US 20050200617A1

(19) United States
(12) Patent Application Publication (10) Pub. No.: US 2005/0200617 A1
Kwak et al. (43) Pub. Date: Sep. 15, 2005

(54) DISPLAY DEVICE AND DRIVING METHOD THEREOF

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(21) Appl. No.: **11/055,400**

(22) Filed: **Feb. 10, 2005**

(30) **Foreign Application Priority Data**

Mar. 15, 2004 (KR) 10-2004-0017309

Publication Classification

(51) **Int. Cl.**^{7} **G09G 3/28**

(52) **U.S. Cl.** **345/204**; 345/76

(57) **ABSTRACT**

Red, green, and blue organic electroluminescent (EL) elements formed on a pixel in an organic EL display are driven by a driving transistor. A capacitor is coupled between a gate and a source of the driving transistor to maintain a voltage for a predetermined time. Emission control transistors are coupled between the driving transistor and the red, green, and blue organic EL elements, respectively. One field is divided into three subfields, and one of the red, green and blue organic EL elements in each pixel starts to emit light in each subfield to thus represent a full color screen. The red, green and blue organic elements sequentially start to emit light in each subfield such that a color separation phenomenon caused by start emitting organic EL elements of one color during each subfield is reduced or eliminated.

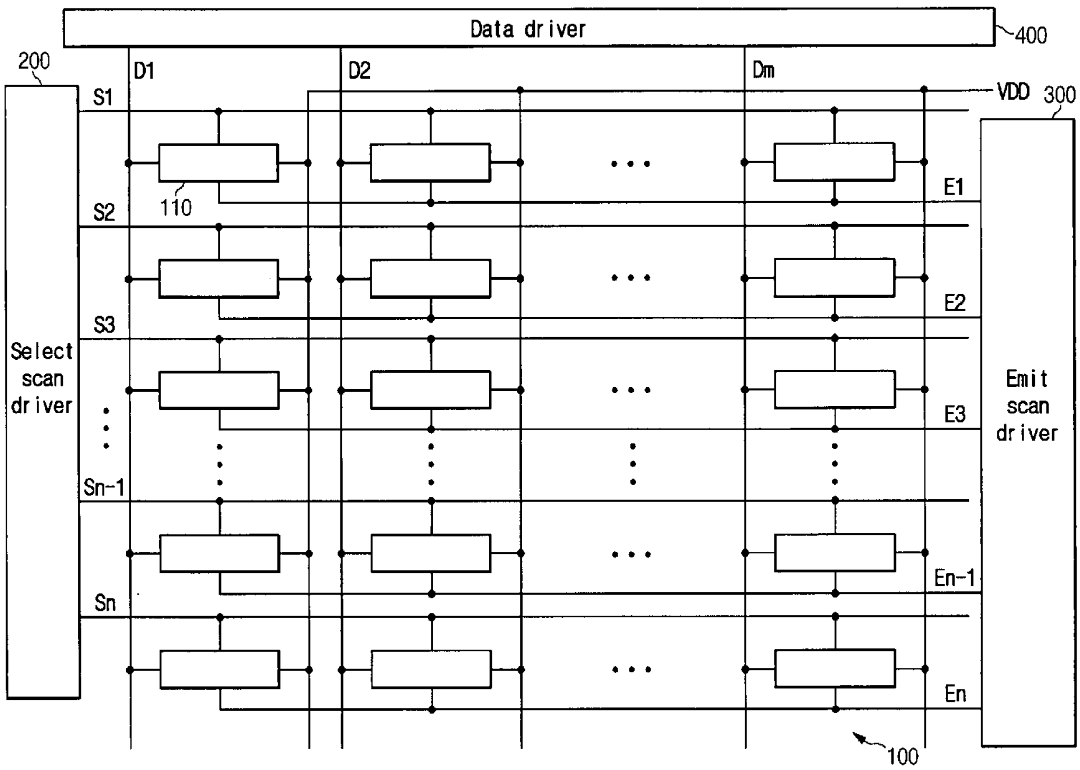


Fig. 1

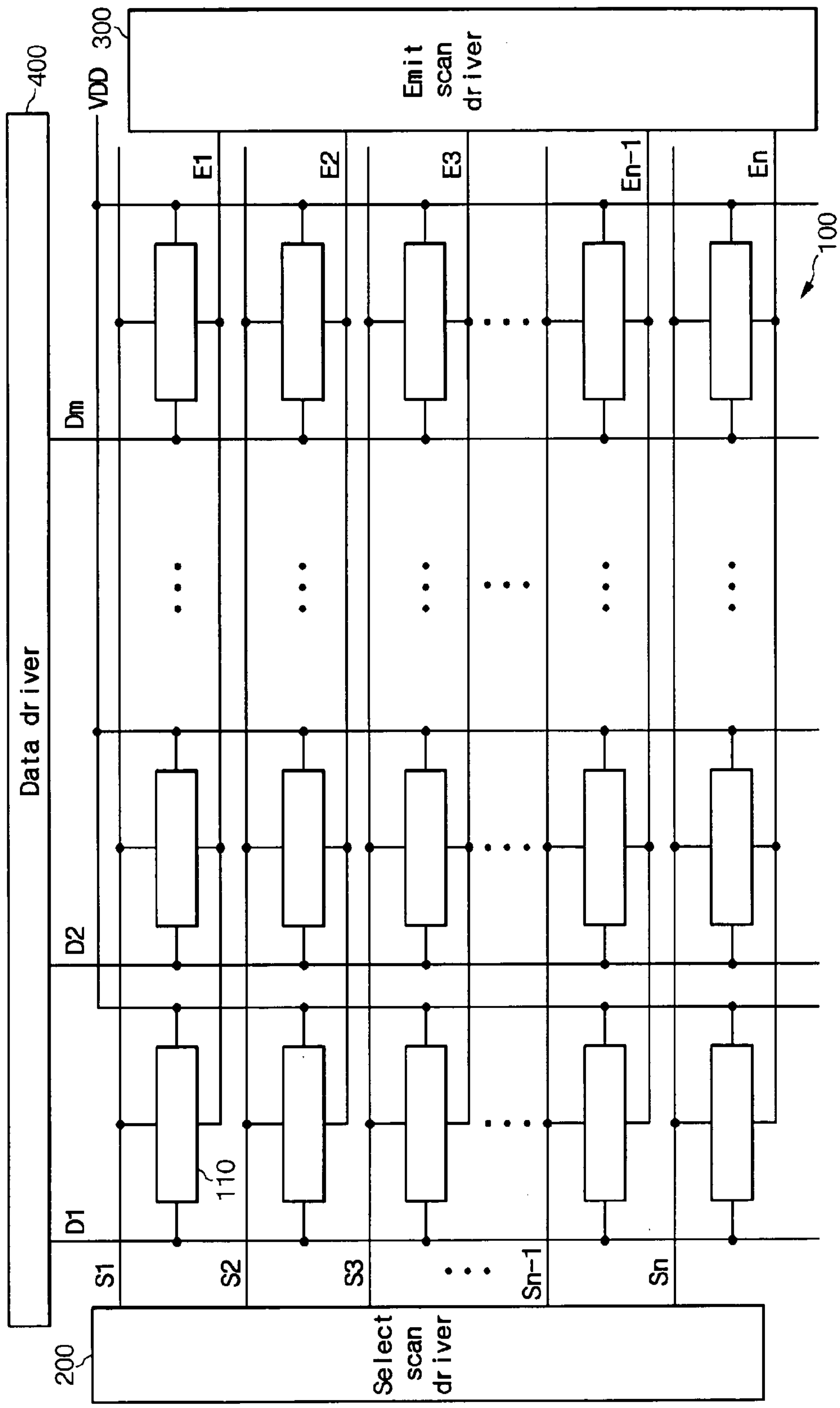

Data driver
400
VDD
300
Emit scan driver
E1
E2
E3
En-1
En
100
Dm
D2
D1
110
S1
S2
S3
Sn-1
Sn
200
Select scan driver

Fig. 2

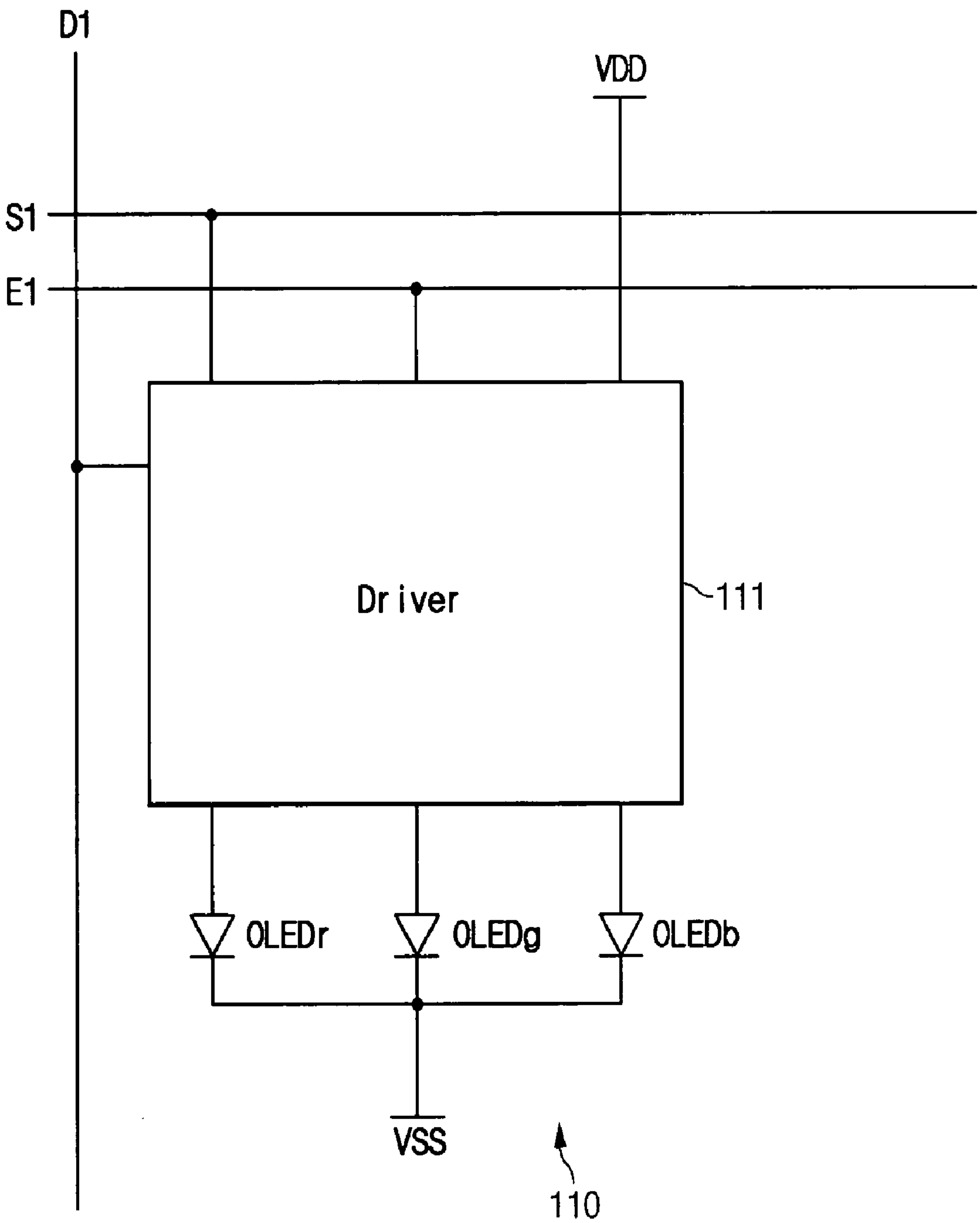


Fig. 3

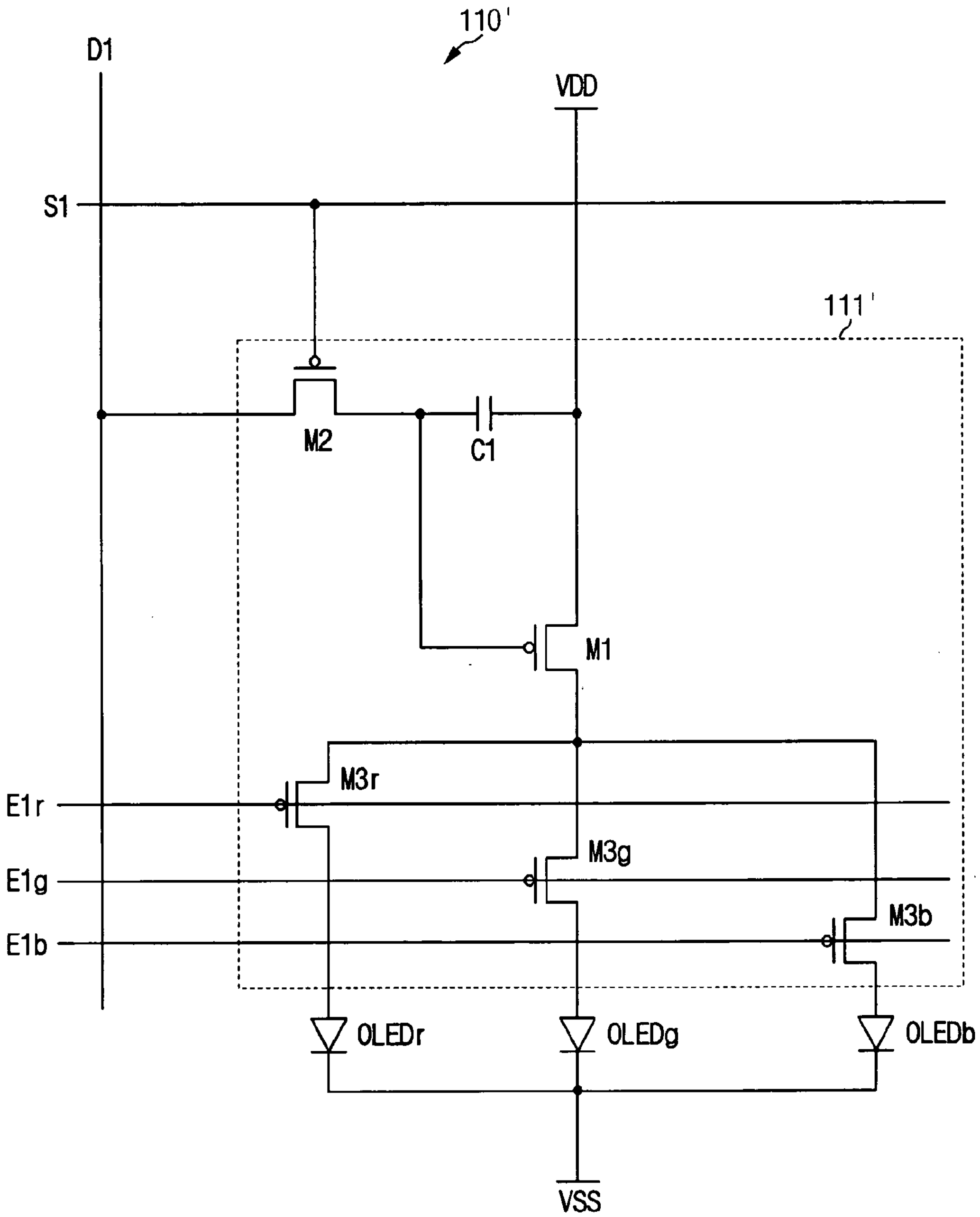

110'
D1
VDD
S1
111'
M2
C1
M1
E1r
M3r
E1g
M3g
E1b
M3b
OLEDr
OLEDg
OLEDb
VSS

Fig. 4

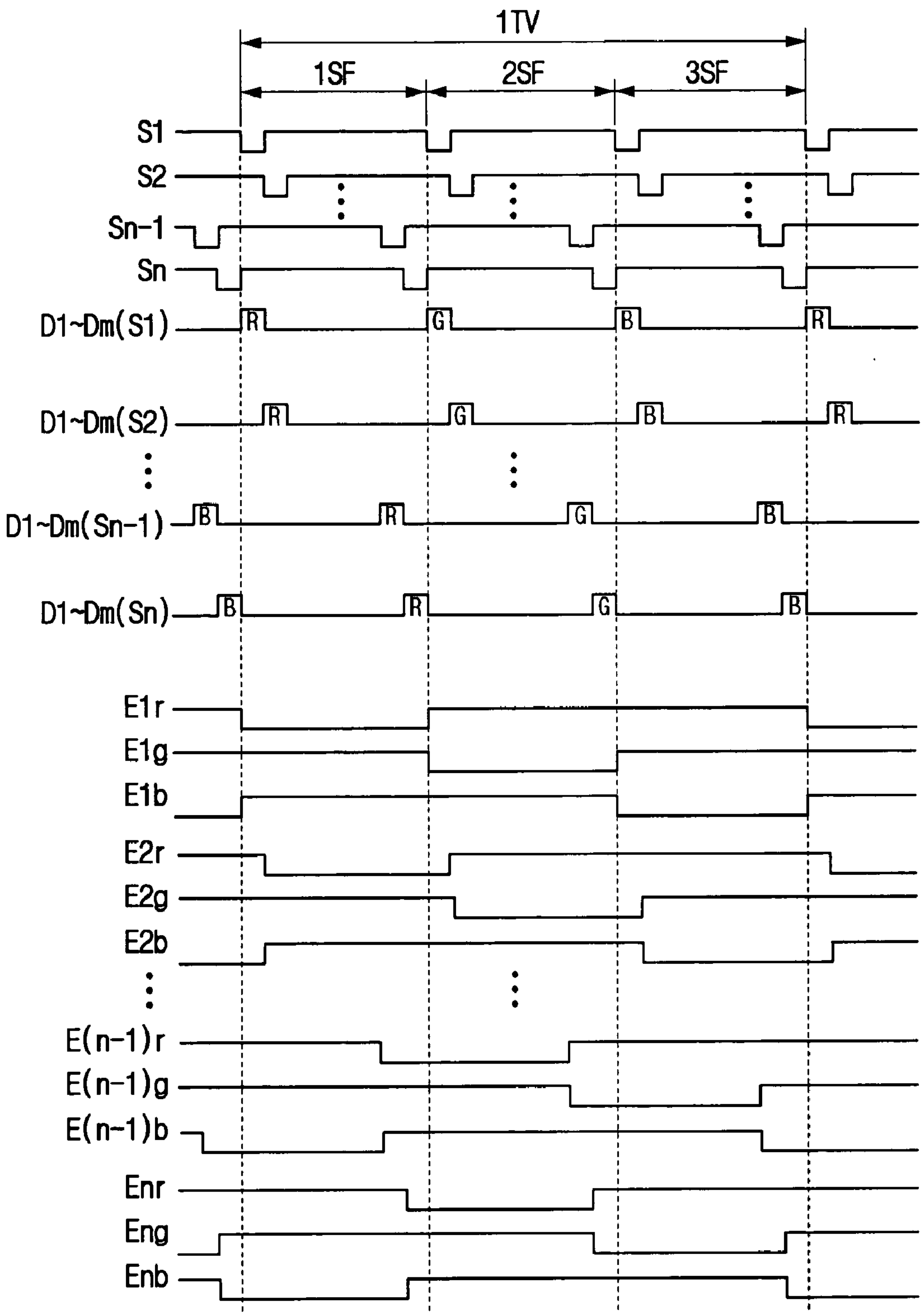

1TV
1SF
2SF
3SF
S1
S2
Sn-1
Sn
D1~Dm(S1)
D1~Dm(S2)
D1~Dm(Sn-1)
D1~Dm(Sn)
R
G
B
E1r
E1g
E1b
E2r
E2g
E2b
E(n-1)r
E(n-1)g
E(n-1)b
Enr
Eng
Enb

Fig. 5

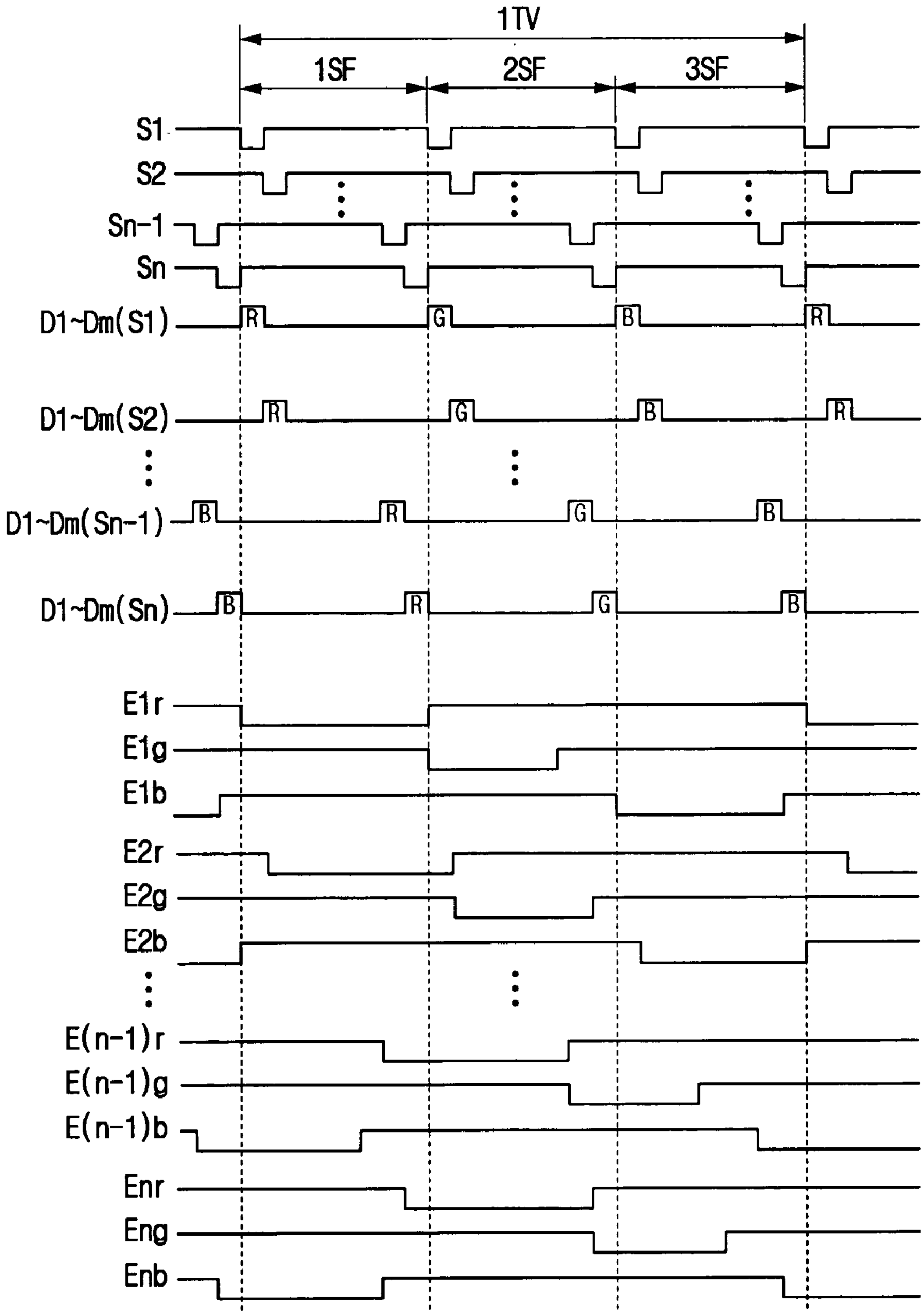

1TV
1SF
2SF
3SF
S1
S2
Sn-1
Sn
D1~Dm(S1)
R
G
B
R
D1~Dm(S2)
R
G
B
R
D1~Dm(Sn-1)
B
R
G
B
D1~Dm(Sn)
B
R
G
B
E1r
E1g
E1b
E2r
E2g
E2b
E(n-1)r
E(n-1)g
E(n-1)b
Enr
Eng
Enb

Fig. 6

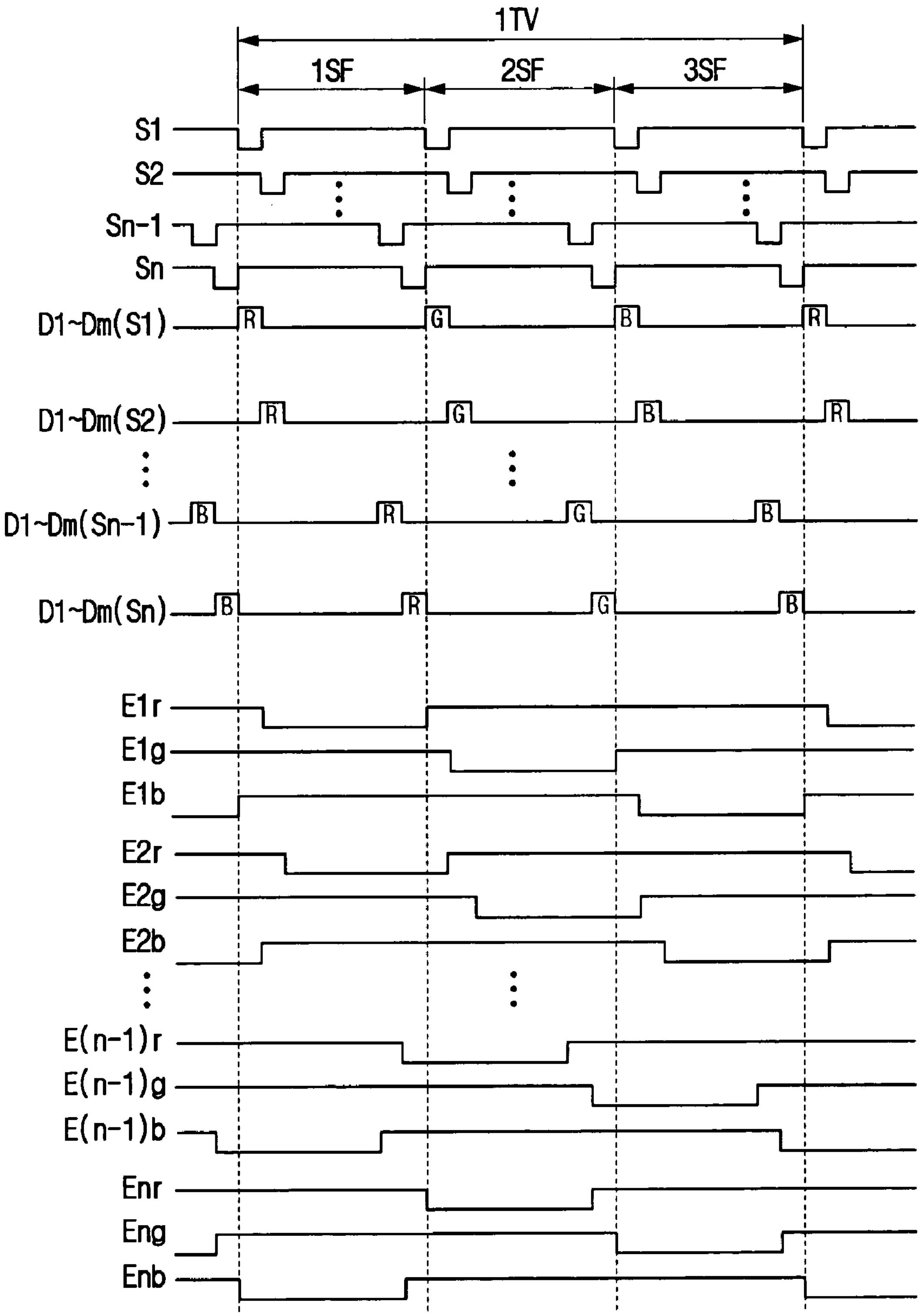

1TV
1SF
2SF
3SF
S1
S2
Sn-1
Sn
D1~Dm(S1)
D1~Dm(S2)
D1~Dm(Sn-1)
D1~Dm(Sn)
R
G
B
E1r
E1g
E1b
E2r
E2g
E2b
E(n-1)r
E(n-1)g
E(n-1)b
Enr
Eng
Enb

Fig. 7

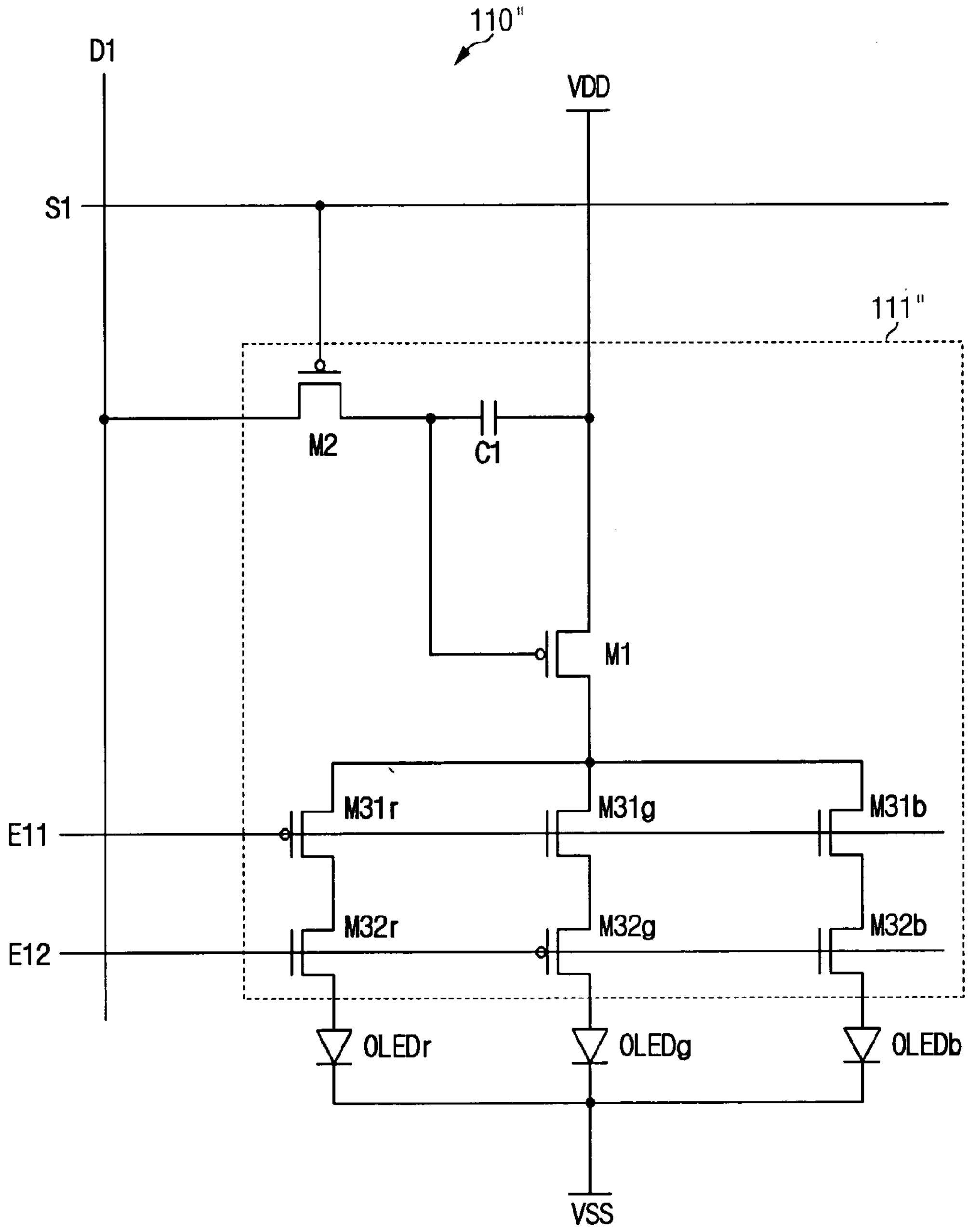

110"
D1
VDD
S1
111"
M2
C1
M1
M31r
M31g
M31b
E11
M32r
M32g
M32b
E12
OLEDr
OLEDg
OLEDb
VSS

Fig. 8

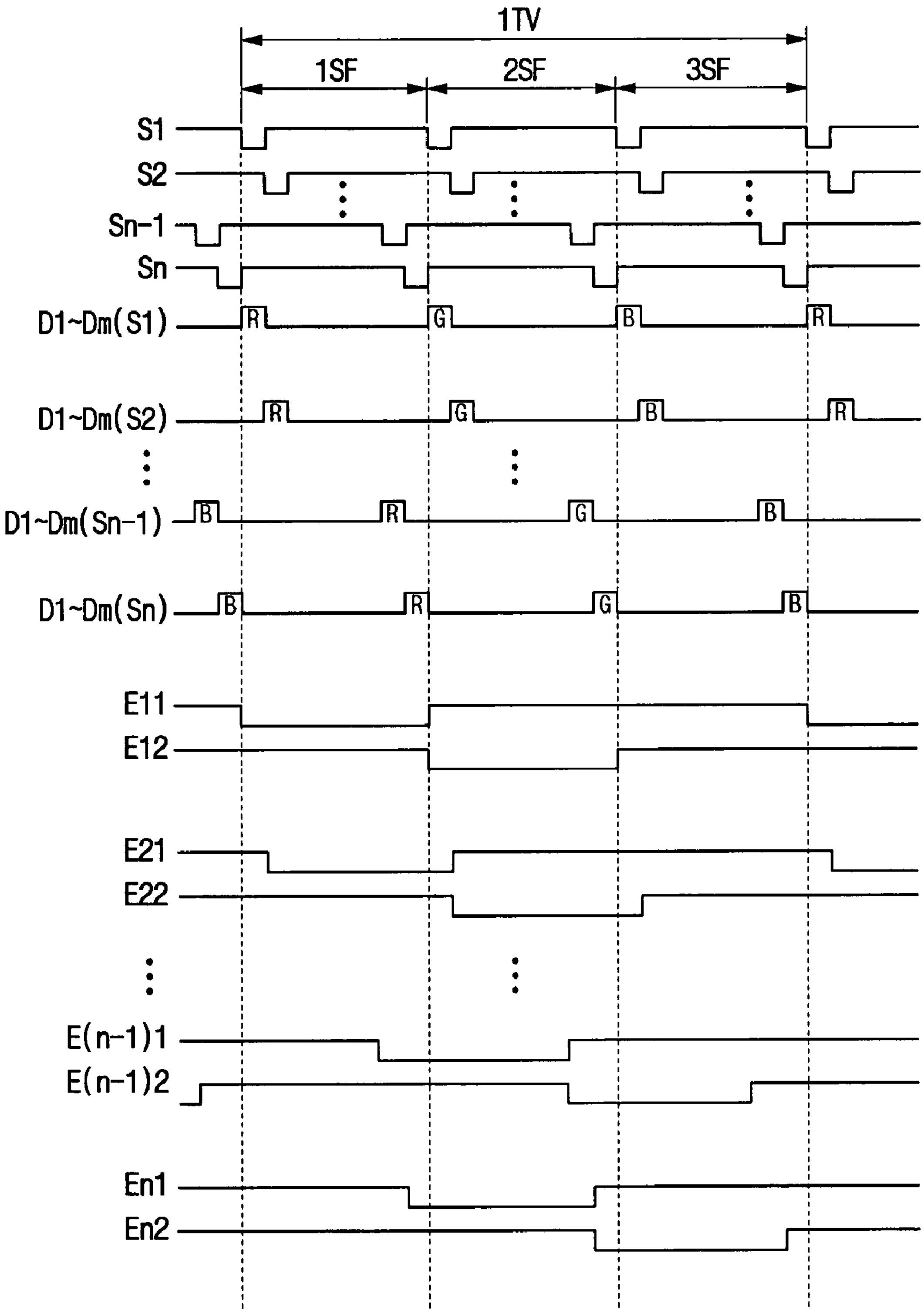
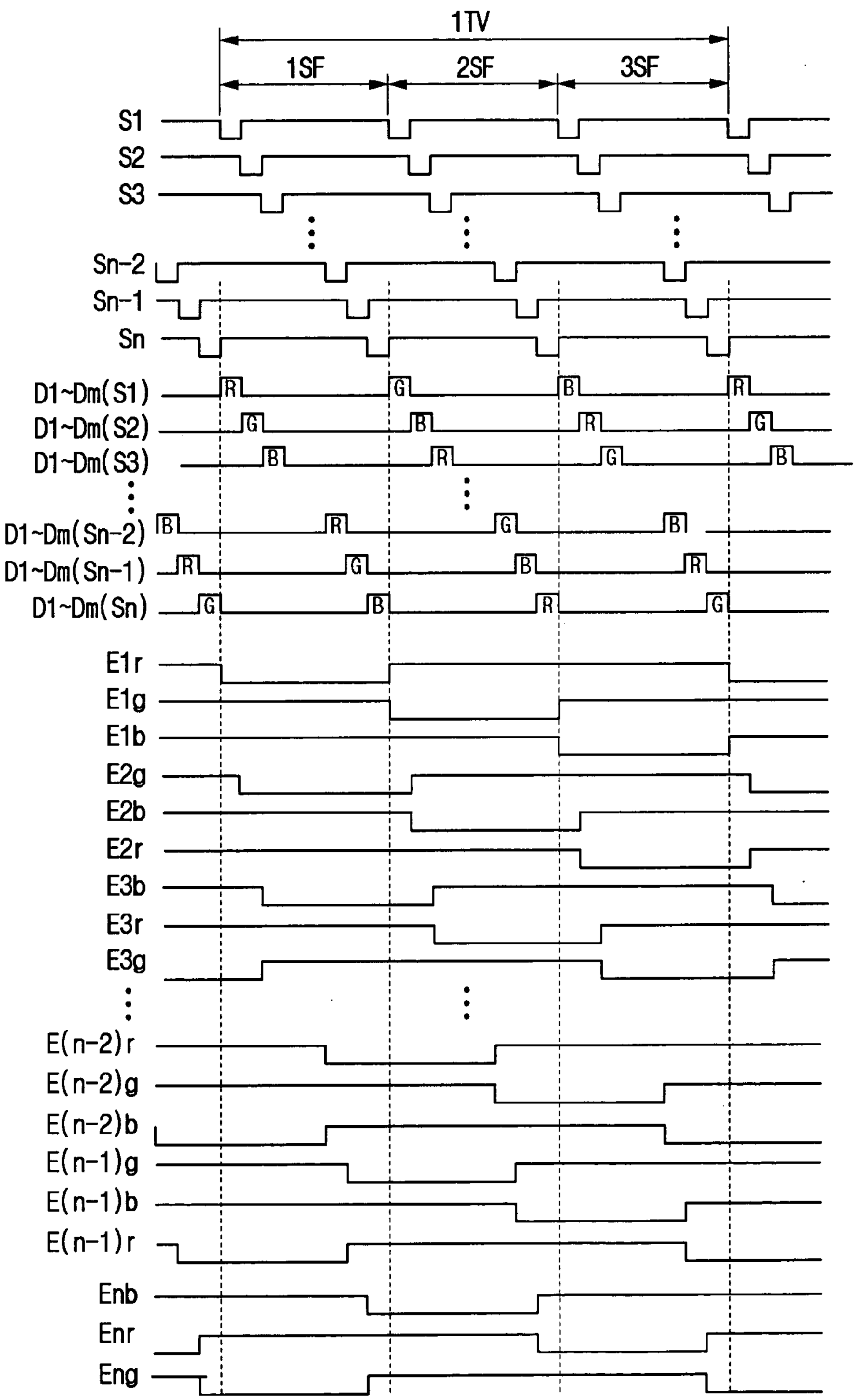

1TV
1SF
2SF
3SF
S1
S2
Sn-1
Sn
D1~Dm(S1)
D1~Dm(S2)
D1~Dm(Sn-1)
D1~Dm(Sn)
R
G
B
E11
E12
E21
E22
E(n-1)1
E(n-1)2
En1
En2

Fig. 9


1TV
1SF
2SF
3SF
S1
S2
S3
Sn-2
Sn-1
Sn
D1~Dm(S1)
D1~Dm(S2)
D1~Dm(S3)
D1~Dm(Sn-2)
D1~Dm(Sn-1)
D1~Dm(Sn)
R
G
B
E1r
E1g
E1b
E2g
E2b
E2r
E3b
E3r
E3g
E(n-2)r
E(n-2)g
E(n-2)b
E(n-1)g
E(n-1)b
E(n-1)r
Enb
Enr
Eng

DISPLAY DEVICE AND DRIVING METHOD THEREOF

CROSS REFERENCE TO RELATED APPLICATION

[0001] This application claims priority to and the benefit of Korea Patent Application No. 10-2004-0017309 filed on Mar. 15, 2004 in the Korean Intellectual Property Office, the entire content of which is incorporated herein by reference.

BACKGROUND OF THE INVENTION

[0002] (a) Field of the Invention

[0003] The present invention relates to a display device and a driving method thereof. More specifically, the present invention relates to an organic electroluminescent (EL) display using electroluminescence of organic matter, and a driving method thereof.

[0004] (b) Description of the Related Art

[0005] In general, an organic EL display is a display device for electrically exciting phosphorous organic compounds and emitting light. The organic EL display drives organic light emission cells arranged in a matrix format to represent images. An organic light emission cell having a diode characteristic is referred to as an organic light emission diode (OLED) and has a structure including an anode electrode layer, an organic thin film, and a cathode electrode layer. Holes and electrons injected through the anode electrode and the cathode electrode are combined on the organic thin film, and emit light. The organic light emission cell emits different amounts of light according to injected amounts of electrons and holes, that is, depending on the applied current.

[0006] In the organic EL display, a pixel includes a plurality of sub-pixels each of which has one of a plurality of colors (e.g., primary colors of light), and colors are represented through combinations of the colors emitted by the sub-pixels. In general, a pixel includes a sub-pixel for displaying red R, a sub-pixel for displaying green G, and a sub-pixel for displaying blue B, and the colors are displayed by combinations of red, green, and blue (RGB).

[0007] Each sub-pixel in the organic EL display includes a driving transistor for driving an organic EL element, a switching transistor, and a capacitor. Also, each sub-pixel has a data line for transmitting a data signal, and a power line for transmitting a power supply voltage VDD. Therefore, many wires are required for transmitting voltages or signals to the transistors and capacitor formed at each pixel. It is difficult to arrange such wires in the pixel, and the aperture ratio corresponding to a light emission area of the pixel is reduced.

SUMMARY OF THE INVENTION

[0008] In an exemplary embodiment of the present invention, is provided a display device in which the aperture ratio is improved.

[0009] In another exemplary embodiment of the present invention, is provided a display device for simplifying configurations and wiring of elements in the pixel.

[0010] In another exemplary embodiment of the present invention, a plurality of light emission elements in one pixel share a driver.

[0011] In one aspect of the present invention, is provided a display device including a plurality of rows of pixels for displaying an image during a field having a plurality of subfields, each of the pixels comprising a plurality of light emitting elements having different colors. A plurality of data lines apply data signals to the pixels for the light emitting elements to emit light, and a plurality of select lines coupled to the pixels apply a plurality of select signals to the pixels. Each of the select lines is coupled to a corresponding one of the rows of pixels to apply a corresponding one of the select signals thereto, wherein the select signals sequentially select the rows of pixels during each of the plurality of subfields. The data signals are applied to the pixels for the light emitting elements having different colors to sequentially start emitting different color lights during each of the plurality of subfields.

[0012] In one aspect of the present invention, is provided a display device including a plurality of scan lines, a plurality of data lines, and a plurality of pixel circuits. The scan lines include a first scan line for applying a first signal and a second scan line for applying a second signal at a time different from that of applying the first signal. The data lines apply a data signal for displaying an image during a field having a plurality of subfields. The pixel circuits include a first pixel circuit coupled to the first scan line and one of the data lines and a second pixel circuit coupled to the second scan line and one of the data lines. Each of the pixel circuits includes: at least two emit elements, a switching transistor, a capacitor, and a driving transistor. The emit elements emit light having different colors, wherein each of the emit elements emits light responsive to an applied current. The switching transistor applies the data signal in response to the first signal or the second signal at least once for each of the subfields. The capacitor stores a voltage which corresponds to the data signal applied by the switching transistor. The driving transistor outputs an applied current which corresponds to the voltage stored in the capacitor. One of the emit elements having a color different from a first color starts emitting light in the second pixel circuit after one of the emit elements having the first color starts emitting light in the first pixel circuit in a first one of the subfields, and one of the emit elements having a color different from a second color starts emitting light in the second pixel circuit after one of the emit elements having the second color starts emitting light in the first pixel circuit in a second one of the subfields.

[0013] Each of the pixel circuits may further include at least two emitting transistors coupled between the driving transistor and the at least two emit elements, and one of the emit elements having one color from among the two emit elements emits light according to an operation of the emitting transistors.

[0014] The emit elements may include an emit element of the first color, an emit element of the second color, and an emit element of a third color. Each of the pixel circuits may further include a first emitting transistor coupled between the driving transistor and the emit element of the first color, a second emitting transistor coupled between the driving transistor and the emit element of the second color, and a third emitting transistor coupled between the driving transistor and the emit element of the third color.

[0015] The emit element of the second color of the second pixel circuit may start emitting light in the first one of the subfields, and the emit element of the third color of the second pixel circuit may start emitting light in the second one of the subfields.

[0016] A third scan line among the scan lines may apply a third signal at a timing which is different from timing of applying the first and second signals. The third pixel circuit having an emit element of the first color, an emit element of the second color and an emit element of the third color may be coupled to the third scan line and one of the data lines. The emit elements of the third color, the first color, and the second color of the third pixel circuit may start emitting light in the first subfield, the second subfield, and the third subfield, respectively.

[0017] One of the emit elements may emit light for a period which is shorter than or equal to a period which corresponds to a corresponding one of the subfields after the one of the emit elements starts emitting light.

[0018] The emit elements may emit light at least once during one field. The emit elements of the same color may emit light during a predetermined period in a plurality of pixel circuits coupled to the same one of the scan lines.

[0019] In another aspect of the present invention, is provided a display device including a plurality of scan lines for applying select signals, a plurality of data lines for applying data signals for displaying an image during a field having a plurality of subfields, and a plurality of pixel circuits coupled to the scan lines and data lines. Each of the pixel circuits includes: at least two emit elements, a switching transistor, a capacitor, a driving transistor, and a switch. The emit elements emit light having different colors, wherein each of the emit elements emits light responsive to an applied current. The switching transistor applies one of the data signals which corresponds to one of the emit elements in response to one of the select signals at least once for each of the subfields. The capacitor stores a voltage which corresponds to the one of the data signals applied by the switching transistor. The driving transistor outputs the applied current which corresponds to the voltage stored in the capacitor. The switch selectively outputs the applied current provided by the driving transistor to one of the emit elements of a color corresponding to the one of the data signals. One of the data signals corresponding to one of the emit elements of a first color is applied to one of the data lines when one of the select signals is applied to a scan line of a first group including at least one of the scan lines, and one of the data signals corresponding to one of the emit elements of a second color is applied to the one of the data lines when one of the select signals is applied to a scan line of a second group including at least one of the scan lines in a first one of the subfields.

[0020] In still another aspect of the present invention, is provided a method of driving during a field having a plurality of subfields in a display device including a plurality of pixel circuits arranged in rows, wherein each of the pixel circuits includes at least two emit elements for emitting light of different colors responsive to an applied current, and a transistor coupled to the emit elements supplies the applied current to one of the emit elements through at least one switch. The method includes: start emitting one of the emit elements of a first color on one of the pixel circuits provided on a row of a first group including at least one of the rows during a first one of the subfields, and start emitting one of the emit elements of a second color in one of the pixel circuits provided on a row of a second group including at least one of the rows during the first one of the subfields.

[0021] The method may further include: start emitting one of the emit elements of a color different from the first color in one of the pixel circuits provided on a row of the first group during a second one of the subfields, and start emitting one of the emit elements of a color different from the second color in one of the pixel circuits provided on a row of the second group during the second one of the subfields.

[0022] In the method, one of the emit elements of a third color may start emitting in one of the pixel circuits provided on a row of a third group including at least one of the rows during the first one of the subfields, and one of the emit elements of a color different from the third color in one of the pixel circuits provided on a row of the third group may start emitting during the second one of the subfields.

[0023] In the method, one of the emit elements of the third color in one of the pixel circuits provided on a row of the first group may start emitting during a third one of the subfields, one of the emit elements of the first color in one of the pixel circuits provided on a row of the second group may start emitting during the third one of the subfields, and one of the emit elements of the second color in one of the pixel circuits provided on a row of the third group may start emitting during the third one of the subfields.

BRIEF DESCRIPTION OF THE DRAWINGS

[0024] The accompanying drawings illustrate exemplary embodiments of the present invention, and, together with the description, serve to explain the principles of the invention:

[0025] **FIG. 1** shows a plan view of an organic EL display used to implement exemplary embodiments of the present invention;

[0026] **FIG. 2** shows a conceptual diagram of a pixel in the organic EL display of **FIG. 1**;

[0027] **FIG. 3** shows a circuit diagram of a pixel in an organic EL display according to a first exemplary embodiment of the present invention;

[0028] **FIG. 4** shows a signal timing diagram of an organic EL display according to the first exemplary embodiment of the present invention;

[0029] **FIGS. 5 and 6** show signal timing diagrams of an organic EL display according to second and third exemplary embodiments of the present invention;

[0030] **FIG. 7** shows a circuit diagram of a pixel in an organic EL display according to a fourth exemplary embodiment of the present invention;

[0031] **FIG. 8** shows a signal timing diagram of the organic EL display according to the fourth exemplary embodiment of the present invention; and

[0032] **FIG. 9** shows a signal timing diagram of an organic EL display according to a fifth exemplary embodiment of the present invention.

DETAILED DESCRIPTION

[0033] In the following detailed description, only certain exemplary embodiments of the present invention are shown and described, simply by way of illustration. As those skilled in the art would realize, the described embodiments may be modified in various different ways, all without departing from the spirit or scope of the present invention. Accordingly, the drawings and description are to be regarded as illustrative in nature, and not restrictive. There may be parts shown in the drawings, or parts not shown in the drawings, that are not discussed in the specification as they are not essential to a complete understanding of the invention. Like reference numerals designate like elements.

[0034] A light emission display and driving method according to exemplary embodiments of the present invention will be described in detail with reference to drawings, and an organic EL display will be exemplified and described in the exemplary embodiments.

[0035] **FIG. 1** shows a plan view of an organic EL display used to implement exemplary embodiments of the present invention, and **FIG. 2** shows a conceptual diagram of a pixel in the organic EL display of **FIG. 1**.

[0036] As shown in **FIG. 1**, the organic EL display includes a display **100**, a select scan driver **200**, an emit scan driver **300**, and a data driver **400**. The display **100** includes a plurality of scan lines S1 to Sn and E1 to En arranged in the row direction, and a plurality of data lines D1 to Dm, a plurality of power lines VDD, and a plurality of pixels **110** respectively arranged in the column direction. The pixels are formed at pixel areas formed by two adjacent ones of the scan lines S1 to Sn and two adjacent ones of the data lines D1 to Dm. Referring to **FIG. 2**, the pixel **110** includes organic EL elements OLEDr, OLEDg, and OLEDb for emitting red, green, and blue lights, respectively, and a driver **111** on which elements for driving the organic EL elements OLEDr, OLEDg, and OLEDb are formed. The organic EL elements emit light having brightness corresponding to the applied current.

[0037] The select scan driver **200** sequentially transmits select signals for selecting corresponding lines to the select scan lines S1 to Sn in order to apply data signals to pixels of the corresponding lines, the emit scan driver **300** sequentially transmits emit signals for controlling light emission of the organic EL elements OLEDr, OLEDg, and OLEDb to the emit scan lines E1 to En, and the data driver **400** applies data signals corresponding to the pixels of lines to which select signals are applied to the data lines D1 to Dm each time the select signals are sequentially applied.

[0038] The select and emit scan drivers **200** and **300** and the data driver **400** are coupled to a substrate on which the display **100** is formed. In addition, the select and emit scan drivers **200** and **300** and/or the data driver **400** can be installed directly on the substrate of the display **100**, and they can be substituted with a driving circuit which is formed on the same layer on the substrate of the display **100** as the layer on which scan lines, data lines, and transistors are formed. Further, the select and emit scan drivers **200** and **300** and/or the data driver **400** can be installed in a chip format on a tape carrier package (TCP), a flexible printed circuit (FPC), or a tape automatic bonding unit (TAB) coupled to the select and emit scan drivers **200** and **300** and/or the data driver **400**.

[0039] One field is divided into three subfields and then driven, and red, green, and blue data are written on the three subfields to emit light in the first exemplary embodiment. For this purpose, the select scan driver **200** sequentially transmits select signals to the select scan lines S1 to Sn for each subfield, the emit scan driver **300** applies emit signals to the emit scan lines E1 to En so that the organic EL element for each color may emit light in a subfield, and the data driver **400** applies data signals respectively corresponding to the red, green, and blue organic EL elements to the data lines D1 to Dm.

[0040] A detailed operation of the organic EL display according to a first exemplary embodiment will be described with reference to **FIGS. 3 and 4**.

[0041] **FIG. 3** shows a circuit diagram of a pixel **110'** in the organic EL display according to the first exemplary embodiment of the present invention, and **FIG. 4** shows a signal timing diagram of the organic EL display according to the first exemplary embodiment of the present invention. The pixel **110'**, for example, can be used as the pixel **110** of **FIGS. 1 and 2**. In detail, **FIG. 3** shows a voltage programmed pixel coupled to the select scan line S1 of the first row and the data line D1 of the first column. The pixel **110'** includes p-channel transistors. No other pixels will be described in reference to the first exemplary embodiment since the pixels of first exemplary embodiment have substantially the same structure as that shown in **FIG. 3**.

[0042] As shown in **FIG. 3**, the pixel circuit **110'** according to the first exemplary embodiment includes a driver **111'** and organic EL elements OLEDr, OLEDg, and OLEDb. The driver **111'** includes a driving transistor M1, a switching transistor M2, and emitting transistors M3*r,* M3*g,* and M3*b* for controlling light emission of the organic EL elements OLEDr, OLEDg, and OLEDb. One emit scan line E1 includes three emit signal lines E1*r,* E1*g,* and E1*b,* and while not illustrated in **FIG. 3**, other emit scan lines E2 to En respectively include three emit signal lines E2*r* to En*r,* E2*g* to Eng, and E2*b* to Enb. The emitting transistors M3*r,* M3*b,* and M3*b* and the emit signal lines E1*r,* E1*g,* and E1*b* form a switch for selectively transmitting the current provided by the driving transistor M1 to the organic EL elements OLEDr, OLEDg, and OLEDb.

[0043] In detail, the switching transistor M2 having a gate coupled to the select scan line S1 and a source coupled to the data line D1 transmits the data voltage provided by the data line D1 in response to the select signal provided by the select scan line S1. The driving transistor has a source coupled to the power line VDD for supplying a power supply voltage, and has a gate coupled to a drain of the switching transistor M2, and a capacitor C1 is coupled between a source and a gate of the driving transistor M1. The driving transistor M1 has a drain coupled to sources of the emit transistors M3*r,* M3*g,* and M3*b,* and gates of the emit transistors M3*r,* M3*g,* and M3*b* are coupled to the emit signal lines E1*r,* E1*g,* and E1*b,* respectively. Drains of the emit transistors M3*r,* M3*g,* and M3*b* are coupled, respectively, to anodes of the organic EL elements OLEDr, OLEDg, and OLEDb, and a power supply voltage VSS is applied to cathodes of the organic EL elements OLEDr, OLEDg, and OLEDb. The power supply voltage VSS in the first exemplary embodiment can be a negative voltage or a ground voltage.

[0044] The switching transistor M2 transmits the data voltage provided by the data line D1 to the gate of the driving transistor M1 in response to a low-level select signal provided by the select scan line **S1**, and the voltage which corresponds to a difference between the data voltage transmitted to the gate of the transistor **M1** and the power supply voltage VDD is stored in the capacitor **C1**. When the emitting transistor **M3***r* is turned on in response to a low-level emit signal provided by the emit signal line E**1***r*, the current which corresponds to the voltage stored in the capacitor C**1** is transmitted to the red organic EL element OLEDr from the driving transistor **M1** to emit light. In a like manner, when the emitting transistor **M3***g* is turned on in response to a low-level emit signal provided by the emit signal line E**1***g*, the current which corresponds to the voltage stored in the capacitor C**1** is transmitted to the green organic EL element OLEDg from the driving transistor **M1** to emit light. Further, when the emitting transistor **M3***b* is turned on in response to a low-level emit signal provided by the emit signal line E**1***b*, the current which corresponds to the voltage stored in the capacitor C**1** is transmitted to the blue organic EL element OLEDb from the driving transistor **M1** to emit light. Three emit signals applied to the three emit signal lines respectively have low-level periods without repetition during one field so that one pixel can display red, green, and blue.

[0045] An organic EL display driving method will be described in detail with reference to **FIG. 4**. Referring to **FIG. 4**, one field **1**TV includes three subfields **1**SF, **2**SF, and **3**SF, and signals for driving the red, green, and blue organic EL elements are applied to the subfields **1**SF, **2**SF, and **3**SF, periods of which are the same.

[0046] In the subfield **1**SF, when a low-level select signal is applied to the select scan line **S1** on the first row, data voltages of R corresponding to red of the pixels on the first row are applied, respectively, to the data lines D**1** to Dm, and a low-level emit signal is applied to the emit signal line E**1***r* on the first row. The corresponding one of the data voltages of R is applied to the capacitor C**1** through the switching transistor **M2** of each pixel on the first row, and a voltage corresponding to the corresponding one of the data voltages of R is charged in the capacitor C**1**. The emitting transistor **M3***r* of the pixel on the first row is turned on, and a current corresponding to a gate-source voltage stored in the capacitor C**1** is transmitted to the red organic EL element OLEDr from the driving transistor **M1** to thus emit light.

[0047] Next, when a low-level select signal is applied to the select scan line **S2** on the second row, the data voltages of R corresponding to the red of pixels of the second row are applied, respectively, to the data lines D**1** to Dm, a low-level emit signal is applied to the emit signal line E**2***r* of the second row, and a current corresponding to the corresponding one of the data voltages of R provided by a corresponding one of the data lines D**1** to Dm is supplied to the red organic EL element OLEDg of each pixel on the second row to thus emit light.

[0048] Then the data voltages are sequentially applied to pixels of from the third to (n-1)th rows to emit the red organic EL element OLEDr. When a low-level select signal is applied to the select scan line Sn on the nth row, the data voltages of R corresponding to the red of the pixels of the nth row are applied to the data lines D**1** to Dm, and a low-level emit signal is applied to the emit signal line Enr of the nth row. A current corresponding to a corresponding one of the data voltages of R provided by the data lines D**1** to Dm is accordingly supplied to the red organic EL element OLEDr of each pixel on the nth row to thus emit light.

[0049] As a result, the data voltages of R corresponding to red are applied to the respective pixels formed on the display panel **100** during the subfield **1**SF. The emit signals applied to the emit signal lines E**1***r* to Enr are maintained at the low level for a predetermined time, and the organic EL element OLEDr coupled to the emitting transistor **M3***r* to which the corresponding emit signal is applied during the emit signal is at the low level consecutively emits light. This period is illustrated to correspond to the subfield **1**SF in **FIG. 4**. That is, the red organic EL element OLEDr for each pixel emits light with brightness which corresponds to the data voltage applied during the period which corresponds to the subfield.

[0050] In the subfield **2**SF, in a like manner as the subfield **1**SF, a low-level select signal is sequentially applied to the select scan lines **S1** to Sn of from the first to the nth rows, and when the select signal is applied to the respective select scan lines **S1** to Sn, data voltages of G corresponding to green of pixels of the corresponding rows are applied, respectively, to the data lines D**1** to Dm. A low-level emit signal is sequentially applied to the emit signal line E**1***g* to Eng in synchronization with sequentially applying the low-level select signal to the select scan lines **S1** to Sn. A current corresponding to the applied data voltage is transmitted to the green organic EL element OLEDg through the emitting transistor **M3***g* in each pixel to emit light.

[0051] In the subfield **3**SF, in a like manner as the subfield **2**SF, a low-level select signal is sequentially applied to the select scan lines **S1** to Sn of from the first to the nth rows, and when the select signal is applied to the respective select scan lines **S1** to Sn, data voltages of B corresponding to blue of pixels of the corresponding rows are applied, respectively, to the data lines D**1** to Dm. A low-level emit signal is sequentially applied to the emit signal lines E**1***b* to Enb in synchronization with sequentially applying the low-level select signal to the select scan lines **S1** to Sn. A current corresponding to the applied data voltage of B is transmitted to the blue organic EL element OLEDb through the emitting transistor **M3***b* in each pixel to emit light.

[0052] As described above, one field is divided into three subfields, and the subfields are sequentially driven in the organic EL display driving method according to the first exemplary embodiment. One color organic EL element of one pixel in each subfield emits light, and the organic EL elements of three colors (red, green, and blue) sequentially emit light through three subfields to thus represent colors.

[0053] The signal timing diagram of **FIG. 4** illustrates that the organic EL display is driven from the single scan method to the progressive scan method. In addition, the organic EL display can be driven using a dual scan method, an interlaced scan method, and other scan methods without being restricted to them.

[0054] Also, the red, green, and blue organic EL elements have been described to emit light during the same period according to the first exemplary embodiment, but the white balance can be incorrect because of different efficiency of the organic EL elements of respective colors when they emit light during the same period. In this case, the emit periods of the organic EL elements of respective colors are to be modified, which will be described with reference to **FIG. 5**.

[0055] FIG. 5 shows a signal timing diagram of the organic EL display according to a second exemplary embodiment of the present invention.

[0056] As shown in FIG. 5 differing from FIG. 4, low-level periods of emit signals applied to the emit signal lines E1*r* to Enr corresponding to red, emit signals applied to the emit signal lines E1*g* to Eng corresponding to green, and emit signals applied to the emit signal lines E1*b* to Enb corresponding to blue are different from each other. As described above, the emit periods of the organic EL elements depend on low-level periods of the emit signals applied to the gates of the emitting transistors M3*r*, M3*g*, and M3*b* coupled to the corresponding organic EL elements, and hence, emit times of the respective organic EL elements can be varied by providing different low-level periods of emit signals.

[0057] For example in FIG. 5, low-level periods of emit signals applied to the emit signal lines E1*r* to Enr coupled to the gate of the transistor M3*r* coupled to the red organic EL element OLEDr are established to be the longest, and low-level periods of emit signals applied to the emit signal lines E1*b* to Enb coupled to the gate of the transistor M3*b* coupled to the blue organic EL element OLEDb are established to be the shortest. An emit time of the red organic EL element OLEDr is lengthened, and an emit time of the blue organic EL element OLEDb is shortened. The white balance is controlled well through the above-noted process when the emit efficiency of the red organic EL element OLEDr is the worst and the emit efficiency of the blue organic EL element OLEDb is the best.

[0058] The colors are controlled to emit light in the order of red, green, and blue in FIGS. 4 and 5, and they can emit light in other orders. Also, it is possible to divide a field into four subfields rather than three subfields and control the fourth subfield to drive an organic EL element of one color to emit light, or drive organic EL elements of two or more colors concurrently. Further, it is possible to add an organic EL element for displaying white in addition to the three organic EL elements, and either drive the white organic EL element during a subfield or drive four-color organic EL elements respectively during four subfields.

[0059] Also, referring to FIGS. 4 and 5, the select signal has been illustrated to be low-level and the emit signal has been illustrated to be concurrently low-level in one pixel. Alternatively, the emit signal can be low-level after the select signal is switched to high-level from low-level. That is, referring to FIG. 6, the select signal becomes high-level and the emit signal applied to the emit signal lines E1*r*, E1*g*, and E1*b* becomes low-level after the select signal applied to the select scan line S1 changes from low-level to high-level and a voltage which corresponds to the data voltage provided by the data lines D1 to Dm is programmed to the capacitor C1 of each pixel according to the third exemplary embodiment. As a result, the organic EL elements are prevented from emitting light while the data are programmed.

[0060] P-channel transistors have been applied to the pixels according to the first to third exemplary embodiments, and n-channel transistors, combinations of p-channel and n-channel transistors, and other switches having similar functions as the p-channel and n-channel transistors can also be used in addition to the p-channel transistors.

[0061] The emitting transistors M3*r*, M3*g*, and M3*b* have been driven by individual emit signal lines in the first to third exemplary embodiments. That is, three emit signal lines have been used for each pixel. Differing from this, all three of the pixels can be driven using only two emit signal lines, which will now be described with reference to FIGS. 7 and 8.

[0062] FIG. 7 shows a circuit diagram of a pixel 110" in the organic EL display according to a fourth exemplary embodiment of the present invention, and FIG. 8 shows a signal timing diagram of the organic EL display according to the fourth exemplary embodiment of the present invention. In detail, FIG. 7 illustrates a voltage programming pixel 110" coupled to the select scan line S1 of the first row and the data line D1 of the first column. The pixel 110", for example, can be used as the pixel 110 of FIGS. 1 and 2.

[0063] Referring to FIG. 7, differing from the pixel circuit of FIG. 3, the pixel circuit according to the fourth exemplary embodiment has two emitting transistors for each color's organic EL element, and the emitting transistors are driven by two emit signal lines. An emit scan line E1 includes two emit signal lines E11 and E12, and other emit scan lines E2 to En have two emit signal lines E21 to En1 and E22 to En2, respectively.

[0064] In detail, a p-channel emitting transistor M31*r* and an n-channel emitting transistor M32*r* are coupled in series between a drain of the driving transistor M1 and a red organic EL element OLEDr, an n-channel emitting transistor M31*g* and a p-channel emitting transistor M32*g* are coupled in series between the drain of the driving transistor M1 and a green organic EL element OLEDg, and n-channel emitting transistors M31*b* and M32*b* are coupled in series between the drain of the driving transistor M1 and a blue organic EL element OLEDb. Gates of the emitting transistors M31*r*, M31*g*, and M31*b* are coupled in common to the emit signal line E11, and gates of the emitting transistors M32*r*, M32*g*, and M32*b* are coupled in common to the emit signal line E12.

[0065] Accordingly, the current is supplied to the red organic EL element OLEDr when an emit signal applied to the emit signal line E11 is low-level and an emit signal applied to the emit signal line E12 is high-level, the current is supplied to the green organic EL element OLEDg when an emit signal applied to the emit signal line E11 is high-level and an emit signal applied to the emit signal line E12 is low-level, and the current is supplied to the blue organic EL element OLEDb when both the emit signals applied to the emit signal lines E11 and E12 are high-level. That is, when the emit signals are supplied in the three subfields according to the above-described method, the red, green, and blue organic EL elements are sequentially driven with two emit signals according to the signal timing of FIG. 8.

[0066] An organic EL display driving method according to the fourth exemplary embodiment of the present invention will be described with reference to FIG. 8. One field (1TV) includes three subfields 1SF, 2SF, and 3SF, and signals for driving red, green, and blue organic EL elements of each pixel are applied to the subfields 1SF, 2SF, and 3SF in a like manner as FIG. 4.

[0067] Referring to FIG. 8, emit signals applied to the emit signal lines E11 to En1 have the same timing as that applied to the emit signal lines E1*r* to Enr of **FIG. 4**, and emit signals applied to the emit signal lines E12 to En2 have the same timing as that applied to the emit signal lines E1*g* to Eng of **FIG. 4**.

[**0068**] In the subfield **1**SF, since the emit signal applied to the emit signal line E11 is low-level and the emit signal applied to the emit signal line E12 is high-level, the emitting transistors **M31***r* and **M32***r* are turned on, and hence, the current is supplied to the red organic EL element OLEDr to emit light. However, no current is supplied to the green and blue organic EL elements OLEDg and OLEDb since the n-channel transistors **M31***g* and **M31***b* coupled to the emit signal line E11 are turned off.

[**0069**] In the subfield **2**SF, since the emit signal applied to the emit signal line E11 is high-level and the emit signal applied to the emit signal line E12 is low-level, the emitting transistors **M31***g* and **M32***g* are turned on, and hence, the current is supplied to the green organic EL element OLEDg to emit light. However, no current is supplied to the red and blue organic EL elements OLEDr and OLEDb since the n-channel transistors **M32***r* and **M32***b* coupled to the emit signal line E12 are turned off.

[**0070**] In the subfield **3**SF, since the emit signals applied to the emit signal lines E11 and E12 are high-level, the emitting transistors **M31***b* and **M32***b* are turned on, and hence, the current is supplied to the blue organic EL element OLEDb to emit light. However, no current is supplied to the red and green organic EL elements OLEDr and OLEDg since the p-channel transistors **M31***r* and **M32***g* respectively coupled to the emit signal lines E11 and E12 are turned off.

[**0071**] Therefore, the three-colored organic EL elements are controlled by using two emit signal lines in the fourth exemplary embodiment. The transistors **M31***r* and **M32***g* are p-channel transistors and the transistors **M32***r*, **M31***g*, **M31***b*, and **M32***b* are n-channel transistors in **FIGS. 7 and 8**. In other embodiments, conductivity types of these transistors can be combined in different manners when the transistors are controllable in a manner similar to that illustrated by the timing diagram of **FIG. 8**. Also, the timing diagrams similar to those of second and third exemplary embodiments in **FIGS. 5 and 6** can be used with the pixel circuit **110**" of **FIG. 7** according to the fourth exemplary embodiment.

[**0072**] The voltage programming pixel circuit using switching transistors and driving transistors has been described in the first to fourth exemplary embodiments, and a voltage programming pixel circuit using transistors for compensating for threshold voltages of the driving transistors or transistors for compensating for voltage dropping as well as the switching transistors and driving transistors is applicable. Also, the present invention is applicable to current programming pixel circuits when the driving waveform described with reference to **FIG. 5**, that is, the driving waveform in which the emit signal is high-level while the select signal is low-level.

[**0073**] The organic EL elements sequentially emit light of one color in one subfield, and other organic EL elements sequentially emit light of other colors in the next subfield in the first to fourth exemplary embodiments. The color emitted at upper rows of the display panel is different from the color emitted at lower rows thereof at an instance during the above-noted driving. Referring to **FIG. 4**, the red organic EL elements emit light in the upper region of the display area and the blue organic EL elements emit light in the lower region of the display area in the temporally middle part of one subfield **1**SF. When the organic EL display is shaken in this instance, red areas and blue areas may look separated, which is generally referred to as a color separation phenomenon.

[**0074**] An exemplary embodiment for eliminating or reducing the color separation phenomenon will now be described with reference to **FIG. 9**.

[**0075**] **FIG. 9** shows a signal timing diagram of the organic EL display according to a fifth exemplary embodiment of the present invention.

[**0076**] Referring to **FIGS. 3 and 9**, in the subfield **1**SF, when a select signal is applied to the scan line **S1** of the first row, data voltages of R corresponding to red of the pixels of the first row are applied, respectively, to the data lines **D1** to Dm, and an emit signal for turning on the emitting transistor **M3***r* coupled to the red organic EL element OLEDr is applied to the emit signal line **E1***r* so that the red organic EL element OLEDr emits light at each pixel on the first row.

[**0077**] A select signal is applied to the scan line **S2** of the second row and data voltages of G corresponding to green of the pixels of the second row are applied, respectively, to the data lines **D1** to Dm, and an emit signal for turning on the emitting transistor **M3***g* coupled to the green organic EL element OLEDg is applied to the emit signal line **E2***g* so that the green organic EL element OLEDg emits light at each pixel on the second row.

[**0078**] A select signal is applied to the scan line **S3** of the third row and data voltages of B corresponding to blue of the pixels of the third row are applied, respectively, to the data lines **D1** to Dm, and an emit signal for turning on the emitting transistor **M3***b* coupled to the blue organic EL element OLEDb is applied to the emit signal line **E3***b* so that the blue organic EL element OLEDb emits light at each pixel on the third row.

[**0079**] Therefore, in the first subfield **1**SF, the red organic EL elements OLEDr start emitting light in the pixel circuits coupled to scan lines (**S4**, **S7**, . . . , S(n-2)) of every third row after the first row where 'n' is assumed to be an integer which is a multiple of **3**, the green organic EL elements OLEDg start emitting light in the pixel circuits coupled to scan lines (**S5**, **S8**, . . . , S(n-1)) of every third row after the second row, and the blue organic EL elements OLEDb start emitting light in the pixel circuits coupled to scan lines (**S6**, **S9**, . . . , Sn) of every third row after the third row.

[**0080**] In the subsequent subfield **2**SF, when a select signal is applied to the scan line **S1** of the first row, data voltages of G corresponding to green of the pixels of the first row are applied, respectively, to the data lines **D1** to Dm, and an emit signal for turning on the emitting transistor **M3***g* coupled to the green organic EL element OLEDg is applied to the emit signal line **E1***g* so that the green organic EL element OLEDg emits light at each pixel on the first row.

[**0081**] A select signal is applied to the scan line **S2** of the second row and data voltages of B corresponding to blue of the second row are applied, respectively, to the data lines **D1** to Dm, and an emit signal for turning on the emitting transistor **M3***b* coupled to the blue organic EL element OLEDb is applied to the emit signal line E2*b* so that the blue organic EL element OLEDb emits light at each pixel on the second row.

[**0082**] A select signal is applied to the scan line **S3** of the third row and data voltages of R corresponding to red of the pixels of the third row are applied, respectively, to the data lines **D1** to Dm, and an emit signal for turning on the emitting transistor **M3***r* coupled to the red organic EL element OLEDr is applied to the emit signal line **E3***r* so that the red organic EL element OLEDr emits light at each pixel on the third row.

[**0083**] Therefore, in the second subfield **2**SF, the green organic EL elements OLEDg start emitting light in the pixel circuits coupled to scan lines (**S4**, **S7**, . . . , S(n-2)) of every third row after the first row, the blue organic EL elements OLEDb start emitting light in the pixel circuits coupled to scan lines (**S5**, **S8**, . . . , S(n-1)) of every third row after the second row, and the red organic EL elements OLEDr start emitting light in the pixel circuits coupled to scan lines (**S6**, **S9**, . . . , Sn) of every third row after the third row.

[**0084**] In the subsequent subfield **3**SF, when a select signal is applied to the scan line **S1** of the first row, data voltages of B corresponding to blue of the pixels of the first row are applied, respectively, to the data lines **D1** to Dm, and an emit signal for turning on the emitting transistor **M3***b* coupled to the blue organic EL element OLEDb is applied to the emit signal line **E1***b* so that the blue organic EL element OLEDb emits light at each pixel on the first row.

[**0085**] A select signal is applied to the scan line **S2** of the second row and data voltages of R corresponding to red of the pixels of the second row are applied, respectively, to the data lines **D1** to Dm, and an emit signal for turning on the emitting transistor **M3***r* coupled to the red organic EL element OLEDr is applied to the emit signal line **E2***r* so that the red organic EL element OLEDr emits light at each pixel on the second row.

[**0086**] A select signal is applied to the scan line **S3** of the third row and data voltages of G corresponding to green of the pixels of the third row are applied, respectively, to the data lines **D1** to Dm, and an emit signal for turning on the emitting transistor **M3***g* coupled to the green organic EL element OLEDg is applied to the emit signal line **E3***g* so that the green organic EL element OLEDg emits light at each pixel on the third row.

[**0087**] Therefore, in the third subfield **3**SF, the blue organic EL elements OLEDb start emitting light in the pixel circuits coupled to scan lines (**S4**, **S7**, . . . , S(n-2)) of every third row after the first row, the red organic EL elements OLEDr start emitting light in the pixel circuits coupled to scan lines (**S5**, **S8**, . . . , S(n-1)) of every third row after the second row, and the green organic EL elements OLEDg start emitting light in the pixel circuits coupled to scan lines (**S6**, **S9**, . . . , Sn) of every third row after the third row.

[**0088**] Hence, the color separation phenomenon which may be generated because of different colors in the upper region and the lower region on a screen is reduced or eliminated by combining colors for each row and emitting them rather than programming data signal which corresponds to one color and controlling the corresponding color's emitting elements in a subfield according to the fifth exemplary embodiment.

[**0089**] Each row emits a different color in the fifth exemplary embodiment, and without being restricted to this, it is possible to combine a plurality of rows into a group, and allow each group to emit a different color. Also, while the emit elements with three colors have been described in reference to the exemplary embodiments, the present invention is applicable to emit elements with two or more than three colors, which will not be described since a person skilled in the art would know how to modify the embodiments described herein to practice such other embodiments.

[**0090**] Since the emit elements with various colors can be driven with common driving and switching transistors and capacitors for each pixel according to the exemplary embodiments of the present invention, a configuration of elements used in the pixel and a wiring design for transmitting the current, voltage, and signals are simplified, and accordingly, the aperture ratio in the pixel is improved, and the color separation phenomenon is reduced or eliminated by emitting different colors for each row in a single subfield.

[**0091**] While this invention has been described in connection with certain exemplary embodiments, it is to be understood that the invention is not limited to the disclosed embodiments, but, on the contrary, is intended to cover various modifications and equivalent arrangements included within the spirit and scope of the appended claims.

What is claimed is:

1. A display device comprising:

a plurality of rows of pixels for displaying an image during a field having a plurality of subfields, each of the pixels comprising a plurality of light emitting elements having different colors;

a plurality of data lines for applying data signals to the pixels for the light emitting elements to emit light; and

a plurality of select lines coupled to the pixels for applying a plurality of select signals, each of the select lines being coupled to a corresponding one of the rows of pixels to apply a corresponding one of the select signals thereto, wherein the select signals sequentially select the rows of pixels during each of the plurality of subfields,

wherein the data signals are applied to the pixels for the light emitting elements having different colors to sequentially start emitting different color lights during each of the plurality of subfields.

2. The display device of claim 1, wherein each of the light emitting elements emits red, green or blue light, and wherein each of the red, green and blue lights is emitted on every third one of the rows of pixels during each of the plurality of subfields.

3. The display device of claim 1, wherein white balance of the image is controlled by making emit periods of the light emitting elements having different colors to be different.

4. The display device of claim 1, further comprising a plurality of emit lines coupled to the rows of pixels for applying emit signals thereto, wherein a number of the emit lines coupled to each of the rows of pixels is the same as a number of the light emitting elements in each of the pixels.

5. The display device of claim 1, further comprising a plurality of emit lines coupled to the rows of pixels for applying emit signals thereto, wherein a number of the emit lines coupled to each of the rows of pixels is less than a number of the light emitting elements in each of the pixels by at least one.

6. A display device comprising a plurality of scan lines including a first scan line for applying a first signal and a second scan line for applying a second signal at a time different from that of applying the first signal, a plurality of data lines for applying a data signal for displaying an image during a field having a plurality of subfields, and a plurality of pixel circuits including a first pixel circuit coupled to the first scan line and one of the data lines and a second pixel circuit coupled to the second scan line and one of the data lines,

wherein each of the pixel circuits comprises:

at least two emit elements for emitting light having different colors, wherein each of the emit elements emits light responsive to an applied current;

a switching transistor for applying the data signal in response to the first signal or the second signal at least once for each of the subfields;

a capacitor for storing a voltage which corresponds to the data signal applied by the switching transistor; and

a driving transistor for outputting the applied current which corresponds to the voltage stored in the capacitor,

wherein one of the emit elements having a color different from a first color starts emitting light in the second pixel circuit after one of the emit elements having the first color starts emitting light in the first pixel circuit in a first one of the subfields, and one of the emit elements having a color different from a second color starts emitting light in the second pixel circuit after one of the emit elements having the second color starts emitting light in the first pixel circuit in a second one of the subfields.

7. The display device of claim 6, wherein each of the pixel circuits further comprises at least two emitting transistors coupled between the driving transistor and the at least two emit elements, and one of the emit elements having one color from among the two emit elements emits light according to an operation of the emitting transistors.

8. The display device of claim 7, further comprising at least two emit signal lines which are respectively coupled to gates of the emitting transistors and which apply control signals for controlling operations of the emitting transistors,

wherein one of the emitting transistors is turned on by one of the control signals applied through the emit signal lines, and the applied current is applied to one of the emit elements from the driving transistor.

9. The display device of claim 6, wherein the first scan line is near the second scan line.

10. The display device of claim 6, wherein the emit elements include an emit element of the first color, an emit element of the second color, and an emit element of a third color, and

each of the pixel circuits further comprises a first emitting transistor coupled between the driving transistor and the emit element of the first color, a second emitting transistor coupled between the driving transistor and the emit element of the second color, and a third emitting transistor coupled between the driving transistor and the emit element of the third color.

11. The display device of claim 10, wherein the emit element of the second color of the second pixel circuit starts emitting light in the first one of the subfields, and the emit element of the third color of the second pixel circuit starts emitting light in the second one of the subfields.

12. The display device of claim 11, wherein the emit element of the first color of the second pixel circuit starts emitting light in a third one of the subfields, and the emit element of the third color of the first pixel circuit starts emitting light in the third one of the subfields.

13. The display device of claim 12, wherein a third scan line among the scan lines applies a third signal at a timing which is different from timing of applying the first and second signals,

wherein a third pixel circuit having an emit element of the first color, an emit element of the second color and an emit element of the third color is coupled to the third scan line and one of the data lines; and

the emit elements of the third color, the first color, and the second color of the third pixel circuit start emitting light in the first subfield, the second subfield, and the third subfield, respectively.

14. The display device of claim 10, further comprising a first signal line for applying a first control signal for controlling an operation of the first emitting transistor, a second signal line for applying a second control signal for controlling an operation of the second emitting transistor, and a third signal line for applying a third control signal for controlling an operation of the third emitting transistor,

wherein one of the first, second and third emitting transistors is turned on responsive to one of the first, second and third control signals, and the applied current is applied to one of the emit elements of the first, second and third colors from the driving transistor.

15. The display device of claim 6, wherein one of the emit elements emits light for a period which is shorter than or equal to a period which corresponds to a corresponding one of the subfields after the one of the emit elements starts emitting light.

16. The display device of claim 6, wherein the emit elements emit light at least once during one field.

17. The display device of claim 16, wherein the emit elements of the same color emit light during a predetermined period in a plurality of pixel circuits coupled to the same one of the scan lines.

18. A display device including a plurality of scan lines for applying select signals, a plurality of data lines for applying data signals for displaying an image during a field having a plurality of subfields, and a plurality of pixel circuits coupled to the scan lines and the data lines,

wherein each of the pixel circuits comprises:

at least two emit elements for emitting light having different colors, wherein each of the emit elements emits light responsive to an applied current;

a switching transistor for applying one of the data signals which corresponds to one of the emit elements in response to one of the select signals at least once for each of the subfields;

a capacitor for storing a voltage which corresponds to the one of the data signals applied by the switching transistor;

a driving transistor for outputting the applied current which corresponds to the voltage stored in the capacitor; and

a switch for selectively outputting the applied current provided by the driving transistor to one of the emit elements of a color corresponding to the one of the data signals,

wherein one of the data signals corresponding to one of the emit elements of a first color is applied to one of the data lines when one of the select signals is applied to a scan line of a first group including at least one of the scan lines, and one of the data signals corresponding to one of the emit elements of a second color is applied to the one of the data lines when one of the select signals is applied to a scan line of a second group including at least one of the scan lines in a first one of the subfields.

19. The display device of claim 18, wherein the switch of one of the pixel circuits coupled to the scan line of the first group applies the applied current provided by the driving transistor to the one of the emit elements of the first color for a predetermined time, and the switch of the pixel circuit coupled to the scan line of the second group applies the applied current provided by the driving transistor to the one of the emit elements of the second color for the predetermined time.

20. The display device of claim 18, wherein one of the data signals corresponding to one of the emit elements of a color which is different from the first color is applied to the data line when the one of the select signals is applied to a scan line of the first group, and one of the data signals corresponding to one of the emit elements of a color which is different from the second color is applied to the one of the data lines when the one of the select signals is applied to a scan line of the second group in a second one of the subfields.

21. The display device of claim 18, wherein the emit elements emit light at least once during one field.

22. In a display device including a plurality of pixel circuits arranged in rows, wherein each of the pixel circuits comprises at least two emit elements for emitting light of different colors responsive to an applied current, and a transistor coupled to the emit elements supplies the applied current to one of the emit elements through at least one switch, a method of driving during a field having a plurality of subfields, comprising:

start emitting one of the emit elements of a first color in one of the pixel circuits provided on a row of a first group including at least one of the rows during a first one of the subfields; and

start emitting one of the emit elements of a second color in one of the pixel circuits provided on a row of a second group including at least one of the rows during the first one of the subfields.

23. The method of claim 22, further comprising:

start emitting one of the emit elements of a color different from the first color in one of the pixel circuits provided on a row of the first group during a second one of the subfields; and

start emitting one of the emit elements of a color different from the second color in one of the pixel circuits provided on a row of the second group during the second one of the subfields.

24. The method of claim 23, further comprising:

start emitting one of the emit elements of a third color in one of the pixel circuits provided on a row of a third group including at least one of the rows during the first one of the subfields; and

start emitting one of the emit elements of a color different from the third color in one of the pixel circuits provided on a row of the third group during the second one of the subfields.

25. The method of claim 24, comprising:

start emitting one of the emit elements of the third color in one of the pixel circuits provided on a row of the first group during a third one of the subfields;

start emitting one of the emit elements of the first color in one of the pixel circuits provided on a row of the second group during the third one of the subfields; and

start emitting one of the emit elements of the second color in one of the pixel circuits provided on a row of the third group during the third one of the subfields.

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专利名称(译)	显示装置及其驱动方法		
公开(公告)号	US20050200617A1	公开(公告)日	2005-09-15
申请号	US11/055400	申请日	2005-02-10
[标]申请(专利权)人(译)	KWAK WON KYU 金炳HEE		
申请(专利权)人(译)	KWAK WON-KYU 金炳HEE		
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IPC分类号	H01L51/50 G09G3/20 G09G3/30 G09G3/32 G09G5/02 H05B33/08 H05B33/14 G09G3/28		
CPC分类号	G09G3/3233 G09G2300/0452 G09G2300/0814 H05B33/0827 G09G2310/0235 G09G2310/06 H05B33/0818 G09G2300/0842 H05B45/37 H05B45/46		
优先权	1020040017309 2004-03-15 KR		
其他公开文献	US7804466		
外部链接	Espacenet USPTO		

摘要(译)

形成在有机EL显示器中的像素上的红色，绿色和蓝色有机电致发光（EL）元件由驱动晶体管驱动。电容器耦合在驱动晶体管的栅极和源极之间，以将电压保持预定时间。发射控制晶体管分别耦合在驱动晶体管和红色，绿色和蓝色有机EL元件之间。一个场被分成三个子场，并且每个像素中的红色，绿色和蓝色有机EL元件之一开始在每个子场中发光，从而表示全色屏幕。红色，绿色和蓝色有机元件在每个子场中依次开始发光，从而减少或消除了在每个子场期间开始发射一种颜色的有机EL元件引起的分色现象。