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(54) **Organic light-emitting display device and driving method thereof**

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Description

CROSS REFERENCE TO RELATED APPLICATION

[0001] This application claims the benefit of Korean Patent Application No. 10-2013-0138238 filed on November 14, 2013.

BACKGROUND OF THE INVENTION

Field of the Invention

[0002] The present invention relates to an organic light-emitting display device and operating method thereof.

Description of Related Art

[0003] Recently, organic light-emitting display devices have been in the spotlight as the next generation display devices. Organic light-emitting display devices use organic light-emitting diodes (OLEDs) that emit light by themselves, and have advantages such as relatively fast response speed, high levels of light emitting efficiency and luminance, as well as wide viewing angles.

[0004] Such an organic light-emitting display device has a structure in which pixels including organic light-emitting diodes are arranged in a matrix form, and the brightness of pixels may be controlled through the selection of a scanning signal according to the grayscale data.

[0005] Each pixel in such an organic light-emitting display device has a structure in which an organic light-emitting diode, a driving transistor for driving the organic light-emitting diode, a storage capacitor and the like are connected to various signal lines.

[0006] Since a conventional pixel structure requires a reference voltage line for initializing a source node (or a drain node) of the driving transistor, the reference voltage line is formed in a display panel for each pixel and is directly connected to respective data driving integrated circuits.

[0007] As a result, a problem may occur in which an aperture ratio of the display panel is reduced, as the number of contacts of the data integrated circuits is increased.

[0008] US 2008/0158110 A1 discloses a display. The display includes a pixel array part configured to include pixel circuits arranged in a matrix, each of the pixel circuits having a drive transistor, a holding capacitor, an electro-optical element, a sampling transistor, and an initialization transistor, a drive current based on information held in the holding capacitor being produced by the drive transistor and being applied to the electro-optical element for light emission of the electro-optical element; and a controller configured to include a write scanner, a horizontal driver, and an initialization scanner.

[0009] US 2012/0299978 A1 discloses 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 advantageously 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.

[0010] WO 2007/090287 A1 discloses a method and system for light emitting device displays. The system includes one or more pixels, each having a light emitting device, a drive transistor for driving the light emitting device, and a switch transistor for selecting the pixel; and a circuit for monitoring and extracting the change of the pixel to calibrate programming data for the pixel. Programming data is calibrated using the monitoring result.

[0011] WO 2013/100686 A1 discloses a technique for outputting threshold voltages by properly changing the threshold voltages such that the threshold voltages can protect low-voltage driving elements within an analog to digital converter when the threshold voltages of an OLED display panel are sensed and outputted to the analog to digital converter. The technique includes: a sampling capacitor which samples threshold voltages sensed and inputted from an organic light-emitting diode on a display panel; a charge-sharing capacitor which charges and shares the threshold voltages sampled from the sampling capacitor, or solely charges the threshold voltages to bypass the threshold voltages; and a sample-and-hold unit which has a plurality of switches for performing switching operations for the sampling operation of the sampling capacitor and the charging and the sharing of the charge- sharing capacitor, and scales the threshold voltages to threshold voltage areas having a certain value or less.

SUMMARY OF THE INVENTION

[0012] Accordingly, the present invention is directed to an organic light-emitting display device and operating method thereof that substantially obviates one or more of the problems due to limitations and disadvantages of the related art.

[0013] An advantage of the present invention is to provide an organic light-emitting display device having a novel pixel structure with a high aperture ratio and an operating method thereof.

[0014] Additional features and advantages of the invention will be set forth in the description which follows, and in part will be apparent from the description, or may be learned by practice of the invention. These and other advantages of the invention will be realized and attained by the structure particularly pointed out in the written description and claims hereof as well as the appended drawings.

[0015] To achieve these and other advantages and in accordance with the purpose of the present invention, as embodied and broadly described, an organic light-emitting display device according to claim 1 is disclosed.

[0016] Further embodiments are described in the dependent claims.

[0017] In one aspect, there is provided a driving method of an organic light-emitting display device according to claim 4.

[0018] In another aspect, there is provided a driving method of an organic light-emitting display device according to claim 5.

[0019] In yet another aspect, there is provided a driving method of an organic light-emitting display device according to claim 6.

[0020] It is to be understood that both the foregoing general description and the following detailed description are exemplary and explanatory and are intended to provide further explanation of the invention as claimed.

BRIEF DESCRIPTION OF THE DRAWINGS

[0021] 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:

FIG. 1 is a diagram illustrating the system of an organic light-emitting display device according to a comparative example;

FIG. 2 is an equivalent circuit diagram illustrating a pixel structure of an organic light-emitting display device according to a comparative example;

FIG. 3 is a timing diagram of an emission mode of an organic light-emitting display device according to a comparative example;

FIG. 4 is a top plan view illustrating a display panel of an organic light-emitting display device according to a comparative example;

FIG. 5 is a diagram illustrating a system of an organic light-emitting display device according to an exemplary embodiment;

FIG. 6 is an equivalent circuit diagram illustrating a pixel structure of an organic light-emitting display device according to an exemplary embodiment;

FIG. 7 is a timing diagram of an emission mode of an organic light-emitting display device according to an exemplary embodiment;

FIG. 8 to FIG. 10 are operation circuit diagrams according to steps of an emission mode of an organic light-emitting display device according to an exemplary embodiment;

FIG. 11 is a circuit diagram illustrating a case in which a pixel of an organic light-emitting display device according to an exemplary embodiment operates in a sensing mode based on voltage sensing;

FIG. 12 is a timing diagram illustrating a case in which a pixel of an organic light-emitting display device according to an exemplary embodiment operates in a threshold voltage sensing mode of a sensing mode based on voltage sensing;

FIG. 13 to FIG. 15 are operation circuit diagrams according to steps when a pixel of an organic light-emitting display device according to an exemplary embodiment operates in a threshold voltage sensing mode of a sensing mode based on voltage sensing;

FIG. 16 is a timing diagram illustrating a case in which a pixel of an organic light-emitting display device according to an exemplary embodiment operates in a mobility sensing mode of a sensing mode based on voltage sensing;

FIG. 17 to FIG. 20 are operation circuit diagrams according to steps when a pixel of an organic light-emitting display device according to an exemplary embodiment operates in a mobility sensing mode of a sensing mode based on voltage sensing;

FIG. 21 is a circuit diagram illustrating a case in which a pixel of an organic light-emitting display device according to an exemplary embodiment operates in a sensing mode based on current sensing;

FIG. 22 is a timing diagram illustrating a case in which a pixel of an organic light-emitting display device according to an exemplary embodiment operates in a sensing mode based on current sensing;

FIG. 23 to FIG. 25 are circuit diagrams when a pixel of an organic light-emitting display device according to an exemplary embodiment operates in a sensing mode based on current sensing;

FIG. 26 is a top plan view illustrating a display panel of an organic light-emitting display device according to an exemplary embodiment; and

FIG. 27 is a diagram obtained by comparing a display panel according to an exemplary embodiment with a display panel according to an exemplary embodiment.

DETAILED DESCRIPTION OF THE ILLUSTRATED EMBODIMENTS

[0022] Reference will now be made in detail to embodiments of the present invention, examples of which are illustrated in the accompanying drawings. The same reference numbers may be used throughout the drawings to refer to the same or like parts. Detailed descriptions of known functions and components incorporated herein may be omitted.

[0023] Although terms such as "first," "second," "A," "B," "(a)" and "(b)" may be used herein to describe various elements, such terms may be used to distinguish one element from another element. The substance, sequence, order or number of these elements may not be limited by these terms. When an element is referred to as being "connected to" or "coupled to" another element, not only can it be "directly connected" or "coupled to" the other element, but it also can be "indirectly connected or coupled to" the other element via an "intervening" element(s). Also, when an element is referred to as being formed "on" or "under" another element, not only can it be directly formed on or under another element, but it also can be indirectly formed on or under another element via an intervening element(s).

[0024] FIG. 1 is a diagram illustrating a system of an organic light-emitting display device 100 according to a comparative example.

[0025] Referring to FIG. 1, the organic light-emitting display device 100 includes a display panel 110 in which a plurality of data lines DL, a plurality of first gate lines GL1, and a plurality of second gate lines GL2 are formed and a plurality of pixels P are defined, a data driver 120 that drives the plurality of data lines DL formed in one direction on the display panel 110, a first gate driver 130 that supplies a sensing signal through the first gate lines GL1 crossing the data lines DL on the display panel 110, a second gate driver 140 that supplies a scanning signal through the second gate lines GL2 formed in parallel with the first gate lines GL1 on the display panel 110, a timing controller 150 that controls the driving timings of the data driver 120, the first gate driver 130 and the second gate driver 140, and a reference voltage supply unit 160 that supplies a reference voltage Vref to each pixel as a common voltage.

[0026] The first gate driver 130 and the second gate driver 140 may be separately provided, and may also be included in one gate driver as desired.

[0027] The first gate driver 130 may be positioned only at one side of the display panel 110 as illustrated in FIG. 1 or may be divided into two and positioned at both sides of the display panel 110 depending on a driving scheme. Similarly, the second gate driver 140 may also be variously positioned.

[0028] Each of the first gate driver 130 and the second gate driver 140 may include a plurality of gate driving integrated circuits. Such gate driving integrated circuits may be connected to bonding pads of the display panel 110 by using a tape automated bonding (TAB) method or a chip on glass (COG) method, or may be provided in a gate in panel (GIP) type directly formed on the display panel 110. Furthermore, the first gate driver 130 and the second gate driver 140 may be integrated with the display panel 110.

[0029] The data driver 120 may include a plurality of data driving integrated circuits (also referred to as source driving integrated circuits). Such data driving integrated circuits may be connected to bonding pads of the display panel 110 by using the tape automated bonding (TAB) method or the chip on glass (COG) method, or may be directly formed on the display panel 110. Furthermore, the data driver 120 may be integrated with the display panel 110.

[0030] The reference voltage supply unit 160 may be connected to the data driving integrated circuit D-IC of the data driver 120, and may supply the reference voltage Vref to a reference voltage line RVL formed on the display panel 110 through the data driving integrated circuit D-IC.

[0031] A pixel structure of each pixel P defined in the display panel 110 of the organic light-emitting display device 100 according to a comparative example will be described with reference to FIG. 2.

[0032] FIG. 2 is an equivalent circuit diagram illustrating a pixel structure of an organic light-emitting display device 100 according to a comparative example.

[0033] Referring to FIG. 2, each pixel P in the display panel 110 of the organic light-emitting display device 100 includes an organic light-emitting diode (OLED), a driving transistor DT, a first transistor T1, a second transistor T2, a storage capacitor Cstg. The driving transistor DT has a first node N1, a second node N2 and a third node N3. The first transistor T1 is controlled by a sensing signal SENSE supplied through the first gate line GL1 and is connected between the reference voltage line RVL (Vref Line) and the first node N1 of the driving transistor DT. The second transistor T2 is controlled by a scanning signal SCAN supplied through the second gate line GL2 and is connected between the data line DL and the second node N2 of the driving transistor DT. The storage capacitor Cstg is connected between the first node N1 and the second node N2 of the driving transistor DT.

[0034] The driving transistor DT in each pixel P is a transistor that receives a driving voltage EVDD supplied by a driving voltage line DVL, is controlled by a voltage (a data voltage) of the second node N2, which is applied through the second transistor T2, and drives the organic light-emitting diode (OLED).

[0035] The driving transistor DT has the first node N1, the second node N2 and the third node N3, wherein the first node N1 is connected to the first transistor T1, the second node N2 is connected to the second transistor T2, and the third node N3 receives the driving voltage EVDD.

[0036] The first node of the driving transistor DT may be referred to as a source node (also referred to as a "source electrode"), the second node may be referred to as a gate node (also referred to as a "gate electrode"), and the third node N3 may be referred to as a drain node (also referred to as a "drain electrode"). The first node and the third node of the driving transistor DT may also be a drain node and a source node depending on a circuit implementation scheme or a circuit state.

[0037] The first transistor T1 is a transistor that is controlled by the sensing signal SENSE supplied by the first gate line GL1, is connected between the reference voltage line RVL supplying the reference voltage Vref or a connection pattern CP connected to the reference voltage line and the first node N1 of the driving transistor DT, and is concerned in a sensing mode, and is also referred to as a "sensor transistor."

[0038] The second transistor T2 is a transistor that is controlled by the scanning signal SCAN supplied by the second gate line GL2, is connected between a corresponding data line DL and the second node N2 of the driving transistor DT, and switches a data voltage to be applied to the second node N2 of the driving transistor DT, and is also referred to as a "switching transistor."

[0039] The storage capacitor Cstg is connected between the first node N1 and the second node N2 of the driving transistor DT, and maintains the data voltage during, for example, one frame period.

[0040] As illustrated in FIG. 2, each pixel defined in the display panel 110 of the organic light-emitting display device 100 according to a comparative example has a 3T (Transistor) 1C (Capacitor) structure including the three transistors DT, T1 and T2 and the one capacitor Cstg.

[0041] Furthermore, as illustrated in FIG. 2, each pixel defined in the display panel 110 of the organic light-emitting display device 100 according to a comparative example requires three vertical signal lines including the data line DL, the driving voltage line (DVL: EVDD Line) and the reference voltage line RVL, and two horizontal signal lines including the first gate line GL1 and the second gate line GL2.

[0042] Each pixel of the organic light-emitting display device 100 according to a comparative example may operate in one of an emission mode that is a driving mode for emitting the organic light-emitting diode (OLED) and a sensing mode for compensating for a threshold voltage Vth and/or mobility as characteristic values of the driving transistor DT of each pixel.

[0043] When the pixel of the organic light-emitting display device 100 according to a comparative example is driven in the emission mode, signal waveforms applied to the pixel are illustrated in the timing diagram of FIG. 3.

[0044] FIG. 3 is a timing diagram of an emission mode of an organic light-emitting display device 100 according to a comparative example.

[0045] Referring to FIG. 3, the emission mode includes an initial step, a writing step and an emission step.

[0046] In the initial step, the first node N1 of the driving transistor DT is initialized. To this end, the reference voltage Vref is applied to the reference voltage line RVL as an initial voltage and the sensing signal SENSE is applied to the first transistor T1, so that the first transistor T1 is turned on. As a result, the reference voltage Vref is applied to the first node N1 of the driving transistor DT. In this case, an initial voltage is determined in consideration of a peak/black current and a voltage that may be output from a data driving integrated circuit (D-IC, also referred to as a source integrated circuit (S-IC)) in the data driver 120.

[0047] In the writing step, the scanning signal SCAN is applied to the second transistor T2 to turn on the second transistor T2, so that a data voltage Vdata is applied to the second node N2 of the driving transistor DT. Accordingly, since a predetermined voltage difference (Vdata-Vref) occurs between the second node N2 and the first node N1 of the driving transistor DT, that is, since the predetermined voltage difference (Vdata-Vref) occurs at both ends of the storage capacitor, charge is accumulated in the storage capacitor Cstg based on the predetermined voltage difference.

[0048] In the emission step, when the first transistor T1 and the second transistor T2 are simultaneously turned off, the first node N1 and the second node N2 of the driving transistor DT are floated and maintain the predetermined potential difference (Vdata-Vref), so that a voltage is boosted. As a result, when a voltage VI of the first node N1 of the driving transistor DT increases beyond a predetermined voltage, a current flows through the organic light-emitting diode (OLED) so that the organic light-emitting diode (OLED) emits light.

[0049] In a case in which a pixel operates in the sensing mode, referring to FIG. 2, in order to compensate for the threshold voltage Vth and the mobility of the driving transistor DT, a digital-to-analog converter (DAC) of the data driving integrated circuit (D-IC) in the data driver 120 applies the data voltage Vdata to the second node N2 of the driving transistor through the data line, and the reference voltage supply unit 160 applies the reference voltage Vref to the first node N1 of the driving transistor DT through the reference voltage line RVL. Afterwards, when the first node N1 of the driving transistor DT is floated and the voltage of the first node N1 changes and becomes constant, the digital-to-analog converter (DAC) of the data driving integrated circuit (D-IC) in the data driver 120 measures the constant voltage (Vdata-Vth) through the reference voltage line RVL and senses the threshold voltage Vth of the driving transistor DT. The sensed threshold voltage is added to each data voltage so that the threshold voltage can be compensated.

[0050] Referring to FIG. 2, the reference voltage line RVL supplying the reference voltage Vref to each pixel may also be formed in correspondence with each pixel array. That is, the reference voltage line RVL may be formed by the same number of data lines.

[0051] One reference voltage line RVL supplying the reference voltage Vref to each pixel may also be formed for several pixel arrays. That is, reference voltage lines RVL having a number smaller than the number of the data lines may be formed.

[0052] For example, one reference voltage line RVL may be formed for four pixel arrays. In this case, the number of the reference voltage lines is 1/4 of the number of the data lines.

[0053] The reference voltage line forming structure in which one reference voltage line RVL is formed for four pixel arrays as described above is illustrated in FIG. 4.

[0054] FIG. 4 is a top-plan view illustrating a display panel 110 of an organic light-emitting display device 100 according to a comparative example.

[0055] FIG. 4 illustrates a part of the display panel 110 including four pixels P1 to P4.

[0056] Referring to FIG. 4, the four pixels P1 to P4 are configured such that the pixel P1 is connected to a $4n\text{-}3^{th}$ data line DL4n-3, the pixel P2 is connected to a $4n\text{-}2^{th}$ data line DL4n-2, the pixel P3 is connected to a $4n\text{-}1^{th}$ data line DL4n-1, and the pixel P4 is connected to a $4n^{th}$ data line DL4n.

[0057] Referring to FIG. 4, one reference voltage line RVL is formed for the four pixels P1 to P4. That is, the number of the data lines is 4 and the number of the reference voltage lines is 1, corresponding to 1/4 of the number of the data lines.

[0058] Referring to FIG. 4, one reference voltage line RVL is formed between the pixel P2 connected to the $4n\text{-}2^{th}$ data line DL4n-2 and the pixel P3 connected to the $4n\text{-}1^{th}$ data line DL4n-1, is directly connected to the first transistor T1 of the pixel P2 and the first transistor T1 of the pixel P3, and is connected to the first transistor T1 of the pixel P1 and the first transistor T1 of the pixel P4 through the connection pattern (CP).

[0059] Referring to FIG. 4, two driving voltage lines DVL2n-1 and DVL2n are formed at both sides of the four pixels P1 to P4.

[0060] Furthermore, referring to FIG. 4, the two data lines DL4n-3 and DL4n-2 for supplying data voltages to the two pixels P1 and P2 are formed between the pixel P1 and the pixel P2, and the two data lines DL4n-1 and DL4n for supplying data voltages to the two pixels P3 and P4 are formed between the pixel P3 and the pixel P4.

[0061] As described above, one reference voltage line RVL is formed for four pixels (four pixel arrays) and two driving voltage lines DVL are formed for four pixels, such that it is possible to improve an aperture ratio, as compared with the case in which one reference voltage line RVL is formed one pixel (one pixel array) and one driving voltage line DVL is formed one pixel (one pixel array).

[0062] Furthermore, in the four pixel structure, the arrangement structure of the two driving voltage lines DVL2n-1 and DVL2n and the four data lines DL4n-3, DL4n-2, DL4n-1 and DL4n is symmetrical to the arrangement structure of the three transistors DT, T1 and T2 and the one capacitor Cstg in each pixel about the one reference voltage line RVL.

[0063] In addition, such a symmetrical structure is repeatedly formed for every four pixels, such that it is possible to easily manufacture the display panel 110.

[0064] The structure of the display panel 110 illustrated in FIG. 4 may be a structure suitable for a display panel in which pixels are patterned to represent WRGB. That is, the pixels P1 to P4 may be WRGB pixels.

[0065] As described above, in a comparative example, only one reference voltage line RVL is formed for four pixel arrays in the display panel 110 to be shared by the four pixel arrays, and the reference voltage line sharing structure of directly connecting one reference voltage line RVL formed for the four pixel arrays to the data driving integrated circuit is provided, such that it is possible to improve an aperture ratio and reduce the number of contacts between the data driving integrated circuit and the reference voltage lines RVL.

[0066] However, in such a comparative example, different types of metal signal lines (connection patterns CP) and contact holes may be required in order that four pixels share one reference voltage line RVL. This may cause reduction of an aperture ratio and an increase in defects due to overlaps between the metal lines.

[0067] Furthermore, since it may be necessary to connect the data driving integrated circuit to the reference voltage lines RVL and an area for configuring a voltage applying circuit may be separately required, the number of contact pins is slightly increased and the area of the data driving integrated circuit is widened, resulting in an increase in the circuit manufacturing cost.

[0068] In order to further improve the organic light-emitting display device 100 described above, an organic light-emitting display device according to an exemplary embodiment will now be described with reference to FIG. 5 to FIG. 26, which has a novel pixel structure with no reference voltage line RVL.

[0069] FIG. 5 is a diagram illustrating a system of an organic light-emitting display device 500 according to an exemplary embodiment.

[0070] Referring to FIG. 5, the organic light-emitting display device 500 includes a display panel 510 in which a plurality of data lines DL, a plurality of first gate lines GL1 and a plurality of second gate lines GL2 are formed and a plurality of pixels P are defined, a data driver 520 that drives the plurality of data lines DL formed in one direction on the display panel 510, a first gate driver 530 that supplies a sensing signal through the first gate lines GL1 formed in another direction and crossing the data lines DL on the display panel 510, a second gate driver 540 that supplies a scanning signal through the second gate lines GL2 formed in parallel with the first gate lines GL1 on the display panel 510, and a timing controller 550 that controls the driving timings of the data driver 520, the first gate driver 530 and the second gate driver 540.

[0071] Referring to FIG. 5, the organic light-emitting display device 500 does not include the reference voltage supply unit, which is different from the organic light-emitting display device 100 illustrated in FIG. 1.

[0072] Furthermore, in the display panel 510 of the organic light-emitting display device 500, the reference voltage line RVL is not formed, which is also different from the display panel 110 of the organic light-emitting display device 100 illustrated in FIG. 1.

[0073] The first gate driver 530 and the second gate driver 540 may be separately provided, and may also be included in one gate driver as desired.

[0074] The first gate driver 530 may be positioned only at one side of the display panel 510 as illustrated in FIG. 5 or may be divided into two and positioned at both sides of the display panel 510 depending on a driving scheme. Similarly, the second gate driver 540 may also be variously positioned.

[0075] Each of the first gate driver 530 and the second gate driver 540 may include a plurality of gate driving integrated circuits. Such gate driving integrated circuits may be connected to bonding pads of the display panel 510 by using a tape automated bonding (TAB) method or a chip on glass (COG) method, or may be provided in a gate in panel (GIP) type directly formed on the display panel 510. Furthermore, the first gate driver 530 and the second gate driver 540 may be integrated with the display panel 510.

[0076] The data driver 520 may include a plurality of data driving integrated circuits (also referred to as source driving integrated circuits). Such data driving integrated circuits may be connected to bonding pads of the display panel 510 by using the tape automated bonding (TAB) method or the chip on glass (COG) method, or may be directly formed on the display panel 510. Furthermore, the data driver 520 may be integrated with the display panel 510.

[0077] A pixel structure of each pixel P defined in the display panel 510 of the organic light-emitting display device 500 according to another exemplary embodiment will be described with reference to FIG. 6.

[0078] FIG. 6 is an equivalent circuit diagram illustrating a pixel structure of an organic light-emitting display device 500 according to another exemplary embodiment.

[0079] Referring to FIG. 6, each pixel defined in the display panel 510 of the organic light-emitting display device 500 according to another exemplary embodiment includes an organic light-emitting diode (OLED), a driving transistor DT, a first transistor T1, a second transistor T2, a storage capacitor Cstg, and the like. The driving transistor DT has a first node N1, a second node N2 and a third node N3. The first transistor T1 is controlled by the sensing signal SENSE supplied through the first gate line GL1 and is connected between the data line DL and the first node N1 of the driving transistor DT. The second transistor T2 is controlled by the scanning signal SCAN supplied through the second gate line GL2 and is connected between the same data line DL connected to the first transistor T1 and the second node N2 of the driving transistor DT. The storage capacitor Cstg is connected between the first node N1 and the second node

N2 of the driving transistor DT.

[0080] The driving transistor DT in each pixel P is a transistor that receives a driving voltage EVDD supplied by a driving voltage line DVL, is controlled by a voltage (a data voltage) of the second node N2 applied through the second transistor T2, and drives the organic light-emitting diode (OLED).

[0081] Such a driving transistor DT has the first node N1 to which the reference voltage Vref is applied through the first transistor T1, the second node N2 to which the data voltage Vdata is applied through the second transistor T2 and the third node N3 connected to the driving voltage line DVL. The first node N1 is connected to the first transistor T1, the second node N2 is connected to the second transistor T2, and the third node N3 receives the driving voltage EVDD.

[0082] In an example, the first node of the driving transistor DT may be referred to as a source node (also referred to as a "source electrode"), the second node may be referred to as a gate node (also referred to as a "gate electrode"), and the third node N3 may be referred to as a drain node (also referred to as a "drain electrode"). The first node and the third node of the driving transistor DT may also be a drain node and a source node according to a circuit implementation scheme or a circuit state.

[0083] The first transistor T1 is a transistor that is controlled by the sensing signal SENSE supplied through the first gate line GL1, is connected between the data line DL and the first node N1 of the driving transistor DT, and is concerned in a sensing mode, and is also referred to as a "sensor transistor."

[0084] The second transistor T2 is a transistor that is controlled by the scanning signal SCAN supplied through the second gate line GL2, is connected between a corresponding data line DL and the second node N2 of the driving transistor DT, and switches a data voltage to be applied to the second node N2 of the driving transistor DT, and is also referred to as a "switching transistor."

[0085] The storage capacitor Cstg is connected between the first node N1 and the second node N2 of the driving transistor DT, and maintains the data voltage during one frame.

[0086] As illustrated in FIG. 6, each pixel defined in the display panel 510 of the organic light-emitting display device 500 has a 3T1C structure including the three transistors DT, T1 and T2 and the one capacitor Cstg.

[0087] Furthermore, as illustrated in FIG. 6, each pixel defined in the display panel 510 of the organic light-emitting display device 500 according to another exemplary embodiment requires two vertical signal lines including the data line DL and the driving voltage line DVL and two horizontal signal lines including the first gate line GL1 and the second gate line GL2.

[0088] That is, each pixel defined in the display panel 510 of the organic light-emitting display device 500 does not include the reference voltage line RVL illustrated in FIG. 2 that is a separate signal line for supplying the reference voltage Vref as an initial voltage in order to initialize the first node N1 of the driving transistor DT.

[0089] Instead, the pixel in the display panel 510 uses the existing data line DL, which supplies the data voltage Vdata, as a signal line for supplying the reference voltage Vref.

[0090] Accordingly, the data line DL may operate as a signal line for supplying the reference voltage Vref or a signal line for supplying the data voltage Vdata depending on an operation timing of the corresponding pixel.

[0091] As described above, each pixel defined in the display panel 510 of the organic light-emitting display device 500 is similar to each pixel defined in the display panel 110 of the organic light-emitting display device 100 illustrated in FIG. 2 in that each pixel has a 3T1C pixel structure, but is different as far as required signal lines are concerned.

[0092] Through such differences, driving methods for the pixel of the organic light-emitting display device 500 in an emission mode and a sensing mode are different from those of the pixel of the organic light-emitting display device 100.

[0093] Hereinafter, a driving method for a pixel of an organic light-emitting display device 500 according to another exemplary embodiment in an emission mode will be described in detail with reference to FIG. 7 to FIG. 10, and a driving method for a pixel of an organic light-emitting display device 500 according to another exemplary embodiment in a sensing mode will be described in detail with reference to FIG. 11 to FIG. 25.

[0094] FIG. 7 is a timing diagram of an emission mode of an organic light-emitting display device 500 according to another exemplary embodiment.

[0095] Referring to the circuit diagram of FIG. 6 and the timing diagram of FIG. 7, in a case in which a pixel operates in the emission mode, the first transistor T1 included in the corresponding pixel is turned on by the sensing signal SENSE and the reference voltage Vref is output to the data line DL, so that the reference voltage Vref is applied to the second node N2 of the driving transistor DT as an initial voltage.

[0096] Thereafter, the first transistor T1 is turned off, the second transistor T2 is turned on by the scanning signal SCAN, and the data voltage Vdata is output to the data line DL, so that the data voltage Vdata is applied to the first node N1 of the driving transistor DT having the second node N2 to which the reference voltage has been applied. Afterwards, a predetermined voltage (a voltage capable of allowing a current to flow through the organic light-emitting diode (OLED)) is applied between the second node N2 and the first node N1 of the driving transistor DT and a current flows through the organic light-emitting diode (OLED), so that the organic light-emitting diode (OLED) emits light.

[0097] Such an emission mode includes an initial step, a writing step and an emission step as illustrated in FIG. 7.

[0098] Signal waveforms and operations of the transistors in each step included in the emission mode will be described in detail with reference to FIG. 8 to FIG. 10.

[0099] FIG. 8 to FIG. 10 are operation circuit diagrams according to steps of the emission mode of the organic light-emitting display device 500 according to another exemplary embodiment.

[0100] With reference to FIG. 8, the initial step of the emission mode will be described.

[0101] Referring to FIG. 8, in the initial step of the emission mode, the first transistor T1 included in a corresponding pixel is turned on by the sensing signal SENSE and the reference voltage Vref applied to the data line DL as an initial voltage is applied to the second node N2 of the driving transistor DT, so that the second node N2 of the driving transistor DT is initialized.

[0102] Afterwards, for the purpose of the performance and efficiency of the emission mode, the second transistor T2 is also turned on by the scanning signal SCAN and the reference voltage Vref applied to the data line DL is also applied to the first node N1 of the driving transistor DT, so that the first node N1 of the driving transistor DT is also initialized.

[0103] Next, with reference to FIG. 9, the writing step of the emission mode will be described.

[0104] Referring to FIG. 9, in the writing step after all the first node N1 and the second node N2 of the driving transistor DT are initialized in the initial step, the sensing signal SENSE drops to a low level to turn off the first transistor T1, and the second transistor T2 is turned on by the scanning signal SCAN, so that the data voltage Vdata supplied to the data line DL is written in (applied to) the first node N1 of the driving transistor DT.

[0105] At this time point, a predetermined voltage (Vdata-Vref) is instantaneously applied between the second node N2 and the first node N1 of the driving transistor DT, so that a charge corresponding to this voltage is accumulated in the storage transistor Cstg. However, since the first transistor T1 has been turned off, the first node N1 of the driving transistor DT does not maintain a constant voltage Vref applied before the first transistor T1 is turned off, and is floated.

[0106] As a result, the storage transistor Cstg is discharged and the voltage of the first node N1 of the driving transistor DT is boosted. At this time, no current flows through the organic light-emitting diode (OLED) by the threshold voltage of the organic light-emitting diode (OLED).

[0107] The voltage of the first node N1 of the driving transistor DT is boosted up to a voltage when a current may flow through organic light-emitting diode (OLED), and the voltage (the potential difference) between the second node N2 and the first node N1 of the driving transistor DT is constantly maintained.

[0108] With reference to FIG. 10, the emission step of the emission mode will be described.

[0109] Referring to FIG. 10, after the predetermined voltage (the boosted voltage of the first node N1 of the driving transistor DT) is applied between the second node N2 and the first node N1 of the driving transistor DT in the writing step, in the emission step starting from that time point, since all the first transistor T1 and the second transistor T2 are turned off, all the second node N2 and the first node N1 of the driving transistor DT are floated, so that voltage boosting occurs and thus a current Ioled flows through organic light-emitting diode (OLED).

[0110] So far, the emission mode has been described, and the sensing mode will be described below.

[0111] The sensing mode of the organic light-emitting display device 500 according to another exemplary embodiment may be classified into a sensing mode based on voltage sensing and a sensing mode based on current sensing.

[0112] The sensing mode based on voltage sensing may be classified into a threshold voltage sensing mode and a mobility sensing mode, and in the sensing mode based on current sensing, the threshold voltage sensing mode and the mobility sensing mode are not separately performed and are performed at a time, such that it is possible to simultaneously calculate a threshold voltage and mobility.

[0113] In any sensing mode, the organic light-emitting display device 500 according to another exemplary embodiment may further include a sensing unit (1100 of FIG. 11 and 2100 of FIG. 21) for sensing one or more of the threshold voltage and the mobility of the driving transistor DT.

[0114] Such a sensing unit is connected to the driving voltage line DVL connected to the third node N3 of the driving transistor DT.

[0115] This is different from the organic light-emitting display device 100 in that the sensing unit (including the ADC and the like of FIG. 2) is connected to the reference voltage line RVL.

[0116] Hereinafter, a circuit for the sensing mode based on voltage sensing will be described with reference to FIG. 11, the threshold voltage sensing mode of the sensing mode based on voltage sensing will be described with reference to FIG. 12 to FIG. 15, and the mobility sensing mode of the sensing mode based on voltage sensing will be described with reference to FIG. 16 to FIG. 20. Afterwards, a circuit for the sensing mode based on current sensing will be described with reference to FIG. 21, and the sensing of a threshold voltage and mobility through the sensing mode based on current sensing will be described with reference to FIG. 22 to FIG. 25.

[0117] FIG. 11 is a circuit diagram illustrating a case in which a pixel of an organic light-emitting display device 500 according to another exemplary embodiment operates in a sensing mode based on voltage sensing.

[0118] Referring to FIG. 11, in the organic light-emitting display device 500, a circuit for the sensing mode based on voltage sensing further includes the sensing unit 1100 connected to the driving voltage line DVL, which is an addition to the pixel structure illustrated in FIG. 6.

[0119] Referring to FIG. 11, the sensing unit 1100 for the sensing mode based on voltage sensing includes an analog-to-digital converter 1110 that measures a voltage of a sensing node Ns connected to the driving voltage line DVL, a first switch Sper that switches a connection between a precharge voltage supply node Npre and the sensing node Ns, and a second switch Vsam that switches a connection between a connection node Nadc of the analog-to-digital converter 1110 and the sensing node Ns.

[0120] When the first switch Sper is turned on, the precharge voltage supply node Npre and the sensing node Ns are connected to each other, and when the first switch Sper is turned off, the precharge voltage supply node Npre and the sensing node Ns are not connected to each other. When the second switch Vsam is turned on, the connection node Nadc of the analog-to-digital converter 1110 and the sensing node Ns are connected to each other, and when the second switch Vsam is turned off, the connection node Nadc of the analog-to-digital converter 1110 and the sensing node Ns are not connected to each other.

[0121] Furthermore, referring to FIG. 11, a resistor R may be connected between the driving voltage line DVL and the sensing node Ns, and a driving voltage line capacitor Cdvl may be formed in the driving voltage line DVL.

[0122] Hereinafter, the threshold voltage sensing mode will be described with reference to FIG. 12 to FIG. 15 on the basis of the circuit for the sensing mode based on voltage sensing illustrated in FIG. 11.

[0123] FIG. 12 is a timing diagram illustrating a case in which a pixel of an organic light-emitting display device 500 according to another exemplary embodiment operates in a threshold voltage sensing mode of a sensing mode based on voltage sensing.

[0124] Referring to FIG. 12, the threshold voltage sensing mode of the sensing mode based on voltage sensing includes an initial step, a sensing step and a sampling step.

[0125] Hereinafter, signal waveforms and operations according to each step will be described with reference to FIG. 13 to FIG. 15.

[0126] With reference to FIG. 13, the initial step of the threshold voltage sensing mode based on voltage sensing will be described.

[0127] Referring to FIG. 13, in the initial step of the threshold voltage sensing mode based on voltage sensing, the first switch Sper is turned on, so that a precharge voltage Vpre is applied to the sensing node Ns.

[0128] At this time, the second transistor T2 is turned on by the scanning signal SCAN, so that the data voltage Vdata supplied through the data line DL is applied to the second node N2 of the driving transistor DT.

[0129] Next, with reference to FIG. 14, the sensing step of the threshold voltage sensing mode based on voltage sensing will be described.

[0130] Referring to FIG. 14, in the sensing step of the threshold voltage sensing mode based on voltage sensing, the first switch Sper is turned off and the first transistor T1 is turned on by the sensing signal SENSE, so that the data voltage Vdata supplied through the data line DL is applied to the first node N1 of the driving transistor DT. That is, the same data voltage Vdata is applied to the first node N1 and the second node N2 of the driving transistor DT.

[0131] Accordingly, a current i flows through the driving voltage line capacitor Cdvl via the sensing node Ns through the driving transistor DT, and the driving voltage line capacitor Cdvl is charged, so that a voltage of the sensing node Ns rises.

[0132] An increase in the voltage of the sensing node Ns starts from the precharge voltage Vpre and stops at a predetermined voltage by the threshold voltage Vth of the driving transistor DT.

[0133] Next, with reference to FIG. 15, the sampling step of the threshold voltage sensing mode based on voltage sensing will be described.

[0134] Referring to FIG. 15, in the sampling step of the threshold voltage sensing mode based on voltage sensing, the sensing signal SENSE changes to a low level, so that the first transistor T1 is turned off and the second transistor T2 is turned on.

[0135] Accordingly, the analog-to-digital converter 1110 senses the voltage (Vsen or Vsen') of the sensing node Ns that stays at the predetermined voltage after the stopping of the increase.

[0136] In the timing diagram of FIG. 15, two lines (a solid line and a dotted line) representing the voltage of the sensing node Ns indicate a case in which the threshold voltage is (-) and a case in which the threshold voltage is (+), respectively. When the threshold voltage is (-), the voltage Vsen of the sensing node Ns is Vdata+Vth in the sampling step, and when the threshold voltage is (+), the voltage Vsen' of the sensing node Ns is Vdata-Vth in the sampling step.

[0137] At this case, since the data voltage Vdata is a well-known value, it is possible to obtain the threshold voltage Vth of the driving transistor DT from the measured sensing voltage (Vsen or Vsen').

[0138] The timing controller 550 adds the obtained threshold voltage Vth to a next data voltage Vdata to be applied to a corresponding pixel or subtracts the obtained threshold voltage Vth from the next data voltage Vdata to be applied to the corresponding pixel, and converts data to be applied to the corresponding pixel, thereby compensating for the threshold voltage.

[0139] Hereinafter, the mobility sensing mode will be described with reference to FIG. 16 to FIG. 20 on the basis of the circuit for the sensing mode based on voltage sensing illustrated in FIG. 11.

[0140] FIG. 16 is a timing diagram illustrating a case in which a pixel of an organic light-emitting display device 500 according to another exemplary embodiment operates in a mobility sensing mode of a sensing mode based on voltage sensing.

[0141] Referring to FIG. 16, the mobility sensing mode based on voltage sensing includes an initial step, a sensing step and a sampling step, and the mobility sensing is performed in such a manner that the second transistor T2 is turned on by the scanning signal SCAN to apply the data voltage Vdata to the second node N2 of the driving transistor DT, the second transistor T2 is turned off to allow a constant current to flow from the first node N1 of the driving transistor DT to the driving voltage line DVL, and the voltage Vsen accumulated in the driving voltage line capacitor Cdvl formed in the driving voltage line DVL is measured.

[0142] FIG. 17 to FIG. 20 are operation circuit diagrams according to steps when a pixel of an organic light-emitting display device 500 according to another exemplary embodiment operates in a mobility sensing mode of a sensing mode based on voltage sensing.

[0143] The initial step of the mobility sensing mode based on voltage sensing includes a first initial step in which the second transistor T2 is turned on by the scanning signal SCAN and a second initial step in which the second transistor T2 is turned off.

[0144] Referring to FIG. 17, in the first initial step of the mobility sensing mode based on voltage sensing, the second transistor T2 is turned on by the scanning signal SCAN and the first transistor T1 is turned on by the sensing signal SENSE, so that the data voltage Vdata is applied to the second node N2 and the first node N1 of the driving transistor DT.

[0145] Referring to FIG. 17, the first switch Sper is turned on, so that the precharge voltage Vpre is applied to the sensing node Ns.

[0146] Referring to FIG. 18, in the second initial step of the mobility sensing mode based on voltage sensing, the scanning signal SCAN drops to a low level and the second transistor T2 is turned off.

[0147] As illustrated in FIG. 17 and FIG. 18, in the initial step (the first initial step and the second initial step) of the mobility sensing mode based on voltage sensing, the voltage of the sensing node Ns is maintained as the precharge voltage Vpre, because the first switch Sper has been turned on.

[0148] Referring to FIG. 19, in the sensing step of the mobility sensing mode based on voltage sensing, the first switch Sper is turned off, a constant current I flows from the first node N1 of the driving transistor DT to the driving voltage line DVL, and the driving voltage line capacitor Cdvl formed in the driving voltage line DVL is charged, so that the voltage of the sensing node Ns rises.

[0149] In the timing diagram of FIG. 19, a voltage slope of the sensing node Ns corresponds to the constant current I flowing from the first node N1 of the driving transistor DT to the driving voltage line DVL as a change in the voltage of the sensing node Ns according to the passage of time.

[0150] In the timing diagram of FIG. 19, a solid line representing a change in the voltage of the sensing node Ns indicates a voltage change in a case of high mobility, and a dotted line representing a change in the voltage of the sensing node Ns indicates a voltage change in a case of low mobility.

[0151] Referring to FIG. 20, in the sampling step of the mobility sensing mode based on voltage sensing, the sensing signal SENSE drops to a low level and the first transistor T1 is turned off, so that the voltage of the sensing node Ns does not rise.

[0152] At this time, since the second switch Vsam is turned on, the analog-to-digital converter 1110 measures the voltage of the sensing node Ns as the sensing voltage (Vsen or Vsen') and senses the mobility of the driving transistor DT from the measured voltage. In this case, the higher the sensing voltage (Vsen>Vsen') is, the higher the sensed mobility of the driving transistor DT is.

[0153] Thus far, the sensing mode (the threshold voltage sensing mode and the mobility sensing mode) of sensing the threshold voltage and the mobility based on voltage sensing has been described, and a sensing mode of sensing the threshold voltage and the mobility based on current sensing will be described with reference to FIG. 21 to FIG. 25 below.

[0154] FIG. 21 is a circuit diagram illustrating a case in which a pixel of an organic light-emitting display device 500 according to another exemplary embodiment operates in a sensing mode based on current sensing.

[0155] Referring to FIG. 21, in the organic light-emitting display device 500 according to another exemplary embodiment, a current for the sensing mode based on current sensing further includes a sensing unit 2100 connected to the driving voltage line DVL on the basis of the pixel structure of FIG. 6.

[0156] Referring to FIG. 21, the sensing unit 2100 for the sensing mode based on current sensing includes a current measuring unit 2110 that measures a current flowing through the driving voltage line DVL, a first switch Sper that switches a connection between the precharge voltage supply node Npre and the sensing node Ns, and a second switch Vsam that switches a connection between a connection node Ni of the current measuring unit 2110 and the sensing node Ns.

[0157] When the first switch Sper is turned on, the precharge voltage supply node Npre and the sensing node Ns are connected to each other, and when the first switch Sper is turned off, the precharge voltage supply node Npre and the sensing node Ns are not connected to each other. When the second switch Vsam is turned on, the connection node Ni of the current measuring unit 2110 and the sensing node Ns are connected to each other, and when the second switch Vsam is turned off, the connection node Ni of the current measuring unit 2110 and the sensing node Ns are not connected to each other.

[0158] Furthermore, referring to FIG. 21, a resistor R may be connected between the driving voltage line DVL and the sensing node Ns, and a driving voltage line capacitor Cdvl may be formed in the driving voltage line DVL.

[0159] FIG. 22 is a timing diagram illustrating a case in which a pixel of an organic light-emitting display device 500 according to another exemplary embodiment operates in a sensing mode based on current sensing.

[0160] Referring to FIG. 22, the sensing mode based on current sensing, in which the pixel of the organic light-emitting display device 500 according to another exemplary embodiment operates, includes an initial step, a sensing step and a sampling step.

[0161] In the sensing mode based on current sensing, when the data voltage Vdata is simultaneously applied to the second node N2 and the first node N1 of the driving transistor DT through the data line DL and the precharge voltage Vpre is applied to the driving voltage line DVL, a current flows from the first node N1 of the driving transistor DT to the driving voltage line DVL. This current is measured by the current measuring unit 2110.

[0162] In this case, currents I1 and I2 are measured for two data voltages Vdata1 and Vdata2, such that it is possible to calculate the threshold voltage and the mobility of the driving transistor DT based on a predetermined relationship.

[0163] Hereinafter, each step of the sensing mode based on current sensing will be described with reference to FIG. 23 to FIG. 25.

[0164] FIG. 23 to FIG. 25 are circuit diagrams when a pixel of an organic light-emitting display device 500 according to another exemplary embodiment operates in a sensing mode based on current sensing.

[0165] Referring to FIG. 23, in the initial step of the sensing mode based on current sensing, the second transistor T2 has been turned off by a low level of the scanning signal SCAN, the first transistor T1 is turned on by the sensing signal SENSE, and the first switch Sper is turned on, so that the precharge voltage Vpre is applied to the sensing node Ns.

[0166] Referring to FIG. 24, in the sensing step of the sensing mode based on current sensing, the scanning signal SCAN is changed to a high level and the second transistor T2 is turned on, so that the data voltage Vdata is supplied through the data line DL.

[0167] Accordingly, the data voltage Vdata is applied to the second node N2 and the first node N1 of the driving transistor DT. That is, voltages of the second node N2 and the first node N1 of the driving transistor DT are the data voltage Vdata.

[0168] Referring to FIG. 25, in the sampling step of the sensing mode based on current sensing, the first switch Sper is turned off and the second switch Vsam is turned on.

[0169] Accordingly, a current flowing from the first node N1 of the driving transistor DT to the driving voltage line DVL is measured as a sensing current Isen.

[0170] The aforementioned process is performed for the two data voltages Vdata1 and Vdata2, thereby measuring two sensing currents I_1 and I_2.

[0171] Afterwards, based on the applied two data voltages Vdata1 and Vdata2, the measured two sensing currents I_1 and I_2 and the applied precharge voltage Vpre, two formulae of the following Formula 1 are used to calculate two unknowns Vth and K, such that it is possible to sense a threshold voltage Vth and a mobility K.

$$\begin{aligned}&(1)\ I_1=K(V_{gs1}-Vth)^2\\&(2)\ I_2=K(V_{gs2}-Vth)^2\end{aligned}\qquad \text{...... Formula 1:}$$

[0172] In Formula 1, I_1 and I_2 indicate currents measured by the current measuring unit 2110. V_{gs1} indicates a voltage difference between the second node N2 and the third node N3 of the driving transistor DT when the data voltage Vdata1 is applied, and may be regarded as "Vdata1-Vpre." V_{gs2} indicates a voltage difference between the second node N2 and the third node N3 of the driving transistor DT when the data voltage Vdata2 is applied, and may be regarded as "Vdata2-Vpre." Accordingly, the following Formula 1 may be rewritten as the following Formula 2.

$$\begin{aligned}&(1)\ I_1=K(Vdata1-Vpre-Vth)^2\\&(2)\ I_2=K(Vdata2-Vpre-Vth)^2\end{aligned}\qquad \text{...... Formula 2:}$$

[0173] In Formula 2, since I_1, I_2, Vdata1, Vdata2 and Vpre are well-known values, it is possible to obtain the threshold voltage Vth and the mobility K that are unknown based on Formulae (1) and (2).

[0174] Thus far, respective pixel structures of the organic light-emitting display device 500 according to another exemplary embodiment and the driving methods for the emission mode and the sensing mode have been described.

[0175] Hereinafter, with reference to FIG. 26, a pixel structure of an organic light-emitting display device 500 according to another exemplary embodiment will be described, along with advantages thereof.

[0176] FIG. 26 is a top plan view illustrating a display panel 510 of an organic light-emitting display device 500 according to another exemplary embodiment, a part of which includes four pixels P1 to P4.

[0177] Referring to FIG. 26, the pixel P1 is connected to a 4n-^{3th} data line DL4n-3, the pixel P2 is connected to a 4n-2th data line DL4n-2, the pixel P3 is connected to a 4n-^{1th} data line DL4n-1, and the pixel P4 is connected to a 4nth data line DL4n.

[0178] As illustrated in FIG. 26, no reference voltage line RVL is formed for the four pixels P1 to P4, and the data line DL is connected to the first transistor T1 and the second transistor T2. Also, two driving voltage lines DVL2n-1 and DVL2n are formed at both sides of the four pixels P1 to P4. The two data lines DL4n-3 and DL4n-2 for supplying the data voltages to the two pixels P1 and P2 are formed between the pixel P1 and the pixel P2, and the two data lines DL4n-1 and DL4n for supplying the data voltages to the two pixels P3 and P4 are formed between the pixel P3 and the pixel P4.

[0179] In the pixels P1 and P2, the arrangement structure of the two data lines DL4n-3 and DL4n-2 is symmetrical to the arrangement structure of three transistors DT, T1 and T2 and one capacitor Cstg in each pixel. Similarly, in the pixels P3 and P4, the arrangement structure of the two data lines DL4n-1 and DL4n is symmetrical to the arrangement structure of three transistors DT, T1 and T2 and one capacitor Cstg in each pixel.

[0180] Furthermore, the two driving voltage lines DVL2n-1 and DVL2n are symmetrically arranged at both sides of the pixel P1 and the pixel P4.

[0181] Such a symmetrical structure is repeatedly formed for every four pixels, so that the display panel 510 can be easily manufactured.

[0182] The structure of the display panel 510 illustrated in FIG. 26 may be a structure suitable for a display panel 510 in which pixels are patterned to represent WRGB. That is, the pixels P1 to P4 may be WRGB pixels.

[0183] FIG. 27 is a diagram for comparing the display panel 510 of the organic light-emitting display device 500 illustrated in FIG. 26 with the display panel 110 of the organic light-emitting display device 100 illustrated in FIG. 4. In particular, the figure labeled as (A) illustrates the display panel 110 of FIG. 4, and the figure labeled as (B) illustrates the display panel 510 of FIG. 26.

[0184] In the display panel 510 illustrated in (B) of FIG. 27, since there is no reference voltage line RVL between the pixel P2 connected to the DL4n-2 and the pixel P3 connected to the DL4n-1, an emission area of each pixel can be increased in a horizontal direction.

[0185] Furthermore, in the display panel 510 illustrated in (B) of FIG. 27, since there is no connection pattern (CP) for connecting the reference voltage line RVL to the first transistor T1 of the pixel P1 and the first transistor T4 of the pixel P4 as in (A) of FIG. 27, the emission area of each pixel can also be increased in a vertical direction.

[0186] As a result, the organic light-emitting display device 500 illustrated in (B) of FIG. 27 has an advantage in that an aperture ratio is increased by more than about 3%, as compared with the organic light-emitting display device 100 illustrated in (A) of FIG. 27.

[0187] Furthermore, in the organic light-emitting display device 500 illustrated in (B) of FIG. 27, since the reference voltage supply unit 160 and the reference voltage line are not separately provided, it may not be necessary to provide contact pins through which the data driving integrated circuit D-IC receives a reference voltage from the reference voltage supply unit 160 and transfers the reference voltage to the reference voltage line. As a result, it may be possible to reduce the number of contact pins of the data driving integrated circuit D-IC, reduce the area of the data driving integrated circuit, and reduce the cost.

[0188] As described above, organic light-emitting display devices 100 and 500 according to embodiments of the present invention have a novel pixel structure and/or operating method thereof, with a high aperture ratio.

[0189] Furthermore, an organic light-emitting display device 500 according to an embodiment of the present invention has a pixel structure in which a reference voltage line is be required, and an overlapping area with additional signal lines (for example, connection patterns (CP)) is reduced, leading to a further increased aperture ratio.

[0190] In addition, an organic light-emitting display device 500 according to an embodiment of the present invention has a pixel structure that can reduce the number of contact pins and the area of a data driving integrated circuit (D-IC), leading to reduced manufacturing costs.

Claims

1. An organic light-emitting display device (500) comprising:

a display panel (510) including a plurality of data lines (DL), a plurality of first gate lines (GL1) and a plurality of second gate lines (GL2), and a plurality of pixels;
a data driver (520) arranged to supply a data signal through at least one of the plurality of data lines (DL);
a first gate driver (530) arranged to supply a sensing signal through at least one of the plurality of first gate lines (GL1) that cross the plurality of data lines (DL) in the display panel (510);

a second gate driver (540) arranged to supply a scanning signal through at least one of the plurality of second gate lines (GL2) that are substantially parallel with the plurality of first gate lines (GL1) in the display panel (510);
a timing controller (550) arranged to control driving timings of the data driver (520), the first gate driver (530) and the second gate driver (540),
wherein each of the plurality of pixels includes an organic light-emitting diode, a driving transistor (DT) having a first node (N1), a second node (N2) and a third node (N3), a first transistor (T1) controlled by the sensing signal and connected between the respective data line (DL) and the first node (N1) of the driving transistor (DT), a second transistor (T2) controlled by the scanning signal and connected between the respective data line (DL) and the second node (N2) of the driving transistor (DT), and a storage capacitor (Cstg) connected between the first and second nodes (N1, N2) of the driving transistor (DT), the third node (N3) being connected to a driving voltage line (DVL), wherein, in an emission mode, a driving voltage (EVDD) is supplied to the driving voltage line (DVL); and
a sensing unit (1100, 2100) connected to the driving voltage line (DVL), the sensing unit (1100, 2100) comprising:

an analog-to-digital converter (1110) adapted to measure a voltage of a sensing node (Ns) connected to the driving voltage line (DVL), or a current measuring unit (2110) adapted to measure a current flowing through the sensing node (Ns) connected to the driving voltage line (DVL), and
a switch (Spre, Vsam) adapted to switch a connection between a precharge voltage supply node (Npre) and the sensing node (Ns) and switching a connection between a connection node (Nadc, Ni) of the analog-to-digital converter (1110) or the current measuring unit (2110) and the sensing node (Ns).

2. The organic light-emitting display device (500) according to claim 1, wherein the data driver (520) is configured for supplying the respective data line (DL) a reference voltage or a data voltage according to an operation timing of a corresponding pixel.

3. The organic light-emitting display device (500) according to claim 1 or 2, wherein the first gate driver (530) is configured to supply a sensing signal which turns on or off the first transistor (T1), the data driver (520) is configured to supply a reference voltage or a data voltage to the respective data line (DL), and the second gate driver (540) is configured to supply a scanning signal which turns on or off the second transistor (T2), wherein, in an emission mode of the organic light-emitting display device, the first gate driver (530), the second gate driver (540) and the data driver (520) are configured to operate the one of the plurality of pixels such that:

- in an initial step of the emission mode, the first transistor (T1) is turned on by the first gate driver (530) and the reference voltage is applied to the first node (N1) of the driving transistor (DT) by the data driver (520),
- in a writing step following the initial step, the first transistor (T1) is turned off by the first gate driver (530) and the second transistor (T2) is turned on by the second gate driver (540) and a data voltage is applied to the second node (N2) of the driving transistor (DT) by the data driver (520), and
- in an emission step following the writing step, the second transistor (T2) is turned off by the second gate driver (540) so that a current flows through the organic light-emitting diode.

4. A driving method of the organic light-emitting display device (500) of claim 1, the method comprising driving a pixel of the organic light-emitting display device (500) in an emission mode and a sensing mode, wherein:
in the emission mode, the driving method comprising:

turning on the first transistor (T1) connected between the data line (DL) and the first node (N1) of the driving transistor (DT) by the first gate driver (530) and applying a reference voltage through the data line (DL) to the first node (N1) of the driving transistor (DT) by the data driver (520);
subsequently turning off the first transistor (T1) by the first gate driver (530) to float a voltage of the first node (N1) of the driving transistor (DT), and applying by the data driver (520) a data voltage through the data line (DL) to the second node (N2) of the driving transistor (DT) through the second transistor (T2) connected between the data line (DL) and the second node (N2) of the driving transistor (DT);
subsequently turning off the second transistor (T2) by the second gate driver (540) to allow a current to flow through the organic light-emitting diode connected to the first node (N1) of the driving transistor (DT); and
in the sensing mode, the driving method comprising:

turning on a precharge switch (Spre) coupled to the sensing node (Ns) which is connected to the third node (N3) of the driving transistor (DT) to apply a precharge voltage to the sensing node (Ns), and turning on the second transistor (T2) by the second gate driver (540) and applying a data voltage by the data driver

(520) to the second node (N2) of the driving transistor (DT);
subsequently turning off the precharge switch (Spre), and turning on the first transistor (T1) by the first gate driver (530) and applying the data voltage by the data driver (520) to the first node (N1), so that a voltage of the sensing node (Ns) increases by charging a driving voltage line capacitor (Cdv) coupled to the sensing node;
subsequently turning off the first transistor (T1) by the first gate driver (530) and turning on the sampling switch (Vsam) coupled to the sensing node (Ns) to sense the voltage of the sensing node (Ns); and
subsequently determining the threshold voltage of the driving transistor (DT) from the sensed voltage of the sensing node (Ns).

5. A driving method of the organic light-emitting display device (500) of claim 1, the method comprising driving a pixel of the organic light-emitting display device (500) in an emission mode and a sensing mode, wherein:
in the emission mode, the driving method comprising:

turning on the first transistor (T1) connected between the data line (DL) and the first node (N1) of the driving transistor (DT) by the first gate driver (530) and applying a reference voltage through the data line (DL) to the first node (N1) of the driving transistor (DT) by the data driver (520);
subsequently turning off the first transistor (T1) by the first gate driver (530) to float a voltage of the first node (N1) of the driving transistor (DT), and applying a data voltage by the data driver (520) through the data line (DL) to the second node (N2) of the driving transistor (DT) through the second transistor (T2) connected between the data line (DL) and the second node (N2) of the driving transistor (DT);
subsequently turning off the second transistor (T2) by the second gate driver (540) to allow a current to flow through the organic light-emitting diode connected to the first node (N1) of the driving transistor (DT); and
in the sensing mode, the driving method comprising:

turning on the precharge switch (Spre) coupled to the sensing node (Ns) which is connected to the third node (N3) of the driving transistor (DT) to apply a precharge voltage to the sensing node (Ns), and turning on the first and second transistor (T1, T2) by the first and second gate drivers (530, 540) to apply a data voltage to the first and second nodes (N1, N2) of the driving transistor (DT);
subsequently turning off the second transistor (T2) by the second gate driver (540);
subsequently turning off the precharge switch (Spre), so that a voltage of the sensing node (Ns) increases by charging a driving voltage line capacitor (Cdv) coupled to the sensing node by means of a constant current flowing from the first node of the driving transistor (N1) to the driving voltage line connected between the driving transistor (DT) and the voltage sensing node (Ns);
subsequently turning off the first transistor (T1) by the first gate driver (530), so that the voltage increase of the sensing node (Ns) stops, and turning on the sampling switch (Vsam) coupled to the sensing node (Ns) to sense the voltage of the sensing node (Ns); and
subsequently determining the mobility of the driving transistor (DT) from the sensed voltage of the sensing node (Ns).

6. A driving method of the organic light-emitting display device of claim 1, the method comprising driving a pixel of the organic light-emitting display device (500) in an emission mode and a sensing mode, wherein:
in the emission mode, the driving method comprising:

subsequently turning on the first transistor (T1) connected between the data line (DL) and the first node (N1) of the driving transistor (DT) by the first gate driver (530) and applying a reference voltage through the data line (DL) to the first node (N1) of the driving transistor (DT);
subsequently turning off the first transistor (T1) by the first gate driver (530) to float a voltage of the first node (N1) of the driving transistor (DT), and applying a data voltage by the data driver (520) through the data line (DL) to the second node (N2) of the driving transistor (DT) through the second transistor (T2) connected between the data line (DL) and the second node (N2) of the driving transistor (DT);
subsequently turning off the second transistor (T2) by the second gate driver (540) to allow a current to flow through the organic light-emitting diode connected to the first node (N1) of the driving transistor (DT); and
in the sensing mode, the driving method comprising the steps of:

(i) turning on the precharge switch (Spre) coupled to the sensing node (Ns) which is connected to the third node (N3) of the driving transistor (DT) to apply a precharge voltage to the sensing node (Ns) and turning on the first transistor (T1) by the first gate driver (530) before applying by the data driver (520) a first data

voltage to the data line (DL);
(ii) subsequently turning on the second transistor (T2) by the second gate driver (540) and applying a first data voltage by the data driver (520) to the first and second nodes (N1, N2); and
(iii) subsequently turning off the precharge switch (Spre) and turning on the sampling switch (Vsam) coupled to the sensing node (Ns) to sense a first current of the sensing node (Ns);
(iv) subsequently repeating steps (i) to (iii) using a second data voltage instead of the first data voltage in step (ii) to sense a second current of the sensing node (Ns) in step (iii); and
(v) determining the threshold voltage and mobility of the driving transistor (DT) from the sensed first current, the sensed second current, the first data voltage, the second data voltage and the precharge voltage.

Patentansprüche

1. Eine organische lichtemittierende Anzeige-Vorrichtung (500), aufweisend:

ein Anzeige-Panel (510), das eine Vielzahl von Datenleitungen (DL), eine Vielzahl von ersten Gate-Leitungen (GL1) und eine Vielzahl von zweiten Gate-Leitungen (GL2) und eine Vielzahl von Pixeln enthält;
einen Datentreiber (520), der so angeordnet ist, dass er ein Datensignal durch mindestens eine der Vielzahl von Datenleitungen (DL) liefert;
einen ersten Gate-Treiber (530), der so angeordnet ist, dass er ein Abtastsignal durch mindestens eine der Vielzahl von ersten Gate-Leitungen (GL1) liefert, die die Vielzahl von Datenleitungen (DL) in dem Anzeige-Panel (510) überkreuzen;
einen zweiten Gate-Treiber (540), der so angeordnet ist, dass er ein Scansignal durch mindestens eine der Vielzahl von zweiten Gate-Leitungen (GL2) liefert, die im Wesentlichen parallel zu der Vielzahl von ersten Gate-Leitungen (GL1) in dem Anzeige-Panel (510) sind;
eine Timing-Steuereinrichtung (550), die so angeordnet ist, dass sie Ansteuerzeiten des Datentreibers (520), des ersten Gate-Treibers (530) und des zweiten Gate-Treibers (540) steuert,
wobei jedes der Vielzahl von Pixeln eine organische lichtemittierende Diode, einen Treibertransistor (DT), der einen ersten Knoten (N1), einen zweiten Knoten (N2) und einen dritten Knoten (N3) hat, einen ersten Transistor (T1), der durch das Abtastsignal gesteuert wird und zwischen die entsprechende Datenleitung (DL) und den ersten Knoten (N1) des Treibertransistors (DT) geschaltet ist, einen zweiten Transistor (T2), der durch das Scansignal gesteuert wird und zwischen die entsprechende Datenleitung (DL) und den zweiten Knoten (N2) des Treibertransistors (DT) geschaltet ist, und einen Speicherkondensator (Cstg), der zwischen den ersten und zweiten Knoten (N1, N2) des Treibertransistors (DT) geschaltet ist, wobei der dritte Knoten (N3) mit einer Treiberspannungsleitung (DVL) verbunden ist, wobei, in einem Emissionsmodus, eine Treiberspannung (EVDD) an die Treiberspannungsleitung (DVL) geliefert wird, enthält; und
eine Abtasteinheit (1100, 2100), die mit der Treiberspannungsleitung (DVL) verbunden ist, die Abtasteinheit (1100, 2100) aufweisend:

einen Analog-zu-Digital-Umwandler (1110), der angepasst ist, eine Spannung eines Abtastknotens (Ns) zu messen, der mit der Treiberspannungsleitung (DVL) verbunden ist, oder eine Strommesseinheit (2110), die angepasst ist, einen Strom zu messen, der durch den Abtastknoten (Ns) fließt, der mit der Treiberspannungsleitung (DVL) verbunden ist, und
einen Schalter (Spre, Vsam), der angepasst ist, eine Verbindung zwischen einem Vorladespannungsversorgungsknoten (Npre) und dem Abtastknoten (Ns) zu schalten, und der eine Verbindung zwischen einem Verbindungsknoten (Nadc, Ni) des Analog-zu-Digital-Umwandlers (1110) oder der Strommesseinheit (2110) und dem Abtastknoten (Ns) schaltet.

2. Die organische lichtemittierende Anzeige-Vorrichtung (500) gemäß Anspruch 1, wobei der Datentreiber (520) konfiguriert ist zum Liefern einer Referenzspannung oder einer Datenspannung an die entsprechende Datenleitung (DL) gemäß eines Betriebs-Timings eines korrespondierenden Pixels .

3. Die organische lichtemittierende Anzeige-Vorrichtung (500) gemäß Anspruch 1 oder 2, wobei der erste Gate-Treiber (530) konfiguriert ist, ein Abtastsignal zu liefern, das den ersten Transistor (T1) ein- oder ausschaltet, der Datentreiber (520) konfiguriert ist, eine Referenzspannung oder eine Datenspannung an die entsprechende Datenleitung (DL) zu liefern, und der zweite Gate-Treiber (540) konfiguriert ist, ein Scansignal zu liefern, das den zweiten Transistor (T2) ein- oder ausschaltet, wobei, in einem Emissionsmodus der organischen lichtemittierenden Anzeige-Vorrichtung, der erste Gate-Treiber (530), der zweite Gate-Treiber (540) und der Datentreiber (520) konfiguriert sind, das eine der Vielzahl von Pixeln so zu betreiben, dass:

- in einem ersten Schritt des Emissionsmodus, der erste Transistor (T1) durch den ersten Gate-Treiber (530) eingeschaltet wird und die Referenzspannung durch den Datentreiber (520) an den ersten Knoten (N1) des Treibertransistors (DT) angelegt wird,
- in einem Schreibschritt, der dem ersten Schritt folgt, der erste Transistor (T1) durch den ersten Gate-Treiber (530) ausgeschaltet wird und der zweite Transistor (T2) durch den zweiten Gate-Treiber (540) eingeschaltet wird und eine Datenspannung an den zweiten Knoten (N2) des Treibertransistors (DT) durch den Datentreiber (520) angelegt wird, und
- in einem Emissionsschritt, der dem Schreibschritt folgt, der zweite Transistor (T2) durch den zweiten Gate-Treiber (540) ausgeschaltet wird, so dass ein Strom durch die organische lichtemittierende Diode fließt.

4. Ein Ansteuerverfahren der organischen lichtemittierenden Anzeige-Vorrichtung (500) gemäß Anspruch 1, das Verfahren Ansteuern eines Pixels der organischen lichtemittierenden Anzeige-Vorrichtung (500) in einem Emissionsmodus und einem Abtastmodus aufweisend, wobei:
in dem Emissionsmodus, das Ansteuerverfahren aufweisend:

Einschalten des ersten Transistors (T1), der zwischen die Datenleitung (DL) und den ersten Knoten (N1) des Treibertransistors (DT) geschaltet ist, durch den ersten Gate-Treiber (530) und Anlegen einer Referenzspannung durch die Datenleitung (DL) an den ersten Knoten (N1) des Treibertransistors (DT) durch den Datentreiber (520);
anschließendes Ausschalten des ersten Transistors (T1) durch den ersten Gate-Treiber (530), um den ersten Knoten (N1) des Treibertransistors (DT) potentialfrei zu machen, und Anlegen einer Datenspannung durch den Datentreiber (520) durch die Datenleitung (DL) an den zweiten Knoten (N2) des Treibertransistors (DT) durch den zweiten Transistor (T2), der zwischen die Datenleitung (DL) und den zweiten Knoten (N2) des Treibertransistors (DT) geschaltet ist;
anschließendes Ausschalten des zweiten Transistors (T2) durch den zweiten Gate-Treiber (540), um einem Strom zu erlauben, durch die organische lichtemittierende Diode zu fließen, die mit dem ersten Knoten (N1) des Treibertransistors (DT) verbunden ist; und
in dem Abtastmodus, das Ansteuerverfahren aufweisend:

Einschalten eines Vorladeschalters (Spre), der mit dem Abtastknoten (Ns) gekoppelt ist, der mit dem dritten Knoten (N3) des Treibertransistors (DT) verbunden ist, um eine Vorladespannung an den Abtastknoten (Ns) anzulegen, und Einschalten des zweiten Transistors (T2) durch den zweiten Gate-Treiber (540) und Anlegen einer Datenspannung durch den Datentreiber (520) an den zweiten Knoten (N2) des Treibertransistors (DT);
anschließendes Ausschalten des Vorladeschalters (Spre) und Einschalten des ersten Transistors (T1) durch den ersten Gate-Treiber (530) und Anlegen der Datenspannung durch den Datentreiber (520) an den ersten Knoten (N1), so dass sich eine Spannung des Abtastknotens (Ns) durch Aufladen eines Ansteuerspannungsleitungskondensators (Cdv) erhöht, der mit dem Abtastknoten gekoppelt ist;
anschließendes Ausschalten des ersten Transistors (T1) durch den ersten Gate-Treiber (530) und Einschalten des Abtastschalters (Vsam), der mit dem Abtastknoten (Ns) gekoppelt ist, um die Spannung des Abtastknotens (Ns) abzutasten; und
anschließendes Bestimmen der Schwellspannung des Treibertransistors (DT) aus der abgetasteten Spannung des Abtastknotens (Ns).

5. Ein Ansteuerverfahren der organischen lichtemittierenden Anzeige-Vorrichtung (500) gemäß Anspruch 1, das Verfahren Ansteuern eines Pixels der organischen lichtemittierenden Anzeige-Vorrichtung (500) in einem Emissionsmodus und einem Abtastmodus aufweisend, wobei:

in dem Emissionsmodus, das Verfahren aufweisend:

Einschalten des ersten Transistors (T1), der zwischen die Datenleitung (DL) und den ersten Knoten (N1) des Treibertransistors (DT) geschaltet ist, durch den ersten Gate-Treiber (530) und Anlegen einer Referenzspannung durch die Datenleitung (DL) an den ersten Knoten (N1) des Treibertransistors (DT) durch den Datentreiber (520);
anschließendes Ausschalten des ersten Transistors (T1) durch den ersten Gate-Treiber (530), um den ersten Knoten (N1) des Treibertransistors (DT) potentialfrei zu machen, und Anlegen einer Datenspannung durch den Datentreiber (520) durch die Datenleitung (DL) an den zweiten Knoten (N2) des Treibertransistors

(DT) durch den zweiten Transistor (T2), der zwischen die Datenleitung (DL) und den zweiten Knoten (N2) des Treibertransistors (DT) geschaltet ist;
anschließendes Ausschalten des zweiten Transistors (T2) durch den zweiten Gate-Treiber (540), um einem Strom zu erlauben, durch die organische lichtemittierende Diode zu fließen, die mit dem ersten Knoten (N1) des Treibertransistors (DT) verbunden ist; und
in dem Abtastmodus, das Ansteuerverfahren aufweisend:

Einschalten des Vorladeschalters (Spre), der mit dem Abtastknoten (Ns) gekoppelt ist, der mit dem dritten Knoten (N3) des Treibertransistors (DT) verbunden ist, um eine Vorladespannung an den Abtastknoten (Ns) anzulegen, und Einschalten des ersten und zweiten Transistors (T1, T2) durch den ersten und zweiten Gate-Treiber (530, 540), um eine Datenspannung an den ersten und zweiten Knoten (N1, N2) des Treibertransistors (DT) anzulegen;
anschließendes Ausschalten des zweiten Transistors (T2) durch den zweiten Gate-Treiber (540);
anschließendes Ausschalten des Vorladeschalters (Spre), so dass sich eine Spannung des Abtastknotens (Ns) durch Aufladen eines Ansteuerspannungsleitungskondensators (Cdv), der mit dem Abtastknoten (Ns) gekoppelt ist, mit Hilfe eines konstanten Stroms, der von dem ersten Knoten des Treibertransistors (N1) an die Treiberspannungsleitung fließt, die zwischen den Treibertransistor (DT) und den Spannungsabtastknoten (Ns) geschaltet ist, erhöht;
anschließendes Ausschalten des ersten Transistors (T1) durch den ersten Gate-Treiber (530), so dass die Spannungserhöhung des Abtastknotens (Ns) stoppt, und Einschalten des Abtastschalters (Vsam), der mit dem Abtastknoten (Ns) gekoppelt ist, um die Spannung des Abtastknotens (Ns) abzutasten; und
anschließendes Bestimmen der Beweglichkeit des Treibertransistors (DT) aus der abgetasteten Spannung des Abtastknotens (Ns).

6. Ein Ansteuerverfahren der organischen lichtemittierenden Anzeige-Vorrichtung gemäß Anspruch 1, das Verfahren Ansteuern eines Pixels der organischen lichtemittierenden Anzeige-Vorrichtung (500) in einem Emissionsmodus und einem Abtastmodus aufweisend, wobei:
in dem Emissionsmodus, das Ansteuerverfahren aufweisend:

anschließendes Einschalten des ersten Transistors (T1), der zwischen die Datenleitung (DL) und den ersten Knoten (N1) des Treibertransistors (DT) geschaltet ist, durch den ersten Gate-Treiber (530) und Anlegen einer Referenzspannung durch die Datenleitung (DL) an den ersten Knoten (N1) des Treibertransistors (DT);
anschließendes Ausschalten des ersten Transistors (T1) durch den ersten Gate-Treiber (530), um den ersten Knoten (N1) des Treibertransistors (DT) potentialfrei zu machen, und Anlegen einer Datenspannung durch den Datentreiber (520) durch die Datenleitung (DL) an den zweiten Knoten (N2) des Treibertransistors (DT) durch den zweiten Transistor (T2), der zwischen die Datenleitung (DL) und den zweiten Knoten (N2) des Treibertransistors (DT) geschaltet ist;
anschließendes Ausschalten des zweiten Transistors (T2) durch den zweiten Gate-Treiber (540), um einem Strom zu erlauben, durch die organische lichtemittierende Diode zu fließen, die mit dem ersten Knoten (N1) des Treibertransistors (DT) verbunden ist; und
in dem Abtastmodus, das Ansteuerverfahren die Schritte aufweisend:

(i) Einschalten des Vorladeschalters (Spre), der mit dem Abtastknoten (Ns) gekoppelt ist, der mit dem dritten Knoten (N3) des Treibertransistors (DT) verbunden ist, um eine Vorladespannung an den Abtastknoten (Ns) anzulegen, und Einschalten des ersten Transistors (T1) durch den ersten Gate-Treiber (530) vor Anlegen einer ersten Datenspannung an die Datenleitung (DL) durch den Datentreiber (520);
(ii) anschließendes Einschalten des zweiten Transistors (T2) durch den zweiten Gate-Treiber (540) und Anlegen einer ersten Datenspannung durch den Datentreiber (520) an den ersten und zweiten Knoten (N1, N2); und
(iii) anschließendes Ausschalten des Vorladeschalters (Spre) und Einschalten des Abtastschalters (Vsam), der mit dem Abtastknoten (Ns) gekoppelt ist, um einen ersten Strom des Abtastknotens (Ns) abzutasten;
(iv) anschließend Wiederholung der Schritte (i) bis (iii) unter Verwendung einer zweiten Datenspannung anstatt der ersten Datenspannung in Schritt (ii), um einen zweiten Strom des Abtastknotens (Ns) in Schritt (iii) abzutasten; und
(v) Bestimmen der Schwellspannung und Beweglichkeit des Treibertransistors (DT) aus dem abgetasteten ersten Strom, dem abgetasteten zweiten Strom, der ersten Datenspannung, der zweiten Datenspannung und der Vorladespannung.

Revendications

1. Dispositif d'affichage électroluminescent organique (500) comprenant :

un panneau d'affichage (510) incluant une pluralité de lignes de données (DL), une pluralité de premières lignes de grille (GL1) et une pluralité de secondes lignes de grille (GL2), et une pluralité de pixels ;
un circuit d'attaque de données (520) agencé de manière à fournir un signal de données à travers au moins l'une de la pluralité de lignes de données (DL) ;
un premier circuit d'attaque de grille (530) agencé de manière à fournir un signal de détection à travers au moins l'une de la pluralité de premières lignes de grille (GL1) qui croisent la pluralité de lignes de données (DL) dans le panneau d'affichage (510) ;
un second circuit d'attaque de grille (540) agencé de manière à fournir un signal de balayage à travers au moins l'une de la pluralité de secondes lignes de grille (GL2) qui sont sensiblement parallèles à la pluralité de premières lignes de grille (GL1) dans le panneau d'affichage (510) ;
un contrôleur de temporisation (550) agencé de manière à commander des temporisations d'attaque du circuit d'attaque de données (520), du premier circuit d'attaque de grille (530) et du second circuit d'attaque de grille (540) ;
dans lequel chaque pixel de la pluralité de pixels comprend une diode électroluminescente organique, un transistor d'attaque (DT) présentant un premier noeud (N1), un deuxième noeud (N2) et un troisième noeud (N3), un premier transistor (T1) commandé par le signal de détection et connecté entre la ligne de données respective (DL) et le premier noeud (N1) du transistor d'attaque (DT), un second transistor (T2) commandé par le signal de balayage et connecté entre la ligne de données respective (DL) et le deuxième noeud (N2) du transistor d'attaque (DT), et un condensateur de stockage (Cstg) connecté entre les premier et deuxième noeuds (N1, N2) du transistor d'attaque (DT), le troisième noeud (N3) étant connecté à une ligne de tension d'attaque (DVL), dans lequel, dans un mode d'émission, une tension d'attaque (EVDD) est fournie à la ligne de tension d'attaque (DVL) ; et
une unité de détection (1100, 2100) connectée à la ligne de tension d'attaque (DVL), l'unité de détection (1100, 2100) comprenant :

un convertisseur analogique-numérique (1110) apte à mesurer une tension d'un noeudde détection (Ns) connecté à la ligne de tension d'attaque (DVL), ou une unité de mesure de courant (2110) apte à mesurer un courant circulant à travers le noeudde détection (Ns) connecté à la ligne de tension d'attaque (DVL) ; et
un commutateur (Spre, Vsam) apte à commuter une connexion entre un noeud de fourniture de tension de précharge (Npre) et le noeud de détection (Ns), et commutant une connexion entre un noeud de connexion (Nadc, Ni) du convertisseur analogique-numérique (1110) ou de l'unité de mesure de courant (2110) et le noeud de détection (Ns).

2. Dispositif d'affichage électroluminescent organique (500) selon la revendication 1, dans lequel le circuit d'attaque de données (520) est configuré de manière à fournir, à la ligne de données respective (DL), une tension de référence ou une tension de données, selon une temporisation de fonctionnement d'un pixel correspondant.

3. Dispositif d'affichage électroluminescent organique (500) selon la revendication 1 ou 2, dans lequel le premier circuit d'attaque de grille (530) est configuré de manière à fournir un signal de détection qui active ou désactive le premier transistor (T1), le circuit d'attaque de données (520) est configuré de manière à fournir une tension de référence ou une tension de données à la ligne de données respective (DL), et le second circuit d'attaque de grille (540) est configuré de manière à fournir un signal de balayage qui active ou désactive le second transistor (T2), dans lequel, dans un mode d'émission du dispositif d'affichage électroluminescent organique, le premier circuit d'attaque de grille (530), le second circuit d'attaque de grille (540) et le circuit d'attaque de données (520) sont configurés de manière à exploiter ledit pixel de la pluralité de pixels, de sorte que :

- dans une étape initiale du mode d'émission, le premier transistor (T1) est activé par le premier circuit d'attaque de grille (530) et la tension de référence est appliquée au premier noeud (N1) du transistor d'attaque (DT) par le circuit d'attaque de données (520) ;
- dans une étape d'écriture suivant l'étape initiale, le premier transistor (T1) est désactivé par le premier circuit d'attaque de grille (530) et le second transistor (T2) est activé par le second circuit d'attaque de grille (540), et une tension de données est appliquée au deuxième noeud (N2) du transistor d'attaque (DT) par le circuit d'attaque de données (520) ; et
- dans une étape d'émission suivant l'étape d'écriture, le second transistor (T2) est désactivé par le second

circuit d'attaque de grille (540) de sorte qu'un courant circule à travers la diode électroluminescente organique.

4. Procédé de commande du dispositif d'affichage électroluminescent organique (500) selon la revendication 1, le procédé comprenant l'étape consistant à commander un pixel du dispositif d'affichage électroluminescent organique (500) dans un mode d'émission et dans un mode de détection, dans lequel :
dans le mode d'émission, le procédé de commande comprend les étapes ci-dessous consistant à :

activer le premier transistor (T1) connecté entre la ligne de données (DL) et le premier noeud (N1) du transistor d'attaque (DT), par le biais du premier circuit d'attaque de grille (530), et appliquer une tension de référence à travers la ligne de données (DL) au premier noeud (N1) du transistor d'attaque (DT) par le biais du circuit d'attaque de données (520) ;
désactiver subséquemment le premier transistor (T1), par le biais du premier circuit d'attaque de grille (530), afin de faire flotter une tension du premier noeud (N1) du transistor d'attaque (DT), et appliquer, par le biais du circuit d'attaque de données (520), une tension de données, à travers la ligne de données (DL), au deuxième noeud (N2) du transistor d'attaque (DT) à travers le second transistor (T2) connecté entre la ligne de données (DL) et le deuxième noeud (N2) du transistor d'attaque (DT) ;
désactiver subséquemment le second transistor (T2), par le biais du second circuit d'attaque de grille (540), afin de permettre à un courant de circuler à travers la diode électroluminescente organique connectée au premier noeud (N1) du transistor d'attaque (DT) ; et
dans le mode de détection, le procédé de commande comprend les étapes ci-dessous consistant à :

activer un commutateur de précharge (Spre) couplé au noeud de détection (Ns) qui est connecté au troisième noeud (N3) du transistor d'attaque (DT) en vue d'appliquer une tension de précharge au noeud de détection (Ns), et activer le second transistor (T2), par le biais du second circuit d'attaque de grille (540), et appliquer, par le biais du circuit d'attaque de données (520), une tension de données au deuxième noeud (N2) du transistor d'attaque (DT) ;
désactiver subséquemment le commutateur de précharge (Spre), et activer le premier transistor (T1), par le biais du premier circuit d'attaque de grille (530), et appliquer la tension de données, par le biais du circuit d'attaque de données (520), au premier noeud (N1), de sorte qu'une tension du noeud de détection (Ns) augmente en chargeant un condensateur de ligne de tension d'attaque (Cdv) couplé au noeud de détection ;
désactiver subséquemment le premier transistor (T1), par le biais du premier circuit d'attaque de grille (530), et activer le commutateur d'échantillonnage (Vsam) couplé au noeud de détection (Ns) en vue de détecter la tension du noeud de détection (Ns) ; et
subséquemment, déterminer la tension de seuil du transistor d'attaque (DT) à partir de la tension détectée du noeud de détection (Ns).

5. Procédé de commande du dispositif d'affichage électroluminescent organique (500) selon la revendication 1, le procédé comprenant l'étape consistant à commander un pixel du dispositif d'affichage électroluminescent organique (500) dans un mode d'émission et dans un mode de détection, dans lequel :
dans le mode d'émission, le procédé de commande comprend les étapes ci-dessous consistant à :

activer le premier transistor (T1) connecté entre la ligne de données (DL) et le premier noeud (N1) du transistor d'attaque (DT), par le biais du premier circuit d'attaque de grille (530), et appliquer une tension de référence à travers la ligne de données (DL) au premier noeud (N1) du transistor d'attaque (DT) par le biais du circuit d'attaque de données (520) ;
désactiver subséquemment le premier transistor (T1), par le biais du premier circuit d'attaque de grille (530), afin de faire flotter une tension du premier noeud (N1) du transistor d'attaque (DT), et appliquer, par le biais du circuit d'attaque de données (520), une tension de données, à travers la ligne de données (DL), au deuxième noeud (N2) du transistor d'attaque (DT) à travers le second transistor (T2) connecté entre la ligne de données (DL) et le deuxième noeud (N2) du transistor d'attaque (DT) ;
désactiver subséquemment le second transistor (T2), par le biais du second circuit d'attaque de grille (540), afin de permettre à un courant de circuler à travers la diode électroluminescente organique connectée au premier noeud (N1) du transistor d'attaque (DT) ; et
dans le mode de détection, le procédé de commande comprend les étapes ci-dessous consistant à :

activer le commutateur de précharge (Spre) couplé au noeud de détection (Ns) qui est connecté au troisième noeud (N3) du transistor d'attaque (DT) pour appliquer une tension de précharge au noeud de détection (Ns), et activer les premier et second transistors (T1, T2), par le biais des premier et second circuits d'attaque

de grille (530, 540) pour appliquer une tension de données aux premier et deuxième noeuds (N1, N2) du transistor d'attaque (DT) ;
désactiver subséquemment le second transistor (T2), par le biais du second circuit d'attaque de grille (540) ;
désactiver subséquemment le commutateur de précharge (Spre), de sorte qu'une tension du noeud de détection (Ns) augmente en chargeant un condensateur de ligne de tension d'attaque (Cdv) couplé au noeud de détection, au moyen d'un courant constant circulant du premier noeud du transistor d'attaque (N1) vers la ligne de tension d'attaque connectée entre le transistor d'attaque (DT) et le noeud de détection (Ns) ;
désactiver subséquemment le premier transistor (T1), par le biais du premier circuit d'attaque de grille (530), de sorte que l'augmentation de tension du noeud de détection (Ns) s'interrompt, et activer le commutateur d'échantillonnage (Vsam) couplé au noeud de détection (Ns) en vue de détecter la tension du noeud de détection (Ns) ; et
déterminer subséquemment la mobilité du transistor d'attaque (DT) à partir de la tension détectée du noeud de détection (Ns).

6. Procédé de commande du dispositif d'affichage électroluminescent organique selon la revendication 1, le procédé comprenant l'étape consistant à commander un pixel du dispositif d'affichage électroluminescent organique (500) dans un mode d'émission et dans un mode de détection, dans lequel :
dans le mode d'émission, le procédé de commande comprend les étapes ci-dessous consistant à :

activer subséquemment le premier transistor (T1) connecté entre la ligne de données (DL) et le premier noeud (N1) du transistor d'attaque (DT), par le biais du premier circuit d'attaque de grille (530), et appliquer une tension de référence à travers la ligne de données (DL), au premier noeud (N1) du transistor d'attaque (DT) ;
désactiver subséquemment le premier transistor (T1), par le biais du premier circuit d'attaque de grille (530), afin de faire flotter une tension du premier noeud (N1) du transistor d'attaque (DT), et appliquer une tension de données, par le biais du circuit d'attaque de données (520), à travers la ligne de données (DL), au deuxième noeud (N2) du transistor d'attaque (DT), à travers le second transistor (T2) connecté entre la ligne de données (DL) et le deuxième noeud (N2) du transistor d'attaque (DT) ;
désactiver subséquemment le second transistor (T2), par le biais du second circuit d'attaque de grille (540), afin de permettre à un courant de circuler à travers la diode électroluminescente organique connectée au premier noeud (N1) du transistor d'attaque (DT) ; et
dans le mode de détection, le procédé de commande comprend les étapes ci-dessous consistant à :

(i) activer le commutateur de précharge (Spre) couplé au noeud de détection (Ns) qui est connecté au troisième noeud (N3) du transistor d'attaque (DT), en vue d'appliquer une tension de précharge au noeud de détection (Ns), et activer le premier transistor (T1), par le biais du premier circuit d'attaque de grille (530) avant d'appliquer, par le biais du circuit d'attaque de données (520), une première tension de données à la ligne de données (DL) ;
(ii) activer subséquemment le second transistor (T2), par le biais du second circuit d'attaque de grille (540), et appliquer une première tension de données, par le biais du circuit d'attaque de données (520), aux premier et deuxième noeuds (N1, N2) ; et
(iii) désactiver subséquemment le commutateur de précharge (Spre) et activer le commutateur d'échantillonnage (Vsam) couplé au noeud de détection (Ns), en vue de détecter un premier courant du noeud de détection (Ns) ;
(iv) répéter subséquemment les étapes (i) à (iii) en utilisant une seconde tension de données au lieu de la première tension de données à l'étape (ii) en vue de détecter un second courant du noeud de détection (Ns) à l'étape (iii) ; et
(v) déterminer la tension de seuil et la mobilité du transistor d'attaque (DT) à partir du premier courant détecté, du second courant détecté, de la première tension de données, de la seconde tension de données et de la tension de précharge.

FIG. 1

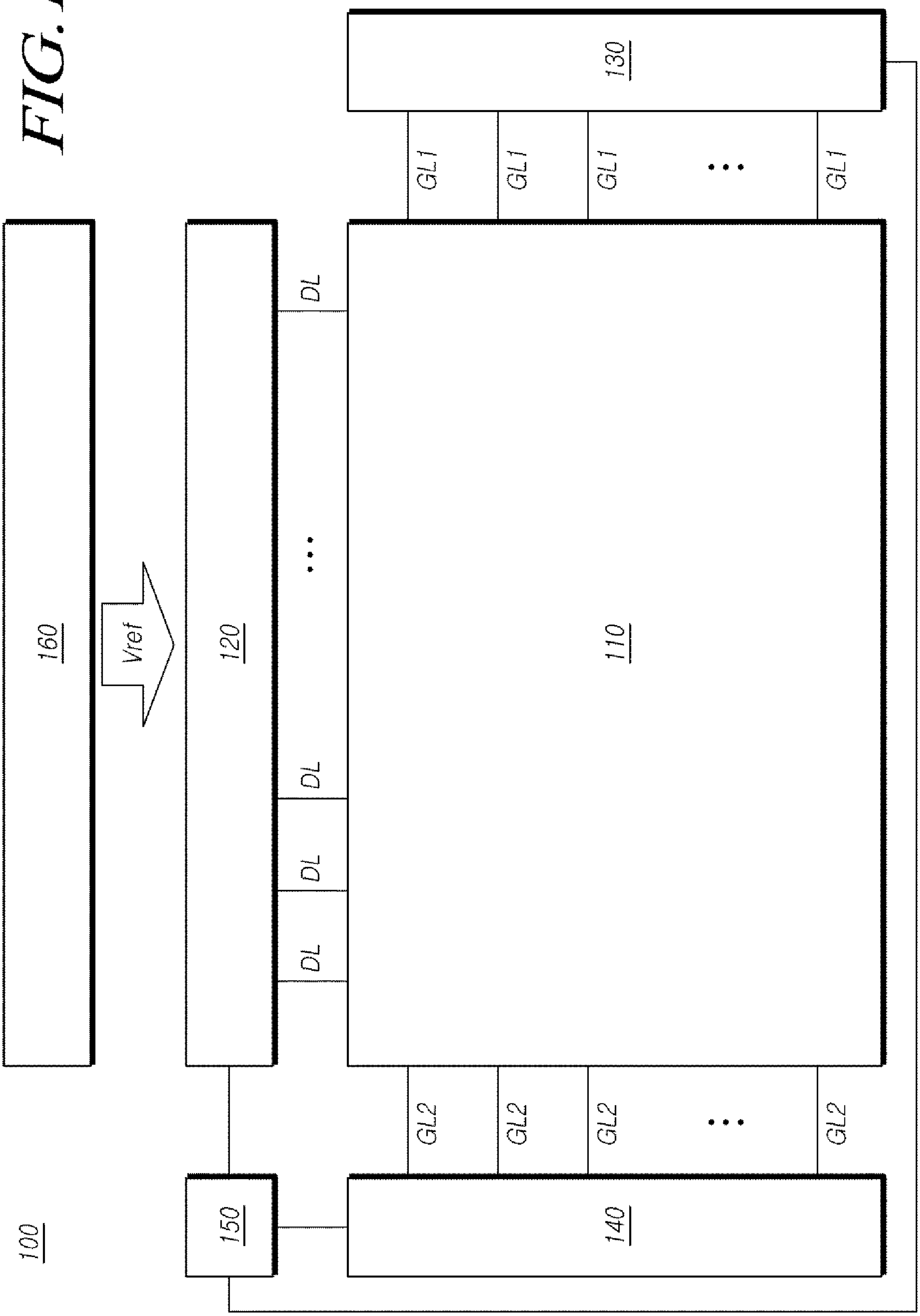

100
160
Vref
120
DL
DL
DL
DL
110
130
GL1
GL1
GL1
GL1
140
GL2
GL2
GL2
GL2
150

FIG.2

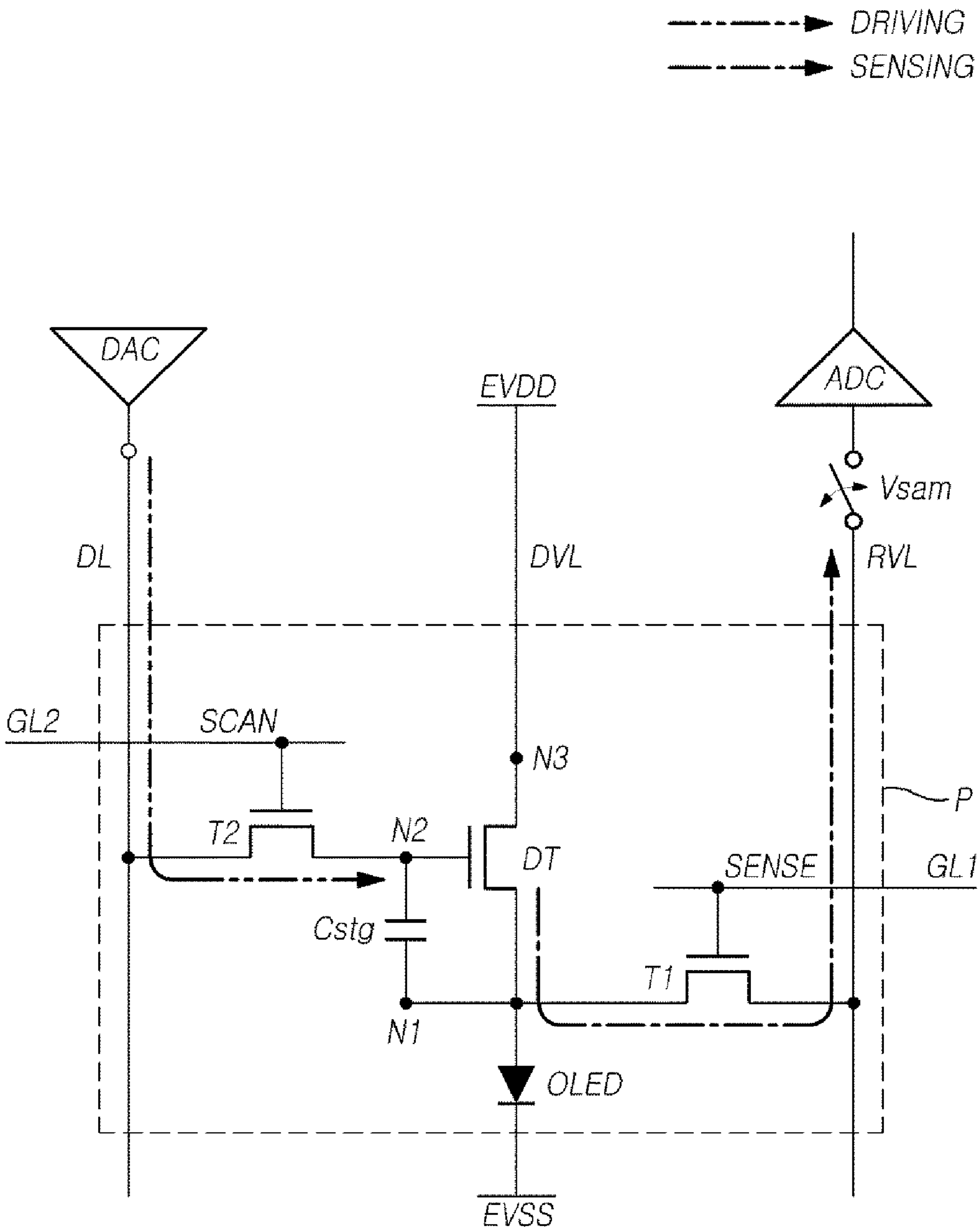

DRIVING
SENSING
DAC
EVDD
ADC
Vsam
DL
DVL
RVL
GL2
SCAN
N3
P
T2
N2
DT
SENSE
GL1
Cstg
T1
N1
OLED
EVSS

FIG.3

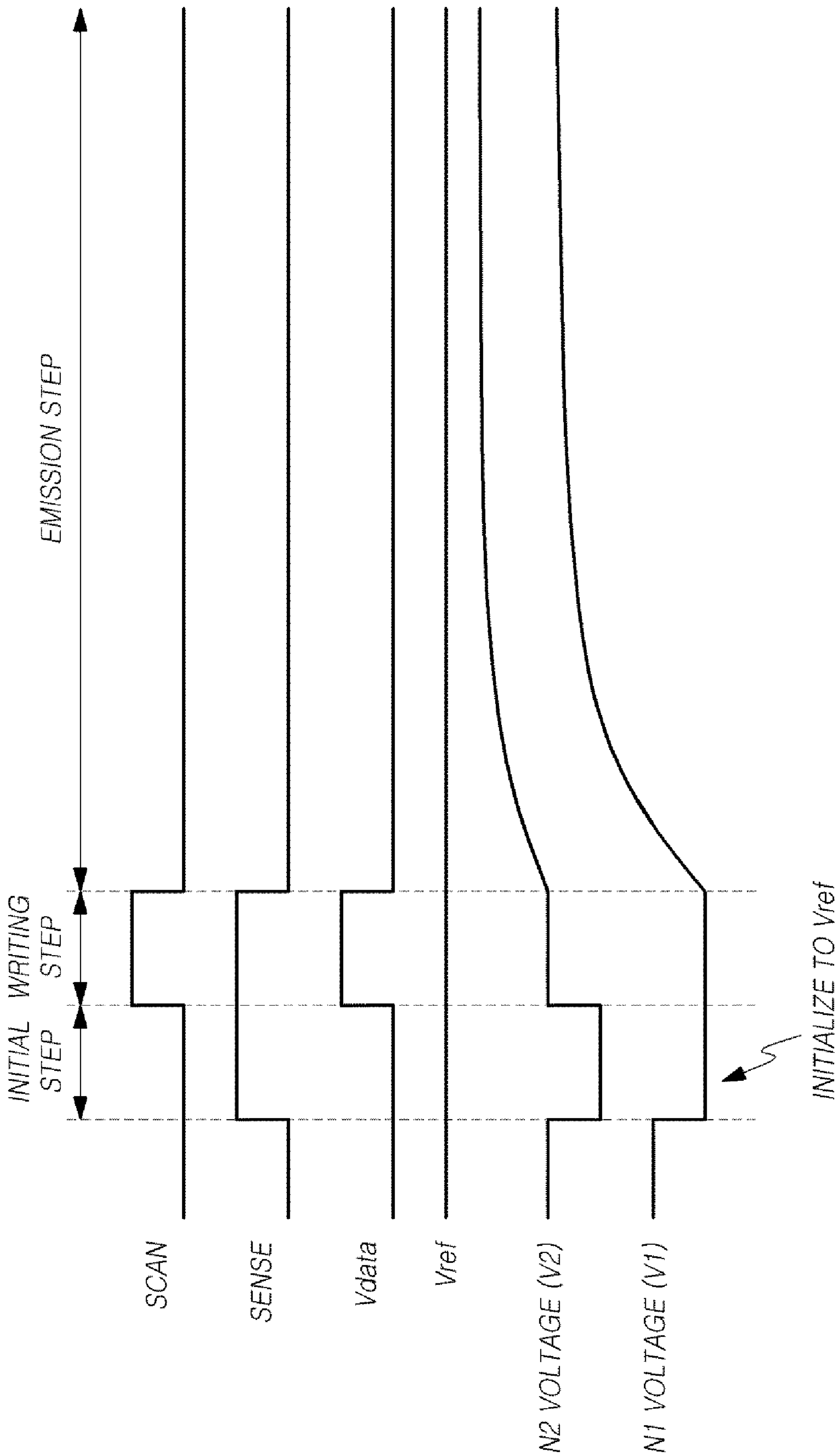

EMISSION STEP
INITIAL STEP
WRITING STEP
SCAN
SENSE
Vdata
Vref
N2 VOLTAGE (V2)
N1 VOLTAGE (V1)
INITIALIZE TO Vref

FIG.4

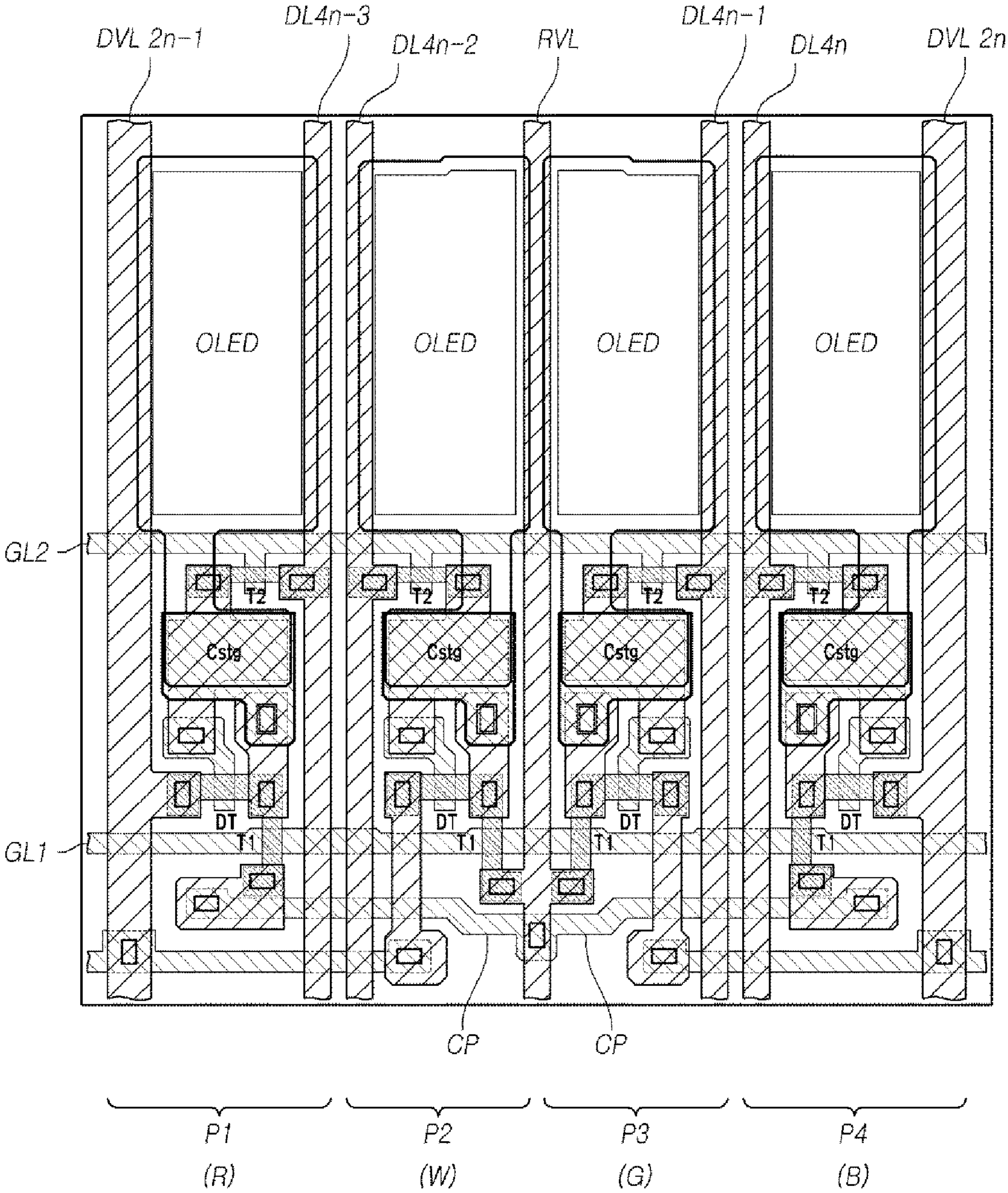

DVL 2n-1
DL4n-3
DL4n-2
RVL
DL4n-1
DL4n
DVL 2n
OLED
OLED
OLED
OLED
GL2
T2
T2
T2
T2
Cstg
Cstg
Cstg
Cstg
DT
DT
DT
DT
GL1
T1
T1
T1
T1
CP
CP
P1
(R)
P2
(W)
P3
(G)
P4
(B)

FIG.5

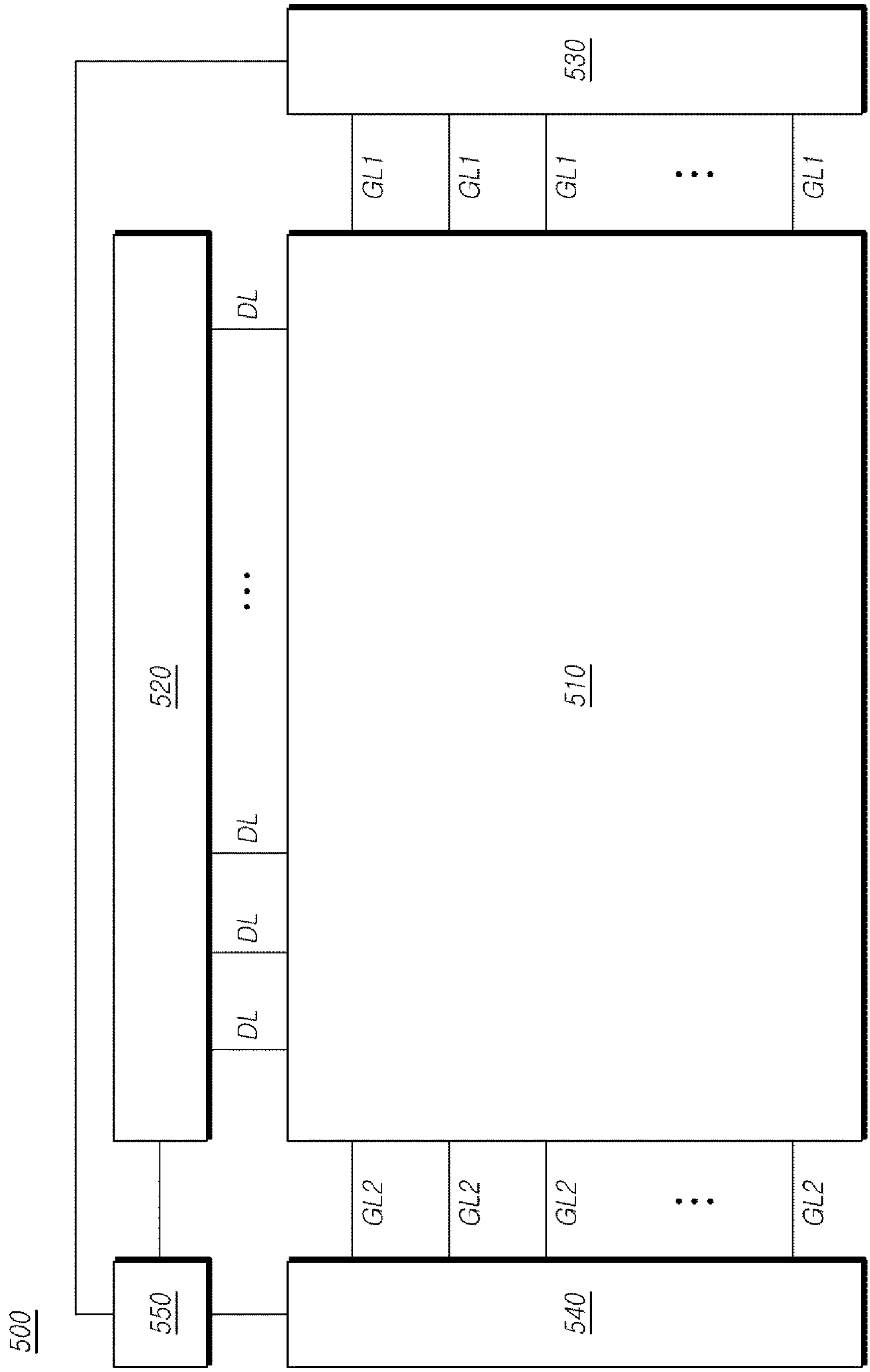

500
510
520
530
540
550
GL1
GL1
GL1
GL1
GL2
GL2
GL2
GL2
DL
DL
DL
DL

FIG.6

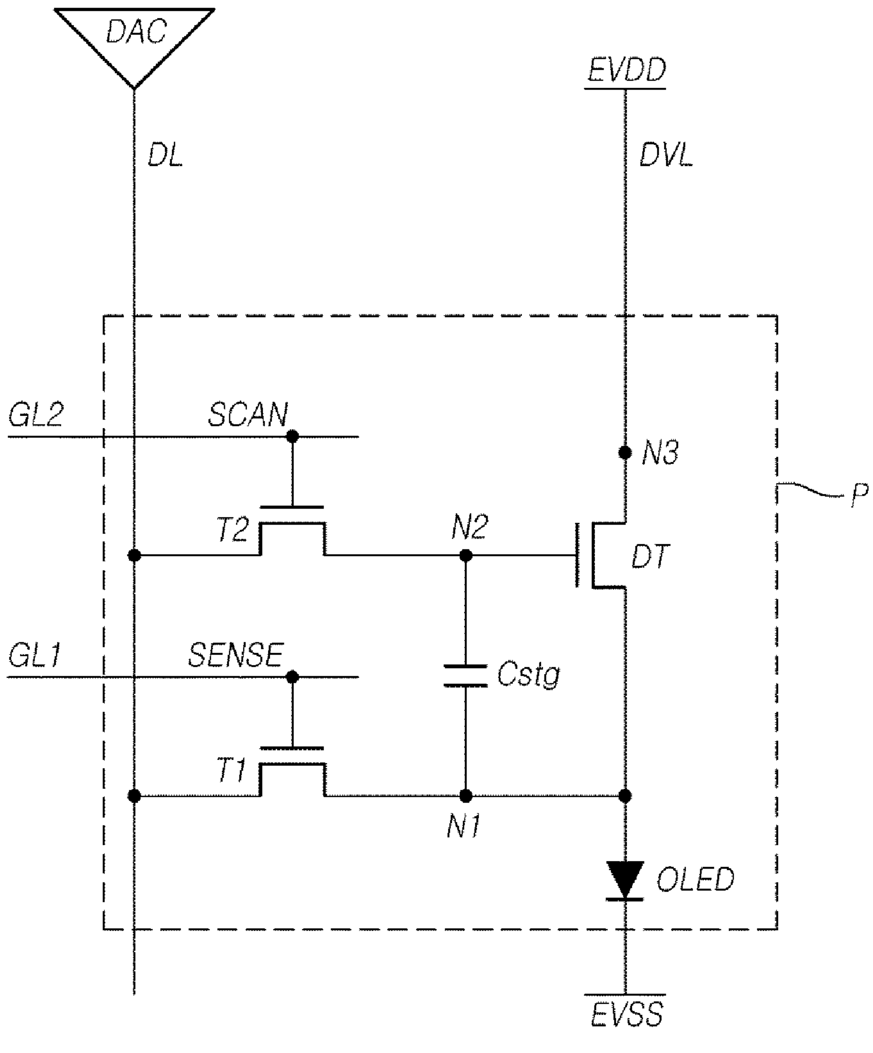

DAC
EVDD
DL
DVL
GL2
SCAN
N3
P
T2
N2
DT
GL1
SENSE
Cstg
T1
N1
OLED
EVSS

FIG. 7

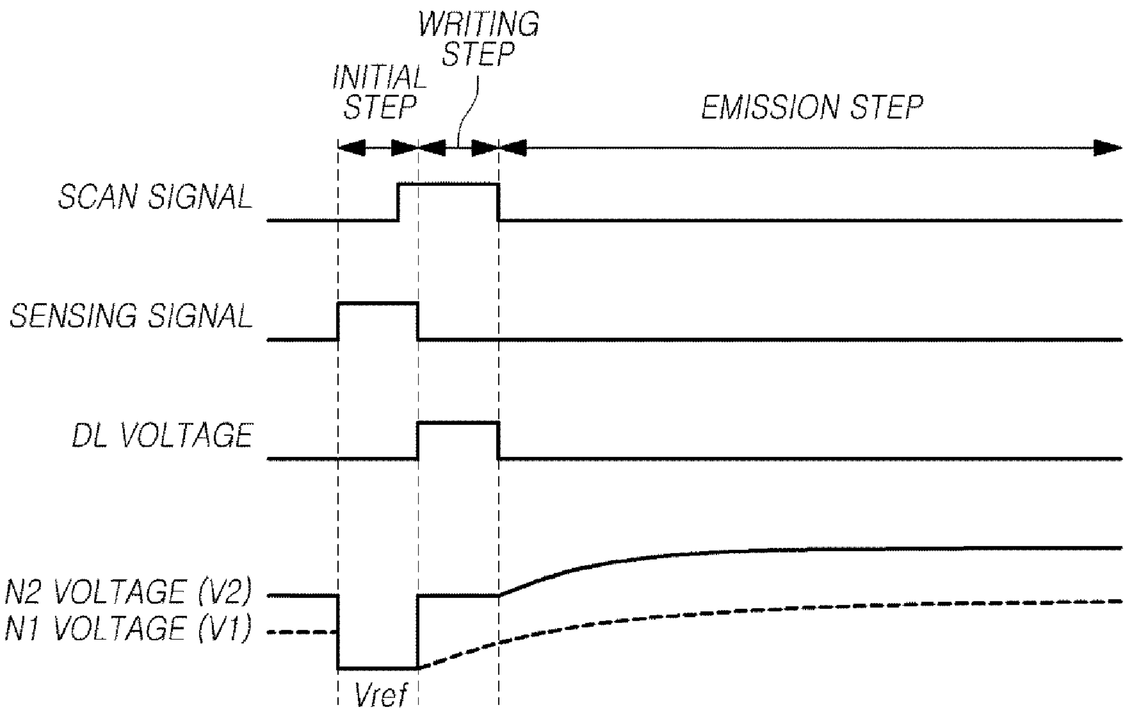

WRITING STEP
INITIAL STEP
EMISSION STEP
SCAN SIGNAL
SENSING SIGNAL
DL VOLTAGE
N2 VOLTAGE (V2)
N1 VOLTAGE (V1)
Vref

FIG.8

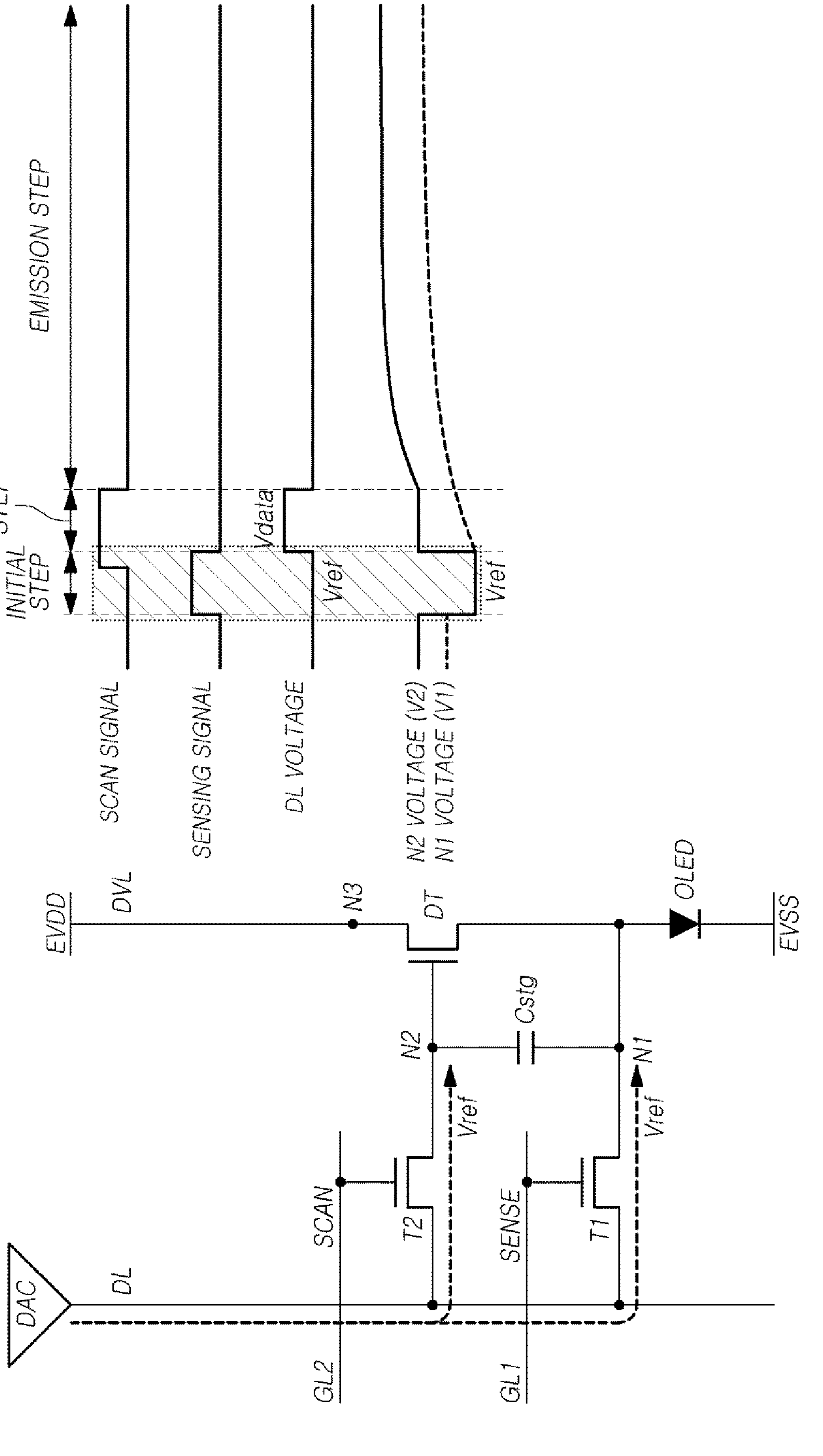

EMISSION STEP
WRITING STEP
INITIAL STEP
SCAN SIGNAL
SENSING SIGNAL
DL VOLTAGE
N2 VOLTAGE (V2)
N1 VOLTAGE (V1)
Vdata
Vref
Vref
EVDD
DVL
N3
DT
OLED
EVSS
Cstg
N2
N1
Vref
Vref
SCAN
T2
SENSE
T1
DAC
DL
GL2
GL1

FIG.9

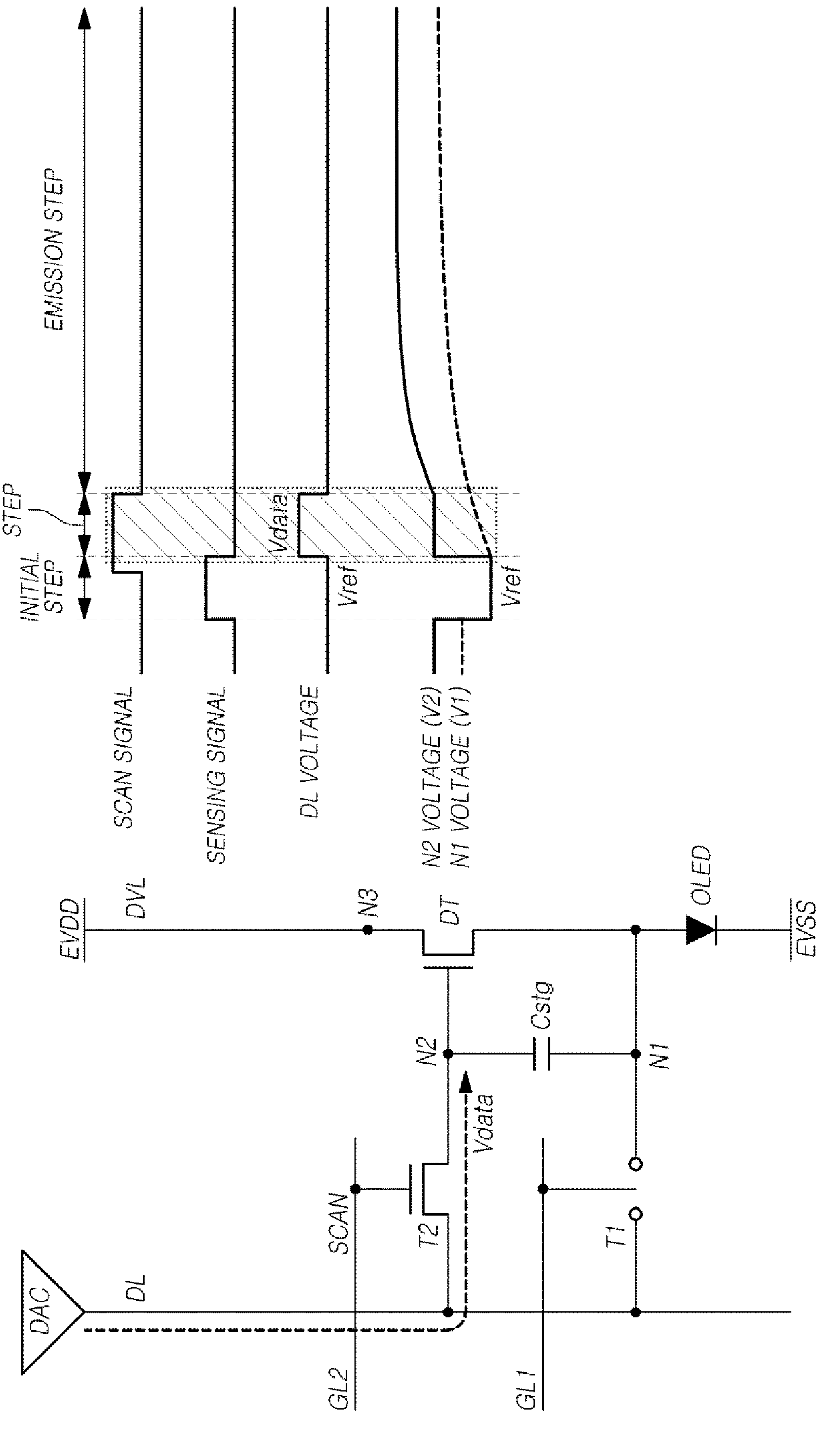

EMISSION STEP
WRITING STEP
INITIAL STEP
Vdata
Vref
Vref
SCAN SIGNAL
SENSING SIGNAL
DL VOLTAGE
N2 VOLTAGE (V2)
N1 VOLTAGE (V1)
EVDD
DVL
N3
DT
OLED
EVSS
Cstg
N2
N1
Vdata
SCAN
T2
T1
DAC
DL
GL2
GL1

FIG.10

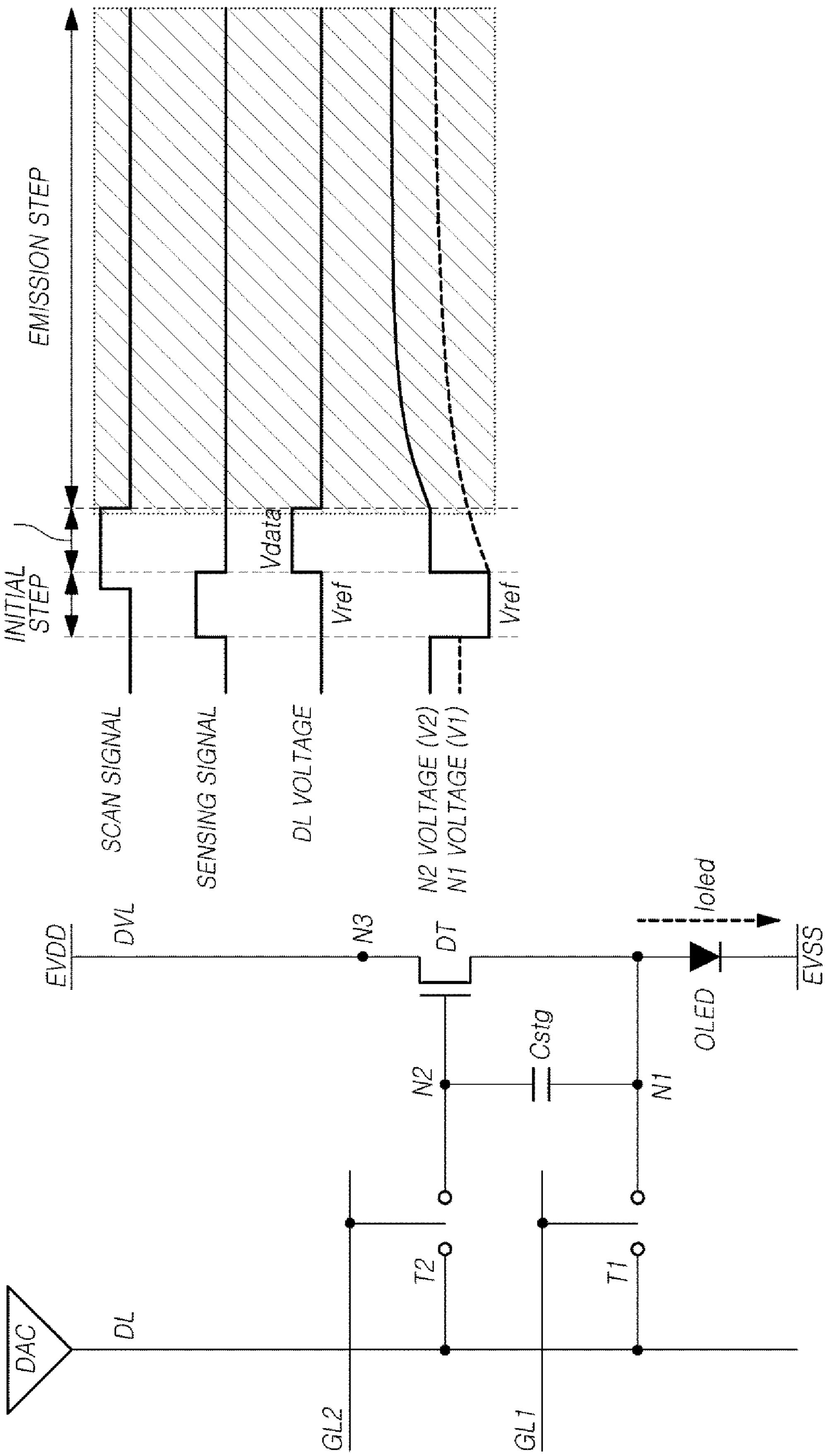

EMISSION STEP
WRITING
INITIAL STEP
SCAN SIGNAL
SENSING SIGNAL
DL VOLTAGE
N2 VOLTAGE (V2)
N1 VOLTAGE (V1)
Vdata
Vref
Vref
EVDD
DVL
N3
DT
Ioled
EVSS
OLED
Cstg
N2
N1
T2
T1
DAC
DL
GL2
GL1

FIG. 11

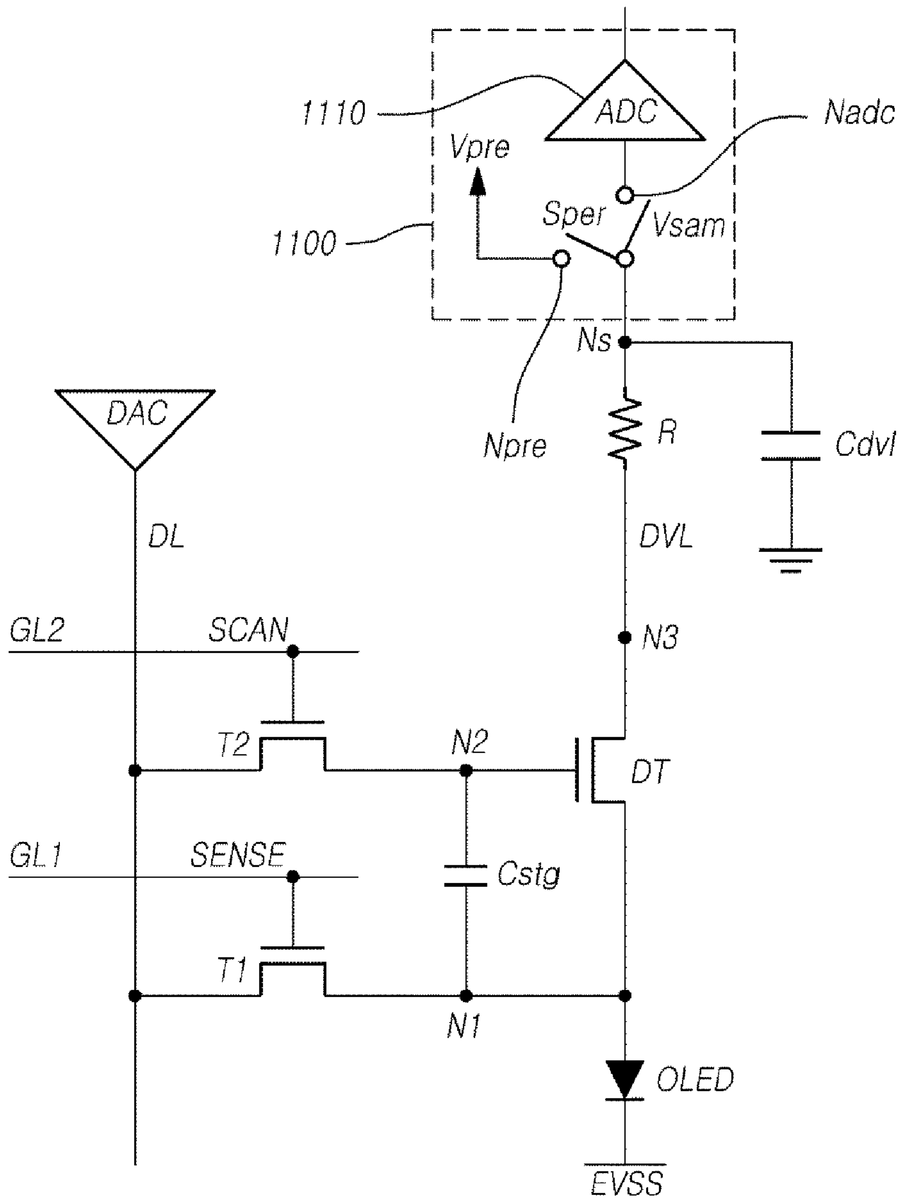
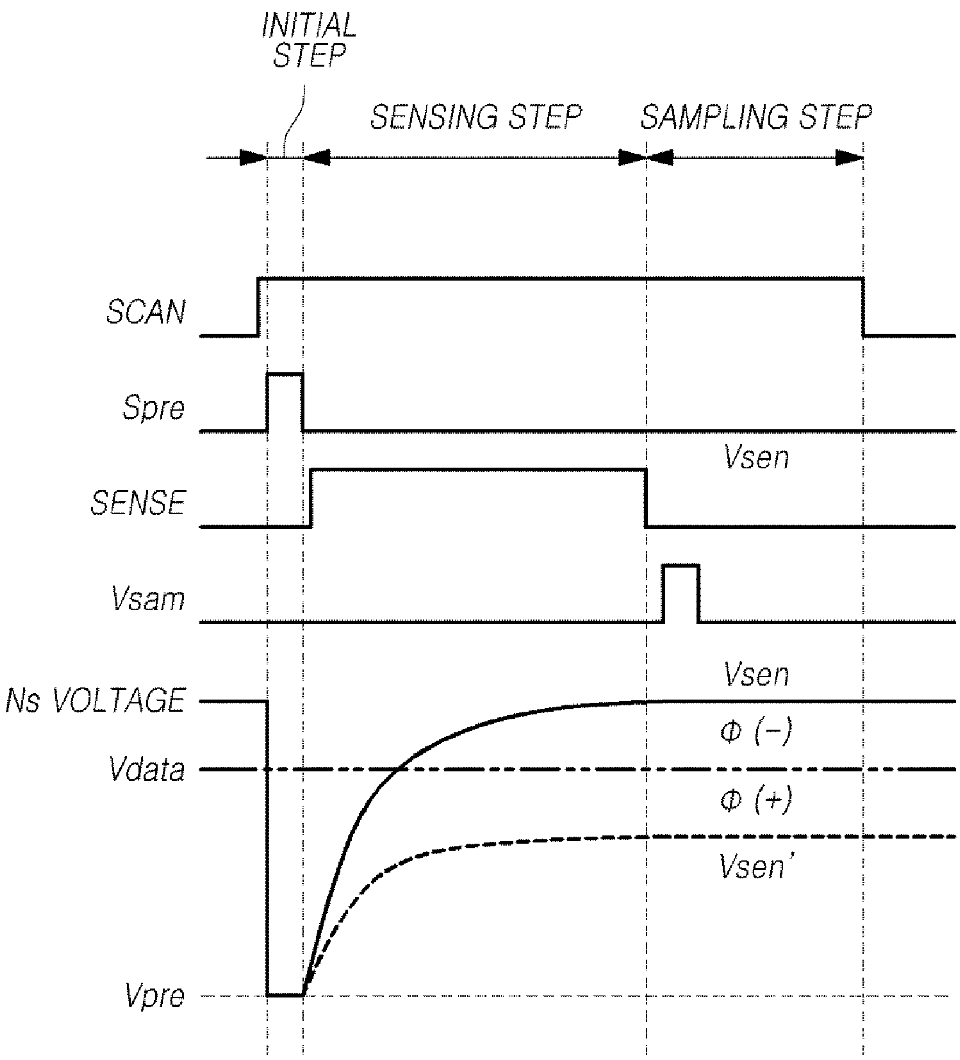

1110
ADC
Nadc
Vpre
Sper
Vsam
1100
Ns
Npre
DAC
R
Cdvl
DL
DVL
GL2
SCAN
N3
T2
N2
DT
GL1
SENSE
Cstg
T1
N1
OLED
EVSS

FIG. 12


INITIAL STEP
SENSING STEP
SAMPLING STEP
SCAN
Spre
SENSE
Vsen
Vsam
Ns VOLTAGE
Vsen
Φ (−)
Vdata
Φ (+)
Vsen'
Vpre

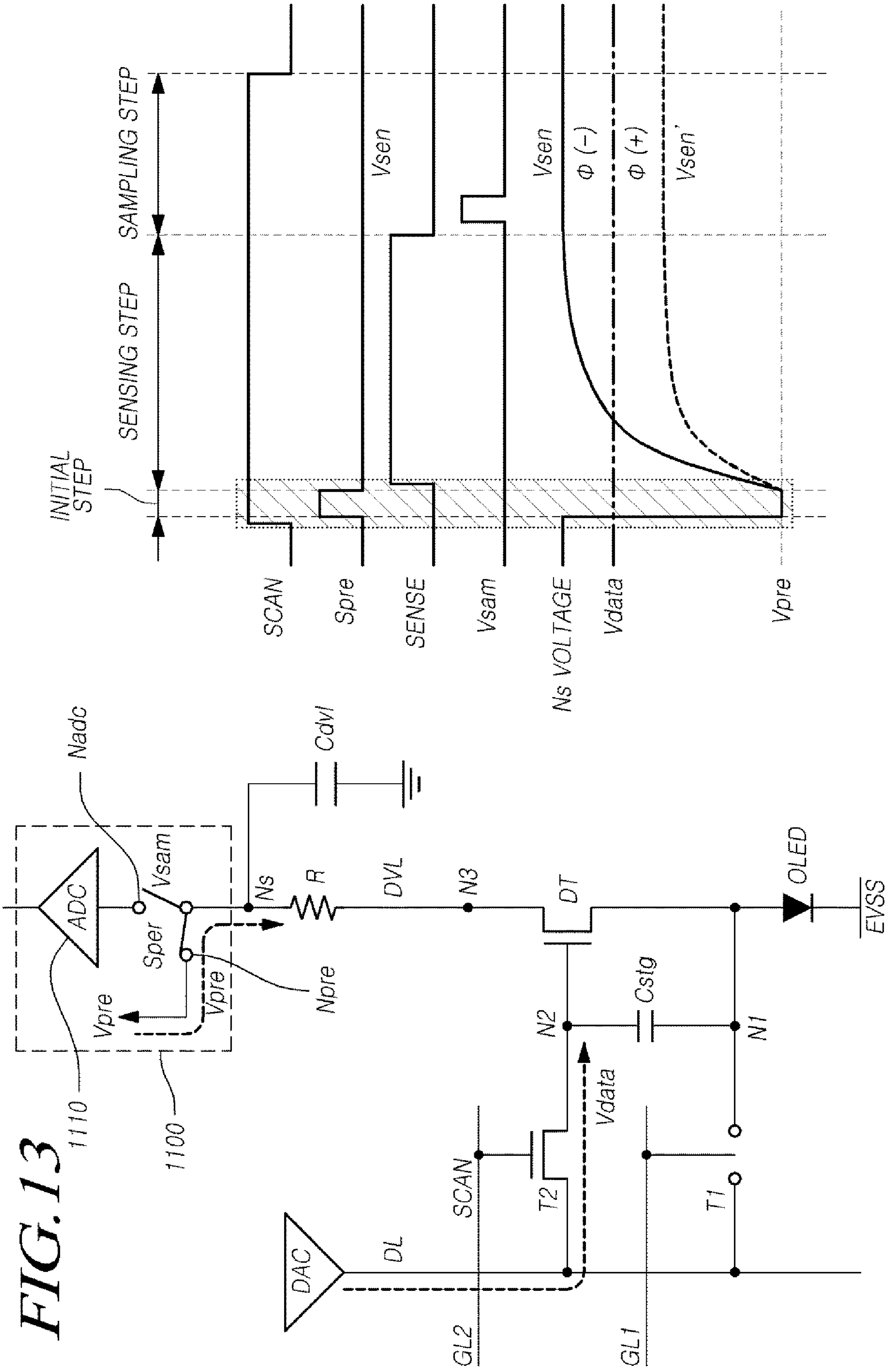

ADC
Nadc
Vsam
Sper
Vpre
Vpre
Npre
1110
1100
Ns
Cdvl
R
DVL
N3
DT
OLED
EVSS
Cstg
N2
N1
Vdata
DAC
DL
SCAN
T2
T1
GL2
GL1
INITIAL STEP
SENSING STEP
SAMPLING STEP
SCAN
Spre
SENSE
Vsam
Ns VOLTAGE
Vdata
Vpre
Vsen
Vsen
Φ (−)
Φ (+)
Vsen'

FIG. 13

FIG. 14

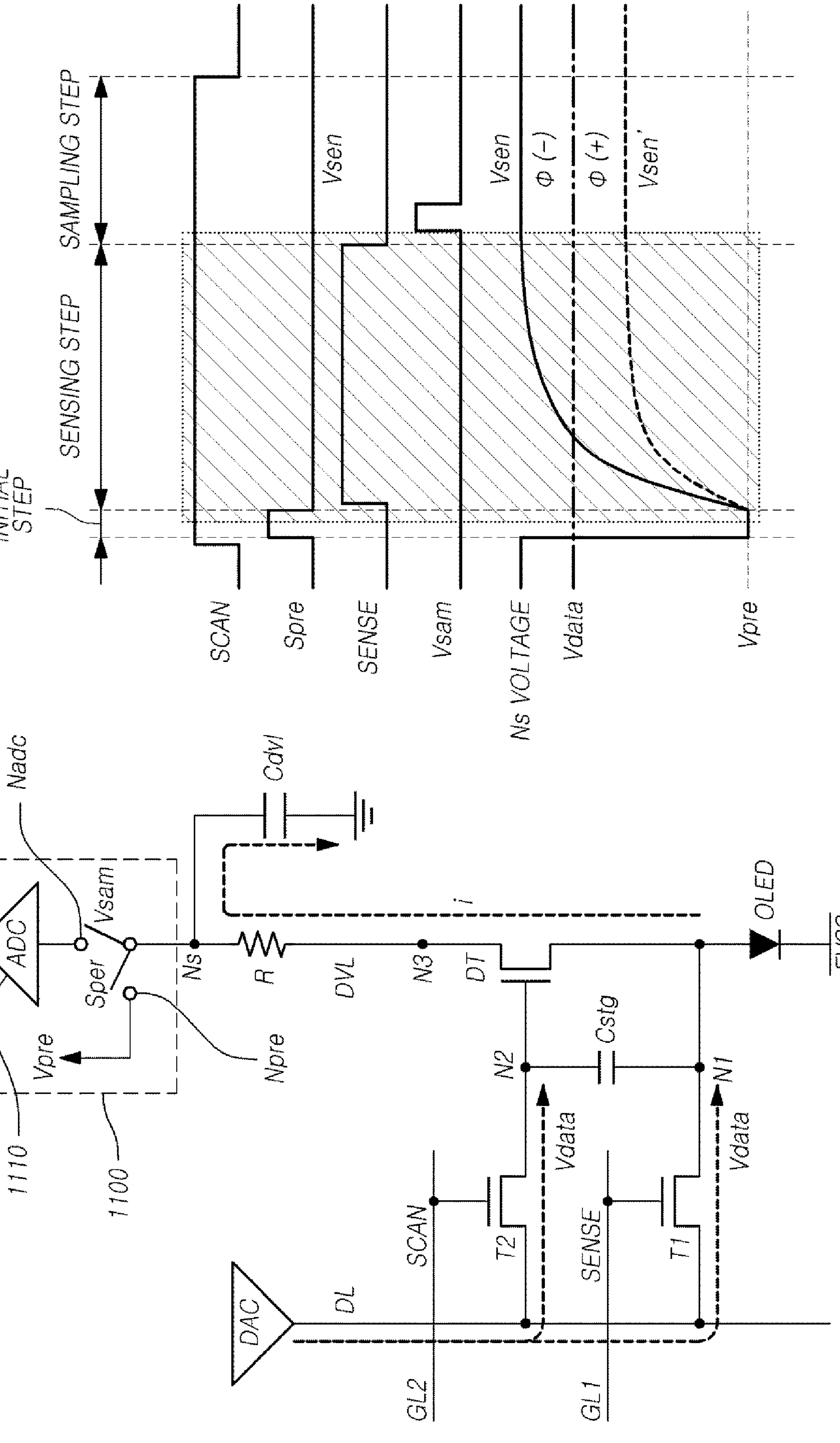

1110
1100
ADC
Nadc
Vsam
Sper
Vpre
Npre
Ns
R
DVL
N3
DT
Cdvl
i
OLED
EVSS
N2
Cstg
N1
Vdata
Vdata
DAC
DL
SCAN
T2
SENSE
T1
GL2
GL1
INITIAL STEP
SENSING STEP
SAMPLING STEP
SCAN
Spre
SENSE
Vsam
Ns VOLTAGE
Vdata
Vpre
Vsen
Vsen
Φ (−)
Φ (+)
Vsen'

FIG.15

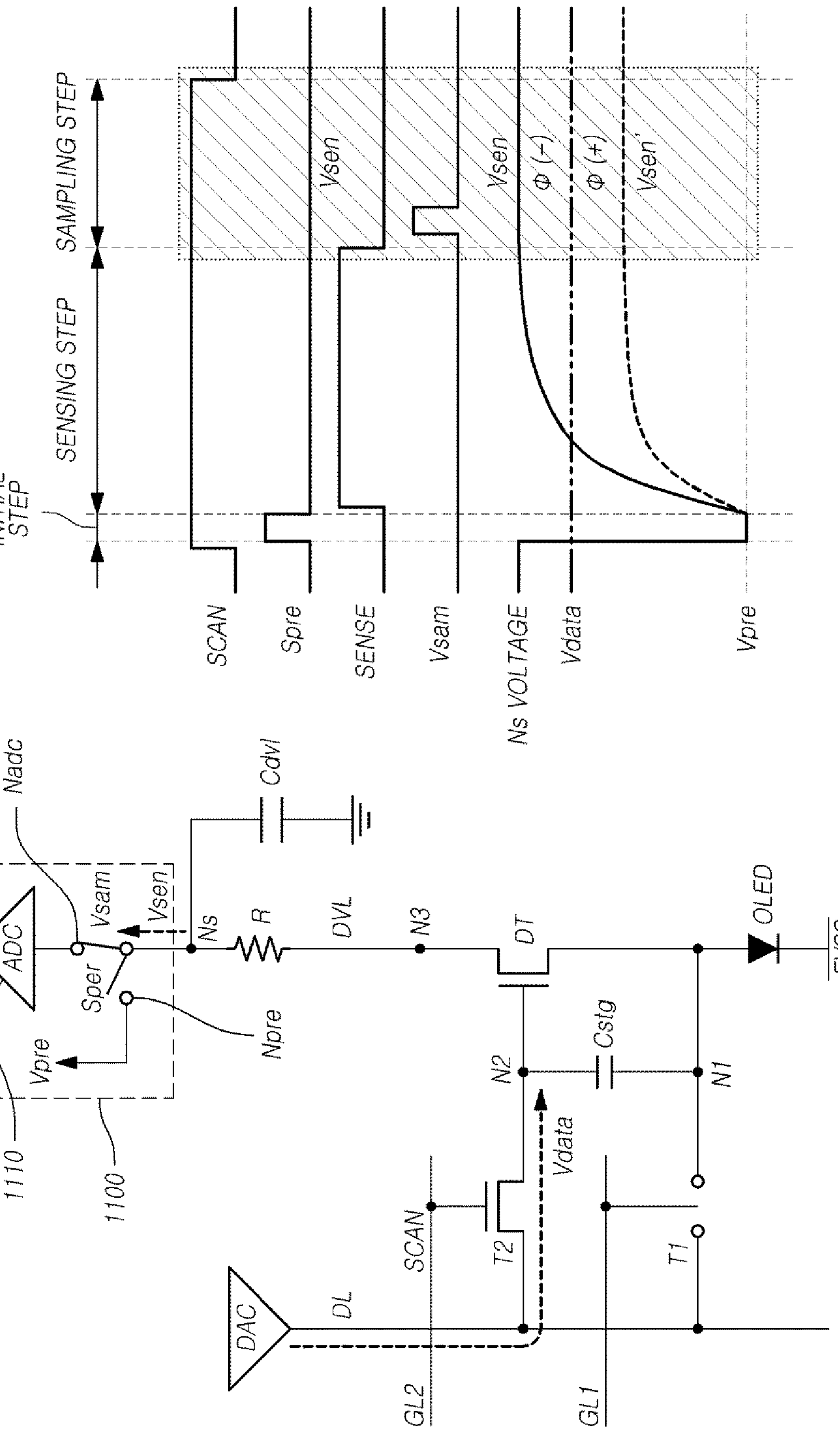
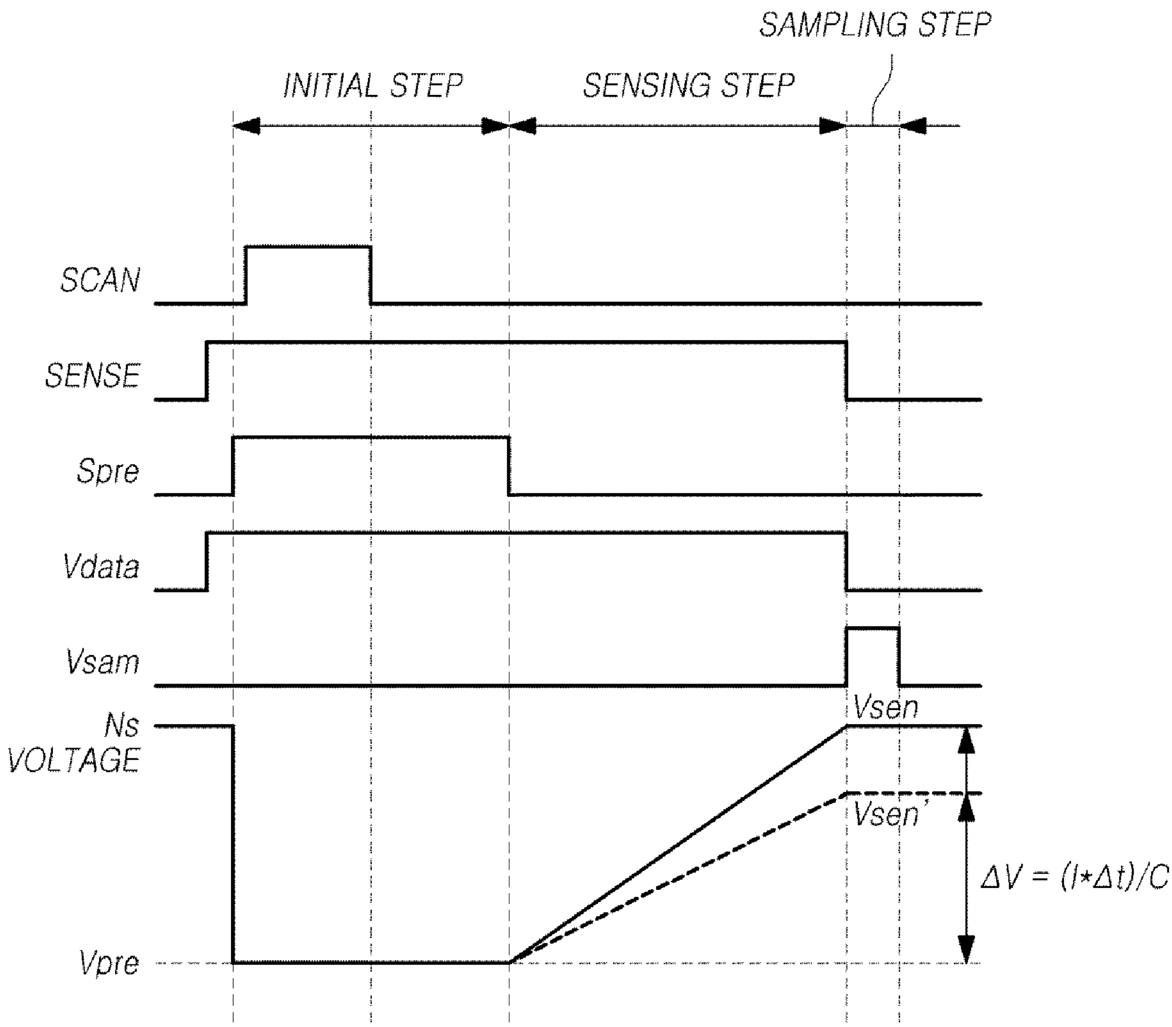

1110
1100
Nadc
ADC
Vsam
Vsen
Sper
Npre
Vpre
Ns
R
Cdvl
DVL
N3
DT
OLED
EVSS
Cstg
N2
N1
Vdata
SCAN
T2
T1
DAC
DL
GL2
GL1
INITIAL STEP
SENSING STEP
SAMPLING STEP
SCAN
Spre
SENSE
Vsam
Ns VOLTAGE
Vdata
Vpre
Vsen
Vsen
Φ (-)
Φ (+)
Vsen'

FIG.16


SAMPLING STEP
INITIAL STEP
SENSING STEP
SCAN
SENSE
Spre
Vdata
Vsam
Ns
VOLTAGE
Vsen
Vsen'
ΔV = (I*Δt)/C
Vpre

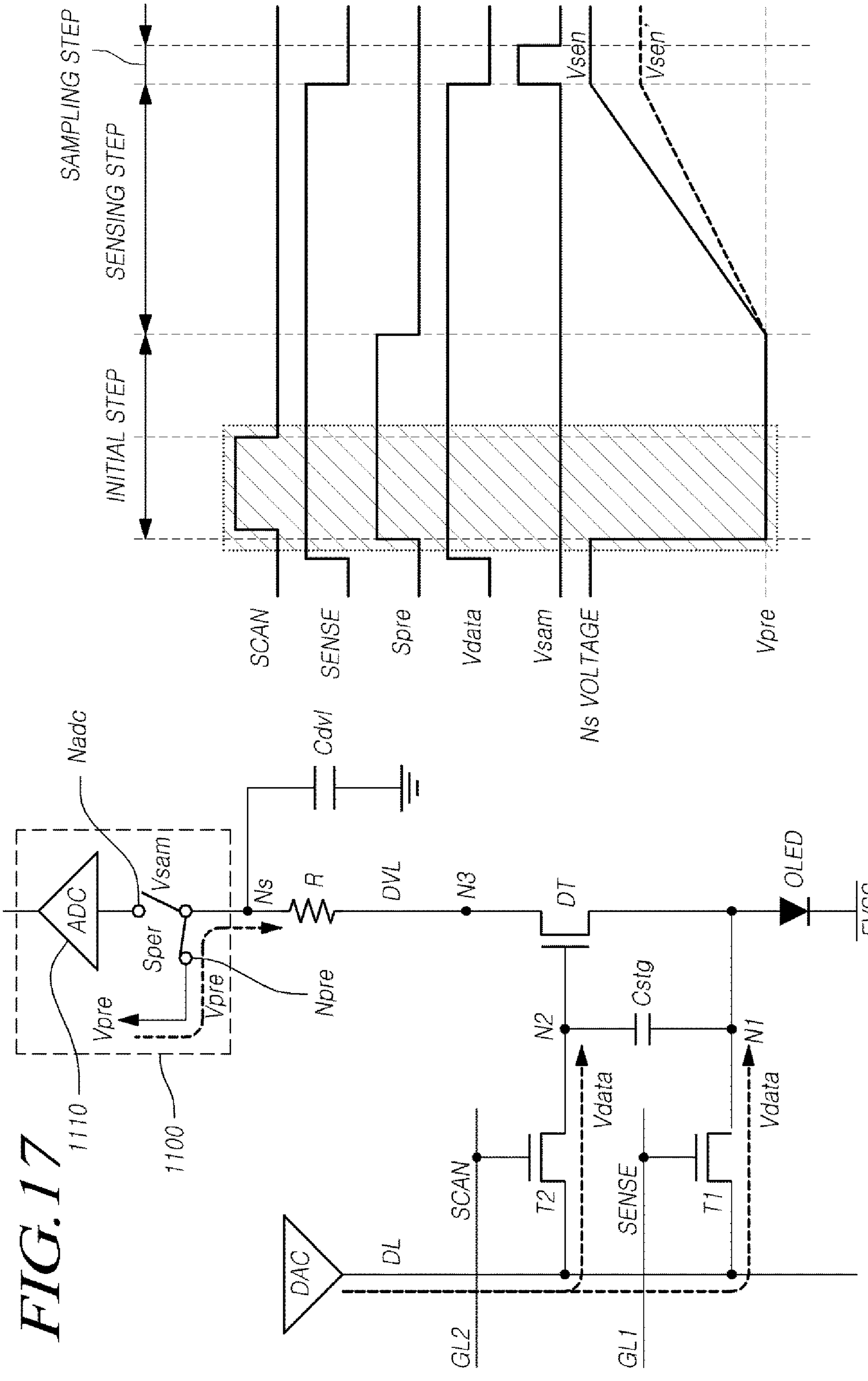

1110
1100
ADC
Nadc
Vsam
Sper
Vpre
Vpre
Npre
Ns
R
DVL
N3
Cdvl
DT
OLED
EVSS
Cstg
N2
N1
Vdata
Vdata
SCAN
SENSE
T2
T1
DAC
DL
GL2
GL1
SAMPLING STEP
SENSING STEP
INITIAL STEP
SCAN
SENSE
Spre
Vdata
Vsam
Ns VOLTAGE
Vpre
Vsen
Vsen'

FIG. 17

FIG. 18

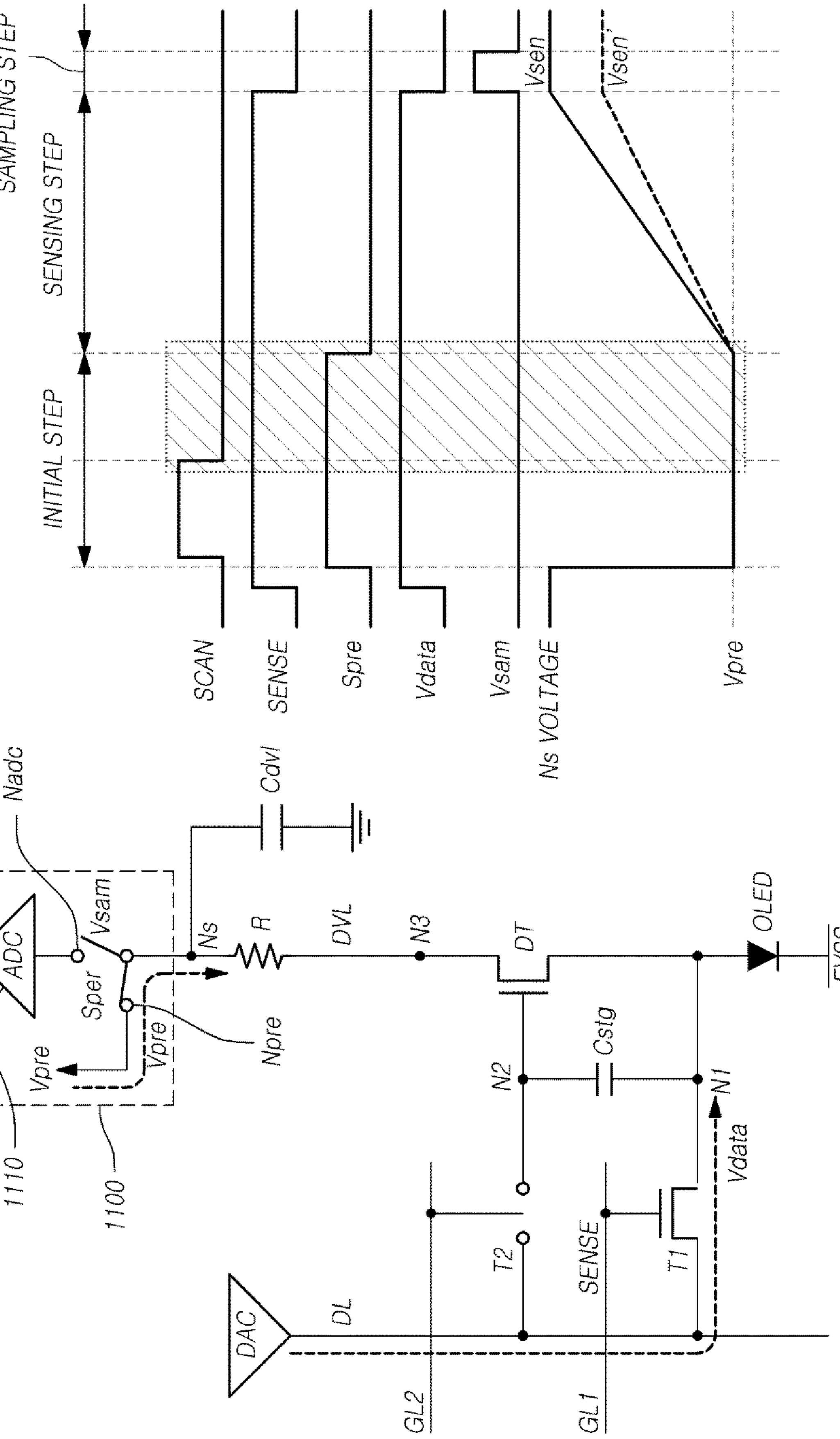
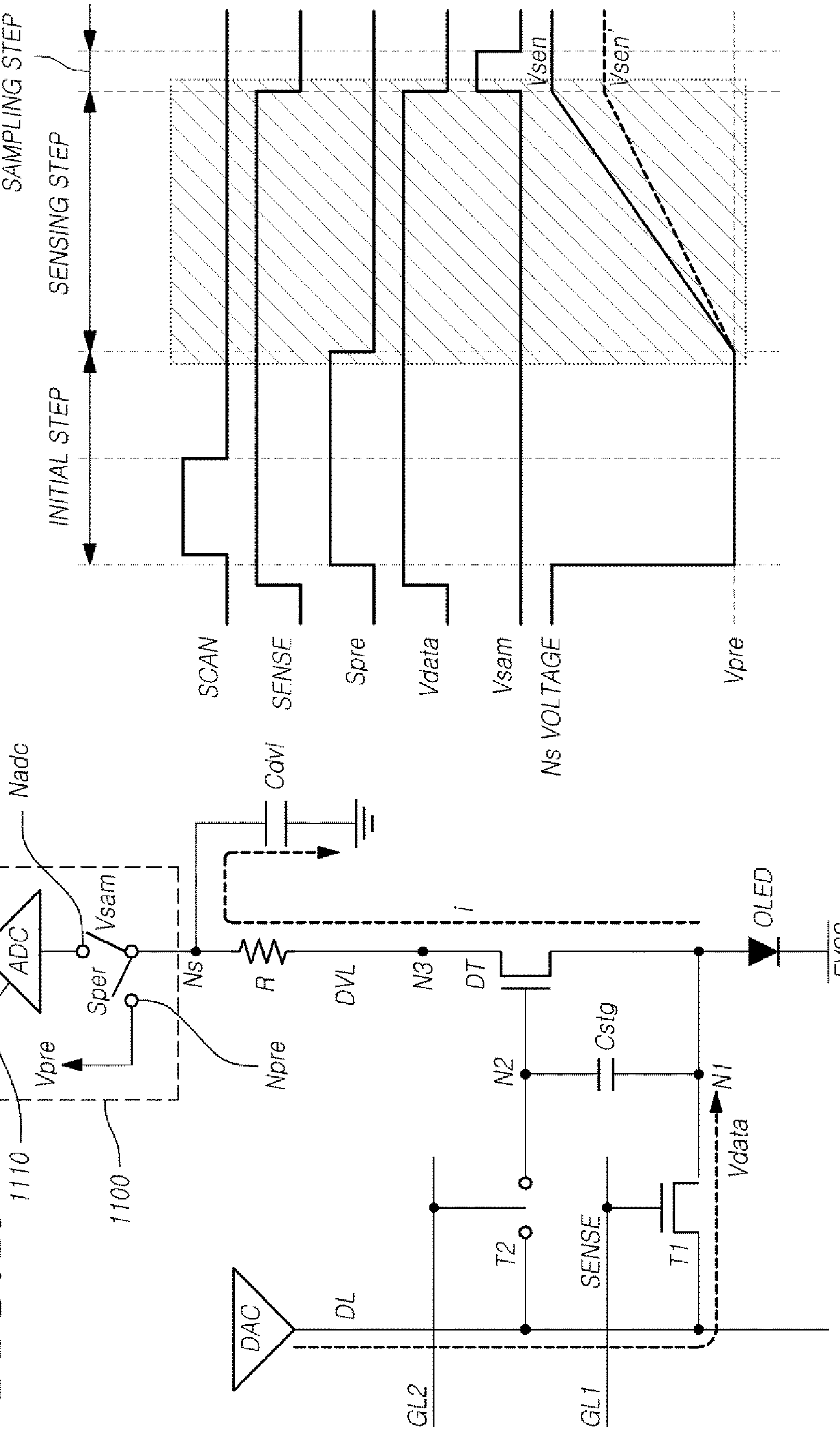

1110
1100
ADC
Nadc
Vsam
Sper
Vpre
Vpre
Npre
Ns
R
Cdvl
DVL
N3
DT
OLED
EVSS
Cstg
N2
N1
Vdata
T2
SENSE
T1
DAC
DL
GL2
GL1
SAMPLING STEP
SENSING STEP
INITIAL STEP
SCAN
SENSE
Spre
Vdata
Vsam
Ns VOLTAGE
Vpre
Vsen
Vsen'

FIG. 19



SAMPLING STEP
SENSING STEP
INITIAL STEP
SCAN
SENSE
Spre
Vdata
Vsam
Ns VOLTAGE
Vpre
Vsen
Vsen'
Nadc
ADC
Vsam
Sper
Vpre
Npre
1110
1100
Ns
R
DVL
N3
DT
Cdvl
i
OLED
EVSS
N2
Cstg
N1
Vdata
T2
SENSE
T1
DAC
DL
GL2
GL1

FIG.20

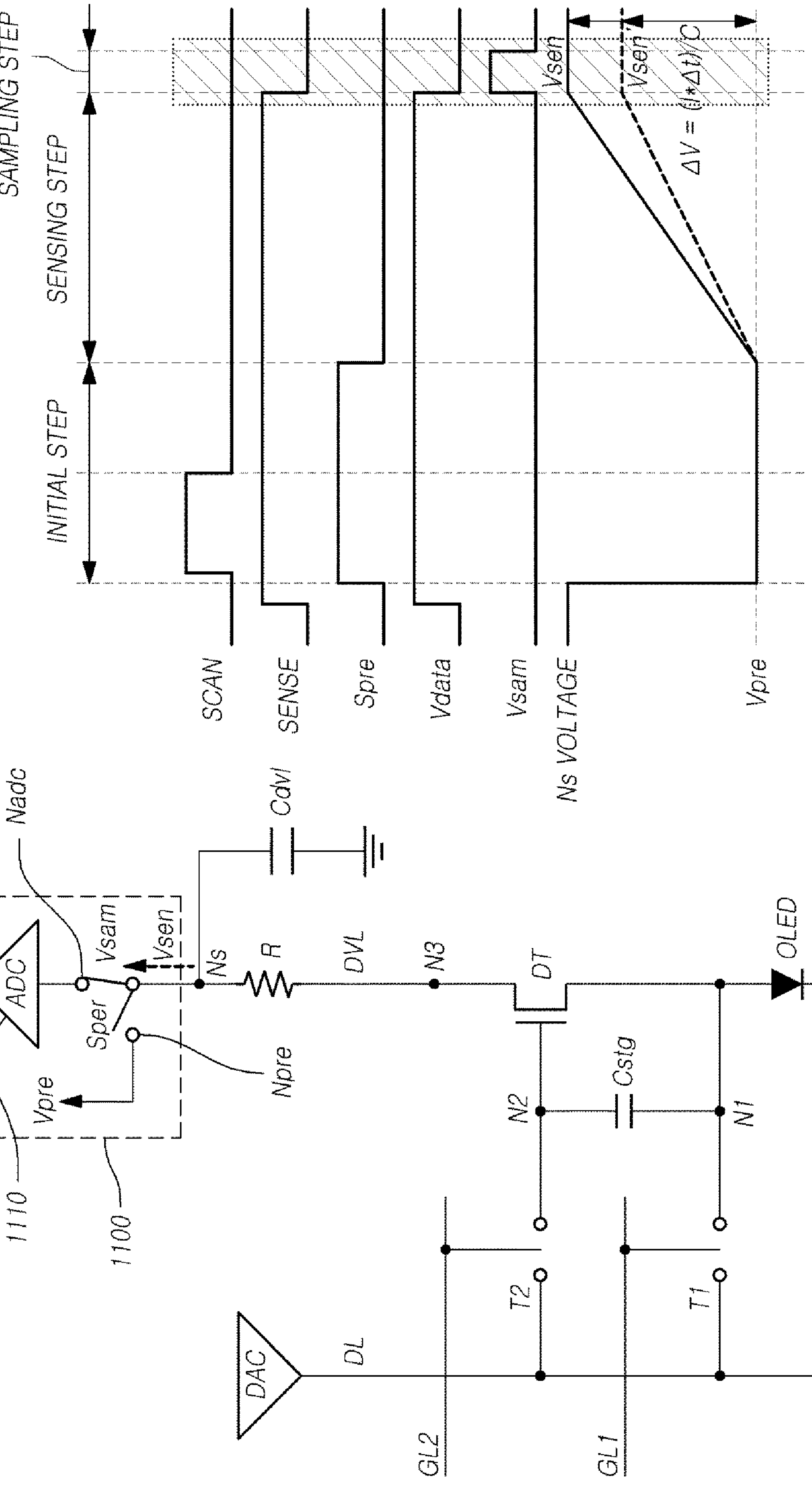

SAMPLING STEP
SENSING STEP
INITIAL STEP
SCAN
SENSE
Spre
Vdata
Vsam
Ns VOLTAGE
Vpre
Vsen
Vsen'
ΔV = (I*Δt)/C
Nadc
Cdvl
ADC
Vsam
Vsen
Ns
R
DVL
N3
DT
OLED
EVSS
Sper
Npre
Vpre
Cstg
N2
N1
1110
1100
DAC
DL
T2
T1
GL2
GL1

FIG.21

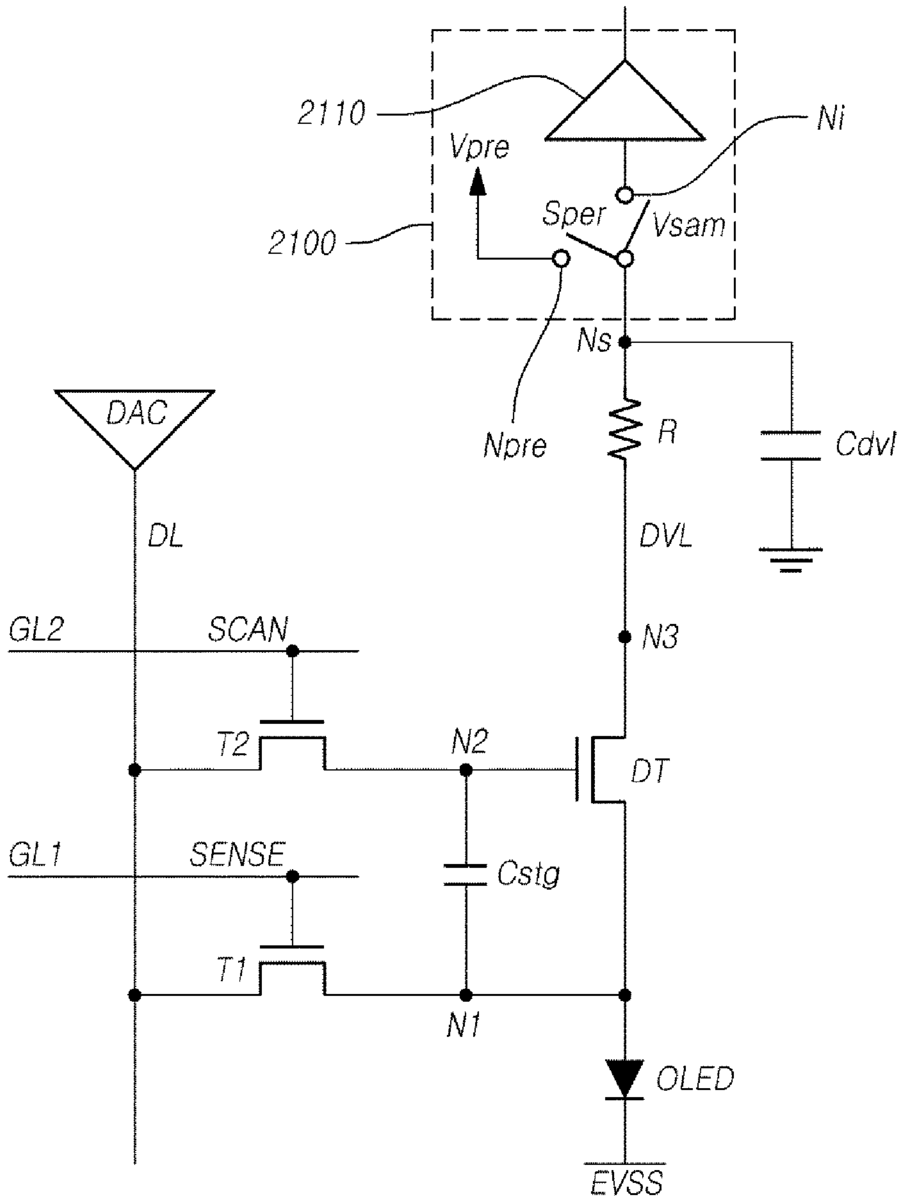
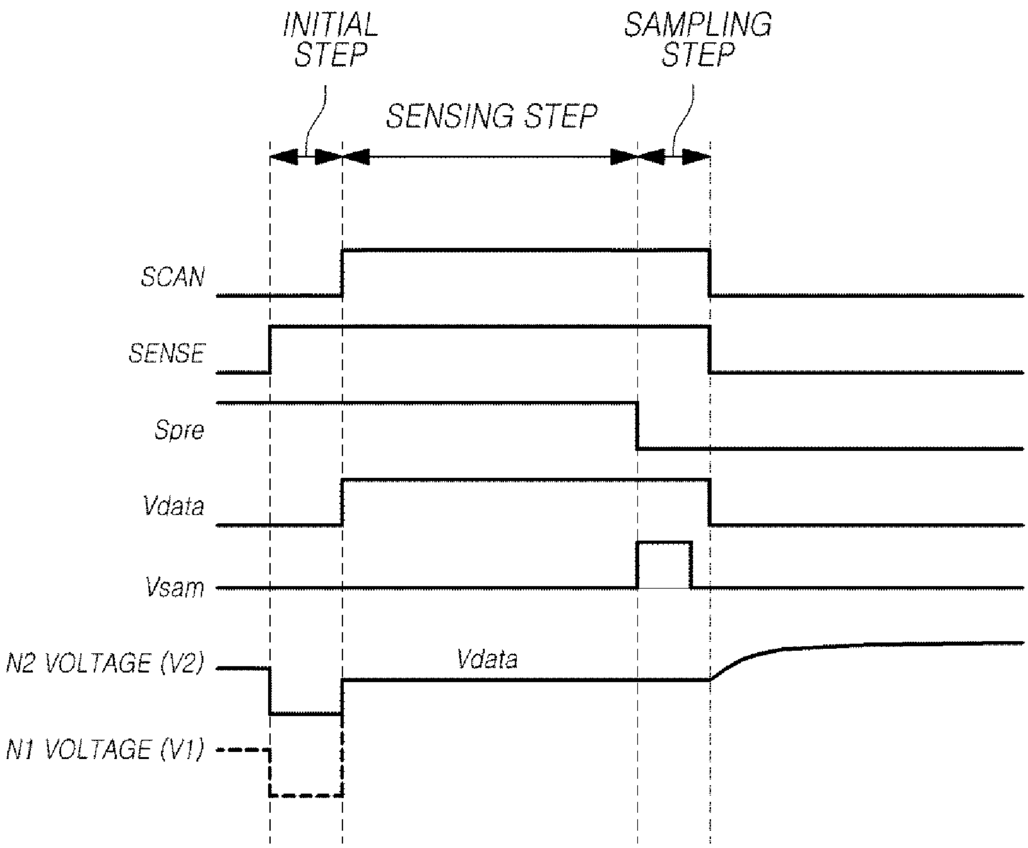
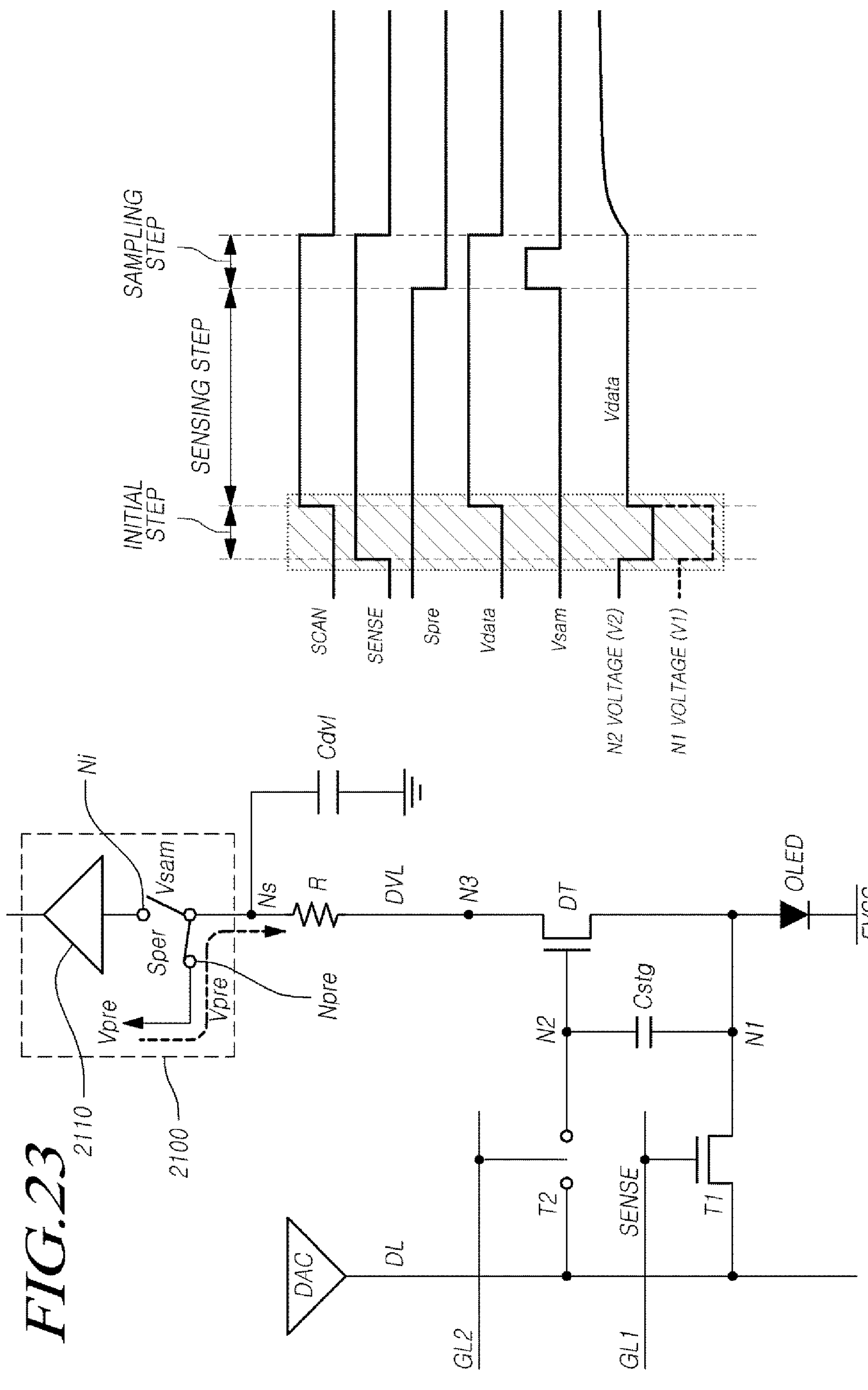

2110
Ni
Vpre
Sper
Vsam
2100
Ns
DAC
Npre
R
Cdvl
DL
DVL
GL2
SCAN
N3
T2
N2
DT
GL1
SENSE
Cstg
T1
N1
OLED
EVSS

FIG.22

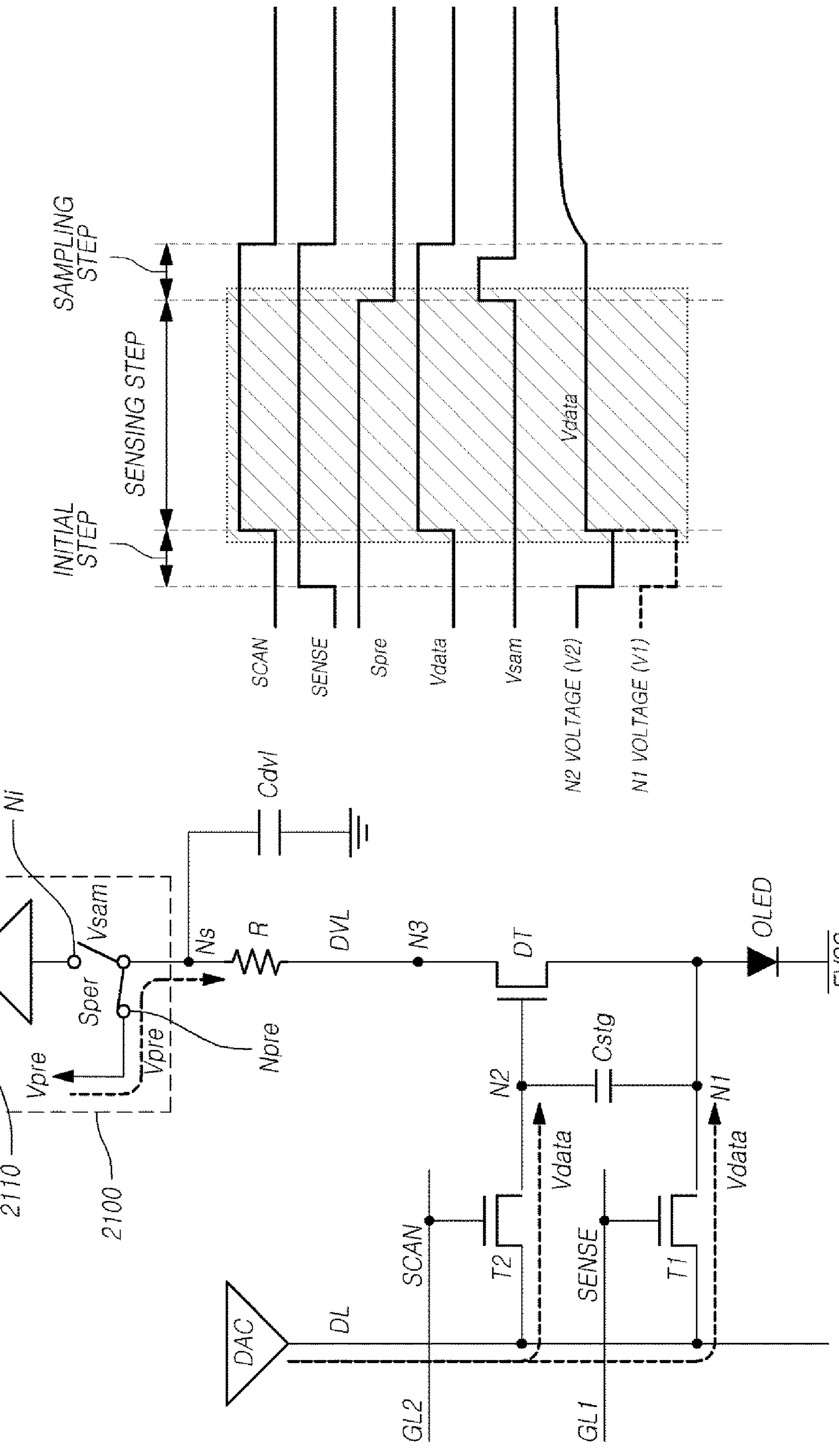

INITIAL STEP
SENSING STEP
SAMPLING STEP
SCAN
SENSE
Spre
Vdata
Vsam
N2 VOLTAGE (V2)
Vdata
N1 VOLTAGE (V1)



SAMPLING STEP
SENSING STEP
INITIAL STEP
SCAN
SENSE
Spre
Vdata
Vsam
N2 VOLTAGE (V2)
N1 VOLTAGE (V1)
Vdata
2110
2100
Ni
Vsam
Sper
Vpre
Vpre
Npre
Ns
R
DVL
N3
DT
OLED
EVSS
Cdvl
Cstg
N2
N1
T2
SENSE
T1
DAC
DL
GL2
GL1

FIG.23

FIG.24


SAMPLING STEP
SENSING STEP
INITIAL STEP
SCAN
SENSE
Spre
Vdata
Vsam
N2 VOLTAGE (V2)
N1 VOLTAGE (V1)
Vdata
Ni
Vsam
Sper
Vpre
Vpre
Npre
2110
2100
Ns
R
Cdvl
DVL
N3
DT
OLED
EVSS
Cstg
N2
N1
Vdata
Vdata
SCAN
SENSE
T2
T1
DAC
DL
GL2
GL1

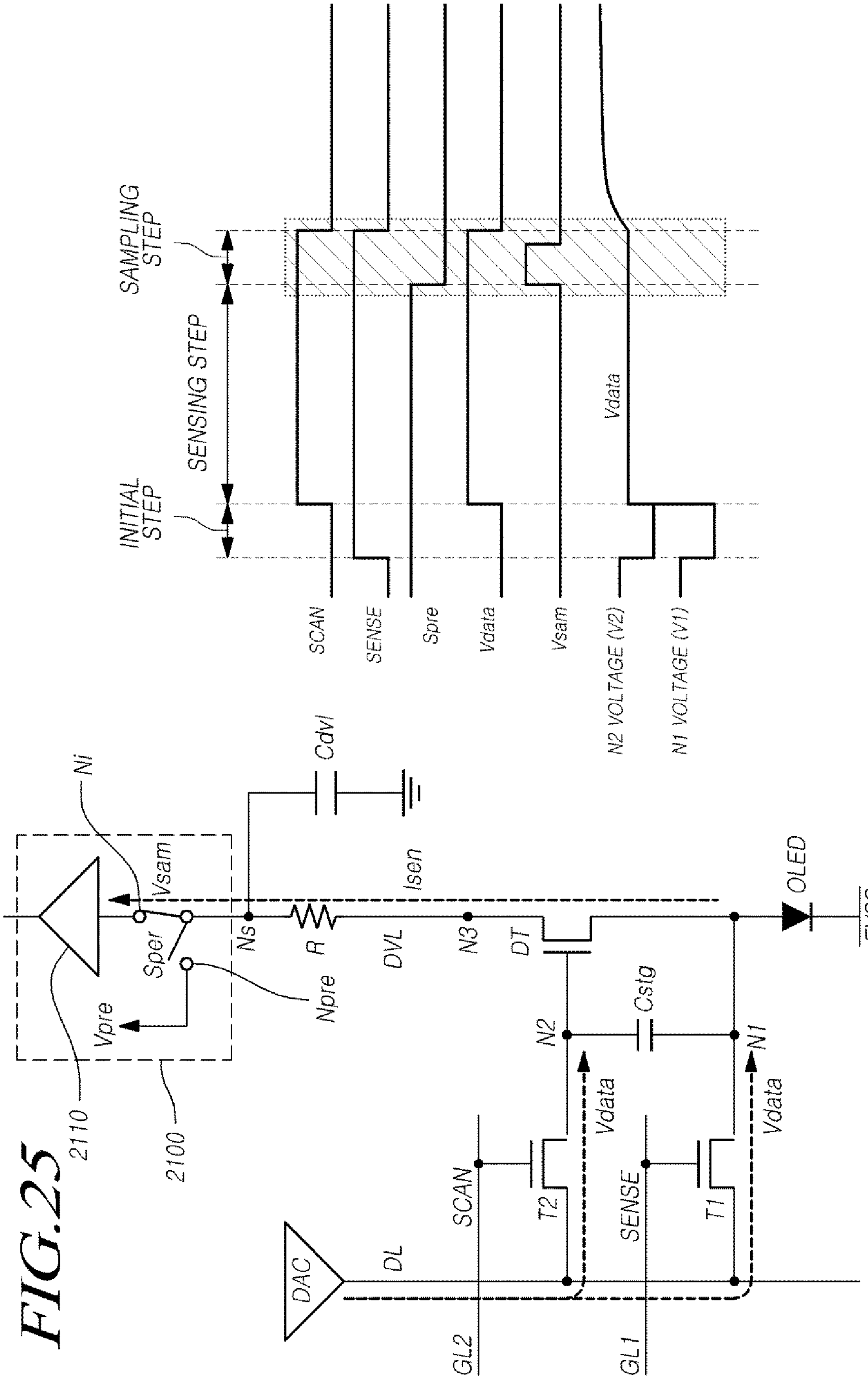

SAMPLING STEP
SENSING STEP
INITIAL STEP
SCAN
SENSE
Spre
Vdata
Vsam
N2 VOLTAGE (V2)
N1 VOLTAGE (V1)
Vdata
Ni
Cdvl
Vsam
Isen
OLED
EVSS
Sper
Ns
R
DVL
N3
DT
Npre
Vpre
Cstg
N2
N1
2110
2100
Vdata
Vdata
SCAN
SENSE
T2
T1
DAC
DL
GL2
GL1

FIG.25

FIG.26

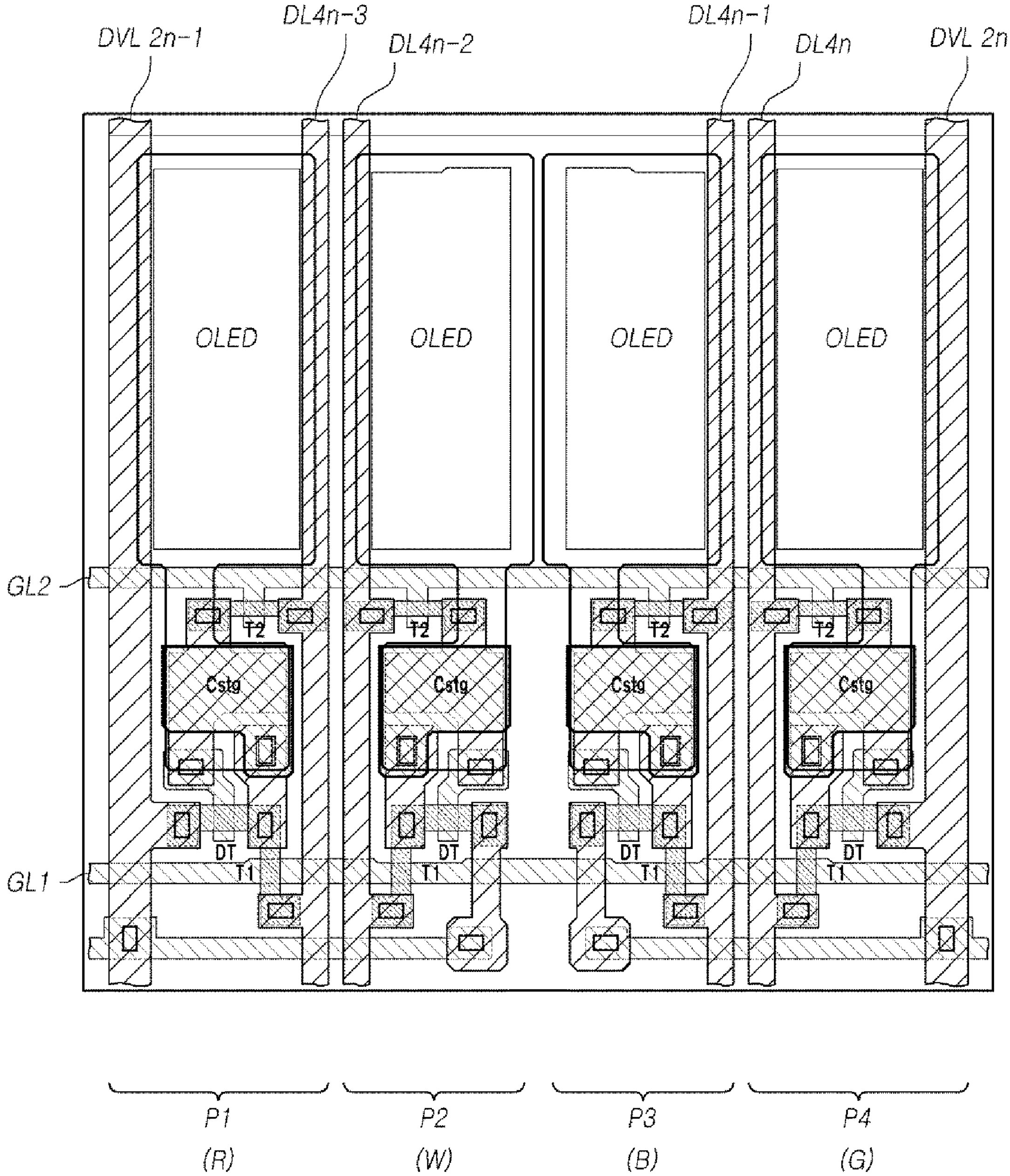
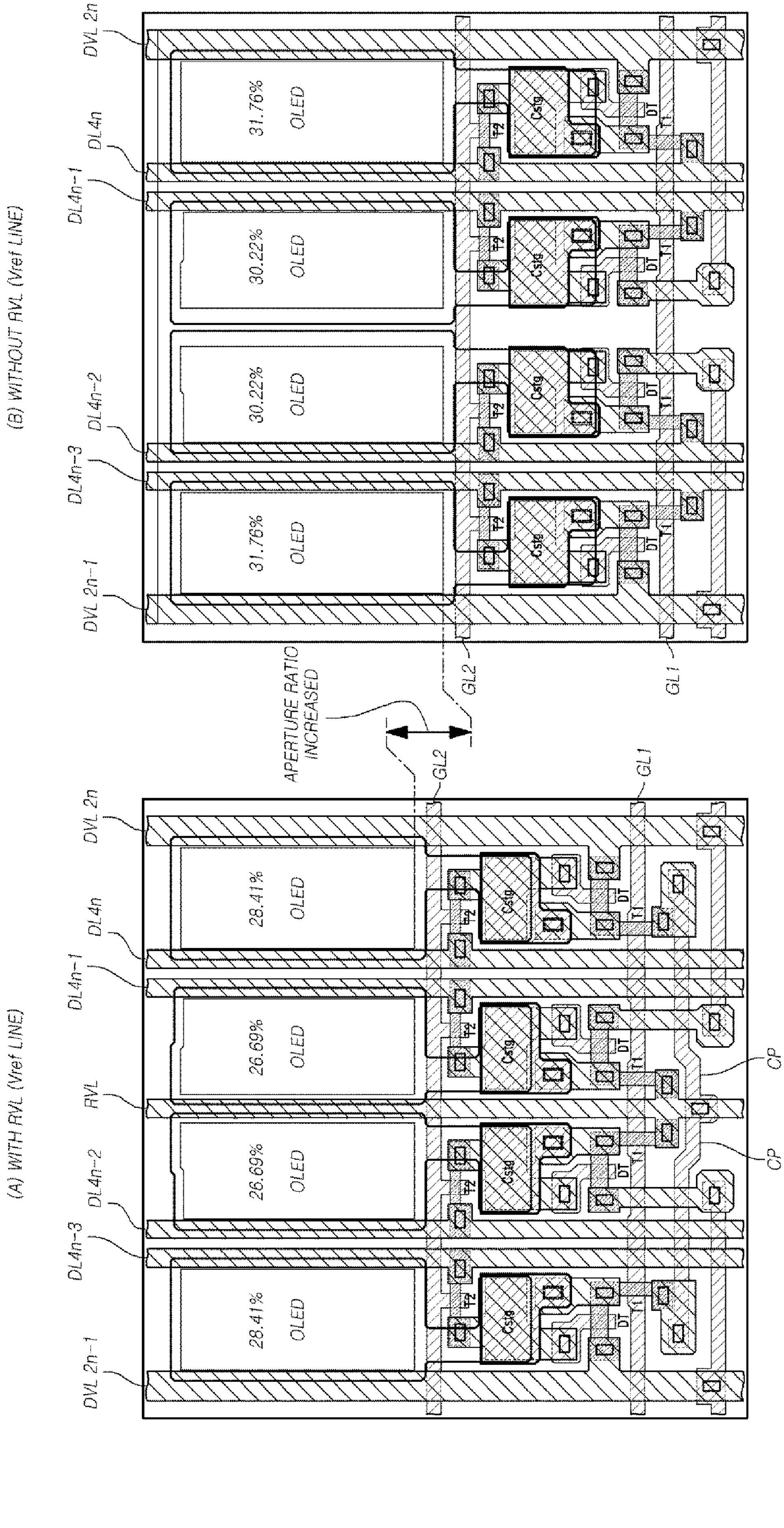

DVL 2n-1
DL4n-3
DL4n-2
DL4n-1
DL4n
DVL 2n
OLED
OLED
OLED
OLED
GL2
T2
T2
T2
T2
Cstg
Cstg
Cstg
Cstg
DT
DT
DT
DT
GL1
T1
T1
T1
T1
P1
(R)
P2
(W)
P3
(B)
P4
(G)

FIG.27


(B) WITHOUT RVL (Vref LINE)
DVL 2n
DL4n
DL4n-1
DL4n-2
DL4n-3
DVL 2n-1
31.76%
30.22%
30.22%
31.76%
OLED
Cstg
T2
DT
T1
GL2
GL1
APERTURE RATIO INCREASED
(A) WITH RVL (Vref LINE)
DVL 2n
DL4n
DL4n-1
RVL
DL4n-2
DL4n-3
DVL 2n-1
28.41%
26.69%
26.69%
28.41%
OLED
CP
CP
GL2
GL1

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- KR 1020130138238 **[0001]**
- US 20080158110 A1 **[0008]**
- US 20120299978 A1 **[0009]**
- WO 2007090287 A1 **[0010]**
- WO 2013100686 A1 **[0011]**

专利名称(译)	有机发光显示装置及其驱动方法		
公开(公告)号	EP2874141B1	公开(公告)日	2019-03-13
申请号	EP2014191840	申请日	2014-11-05
[标]申请(专利权)人(译)	乐金显示有限公司		
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当前申请(专利权)人(译)	LG DISPLAY CO.，LTD.		
[标]发明人	SHIN HUNKI KIM BUMSIK		
发明人	SHIN, HUNKI KIM, BUMSIK		
IPC分类号	G09G3/32		
CPC分类号	G09G3/3233 G09G2300/0465 G09G2300/0842 G09G2310/0262 G09G2320/0295 G09G2320/043 G09G3/30 G09G3/32 G09G3/3258 G09G3/3291 G09G5/18		
优先权	1020130138238 2013-11-14 KR		
其他公开文献	EP2874141A1		
外部链接	Espacenet		

摘要(译)

公开了一种有机发光显示装置及其操作方法，其可包括有机发光二极管，由感测信号控制并连接到数据线的第一晶体管，由扫描信号控制并连接到第二晶体管的第二晶体管。数据线和具有第一至第三节点的驱动晶体管，其中参考电压通过第一晶体管施加到第一节点，数据电压通过第二晶体管施加到第二节点，第三节点连接到驱动电压线。

$$(1)\ I_1=K(V_{gs1}-Vth)^2$$

$$(2)\ I_2=K(V_{gs2}-Vth)^2 \quad \text{.....Formula 1;}$$