~~High~~ High-Efficiency Driver Circuit for AMOLED Displays with Compensation

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Abstract

Flat-panel display (FPD) technologies such as LCD and plasma suffer from limitations such as low contrast and high power consumption under speed conditions that are unacceptable for three-dimensional displays. To overcome these limitations, organic-electronic displays based on organic light-emitting diode (OLED) technology have been developed; however, they suffer from several technical problems. To this end, a~~A~~ ~~new~~ novel ~~proposed~~ compensation driver circuit ~~of flat-panel display (FPD)~~ based on ~~organic light emitting diodes (OLEDs)~~ OLED and ~~on~~ poly-crystalline silicon thin-film transistors (~~poly-Si~~ TFTs) is ~~presented~~proposed here for FPDs. This driver circuit is developed specifically for an active-matrix organic light-emitting-diode ~~(AMOLED)~~ display. ~~and its~~ Its efficiency is verified by comparing~~ed~~ it with ~~the~~ a conventional configuration ~~with~~ using two~~2~~ TFTs. ~~According to results~~The results indicate that the power consumption of the proposed~~,~~ ~~this~~ circuit is ~~suitable to achieve~~ at an acceptable level and that the circuit can achieve ~~for power consumption,~~ high contrast, maximum gr~~a~~ey levels, and ~~better~~ good brightness. ~~And, to show this,~~ In addition, to demonstrate the feasibility of the proposed circuit, a stable driving scheme is developed for the circuit with ~~much compensation such~~ compensation ~~as against~~ for ~~the~~ data degradation, ~~the~~ threshold voltage dispersions of the TFT drive, and suppression of the TFT leakage current effect.

Keywords: compensation driver circuit; poly-crystalline silicon thin-film transistor; AMOLED; pixel driver scheme

1. Introduction

Display technologies such as LCD and plasma suffer from limitations such as low contrast and high power consumption [1, 2] under speed conditions that are unacceptable for three-dimensional displays because of the addressing phase. ~~The new generation of display, organic~~ Organic-electronic displays~~,~~ based on organic ~~light~~ light-emitting diode~~s~~ (OLED~~s~~) technology have been developed ~~has established~~ to ~~eliminate~~ overcome these limitations~~the defects reported for the other technologies (LCD and PLASMA): low contrast and high consumption[1, 2] with speed conditions that may be unacceptable for some displays of 3 dimensions due to addressing type~~. ~~This new technology~~ OLED displays can ~~meets~~ satisfy user requirements ~~the needs of users in terms of~~ such as ~~pure~~ high picture quality and functioning levels, particularly ~~especially~~ for mobile devices~~;~~. In addition, because of the low temperature of the OLED treatments, they~~it~~ offer~~s~~ new possibilities that were previously considered ~~previously~~ unattainable (such as ~~as the~~ deposition on large surfaces or ~~on~~ flexible substrates) ~~because of low temperature of the OLED treatments~~ [3, 4]. ~~; also~~ Moreover, the vision affects reality in terms of quality.

~~On the other hand, t~~A ~~he current~~ current-driven ~~of~~ OLED device can be ~~provided~~ realized using ~~by~~ a ~~passive~~ passive-matrix or ~~active~~ active-matrix backplane architecture [5]. In the latter, ~~case the colour~~color adjustment is ~~determined~~ achieved ~~by~~ using a command based on a ~~thin~~ thin-film

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transistor (TFT) ~~-~~[1, 5]. This solution is preferred~~, especially,~~ ~~-~~ particularly when the size of the display ~~increased~~ increases, which can often result in ~~where we have~~ technical problems. The ~~backplane of the~~ active~~-~~matrix backplane is ~~like a~~ similar to a group of switche~~r~~s or circuits ~~which~~ that can control~~s~~ the current intensity flowing through each OLED pixel and ~~does not let~~ limit ~~electricity~~ electric flow to only when ~~this~~ it is necessary.

~~These circuits'~~ Circuit designs are developed to complement ~~designs are based on~~ amorphous silicon (a-Si), polycrystalline silicon (poly-Si) [2], and organic TFTs (OTFTs)~~, and circuits' designs complementariness~~. According to ~~the~~ manufacturers, several ~~technologies~~ technology backplanes ~~in terms of~~ consider the structure and level of fitness, which are used to determine the ~~used for~~ uniformity and stability ~~sufficient for~~ of brightness; these ~~which~~ backplanes differ in their driving speed, power consumption, area occupied, and the accuracy ~~needed~~ required to set the current level~~, have been presented~~. ~~In particular, t~~These driver circuits ~~can be~~ are classified into two programming modes ~~in accordance with~~ based on the data type: voltage-~~programming circuit~~ and current-programming circuits. ~~However for both types of circuits at the driving scheme, the v~~However, in both these types, variations in the threshold voltage of the TFTs~~, due to~~ attributed to ~~the~~ changes in mobility under the influence of operating time and under abnormal thermal conditions ~~which~~ can ~~attain, respectively,~~ lead to 10~~–% to~~–50%~~, the~~ data degradation~~,~~; v~~and the change~~ariation in the supply voltage, ~~the~~ leakage current, and ~~the~~ speed~~,~~ can result in the ~~generate~~ degradation and nonuniformity ~~in~~ of brightness over time in the pixel ~~itself~~. ~~and i~~In many cases, ~~there is a fluctuation in~~ the brightness in the surrounding pixels also fluctuates. These disturbances add up over time and ~~may be the cause~~ cause ~~of~~ poor vision. M~~To avoid these problems, the m~~anufacturers have started using ~~are using these~~ transistors with adequate compensation methods to avoid these problems [5~~].~~].

~~Nevertheless,~~ Several driving transistors per pixel are required to compensate for the major technical problems, ~~high-quality displays, low power consumption, and improvement of~~ improve ~~the~~ nonuniform brightness and ~~the~~ efficiency of the driver circuits, and realize high-quality displays with low power consumption ~~require several driving transistors per pixel to allow compensation for major technical problems~~. ~~Specifically using c~~Compensation circuits based on poly-Si technology ~~has been~~ have achieved ~~a~~ considerable progress in providing stable and uniform brightness with a ~~great~~ long lifetime. ~~Also it~~ Although this approach is ~~is~~ not as cost-effective ~~in~~ as ~~comparison with~~ other TFT technologies ~~(~~such as a-TFT and O-TFT~~)~~, ~~and~~ it ~~can~~ provides a constant current to the OLED and achieves excellent mobility~~;~~. The ~~compensation~~ compensation circuits ~~reached~~ can satisfy the requirements of the OLED driving current under the minimum power supply ~~respecting~~ while meeting the ~~the~~ speed condition and ~~also~~ assist~~s~~ing in the direct integration of the driver circuit on ~~the~~ flexible substrates [2, 5].

In this ~~paper~~study, we ~~privilege the~~ use ~~of~~ a poly-Si transistor for the proposed driver circuit. T~~And generally we can say that t~~he ~~choice of one of these~~ transistors is selected considering ~~is closely related to~~ the ~~manufacture~~ manufacturing method, which has ~~its own~~ separate parameters, the ~~and its~~ driving scheme~~s~~, and the technology used to ~~make~~ fabricate the AMOLED screen.

2. ~~The~~ Proposed ~~Driver~~ Pixel Driver Circuit

~~As we have said before,~~ As explained previously, we used a ~~we have chosen the use of~~ poly-Si transistor for the proposed driver circuit. ~~And to~~ It is preferable to use ~~ensure high speed; it will be preferable to use~~ N-type transistors ~~rather~~ instead of ~~than~~ P-type ones to ensure high speed~~.~~; ~~Also for applications of high frequency, it is better to use those of~~ N-type transistors are also preferred for high-frequency applications~~instead of P-type~~. ~~For these reasons we~~ Therefore, we used an ~~chose~~

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~~using an~~ N-type transistor as a scan transistor. ~~And for~~ For its application, we used ~~enrichment~~ improved MOSFET models ~~thanks to~~ because of their excellent ~~the~~ performance, especially ~~s that they give especially~~ under abnormal thermal conditions. Figure 1 shows the ~~The proposed design is explained compared with the~~ conventional circuit based on ~~2~~ two TFTs~~,~~ and the proposed circuit. ~~Figure 1(a).~~

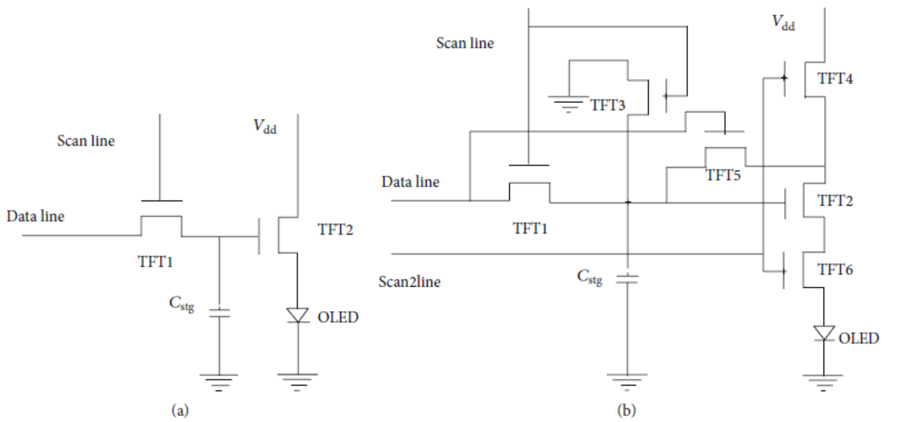

Figure 1: AMOLED: (a) conventional pixel circuit and (b) proposed pixel circuit.

This last is established to depart from the approach of the passive matrix and ~~to~~ better enhance the performances of the pixel ~~with~~ using one transistor, where a high current~~,~~ (I_{OLED}~~,~~) with ~~to achieve the desired brightness is required with~~ nonuniform levels is required to achieve the desired brightness where the pixel is almost always active. It contains an embedded memory~~,~~ (C_{stg}~~,~~) and ~~tow~~ two transistors (TFT1 and TFT2). ~~.~~TFT1 is used to select a specific pixel and ~~to~~ transfer ~~the~~ data through the data line. The data ~~make the loading of~~ loads the storage capacitance~~,~~ (C_{stg}~~,~~) during one period of operation when the scan line is in the high state. The current is injected into the organic diode ~~which~~ that emits light~~.~~, and it is then ~~It is~~ adjusted by ~~the~~ TFT2, i.e., the driver transistor~~,~~ and is expressed ~~by~~ as [5]~~:~~

$$I_{OLED} = \frac{K_{TFT2}}{2} \times \left(V_{GS\text{-}TFT2} - V_{Th\text{-}TFT2}\right)^2, \qquad (1)$$

(1)

where K_{TFT2}, $V_{GS\text{-}TFT2}$, and $V_{Th\text{-}TFT2}$ represent the ~~K_{TFT2} is the~~ transconductance factor of TFT2, ~~$V_{GS\text{-}TFT2}$ is the~~ voltage applied to the TFT2 gate-source terminal, and ~~$V_{Th\text{-}TFT2}$ is the~~ threshold voltage of TFT2, respectively. The simulation for the current delivered to the OLED of this conventional circuit is ~~presented~~ shown in Figure 2. ~~From the curve, t~~The maximum value of I_{OLED} is 3.798 μA~~.~~; ~~This~~ this value ~~last value~~ does not ~~represent~~ truly represent the data voltage because the voltage level representing the data ~~has~~ dropp~~eds, and this is~~ ~~due to~~ because of the threshold voltage $V_{Th\text{-}TFT1}$ of TFT1~~,~~. ~~and~~ The ~~the~~ recovered voltage is $V_{Data} - V_{Th\text{-}TFT1}$. ~~Also,~~ Additionally, this conventional configuration presents a variation in the threshold voltage of TFT2 and TFT1. ~~All t~~These problems lead to a nonuniform brightness during the display phase and ~~so have a~~ directly ~~influence on~~ affect the ~~gray~~ grey levels. ~~So,~~ Therefore, we must ~~think~~ consider using ~~about~~ compensation methods to avoid these problems.

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"Unlike the passive matrix backplane that can improve the performances of the pixel using one transistor, wherein a high current (I_{OLED}) with nonuniform levels is required to achieve the desired brightness where the pixel is almost always active; the active-matrix backplane contains an embedded memory (C_{stg}) and two transistors (TFT1 and TFT2)."

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First~~ly~~, to well compensate the loss in data voltage, we add another ~~transistor of~~ P-type transistor~~:~~, i.e., the ~~a~~ restoration transistor TFT3, as shown in Figure 1(b)~~Figure 1(b)~~. ~~With t~~This transistor~~,~~ ensures that the ~~the charge~~ stored charge ~~stored in the capacity~~ is ~~exactly~~ the same as the data voltage~~,~~; however, the ~~but the~~ most important ~~issue~~ factor is the size of this restoration transistor. ~~.~~ In reality, it acts as the capacitance, and ~~their~~ its limited size is directly related to the loading time of C_{stg} with TFT1 and its ~~their~~ internal capacitance~~,~~ C_{gb} (gate-bulk capacitance~~);~~); ~~this~~ this is a very important condition for calculating ~~their~~ its capacitance. ~~Therefore, t~~This transistor provides the ~~a~~ load current in capacitance C_{stg} and decreases the charging time to make it equal to the loading time of ~~loading capacitance~~ C_{stg} through TFT1~~,~~. Therefore, ~~so it~~ there is a need to ~~must~~ reduce its internal resistance (R_{sh}: drain, source diffusion sheet resistance), resulting from an increase in ~~their~~ the ratio W_{TFT3}/L_{TFT3}.

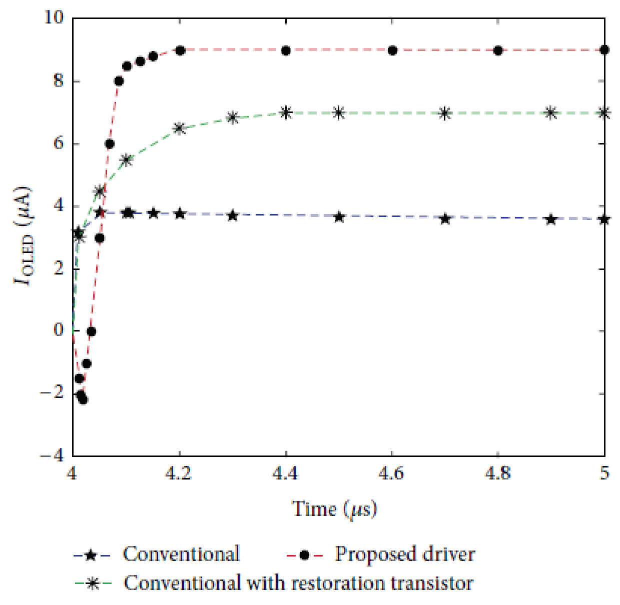

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Figure 2: OLED current during the display phase in the conventional configuration ~~of~~ that uses ~~2~~ two TFTs, conventional driver circuit with the restoration transistor, and final model of the proposed driver circuit.

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Subsequently, ~~we have t~~two conditions ~~that~~ must be ~~respected~~met: ~~we increase~~ W/L should be increased to reduce the resistance and ~~we increase~~ $W\times L$ should be increased to ~~to~~ increase the internal capacitance~~,~~ C_{gb}~~, of this transistor~~. ~~The o~~Optimal values that allow us to offset ~~the~~ data degradation ~~are~~ include the threshold voltage $V_{Th\text{-}TFT3} = -V_{Th\text{-}TFT1}$ and $W = 4 \times L$. ~~In~~ Under ~~this~~ these conditions, ~~condition,~~ the maximum current delivered to the OLED becomes 7 μA~~; see~~, as shown in Figure 2~~,~~. ~~and therefore~~ Thus, we ~~we have~~ successfully corrected ~~the~~ data degradation and increased ~~the current~~ I_{OLED}. ~~In addition, D~~Despite ~~the compensation of~~ compensating for ~~the~~ data degradation, we ~~have always the problem of~~ suffer from the threshold voltage variation of TFT2 with increased energy consumption ~~due to~~ caused by the ~~the~~ presence of ~~anther~~ another capacitance ~~which is~~ represented by ~~the~~ transistor TFT3. ~~So we~~ Therefore, we seek to develop a ~~a~~ method that can ~~to~~ resolve these problems.

~~First, to minimize power consumption, t~~The OLED is only activated ~~active only if necessary~~for minimizing power consumption. For this, a new ~~transistor of~~ P-type transistor~~,~~ (TFT4)~~,~~ ordered by a new control line, Scan2line, is added as shown in Figure 1(b)~~;~~). T~~t~~his transistor does not ~~leave~~ allow the driver circuit to work ~~works only if~~ when ~~that is~~ necessary even if ~~the~~ V_{Data} is ~~already~~ stored in ~~the~~ capacitance C_{stg}. ~~Second, to avoid the problem of the threshold voltage variation of TFT2, w~~We add another P-type transistor ~~of P-type,~~ (TFT5)~~,~~ to avoid the problem of the threshold voltage variation of TFT2, as shown in Figure 1(b). The simulation ~~gives an~~ increases ~~in~~ the maximum current to 9 μA~~;~~, as shown in ~~see~~ Figure 2~~.~~; ~~This~~ this increase of 2 μA is ~~due in~~ attributed to the ~~fact to the~~ storage of the threshold voltage $V_{\text{Th-TFT2}}$ of TFT2 in ~~the~~ capacitance C_{stg}. ~~Moreover the~~ The presence of a leakage current in the OLED during the reset phase requires us to add another transistor to eliminate it~~,~~ because this current becomes critical for the lifetime of the OLED. Thus, ~~so in screen over time where the~~ screen ~~colours~~colors ~~will~~ become darker over time if we exceed certain hours of the operation, and this has a ~~and has a~~ direct effect on the contrast and ~~on the~~ stored charge in C_{stg}. Therefore, there~~So~~ ~~it must~~ is a need to reduce the ~~be reducing~~ leakage current. ~~To do this~~To this end, ~~,~~we add another P-type transistor~~, P-type~~ (TFT6)~~,~~ to block the emission current through the OLED during the reset phase and ensure greater stability for the pixel~~,~~, as shown in Figure 1(b).

Therefore, the final proposed driver circuit ~~is able to~~ can ~~reduce~~ avoid the problem of ~~nonuniformity of brightness~~nonuniformity in brightness~~,~~. In addition, it has a ~~it has a~~ large output current with a faster response time, it can block the current circulating in the OLED during the reset period where an increase in the contrast ratio is guaranteed~~,~~, and ~~and~~ it can reduce~~s~~ energy consumption. ~~Also,~~ T~~t~~he OLED is placed between the drain of TFT6 and the ground to cancel the transient characteristics. ~~So~~ T~~we can say that t~~he proposed ~~circuit~~ pixel circuit is suitable for the AMOLED screen~~,~~; however, ~~but~~ it requires ~~more precision by~~ the insertion of ~~the~~ a new control signal, Scan2line, to achieve better precision.

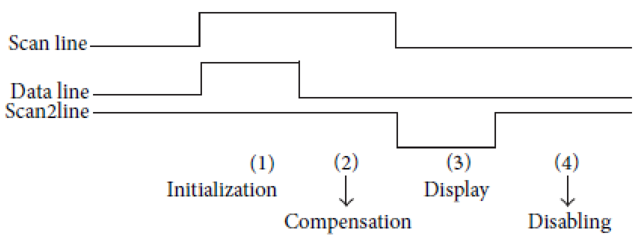

Figure 3: Timing scheme.

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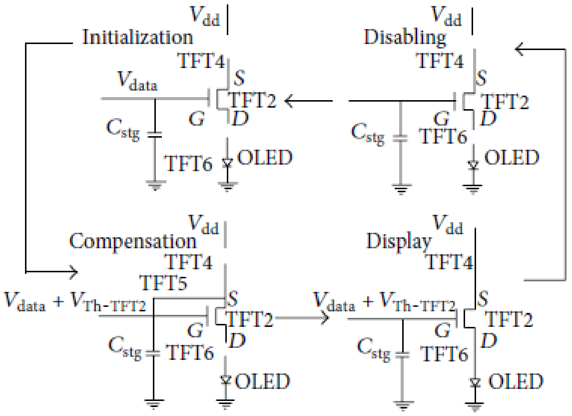

Figure 4: Equivalent circuits in each step of operation of the proposed design.

3. Driving Scheme

In the proposed design exposed in Figure 1(b) TFT1, TFT4, TFT5, and TFT6 function as switches, TFT3 is the restoration transistor, and TFT2 is the driving transistor; it operates in saturation regime when it is in the passant state. The timing or the driving scheme for this proposed driver is defined as shown in Figure 3. Figure 4 shows the operations steps with the main compensations. From these figures we find the following.

Initialization Phase of Data. It is the activation phase. During it, the signals scan line and data line are in the high state; the TFT1 and TFT3 are passers. The capacitance, C_{stg}, loads up a specific value which is $Q = C \cdot V_{Data}$. But it must pay attention to the threshold voltage of TFT1, $V_{Th\text{-}TFT1}$, because the output of this transistor is also $V_{Data} - V_{Th\text{-}TFT1}$, so the presence of TFT3 is verified, because it enables making the correction for the loss of V_{Data}, so during this phase the capacitance C_{stg} loads to V_{Data} as shown the relationship

$$V_{stg} = V_{Data} - V_{Th\text{-}TFT1} + |V_{Th\text{-}TFT3}|. \qquad (2)$$

(2)

Compensation Phase of the Threshold Voltage of TFT2. During this phase the signal Scan2line is in the high state, TFT4 and TFT6 are blocked, and data line is in the low state to make the loading of the threshold voltage of TFT2 in the capacitance C_{stg}. At this time the gate of TFT2 is connected with their drain through the transistor TFT5, where we have a diode type connection, and so the voltage across the capacity C_{stg} becomes $V_{Data} + V_{Th\text{-}TFT2}$. This technique allows cancelling the threshold voltage variation when the TFT2 commands OLED.

Display Phase. After the scan time of pixel and the step of initialization and compensation for the data voltages and for the $V_{Th\text{-}TFT2}$, the signal Scan2line becomes in the low state. During this period, the TFT2 provided to the OLED the current:

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$$I_{OLED} = \frac{K}{2} \times (V_{GS\text{-}TFT2} - V_{Th\text{-}TFT2})^2 = \frac{K}{2} \times (V_{Data} + V_{Th\text{-}TFT2} - V_{Th\text{-}TFT2})^2 = \frac{K}{2} V_{Data}{}^2. \quad (3)$$

(3)

As indicated in this expression, the drain current of TFT2 is independent of the threshold voltage of TFT2 and is only affected by V_{Data}; therefore uniform brightness of the image can be defined according to the desired gray levels.

Disabling Phase. This is the nonoperation phase of the pixel. It is applied if we want to avoid the operation of the pixel. It is obtained by forcing the signal Scan2line to be in a high state, even in the case where we have a charge stored in the capacitance C_{stg}. This charge remains constant until the next reset phase.

4. ~~Performances~~ Results and Discussion

In the proposed design of the driver circuit, the OLED current depends only on data. ~~Also there~~ T~~is an increase in t~~he contrast ratio is increased by inserting ~~the transistor~~ TFT6 ~~as~~ when the OLED is disconnected from another part of the circuit during the initialization and compensation phase~~,~~; therefore, ~~so~~ it does not emit light during the addressing phase, and ~~therefore~~ a perfect black ~~colour~~color is displayed. ~~In the other hand, t~~Meanwhile, the circuit is thermally ~~stressed~~stressed, and its operating temperature increases over time. ~~And to assess how this circuit operates under abnormal thermal conditions, w~~We ~~also~~ perform ~~the~~ simulations at different temperatures to assess how this circuit operates under abnormal thermal conditions. The results are ~~shown~~ illustrated in Figure 5 ~~at~~ for 27 and 100 °C~~°C~~.

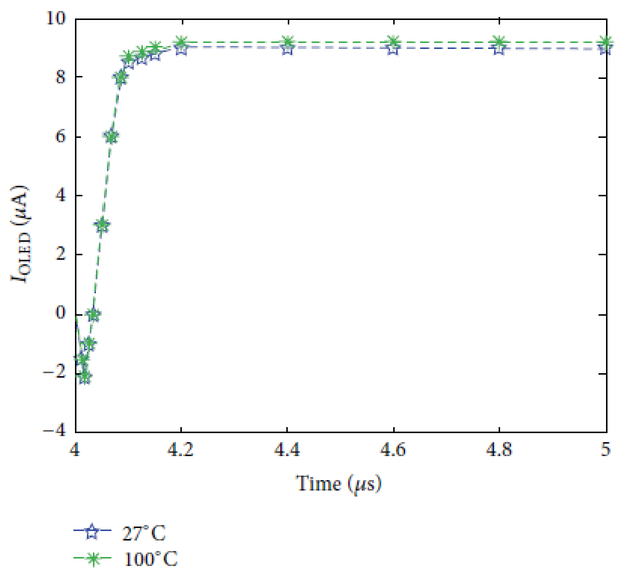

Figure 5: Influence of abnormal thermal condition on I_{OLED}.

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~~As a result there is a~~A slight variation is observed in I_{OLED} under thermal conditions, and this can be ~~due to the~~ attributed to changes in mobility in ~~the driving transistor~~ TFT2. ~~In addition,~~ Further, a reduction in energy consumption is accomplished by inserting ~~the transistor~~ TFT4. ~~And generally, t~~The driver circuit behaves as a multitude of capacities that need to load and unload. Energy consumption can be classified as ~~In general, we have the two energy~~ static or dynamic energy ~~contributions~~consumption~~: static and dynamic.~~; ~~However,~~ the ~~static consumption is~~ former is almost zero~~,~~. Thus, we ~~so we~~ need to ~~only~~ consider only ~~the~~ dynamic power consumption, which is ~~given by the following formula:~~expressed as

$$P_{\text{dynamique}} = \frac{1}{2}\times\alpha_{0\to1}\times C_L\times V_{dd}^{2}\times f, \qquad (4)$$

(4)

where C_L, V_{dd}, and f represent ~~C_L is~~ the equivalent capacitance of loading and unloading in the driver circuit, ~~V_{dd} is the~~ supply voltage, and ~~f is the~~ operating frequency of the driver circuit~~:~~ position set by Scan2line, respectively. Further, ~~The~~ $\alpha_{0\to1}$ ~~is~~ represents the probability of ~~having~~ consumption during one clock cycle. This ~~, this~~ parameter is determined ~~according to~~ based on the driving scheme used, and its value is between 0 and 1. This expression of power explains the continuing efforts of ~~the~~ circuit designers to ~~reduce~~ minimize the size of transistors, which helps reduce~~s~~ the value of parasitic capacities~~,~~ and ~~reduce the~~ supply voltage~~, in order~~ to increase the working frequency of circuits. For the proposed pixel circuits, we ~~take~~ consider the values $\alpha = 0.33$ and $C_L = 1$ pF~~.~~; hence, ~~Hence~~ $P_{\text{dynamique}} = 2.0625\cdot10^{-6}$ W. If we calculate this consumption for a screen with ~~the~~ a resolution of 176 × 220 pixels, we obtain $P = 79.68$ mW. ~~And~~ This ~~when a comparison is made between AMOLED screen of 2.2 inch with resolution 176 × 220 that is presented in [1] and AMOLED screen with the same resolution using the proposed circuit, we note that this~~ indicates a decrease ~~consumption has decreased by~~ of ~~about~~ approximately 60% in consumption when a comparison is drawn between a 2.2-inch AMOLED screen with a resolution of 176 × 220 [1] and another AMOLED screen with the same resolution using the proposed circuit. ~~Furthermore, we must note that t~~This consumption is calculated without resistive and capacitive couplings for ~~a~~ the total screen~~,~~; ~~so~~ therefore, ~~to make clear consumption~~ we must consider ~~take into account~~ these capacitances to obtain an accurate consumption. Further, we ~~We~~ must ~~also take into account~~ consider the overlap capacitances of TFTs (C_{GS}, C_{GD}, and C_{GB}). ~~Also these~~ In addition, these capacitances have a direct influence on the loading of the data voltage ($C_{Dataline}$) in ~~the capacitance~~ C_{stg} and on the speed of circuit ($C_{Scanline}$ and $R_{Scanline}$) for the AMOLED screen. ~~But generally T~~These values generally depend on the manufacturing process of TFTs, and therefore, we can neglect them. ~~Moreover, when we talk about gray levels, t~~The parameter ~~which~~ directly ~~affects~~ affecting ~~these~~ the grey levels is the size of ~~the capacitance~~ C_{stg}~~,~~ because ~~with a very precise adjustment~~ we can employ precise adjustments to ensure that ~~oblige the~~ capacitances ~~not to~~ do not ~~make~~ produce an error that exceeds the voltage necessary to pass from one ~~gray~~ grey level to another level.~~.~~

5. Conclusion

In this work, a new compensation driver circuit ~~based on~~using ~~the technology~~ TFT poly-Si technology as a support ~~of~~ for the organic matrix ~~thanks to~~ because of its speed and ~~its~~ thermal stability ~~is~~ was proposed with ~~its~~ a driving scheme~~,~~. The proposed circuit comprises ~~consisting of 6~~ six ~~transistors~~ TFTs, ~~and having~~ three input lines (data line and scan line plus one additional control signal: Scan2line), ~~plus~~ and ~~one~~ a storage capacitance. ~~By results of~~ The circuit ~~tests~~test results indicated that ~~, it is found that~~ the proposed circuit can be ~~successfully~~ operated successfully under the optimal timing scheme~~;~~, and it offers a stable output current of a high value while ~~keeping~~ maintaining a ~~response time~~ relatively fast response time and minimal power consumption. It is compatible with the requirements of AMOLED displays under ~~minimal power consumption and~~ abnormal thermal conditions. The ~~We have shown for this proposed circuit a~~ driving scheme

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designed for the proposed circuit is based on a restoration technique for ~~the~~ data degradation and compensation ~~of the~~ for the threshold voltage variation of TFT2 ~~driver by using the method of loading this voltage in the capacitance C_{stg}. On the other hand,~~ Tto reduce energy consumption, increase the contrast ratio, and suppress the TFT leakage effect, we ~~have~~ introduced two other transistors with an additional signal line to prevent the leakage current and allow the pixels ~~and~~ to ~~make this pixel~~ operate as ~~needed~~required. ~~This~~ The proposed circuit ~~is~~ was compared with ~~the~~ a conventional circuit of two2 TFTs~~,~~. The results ~~and we can simply say that it~~ confirmed that it is ~~very~~ extremely suitable ~~for~~ in terms of its contrast, power consumption, speed, and stability of brightness.

Acknowledgements

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