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(54) **Method and apparatus for power level control and/or contrast control of a display device**

Verfahren und Vorrichtung zur Steuerung des Leistungsniveaus und/oder Kontrastes einer Anzeigevorrichtung

Procédé et appareil pour contrôle du niveau de puissance et/ou du contraste d'un dispositif d'affichage

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- **PATENT ABSTRACTS OF JAPAN vol. 2002, no. 10, 10 October 2002 (2002-10-10) -& JP 2002 182612 A (SONY CORP), 26 June 2002 (2002-06-26)**

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Description

[0001] The present invention relates to a method and an apparatus for controlling the power level and/or the contrast in a display device having a plurality of luminous elements corresponding to the colour components of the pixels of a picture, wherein the luminance generated by each of said luminous element is based on the intensity of the signal supplied to the luminous element.

[0002] More specifically, the invention is closely related to organic light emitting displays (OLED).

Background

[0003] A high peak-white luminance is always required to achieve a good contrast ratio in every display technologies even with ambient light conditions and, for every kind of active displays, more peak white luminance corresponds to a higher power that flows in the electronic of the display. Therefore, if no specific management is done, the enhancement of the peak luminance for a given electronic efficacy will introduce an increase of the power consumption.

[0004] The main idea behind every kind of power management concept associated with peak white enhancement is based on the variation of the peak-luminance depending on the picture content in order to stabilize the power consumption to a specified value. This concept is shown in Figure 1. When the picture load is low, the peak luminance is high and when the picture load is high, the peak luminance is low. The concept described on this figure enables to avoid any overloading of the power supply of the display panel as well as a maximum contrast for a given picture.

[0005] Such a concept suits very well to the human visual system. When the picture load is low, the contrast ratio is high and when the picture is high, the human eye is dazzled and is less sensitive to contrast ratio. So, for a full-white picture, the contrast ratio can be lower than for a peak-white picture.

[0006] In the case of cathode Ray Tubes (CRTs), the power management is based on a so called ABL function (Average Beam-current Limiter), which is implemented by analog means and which decreases video gain as a function of the average luminance of the pictures.

[0007] In the case of an organic light-emitting diode display, also called OLED display, the luminance as well as the power consumption is directly linked to the current that flows through each cell. Currently, there is no power level control means for stabilizing the power consumption to a target value.

[0008] In the other hand, in such a display device, the contrast is adjusted by a video scaler acting on the video signal. If the video signal is coded on 8 bits and if the contrast should be reduced by 50%, the video signal is rescaled leading to a video signal with only a 7 bit resolution. So, there is a loss of video resolution.

[0009] Otherwise, US 2003/218583 discloses a method of controlling the power consumption of an organic electroluminescent display with luminescing elements of red, green and blue. This method comprises measuring the power consumption via a so-called summation data detection circuit, and controlling the power consumption by changing the luminescing time period according to the measured data.Otherwise, US 2003/218583 discloses a method of controlling the power consumption of an organic electroluminescent display with luminescing elements of red, green and blue. This method comprises measuring the power consumption via a so-called summation data detection circuit, and controlling the power consumption by changing the luminescing time period according to the measured data.

[0010] EP-A-1 310 935 discloses a method for controlling the brightness of a display device. A brightness suppression coefficient is calculated for adjusting the emission brightness of the display panel in accordance with the average brightness of the image to be displayed. This coefficient is so calculated as to have such a relationship that the emission brightness of the display panel is decreased for a higher average brightness of the image. It is coupled with a scene changeover detection circuit to change rapidly the display brightness when a scene change over is detected and to change slowly the display brightness when no scene change over is detected. So, the emission brightness adjustment is done by changing a brightness component of the video signal or by changing the drive voltage of the electron emitting devices or by changing the acceleration voltage.

[0011] EP-A-1 310 935 discloses a method for controlling the brightness of a display device. A brightness suppression coefficient is calculated for adjusting the emission brightness of the display panel in accordance with the average brightness of the image to be displayed. This coefficient is so calculated as to have such a relationship that the emission brightness of the display panel is decreased for a higher average brightness of the image. It is coupled with a scene changeover detection circuit to change rapidly the display brightness when a scene change over is detected and to change slowly the display brightness when no scene change over is detected. So, the emission brightness adjustment is done by changing a brightness component of the video signal or by changing the drive voltage of the electron emitting devices or by changing the acceleration voltage.

[0012] Furthermore, an image display device wherein a pixel has a light emitting element for emitting light in accordance with a luminance level of an image signal to be input and a luminance adjustment method thereof already has been disclosed according to EP 1469449 A1.

Invention

[0013] The invention is set forth in claims 1 and 6. The present invention proposes a new method and apparatus for controlling the power level and/or the contrast in display devices having a plurality of luminous elements, wherein the luminance generated by each of said luminous element is based on the intensity of the signal supplied to the luminous element and the power level and/or contrast for each picture is controlled by adjusting the intensity of the signal to be supplied to each luminous element.

[0014] The basic idea of this invention is to supply the luminous elements of the display device with a signal whose intensity is based on reference signals and to modify the level of these reference signals for adjusting the intensity of the signals supplied to the luminous elements.

[0015] So, the invention relates to a method for controlling the power level and/or the contrast in a display device having a plurality of luminous elements corresponding to the colour components of the pixels of a picture, wherein the luminance generated by each of said luminous elements is based on the intensity of the signal supplied to the luminous element and the power level and/or contrast for each picture is controlled by adjusting the intensity of the signal to be supplied to each luminous element, **characterized in that** the intensity of the signal to be supplied to each luminous element is based on reference signals and in that the adjustment of the signal intensity is made by adjusting the level of the reference signals.

[0016] By this method, the resolution of the video signal supplied to the luminous elements is not modified.

[0017] For controlling the power level, the method further comprises the two following steps:

- calculating, for each picture received by the display device, a parameter representative of the power needed by the display device for displaying said picture; this parameter is for example the average power level; and
- adjusting the intensity of the signal to be supplied to each luminous element in order that the power needed by the display device for displaying said picture is lower than a target value.

[0018] For controlling the contrast of the pictures displayed by the display device, the method further comprises the following steps :

- calculating an adjustment factor to be applied to the intensity of the picture signal supplied to the luminous elements in order that the resulting contrast is equal to a required contrast, and
- applying said adjustment factor to said reference signals.

[0019] In a preferred embodiment, a non linear transformation is applied to reference signals, before adjustment of the signal intensity, in order to increase the amplitude of the low-amplitude reference signals. To compensate this transformation, the inverse transformation is applied to the picture signal.

[0020] The invention concerns also an apparatus for controlling the power level and/or the contrast in a display device having a plurality of luminous elements corresponding to the colour components of the pixels of a picture, wherein the luminance generated by each of said luminous elements is based on the intensity of the signal supplied to the luminous element and the power level and/or contrast for each picture is controlled by adjusting the intensity of the signal to be supplied to each luminous element, **characterized in that** the intensity of the signal to be supplied to each luminous element is based on reference signals and in that it comprises adjustment means for modifying the signal intensity by adjusting the level of the reference signals.

[0021] For controlling the power level, the apparatus further comprises calculation means for calculating, for each picture received by the display device, a parameter representative of the power needed by the display device for displaying said picture, and in that the adjustment means adjusts the level of the reference signals in order that the power needed by the display device for displaying each picture is lower than a target value. The calculation means calculates for example, for each picture received by the display device, the average power level of said picture.

[0022] For controlling the contrast of the pictures displayed by the display device, the apparatus further comprises calculation means for calculating an adjustment factor to be applied to the intensity of the signal supplied to the luminous elements in order that the resulting contrast is equal to a required contrast, and in that the adjustment means applies said adjustment factor to said reference signals.

[0023] For these two applications, the apparatus comprises a frame memory for storing a picture before transmitting it to the display device.

[0024] In a preferred embodiment, the adjustment means of the apparatus comprises means for applying a non linear transformation to reference signals in order to increase the amplitude of the low-amplitude reference signals and the apparatus comprises means for applying the inverse transformation to the picture signal.

[0025] Lastly, the invention concerns also a display device comprising

- a plurality of organic light emitting diodes,
- signal processing means for processing the picture signal received by the display device,
- driving means for driving said plurality of organic light emitting diodes according to the signal processed by the signal processing means,
- reference signalling means for outputting reference signals to the driving means, and
- an apparatus as defined above which is integrated to the signal processing means.

Brief description of the drawings

[0026] Exemplary embodiments of the invention are illustrated in the drawings and in more detail in the following description.

[0027] In the figures :

Fig.1 shows the variation of the peak luminance versus the picture load in a display device ;
Fig.2 shows the structure of the control electronic in a OLED display;
Fig.3 shows the variations of reference voltages according to picture load in a basic embodiment of the invention;
Fig.4 shows the variations of reference voltages according to picture load in an improved embodiment of the invention; and
Fig.5 shows the structure of the control electronic in a OLED display used for implementing the method of the invention;

Description of preferred embodiments

[0028] The invention is described in relation to a OLED display with an active matrix where each luminous element of the display is controlled via an association of several thin-film transistors (TFTs). The general structure of the electronic for controlling the OLED elements is illustrated by figure 2. It comprises :

- an active matrix 1 containing, for each OLED element, an association of several thin-film transistors with a capacitor connected to the OLED material of the luminous element; the capacitor acts as a memory component that stores the value of the luminous element during a certain part of the frame; the thin-film transistors act as switches enabling the selection of the luminous element, the storage of the capacitor and the lighting of the luminous element; in the present structure, the value stored in the capacitor determines the luminance produced by the luminous element;
- at least one row driver 2 that selects line by line the luminous elements of the display in order to refresh their content,
- at least one column driver 3 that delivers the value or content to be stored in each luminous element of the current selected line; this component receives the video information for each luminous element;
- a digital processing and driving unit 4 that applies required video and signal processing steps to the video input signal and that delivers the required signals to the row and column drivers.

[0029] Actually, there are two ways for driving the OLED elements:

- in a current driven concept, the digital video information sent by the digital processing and driving unit 4 is converted by the column driver 3 in a current amplitude that is supplied to the luminous element via the active matrix 1;
- in a voltage driven concept, the digital video information send by the digital processing and driving unit 4 is converted by the column driver 3 in a voltage amplitude that is supplied to the luminous element via the active matrix 1; but, even so, it should be noticed that an OLED element is a current driven so that each voltage based driving unit is based on a voltage to current converter to achieve appropriate lighting.

[0030] The column driver 3 represents, with the digital processing and driving unit 4, the real active part of the electronic and can be considered as a high-level digital to analog converter. The row driver 2 has a quite simple function since it only has to apply a selection line by line. It is more or less a shift register.

[0031] The functioning of said electronic is the following : the input video signal is forwarded to the digital processing and driving unit 4 that delivers, after internal processing, a timing signal for row selection to the row driver 2 synchronized with the data sent to the column driver 3. Depending on the used column driver 3, the data are sent either in a parallel way or in a serial way. Additionally, the column driver 3 is equipped with a reference signaling device 5 for delivering reference signals. More precisely, this device delivers a set of reference voltages in case of voltage driven circuitry or a set of reference currents in case of current driven circuitry, the highest reference being used for the highest gray level (white) and the lowest for the smallest gray level. These reference signals are used by the column driver 3 for generating the signal to be supplied to the OLED element.

[0032] An example of reference signals is given below for a voltage driven circuitry. Eight reference voltages named

V_0 to V_7 are used :

$$V0 = 3V$$

$$V1 = 2{,}6V$$

$$V2 = 2{,}2V$$

$$V3 = 1{,}4V$$

$$V4 = 0{,}6V$$

$$V5 = 0{,}3V$$

$$V6 = 0{,}16V$$

$$V7 = 0V$$

[0033] The different gray levels can be defined as given by the following table. The whole table is given by the annex 1.

gray level	gray level voltage	Gray level voltage
0	V7	0.00V
1	V7+(V6-V7)x9/1175	0.001V
2	V7+(V6-V7)x32/1175	0.005V
3	V7+(V6-V7)x76/1175	0.011V
4	V7+(V6-V7)x141/1175	0.02V
5	V7+(V6-V7)x224/1175	0.032V
6	V7+(V6-V7)x321/1175	0.045V
7	V7+(V6-V7)x425/1175	0.06V
8	V7+(V6-V7)x529/1175	0.074V
9	V7+(V6-V7)x630/1175	0.089V
10	V7+(V6-V7)x727/1175	0.102V
11	V7+(V6-V7)x820/1175	0.115V
12	V7+(V6-V7)x910/1175	0.128V
13	V7+(V6-V7)x998/1175	0.14V
14	V7+(V6-V7)x1086/1175	0.153V
15	V6	0.165V
16	V6+(V5-V6)x89/1097	0.176V
...	...	...
252	V1+(V0-V1)x2549/3029	2.937V

(continued)

gray level	gray level voltage	Gray level voltage
253	V1+(V0-V1)x2694/3029	2.956V
254	V1+(V0-V1)x2851/3029	2.977V
255	V0	3.00V

[0034] Of course, these voltage levels are converted into current before being supplied to the OLED elements. For deducing a luminance value from these voltages, it will be assumed in the rest of the present specification that a 3V voltage applied to an OLED element corresponds to a 400cd/m^2 luminance and that it represents the maximal luminance that can be displayed by the screen of the display device. This value is given as an example.

[0035] For a 4/3 screen with a 6.5" (=16.25cm) diagonal (size = 13cm x 9.75cm) and an efficacy for the OLED material around 14Cd/A, the surface of the screen is 13x9.75 = 126.75cm^2 and the current density is 40000/14000 = 2.86mA/cm^2. So, the total current needed by the panel is 126.75x2.86 = 362.1 mA.

[0036] This current value can be considered as too high. For example, it is sought a maximum current value of 80mA.

[0037] According to the invention, the luminance of the display panel is adjusted in order that the current value necessary for displaying the picture is lower than a maximum current value.

[0038] The power of the incoming picture is first evaluated and the luminance of the panel is then adjusted in order to limit the power consumption of the panel to the maximum current value.

[0039] A first step of the inventive method consists in evaluating the power of the incoming picture to decide which luminance should be used for a white level. The computation of the picture power is done by computing the Average Power Level (APL) of the picture through the following function:

$$APL(I(x,y)) = \frac{1}{C \times L} \cdot \sum_{x,y} I(x,y)$$

where I(x,y) represents the video level of the pixel with coordinates x, y in the picture, C is the number of elements columns of the screen and L is the number of elements lines of the screen.

[0040] In the present specification, the APL value of a picture will be expressed as a percentage of white surface in the picture for clarity and simplicity reasons.

[0041] In a second step, the maximal luminance of the screen is determined for different percentages of white surface as shown in the following table. In the case of a maximum current value of 80 mA, the luminance of a full white image (100% white surface) for the above-mentioned 4/3 screen is: $80 \cdot \frac{14 \cdot 10^{-3}}{126.75 \cdot 10^{-4}} = 88.363$ cd/m2.

Surface (white)	Luminance (Cd/m2)	Power (mA)
100.00%	88.363 Cd/m2	80.00 mA
97.50%	90.629 Cd/m2	80.00 mA
95.00%	93.014 Cd/m2	80.00 mA
92.50%	95.527 Cd/m2	80.00 mA
90.00%	98.181 Cd/m2	80.00 mA
87.50%	100.986 Cd/m2	80.00 mA
85.00%	103.956 Cd/m2	80.00 mA
82.50%	107.107 Cd/m2	80.00 mA
80.00%	110.454 Cd/m2	80.00 mA
77.50%	114.017 Cd/m2	80.00 mA
75.00%	117.817 Cd/m2	80.00 mA
72.50%	121.88 Cd/m2	80.00 mA

(continued)

Surface (white)	Luminance (Cd/m2)	Power (mA)
70.00%	126.233 Cd/m2	80.00 mA
67.50%	130.908 Cd/m2	80.00 mA
65.00%	135.943 Cd/m2	80.00 mA
62.50%	141.381 Cd/m2	80.00 mA
60.00%	147.272 Cd/m2	80.00 mA
57.50%	153.675 Cd/m2	80.00 mA
55.00%	160.66 Cd/m2	80.00 mA
52.50%	168.31 Cd/m2	80.00 mA
50.00%	176.726 Cd/m2	80.00 mA
47.50%	186.027 Cd/m2	80.00 mA
45.00%	196.362 Cd/m2	80.00 mA
42.50%	207.913 Cd/m2	80.00 mA
40.00%	220.907 Cd/m2	80.00 mA
37.50%	235.634 Cd/m2	80.00 mA
35.00%	252.465 Cd/m2	80.00 mA
32.50%	271.886 Cd/m2	80.00 mA
30.00%	294.543 Cd/m2	80.00 mA
27.50%	321.32 Cd/m2	80.00 mA
25.00%	353.452 Cd/m2	80.00 mA
22.50%	392.724 Cd/m2	80.00 mA
20.00%	400.00 Cd/m2	72.429 mA
17.50%	400.00 Cd/m2	63.375 mA
15.00%	400.00 Cd/m2	54.321 mA
12.50%	400.00 Cd/m2	45.268 mA
10.00%	400.00 Cd/m2	36.214 mA
7.50%	400.00 Cd/m2	27.161 mA
5.00%	400.00 Cd/m2	18.107 mA
2.50%	400.00 Cd/m2	9.054 mA

[0042] As the luminance is in this example limited to 400 cd/m^2, the power consumption for the picture with a white surface percentage inferior to 22 % is inferior to 80 mA. The maximal contrast ratio is obtained for a 22% white surface percentage and is equal to 4.5.

[0043] According to an important characteristics of the invention, the luminance of the screen is adjusted by modifying the value of the reference levels Vn, n $\in$ [0,...,7] defined above. The luminance LUM of the screen can be approximated by a quadratic function of the applied voltage V:

$$\mathrm{LUM}(x;y) = 44 \times (V(x;y))^2 .$$

[0044] This formula is given as an example. The following table gives the different voltage values for the reference voltage V0 :

Surface (white)	V0	Luminance (Cd/m2)
100.00%	1.41 V	88.363 Cd/m2
97.50%	1.43 V	90.629 Cd/m2
95.00%	1.45 V	93.014 Cd/m2
92.50%	1.47 V	95.527 Cd/m2
90.00%	1.49 V	98.181 Cd/m2
87.50%	1.51 V	100.986 Cd/m2
85.00%	1.53 V	103.956 Cd/m2
82.50%	1.55 V	107.107 Cd/m2
80.00%	1.58 V	110.454 Cd/m2
77.50%	1.6 V	114.017 Cd/m2
75.00%	1.63 V	117.817 Cd/m2
72.50%	1.66 V	121.88 Cd/m2
70.00%	1.69 V	126.233 Cd/m2
67.50%	1.72 V	130.908 Cd/m2
65.00%	1.75 V	135.943 Cd/m2
62.50%	1.78 V	141.381 Cd/m2
60.00%	1.82 V	147.272 Cd/m2
57.50%	1.86 V	153.675 Cd/m2
55.00%	1.9 V	160.66 Cd/m2
52.50%	1.95 V	168.31 Cd/m2
50.00%	2.0 V	176.726 Cd/m2
47.50%	2.05 V	186.027 Cd/m2
45.00%	2.1 V	196.362 Cd/m2
42.50%	2.16 V	207.913 Cd/m2
40.00%	2.23 V	220.907 Cd/m2
37.50%	2.3 V	235.634 Cd/m2
35.00%	2.38 V	252.465 Cd/m2
32.50%	2.47 V	271.886 Cd/m2
30.00%	2.58 V	294.543 Cd/m2
27.50%	2.69 V	321.32 Cd/m2
25.00%	2.82 V	353.452 Cd/m2
22.50%	2.97 V	392.724 Cd/m2
20.00%	3.0 V	400.00 Cd/m2
17.50%	3.0 V	400.00 Cd/m2
15.00%	3.0 V	400.00 Cd/m2
12.50%	3.0 V	400.00 Cd/m2
10.00%	3.0 V	400.00 Cd/m2
7.50%	3.0 V	400.00 Cd/m2

(continued)

Surface (white)	V0	Luminance (Cd/m2)
5.00%	3.0 V	400.00 Cd/m2
2.50%	3.0 V	400.00 Cd/m2

[0045] The other reference levels, V1 to V7, can be adjusted in a linear way from the reference level V0. For example, the reference level Vn for a given average power level APL can then be computed as follows :

$$Vn(APL) = \frac{V0(APL) \times Vn(0\%)}{V0(0\%)}$$

[0046] The following table gives the voltage values of all the reference levels V0 to V7 for different APL :

Surface (white)	V0	V1	V2	V3	V4	V5	V6	V7
100.00%	1.41 V	1.22 V	1.03 V	0.66 V	0.28 V	**0.14 V**	**0.08 V**	0.0 V
97.50%	1.43 V	1.24 V	1.05 V	0.67 V	0.29 V	**0.14 V**	**0.08 V**	0.0 V
95.00%	1.45 V	1.25 V	1.06 V	0.68 V	0.29 V	**0.14 V**	**0.08 V**	0.0 V
92.50%	1.47 V	1.27 V	1.08 V	0.68 V	0.29 V	**0.15 V**	**0.08 V**	0.0 V
90.00%	1.49 V	1.29 V	1.09 V	0.69 V	0.3 V	**0.15 V**	**0.08 V**	0.0 V
87.50%	1.51 V	1.31 V	1.11 V	0.7 V	0.3 V	**0.15V**	**0.08 V**	0.0 V
85.00%	1.53 V	1.33 V	1.12 V	0.71 V	0.31 V	**0.15V**	**0.08 V**	0.0 V
82.50%	1.55 V	1.35 V	1.14 V	0.72V	0.31 V	0.16 V	**0.08 V**	0.0 V
80.00%	1.58 V	1.37 V	1.16 V	0.74 V	0.32 V	0.16 V	**0.08 V**	0.0 V
77.50%	1.6 V	1.39 V	1.18 V	0.75 V	0.32 V	0.16 V	**0.09 V**	0.0 V
75.00%	1.63 V	1.41 V	1.19 V	0.76 V	0.33 V	0.16 V	**0.09 V**	0.0V
72.50%	1.66 V	1.44 V	1.21 V	0.77 V	0.33 V	0.17 V	**0.09 V**	0.0 V
70.00%	1.69 V	1.46 V	1.24 V	0.79 V	0.34 V	0.17 V	**0.09 V**	0.0 V
67.50%	1.72V	1.49 V	1.26 V	0.8 V	0.34 V	0.17 V	**0.09 V**	0.0 V
65.00%	1.75 V	1.52 V	1.28 V	0.82 V	0.35 V	0.17 V	**0.09 V**	0.0 V
62.50%	1.78 V	1.55 V	1.31 V	0.83 V	0.36 V	0.18 V	**0.1 V**	0.0 V
60.00%	1.82 V	1.58 V	1.34 V	0.85 V	0.36 V	0.18 V	**0.1 V**	0.0 V
57.50%	1.86 V	1.61 V	1.36 V	0.87 V	0.37 V	0.19 V	**0.1 V**	0.0 V
55.00%	1.9 V	1.65 V	1.39 V	0.89 V	0.38 V	0.19 V	**0.1 V**	0.0 V
52.50%	1.95 V	1.69 V	1.43 V	0.91 V	0.39 V	0.19 V	**0.1 V**	0.0 V
50.00%	2.0 V	1.73 V	1.46 V	0.93 V	0.4 V	0.2 V	**0.11 V**	0.0 V
47.50%	2.05 V	1.77 V	1.5 V	0.96 V	0.41 V	0.2 V	**0.11 V**	0.0 V
45.00%	2.1 V	1.82 V	1.54 V	0.98 V	0.42 V	0.21 V	**0.11 V**	0.0 V
42.50%	2.16 V	1.88 V	1.59 V	1.01 V	0.43 V	0.22 V	**0.12 V**	0.0 V
40.00%	2.23V	1.93 V	1.64 V	1.04 V	0.45 V	0.22 V	**0.12 V**	0.0 V
37.50%	2.3 V	2.0 V	1.69 V	1.08 V	0.46 V	0.23 V	**0.12 V**	0.0 V
35.00%	2.38 V	2.07 V	1.75 V	1.11 V	0.48 V	0.24 V	**0.13 V**	0.0 V

(continued)

Surface (white)	V0	V1	V2	V3	V4	V5	V6	V7
32.50%	2.47 V	2.14 V	1.81 V	1.15V	0.49 V	0.25 V	**0.13 V**	0.0 V
30.00%	2.58 V	2.23 V	1.89 V	1.2 V	0.52 V	0.26 V	**0.14 V**	0.0 V
27.50%	2.69 V	2.33 V	1.97 V	1.26 V	0.54 V	0.27 V	**0.14 V**	0.0 V
25.00%	2.82 V	2.45 V	2.07 V	1.32 V	0.56 V	0.28 V	**0.15 V**	0.0 V
22.50%	2.97V	2.58 V	2.18 V	1.39 V	0.59 V	0.3 V	0.16 V	0.0 V
20.00%	3.0 V	2.6 V	2.2 V	1.4 V	0.6 V	0.3 V	0.16 V	0.0 V
17.50%	3.0 V	2.6 V	2.2 V	1.4 V	0.6 V	0.3 V	0.16 V	0.0 V
15.00%	3.0 V	2.6 V	2.2 V	1.4 V	0.6 V	0.3 V	0.16 V	0.0 V
12.50%	3.0 V	2.6 V	2.2 V	1.4 V	0.6 V	0.3 V	0.16 V	0.0 V
10.00%	3.0 V	2.6 V	2.2 V	1.4 V	0.6 V	0.3 V	0.16 V	0.0 V
7.50%	3.0 V	2.6 V	2.2 V	1.4 V	0.6 V	0.3 V	0.16 V	0.0 V
5.00%	3.0 V	2.6 V	2.2 V	1.4 V	0.6 V	0.3 V	0.16 V	0.0 V
2.50%	3.0 V	2.6 V	2.2 V	1.4 V	0.6V	0.3 V	0.16 V	0.0 V

[0047] Figure 3 shows curves illustrating this table and showing the variations of the reference voltages for the percentages of white surface 5%, 10%, 30%, 40%, 50%, 60%, 70%, 80%, 90% and 100%.

[0048] A problem can appear when the voltage references related to the lowest gray levels are very low, which is the case in the above table for the reference voltages V5 and V6 when the picture load is high. Actually, in a voltage driven system, if the voltage is too low, the error (coming from the mismatch between neighbouring luminous elements) becomes higher than the required precision and the information is lost. In a current driven system, the problem is different. In such a system, the lower the current is, the longer it takes to load the capacitance of the luminous element. So, if the required current is too low, the writing time of the luminous element will be too long for a video application.

[0049] In the present example, the voltage values below 0.16V (bold values in the above table) can create a precision error. So, as an improvement, it is proposed to modify the reference voltages V1 to V7 in a non-linear way according to the reference level V0. The voltage values for the reference voltage V0 is kept constant while the other ones are modified by a non-linear mathematical transformation f(x,y,z) as followed:

$$Vn(APL) = f(V0(APL); Vn(0\%); V0(0\%)).$$

[0050] An example of the result of such a transformation is given in the next table:

Surface (white)	V0	V1	V2	V3	V4	V5	V6	V7
100.00%	1.41 V	1.35V	1.26V	0.97 V	0.5 V	0.27 V	0.16 V	0.0 V
97.50%	1.44 V	1.38 V	1.28 V	0.97 V	0.5 V	0.27 V	0.16 V	0.0 V
95.00%	1.47 V	1.4 V	1.3 V	0.98 V	0.5 V	0.27V	0.16 V	0.0 V
92.50%	1.51 V	1.43 V	1.32 V	0.99 V	0.5 V	0.27 V	0.16 V	0.0 V
90.00%	1.54 V	1.45 V	1.34 V	1.0 V	0.51 V	0.27 V	0.16 V	0.0 V
87.50%	1.57 V	1.48 V	1.36 V	1.01 V	0.51 V	0.27 V	0.16 V	0.0 V
85.00%	1.61 V	1.51 V	1.38 V	1.02 V	0.51 V	0.27 V	0.16 V	0.0 V
82.50%	1.65 V	1.54 V	1.4 V	1.03 V	0.51 V	0.27 V	0.16 V	0.0 V
80.00%	1.68 V	1.57 V	1.42 V	1.04 V	0.51 V	0.27 V	0.16 V	0.0 V
77.50%	1.72 V	1.6 V	1.45 V	1.05V	0.52 V	0.27 V	0.16 V	0.0 V

(continued)

Surface (white)	V0	V1	V2	V3	V4	V5	V6	V7
75.00%	1.76 V	1.63 V	1.47 V	1.06 V	0.52 V	0.28 V	0.16 V	0.0 V
72.50%	1.81 V	1.66 V	1.5 V	1.07 V	0.52 V	0.28 V	0.16 V	0.0 V
70.00%	1.85 V	1.7 V	1.52 V	1.09 V	0.53 V	0.28 V	0.16 V	0.0 V
67.50%	1.9 V	1.73 V	1.55 V	1.1 V	0.53 V	0.28 V	0.16 V	0.0 V
65.00%	1.94 V	1.77 V	1.58 V	1.11 V	0.53 V	0.28 V	0.16 V	0.0 V
62.50%	1.99 V	1.81 V	1.61 V	1.12V	0.53 V	0.28 V	0.16 V	0.0 V
60.00%	2.04 V	1.85 V	1.64V	1.14V	0.54 V	0.28 V	0.16 V	0.0 V
57.50%	2.1 V	1.89 V	1.67V	1.15V	0.54 V	0.28 V	0.16 V	0.0 V
55.00%	2.15 V	1.94 V	1.7V	1.17V	0.55V	0.28 V	0.16 V	0.0 V
52.50%	2.21 V	1.98 V	1.73V	1.18V	0.55 V	0.28 V	0.16 V	0.0 V
50.00%	2.27 V	2.03 V	1.77V	1.2V	0.55 V	0.29 V	0.16 V	0.0 V
47.50%	2.33 V	2.08 V	1.81 V	1.22 V	0.56 V	0.29 V	0.16 V	0.0 V
45.00%	2.4 V	2.13 V	1.85V	1.24V	0.56 V	0.29 V	0.16 V	0.0 V
42.50%	2.47 V	2.18 V	1.89 V	1.25 V	0.57 V	0.29 V	0.16 V	0.0 V
40.00%	2.54 V	2.24 V	1.93 V	1.27 V	0.57 V	0.29 V	0.16 V	0.0 V
37.50%	2.61 V	2.29 V	1.97 V	1.29 V	0.57 V	0.29 V	0.16 V	0.0 V
35.00%	2.68 V	2.35 V	2.01 V	1.31 V	0.58 V	0.29 V	0.16 V	0.0 V
32.50%	2.76 V	2.41 V	2.06 V	1.33V	0.58 V	0.3V	0.16 V	0.0 V
30.00%	2.83 V	2.47 V	2.1 V	1.35V	0.59 V	0.3 V	0.16 V	0.0 V
27.50%	2.9 V	2.52 V	2.14V	1.37V	0.59 V	0.3 V	0.16 V	0.0 V
25.00%	2.96 V	2.57 V	2.18V	1.39V	0.6 V	0.3 V	0.16 V	0.0 V
22.50%	3.0 V	2.6V	2.2V	1.4V	0.6 V	0.3 V	0.16 V	0.0 V
20.00%	3.0 V	2.6 V	2.2V	1.4V	0.6 V	0.3V	0.16 V	0.0 V
17.50%	3.0 V	2.6 V	2.2 V	1.4V	0.6 V	0.3V	0.16 V	0.0 V
15.00%	3.0 V	2.6 V	2.2 V	1.4V	0.6 V	0.3 V	0.16 V	0.0 V
12.50%	3.0 V	2.6 V	2.2 V	1.4V	0.6 V	0.3 V	0.16 V	0.0 V
10.00%	3.0 V	2.6 V	2.2V	1.4V	0.6 V	0.3 V	0.16 V	0.0 V
7.50%	3.0 V	2.6 V	2.2 V	1.4V	0.6 V	0.3 V	0.16 V	0.0 V
5.00%	3.0 V	2.6 V	2.2 V	1.4V	0.6 V	0.3 V	0.16 V	0.0 V
2.50%	3.0 V	2.6 V	2.2 V	1.4V	0.6 V	0.3 V	0.16 V	0.0 V

[0051] Figure 4, to be compared with Figure 3, illustrates these new variations of voltage references V0 to V7 by curves. After this transformation, there are almost no more differences for the reference voltages V6 and V7 between the different APL values.

[0052] This non linear transformation f applied to the reference voltages V1 to V7 should be compensated by an inverse transformation f^{-1} in the video signal processing chain of the device. With such transformations (f and f^{-1}), it is possible to obtain an optimized power management without introducing too much difficulties in the low level gradations (low voltages/low currents).

[0053] A circuit implementation of the digital processing and driving unit 4 to be used the power level control method of the invention is given at figure 5.

[0054] An input picture is forwarded to a power evaluation block 41 that performs the computation of the APL level of the input picture. The APL value is transmitted to a power management block 42. Since the result of this computation can be only made after a complete frame, the input picture should be then stored in a frame memory 43, for example a DDRAM, in order to dispose of one frame delay. This memory can be inside or outside the unit 4.

[0055] Based on this APL value, an appropriate set of reference signals Refn is chosen for instance from a Look Up Table and sent to the Reference Signaling Unit 5 via a programming bus. Advantageously, a non-linear transformation f is integrated in these signals. As indicated previously, these reference signals can be reference voltages or reference currents. This programming should occur during the vertical blanking in order not to disturb the displayed picture.

[0056] In parallel to that, a non-linear transfer function f^{-1} (it can be a mathematical function or a Look Up Table) which is the inverse of the transformation integrated in the chosen set of reference signals Refn is chosen and is applied to the delayed picture by a block 44. The picture after processing is sent to a standard OLED processing block 45 and then to a standard OLED driving block 46 for finally driving the display with the current picture information.

[0057] The method of the invention can be used for controlling the contrast of the pictures displayed by the display device. In that case, the method consists in calculating an adjustment factor that is to be applied to the intensity of the signal supplied to the luminous elements in order to make the contrast go from a present value to a required value. This adjustment factor is then applied to the reference signals.

[0058] For example, for reducing the contrast by 50%, the reference signals are decreased from 50%.

Annexe 1

[0059]

0	V7	0.00V		50	V5+(V4-V5)×957/1501	0,487V
1	V7+(V6-V7)×9/1175	0,001V		51	V5+(V4-V5)×1001/1501	0,496V
2	V7+(V6-V7)×32/1175	0,004V		52	V5+(V4-V5)×1045/1501	0,505V
3	V7+(V6-V7)×76/1175	0,01V		53	V5+(V4-V5)×1088/1501	0,514V
4	V7+(V6-V7)×141/1175	0,019V		54	V5+(V4-V5)×1131/1501	0,523V
5	V7+(V6-V7)×224/1175	0,03V		55	V5+(V4-V5)×1173/1501	0,532V
6	V7+(V6-V7)×321/1175	0,043V		56	V5+(V4-V5)×1215/1501	0,541V
7	V7+(V6-V7)×425/1175	0,057V		57	V5+(V4-V5)×1257/1501	0,55V
8	V7+(V6-V7)×529/1175	0,071V		58	V5+(V4-V5)×1298/1501	0,559V
9	V7+(V6-V7)×630/1175	0,084V		59	V5+(V4-V5)×1339/1501	0,567V
10	V7+(V6-V7)×727/1175	0,097V		60	V5+(V4-V5)×1380/1501	0,576V
11	V7+(V6-V7)×820/1175	0,11V		61	V5+(V4-V5)×1421/1501	0,584V
12	V7+(V6-V7)×910/1175	0,122V		62	V5+(V4-V5)×1461/1501	0,593V
13	V7+(V6-V7)×99811175	0,133V		63	V4	0,601V
14	V7+(V6-V7)×1086/1175	0,145V		64	V4+(V3-V4)×40/2215	0,615V
15	V6	0,157V		65	V4+(V3-V4)×80/2215	0,628V
16	V6+(V5-V6)×89/1097	0,167V		66	V4+(V3-V4)×120/2215	0,641V
17	V6+(V5-V6)×173/1097	0,177V		67	V4+(V3-V4)×160/2215	0,654V
18	V6+(V5-V6)×250/1097	0,186V		68	V4+(V3-V4)×200/2215	0,667V
19	V6+(V5-V6)×320/1097	0,194V		69	V4+(V3-V4)×240/2215	0,681V
20	V6+(V5-V6)×386/1097	0,202V		70	V4+(V3-V4)×280/2215	0,694V
21	V6+(V5-V6)×451/1097	0,21V		71	V4+(V3-V4)×320/2215	0,707V
22	V6+(V5-V6)×517/1097	0,217V		72	V4+(V3-V4)×360/2215	0,72V
23	V6+(V5-V6)×585/1097	0,225V		73	V4+(V3-V4)×400/2215	0,734V
24	V6+(V5-V6)×654/1097	0,233V		74	V4+(V3-V4)×440/2215	0,747V

(continued)

25	V6+(V5-V6)×723/1097	0,241V		75	V4+(V3-V4)×480/2215	0,76V
26	V6+(V5-V6)×790/1097	0,249V		76	V4+(V3-V4)×520/2215	0,773V
27	V6+(V5-V6)×855/1097	0,257V		77	V4+(V3-V4)×560/2215	0,787V
28	V6+(V5-V6)×917/1097	0,264V		78	V4+(V3-V4)×600/2215	0,80V
29	V6+(V5-V6)×977/1097	0,271V		79	V4+(V3-V4)×640/2215	0,813V
30	V6+(V5-V6)×1037/1097	0,278V		80	V4+(V3-V4)×680/2215	0,826V
31	V5	0,285V		81	V4+(V3-V4)×719/2215	0,839V
32	V5+(V4-V5)×60/1501	0,298V		82	V4+(V3-V4)×758/2215	0,852V
33	V5+(V4-V5)×119/1501	0,31V		83	V4+(V3-V4)×796/2215	0,865V
34	V5+(V4-V5)×176/1501	0,322V		84	V4+(V3-V4)×834/2215	0,877V
35	V5+(V4-V5)×231/1501	0,334V		85	V4+(V3-V4)×/2215	0,889V
36	V5+(V4-V5)×284/1501	0,345V		86	V4+(V3-V4)×/2215	0,902V
37	V5+(V4-V5)×335/1501	0,356V		87	V4+(V3-V4)×944/2215	0,914V
38	V5+(V4-V5)×385/1501	0,366V		88	V4+(V3-V4)×980/2215	0,925V
39	V5+(V4-V5)×434/1501	0,376V		89	V4+(V3-V4)×1016/2215	0,937V
40	V5+(V4-V5)×483/1501	0,387V		90	V4+(V3-V4)×1052/2215	0,949V
41	V5+(V4-V5)×532/1501	0,397V		91	V4+(V3-V4)×1087/2215	0,961V
42	V5+(V4-V5)×580/1501	0,407V		92	V4+(V3-V4)×1122/2215	0,972V
43	V5+(V4-V5)×628/1501	0,417V		93	V4+(V3-V4)×1157/2215	0,984V
44	V5+(V4-V5)×676/1501	0,427V		94	V4+(V3-V4)×/2215	0,996V
45	V5+(V4-V5)×724/1501	0,438V		95	V4+(V3-V4)×1226/2215	1,007V
46	V5+(V4-V5)×772/1501	0,448V		96	V4+(V3-V4)×1260/2215	1,018V
47	V5+(V4-V5)×819/1501	0,458V		97	V4+(V3-V4)×1294/2215	1,029V
48	V5+(V4-V5)×866/1501	0,468V		98	V4+(V3-V4)×1328/2215	1,04V
49	V5+(V4-V5)×912/1501	0,477V		99	V4+(V3-V4)×1362/2215	1,052V
100	V4+(V3-V4)×1396/2215	1,063V		150	V3+(V2-V3)×777/2343	1,581V
101	V4+(V3-V4)×1429/2215	1,074V		151	V3+(V2-V3)×813/2343	1,593V
102	V4+(V3-V4)×1462/2215	1,085V		152	V3+(V2-V3)×849/2343	1,604V
103	V4+(V3-V4)×1495/2215	1,096V		153	V3+(V2-V3)×885/2343	1,616V
104	V4+(V3-V4)×1528/2215	1,107V		154	V3+(V2-V3)×921/2343	1,627V
105	V4+(V3-V4)×1561/2215	1,118V		155	V3+(V2-V3)×958/2343	1,639V
106	V4+(V3-V4)×1593/2215	1,128V		156	V3+(V2-V3)×995/2343	1,651V
107	V4+(V3-V4)×1625/2215	1,139V		157	V3+(V2-V3)×1032/2343	1,663V
108	V4+(V3-V4)×1657/2215	1,149V		158	V3+(V2-V3)×1069/2343	1,674V
109	V4+(V3-V4)×1688/2215	1,16V		159	V3+(V2-V3)×1106/2343	1,686V
110	V4+(V3-V4)×1719/2215	1,17V		160	V3+(V2-V3)×1143/2343	1,698V
111	V4+(V3-V4)×1750/2215	1,18V		161	V3+(V2-V3)×1180/2343	1,71V
112	V4+(V3-V4)×1781/2215	1,19V		162	V3+(V2-V3)×1217/2343	1,722V
113	V4+(V3-V4)×1811/2215	1,20V		163	V3+(V2-V3)×1255/2343	1,734V

(continued)

114	V4+(V3-V4)×1841/2215	1,21V		164	V3+(V2-V3)×1293/2343	1,746V
115	V4+(V3-V4)×1871/2215	1,22V		165	V3+(V2-V3)×1331/2343	1,758V
116	V4+(V3-V4)×1901/2215	1,23V		166	V3+(V2-V3)×1369/2343	1,77V
117	V4+(V3-V4)×1930/2215	1,24V		167	V3+(V2-V3)×1407/2343	1,782V
118	V4+(V3-V4)×1959/2215	1,249V		168	V3+(V2-V3)×1445/2343	1,794V
119	V4+(V3-V4)×1988/2215	1,259V		169	V3+(V2-V3)×1483/2343	1,806V
120	V4+(V3-V4)×2016/2215	1,268V		170	V3+(V2-V3)×1521/2343	1,819V
121	V4+(V3-V4)×2044/2215	1,277V		171	V3+(V2-V3)×1559/2343	1,831V
122	V4+(V3-V4)×2072/2215	1,287V		172	V3+(V2-V3)×1597/2343	1,843V
123	V4+(V3-V4)×2100/2215	1,296V		173	V3+(V2-V3)×1635/2343	1,855V
124	V4+(V3-V4)×2128/2215	1,305V		174	V3+(V2-V3)×1673/2343	1,867V
125	V4+(V3-V4)×2156/2215	1,314V		175	V3+(V2-V3)×1712/2343	1,879V
126	V4+(V3-V4)×2185/2215	1,324V		176	V3+(V2-V3)×1751/2343	1,892V
127	V3	1,334V		177	V3+(V2-V3)×1790/2343	1,904V
128	V3+(V2-V3)×31/2343	1,344V		178	V3+(V2-V3)×1829/2343	1,917V
129	V3+(V2-V3)×64/2343	1,354V		179	V3+(V2-V3)×1868/2343	1,929V
130	V3+(V2-V3)×97/2343	1,365V		180	V3+(V2-V3)×1907/2343	1,942V
131	V3+(V2-V3)×130/2343	1,375V		181	V3+(V2-V3)×1946/2343	1,954V
132	V3+(V2-V3)×163/2343	1,386V		182	V3+(V2-V3)×1985/2343	1,966V
133	V3+(V2-V3)×196/2343	1,396V		183	V3+(V2-V3)×2024/2343	1,979V
134	V3+(V2-V3)×229/2343	1,407V		184	V3+(V2-V3)×2064/2343	1,992V
135	V3+(V2-V3)×262/2343	1,417V		185	V3+(V2-V3)×2103/2343	2,004V
136	V3+(V2-V3)×295/2343	1,428V		186	V3+(V2-V3)×2143/2343	2,017V
137	V3+(V2-V3)×328/2343	1,438V		187	V3+(V2-V3)×2183/2343	2,03V
138	V3+(V2-V3)×361/2343	1,449V		188	V3+(V2-V3)×2223/2343	2,042V
139	V3+(V2-V3)×395/2343	1,46V		189	V3+(V2-V3)×2263/2343	2,055V
140	V3+(V2-V3)×429/2343	1,471V		190	V3+(V2-V3)×2303/2343	2,068V
141	V3+(V2-V3)×463/2343	1,481V		191	V2	2,081V
142	V3+(V2-V3)×497/2343	1,492V		192	V2+(V1-V2)×40/1638	2,09V
143	V3+(V2-V3)×531/2343	1,503V		193	V2+(V1-V2)×81/1638	2,10V
144	V3+(V2-V3)×566/2343	1,514V		194	V2+(V1-V2)×124/1638	2,11V
145	V3+(V2-V3)×601/2343	1,525V		195	V2+(V1-V2)×168/1638	2,121V
146	V3+(V2-V3)×636/2343	1,536V		196	V2+(V1-V2)×213/1638	2,131V
147	V3+(V2-V3)×671/2343	1,548V		197	V2+(V1-V2)×259/1638	2,142V
148	V3+(V2-V3)×706/2343	1,559V		198	V2+(V1-V2)×306/1638	2,153V
149	V3+(V2-V3)×741/2343	1,57V		199	V2+(V1-V2)×353/1638	2,165V
200	V2+(V1-V2)×401/1638	2,176V		250	V1+(V0-V1)×2278/3029	2,756V
201	V2+(V1-V2)×450/1638	2,188V		251	V1+(V0-V1)×2411/3029	2,773V
202	V2+(V1-V2)×499/1638	2,199V		252	V1+(V0-V1)×2549/3029	2,79V

(continued)

203	V2+(V1-V2)×548/1638	2,211V		253	V1+(V0-V1)×2694/3029	2,808V
204	V2+(V1-V2)×597/1638	2,223V		254	V1+(V0-V1)×2851/3029	2,828V
205	V2+(V1-V2)×646/1638	2,234V		255	V0	2,85V
206	V2+(V1-V2)×695/1638	2,246V				
207	V2+(V1-V2)×745/1638	2,258V				
208	V2+(V1-V2)×795/1638	2,27V				
209	V2+(V1-V2)×846/1638	2,282V				
210	V2+(V1-V2)×897/1638	2,294V				
211	V2+(V1-V2)×949/1638	2,307V				
212	V2+(V1-V2)×1002/1638	2,319V				
213	V2+(V1-V2)×1056/1638	2,332V				
214	V2+(V1-V2)×1111/1638	2,345V				
215	V2+(V1-V2)×1167/1638	2,359V				
216	V2+(V1-V2)×1224/1638	2,372V				
217	V2+(V1-V2)×1281/1638	2,386V				
218	V2+(V1-V2)×1339/1638	2,40V				
219	V2+(V1-V2)×1398/1638	2,414V				
220	V2+(V1-V2)×1458/1638	2,428V				
221	V2+(V1-V2)×1518/1638	2,442V				
222	V2+(V1-V2)×1578/1638	2,457V				
223	V1	2,471V				
224	V1+(V0-V1)×60/3029	2,478V				
225	V1+(V0-V1)×120/3029	2,486V				
226	V1+(V0-V1)×180/3029	2,493V				
227	V1+(V0-V1)×241/3029	2,501V				
228	V1+(V0-V1)×304/3029	2,509V				
229	V1+(V0-V1)×369/3029	2,517V				
230	V1+(V0-V1)×437/3029	2,526V				
231	V1+(V0-V1)×507/3029	2,534V				
232	V1+(V0-V1)×580/3029	2,544V				
233	V1+(V0-V1)×655/3029	2,553V				
234	V1+(V0-V1)×732/3029	2,563V				
235	V1+(V0-V1)×810/3029	2,572V				
236	V1+(V0-V1)×889/3029	2,582V				
237	V1+(V0-V1)×969/3029	2,592V				
238	V1+(V0-V1)×1050/3029	2,602V				
239	V1+(V0-V1)×1133/3029	2,613V				
240	V1+(V0-V1)×1218/3029	2,623V				
241	V1+(V0-V1)×1304/3029	2,634V				

(continued)

242	V1+(V0-V1)×1393/3029	2,645V		
243	V1+(V0-V1)×1486/3029	2,657V		
244	V1+(V0-V1)×1583/3029	2,669V		
245	V1+(V0-V1)×1686/3029	2,682V		
246	V1+(V0-V1)×1794/3029	2,695V		
247	V1+(V0-V1)×1907/3029	2,71V		
248	V1+(V0-V1)×2026/3029	2,724V		
249	V1+(V0-V1)×2150/3029	2,74V		

Claims

1. Method for controlling the power level and/or the contrast in a display device having a plurality of luminous elements corresponding to the colour components of the pixels of a picture, wherein the luminance generated by each of said luminous elements is based on the intensity of the signals supplied to the luminous element and the power level and/or contrast for each picture is controlled by adjusting the intensity of the signals to be supplied to each luminous element, wherein the intensity of the signals to be supplied to the luminous elements is based on a plurality of analog reference signals (Refn), and wherein the power level and/or contrast is controlled by adjusting the intensity of said analog reference signals (Refn) based on an average power level of said picture and **characterized in that** a non-linear transformation is applied to the reference levels and the inverse transformation (f^{-1}) is applied to the picture signal for using instead of reference levels (Vn) below a predetermined value (0.16V) said predetermined value (0.16V) or a value above said predetermined value (0.16V) for said analog reference signals (Refn) to avoid reference levels (V5, V6) having a value between zero and below the predetermined value (0.16V) to avoid precision errors.

2. Method according to claim 1, **characterized in that**, for the controlling the contrast of the pictures displayed by the display device, it further comprises the following steps :

   - calculating an adjustment factor to be applied to the intensity of the picture signal supplied to the luminous elements in order that the resulting contrast is equal to a required contrast, and
   - applying said adjustment factor to the analog reference signals (Refn)

3. Method according to one of claims 1 or 2, **characterized in that**, before adjustment of the signal intensity, the non linear transformation (f) is applied to reference signals(Refn) in order to increase the amplitude of the low-amplitude reference signals (Refn) and the inverse transformation (f^{-1}) is applied to the picture signal to adapt further reference levels related to a certain percentage of white surface in the picture.

4. Method according to one of claims 1 to 3, **characterized in that** the luminous elements are organic light emitting display diodes.

5. Method according to one of claims 1 to 4, **characterized in that** the analog reference signals (Refn) are reference voltages or reference currents.

6. Apparatus for controlling the power level and/or the contrast in a display device having a plurality of luminous elements corresponding to the colour components of the pixels of a picture, wherein the luminance generated by each of said luminous elements is based on the intensity of the signals supplied to the luminous element and the power level and/or contrast for each picture is controlled by adjusting the intensity of the signals to be supplied to each luminous element, and wherein the intensity of the signals to be supplied to the luminous elements is based on a plurality of analog reference signals(Refn) **characterized in that** it comprises adjustment means (42) for controlling the power level and/or contrast by adjusting the intensity of the reference signals (Refn) based on an average power level of said picture and wherein
a non-linear transformation is applied to the reference levels, provided by a reference signalling unit (5), for providing instead of reference levels (Vn) below a predetermined value (0.16V) said predetermined value (0.16V) or a value above said predetermined value (0.16V) for avoiding reference levels (V5, V6) having a value above zero and below

the predetermined value (0.16V) and means (44) for applying the inverse transformation (f^{-1}) to the picture signal are provided to avoid precision errors.

7. Apparatus according to claim 6, **characterized in that**, for controlling the contrast of the pictures displayed by the display device, it further comprises calculation means for calculating an adjustment factor to be applied to the intensity of the signal supplied to the luminous elements in order that the resulting contrast is equal to a required contrast, and **in that** the adjustment means (42) applies said adjustment factor to the analog reference signals (Refn)

8. Apparatus according to one of claims 6 or 7, **characterized in that** it comprises a frame memory (43) for storing a picture before transmitting it to the display device.

9. Apparatus according to claim 6 or 7, **characterized in that** the adjustment means (42) comprises means for applying the non linear transformation (f) to reference signals (Refn) and means (44) for applying the inverse transformation (f^{-1}) to the picture signal.

10. Display device comprising

- a plurality of organic light emitting diodes (1),
- signal processing means (4) for processing the picture signal received by the display device,
- driving means (2, 3) for driving said plurality of organic light emitting diodes (1) according to the signal processed by the signal processing means (4),
- reference signalling means (5) for outputting analog reference signals (Refn) to the driving means (3),

characterized in that said signal processing means (4) comprises an apparatus according to any of claims 6 to 9 .

Patentansprüche

1. Verfahren zum Steuern des Leistungspegels und/oder des Kontrasts in einer Anzeigevorrichtung, die eine Mehrzahl leuchtender Elemente aufweist, die den Farbkomponenten der Pixel eines Bilds entsprechen, wobei die durch jedes der leuchtenden Elemente erzeugte Leuchtdichte auf der Stärke der dem leuchtenden Element zugeführten Signale beruht und der Leistungspegel und/oder der Kontrast für jedes Bild durch Einstellen der Stärke der jedem leuchtenden Element zuzuführenden Signale gesteuert werden, wobei die Stärke der den leuchtenden Elementen zuzuführenden Signale auf einer Mehrzahl analoger Referenzsignale (Refn) beruht und wobei der Leistungspegel und/oder der Kontrast durch Einstellen der Stärke der analogen Referenzsignale (Refn) auf der Grundlage eines mittleren Leistungspegels des Bilds gesteuert werden und **dadurch gekennzeichnet, dass** auf die Referenzpegel eine nichtlineare Transformation angewendet wird und dass auf das sildsignal die inverse Transformation (f^{-1}) angewendet wird, um für die analogen Referenzsignale (Refn) unter einem vorgegebenen Wert (0,16 V) anstelle der Referenzpegel (Vn) den vorgegebenen Wert (0,16 V) oder einen Wert über dem vorgegebenen Wert (0,16 V) zu verwenden, um zu vermeiden, dass die Referenzpegel (V5, V6) einen Wert zwischen null und unter dem vorgegebenen Wert (0,16 V) aufweisen, um Präzisionsfehler zu vermeiden.

2. Verfahren nach Anspruch 1, **dadurch gekennzeichnet, dass** es zum Steuern des Kontrasts der durch die Anzeigevorrichtung angezeigten Bilder ferner die folgenden Schritte umfasst:

- Berechnen eines Einstellfaktors, der auf die Stärke des den leuchtenden Elementen zugeführten Bildsignals anzuwenden ist, damit der resultierende Kontrast gleich einem geforderten Kontrast ist, und
- Anwenden des Einstellfaktors auf die analogen Referenzsignale (Refn).

3. Verfahren nach einem der Ansprüche 1 oder 2, **dadurch gekennzeichnet, dass** vor Einstellung der Signalstärke auf die Referenzsignale (Refn) die nichtlineare Transformation (f) angewendet wird, um die Amplitude der Referenzsignale (Refn) mit niedriger Amplitude zu erhöhen, und dass auf das Bildsignal die inverse Transformation (f^{-1}) angewendet wird, um die Referenzpegel in Bezug auf einen bestimmten Prozentsatz einer weißen Fläche in dem Bild weiter anzupassen.

4. Verfahren nach einem der Ansprüche 1 bis 3, **dadurch gekennzeichnet, dass** die leuchtenden Elemente organische Lichtemitter-Anzeigedioden sind.

5. Verfahren nach einem der Ansprüche 1 bis 4, **dadurch gekennzeichnet, dass** die analogen Referenzsignale (Refn) Referenzspannungen oder Referenzströme sind.

6. Vorrichtung zum Steuern des Leistungspegels und/oder des Kontrasts in einer Anzeigevorrichtung, die eine Mehrzahl leuchtender Elemente aufweist, die den Farbkomponenten der Pixel eines bilds entsprechen, wobei die durch jedes der leuchtenden Elemente erzeugte Leuchtdichte auf der Stärke der dem leuchtenden Element zugeführten Signale beruht und der Leistungspegel und/oder Kontrast für jedes Bild durch Einstellen der Stärke der jedem leuchtenden Element zuzuführenden Signale gesteuert werden und wobei die Stärke der den leuchtenden Elementen zuzuführenden Signale auf einer Mehrzahl analoger Referenzsignale (Refn) beruht, **dadurch gekennzeichnet, dass** die Vorrichtung Einstellmittel (42) zum Steuern des Leistungspegels und/oder des Kontrasts durch Einstellen der Stärke der Referenzsignale (Refn) auf der Grundlage eines mittleren Leistungspegels des Bilds umfasst, und wobei auf die Referenzpegel eine nichtlineare Transformation angewendet wird, die durch eine Referenzsignalgebungseinheit (5) bereitgestellt wird, um unter einem vorgegebenen Wert (0,16 V) anstelle der Referenzpegel (Vn) den vorgegebenen Wert (0,16 V) oder einen Wert über dem vorgegebenen Wert (0,16 V) bereitzustellen, um zu vermeiden, dass die Referenzpegel (V5, V6) einen Wert über null und unter dem vorgegebenen Wert (0,16 V) aufweisen, und Mittel (44) zum Anwenden der inversen Transformation (f^{-1}) auf das Bildsignal bereitgestellt sind, um Präzisionsfehler zu vermeiden.

7. Vorrichtung nach Anspruch 6, **dadurch gekennzeichnet, dass** die Anzeigevorrichtung zum Steuern des Kontrasts der durch sie angezeigten Bilder ferner Rechenmittel zum Berechnen eines auf die Stärke des den leuchtenden Elementen zugeführten Signals anzuwendenden Einstellfaktors, damit der resultierende Kontrast gleich einem geforderten Kontrast ist, umfasst und dass das Einstellmittel (42) den Einstellfaktor auf die analogen Referenzsignale (Refn) anwendet.

8. Vorrichtung nach einem der Ansprüche 6 oder 7, **dadurch gekennzeichnet, dass** sie einen Bildspeicher (43) zum Speichern eines Bilds, bevor es an die Anzeigevorrichtung übertragen wird, umfasst.

9. Vorrichtung nach Anspruch 6 oder 7, **dadurch gekennzeichnet, dass** das Einstellmittel (42) Mittel zum Anwenden der nichtlinearen Transformation (f) auf die Referenzsignale (Refn) und Mittel (44) zum Anwenden der inversen Transformation (f^{-1}) auf das Bildsignal umfasst.

10. Anzeigevorrichtung, die umfasst

- eine Mehrzahl organischer Lichtemitterdioden (1),
- ein Signalverarbeitungsmittel (4) zum Verarbeiten des durch die Anzeigevorrichtung empfangenen Bildsignals,
- Ansteuermittel (2, 3) zum Ansteuern der Mehrzahl organischer Lichtemitterdioden (1) in Übereinstimmung mit dem durch das Signalverarbeitungsmittel (4) verarbeiteten Signal,
- Referenzsignalgebungsmittel (5) zum Ausgeben analoger Referenzsignale (Refn) an das Ansteuermittel (3), **dadurch gekennzeichnet, dass** das Signalverarbeitungsmittel (4) eine Vorrichtung nach einem der Ansprüche 6 bis 9 umfasst.

Revendications

1. Procédé pour contrôle du niveau de puissance et/ou du contraste d'un dispositif d'affichage possédant une pluralité d'éléments lumineux correspondant aux composantes de couleur des pixels d'une image, où la luminance générée par chacun desdits éléments lumineux se base sur l'intensité des signaux fournis à l'élément lumineux et le niveau de puissance et/ou le contraste de chaque image est contrôlé par un réglage de l'intensité des signaux devant être fournis à chaque élément lumineux, où l'intensité des signaux devant être fournis aux éléments lumineux se base sur une pluralité de signaux de référence analogiques (Refn), et où le niveau de puissance et/ou le contraste est contrôlé par un réglage de l'intensité desdits signaux de référence analogiques (Refn) en fonction d'un niveau de puissance moyen de ladite image et **caractérisé en ce qu'**une transformation non linéaire est appliquée aux niveaux de référence et la transformation inverse (f^{-1}) est appliquée au signal d'image pour une utilisation, à la place de niveaux de référence (Vn) en-dessous d'une valeur prédéterminée (0,16 V), de ladite valeur prédéterminée (0,16 V) ou d'une valeur supérieure à ladite valeur prédéterminée (0,16 V) pour lesdits signaux de référence analogiques (Refn) pour éviter que les niveaux de référence (V5, V6) ne présentent une valeur environ égale à zéro et inférieure à la valeur prédéterminée (0,16 V) pour éviter les erreurs de précision.

2. Procédé selon la revendication 1, **caractérisé en ce que**, pour le contrôle du contraste des images affichées par le dispositif d'affichage, il comprend en outre les étapes suivantes :

- calcul d'un facteur de réglage devant être appliqué à l'intensité du signal d'image fourni aux éléments lumineux afin que le contraste obtenu soit égal à un contraste requis, et
- application dudit facteur de réglage aux signaux de référence analogiques (Refn).

3. Procédé selon une des revendications 1 ou 2, **caractérisé en ce que**, avant le réglage de l'intensité du signal, la transformation non linéaire (f) est appliquée à des signaux de référence (Refn) afin d'augmenter l'amplitude des signaux de référence (Refn) à faible amplitude et la transformation inverse (f^{-1}) est appliquée au signal d'image pour adapter en outre des niveaux de référence associés à un certain pourcentage de la surface blanche de l'image.

4. Procédé selon une des revendications 1 à 3, **caractérisé en ce que** les éléments lumineux sont des diodes d'affichage émettrices de lumière organique.

5. Procédé selon une des revendications 1 à 4, **caractérisé en ce que** les signaux de référence analogiques (Refn) sont des tensions de référence ou des courants de référence.

6. Appareil pour contrôle du niveau de puissance et/ou du contraste d'un dispositif d'affichage possédant une pluralité d'éléments lumineux correspondant aux composantes de couleur des pixels d'une image, où la luminance générée par chacun desdits éléments lumineux se base sur l'intensité des signaux fournis à l'élément lumineux et le niveau de puissance et/ou le contraste de chaque image est contrôlé par un réglage de l'intensité des signaux devant être fournis à chaque élément lumineux, et où l'intensité des signaux devant être fournis aux éléments lumineux se base sur une pluralité de signaux de référence analogiques (Refn), **caractérisé en ce qu'**il comprend un moyen de réglage (42) pour contrôler le niveau de puissance et/ou le contraste par un réglage de l'intensité des signaux de référence (Refn) en fonction d'un niveau de puissance moyen de ladite image et où une transformation non linéaire est appliquée aux niveaux de référence, fournie par une unité de signalement de référence (5), pour fournir, à la place de niveaux de référence (Vn) en-dessous d'une valeur prédéterminée (0,16 V), ladite valeur prédéterminée (0,16 V) ou une valeur supérieure à ladite valeur prédéterminée (0,16 V) pour éviter que les niveaux de référence (V5, V6) ne présentent une valeur supérieure à zéro et inférieure à la valeur prédéterminée (0,16 V) et un moyen (44) pour appliquer la transformation inverse (f^{-1}) au signal d'image est fourni pour éviter les erreurs de précision.

7. Appareil selon la revendication 6, **caractérisé en ce que**, pour le contrôle du contraste des images affichées par le dispositif d'affichage, il comprend en outre un moyen de calcul pour calculer un facteur de réglage devant être appliqué à l'intensité du signal fourni aux éléments lumineux afin que le contraste obtenu soit égal à un contraste requis, et **en ce que** le moyen de réglage (42) applique ledit facteur de réglage aux signaux de référence analogiques (Refn).

8. Appareil selon une des revendications 6 ou 7, **caractérisé en ce qu'**il comprend une mémoire de trame (43) pour stocker une image avant de la transmettre au dispositif d'affichage.

9. Appareil selon la revendication 6 ou 7, **caractérisé en ce que** le moyen de réglage (42) comprend un moyen pour appliquer la transformation non linéaire (f) à des signaux de référence (Refn) et un moyen (44) pour appliquer la transformation inverse (f^{-1}) au signal d'image.

10. Dispositif d'affichage comprenant

- une pluralité de diodes émettrices de lumière organique (1),
- un moyen de traitement de signal (4) pour traiter le signal d'image reçu par le dispositif d'affichage,
- un moyen de commande (2, 3) pour commander ladite pluralité de diodes émettrices de lumière organique (1) selon le signal traité par le moyen de traitement de signal (4),
- un moyen de signalement de référence (5) pour émettre des signaux de référence analogiques (Refn) vers le moyen de commande (3),

caractérisé en ce que ledit moyen de traitement de signal (4) comprend un appareil selon une quelconque des revendications 6 à 9.

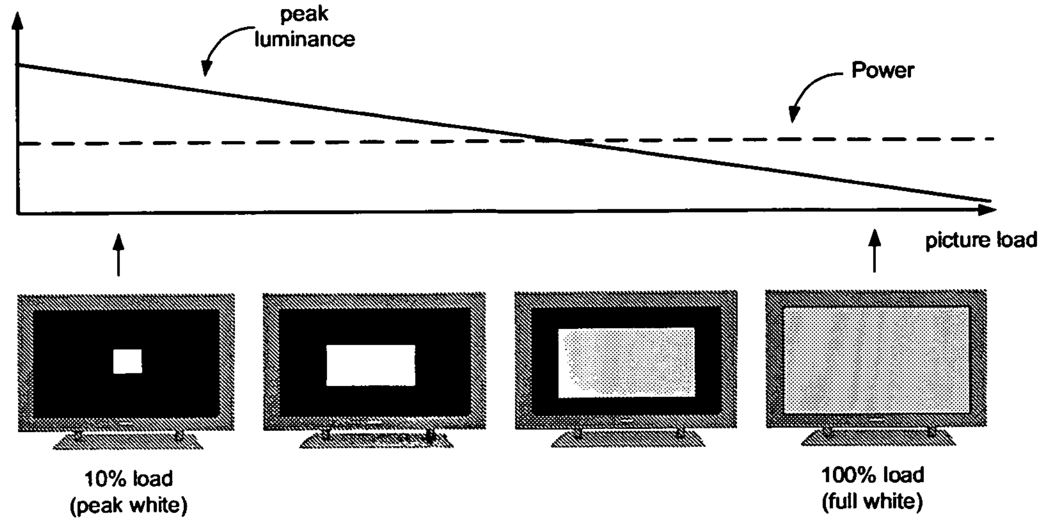

FIGURE 1

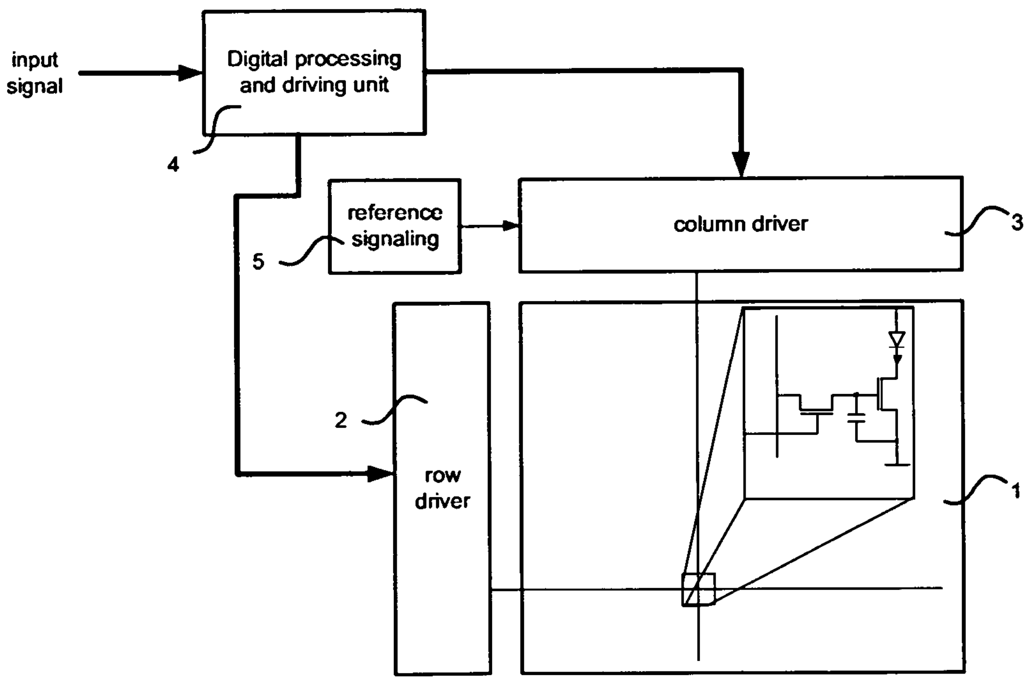

FIGURE 2

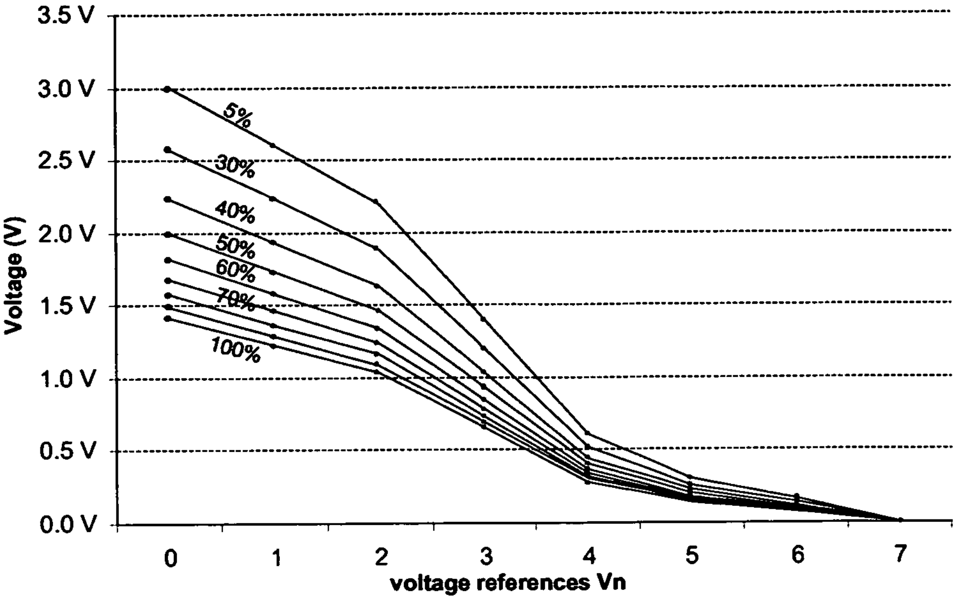

FIGURE 3

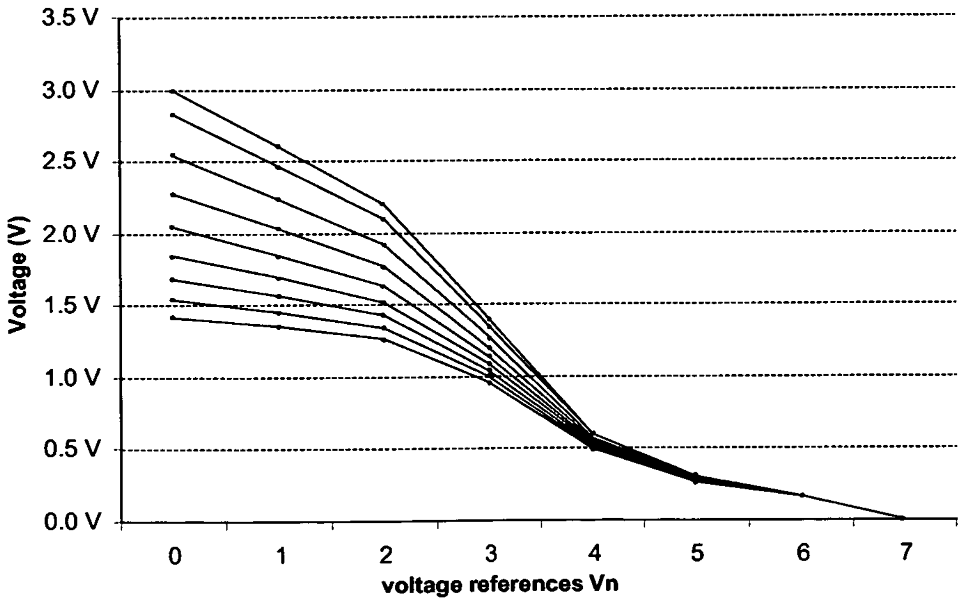

FIGURE 4

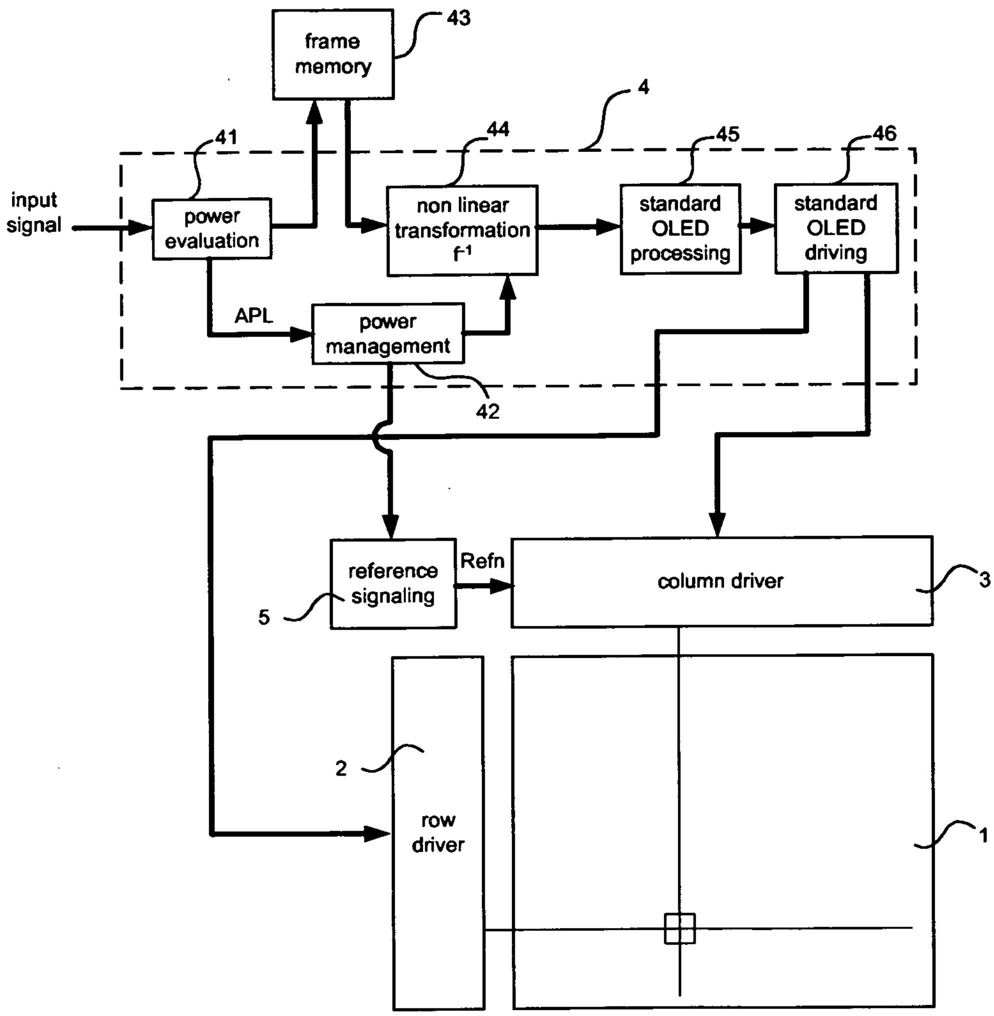
frame memory
43
4
41
44
45
46
input signal
power evaluation
non linear transformation f^{-1}
standard OLED processing
standard OLED driving
APL
power management
42
reference signaling
Refn
column driver
3
5
2
row driver
1

FIGURE 5

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- US 2003218583 A **[0009]**
- EP 1310935 A **[0010] [0011]**
- EP 1469449 A1 **[0012]**

专利名称(译)	用于显示设备的功率电平控制和/或对比度控制的方法和设备		
公开(公告)号	EP1624438B1	公开(公告)日	2010-09-22
申请号	EP2005106877	申请日	2005-07-26
[标]申请(专利权)人(译)	汤姆森特许公司		
申请(专利权)人(译)	汤姆森许可		
当前申请(专利权)人(译)	汤姆森许可		
[标]发明人	WEITBRUCH SEBASTIEN COTA DENNIS LE ROY PHILIPPE		
发明人	WEITBRUCH, SEBASTIEN COTA, DENNIS LE ROY, PHILIPPE		
IPC分类号	G09G3/32		
CPC分类号	G09G3/3225 G09G2320/0626 G09G2320/066 G09G2330/021 G09G2360/16		
代理机构(译)	KURTH迪特尔		
优先权	2004291945 2004-07-29 EP		
其他公开文献	EP1624438A1		
外部链接	Espacenet		

摘要(译)

本发明涉及一种用于控制具有多个发光元件的显示装置中的功率电平和/或对比度的方法和装置，所述多个发光元件对应于图像的像素的颜色分量，其中由所述发光元件的亮度基于提供给发光元件的信号的强度，并且通过调节提供给每个发光元件的信号的强度来控制每个图像的功率电平和/或对比度。本发明适用于有机发光显示器（OLED）。根据本发明，要提供给每个发光元件的信号的强度基于参考信号，并且通过调整参考信号的电平来进行信号强度的调整。