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(54) PIXEL DRIVING METHOD AND APPARATUS FOR ORGANIC LIGHT EMITTING DEVICE

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(52) **U.S. Cl.** **345/82**

(57) **ABSTRACT**

A pixel driving method for an organic light emitting device includes charging a data voltage supplied through a data line to a storage capacitor and driving an N-channel switching transistor while cutting off supply of an upper power supply voltage to an organic light emitting diode; and powering the organic light emitting diode emit light by driving the N-channel driving transistor by the data voltage charged onto the storage capacitor while supplying the upper power supply voltage to the light emitting diode.

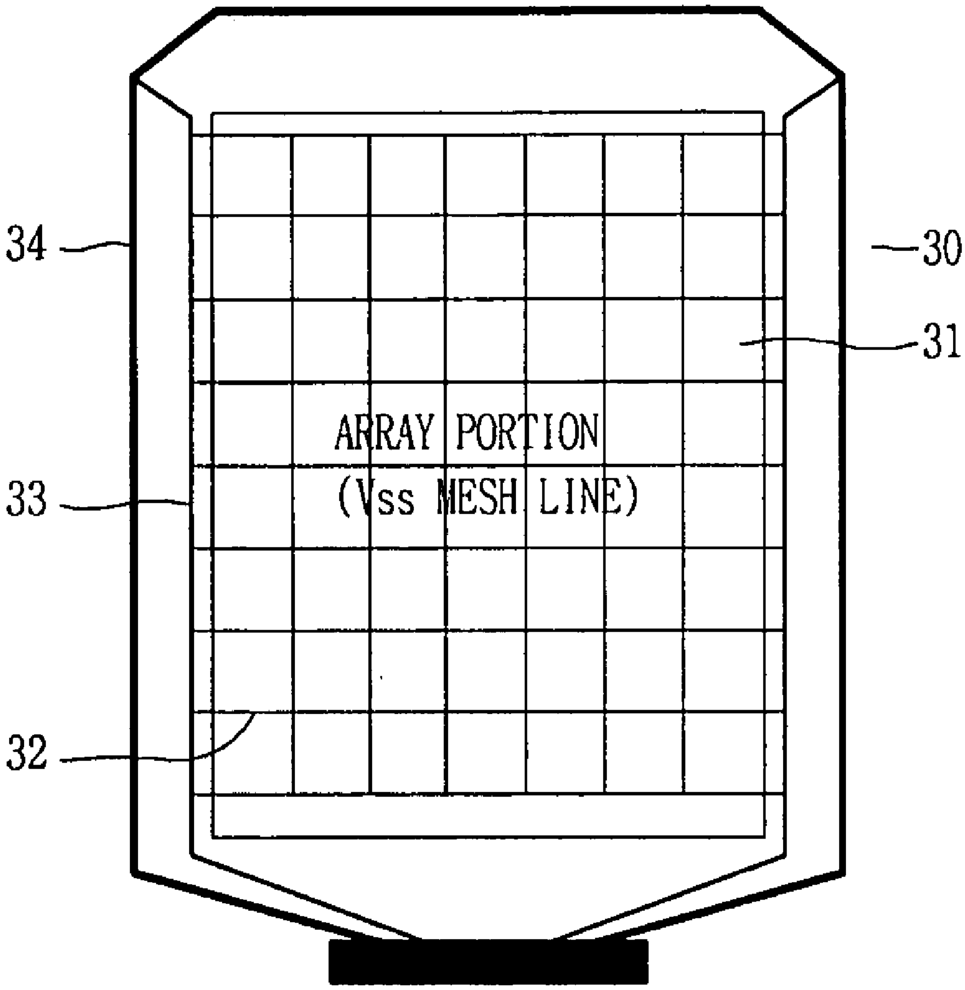


FIG. 1A
RELATED ART

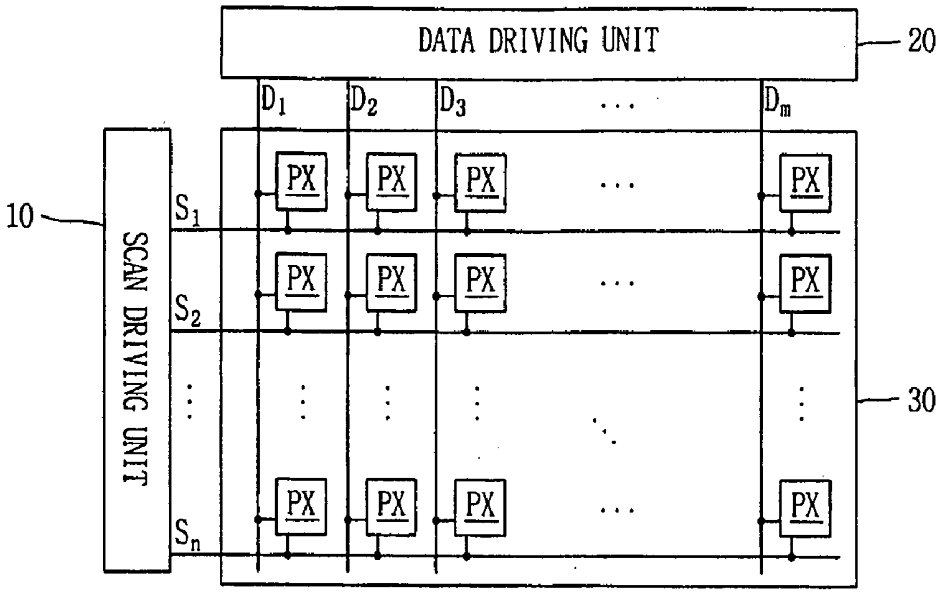


FIG. 1B
RELATED ART

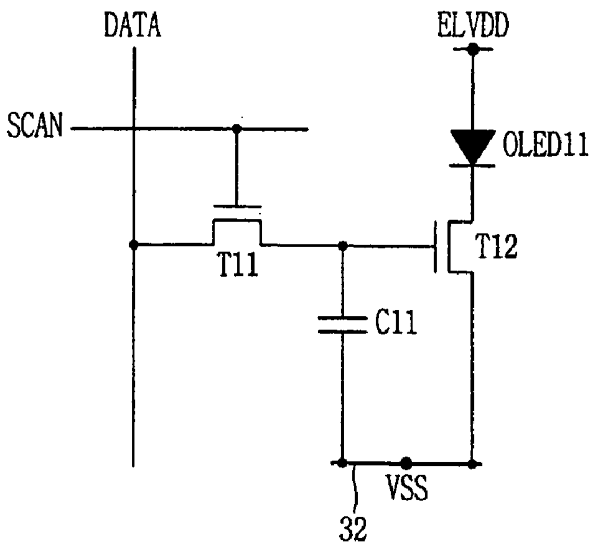


FIG. 2
RELATED ART

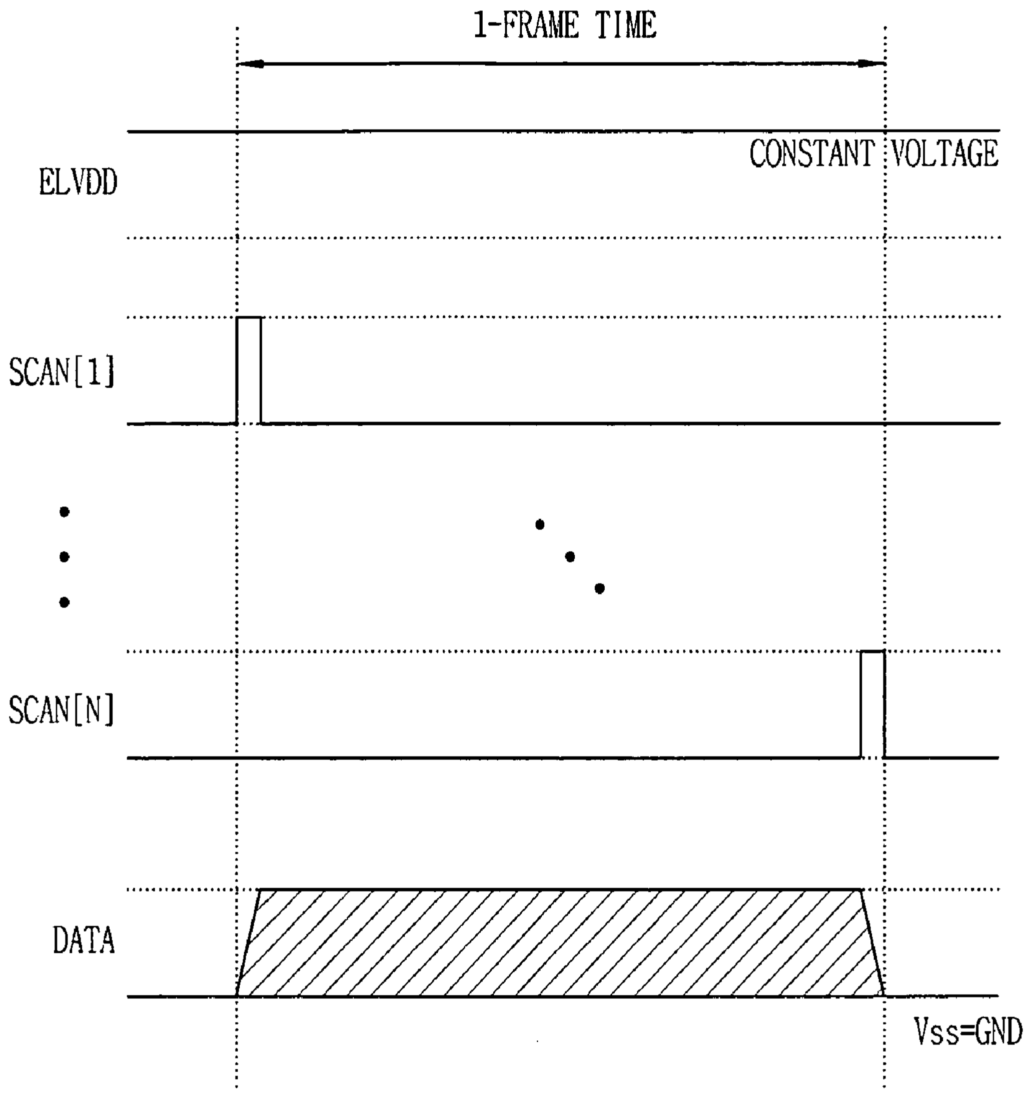


FIG. 3

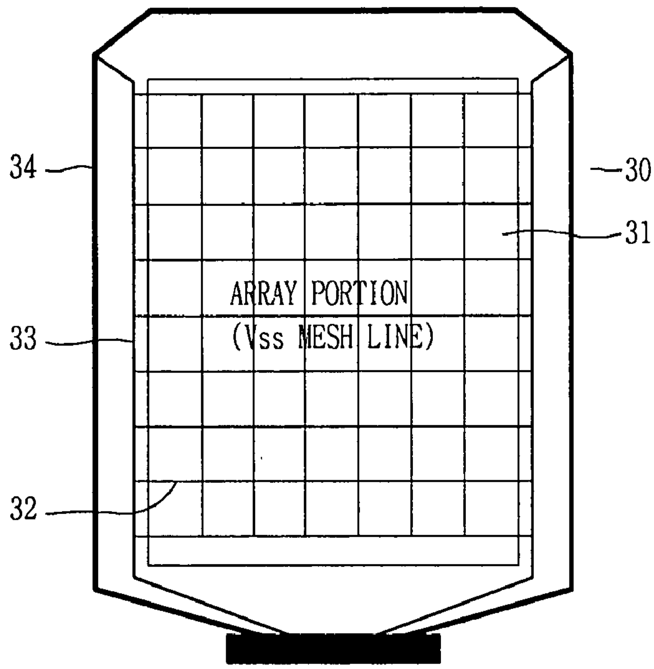

34
33
32
30
31
ARRAY PORTION
(Vss MESH LINE)

FIG. 4

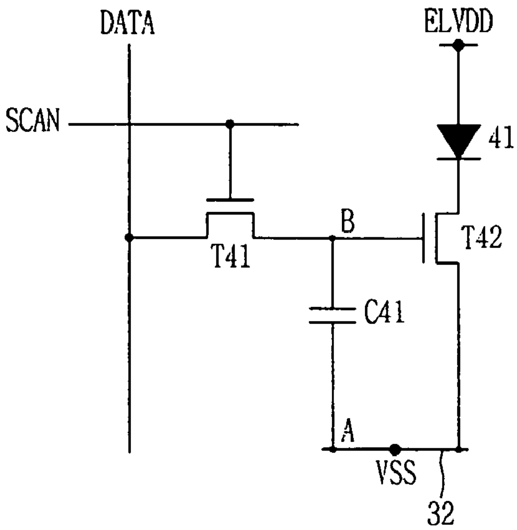

DATA
ELVDD
SCAN
41
B
T41
T42
C41
A
VSS
32

FIG. 5

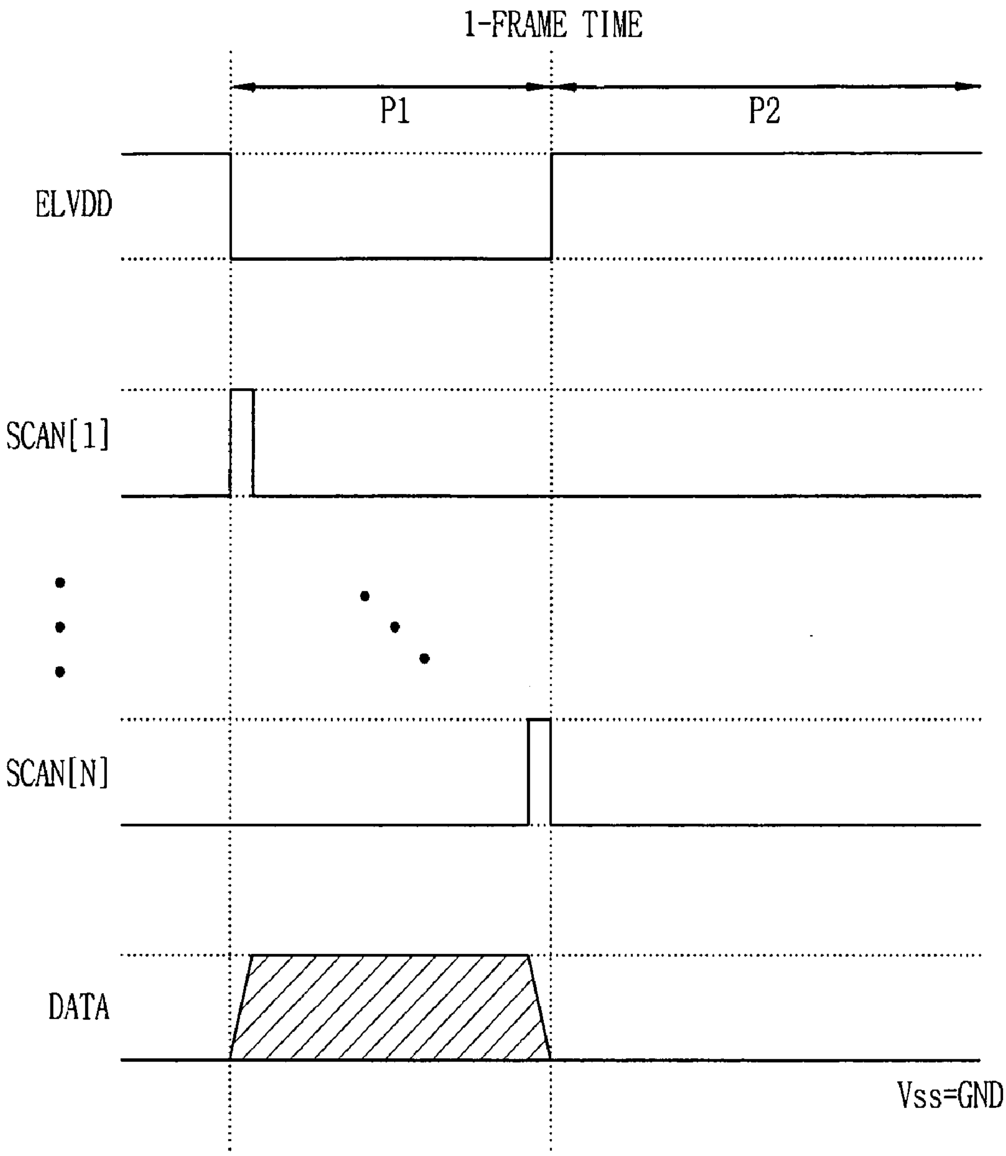


FIG. 6

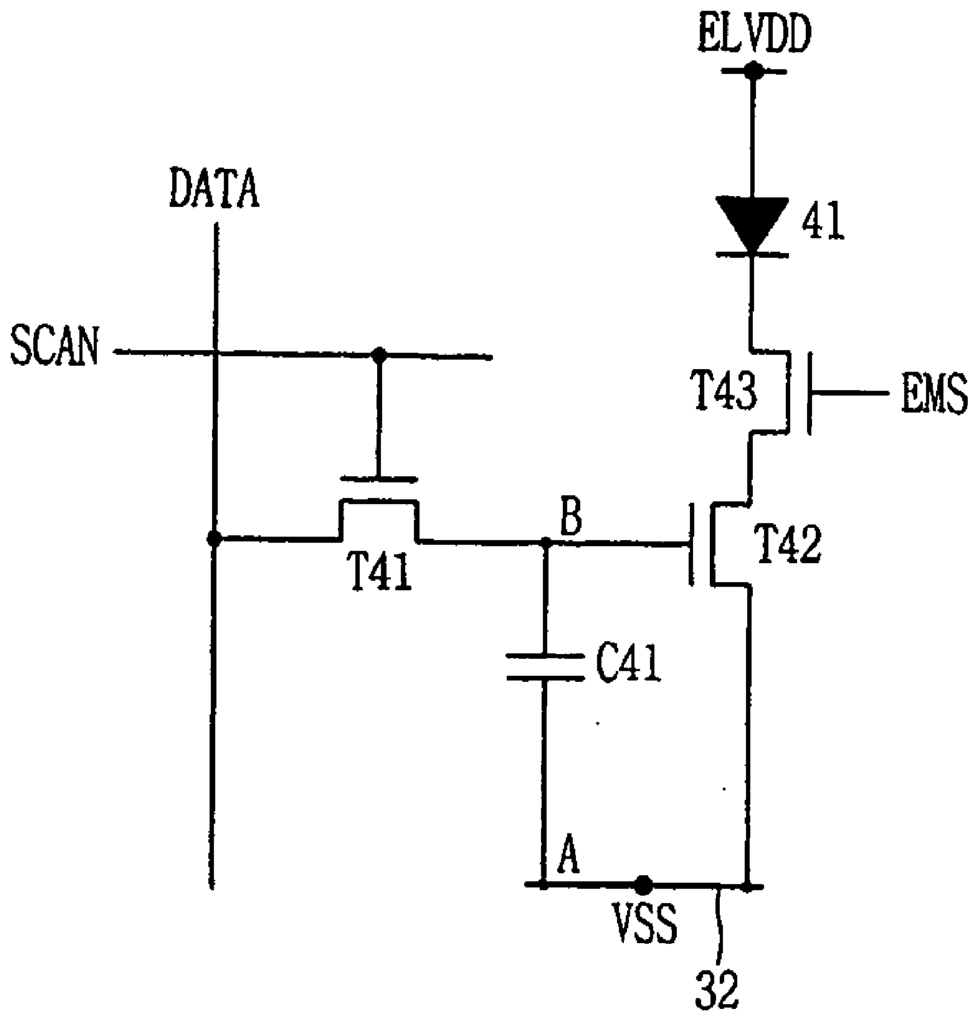


FIG. 7

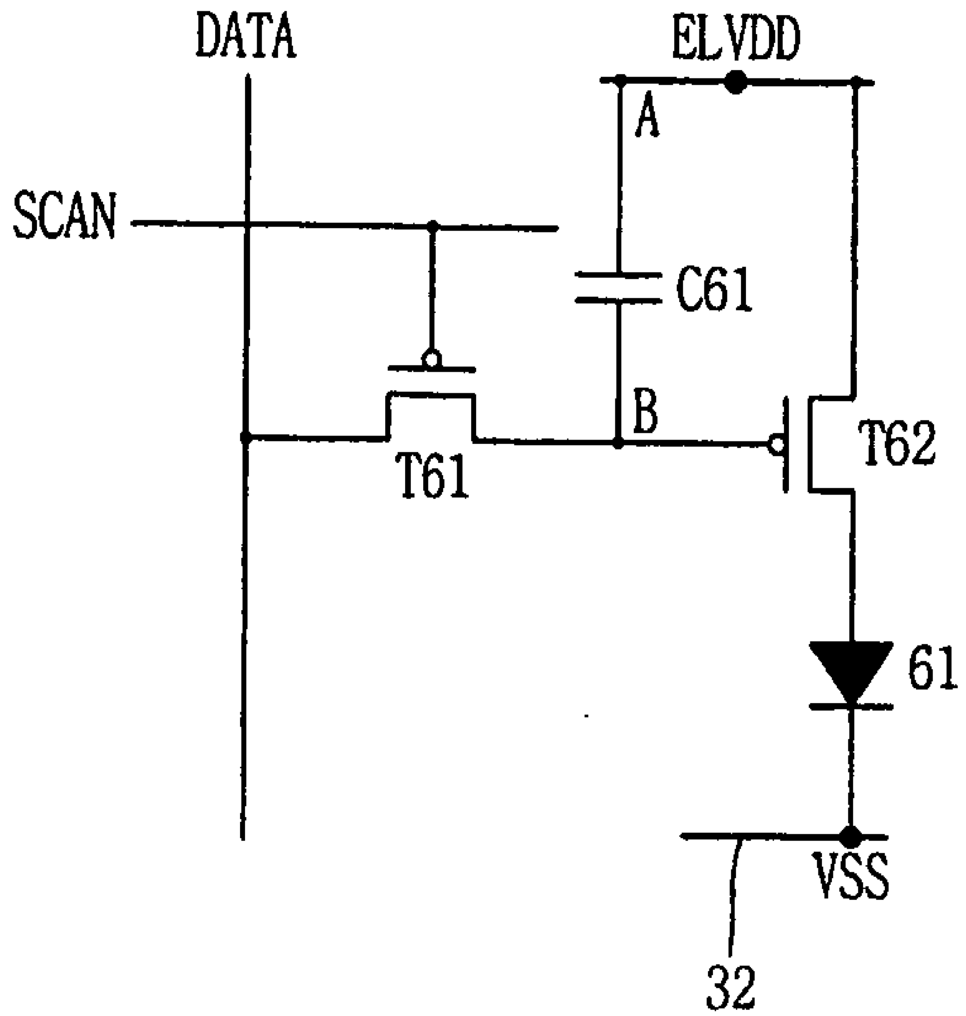


FIG. 8

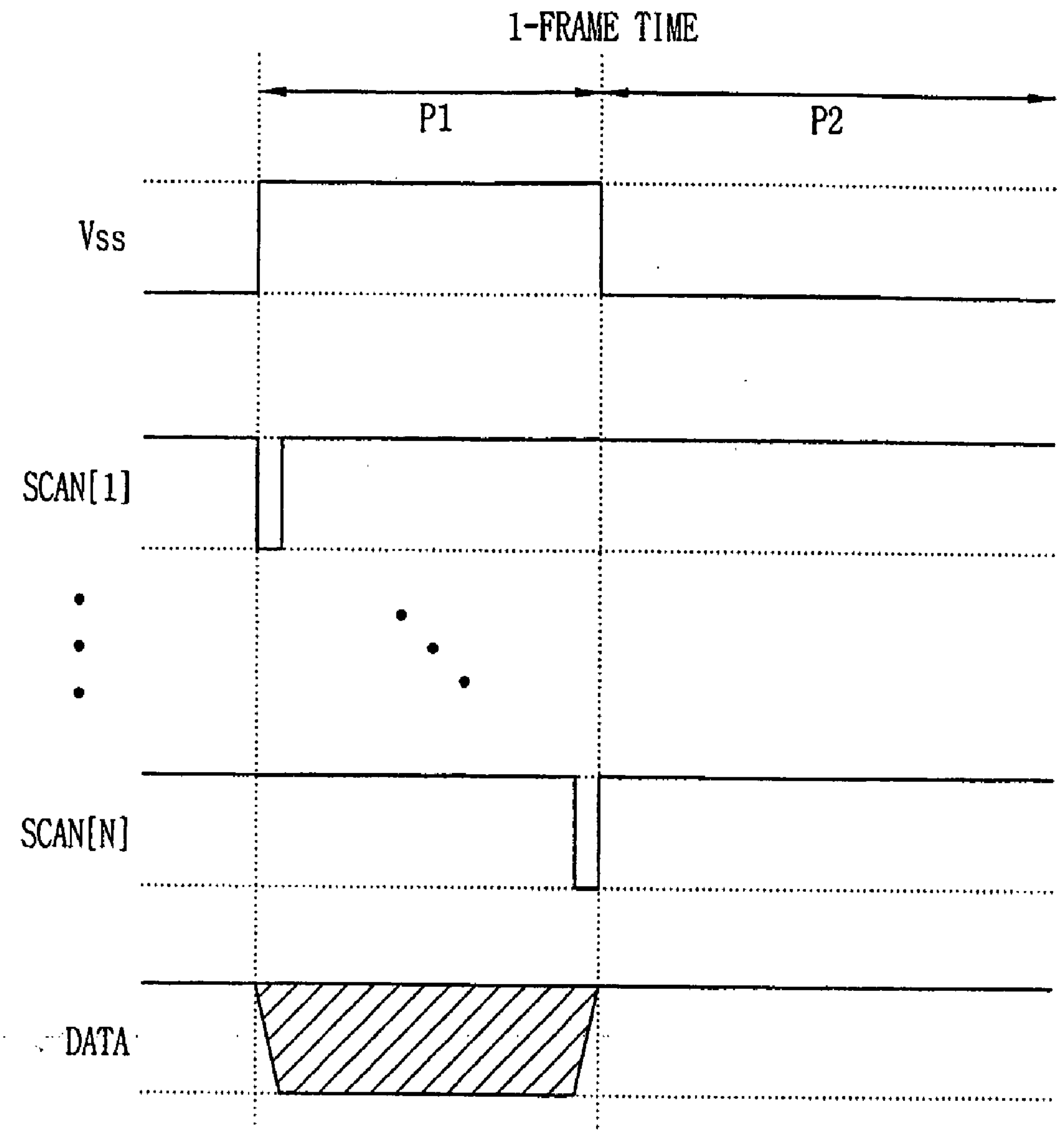


FIG. 9

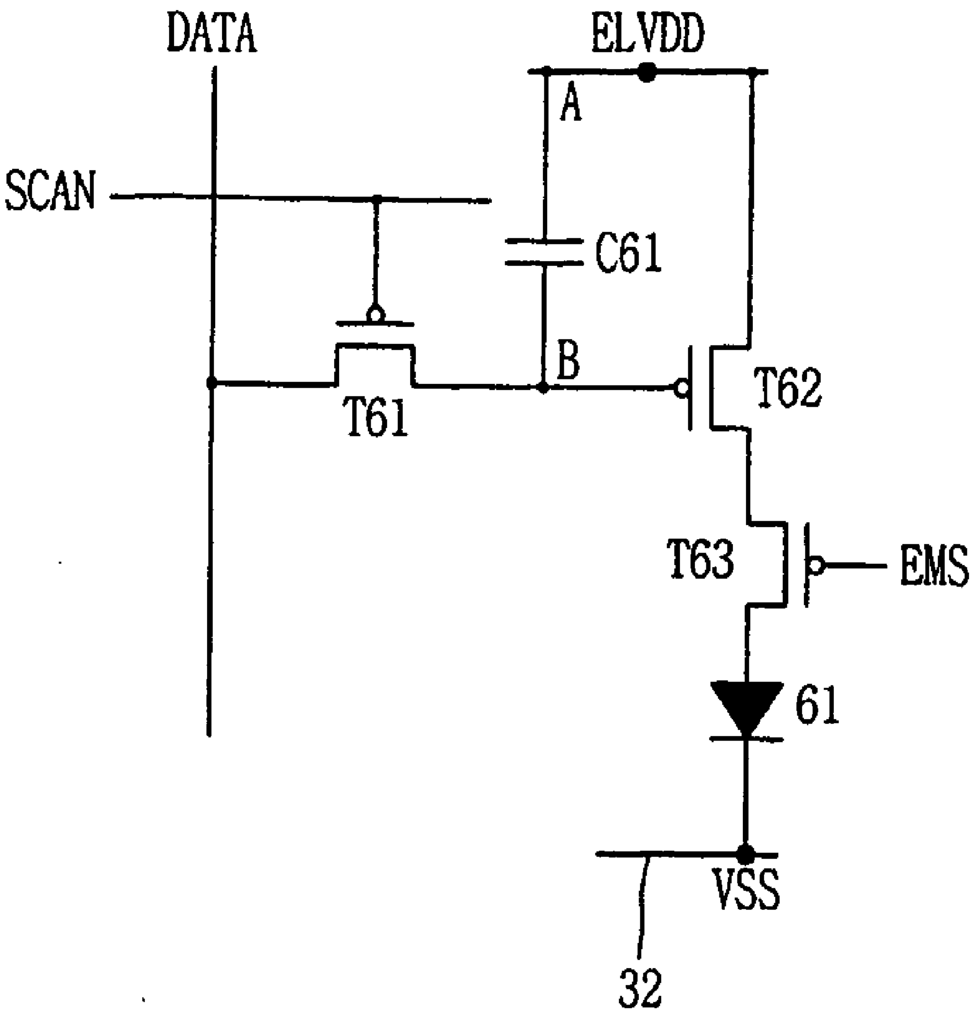


FIG. 10

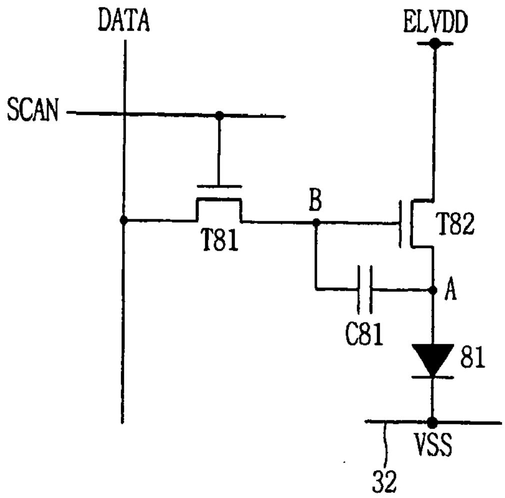

DATA
ELVDD
SCAN
B
T82
T81
A
C81
81
VSS
32

FIG. 11

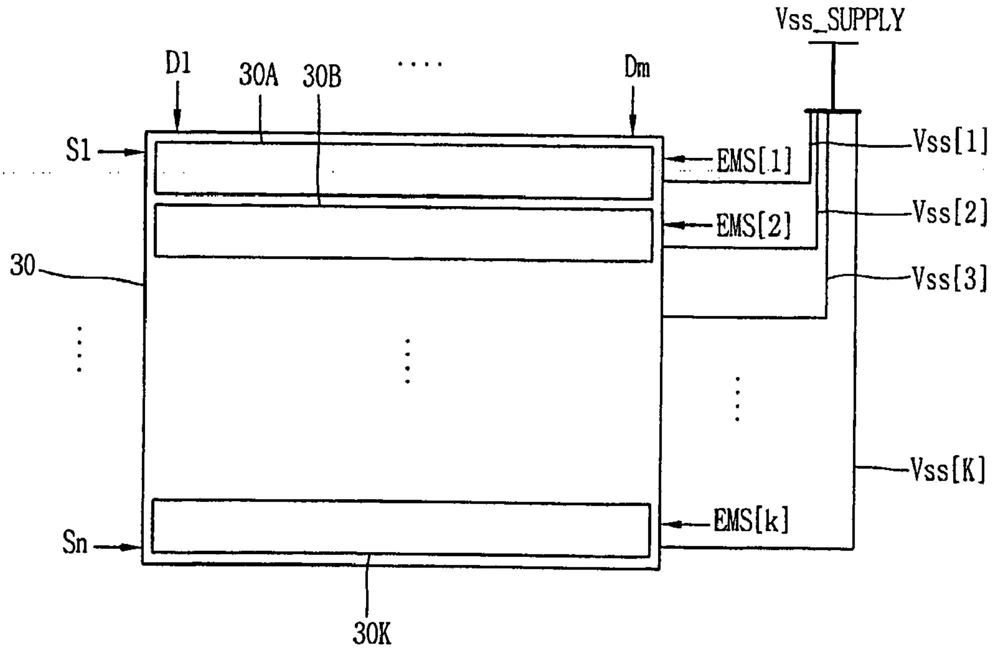

Vss_SUPPLY
D1
30A
30B
Dm
S1
EMS[1]
Vss[1]
EMS[2]
Vss[2]
30
Vss[3]
Vss[K]
EMS[k]
Sn
30K

FIG. 12A

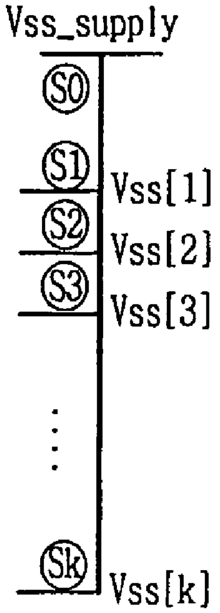


FIG. 12B

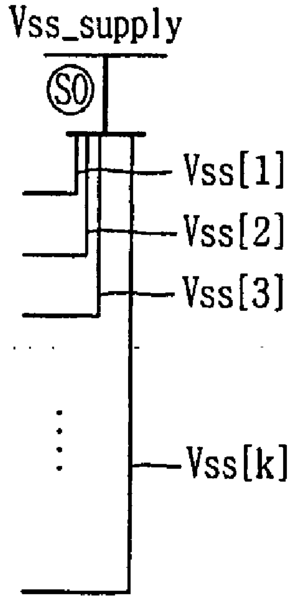
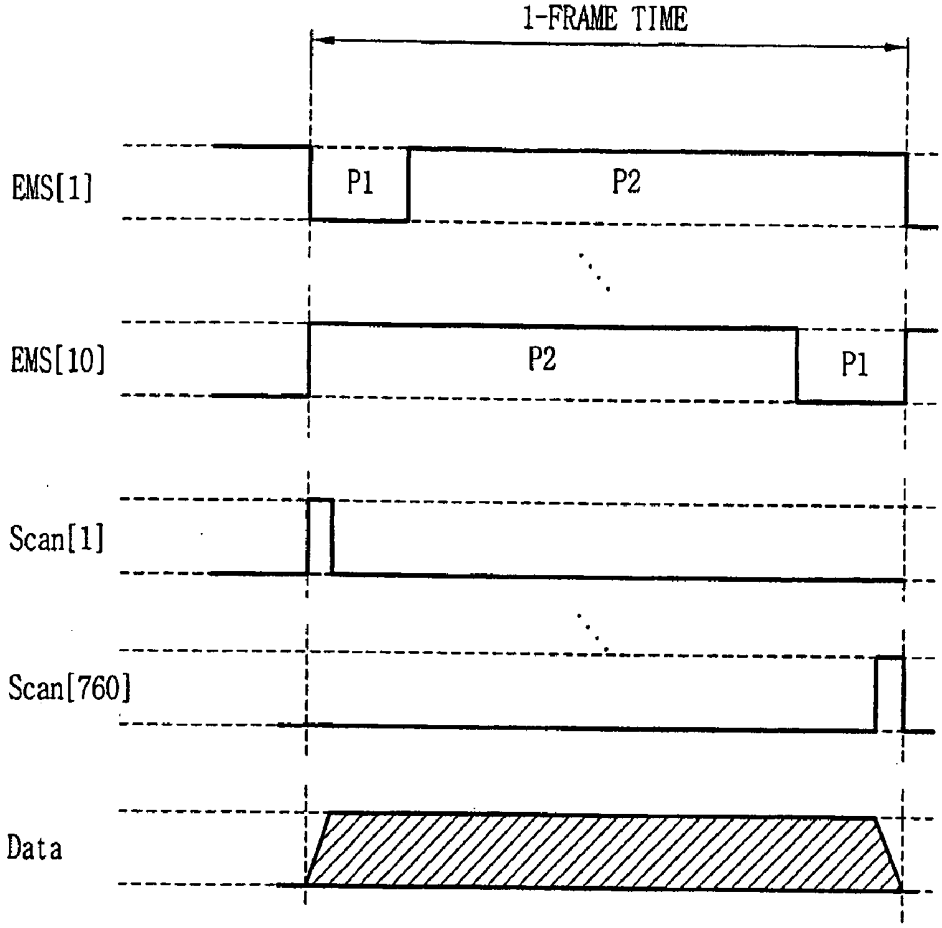


FIG. 13



PIXEL DRIVING METHOD AND APPARATUS FOR ORGANIC LIGHT EMITTING DEVICE

CROSS-REFERENCE TO RELATED APPLICATION

[0001] The present disclosure relates to subject matter contained in priority Korean Application No. 10-2007-0096141, filed on Sep. 20, 2007, which is hereby incorporated by reference in its entirety.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] The present disclosure relates to a method for driving a display panel, and more particularly, to a pixel driving method and apparatus for an organic light emitting device (OLED). Although embodiments of the invention are suitable for a wide scope of applications, it is particularly suitable for preventing a non-uniform brightness due to different levels of a common voltage at different positions within a display panel, and for preventing a flicker phenomenon due to a short data voltage emission period in a large display panel.

[0004] 2. Description of the Related Art

[0005] Generally, an organic light emitting device (OLED) is a plane-type light emitting device. In an OLED, an organic light emitting layer is disposed between two electrodes facing each other so that when a voltage is applied between the two electrodes, electrons injected from one electrode are combined with holes injected from another electrode in the organic light emitting layer. As a result of the combination, molecules in the light emitting layer are excited such that light is emitted. Presently, the OLED is seen as the next generation of display apparatus due to its excellent viewing characteristics, light weight, thin thickness, and low voltage driving. The OLED is classified as either an Active-Matrix type OLED or a Passive-Matrix type OLED according to whether a switching device is provided in each of the unit pixels of a display panel.

[0006] FIG. **1**A is a block diagram showing an OLED in accordance with the related art. As shown in FIG. **1**A, the related art OLED includes a scan driving unit **10** for sequentially outputting scan signals to drive scan lines S**1**-Sn on a display panel **30** under control of a signal controller (not shown); a data driving unit **20** for outputting data voltages to data lines D**1**-Dm on the display panel **30**; and a display panel **30** having a plurality of pixels PXs at intersections between the scan lines S**1**-Sn and the data lines D**1**-Dm. The pixels of the active-matrix type OLED are driven by one of voltage writing, current writing and digital writing.

[0007] FIG. **1**B is a circuit for driving pixels PXs on the display panel **30** of FIG. **1**A. As shown in FIG. **1**B, the pixel circuit includes a switching transistor T**1** transmitting data voltages DATA supplied through the data lines D to a storage capacitor C**11** by being driven by the scan signals SCAN supplied through the scan lines S; the storage capacitor C**11** for being charged to the data voltage DATA is also connected between a gate terminal of a driving transistor T**12** and a lower power supply voltage terminal Vss; a driving transistor T**12** supplies a driving current to an organic light emitting diode OLED **11** having a brightness corresponding to the driving current by having an anode connected to an upper power supply ELVDD voltage terminal and having a cathode connected to a drain of the driving transistor T**12**. The driving current corresponds to the data voltage DATA charged onto the storage capacitor C**11**. The transistors T**11** and T**12** are implemented as N-channel type thin film transistors (TFTs).

[0008] FIG. **2** is a waveform of FIGS. **1**A and **1**B. FIG. **3** is a schematic view showing an arrangement structure of power supply voltage supply lines on a display panel. The operation of the related art circuit for driving pixels shown in FIGS. **1**A and **1**B will be explained with reference to FIGS. **2** and **3**.

[0009] In each frame period as shown in FIG. **2**, positive scan signals Scan [**1**]-Scan [N] are sequentially supplied from the scan driving unit **10** to the scan lines S**1**-Sn on the display panel **30**, thereby driving the pixels PXs on a corresponding scan line (horizontal line). As also shown in FIG. **2**, an upper power supply voltage ELVDD of a certain level (i.e., 15V) is continuously supplied to the anode of the OLED **11** for one frame period. FIG. **1**B is an exemplary view showing just one of a plurality of pixels (including a driving circuit) connected to an optional scan line.

[0010] The switching transistor T**11** is turned ON by a corresponding scan signal among the scan signals Scan [**1**]-Scan [N]. The data voltage DATA supplied from the data driving unit **20** through a corresponding data line among the data lines D**1**-Dm charges the storage capacitor C**11** through the switching transistor T**11**, and is maintained for a data voltage emission period. The driving transistor T**12** is turned ON by the data voltage DATA charged onto the storage capacitor C**11**, and a certain amount of driving current corresponding to the data voltage DATA flows through the OLED **11**. Accordingly, the organic light emitting diode OLED **11** emits light with a brightness corresponding to the data voltage DATA.

[0011] The driving current I_{OLED} flowing in the OLED **11** is expressed as the following equation 1.

$$I_{OLED} = \frac{1}{2} \cdot \frac{W}{L} \cdot C_{SINx} \cdot \{V_{DATA} - V_{SS} - V_{TH}\}^2 \quad \text{[Equation 1]}$$

Here, "L" denotes a channel length of the driving transistor T**12**, the "W" denotes a channel width of the driving transistor T**12**, the "C_{SINx}" is a capacitor component of a gate insulator, the "V_{TH}" denotes a threshold voltage, and the "V_{DATA}" is a data voltage charged onto the storage capacitor C**11**.

[0012] As shown in FIG. **3**, a lower power supply voltage Vss supply line **32** is arrayed on an array portion **31** with a mesh structure so as to minimize a resistance. On each outer periphery of the array portion **31** and the display panel **30**, other lower power supply voltage supply lines **33** and **34** having a wider width are arrayed, thereby smoothly supplying the lower power supply voltage Vss.

[0013] In a data voltage programming period, when data voltages are being charged onto the storage capacitors C**11** of the pixels PXs inside the display panel **30**, about 1 μA of current flows through the OLED **11** and the driving transistor T**12**. The current flows to the lower power supply voltage supply lines **33** and **34** through the lower power supply voltage supply line **32**. Accordingly, the current flowing in the display panel **30** has a total amount corresponding to several tens of mA, and thus a potential on the lower power supply voltage supply line **32** is increased. The increased lower power supply voltage Vss' is expressed as the following equation 2.

$$Vss' = Vss + I_{OLED} \cdot R_{line} \quad \text{[Equation 2]}$$

The driving current I_{OLED} of the OLED **11**, and the resistance R_{line} of the lower power supply voltage supply line **32** have different values depending on position inside of the display panel **30**.

[0014] As the potential on the lower power supply voltage supply line **32** is increased, a driving voltage of the driving transistor T**12** inside the pixel is lowered, thereby lowering a brightness of the OLED **11**. As the lower power supply voltage Vss changes to Vss', the driving current I_{OLED} of the OLED **11** is lowered, which is expressed as the following equation 3.

$$I_{OLED}=\frac{1}{2}\cdot\frac{W}{L}\cdot C_{SINx}\cdot\{V_{DATA}-Vss'-V_{TH}\}^2\leq\frac{1}{2}\cdot\frac{W}{L}\cdot C_{SINx}\cdot\{V_{DATA}-V_{SS}-V_{TH}\}^2 \quad \text{[Equation 3]}$$

[0015] The potential on the lower power supply voltage supply line **32** is increased at the time of programming the data voltages due to the organic light emitting diode (OLED) of each pixel, the lower power supply voltage supply line **32** having a mesh structure, and the current flowing the lower power supply voltage supply line **32**. Accordingly, the driving voltage of the driving transistor inside the pixel is lowered, thereby lowering brightness of the organic light emitting diode depending on the location of the pixel in the mesh. Since the brightness can be lowered at respective pixels by different levels, a non-uniform brightness can result in the overall display panel.

SUMMARY OF THE INVENTION

[0016] Accordingly, embodiments of the invention are directed to a pixel driving method and apparatus for an organic light emitting device that substantially obviates one or more of the problems due to limitations and disadvantages of the related art.

[0017] An object of embodiments of the invention is to provide a pixel driving method and apparatus for an organic light emitting device for preventing a driving voltage of a driving transistor inside a pixel from dropping.

[0018] Another object of the present disclosure is to provide a pixel driving method and apparatus for an organic light emitting device capable of sufficiently obtaining a data voltage programming period and a lighting duration of an organic light emitting diode regardless of a size of a display panel.

[0019] Additional features and advantages of embodiments 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 embodiments of the invention. The objectives and other advantages of the embodiments 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.

[0020] To achieve these and other advantages and in accordance with the purpose of embodiments of the invention, as embodied and broadly described, there is provided a pixel driving method for an organic light emitting device includes: charging a data voltage supplied through a data line to a storage capacitor and driving an N-channel switching transistor while cutting off supply of an upper power supply voltage to an organic light emitting diode; and powering the organic light emitting diode emit light by driving the N-channel driving transistor by the data voltage charged onto the storage capacitor while supplying the upper power supply voltage to the light emitting diode.

[0021] According to another aspect, there is provided a pixel driving method for an organic light emitting device includes: charging a data voltage supplied through a data line to a storage capacitor and driving a P-channel switching transistor while cutting off supply of a lower power supply voltage to an organic light emitting diode; and powering the organic light emitting diode emit light by driving the P-channel driving transistor by the data voltage charged onto the storage capacitor while supplying the lower power supply voltage to the organic light emitting diode.

[0022] According to another aspect, there is provided a pixel driving apparatus for an organic light emitting device including: a first switching transistor for transmitting data voltages supplied through data lines to a storage capacitor by being driven by scan signals when an upper power supply voltage is cut off; a storage capacitor for being charged by the data voltage when the upper power supply voltage is cut off by being connected between a gate terminal of a driving transistor and a lower power supply voltage terminal; a driving transistor for supplying a driving current to an organic light emitting diode when the upper power supply voltage is supplied, the driving current corresponding to the data voltage charged onto the storage capacitor; a second switching transistor turned OFF when scan signals are supplied and connected between the cathode of the OLED and the drain of the driving transistor; an organic light emitting diode for emitting light with a brightness corresponding to the driving current by having an anode connected to the upper power supply voltage and a cathode connected to a drain of the second switching transistor.

[0023] According to yet another aspect, there is provided a pixel driving apparatus for an organic light emitting device including: a display panel having a plurality of display panel regions such that a plurality of adjacent scan lines can be included in each region; a plurality of diverged lower power supply voltages; and pixels inside each of the plurality of display panel regions share one lower power supply voltage among the plurality of lower power supply voltages.

[0024] 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 embodiments of the invention as claimed.

BRIEF DESCRIPTION OF THE DRAWINGS

[0025] 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:

[0026] FIG. **1**A is a block diagram showing an organic light emitting device (OLED) in accordance with the related art;

[0027] FIG. **1**B is a pixel circuit in accordance with the related art;

[0028] FIG. **2** is a waveform of FIGS. **1**A and **1**B;

[0029] FIG. **3** is a schematic view showing an arrangement structure of power supply voltage supply lines on a display panel;

[0030] FIG. **4** is a view of a pixel circuit to which a pixel driving method according to embodiments of the invention can be applied;

[0031] FIG. **5** is a waveform showing the pixel circuit of FIG. **4**;

[0032] FIG. **6** is a view of another pixel circuit to which the pixel driving method according to embodiments of the invention can be applied;

[0033] FIG. **7** is a view of still another pixel circuit to which the pixel driving method according to embodiments of the invention can be applied;

[0034] FIG. **8** is a waveform showing the pixel circuit of FIG. **7**;

[0035] FIG. **9** is a view of yet another pixel circuit to which the pixel driving method according to embodiments of the invention can be applied;

[0036] FIG. **10** is a view of an anode contact type-pixel circuit according to embodiments of the invention in which the driving transistor comes in contact with the anode of the organic light emitting diode;

[0037] FIG. **11** is a view of a pixel circuit to which the pixel driving method according to additional embodiments of the invention;

[0038] FIGS. **12**A and **12**B are exemplary views showing each lower power supply voltage; and

[0039] FIG. **13** is timing diagrams for a display panel driving according to additional embodiments of the invention.

DETAILED DESCRIPTION OF THE INVENTION

[0040] Reference will now be made in detail to the preferred embodiments of the invention, examples of which are illustrated in the accompanying drawings.

[0041] FIG. **4** is a view of a pixel circuit to which a pixel driving method according to embodiments of the invention can be applied, which is implemented with an N-channel thin film transistor (TFT). FIG. **4** is an exemplary view showing just one of a plurality of pixels (including a driving circuit) arrayed on a horizontal line. As shown in FIG. **4**, the pixel circuit includes a switching transistor T**41** driven by scan signals for transmitting data voltages DATA supplied through data lines to a storage capacitor C**41** when an upper power supply voltage ELVDD is cut off; a storage capacitor C**41** connected between a gate terminal of a driving transistor T**42** and a lower power supply voltage terminal Vss for be charged by the data voltage DATA when the upper power supply voltage ELVDD is cut off; a driving transistor T**42** for supplying a driving current corresponding to the data voltage DATA charged onto the storage capacitor C**41** to an organic light emitting diode OLED **41** when the upper power supply voltage ELVDD is supplied; and an organic light emitting diode OLED **41** having an anode connected to the upper power supply voltage ELVDD and a cathode connected to a drain of the driving transistor T**42** for emitting light with a brightness corresponding to the driving current.

[0042] FIG. **5** is a waveform showing the pixel circuit of FIG. **4**. Hereinafter, a pixel driving method on the pixel circuit will be explained in more detail with reference to FIG. **5**. The ELVDD of a 'high' level is not supplied to the anode of the OLED **41** throughout one frame period. Instead, the ELVDD of a 'low' level (OV) is supplied during the data voltage programming period P**1** of said one frame period. During the data voltage programming period P**1**, positive scan signals Scan[**1**]-Scan[N] are sequentially supplied to the respective horizontal lines, thereby driving the pixels on the horizontal lines. The driving of the pixels results in the data voltage DATA being supplied trough the corresponding data line to the storage capacitor C**41** through the switching transistor T**41** and being maintained for use during the data voltage emission period P**2**, shown in FIG. **5**. During the data voltage programming period P**1**, the data voltage DATA of a 'high' level charged onto the storage capacitor C**41** is also supplied to the gate terminal of the driving transistor T**42** so as to turn on the driving transistor T**42**. However, since supply of the upper power supply voltage ELVDD to the anode of the OLED **41** is cut off, a voltage between drain and source terminals Vds is 'OV'. Accordingly, a current does not flow to the lower power supply voltage Vss supply line **32** through the OLED **41** and the driving transistor T**42**. That is, the driving current I_{OLED} of the OLED **41** is '0.' Since the current does not flow to the lower power supply voltage supply line **32** through the OLED **41**, a voltage of a lower power supply voltage node A is maintained as the original level (OV) regardless of a resistance of the lower power supply voltage supply line **32**. Accordingly, the data voltage DATA having a desired level can be charged onto the storage capacitor C**41**.

[0043] Next, when the data voltage programming operation (scanning operation) is completed, the switching transistor T**41** is turned OFF such that a gate node B is in an electrical floating status.

[0044] Next, in the data voltage emission period P**2**, the ELVDD of a 'high' level is supplied to the anode of the OLED **41**. Since the gate terminal of the driving transistor T**42** is being supplied with the data voltage DATA stored on the storage capacitor C**41**, the driving transistor T**42** is turned ON such that current flows to the lower power supply voltage supply line **32** through the OLED **41** and the driving transistor T**42** and the OLED **41** emits light.

[0045] As all the pixels on the display panel **30** are operated, a large amount of current flows to the lower power supply voltage supply line **32**. Accordingly, the voltage Vss of the lower power supply voltage node A is increased to Vss' in accordance with Ohm's law (V=IR). Since the switching transistor T**41** is turned OFF, the gate node B is in an electrical floating status. Therefore, when the voltage Vss of the lower power supply voltage node A is increased to the Vss', the voltage of the gate node B is also increased by coupling through the storage capacitor C**41**. The voltage VB of the gate node B is expressed as the following equation 4.

$$V_B = \text{Data.}[N] + V_{SS}' - V_{SS} \quad \text{[Equation 4]}$$

[0046] A current flows to the lower power supply voltage node A through the OLED **41** and the driving transistor T**42** from the supplied ELVDD during the data voltage emission period P**2**, and thus the voltage of the lower power supply voltage node A changes from the Vss to the Vss.' Although the voltage of the gate node B changes, a voltage Vgs between the gate and source terminals of the driving transistor T**42** does not change. Accordingly, the driving current I_{OLED} of the OLED **41** is not influenced by the voltage change of the lower power supply voltage node A, but is only influenced by the data voltage DATA stored in the storeage capacitor C**41**. The driving current I_{OLED} of the OLED **41** is expressed as the following equation 5.

$$I_{OLED} = \frac{1}{2}\cdot\frac{W}{L}\cdot C_{SINx}\cdot\{V_B - V_{SS}' - V_{TH}\}^2 = \frac{1}{2}\cdot\frac{W}{L}\cdot C_{SINx}\cdot\{\text{Data.}[N] - V_{SS} - V_{TH}\}^2 \quad \text{[Equation 5]}$$

[0047] The following table shows each change of the voltages of the nodes A and B, and the driving current I_{OLED} of the OLED **41** in the data voltage programming period P**1** and the data voltage emission period P**2**.

Operation	Period 1	Period 2
Node 'A'	Vss	Vss' (potential rising)
Node 'B'	Data · [N]	Data · [N] + Vss' − Vss
I_{OLED}	0	k · (Data · [N] − Vss − V_{TH})^2

In the data voltage programming period P**1** of one frame period, the supply of the ELVDD may be cut off by various methods so as to prevent a current from flowing to the lower power supply voltage Vss supply line **32** through the OLED **41** and the driving transistor T**42**.

[0048] FIG. **6** is a view of another pixel circuit to which the pixel driving method according to embodiments of the invention can be applied. FIG. **6** shows one method for cutting-off the supply of the ELVDD by using a switching transistor in each pixel. More specifically, a drain and a source of the switching transistor T**43** are respectively connected between the cathode of the OLED **41** and the drain of the driving transistor T**42**. The switching transistor T**43** is turned OFF with a switching control signal EMS of a 'low' level to the gate of the switching transistor T**43** by a signal controller (not shown) during the data voltage programming period P**1**.

[0049] FIG. **7** is a view of still another pixel circuit to which the pixel driving method according to embodiments of the invention can be applied, which shows a P-channel type Thin Film Transistor (TFT). As shown in FIG. **7**, the P-channel type TFT includes a switching transistor T**61** driven by a scan signal for transmitting a data voltage DATA supplied through a data line to a storage capacitor C**61** when a lower power supply voltage Vss is cut off; a storage capacitor C**61** connected between a gate terminal of a driving transistor T**62** and an upper power supply voltage terminal ELVDD is charged by the data voltage DATA when the lower power supply voltage Vss is cut off; a driving transistor T**62** for supplying a driving current to an organic light emitting diode OLED **61** when the lower power supply voltage Vss is supplied; and an OLED **61** having an anode connected to a source terminal of the driving transistor T**62** and having a cathode connected to the lower power supply voltage Vss for emitting light having a brightness corresponding to the driving current. The driving current corresponds to the data voltage DATA charged onto the storage capacitor C**61**. Hereinafter, a pixel driving method for the pixel circuit will be explained in more detail with reference to FIG. **8**.

[0050] FIG. **8** is a waveform showing the pixel circuit of FIG. **7**. The lower power supply voltage Vss of a 'low' level is not supplied to the cathode of the OLED **61** during all of one frame period. Instead, the Vss of a 'high' level is supplied during the data voltage programming period P**1** of said one frame period. During the data voltage programming period P**1**, negative scan signals Scan[**1**]-Scan[N] are sequentially supplied to the respective horizontal lines, thereby driving the pixels on the horizontal lines. The driving of the pixels results in the data voltage DATA being supplied through the corresponding data line to the storage capacitor C**61** through the switching transistor T**61** and being maintained for use in the data voltage emission period P**2**, as shown in FIG. **8**. During the data voltage programming period P**1**, the data voltage DATA of a 'low' level is charged onto the storage capacitor C**61** and is also applied to the gate terminal of the driving transistor T**62** so as to turn on the driving transistor T**62**. However, since the supply of the lower power supply voltage Vss to the cathode of the OLED **61** is cut off, a voltage between drain and source terminals Vds is 'OV' Accordingly, the current does not flow in the OLED **61** from the upper power supply voltage ELVDD supply line. That is, the driving current I_{OLED} of the OLED **61** is '0.' Since the current does not flow in the OLED **61** from the upper power supply voltage ELVDD supply line, a voltage of an upper power supply voltage node A is maintained as the original level (15V) during the data voltage programming period P**1** regardless of a resistance of the upper power supply voltage ELVDD supply line. Accordingly, the data voltage DATA having a desired level can be charged onto the storage capacitor C**61**.

[0051] Next, when the data voltage programming operation (scanning operation) is completed, the switching transistor T**61** is turned OFF and thereby the gate node B is in an electrical floating status.

[0052] Next, in the data voltage emission period P**2**, the low power supply voltage Vss of a 'low' level (OV) is supplied to the cathode of the OLED **61**. Since the gate terminal of the driving transistor T**62** is being supplied with the data voltage DATA stored at the storage capacitor C**61**, the driving transistor T**62** is turned ON so that the upper power supply voltage ELVDD is supplied to the OLED **61** and the OLED **61** emits light.

[0053] As all the pixels on the display panel **30** are operated, a large amount of current flows to upper power supply voltage supply line. Accordingly, the voltage VDD of the upper power supply voltage node A is decreased to VDD' according to the Ohm's law (V=IR). Since the switching transistor T**61** is turned OFF, the gate node B is in an electrical floating status. Therefore, when the voltage VDD of the upper power supply voltage node A is lowered to the VDD', the voltage of the gate node B is also lowered due to coupling with the storage capacitor C**61**. The voltage VB of the gate node B is expressed as the following equation 6.

$$V_B = \text{Data}[N] + VDD' - VDD \qquad \text{[Equation 6]}$$

[0054] A current flows from the upper power supply voltage node A to the OLED **41** through the driving transistor T**62** by the supplied lower power supply voltage Vss in the data voltage emission period P**2**, and thus the voltage of the upper power supply voltage node A changes from the VDD to the VDD'. However, since the voltage of the gate node B also changes, a voltage Vgs between the gate and source terminals of the driving transistor T**62** does not change. Accordingly, the driving current I_{OLED} of the OLED **61** is not influenced by the voltage change of the upper power supply voltage node A and is only influenced by the data voltage DATA stored in the storage capacitor C**61**. The driving current I_{OLED} of the OLED **61** is expressed as the following equation 7.

$$I_{OLED} = \frac{1}{2}\cdot\frac{W}{L}\cdot C_{SINx}(V_B - VDD' - V_{TH}\}^2 = \frac{1}{2}\cdot\frac{W}{L}\cdot C_{SINx}\cdot\{V_{DATA}[N] - VDD - V_{TH}\}^2 \qquad \text{[Equation 7]}$$

[0055] The following table shows each change of the voltages of the nodes A and B and the driving current I_{OLED} of the OLED **61** in the data voltage programming period P**1** and the data voltage emission period P**2**.

Operation	Period 1	Period 2
Node 'A'	VDD	VDD' (potential drop)
Node 'B'	Data · [N]	Data · [N] + VDD' − VDD
I_{OLED}	0	$k \cdot (\text{Data} \cdot [N] - VDD - V_{TH})^2$

To prevent a current from flowing to the lower power supply voltage Vss supply line **32** through the OLED **61** and the driving transistor T**62** in the data voltage programming period P**1** for one frame period supply of the upper power supply voltage ELVDD may be cut off by various methods.

[0056] FIG. **9** is a view of an additional pixel circuit to which the pixel driving method according to embodiments of the invention can be applied. More specifically, FIG. **9** shows a method for cutting-off supply of the ELVDD by using a switching transistor. A drain and a source of the switching transistor T**63** are respectively connected between the anode of the OLED **61** and the drain of the driving transistor T**62**. The switching transistor T**63** is turned OFF due to a switching control signal EMS of a 'high' level applied to the gate of the switching transistor T**63** by a signal controller (not shown) in the data voltage programming period P**1**.

[0057] FIG. **10** is a view of an anode contact type-pixel circuit according to embodiments of the invention in which the driving transistor comes in contact with the anode of the organic light emitting diode. As shown in FIG. **10**, the pixel circuit according to embodiments of the invention includes a switching transistor T**81** driven by a scan signal for transmitting a data voltage DATA supplied from a data line to a storage capacitor C**81**, when an upper power supply voltage ELVDD is cut off; a storage capacitor C**81** connected between a gate terminal and a source terminal of a driving transistor T**82** for being charged with the data voltage DATA when the upper power supply voltage ELVDD is cut off; a driving transistor T**82** for supplying a driving current to the OLED **81** when the upper power supply voltage ELVDD is cut off; and an organic light emitting diode OLED **81** having an anode connected to the source terminal of the driving transistor T**82** and a cathode connected to a lower power supply voltage terminal Vss for emitting light with a brightness corresponding to the driving current. The driving current corresponds to the data voltage DATA. Hereinafter, a pixel driving method at the pixel circuit will be explained in more detail with reference to FIG. **5**.

[0058] The ELVDD of a 'high' level is not supplied to the drain of the driving transistor T**82** during all of one frame period. Instead, the ELVDD of a 'low' level is supplied only during the data voltage programming period P**1** of the one frame period. During the data voltage programming period P**1**, positive scan signals Scan[**1**]-Scan[N] are sequentially supplied to the respective horizontal lines, thereby driving the pixels on the horizontal lines. As a result of the pixels being driven, the data voltage DATA supplied through the corresponding data line is charged onto the storage capacitor C**81** through the switching transistor T**81** and is maintained for the data voltage emission period P**2**. The data voltage DATA of a 'high' level charged to the storage capacitor C**81** is also supplied to the gate terminal of the driving transistor T**82**, thereby turning on the driving transistor T**82**. However, since supply of the upper power supply voltage ELVDD to the drain of the driving transistor T**82** is cut off, a voltage between the drain and source terminals Vds becomes 'OV'. Accordingly, the current does not flow to the lower power supply voltage Vss supply line **32** through the OLED **81** and the driving transistor T**82**. That is, the driving current I_{OLED} of the OLED **81** becomes '0.' Since the current does not flow to the lower power supply voltage supply line **32** through the OLED **81**, a voltage of an anode node A is maintained as the original level Vss regardless of a resistance of the lower power supply voltage supply line **32**. Accordingly, the data voltage DATA having a desired level can be charged onto the storage capacitor C**81**.

[0059] Next, when the data voltage programming operation (scanning operation) is completed, the switching transistor T**81** is turned OFF and thereby the gate node B is in an electrical floating status.

[0060] Next, in the data voltage emission period P**2**, the ELVDD of a 'high' level is supplied to the driving transistor T**82** in the data voltage emission period P**2**. Since the gate terminal of the driving transistor T**82** is being supplied with the data voltage DATA stored at the storage capacitor C**81** the driving transistor T**82** is turned ON to allow current flow to the lower power supply voltage supply line **32** through the OLED **81** and the driving transistor T**82** so that the OLED **81** emits light.

[0061] As all the pixels on the display panel **30** are operated, a large amount of current flows to the lower power supply voltage supply line **32**. Accordingly, the voltage Vss of the anode node A is increased to V_{OLED} according to the Ohm's law (V=IR). Since the switching transistor T**81** is turned OFF, the gate node B is in an electrical floating status. Therefore, when the voltage Vss of the anode node A is increased to V_{OLED}, the voltage of the gate node B is also increased by coupling through the storage capacitor C**81**. The voltage VB of the gate node B is expressed as the following equation 8.

$$V_B = \text{Data}[N] + V_{OLED} - V_{SS} \qquad \text{[Equation 8}$$

[0062] A current flows to the lower power supply voltage supply line **32** through the OLED **81** and the driving transistor T**82** by the supplied ELVDD in the data voltage emission period P**2**, and thus the voltage of the anode node A changes from the Vss to V_{OLED}. However, since the voltage of the gate node B also changes, a voltage Vgs between the gate and source terminals of the driving transistor T**82** does not change. Accordingly, the driving current I_{OLED} of the OLED **81** is not influenced by the voltage change of the anode node A, but is only influenced by the data voltage stored in the storage capacitor C**81**. The driving current I_{OLED} of the OLED **81** is expressed as the following equation 9.

$$I_{OLED} = \frac{1}{2} \cdot \frac{W}{L} \cdot C_{SiNx} \cdot \{\text{Data}[N] + V_{OLED} - V_{SS} - V_{OLED} - V_{TH}\}^2 = \frac{1}{2} \cdot \frac{W}{L} \cdot C_{SiNx} \cdot \{\text{Data}[N] - V_{SS} - V_{TH}\}^2 \qquad \text{[Equation 9]}$$

[0063] The following table shows each change of the voltages of the nodes A and B, and the driving current I_{OLED} of the

OLED **81** in the data voltage programming period P**1** and the data voltage emission period P**2**.

Operation	Period 1	Period 2
Node 'A'	Vss	V_{OLED}
Node 'B'	Data · [N]	Data · [N] + V_{OLED} − Vss
I_{OLED}	0	k · (Data · [N] − Vss − $V_{TH})^2$

In the same manner as the aforementioned embodiments of the invention, the data voltage programming period P**1** is set in one frame period, during which the data voltage is charged to the storage capacitor in a state that supply of the power supply voltage to the organic light emitting diode OLED is cut off. Accordingly, a driving voltage of the driving transistor is prevented from dropping.

[0064] Since time corresponding to the data voltage programming period P**1** takes time from the data voltage emission period P**2** in one frame period, lighting duration of the OLED is reduced. When embodiments of the invention are applied to a small type display panel **30** having relatively a small number of scan lines, the lighting duration of the organic light emitting diode can be sufficient without the need to reduce the data voltage programming period P**1**. When embodiments of the invention are implemented in a large display panel **30** having relatively a large number of scan lines (i.e., 768 scan lines), the data voltage programming period P**1** becomes relatively long. Accordingly, there is a difficulty in obtaining sufficient lighting duration of the organic light emitting diode, and thus a brightness flicker phenomenon occurs. To solve this problem, the data voltage programming period and the lighting duration of the organic light emitting diode in additional embodiments of the invention are sufficiently obtained regardless of the size of the display panel. Hereinafter, the additional embodiments of the invention will be explained in more detail.

[0065] FIG. **11** is a view of a pixel circuit to which the pixel driving method according to additional embodiments of the invention. Referring to FIG. **1**, the display panel **30** is defined as a plurality of display panel regions **30**A-**30**K in a horizontal direction so that a plurality of adjacent scan lines can be included. Pixels inside the plurality of display panel regions **30**A-**30**K share one lower power supply voltage among a plurality of lower power supply voltages Vss[**1**]-Vss[K] supplied from the lower power supply voltage supply terminals (Vss_supply) by being diverged. A data voltage programming period and a data voltage emission period are determined in one frame period according to each of the display panel regions **30**A-**30**K.

[0066] As shown in FIG. **11**, scan lines S**1**-Sn and data lines D**1**-Dm are arrayed on the display panel **30** in the same manner as a general display panel. The display panel **30** is defined as a plurality of display panel regions **30**A-**30**K in a horizontal direction so that a plurality of adjacent scan lines can be included. A plurality of lower power supply voltages Vss[**1**]-Vss[K] are supplied to the display panel regions **30**A-**30**K, respectively. For instance, a large display panel **30** having **760** scan lines S**1**-Sn is defined as **10** display panel regions **30**A-**30**K. Here, each of the ten display panel regions **30**A-**30**K is implemented to include **76** scan lines {**S1**-**S76**,**S77**-**S152** . . . S**685**-**S760**}. For reference, the display panel **30** of the invention has to be provided with **768** scan lines S**1**-Sn since it is implemented as an XGA-type (1024×768). However, the display panel **30** is supposed to have 760 scan lines for convenience.

[0067] The operation of the pixel driving apparatus for an organic light emitting device according to additional embodiments of the invention will be explained with reference to FIGS. **12**A-**12**B and **13**. FIGS. **12**A and **12**B are exemplary views showing each lower power supply voltage. FIG. **13** is timing diagrams for a display panel driving according to additional embodiments of the invention.

[0068] The lower power supply voltages Vss[**1**]-Vss[k] are respectively supplied to the display panel regions **30**A-**30**K. FIGS. **12**A and **12**B show examples for distributing the lower power supply voltages Vss[**1**]-Vss[k]. Referring to FIGS. **12**A and **12**B, the lower power supply voltage Vss supplied through a main line connected to the lower power supply voltage supply terminal (Vss_supply) is distributed to 10 sub-lines (k=10). The lower power supply voltages Vss is supplied to 9 sub-lines among the 10 sub-lines, and a data voltage emission operation is performed at the other one sub-line by a switching control signal EMS in a state that supply of the lower power supply voltage Vss is cut off.

[0069] FIG. **12**A is an exemplary view showing a method for obtaining lower power supply voltages Vss[**1**]-Vss[k] by sequentially diverging a power supplied to the lower power supply voltage supply terminal (Vss_supply) from an external power supply unit (not shown), and then for supplying the obtained lower power supply voltages Vss[**1**]-Vss[k] to each of the display panel regions **30**A-**30**K. Here, due to distribution resistance values, voltages are diverged from distribution nodes S**1**-Sk in the order of "Vss[**1**]>Vss[**2**]>. . . Vss[k-**1**] >Vss[k]". Here, the previously diverged voltage is higher than the next one by a small degree.

[0070] Referring to FIG. **12**B, a voltage of a common node S**0** is expressed as a lower power supply voltage rising (Vss rising) by current applied to the diverged 9 lines. The Vss rising maintains a nearly constant value even if it varied little by little by an image change. FIG. **12**B is an exemplary view showing a method for obtaining lower power supply voltages Vss[**1**]-Vss[k] by diverging a power supplied to the lower power supply voltage supply terminal (Vss_supply) from an external power supply unit (not shown) at the same position, and then for supplying the obtained lower power supply voltages Vss[**1**]-Vss[k] to each of the display panel regions **30**A-**30**K. Here, since distribution resistance values are equal to each other, each of the lower power supply voltages Vss[**1**]-Vss[k] has the same level as the common node S**0**.

[0071] In an assumption that a voltage of SO varied at the gate according to a switching control signal EMS is V_{SO}, current of the rest display panel regions currently undergoing a light emitting operation can be expressed as the following equation 10.

$$I_{OLED} = \frac{\beta}{2}\cdot\{(V_{DATA}+\Delta V_{S0})-(V_{S0}+\Delta V_{S0})-V_{TH}\}^2 = \frac{\beta}{2}\cdot\{V_{DATA}-V_{S0}-V_{TH}\}^2 \qquad \text{[Equation 10]}$$

Here, it can be seen that the current on the display panel regions currently performing a light emitting operation is not varied. Accordingly, the problem of the Vss rising is solved, thereby preventing non-uniformity of a brightness according to different positions on the large display panel **30**.

[0072] The lower power supply voltages Vss[1]-Vss[k] are respectively supplied to the corresponding lower power supply voltage supply lines in the display panel regions **30**A-**30**K by being diverged, as shown in FIG. **12**B. For instance, in the display panel region **30**A, the lower power supply voltage Vss**1** is diverged into **76** lower power supply voltages in the same manner, as shown in FIG. **12**B, and is supplied to the corresponding lower power supply voltage supply line.

[0073] FIG. **13** is timing diagrams for a display panel driving according to additional embodiments of the invention. FIG. **13** shows a data voltage programming period P**1**, a data voltage emission period P**2**, scan signals, and data voltages on the display panel regions **30**A-**30**K to which the lower power supply voltages Vss[**1**]-Vss[k] are respectively supplied. More specifically, FIG. **13** shows examples of the data voltage programming period P**1** and the data voltage emission period P**2** with respect to each of the display panel regions **30**A-**30**K. When the display panel **30** is defined as 10 display panel regions **30**A-**30**K, 1/10 of one frame period is set as the data voltage programming period P**1** with respect to each of the display panel regions **30**A-**30**K, and the rest 9/10 of the one frame period is set as the data voltage emission period P**2**. Further, FIG. **13** shows exemplary timing diagrams of scan signals with respect to each of the display panel regions **30**A-**30**K. Furthermore, FIG. **13** shows a timing diagram for data voltages supplied through data lines D**1**-Dn with respect to each of the display panel regions **30**A-**30**K.

[0074] Based on the pixel circuit shown in FIG. **6**, a display region (**30**A) among the display panel regions **30**A-**30**K on the display panel **30** of FIG. **11**, data voltage programming and emission operations will be explained. The data voltage programming period P**1** is set with respect to the first display panel region **30**A including all the pixels PXs connected to first to 76th scan lines G**1**-G**76**. As shown in FIG. **13**, since a switching control signal EMS[**1**] of a 'low' level is applied to the gate of the switching transistor T**43** inside all the pixels PXs connected to the first to 76^{th} scan lines G**1**-G**76**, the switching transistor T**43** is turned OFF. Accordingly, the lower power supply voltage Vss from the lower power supply voltage supply line is not supplied to the corresponding pixel PX. The scan signals Scan[**1**]-Scan[**76**] are sequentially supplied to the first to 76^{th} scan lines G**1**-G**76** in the data voltage programming period P**1**, thereby turning-ON the switching transistors T**41** connected to the scan signals inside all the pixels PXs. As a result, data voltages DATA are supplied to the switching transistors T**41** through the data lines D**1**-Dm. The data voltage DATA is charged onto each storage capacitor C**41** through the switching transistors T**41** inside the respective pixels PXs, and is maintained for the subsequent data voltage emission period P**2**. The data voltage programming and emission operations for the other display panel regions **30**B-**30**K are subsequently performed in the same manner as the display panel region **30**A. Accordingly, the data voltage programming period and the lighting duration of the organic light emitting diode can be sufficiently obtained regardless of the size of the display panel **30**.

[0075] In the pixel driving method and apparatus for an organic light emitting device according to embodiments of the invention, in the data voltage programming period, a data voltage of a desired level can be precisely charged by charging the data voltage to the storage capacitor when the power supply voltage supplied to the organic light emitting diode is cut off. Also, in the data voltage emission period, the power supply to the OLED is started, thereby preventing a driving voltage of the driving transistor from changing. Accordingly, OLEDs having a non-uniform brightness can be prevented.

[0076] It will be apparent to those skilled in the art that various modifications and variations can be made in embodiments of the invention without departing from the spirit or scope of the invention. Thus, it is intended that embodiments of the invention cover the modifications and variations of this invention provided they come within the scope of the appended claims and their equivalents.

What is claimed is:

1. A pixel driving method for an organic light emitting device, comprising:
- charging a data voltage supplied through a data line to a storage capacitor and driving an N-channel switching transistor while cutting off supply of an upper power supply voltage to an organic light emitting diode; and
- powering the organic light emitting diode emit light by driving the N-channel driving transistor by the data voltage charged onto the storage capacitor while supplying the upper power supply voltage to the light emitting diode.

2. The method of claim **1**, wherein the N-channel switching transistor is driven by positive scan signals.

3. The method of claim **1**, wherein the storage capacitor is connected between a gate terminal of the N-channel driving transistor and a lower power supply voltage terminal.

4. The method of claim **3**, wherein the lower power supply voltage terminal is connected to a lower power supply voltage supply line having a mesh structure.

5. The method of claim **1**, wherein the storage capacitor is connected between a gate terminal and a source terminal of the N-channel driving transistor.

6. The method of claim **1**, wherein the organic light emitting diode has an anode connected to an upper power supply voltage terminal, and a cathode connected to a drain of the N-channel driving transistor.

7. The method of claim **1**, wherein the organic light emitting diode has an anode connected to a source terminal of the N-channel driving transistor, and a cathode connected to a lower power supply voltage terminal.

8. The method of claim **1**, wherein supply or cut off of the upper power supply voltage to the organic light emitting diode is controlled by a switching transistor connected between the organic light emitting diode and the driving transistor.

9. A pixel driving method for an organic light emitting device, comprising:
- charging a data voltage supplied through a data line to a storage capacitor and driving a P-channel switching transistor while cutting off supply of a lower power supply voltage to an organic light emitting diode; and
- powering the organic light emitting diode emit light by driving the P-channel driving transistor by the data voltage charged onto the storage capacitor while supplying the lower power supply voltage to the organic light emitting diode.

10. The method of claim **9**, wherein the P-channel switching transistor is driven by negative scan signals.

11. The method of claim **9**, wherein the storage capacitor is connected between a gate terminal of the P-channel driving transistor and an upper power supply voltage terminal.

12. The method of claim **9**, wherein the organic light emitting diode has an anode connected to a source terminal of the

P-channel driving transistor, and a cathode connected to a lower power supply voltage terminal.

13. The method of claim **9**, wherein supply or cut off of the lower power supply voltage to the organic light emitting diode is controlled by a switching transistor connected between the organic light emitting diode and the driving transistor.

14. A pixel driving method for an organic light emitting device, comprising:

dividing a display panel of the organic light emitting device into a number of display panel regions such that a plurality of adjacent scan lines can be included in each region;

providing pixels inside each of the plurality of display panel regions to share one lower power supply voltage among a plurality of lower power supply voltages supplied from a lower power supply voltage supply terminal by being diverged; and

determining a data voltage programming period and a data voltage emission period in one frame period according to an inverse of the number of display panel regions.

15. The method of claim **14**, wherein the plurality of lower power supply voltages is supplied by being diverged from one common point.

16. The method of claim **14**, wherein scan signals are sequentially supplied to the scan lines in one frame period.

17. The method of claim **14**, wherein the data voltage programming period is determined by dividing the one frame period by the number of the display panel regions.

18. The method of claim **14**, wherein the data voltage emission period corresponds to a period other than the data voltage programming period in one frame period.

19. A pixel driving apparatus for an organic light emitting device, comprising;

a first switching transistor for transmitting data voltages supplied through data lines to a storage capacitor by being driven by scan signals when an upper power supply voltage is cut off;

a storage capacitor for being charged by the data voltage when the upper power supply voltage is cut off by being connected between a gate terminal of a driving transistor and a lower power supply voltage terminal;

a driving transistor for supplying a driving current to an organic light emitting diode when the upper power supply voltage is supplied, the driving current corresponding to the data voltage charged onto the storage capacitor;

a second switching transistor turned OFF when scan signals are supplied and connected between the cathode of the organic light emitting diode and the drain of the driving transistor;

an organic light emitting diode for emitting light with a brightness corresponding to the driving current by having an anode connected to the upper power supply voltage and a cathode connected to a drain of the second switching transistor.

20. A pixel driving apparatus for an organic light emitting device, comprising:

a display panel having a plurality of display panel regions such that a plurality of adjacent scan lines can be included in each region;

a plurality of diverged lower power supply voltages; and

pixels inside each of the plurality of display panel regions share one lower power supply voltage among the plurality of lower power supply voltages.

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摘要(译)

一种用于有机发光装置的像素驱动方法，包括：将通过数据线提供的数据电压充电到存储电容器并驱动N沟道开关晶体管，同时切断向有机发光二极管提供上电源电压;并且通过在向发光二极管提供上电源电压的同时通过充电到存储电容器上的数据电压驱动N沟道驱动晶体管来为有机发光二极管供电。