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(54) **PIXEL CIRCUIT, ORGANIC ELECTROLUMINESCENT DISPLAY PANEL AND DISPLAY APPARATUS**

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CPC G09G 3/3233; G09G 2330/026
See application file for complete search history.

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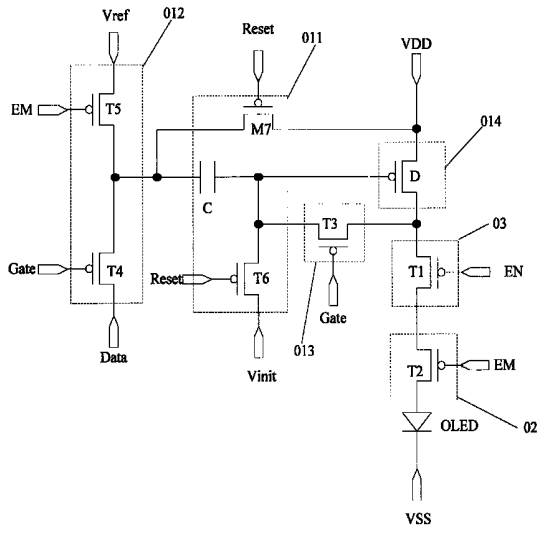
(57) **ABSTRACT**

The present disclosure discloses a pixel circuit, an organic electroluminescent display panel and a display apparatus. By adding one switch module in the pixel circuit, the abnormal drive current output by the driving module may be prevented from flowing to the light emitting device during a first frame of display picture as startup, and thus the problem of screen flicker can be overcome in the screen of the first frame when the display panel is started up.

20 Claims, 7 Drawing Sheets



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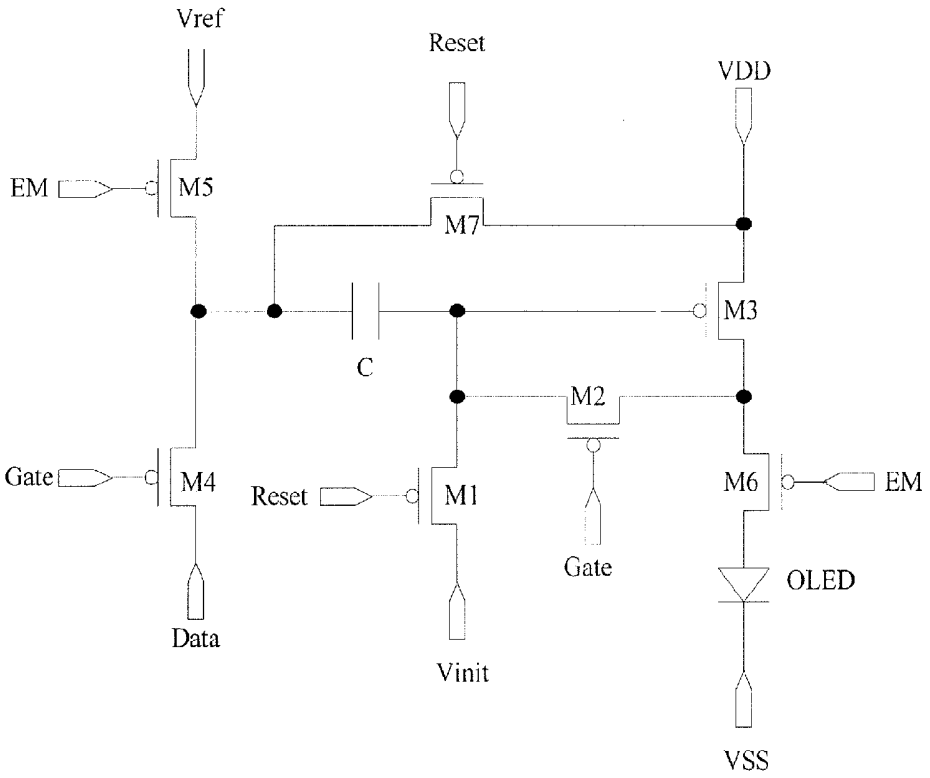
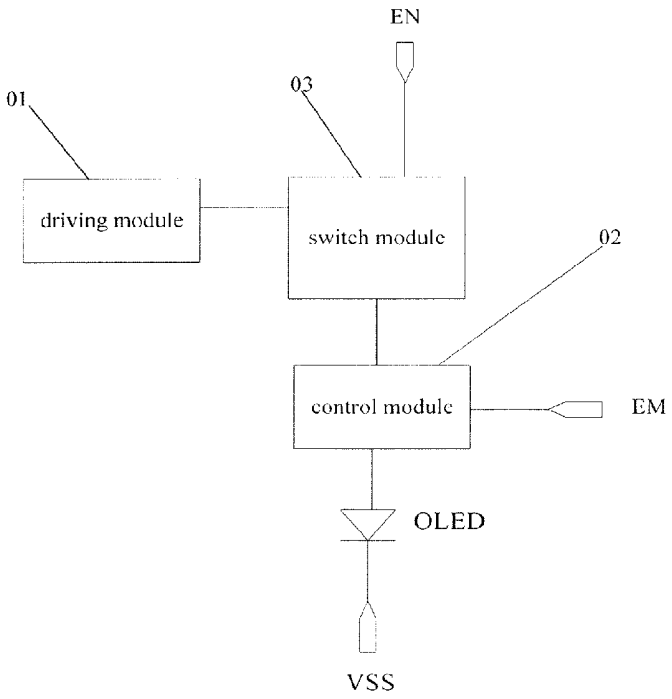

Vref
Reset
VDD
EM
M5
M7
M3
C
M2
Gate
M4
Reset
M1
M6
EM
Gate
OLED
Data
Vinit
VSS

Fig.1


EN
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driving module
switch module
02
control module
EM
OLED
VSS

Fig.2

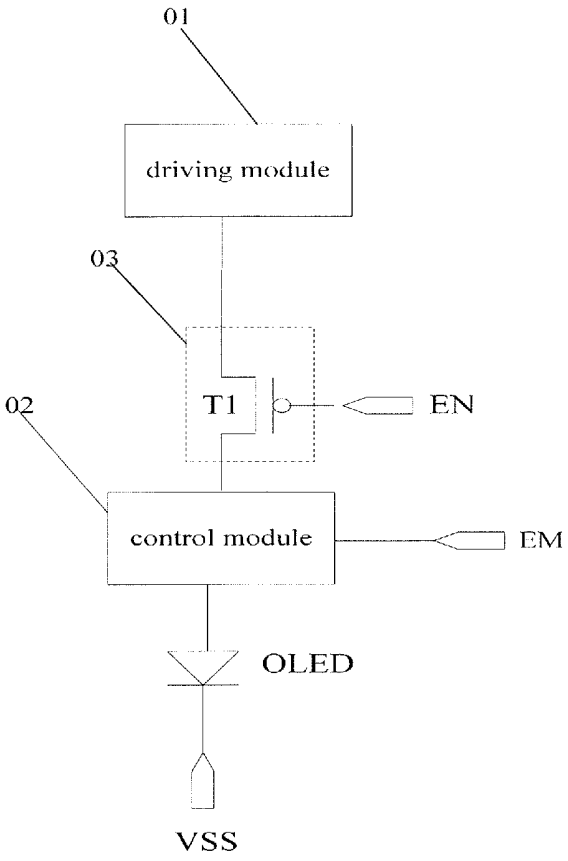


Fig.3

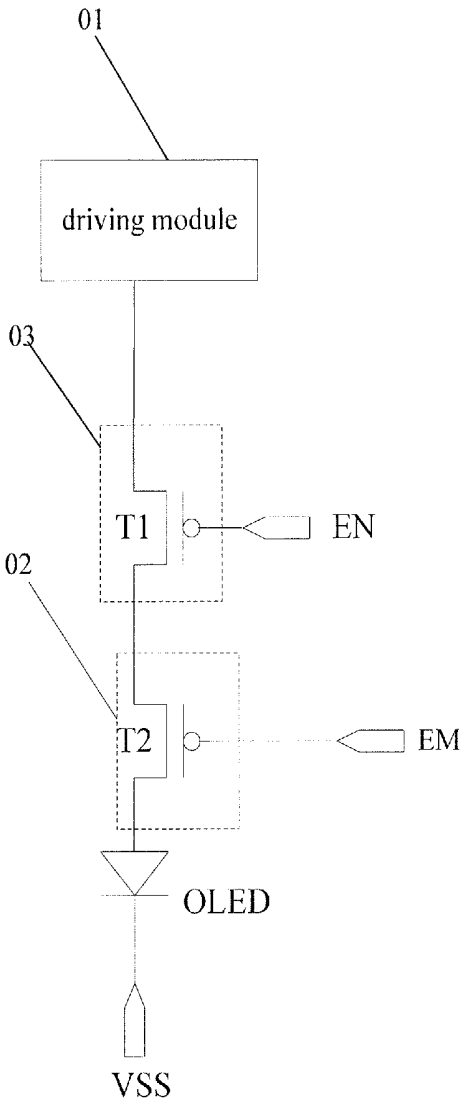


Fig.4

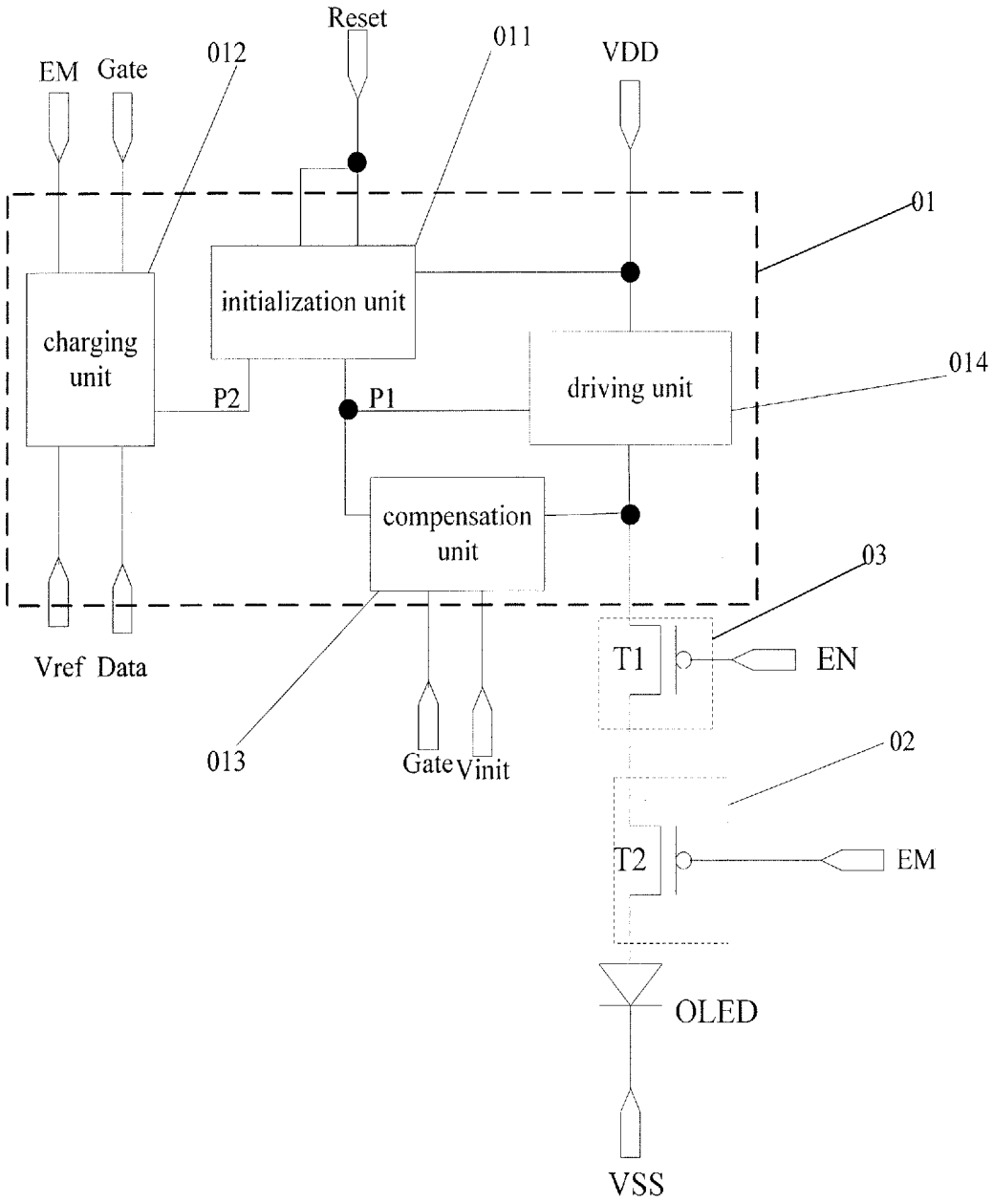
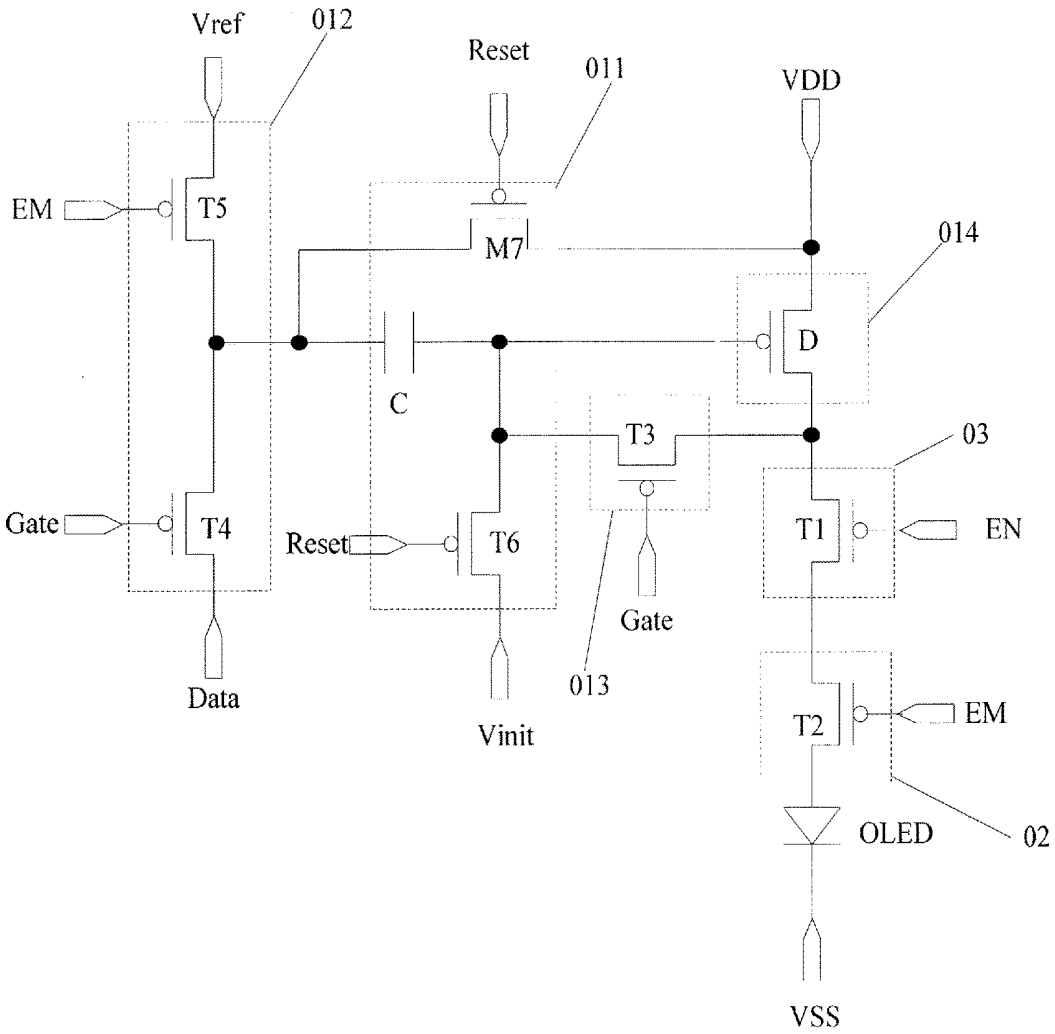

Reset
011
012
EM
Gate
VDD
01
initialization unit
charging unit
driving unit
014
P2
P1
compensation unit
03
T1
EN
Vref
Data
013
Gate
Vinit
02
T2
EM
OLED
VSS

Fig.5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012
Reset
011
VDD
EM
T5
M7
014
D
C
T3
03
Gate
T4
Reset
T6
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013
Vinit
T2
EM
OLED
02
VSS

Fig.6

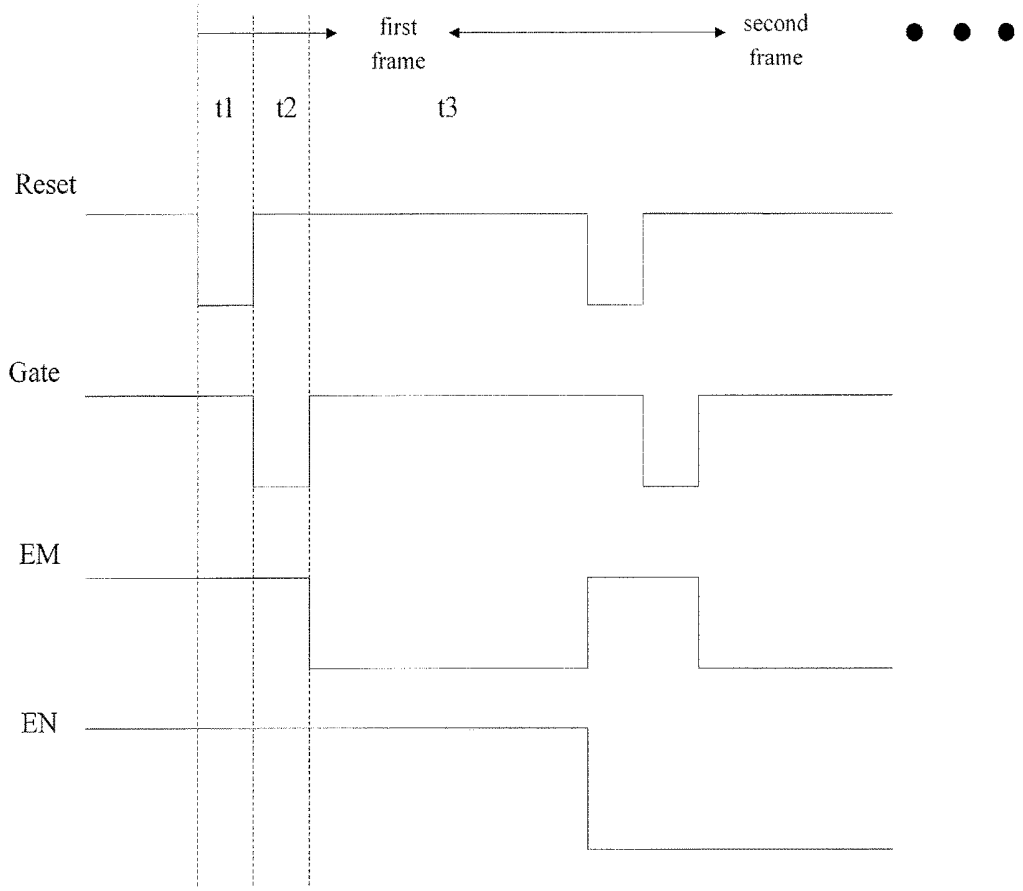

Fig.7

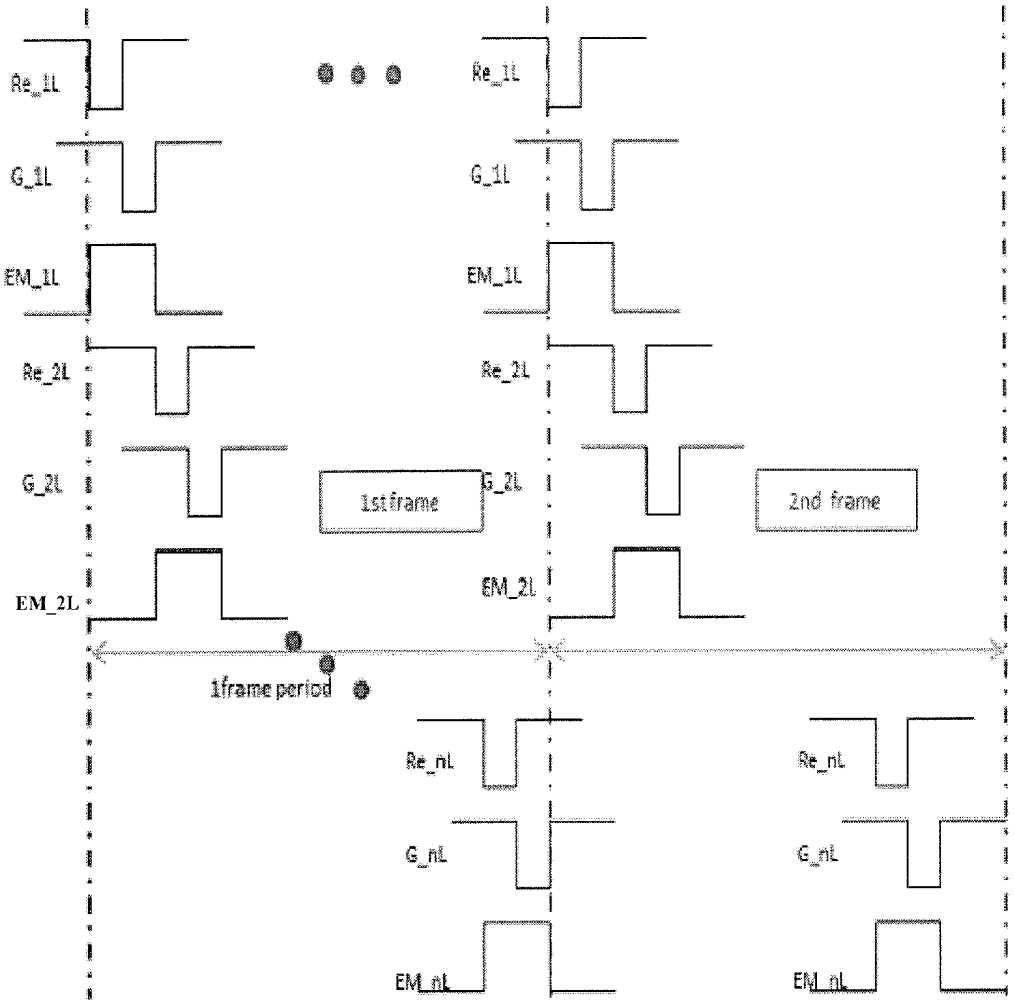
Re_1L
G_1L
EM_1L
Re_2L
G_2L
EM_2L
1st frame
2nd frame
1frame period
Re_nL
G_nL
EM_nL

Fig.8

PIXEL CIRCUIT, ORGANIC ELECTROLUMINESCENT DISPLAY PANEL AND DISPLAY APPARATUS

TECHNICAL FIELD

Embodiments of the present disclosure relate to a pixel circuit, and organic electroluminescent display panel and a display apparatus.

BACKGROUND

With advancements of the display technology, an Organic Light Emitting Diode (OLED) is one hot spot of a research field for current panel displays; more and more Active Matrix Organic Light Emitting Diode (AMOLED) display panels have come into the market, and as compared with a traditional Thin Film Transistor Liquid Crystal Displays (TFT LCDs), the AMOLEDs are of a faster response speed, a higher contrast as well as a wider viewing angle. The AMOLED is an autonomous light emitting device, and may realize a broad viewing angle display and may realize a panel display such as an ultra-thin display, a flexible display, etc., without an assistance of a backlight; the AMOLED is capable of emitting light because it is driven by a current generated by a drive transistor in a pixel circuit when the drive transistor is in a saturation state.

Generally, as shown in FIG. **1**, an existing pixel circuit consists mainly of seven transistors of M**1**-M**7** and one capacitor C, wherein the transistor M**3** is a drive transistor; when the AMOLED display panel is started up to display a first frame, prior to the pixel circuit being charged, a power supply signal VDD loaded onto the pixel circuit is generally a ground level signal, i.e., 0V, then a gate voltage of the drive transistor M**3** in the pixel circuit is 0V−Vth (Vth is a threshold voltage of the drive transistor); and during a light emitting stage, the power supply signal loaded onto the pixel circuit becomes a high voltage (for example 4.5V), and a voltage difference Vgd between a gate and a drain of the drive transistor M**3** (the voltage difference between the Gate-Drain, which determines turning-on or turning off the TFT) becomes larger, and a voltage signal for driving the OLED to emit light becomes abnormal, therefore a drive current for driving the OLED to emit light which is output by the drive transistor M**3** also becomes an abnormally large current; then even if a normal drive current is output by the pixel circuit for a next frame, a problem of screen flicker may occur in the first frame in the startup screen due to the aforementioned abnormal drive occurring in the screen of the first frame.

In addition, before a low level signal is loaded onto the pixel circuit, since an output terminal for outputting a low level signal in a power supply signal chip is in a floating state, and an output terminal for outputting a high level signal to the pixel circuit in power supply signal chip is on, and since after the transistors M**3** and M**6** are both turned on, the low level signal terminal VSS is at a positive potential; and when the low level signal output terminal of the power supply signal chip is on, since the low level signal terminal VSS of the pixel circuit is at the positive potential, there are difficulties for the low level signal terminal VSS of this pixel circuit to receive a signal, thus the power supply signal chip for providing the power supply signal may be damaged or broken; in this case, a self-protection device of the power source chip may perform a protection function and cut off the power source, which may cause the abnormal displaying of the display panel screen.

Accordingly, the technical problems needed to be solved by those skilled in the art are as follows: how to overcome the problem of screen flicker due to the abnormal drive current output by the pixel circuit when the display panel is started up and the first frame is displayed on a screen; and how to overcome the problem of the abnormal displaying of the display panel due to the self-protection function of a power supply signal chip triggered by the difficulty for the low level signal terminal of the pixel circuit receiving a positive potential and a negative potential.

SUMMARY

Embodiments of the present disclosure provide a pixel circuit, an organic electroluminescent display panel and a display apparatus, which can solve the following problems in the prior art: the screen flicker due to the abnormal drive current output by the pixel circuit when the display panel is started up and the first frame is displayed a screen; and the abnormal displaying of the display panel due to the self-protection function of a power supply signal chip triggered by the difficulty for the low level signal terminal of the pixel circuit receiving a positive potential and a negative potential.

An embodiment of the present disclosure provides a pixel circuit comprising: a light emitting device, a driving module configured to drive the light emitting device to emit light and a control module configured to control the light emitting device to emit light during a light emitting stage; the pixel circuit further comprises a switch module;

a control terminal of the switch module is connected with a switch signal terminal, an input terminal of the switch module is connected with an output terminal of the driving module, and an output terminal of the switch module is connected with an input terminal of the control module;

a control terminal of the control module is connected with a light emitting signal terminal, and an output terminal of the control module is connected with an input terminal of the light emitting device; and an output terminal of the light emitting device is connected with a low level signal terminal;

under the control of the switch signal terminal, the switch module is configured to be in an off state during a first frame of display picture as startup so as to prevent an abnormal drive current output by the driving module from flowing to the control module, and is configured to be in an on state from a second frame of display picture so as to output a normal drive current output by the driving module to the control module;

under the control of the light emitting signal terminal, the control module outputs the normal drive current output by the driving module to the input terminal of the light emitting device during the light emitting stage, and the light emitting device emits light normally when driven by the normal drive current.

In one possible implementation, in the above-mentioned pixel circuit according to the embodiment of the present disclosure, the switch module comprises: a first switch transistor;

a gate of the first switch transistor is connected with the switch signal terminal, a source of the first switch transistor is connected with the output terminal of the driving module, and a drain of the first switch transistor is connected with the input terminal of the control module.

In one possible implementation, in the above-mentioned pixel circuit according to the embodiment of the present disclosure, the control module comprises: a second switch transistor;

a gate of the second switch transistor is connected with the light emitting signal terminal, a source of the second switch transistor is connected with an output terminal of the switch module, and a drain of the second switch transistor is connected with the input terminal of the light emitting device.

In one possible implementation, in the above-mentioned pixel circuit according to the embodiment of the present disclosure, the driving module comprises: an initialization unit, a charging unit, a compensation unit and a driving unit;

a control terminal of the driving unit is connected with a first node, an input terminal of the driving unit is connected with a high level signal terminal, and an output terminal of the driving unit is connected with an input terminal of the switch module and an input terminal of the compensation unit respectively; a control terminal of the compensation unit is connected with a scanning signal terminal, an output terminal of the compensation unit is connected with the first node; a first control terminal of the charging unit is connected with the scanning signal terminal, a second control terminal of the charging unit is connected with of the light emitting signal terminal, a first input terminal of the charging unit is connected with a data signal terminal, a second input terminal of the charging unit is connected with a reference signal terminal, and an output terminal of the charging unit is connected with a second node; the initialization unit is connected with a reset signal terminal, a restore signal terminal, the high level signal terminal and the first node;

during an initialization stage, under the control of the reset signal terminal, the initialization unit is configured to perform initialization on the first node and the second node by a signal input via the restore signal terminal and a signal input via the high level signal terminal respectively; during a charging stage, under the control of the scanning signal terminal, the compensation unit is configured to perform a compensation for the threshold voltage of the driving unit at the first node, and under the control of the scanning signal terminal, the charging unit is configured to perform a data writing at the first node by a signal input via the data signal terminal; during the light emitting stage, under the control of the light emitting signal terminal, the charging unit is configured to perform an adjustment on a voltage signal at the first node by a signal input via the reference signal terminal, and under the control of the first node at which the voltage signal is adjusted, the driving unit outputs to the input terminal of the switch module a drive current for driving the light emitting device to emit light.

In one possible implementation, in the above-mentioned pixel circuit according to the embodiment of the present disclosure, the driving unit comprises: a drive transistor;

a gate of the drive transistor is connected with the first node, a source of the drive transistor is connected with the high level signal terminal, and a drain of the drive transistor is connected with an input terminal of the switch module.

In one possible implementation, in the above-mentioned pixel circuit according to the embodiment of the present disclosure, the compensation unit comprises: a third switch transistor;

a gate of the third switch transistor is connected with the scanning signal terminal, a source of the third switch transistor is connected with the output terminal of the driving unit, and a drain of the third switch transistor is connected with the first node.

In one possible implementation, in the above-mentioned pixel circuit according to the embodiment of the present disclosure, the charging unit comprises: a fourth switch transistor and a fifth switch transistor; wherein,

a gate of the fourth switch transistor is connected with the scanning signal terminal, a source of the fourth switch transistor is connected with the data signal terminal, and a drain of the fourth switch transistor is connected with the second node;

a gate of the fifth switch transistor is connected with the light emitting signal terminal, the source of the fifth switch transistor is connected with the reference signal terminal, and the drain of the fifth switch transistor is connected with the second node.

In one possible implementation, in the above-mentioned pixel circuit according to the embodiment of the present disclosure, the initialization unit comprises: a sixth switch transistor, a seventh switch transistor and a capacitor; wherein,

a gate of the sixth switch transistor is connected with the reset signal terminal, a source of the sixth switch transistor is connected with the restore signal terminal, and a drain of the sixth switch transistor is connected with the first node;

a gate of the seventh switch transistor is connected with the reset signal terminal, a source of the seventh switch transistor is connected with the high level signal terminal, and a drain of the seventh switch transistor is connected with the second node;

the capacitor is connected between the first node and the second node.

An embodiment of the present disclosure provides an organic electroluminescent display panel, which comprises the above-mentioned pixel circuit according to the embodiment of the present disclosure.

An embodiment of the present disclosure provides a display apparatus, which comprises the above-mentioned organic electroluminescent display panel according to the embodiment of the present disclosure.

The advantageous effects according to embodiments of the present disclosure are as follows.

Embodiments of the present disclosure provide a pixel circuit, an organic electroluminescent display panel and a display apparatus, the pixel circuit comprises: a light emitting device, a driving module configured to drive the light emitting device to emit light, and a control module configured to control the light emitting device to emit light during a light emitting stage; and the pixel circuit further comprises: a switch module; under the control of the switch signal terminal, the switch module is configured to be in an off state during a first frame of display picture as startup so as to prevent the abnormal drive current output by the driving module from flowing to the control module, and is configured to be in an on state from a second frame of display picture so as to output the normal drive current output by the driving module to the control module; under the control of the light emitting signal terminal, the control module outputs the normal drive current output by the driving module to the input terminal of the light emitting device during the light emitting stage, and the light emitting device emits light normally when driven by the normal drive current.

In this way, by adding one switch module in the pixel circuit, the abnormal drive current output by the driving module is prevented from flowing to the light emitting

device during the first frame of display picture as startup, and thus the problem of screen flicker can be overcome in the screen of the first frame when the display panel is started up; and additionally since the switch module can prevent the abnormal drive current of the pixel circuit from flowing to the light emitting device, a high level signal can be prevented from flowing to the low level signal terminal before a low level signal is input to the low level signal terminal; in this way, a positive potential will not occur before the low level signal terminal of the pixel circuit receives a low level signal, and thus the problem of the abnormal displaying of the display panel due to the self-protection function of a power supply signal chip triggered by the difficulty for the low level signal terminal of the pixel circuit receiving a positive potential and a negative potential can be overcome.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is an exemplary view illustrating a structure of a pixel circuit in the prior art;

FIG. **2**-FIG. **6** are exemplary views illustrating structures of pixel circuits according to embodiments of the present disclosure respectively;

FIG. **7** is an operating timing schematic diagram of the pixel circuit according to an embodiment of the present disclosure;

FIG. **8** is an operating timing schematic diagram of various control signals in the pixel circuit as being scanned line by line according to an embodiment of the present disclosure.

DETAILED DESCRIPTION

Hereinafter, the detailed description of a pixel circuit, an organic electroluminescent display panel and a display apparatus according to embodiments of the present disclosure will be explained in detail with reference to the drawings.

As shown in FIG. **2**, an embodiment of the present disclosure provides a pixel circuit, which may comprise: a light emitting device OLED, a driving module **01** configured to drive the light emitting device OLED to emit light and a control module **02** configured to control the light emitting device OLED to emit light during a light emitting stage; the pixel circuit further comprises a switch module **03**;

a control terminal of the switch module **03** is connected with a switch signal terminal EN, an input terminal of the switch module **03** is connected with an output terminal of the driving module **01**, and an output terminal of the switch module **03** is connected with an input terminal of the control module **02**;

a control terminal of the control module **02** is connected with a light emitting signal terminal EM, and an output terminal of the control module **02** is connected with an input terminal of the light emitting device OLED; and an output terminal of the light emitting device OLED is connected with a low level signal terminal VSS;

under the control of the switch signal terminal EN, the switch module **03** is configured to be in an off state during a first frame of display picture as startup so as to prevent an abnormal drive current output by the driving module **01** from flowing to the control module **02**, and is configured to be in an on state from a second frame of display picture so as to output a normal drive current output by the driving module **01** to the control module **02**; under the control of the light emitting signal terminal EM, the control module **02** outputs the normal drive current output by the driving module **01** to the input terminal of the light emitting device OLED during the light emitting stage, and the light emitting device OLED emits light normally as driven by the normal drive current.

In the above-mentioned pixel circuit according to the embodiment of the present disclosure, under the control of the switch signal terminal, the switch module is in the off state during the first frame of display picture as startup so as to prevent an abnormal drive current output by the driving module from flowing to the control module, and is in the on state from the second frame of display picture so as to output the normal drive current output by the driving module to the control module; under the control of the light emitting signal terminal, the control module outputs the normal drive current output by the driving module to the input terminal of the light emitting device during the light emitting stage, and the light emitting device emits light normally when driven by the normal drive current.

In this way, by adding one switch module in the pixel circuit, the abnormal drive current output by the driving module is prevented from flowing to the light emitting device during the first frame of display picture as startup, and thus the problem of screen flicker can be overcome in the screen of the first frame when the display panel is started up; and additionally since the switch module can prevent the abnormal drive current of the pixel circuit from flowing to the light emitting device, a high level signal can be prevented from flowing to the low level signal terminal before a low level signal is input to the low level signal terminal; in this way, a positive potential will not occur before the low level signal terminal of the pixel circuit receives a low level signal, and thus the problem of the abnormal displaying of the display panel due to the self-protection function of a power supply signal chip triggered by the difficulty for the low level signal terminal of the pixel circuit receiving a positive potential and a negative potential can be overcome.

As implemented in practice, in the above-mentioned pixel circuit according to the embodiment of the present disclosure, as shown in FIG. **3**, the switch module **03** may comprises: a first switch transistor T**1**; a gate of the first switch transistor T**1** is connected with the switch signal terminal EN, the source of the first switch transistor T**1** is connected with the output terminal of the driving module **01**, and the drain of the first switch transistor T**1** is connected with the input terminal of the control module **02**.

Particularly, in the above-mentioned pixel circuit according to the embodiment of the present disclosure, from the second frame of display picture, the switch signal terminal may input a signal for turning on the first switch transistor T**1**, that is, when a low level signal is input by the switch signal terminal EN, the first switch transistor T**1** is turned on, and the first switch transistor T**1** which is in a turned-on state connects the output terminal of the driving module **01** to the input terminal of the control module **02**, and then the drive current output by the driving module **01** passes through the control module **02** and is output to the input terminal of the light emitting device OLED for driving the light emitting device OLED to emit light normally.

As implemented in practice, in the above-mentioned pixel circuit according to the embodiment of the present disclosure, as shown in FIG. **4**, the control module **02** may comprises: a second switch transistor T**2**; a gate of the second switch transistor T**2** is connected with the light emitting signal terminal EM, a source of the second switch transistor T**2** is connected with an output terminal of the switch module **03**, and a drain of the second switch transistor T**2** is connected with the input terminal of the light emitting device OLED.

Particularly, in the above-mentioned pixel circuit according to the embodiment of the present disclosure, during the light emitting stage, the light emitting signal terminal EM may input a signal for turning on the second switch transistor T2; that is, when a low level signal is input by the light emitting signal terminal, the second switch transistor T2 will be in a turned-on state, and the second switch transistor T2 which is in the turned-on state connects the output terminal of the switch module **03** and the input terminal of the light emitting device OLED, and then the drive current for driving the light emitting device OLED to emit light may be output to the input terminal of the light emitting device OLED to drive the light emitting device OLED to emit light normally.

As implemented in practice, in the above-mentioned pixel circuit according to the embodiment of the present disclosure, as shown in FIG. **5**, the driving module **01** may comprises: an initialization unit **011**, a charging unit **012**, a compensation unit **013** and a driving unit **014**;

a control terminal of the driving unit **014** is connected with a first node P1, an input terminal of the driving unit **014** is connected with a high level signal terminal VDD, and an output terminal of the driving unit **014** is connected with the input terminal of the switch module **03** and an input terminal of the compensation unit **013** respectively; a control terminal of the compensation unit **013** is connected with a scanning signal terminal Gate, the output terminal of the compensation unit **013** is connected with the first node P1; a first control terminal of the charging unit **012** is connected with the scanning signal terminal Gate, a second control terminal of the charging unit **012** is connected with of the light emitting signal terminal EM, a first input terminal of the charging unit **012** is connected with a data signal terminal Data, a second input terminal of the charging unit **012** is connected with a reference signal terminal Vref, and an output terminal of the charging unit **012** is connected with a second node P2; the initialization unit **011** is connected with a reset signal terminal Reset, a restore signal terminal Vinit, a high level signal terminal VDD and the first node P1.

During an initialization stage, under the control of the reset signal terminal Reset, the initialization unit **011** is configured to perform initializations on the first node P1 and the second node P2 by a signal input via the restore signal terminal Vinit and a signal input via the high level signal terminal VDD respectively; during a charging stage, under the control of the scanning signal terminal Gate, the compensation unit **013** is configured to perform a compensation for a threshold voltage of the driving unit **014** at the first node P1, and under the control of the scanning signal terminal Gate, the charging unit **012** is configured to perform a data writing to the first node P1 by a signal input via the data signal terminal Data; during the light emitting stage, under the control of the light emitting signal terminal EM, the charging unit **012** is configured to perform an adjustment on a voltage signal at the first node P1 by a signal input via the reference signal terminal Vref, and under the control of the first node P1 at which the voltage signal is adjusted, the driving unit **014** outputs to the input terminal of the switch module **03** a drive current for driving the light emitting device OLED to emit light.

Particularly, in the above-mentioned pixel circuit according to the embodiment of the present disclosure, the driving module may comprise the initialization unit, the charging unit, the compensation unit and the driving unit, in this way, the driving module may perform the initialization on the first node and the second node by the initialization unit during the initialization stage, therefore an effect of a voltage difference in the previous stage on the subsequent stages; during the charging stage, the compensation for the threshold voltage and writing of the data are implemented by the compensation unit and the charging unit, the compensation for the threshold voltage can avoid an effect of varying in the threshold voltage on a luminance of the light emitting device, and an uniformity of the luminance of the light emitting device is improved and a quality of a display screen can be guaranteed; and during the light emitting stage, by adjusting the voltage signal at the first node by the charging unit, the drive current output by the drive transistor can be adjusted and then the luminance of the light emitting device can be adjusted, and thus the light emitting device may be driven to emit light normally.

As implemented in practice, in the above-mentioned pixel circuit according to the embodiment of the present disclosure, as shown in FIG. **6**, the driving unit **014** may comprises: a drive transistor D; a gate of the drive transistor D is connected with the first node P1, a source of the drive transistor D is connected with the high level signal terminal VDD, and a drain of the drive transistor D is connected with the input terminal of the switch module **03**.

Particularly, in the above-mentioned pixel circuit according to the embodiment of the present disclosure, during the initialization stage, the initialization unit performs an initialization on the gate voltage of the drive transistor, i.e., the voltage of the first node; during the charging stage, the compensation unit performs the compensation for the threshold voltage of the drive transistor, and the charging unit performs the data writing to the first node; during the light emitting stage, the charging unit may perform an adjustment on the voltage at the first node, and then under the control of the first node at which the voltage is adjusted, the drive transistor may output the drive current for driving the light emitting device OLED to emit light during the light emitting stage.

As implemented in practice, in the above-mentioned pixel circuit according to the embodiment of the present disclosure, as shown in FIG. **6**, the compensation unit **013** may comprises: a third switch transistor T3; a gate of the third switch transistor T3 is connected with the scanning signal terminal Gate, a source of the third switch transistor T3 is connected with the output terminal of the driving unit **014**, and a drain of the third switch transistor T3 is connected with the first node P1.

Particularly, in the above-mentioned pixel circuit according to the embodiment of the present disclosure, during the charging stage, under the control of the scanning signal terminal Gate, the third switch transistor T3 is turned on, and then the third switch transistor T3 which is in the turned-on state connects the output terminal of the driving unit **014** and the first node P1, and at this point, the power supply signal Vdd input via the high level signal terminal VDD performs the compensation for the threshold voltage at the first node P1 via the drive transistor D and the third switch transistor T1 which is in the turned-on state until the voltage at the first node P1 reaches Vdd−Vth, and then the drive transistor D is turned off, and at this time the compensation for the threshold voltage of the drive transistor D may be completed.

As implemented in practice, in the above-mentioned pixel circuit according to the embodiment of the present disclosure, as shown in FIG. **6**, the charging unit **012** may comprises: a fourth switch transistor T4 and a fifth switch transistor T5; wherein, a gate of the fourth switch transistor T4 is connected with the scanning signal terminal Gate, a source of the fourth switch transistor T4 is connected with the data signal terminal Data, and a drain of the fourth switch transistor T4 is connected with the second node P2; a gate

of the fifth switch transistor **15** is connected with the light emitting signal terminal EM, a source of the fifth switch transistor T**5** is connected with the reference signal terminal Vref, and a drain of the fifth switch transistor T**5** is connected with the second node P**2**.

Particularly, in the above-mentioned pixel circuit according to the embodiment of the present disclosure, during the charging stage, under the control of the scanning signal terminal, the fourth switch transistor T**4** is turned on, and then the fourth switch transistor T**4** which is in the turned-on state may connect the data signal terminal Data and the second node P**2**, and thus a signal of the data signal terminal Data may be input to the second node P**2**; during the light emitting stage, under the control of the emit light signal terminal EM, the fifth switch transistor T**5** is turned on, and then the fifth switch transistor T**5** which is in the turned-on state connects the reference signal terminal Vref and the second node P**2**, and in turn a signal input via the reference signal terminal Vref may be output to the second node P**2**; since the first node P**1** and the second node P**2** correspond to the two terminals of the capacitor, the voltage signal at the first node P**1** may be adjusted by the voltage signal input to the second node P**2** by means of the charging and discharging function of the capacitor.

As implemented in practice, in the above-mentioned pixel circuit according to the embodiment of the present disclosure, as shown in FIG. **6**, the initialization unit **011** may comprises: a sixth switch transistor T**6**, a seventh switch transistor T**7** and a capacitor C; wherein, a gate of the sixth switch transistor T**6** is connected with the reset signal terminal Reset, a source of the sixth switch transistor T**6** is connected with the restore signal terminal Vinit, and a drain of the sixth switch transistor T**6** is connected with the first node P**1**; a gate of the seventh switch transistor T**7** is connected with the reset signal terminal Reset, a source of the seventh switch transistor T**7** is connected with the high level signal terminal VDD, and a drain of the seventh switch transistor T**7** is connected with the second node P**2**; and the capacitor C is connected between the first node P**1** and the second node P**2**.

Particularly, in the above-mentioned pixel circuit according to the embodiment of the present disclosure, during the initialization stage, under the control of the reset signal terminal Reset, the sixth switch transistor T**6** and the seventh switch transistor T**7** are turned on, the sixth switch transistor T**6** which is in the turned-on state connects the restore signal terminal Vinit and the first node P**1**, and thus the initialization is performed for the first node P**1** by the signal input via the restore signal terminal Vinit; and the seventh switch transistor T**7** which is in the turned-on state connects the high level signal terminal VDD and the second node P**2**, and then the initialization is performed for the second node P**2** by the signal input via the high level signal terminal VDD.

It should be noted that, the switch transistors and the drive transistors mentioned in the above-described embodiments of the present disclosure may be Thin Film Transistors (TFTs), and may also be the Metal Oxide Semiconductor field effect tubes (MOSS), and there is no limitation on it. In a specific implementation, the sources and the drains of these transistors can be exchanged without being distinguished from each other. Various specific embodiments are explained by taking a thin film transistor as an example.

Thereafter, an operating process of the pixel circuit according to embodiments of the present disclosure will be described in detail with reference to the pixel circuit and the operating timing according to embodiments of the present disclosure. The operating process of the pixel circuit according to embodiments of the present disclosure will be described by taking the pixel circuit as shown in FIG. **6** and the timing diagram of data inputting/outputting of the pixel circuit of FIG. **6** as shown in FIG. **7** as an example. Particularly, the description is given by selecting t**1**~t**3** in the timing diagram of inputting/outputting as three stages. In the following description, from the time when the startup is performed to display a first frame, "1" indicates a high level signal, and "0" indicates a low level signal.

During the t**1** stage, Reset=0, Gate=1, EM=1, and EN=1. Since Reset=0, the sixth switch transistor T**6** and the seventh switch transistor T**7** are turned on; since Gate=1, EM=1, and EN=1, the first switch transistor T**1**, the second switch transistor T**2**, the third switch transistor T**3**, the fourth switch transistor T**4** and the fifth switch transistor T**5** are turned off. The sixth switch transistor T**6** which is in the turned-on state connects the restore signal terminal Vinit and the first node P**1**, and then the initialization is performed for the first node P**1** by the signal input via the restore signal terminal Vinit; the seventh switch transistor T**7** which is in the turned-on state connects the high level signal terminal VDD and the second node P**2**, and then the initialization is performed for the second node P**2** by the signal input via the high level signal terminal VDD. The t**1** stage is the initialization stage.

During the t**2** stage, Reset=1, Gate=0, EM=1, and EN=1. Since Gate=0, the third switch transistor T**3** and the fourth switch transistor T**4** are turned on; since EM=1, Reset=1, and EN=1, the first switch transistor T**1**, the second switch transistor T**2**, the fifth switch transistor T**5**, the sixth switch transistor T**6** and the seventh switch transistor T**7** are turned off. The third switch transistor T**3** which is in the turned-on state connects the drain of the drive transistor D and the first node P**1**, and due to a voltage difference occurs between the two terminals of the capacitor C during the initialization stage, the drive transistor D is in the turned-on state, and at this point the first node P**1** is charged by the power supply signal Vdd input from the high level signal terminal VDD via the third switch transistor T**3** and the drive transistor which are in the turned-on state, until the voltage at the first node reaches Vdd−Vth, then the drive transistor D is turned off, and at this time the compensation for the threshold voltage of the drive transistor D may be completed. The fourth switch transistor T**4** which is in the turned-on state connects the data signal terminal Data and the second node P**2**, and thus a signal Vdata input by the data signal terminal Data is input to the second node P, and at this time the voltage difference between the two terminals of the capacitor C is Vdata−Vdd+vth. The t**2** stage is the charging stage.

During the t**3** stage, Reset=1, Gate1, and EM=0. Since EM=0, the second switch transistor T**2** and the fifth switch transistor T**5** are turned on; since Gate=1, Reset=1, and EN=1, the third switch transistor T**3**, the fourth switch transistor T**4**, the sixth switch transistor T**6** and the seventh switch transistor T**7** are turned off. The fifth switch transistor T**5** which is in the turned-on state outputs the signal Vref input via the reference signal terminal to the second node P**2**, and the voltage signal at the first node P**1** is adjusted by the capacitor C, and at this time, the voltage signal at the first node P**1** is Vref−Vdata+Vdd−Vth, and under control of the voltage signal at the first node P**1**, the drive transistor D outputs a current $I=\frac{1}{2}*K(Vref-Vdata)^2$ for driving the light emitting device to emit light. At this time, the second switch transistor T**2** which is in the turned-on state connects the drain of the first switch transistor T**1** and the input terminal of the light emitting device OLED; however, since the first switch transistor T**1** is in the turned-off state, the light emitting device OLED does not emit light. This is because

during the first frame of display picture, the drive current output by the drive transistor D is an abnormally large current, and the first switch transistor T1 is in the turned-off state, then the abnormal drive current is prevented from flowing to the light emitting device OLED, and thus the problem of screen flicker can be overcome in the screen of the first frame when the display panel is started up. That is, after the startup, the first frame of display picture after startup is a black screen; however, from the second frame of display picture, a low level signal is input by the switch signal terminal EN, i.e., EN=0, and then the first switch transistor T1 is in the turned-on state, the first switch transistor T1 which is in the turned-on state connects the drain of the drive transistor D and the source of the second switch transistor T2, and thus the drive current output by the drive transistor D may be output to the input terminal of the light emitting device OLED, and therefore the light emitting device OLED is driven to emit light normally. The t3 stage is the light emitting stage.

In the subsequent time periods, the respective control signals are the same as those in the time period t3, therefore the light-emitting state of the light emitting device OLED will be maintained until a low level is input by the reset signal terminal Reset again in some time period.

As implemented in practice, in a line by line scan process of the whole display panel, the input timing diagram of various control signals in the pixel circuit is shown in FIG. 8, wherein Re_1L, Re_2L, G_1L, G_2L, EM_1L, EM_2L . . . are the input timing for identifying various control signals in the first row, the second row . . . the nth row respectively. Particularly, it should be noted that, when the first frame is displayed, a high level signal is input by the switch signal terminal (not shown in FIG. 8), and from the second frame of display picture, a low level signal is input by the switch signal terminal (not shown in FIG. 8); in this way, the abnormal drive current output by the driving module during the first frame of display picture as startup can be prevented from flowing to the light emitting device, and thus the problem of screen flicker can be overcome in the screen of the first frame when the display panel is started up; and additionally since the switch module can prevent the abnormal drive current of the pixel circuit from flowing to the light emitting device, a high level signal can be prevented from flowing to the low level signal terminal before a low level signal is input to the low level signal terminal of the pixel circuit; in this way, a positive potential will not occur before the low level signal terminal of the pixel circuit receives a low level signal, and thus the problem of the abnormal displaying of the display panel due to the self-protection function of a power supply signal chip triggered by the difficulty for the low level signal terminal of the pixel circuit receiving a positive potential and a negative potential can be overcome.

An embodiment of the present disclosure provides an organic electroluminescent display panel, which comprises the above-mentioned pixel circuit according to the embodiment of the present disclosure. Since the principle for the organic electroluminescent display panel to solve problems is similar to that of the above-mentioned pixel circuit, therefore the implementation of the organic electroluminescent display panel can be founded in the implementation of the above-mentioned pixel circuit, and the repetitive parts will be omitted.

An embodiment of the present disclosure provides a display apparatus, which comprises the above-mentioned organic electroluminescent display panel according to the embodiment of the present disclosure. The display apparatus may be any products or components having the function of displaying such as a handset, a tablet computer, a TV set, a display, a notebook computer, a digital frame, and a navigator etc. Since the principle for the display apparatus to solve problems is similar to that of the above-mentioned organic electroluminescent display panel, therefore the implementation of the display apparatus can be found in the implementation of the above-mentioned organic electroluminescent display panel, and the repetitive parts will be omitted.

Embodiments of the present disclosure provide a pixel circuit, an organic electroluminescent display panel and a display apparatus, the pixel circuit comprises: a light emitting device, a driving module configured to drive the light emitting device to emit light, and a control module configured to control the light emitting device to emit light during a light emitting stage; and the pixel circuit further comprises: a switch module; under the control of the switch signal terminal, the switch module is configured to be in an off state during a first frame of display picture as startup so as to prevent an abnormal drive current output by the driving module from flowing to the control module, and is configured to be in an on state from a second frame of display picture so as to output a normal drive current output by the driving module to the control module; under the control of the light emitting signal terminal, the control module outputs the normal drive current output by the driving module to the input terminal of the light emitting device during the light emitting stage, and the light emitting device emits light normally when driven by the normal drive current. In this way, by adding one switch module in the pixel circuit, the abnormal drive current output by the driving module is prevented from flowing to the light emitting device during the first frame of display picture as startup, and thus the problem of screen flicker can be overcome in the screen of the first frame when the display panel is started up; and additionally since the switch module can prevent the abnormal drive current of the pixel circuit from flowing to the light emitting device, a high level signal is prevented from flowing to the low level signal terminal before a low level signal is input to the low level signal terminal; in this way, a positive potential will not occur before the low level signal terminal of the pixel circuit receives a low level signal, and thus the problem of the abnormal displaying of the display panel due to the self-protection function of a power supply signal chip triggered by the difficulty for the low level signal terminal of the pixel circuit receiving a positive potential and a negative potential can be overcome.

Obviously, those skilled in the art may make various changes and variations on the present disclosure without departing from the spirit and scope of the present disclosure. Thus, the present disclosure intends to cover the changes and variations to the present disclosure if such changes and variations belong to the scope defined by the claims of the present disclosure and equivalence thereof.

What is claimed is:

1. A pixel circuit, comprising: a light emitting device, a driving module configured to drive the light emitting device to emit light, and a control module configured to control the light emitting device to emit light during a light emitting stage; further comprising: a switch module;

a control terminal of the switch module is connected with a switch signal terminal, an input terminal of the switch module is connected with an output terminal of the driving module, and an output terminal of the switch module is connected with an input terminal of the control module;

a control terminal of the control module is connected with a light emitting signal terminal, and an output terminal of the control module is connected with an input terminal of the light emitting device; and an output terminal of the light emitting device is connected with a low level signal terminal;

under the control of the switch signal terminal, the switch module is configured to be in an off state during a first frame of display picture as startup and prevent an abnormal drive current output by the driving module from flowing to the control module, and is configured to be in an on state from a second frame of display picture so as to output a normal drive current output by the driving module to the control module, wherein each of the first frame of display picture and the second frame of display picture includes an initialization stage, a charging stage and the light emitting stage, during the initialization stage and the charging stage, the voltage level of the light emitting signal terminal is ineffective, and during the light emitting stage, the voltage level of the light emitting signal terminal is effective, and the switch module is configured to be in an off state during entire duration of the first frame;

under the control of the light emitting signal terminal, the control module outputs the normal drive current output by the driving module to the input terminal of the light emitting device during the light emitting stage, and the light emitting device emits light normally when driven by the normal drive current.

2. The pixel circuit as claimed in claim **1**, wherein the switch module comprises: a first switch transistor;

a gate of the first switch transistor is connected with the switch signal terminal, a source of the first switch transistor is connected with the output terminal of the driving module, and a drain of the first switch transistor is connected with the input terminal of the control module.

3. The pixel circuit as claimed in claim **1**, wherein the control module comprises: a second switch transistor;

a gate of the second switch transistor is connected with the light emitting signal terminal, a source of the second switch transistor is connected with an output terminal of the switch module, and a drain of the second switch transistor is connected with the input terminal of the light emitting device.

4. The pixel circuit as claimed in claim **1**, wherein the driving module comprises: an initialization unit, a charging unit, a compensation unit and a driving unit;

a control terminal of the driving unit is connected with a first node, an input terminal of the driving unit is connected with a high level signal terminal, and an output terminal of the driving unit is connected with an input terminal of the switch module and an input terminal of the compensation unit respectively; a control terminal of the compensation unit is connected with a scanning signal terminal, an output terminal of the compensation unit is connected with the first node; a first control terminal of the charging unit is connected with the scanning signal terminal, a second control terminal of the charging unit is connected with of the light emitting signal terminal, a first input terminal of the charging unit is connected with a data signal terminal, a second input terminal of the charging unit is connected with a reference signal terminal, and an output terminal of the charging unit is connected with a second node; the initialization unit is connected with a reset signal terminal, a restore signal terminal, the high level signal terminal and the first node;

during the initialization stage, under the control of the reset signal terminal, the initialization unit is configured to perform an initialization for the first node and the second node by a signal input via the restore signal terminal and a signal input via the high level signal terminal respectively; during the charging stage, under the control of the scanning signal terminal, the compensation unit is configured to perform an compensation for the threshold voltage of the driving unit at the first node, and under the control of the scanning signal terminal, the charging unit is configured to perform a data writing to the first node by a signal input via the data signal terminal; during the light emitting stage, under the control of the light emitting signal terminal, the charging unit is configured to perform an adjustment on a voltage signal at the first node by a signal input via the reference signal terminal, and under the control of the first node at which the voltage signal is adjusted, the driving unit outputs to the input terminal of the switch module a drive current for driving the light emitting device to the emit light.

5. The pixel circuit as claimed in claim **4**, wherein the driving unit comprises: a drive transistor;

a gate of the drive transistor is connected with the first node, a source of the drive transistor is connected with the high level signal terminal, and a drain of the drive transistor is connected with an input terminal of the switch module.

6. The pixel circuit as claimed in claim **4**, wherein the compensation unit comprises: a third switch transistor;

a gate of the third switch transistor is connected with the scanning signal terminal, a source of the third switch transistor is connected with the output terminal of the driving unit, and a drain of the third switch transistor is connected with the first node.

7. The pixel circuit as claimed in claim **4**, wherein the charging unit comprises: a fourth switch transistor and a fifth switch transistor; wherein,

a gate of the fourth switch transistor is connected with the scanning signal terminal, a source of the fourth switch transistor is connected with the data signal terminal, and a drain of the fourth switch transistor is connected with the second node;

a gate of the fifth switch transistor is connected with the light emitting signal terminal, the source of the fifth switch transistor is connected with the reference signal terminal, and the drain of the fifth switch transistor is connected with the second node.

8. The pixel circuit as claimed in claim **4**, wherein the initialization unit comprises: a sixth switch transistor, a seventh switch transistor and a capacitor; wherein,

a gate of the sixth switch transistor is connected with the reset signal terminal, a source of the sixth switch transistor is connected with the restore signal terminal, and a drain of the sixth switch transistor is connected with the first node;

a gate of the seventh switch transistor is connected with the reset signal terminal, a source of the seventh switch transistor is connected with the high level signal terminal, and a drain of the seventh switch transistor is connected with the second node;

the capacitor is connected between the first node and the second node.

9. An organic electroluminescent display panel, comprising a pixel circuit, the pixel circuit comprises: a light

emitting device, a driving module configured to drive the light emitting device to emit light, and a control module configured to control the light emitting device to emit light during a light emitting stage; further comprising: a switch module;

a control terminal of the switch module is connected with a switch signal terminal, an input terminal of the switch module is connected with an output terminal of the driving module, and an output terminal of the switch module is connected with an input terminal of the control module;

a control terminal of the control module is connected with a light emitting signal terminal, and an output terminal of the control module is connected with an input terminal of the light emitting device; and an output terminal of the light emitting device is connected with a low level signal terminal;

under the control of the switch signal terminal, the switch module is configured to be in an off state during a first frame of display picture as startup and prevent an abnormal drive current output by the driving module from flowing to the control module, and is configured to be in an on state from a second frame of display picture so as to output a normal drive current output by the driving module to the control module, wherein each of the first frame of display picture and the second frame of display picture includes an initialization stage, a charging stage and the light emitting stage, during the initialization stage and the charging stage, the voltage level of the light emitting signal terminal is ineffective, and during the light emitting stage, the voltage level of the light emitting signal terminal is effective, and the switch module is configured to be in an off state during entire duration of the first frame;

under the control of the light emitting signal terminal, the control module outputs the normal drive current output by the driving module to the input terminal of the light emitting device during the light emitting stage, and the light emitting device emits light normally when driven by the normal drive current.

10. The organic electroluminescent display panel as claimed in claim **9**, wherein the switch module comprises: a first switch transistor;

a gate of the first switch transistor is connected with the switch signal terminal, a source of the first switch transistor is connected with the output terminal of the driving module, and a drain of the first switch transistor is connected with the input terminal of the control module.

11. The organic electroluminescent display panel as claimed in claim **9**, wherein the control module comprises: a second switch transistor;

a gate of the second switch transistor is connected with the light emitting signal terminal, a source of the second switch transistor is connected with an output terminal of the switch module, and a drain of the second switch transistor is connected with the input terminal of the light emitting device.

12. The organic electroluminescent display panel as claimed in claim **9**, wherein the driving module comprises: an initialization unit, a charging unit, a compensation unit and a driving unit;

a control terminal of the driving unit is connected with a first node, an input terminal of the driving unit is connected with a high level signal terminal, and an output terminal of the driving unit is connected with an input terminal of the switch module and an input terminal of the compensation unit respectively; a control terminal of the compensation unit is connected with a scanning signal terminal, an output terminal of the compensation unit is connected with the first node; a first control terminal of the charging unit is connected with the scanning signal terminal, a second control terminal of the charging unit is connected with of the light emitting signal terminal, a first input terminal of the charging unit is connected with a data signal terminal, a second input terminal of the charging unit is connected with a reference signal terminal, and an output terminal of the charging unit is connected with a second node; the initialization unit is connected with a reset signal terminal, a restore signal terminal, the high level signal terminal and the first node;

during the initialization stage, under the control of the reset signal terminal, the initialization unit is configured to perform an initialization for the first node and the second node by a signal input via the restore signal terminal and a signal input via the high level signal terminal respectively; during the charging stage, under the control of the scanning signal terminal, the compensation unit is configured to perform an compensation for the threshold voltage of the driving unit at the first node, and under the control of the scanning signal terminal, the charging unit is configured to perform a data writing to the first node by a signal input via the data signal terminal; during the light emitting stage, under the control of the light emitting signal terminal, the charging unit is configured to perform an adjustment on a voltage signal at the first node by a signal input via the reference signal terminal, and under the control of the first node at which the voltage signal is adjusted, the driving unit outputs to the input terminal of the switch module a drive current for driving the light emitting device to the emit light.

13. The organic electroluminescent display panel as claimed in claim **12**, wherein the driving unit comprises: a drive transistor;

a gate of the drive transistor is connected with the first node, a source of the drive transistor is connected with the high level signal terminal, and a drain of the drive transistor is connected with an input terminal of the switch module.

14. The organic electroluminescent display panel as claimed in claim **12**, wherein the compensation unit comprises: a third switch transistor;

a gate of the third switch transistor is connected with the scanning signal terminal, a source of the third switch transistor is connected with the output terminal of the driving unit, and a drain of the third switch transistor is connected with the first node.

15. The organic electroluminescent display panel as claimed in claim **12**, wherein the charging unit comprises: a fourth switch transistor and a fifth switch transistor; wherein,

a gate of the fourth switch transistor is connected with the scanning signal terminal, a source of the fourth switch transistor is connected with the data signal terminal, and a drain of the fourth switch transistor is connected with the second node;

a gate of the fifth switch transistor is connected with the light emitting signal terminal, the source of the fifth switch transistor is connected with the reference signal terminal, and the drain of the fifth switch transistor is connected with the second node.

16. The organic electroluminescent display panel as claimed in claim 12, wherein the initialization unit comprises: a sixth switch transistor, a seventh switch transistor and a capacitor; wherein,

a gate of the sixth switch transistor is connected with the reset signal terminal, a source of the sixth switch transistor is connected with the restore signal terminal, and a drain of the sixth switch transistor is connected with the first node;

a gate of the seventh switch transistor is connected with the reset signal terminal, a source of the seventh switch transistor is connected with the high level signal terminal, and a drain of the seventh switch transistor is connected with the second node;

the capacitor is connected between the first node and the second node.

17. A display apparatus, comprising an organic electroluminescent display panel having a pixel circuit, the pixel circuit comprises: a light emitting device, a driving module configured to drive the light emitting device to emit light, and a control module configured to control the light emitting device to emit light during a light emitting stage; further comprising: a switch module;

a control terminal of the switch module is connected with a switch signal terminal, an input terminal of the switch module is connected with an output terminal of the driving module, and an output terminal of the switch module is connected with an input terminal of the control module;

a control terminal of the control module is connected with a light emitting signal terminal, and an output terminal of the control module is connected with an input terminal of the light emitting device; and an output terminal of the light emitting device is connected with a low level signal terminal;

under the control of the switch signal terminal, the switch module is configured to be in an off state during a first frame of display picture as startup and prevent an abnormal drive current output by the driving module from flowing to the control module, and is configured to be in an on state from a second frame of display picture so as to output a normal drive current output by the driving module to the control module, wherein each of the first frame of display picture and the second frame of display picture includes an initialization stage, a charging stage and the light emitting stage, during the initialization stage and the charging stage, the voltage level of the light emitting signal terminal is ineffective, and during the light emitting stage, the voltage level of the light emitting signal terminal is effective, and the switch module is configured to be in an off state during the entire duration of the first frame;

under the control of the light emitting signal terminal, the control module outputs the normal drive current output by the driving module to the input terminal of the light emitting device during the light emitting stage, and the light emitting device emits light normally when driven by the normal drive current.

18. The display apparatus as claimed in claim 17, wherein the switch module comprises: a first switch transistor;

a gate of the first switch transistor is connected with the switch signal terminal, a source of the first switch transistor is connected with the output terminal of the driving module, and a drain of the first switch transistor is connected with the input terminal of the control module.

19. The display apparatus as claimed in claim 17, wherein the control module comprises: a second switch transistor;

a gate of the second switch transistor is connected with the light emitting signal terminal, a source of the second switch transistor is connected with an output terminal of the switch module, and a drain of the second switch transistor is connected with the input terminal of the light emitting device.

20. The display apparatus as claimed in claim 17, wherein the driving module comprises: an initialization unit, a charging unit, a compensation unit and a driving unit;

a control terminal of the driving unit is connected with a first node, an input terminal of the driving unit is connected with a high level signal terminal, and an output terminal of the driving unit is connected with an input terminal of the switch module and an input terminal of the compensation unit respectively; a control terminal of the compensation unit is connected with a scanning signal terminal, an output terminal of the compensation unit is connected with the first node; a first control terminal of the charging unit is connected with the scanning signal terminal, a second control terminal of the charging unit is connected with of the light emitting signal terminal, a first input terminal of the charging unit is connected with a data signal terminal, a second input terminal of the charging unit is connected with a reference signal terminal, and an output terminal of the charging unit is connected with a second node; the initialization unit is connected with a reset signal terminal, a restore signal terminal, the high level signal terminal and the first node;

during the initialization stage, under the control of the reset signal terminal, the initialization unit is configured to perform an initialization for the first node and the second node by a signal input via the restore signal terminal and a signal input via the high level signal terminal respectively; during the charging stage, under the control of the scanning signal terminal, the compensation unit is configured to perform an compensation for the threshold voltage of the driving unit at the first node, and under the control of the scanning signal terminal, the charging unit is configured to perform a data writing to the first node by a signal input via the data signal terminal; during the light emitting stage, under the control of the light emitting signal terminal, the charging unit is configured to perform an adjustment on a voltage signal at the first node by a signal input via the reference signal terminal, and under the control of the first node at which the voltage signal is adjusted, the driving unit outputs to the input terminal of the switch module a drive current for driving the light emitting device to the emit light.

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[标]申请(专利权)人(译)	京东方科技集团股份有限公司 成都京东方光电科技有限公司		
申请(专利权)人(译)	京东方科技集团股份有限公司. 成都京东方光电科技有限公司.		
当前申请(专利权)人(译)	京东方科技集团股份有限公司. 成都京东方光电科技有限公司.		
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优先权	201510571804.1 2015-09-09 CN		
其他公开文献	US20170069264A1		
外部链接	Espacenet		

摘要(译)

本公开公开了一种像素电路，有机电致发光显示面板和显示装置。通过在像素电路中增加一个开关模块，可以防止在启动显示画面的第一帧期间驱动模块输出的异常驱动电流流到发光器件，从而可以解决屏幕闪烁的问题。显示面板启动时第一帧的屏幕。