de la tension efficace actuelle V_{OLED} dudit dispositif électroluminescent (114) à partir de la différence entre lesdites première et deuxième tensions de programmation ;
dans lequel la tension efficace actuelle V_{OLED} est la tension de service du dispositif électroluminescent (114) à un temps de service (t) où la deuxième tension de programmation est appliquée.

2. Procédé selon la revendication 1 dans lequel les dispositifs électroluminescents (114) sont des diodes OLED.

3. Procédé selon la revendication 1 dans lequel ledit courant est mesuré via un transistor de lecture dans chaque pixel.

4. Procédé selon la revendication 3 dans lequel ledit premier courant est alimenté à un premier temps, et ledit deuxième courant est alimenté à un deuxième temps suite à une utilisation substantielle dudit affichage (40).

5. Système de détermination d'une tension efficace actuelle V_{OLED} d'un dispositif électroluminescent (114) dans un pixel sélectionné dans un réseau (20) de pixels dans un affichage (40) dans lequel chaque pixel comprend un dispositif électroluminescent (114) qui émet de la lumière lorsqu' il est alimenté avec une tension V_{OLED}, et un transistor d'attaque (112) pour alimenter du courant audit dispositif électroluminescent (114), ledit système comprenant
un circuit de pixels dans chaque pixel, le circuit de pixels incluant un transistor d'attaque adapté pour envoyer un courant à travers le dispositif électroluminescent (114) conformément à une tension d'attaque sur le transistor d'attaque (112) durant un cycle d'émission, et incluant :

> un condensateur de stockage (116) couplé entre la source et la grille dudit transistor d'attaque (112) pour fournir ladite tension d'attaque audit transistor d'attaque (112),
> une ligne de surveillance (MON) couplée à un transistor de lecture (119) qui contrôle le couplage de ladite ligne de surveillance à un noeud (B) commun à la source dudit transistor d'attaque (112) et audit dispositif électroluminescent (114), et
> une ligne de données (V_{DATA}) couplée à un transistor de commutation (118) qui contrôle le couplage de ladite ligne de données à la grille dudit transistor d'attaque (112) ; et
> un contrôleur couplé auxdites lignes de données et de surveillance et auxdits transistors de commutation et de lecture, et adapté pour
> activer lesdits transistors de commutation et de lecture d'un pixel sélectionné (10) pour appliquer une première tension de programmation audit transistor d'attaque (112) et pour alimenter un premier courant au noeud (B) dans ledit pixel sélectionné, tout en appliquant une tension au noeud (B) du pixel sélectionné avec une tension qui désactive le dispositif électroluminescent (114) dudit pixel sélectionné de telle sorte que ledit premier courant est indépendant de la tension V_{OLED} dudit dispositif électroluminescent ;
> mesurer le premier courant qui traverse ledit transistor d'attaque (112) ;
> **caractérisé en ce que** ledit contrôleur est adapté pour
> activer lesdits transistors de commutation et de lecture du pixel sélectionné (10) pour appliquer une deuxième tension de programmation audit transistor d'attaque (112) dans ledit pixel sélectionné (10) et alimenter, via ledit transistor d'attaque (112), un deuxième courant audit dispositif électroluminescent dans ledit pixel sélectionné (10), tout en alimentant audit noeud (B) dudit pixel sélectionné (10) une tension suffisante pour activer ledit dispositif électroluminescent (114) dudit pixel sélectionné (10), le courant alimenté audit dispositif électroluminescent (114) étant une fonction de la tension V_{OLED} dudit dispositif électroluminescent ;
> mesurer le deuxième courant qui traverse ledit transistor d'attaque (112) et ledit dispositif électroluminescent du pixel sélectionné (10) ;
> ajuster ladite deuxième tension de programmation pour égaler substantiellement le deuxième courant audit premier courant ; et
> extraire la valeur de la tension efficace actuelle V_{OLED} dudit dispositif électroluminescent (114) à partir de la différence entre lesdites première et deuxième tensions de programmation ;
> dans lequel la tension efficace actuelle V_{OLED} est la tension de service du dispositif électroluminescent (114) à un temps de service (t) où la deuxième tension de programmation est appliquée.

6. Système selon la revendication 5, dans lequel
ledit transistor d'attaque (112) comporte une grille, une source et un drain et est **caractérisé par** une tension de seuil, et
ledit contrôleur est adapté pour,
durant un premier cycle (150), activer lesdits transistors de commutation et de lecture tout en fournissant une tension Vb à ladite ligne de surveillance et la première tension de programmation Vd1 à ladite

ligne de données, pour alimenter ledit noeud (B) avec une tension qui est indépendante de la tension sur ledit dispositif électroluminescent (114),
durant un deuxième cycle (154), activer ledit transistor de lecture et désactiver ledit transistor de commutation tout en fournissant une tension Vref à ladite ligne de surveillance, et lire un premier échantillon du courant d'attaque audit noeud via ledit transistor de lecture et ladite ligne de surveillance,
durant un troisième cycle (158), désactiver ledit transistor de lecture et activer ledit transistor de commutation tout en alimentant la deuxième tension de programmation Vd2 à ladite ligne de données, de telle sorte que la tension sur ledit noeud est une fonction de V_{OLED},
durant un quatrième cycle (162), activer ledit transistor de lecture et désactiver ledit transistor de commutation tout en fournissant une tension Vref à ladite ligne de surveillance, et lire un deuxième échantillon du courant d'attaque audit noeud via ledit transistor de lecture et ladite ligne de surveillance, et
comparer lesdits premier et deuxième échantillons et, si lesdits premier et deuxième échantillons sont différents, répéter lesdits deuxième à quatrième cycles en utilisant une valeur ajustée de ladite deuxième tension de programmation Vd2, jusqu'à ce que lesdits premier et deuxième échantillons soient substantiellement identiques.

7. Système selon la revendication 6 dans lequel lesdits pixels sont agencés en rangées et en colonnes, et lesdits circuits de pixels dans une pluralité de colonnes partagent une ligne de surveillance commune.

8. Système selon la revendication 7 dans lequel lesdits circuits de pixels qui partagent une ligne de surveillance commune se trouvent dans des colonnes adjacentes.

9. Système selon la revendication 7 dans lequel, durant lesdits deuxième et quatrième cycles, ledit contrôleur est adapté pour désactiver tous les transistors d'attaque (112) dans tous lesdits circuits de pixels qui partagent une ligne de surveillance commune, à l'exception du circuit de pixels dans lequel est lu ledit courant d'attaque.

10. Système selon la revendication 9 dans lequel ledit contrôleur est adapté pour déterminer la valeur actuelle de V_{OLED} quand il a été déterminé que lesdits premier et deuxième échantillons sont substantiellement identiques.

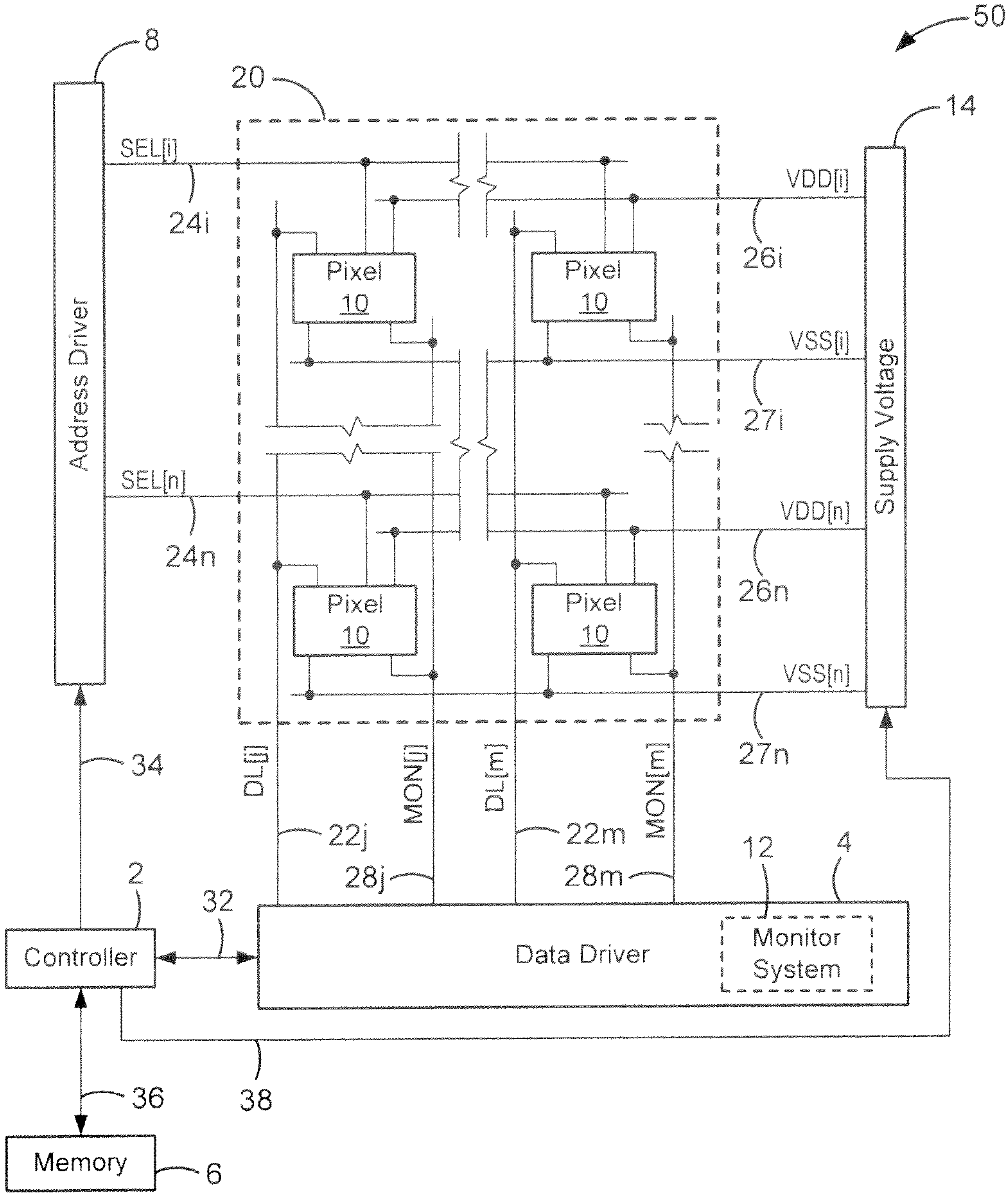
50
8
20
14
SEL[i]
24i
Address Driver
Pixel
10
Pixel
10
VDD[i]
26i
VSS[i]
27i
Supply Voltage
SEL[n]
24n
Pixel
10
Pixel
10
VDD[n]
26n
VSS[n]
27n
34
DL[j]
MON[j]
DL[m]
MON[m]
22j
22m
28j
28m
12
4
2
32
Controller
Data Driver
Monitor
System
36
38
Memory
6

FIG. 1

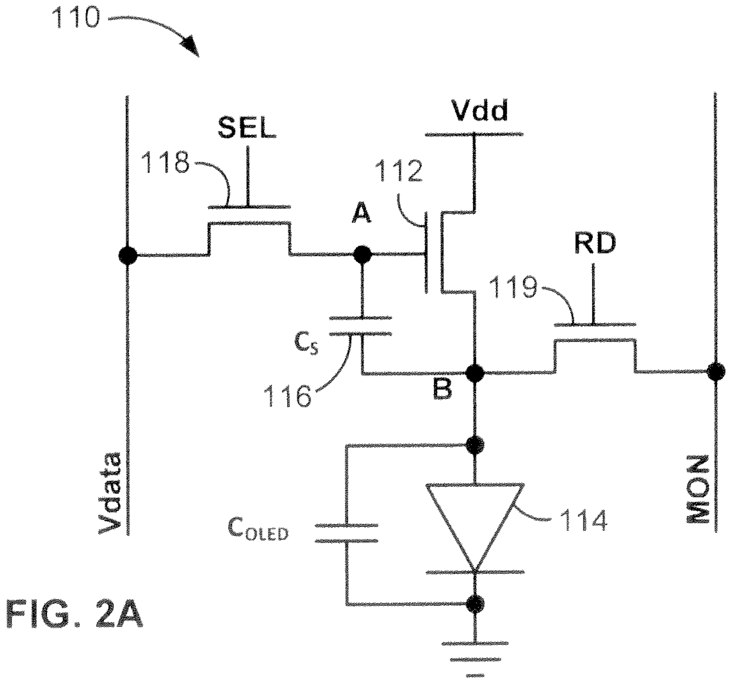
110
SEL
118
Vdd
112
A
RD
119
C_S
116
B
Vdata
C_{OLED}
114
MON

FIG. 2A

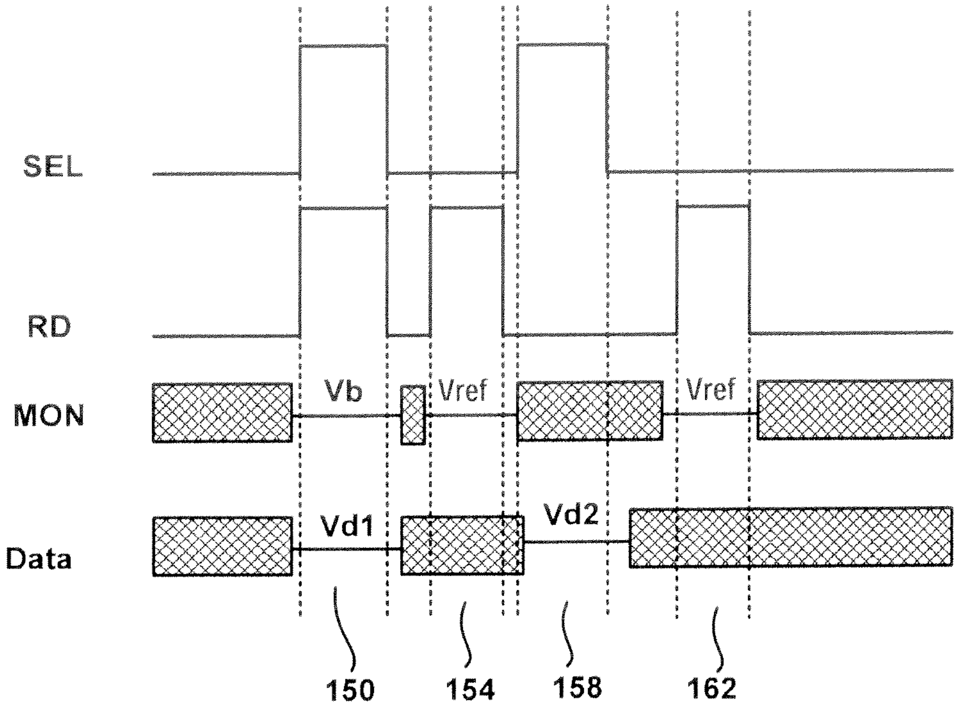
SEL
RD
MON
Vb
Vref
Vref
Data
Vd1
Vd2
150
154
158
162

FIG. 2B

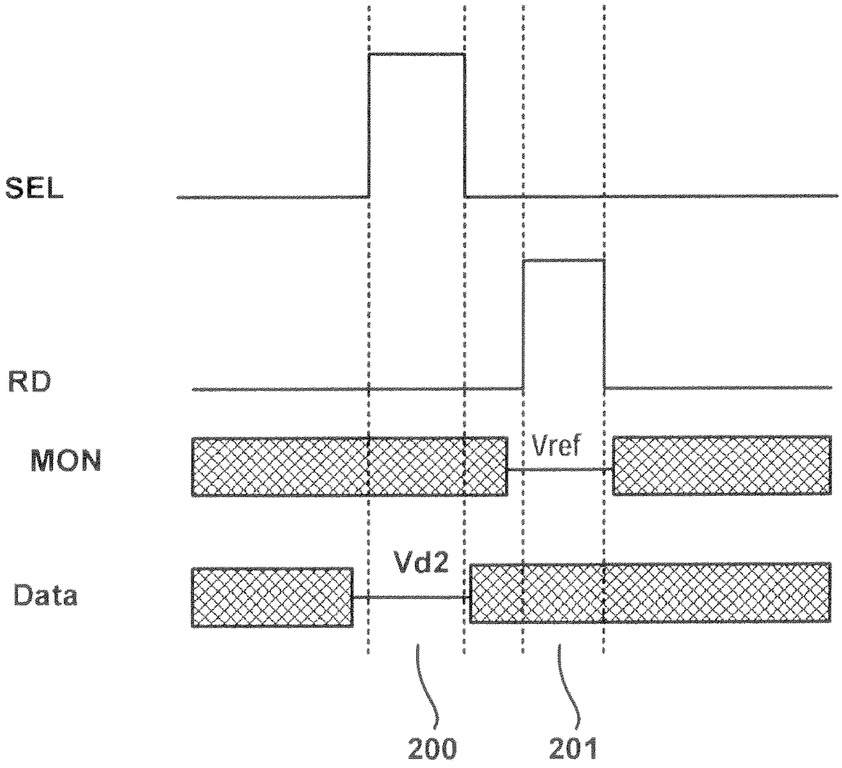

FIG. 2C

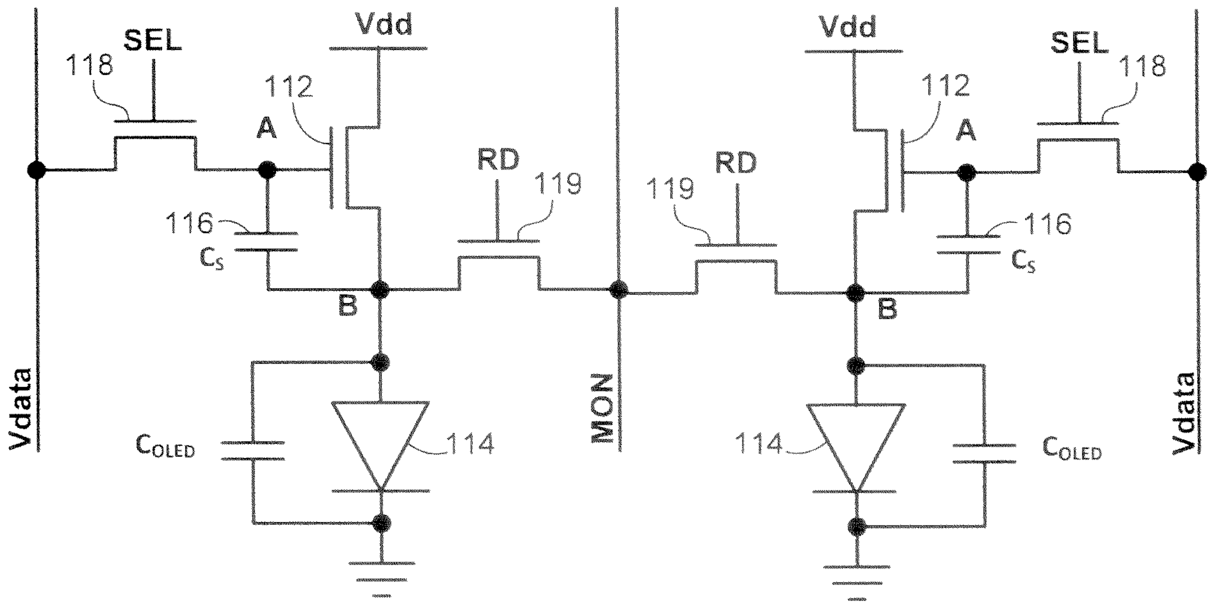
SEL
118
112
Vdd
A
RD
119
116
C_S
B
C_{OLED}
114
Vdata
MON
119
RD
Vdd
112
A
SEL
118
116
C_S
B
114
C_{OLED}
Vdata

FIG. 3

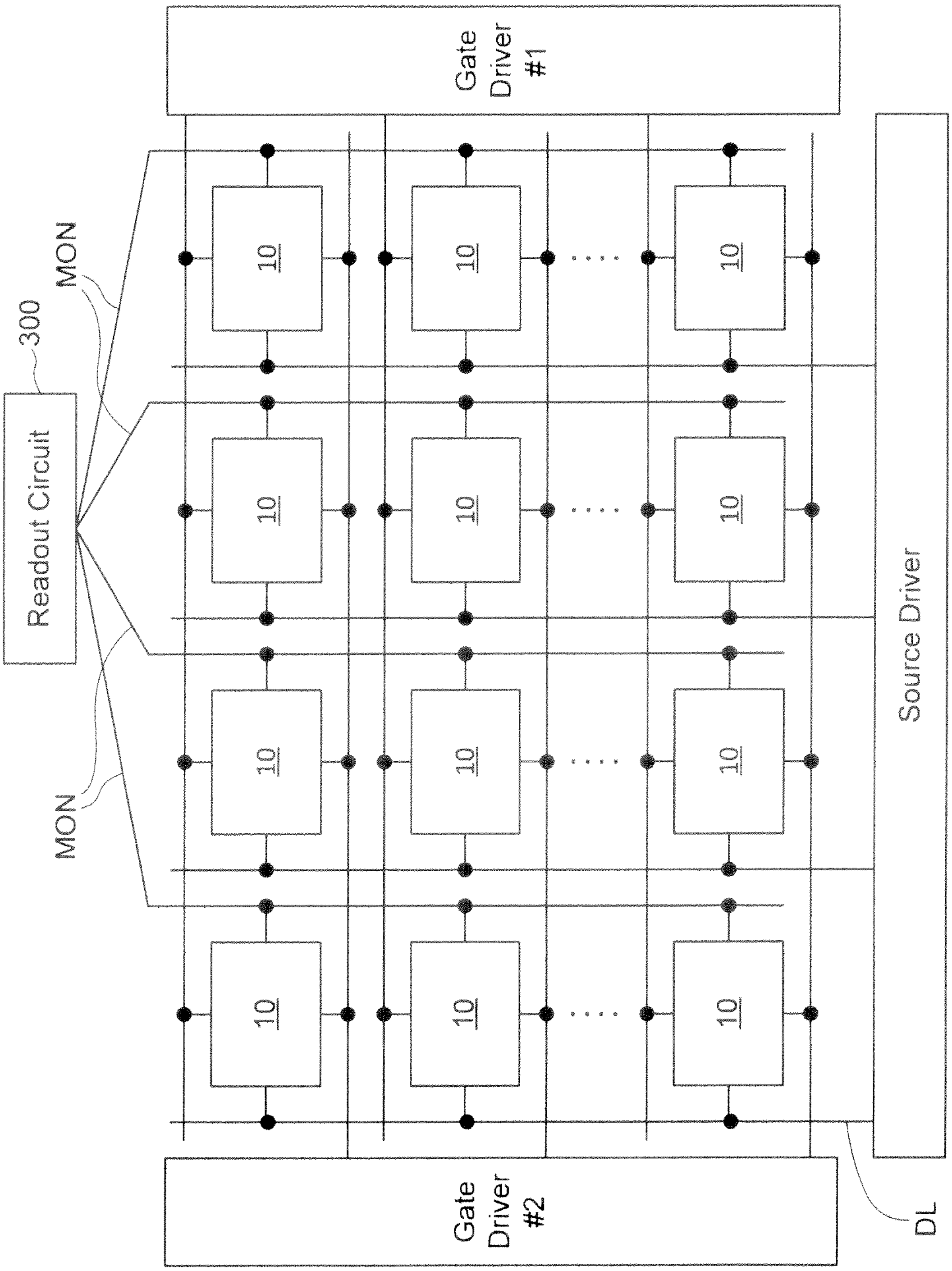
Gate Driver #1
300
Readout Circuit
MON
MON
10
Source Driver
Gate Driver #2
DL

FIG. 4

REFERENCES CITED IN THE DESCRIPTION

Patent documents cited in the description

- US 2012299978 A1 **[0004]**
- EP 2133860 A1 **[0005]**
- US 2009295423 A1 **[0006]**
- US 2011205250 A1 **[0007]**
- EP 2383720 A2 **[0008]**
- US 2010103159 A1 **[0009]**
- US 20100103082 A1 **[0010]**
- US 20080315788 A1 **[0011]**

专利名称(译)	用于amoled显示器的像素电路		
公开(公告)号	EP2782090B1	公开(公告)日	2018-11-21
申请号	EP2014157112	申请日	2014-02-28
[标]申请(专利权)人(译)	伊格尼斯创新公司		
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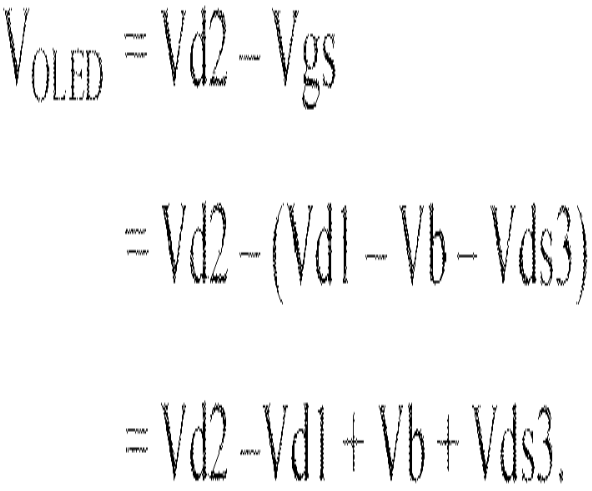
当前申请(专利权)人(译)	IGNIS创新INC.		
[标]发明人	AZIZI YASER CHAJI GHOLAMREZA		
发明人	AZIZI, YASER CHAJI, GHOLAMREZA		
IPC分类号	G09G3/32		
CPC分类号	G09G3/3233 G09G2300/0842 G09G2320/0295 G09G2320/045 G09G2320/0693 G09G3/3258 G09G2300/0819 G09G2320/048 G09G2320/10 H05B45/14		
优先权	13/789978 2013-03-08 US		
其他公开文献	EP2782090A1		
外部链接	Espacenet		

摘要(译)

从像素被编程时产生的像素中提取所选像素的OLED电压，使得像素电流是OLED电压的函数。用于提取OLED电压的一种方法是首先以电流不是OLED电压的函数的方式对像素进行编程，然后以电流是OLED电压的函数的方式对像素进行编程。在后一阶段期间，改变编程电压，使得像素电流与像素被编程的像素电流相同，使得电流不是OLED电压的函数。然后使用两个编程电压的差异来提取OLED电压。



$$V_{OLED} = Vd2 - Vgs$$

$$= Vd2 - (Vd1 - Vb - Vds3)$$

$$= Vd2 - Vd1 + Vb + Vds3,$$