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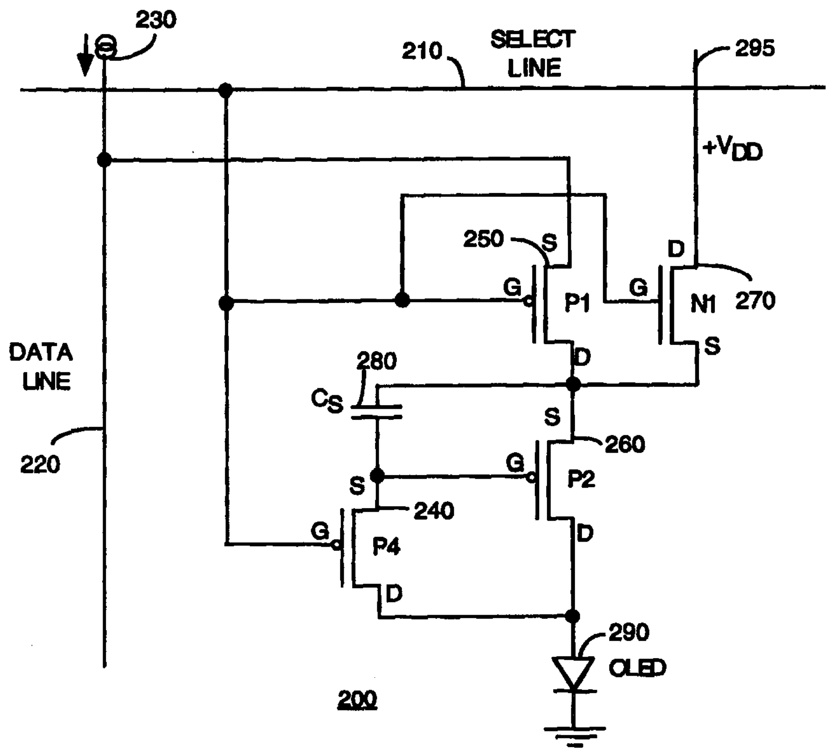
(57) Abstract

A LED pixel structure (200, 300, 400, 600, 700) that reduces current nonuniformities and threshold voltage variations in a "drive transistor" of the pixel structure is disclosed. The LED pixel structure incorporates a current source for loading data into the pixel via a data line. Alternatively, an auto zero voltage is determined for the drive transistor prior to the loading of data.



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ACTVE MATRIX LIGHT EMITTING DIODE PIXEL STRUCTURE AND METHOD

This application claims the benefit of U.S. Provisional Application No. 60/ 044, 174 filed April 23, 1997, which is herein incorporated by reference.

This invention was made with U.S. government support under contract number F33615-96-2-1944. The U.S. government has certain rights in this invention.

The invention relates to an active matrix light emitting diode pixel structure. More particularly, the invention relates to a pixel structure that reduces current nonuniformities and threshold voltage variations in a "drive transistor" of the pixel structure and method of operating said active matrix light emitting diode pixel structure.

BACKGROUND OF THE DISCLOSURE

Matrix displays are well known in the art, where pixels are illuminated using matrix addressing as illustrated in FIG. 1. A typical display 100 comprises a plurality of picture or display elements (pixels) 160 that are arranged in rows and columns. The display incorporates a column data generator 110 and a row select generator 120. In operation, each row is sequentially activated via row line 130, where the corresponding pixels are activated using the corresponding column lines 140. In a passive matrix display, each row of pixels is illuminated sequentially one by one, whereas in an active matrix display, each row of pixels is first loaded with data sequentially.

With the proliferation in the use of portable displays, e.g., in a laptop computer, various display technologies have been employed, e.g., liquid crystal display (LCD) and light-emitting diode (LED) display. An important distinction between these two technologies is that a LED is an emissive device which has power efficiency advantage over non-emissive devices such as (LCD). In a LCD, a fluorescent backlight is on for the entire duration in which the display is in use, thereby dissipating power even for "off" pixels. In contrast, a LED (or OLED) display only illuminates those pixels that are activated, thereby conserving power by not having to illuminate "off" pixels.

Although a display that employs an OLED pixel structure can reduce power consumption, such pixel structure may exhibit nonuniformity in intensity, which is attributable to two sources, threshold voltage drift of the drive transistor and transistor nonuniformity due to manufacturing. However, it has been observed that the brightness of the OLED is proportional to the current passing through the OLED.

Therefore, a need exists in the art for a pixel structure and concomitant method that reduces current nonuniformities and threshold voltage variations in a "drive transistor" of the pixel structure.

SUMMARY OF THE INVENTION

In one embodiment of the present invention, a current source is incorporated in a LED (OLED) pixel structure that reduces current nonuniformities and threshold voltage variations in a "drive transistor" of the pixel structure. The current source is coupled to the data line, where a constant current is initially programmed and then captured.

In an alternate embodiment, the constant current is achieved by initially applying a reference voltage in an auto-zero phase that determines and stores an auto zero voltage. The auto zero voltage effectively accounts for the threshold voltage of the drive transistor. Next, a data voltage which is referenced to the same reference voltage is now applied to illuminate the pixel.

In an another alternate embodiment, a resistor is incorporated in a LED (OLED) pixel structure to desensitize the dependence of the current passing through the OLED to the threshold voltage of the drive transistor.

BRIEF DESCRIPTION OF THE DRAWINGS

The teachings of the present invention can be readily understood by considering the following detailed description in conjunction with the accompanying drawings, in which:

FIG. 1 depicts a block diagram of a matrix addressing interface;

FIG. 2 depicts a schematic diagram of an active matrix LED pixel structure of the present invention;

FIG. 3 depicts a schematic diagram of an alternate embodiment of the present active matrix LED pixel structure;

FIG. 4 depicts a schematic diagram of another alternate embodiment of the present active matrix LED pixel structure;

FIG. 5 depicts a block diagram of a system employing a display having a plurality of active matrix LED pixel structures of the present invention;

FIG. 6 depicts a schematic diagram of an alternate embodiment of the active matrix LED pixel structure of FIG. 2; and

FIG. 7 depicts a schematic diagram of an alternate embodiment of an active matrix LED pixel structure of the present invention.

To facilitate understanding, identical reference numerals have been used, where possible, to designate identical elements that are common to the figures.

DETAILED DESCRIPTION

FIG. 2 depicts a schematic diagram of an active matrix LED pixel structure 200 of the present invention. In the preferred embodiment, the active matrix LED pixel structure is implemented using thin film transistors (TFTs), e.g., transistors manufactured using amorphous or poly-silicon. Similarly, in the preferred embodiment, the active matrix LED pixel structure incorporates an organic light-emitting diode (OLED). Although the present pixel structure is implemented using thin film transistors and an organic light-emitting diode, it should be understood that the present invention can be implemented using other types of transistors and light emitting diodes. For example, if transistors that are manufactured using other materials exhibit the threshold nonuniformity as discussed above, then the present invention can be employed to provide a constant current through the lighting element.

Although the present invention is illustrated below as a single pixel or pixel structure, it should be understood that the pixel can be employed with other pixels, e.g., in an array, to form a display. Furthermore,

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