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(54) **Liquid crystal display control system**

(57) The present invention relates to a liquid crystal display control system comprising:
- a liquid crystal display (10) comprising a first region (21) in which, in every second row, a voltage determining a light transmission applied to each pixel is inverted between two image frames, whereas the voltage is kept constant for the other rows, the liquid crystal display comprising a second region (22) in which in every second pixel of a row the voltage determining the light transmission applied to each pixel is inverted between two image frames, whereas the voltage is kept constant for the other pixels of said row,
- a control unit configured to adapt a common voltage applied to each pixel.

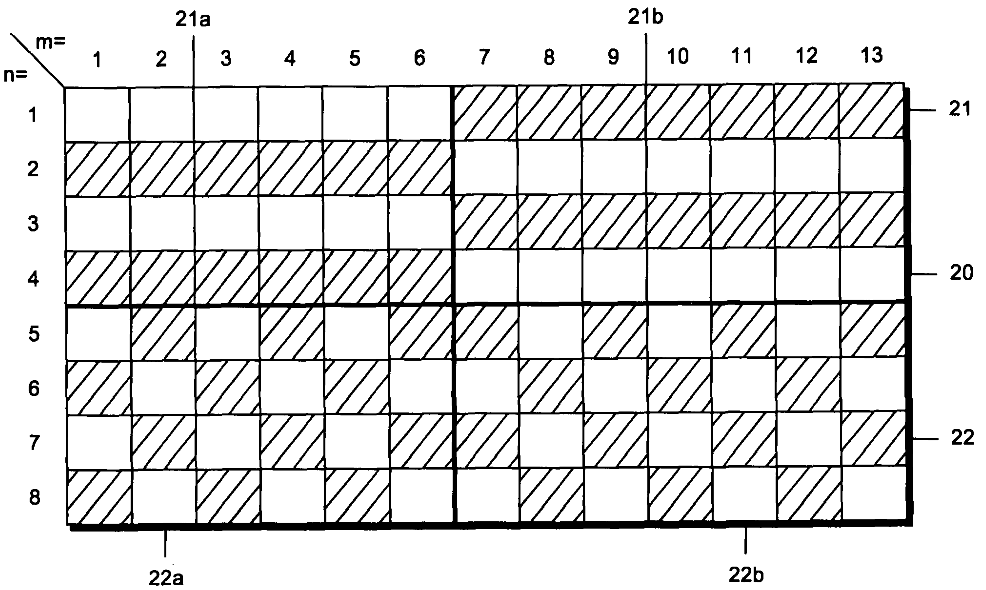

FIG. 2

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Description

[0001] This invention relates to a liquid crystal display control system and to a method for controlling a liquid crystal display.

Background

[0002] A liquid crystal display (LCD) is a flat display device containing a number of pixels arrayed in front of a light source or reflector. Each pixel of a LCD typically contains a layer of molecules aligned between two transparent electrodes and two polarizing filters, the axes of transmission of which are perpendicular to each other. With no liquid crystal between the polarizing filters light passing through the first filter is blocked by the second crossed polarizer.

[0003] When comparing a cathode ray tube screen (CRT) to a LCD screen, one of the most recognized differences is the issue of a flicker. Most users assume that CRT screens flicker while LCD do not. However, both screens have some amount of flicker, but the mechanisms for the flicker are different for both screens. LCD screens have an array of pixels constantly lit by a back light. The constancy of the light removes the type of flicker found in CRT screens. In a LCD screen the voltage applied between the two electrodes is responsible for the amount of transmitted light. The voltage controls the alignment of the liquid crystal molecules in the electric field between the two electrodes of a pixel of the LCD screen. If the voltage between the two electrodes is large enough, no light can pass the two electrodes and the pixel will appear black. By controlling the voltage applied across the liquid crystal layer in each display, light can be allowed to pass through in varying amounts, thus constituting different levels of gray. For a colored LCD screen a red light, a green light and a blue light source is provided for each pixel together with filters.

[0004] The video source signal to be displayed on the LCD screen typically ranges from 0 V to 10 V, the applied voltage for each pixel corresponding to the intensity information that appears across the pixel. The bottom of the pixel is normally connected to a back plane of the LCD screen. The voltage common to all the bottoms of the pixels is known as V_{com}. Assuming the V_{com} voltage is at ground, the voltage across the pixel varies from 0 to 10 V resulting in an average of 5 V. This would lead to a substantial DC voltage across each pixel, what would result in an accelerated aging of the LCD screen. A LCD screen is now configured in such a way that, as shown in Fig. 3, the common voltage V_{com} is set to the midpoint of the video signal. The brightness at every pixel is determined by the difference between the voltage and the voltage V_{com}. As can be seen from Fig. 3, the relationship between the light emitted from a pixel and the voltage applied is a non-linear S-shaped curve. The light transmitted only depends on the voltage difference, so that the same transmittance is obtained for the voltages V+ and V-. Most liquid crystal display screens switch alternating pixels between one polarity and the other, resulting in an average DC voltage across the display of 0 V. The V_{com} voltage needs to be placed exactly at the midpoint of the video signal to avoid flicker. If V_{com} is not exactly set to the midpoint, e.g. 5.3 V for a video signal swinging between 0 V and 10 V, the full-scale voltage will be different on each pixel, on one pixel the full scale voltage will be 4.7 V, whereas on the other pixel the full-scale voltage will be 5.3 V. This difference in voltage translates to a difference in intensity experienced as a flicker when the voltage is inverted from image frame to image frame.

[0005] In the art it is known to use a uniform gray image comprising 50% white in connection with an optical sensor recognizing an intensity modulation of the LCD screen when the intensity is inverted pixel- or row-wise. However, this method of minimizing the flicker has the disadvantage that the intensity differences between the two polarities are relatively small and difficult to detect. Furthermore, there are two different types of LCD screens, a LCD screen using a dot inversion pattern in which the polarity of neighbored pixels is in antiphase. Furthermore, LCD screens using a row inversion patterns are used in which pixels of one row use the positive voltage between V_{com} and V_{max}, whereas the neighboring row uses the negative voltage between V_{com} and 0.

Summary

[0006] In the art a need exists to easily detect a possible flicker of a LCD screen for the different types of LCD screens commonly used.

[0007] This need is met by the features of the independent claims. In the dependent claims preferred embodiments of the invention are described.

[0008] According to a first aspect of the invention, a liquid display control system is provided comprising a LCD having a first region in which, in every second row, a voltage determining a light transmission applies to each pixel as inverted between the image frames, whereas the voltage is kept constant for the other rows. The liquid crystal display furthermore comprises a second region in which in every second pixel of a row the voltage determining the light transmission applied to each pixel is inverted between the image frames, whereas the voltage is kept constant for the other pixels of said row. Furthermore, a control unit is provided allowing to adapt a common voltage applied to each pixel. The liquid crystal display displaying the two different regions has the advantage that the frequency of the flicker corresponding to the frequency of the image frames is set such that it is perceivable for the human eye. Additionally, the difference between the positive and the negative polarity is emphasized and the flicker can be easily detected for both types of LCD screens known on the market. If the LCD screen is a screen for which the voltage is inverted row by row, the first region shows a flicker for a not well adjusted V_{com}. However, when the LCD screen is a screen using a pixel-wise inversion, a flicker will appear in the second region of the screen.

[0009] Preferably, in the second region the voltage distribution applied to the different pixels in a row adjacent to said row is shifted by one column compared to the pixels of said row, resulting in a chequered pattern of the pixels. In a second region the pixels for which the voltage is inverted from frame to frame and for which the voltage is kept constant are arranged in an alternating manner resulting in a chequered pattern.

[0010] Preferably, the voltage that is kept constant is 0, resulting in a black pixel, whereas the voltage applied to the different pixels that is inverted should lie between 30 and 70% of the maximum voltage applied. Preferably, the voltage applied is selected in such a way that approximately 50% of light is transmitted through the pixels resulting in a gray. Accordingly, the image displayed by the LCD screens shows in the first region alternating black and gray rows. The pixels of the black rows do not change in intensity in case the voltage is inverted, whereas the intensity of the gray pixels may change when the voltage is not exactly at half of the video signal voltage. The different gray levels due to the voltage inversion are responsible for the flicker. In the second region the gray pixels arranged in the chequered pattern also suffer from a varying intensity in the case of a not correctly fixed voltage V_{com}.

[0011] The LCD control system displaying a screen with the two different regions shows the flicker for the two different kinds of LCD screens known, so that independent of the type of screen used a flicker will be detected.

[0012] Preferably, the first region comprises a first part and a second part, whereas the voltage distribution applied to the different pixels of the second part is shifted by one row compared to the voltage distribution applied to the different pixels of the first part. The same can be done for the second region, so that the second region comprises a first part and a second part resulting in a voltage distribution of the pixels of the second part being shifted by one row compared to the voltage distribution of the first part of the second region. If the two different parts for one region are displayed one next to the other, both polarities are visible at the same time.

[0013] Furthermore, the voltage applied to every second row is inverted for every second row in one image frame.

[0014] The LCD control system may further comprise an optical sensor detecting an intensity modulation of the liquid crystal display displaying the different regions. The optical sensor now may control the control unit in such a way that the intensity modulation is minimized. When the sensor detects all four different parts of the LCD screen, a flicker of the display can be detected independent of the type of LCD screen used.

[0015] According to another aspect of the invention a method for controlling a liquid crystal display is provided, the method comprising the steps of providing the first region of the liquid crystal display as described above and the second region as described above. Furthermore, the common voltage V_{com} applied to each pixel is adapted in such a way that the intensity modulation of the display is minimized.

Brief Description of the Drawings

[0016] In the following the invention will be described in further detail with reference to the accompanying drawings, in which:

Fig. 1 shows schematically a system used for controlling a flicker of a liquid crystal display,

Fig. 2 shows an image of the screen used to detect and minimize a flicker, and

Fig. 3 shows the non-linear relationship between the light emitted from a pixel and the voltage applied to it.

Detailed Description of Preferred Embodiments

[0017] In Fig. 1 a liquid crystal display control system is shown in which a liquid crystal display 10 comprises a control unit 11, the control unit allowing the adaption of a common voltage V_{com} as shown in Fig. 3. The possibility to adapt the common voltage V_{com} is schematically illustrated by a control button 12, with which the common voltage V_{com} can be adjusted to half of the video signal voltage. For providing the common voltage V_{com} a V_{com} amplifier (not shown) can be used to supply a very stable reference voltage for all the pixels of the liquid crystal display.

[0018] As can be deduced from Fig. 3, the brightness at every pixel depends on the difference between the voltage applied to each pixel and this common voltage V_{com}. The gamma curve shown in Fig. 3b can be either positive- or negative-referenced to V_{com}. Generally, only the voltage difference is responsible for the light transmitted through the pixel, so that in case V^+ as shown in Fig. 3 is applied to one pixel and in case V- is applied to another pixel, both pixels should have the same amount of light transmitted. In order to have a voltage across the display of 0 V, alternating pixels are switched between one polarity and the other. In order to prevent polarization of the liquid crystal material, the polarity of this pixel voltage is reversed on alternate image frames. Furthermore, the voltage is inverted depending on the position of the pixel in one image frame. Presently, LCDs are used using a row inversion scheme in which the applied voltage is inverted from row to row. Furthermore, a dot inversion pattern is known in which the polarity of nearby pixels is in antiphase. In Fig. 2 a screen of the LCD screen is shown with which a badly adjusted voltage V_{com} can be recognized and with which the resulting flicker can be minimized. The LCD screen 20 shown in Fig. 2 comprises two main regions, the main region 21 shown in the upper part and the main region 22 shown in the lower part of the screen 20. In the embodiment of Fig. 2 only a few pixels are shown, namely the pixels located in the neighborhood where one region neighbors another region. The first region 21 comprises a first part 21a and a second part 21b. The first part 21a comprises the rows n=1-4 and the columns m=1-6, the part 21b comprising, in the example shown, the rows n=1-4 and the columns m=7-13. In this part of the LCD screen every second row is controlled with an inverted voltage meaning that in row 2 the voltage V^+ is applied, resulting in a transmission shown by the hatched area in Fig. 2. In row 4 the voltage V-is applied, resulting in a transmission of light displayed by the hatched area. No voltage is applied to the other rows of region 21a (rows 1 and 3 of the embodiment shown), these rows having a black appearance, as no light is transmitted. As a consequence, in region 21a a black row is followed by a row to which voltage is applied, e.g. having a gray appearance. In the next image frame the voltage applied to the different rows is inverted, so that for a row n=2 the negative voltage is applied, whereas for a row n=4 the positive voltage is applied. If V_{com} is not well-regulated, a low-frequency flicker occurs, in the range of 50 or 60 Hz depending on the image frame rate. This flicker can be observed by a user of the liquid crystal display. In the right part of the first region, in region 21 b the voltage pattern is shifted by one row, so that the black rows of region 21a are gray and region 21 b and vice versa. If the liquid crystal display 10 is a display using the row inversion scheme, the flicker will occur in the first region 21. If the display used is a display in which the voltage is inverted from pixel to pixel, the second region 22 will indicate that the liquid crystal display is not well-adjusted. The second region 22 comprises a first part 22a and a second part 22b. In the left part 22a a voltage is applied to every second pixel of a row, e.g. in row n=5 the pixels having the column number 2, 4, and 6, whereas in row n=6 the pixels with the column number 1, 3, and 5 are supplied with voltage.

[0019] The result is a chequered pattern with black pixels and gray pixels, the gray pixels being indicated as hatched.

[0020] When a LCD with a dot inversion pattern is used, an inverted voltage is applied to every second pixel, e.g. to pixels n=5 and m=2 the voltage V^+ is applied, whereas to pixels n=5 and m=4 the voltage V- is applied, etc. Furthermore, the voltage is inverted from one image frame to the next image frame. Accordingly, a pixel having a positive polarity in one image frame has a negative polarity in the next image frame. If V_{com} is not well-adjusted, a flicker of the display results, as the intensity of the transmitted light differs for the two different voltages. In the part 22b the pattern of part 22a is again shifted by one row. By shifting the parts of the screen 22b relative to 22a and by shifting the part 21 b relative to 21a by one row, both polarities are visible at the same time. When the display 10 shows a screen having a pattern as shown in Fig. 2, a flicker can be recognized for any type of LCD used. When a screen as shown in Fig. 2 is shown in the LCD, the flicker can be minimized by either manually controlling control unit 11 in such a way that the intensity modulation is minimized, or this can be done automatically by using an optical sensor 13 as shown in Fig. 1. The optical sensor 13, when detecting the screen as shown in Fig. 2, can minimize the intensity modulation by controlling the control unit 11. If the LCD is a display with a row inversion scheme, the upper part of the display shown will flicker. Then the LCD is a display using a dot inversion scheme, the lower part of the screen will flicker. In any way the intensity modulation will be detected by the light sensor 13 and the light sensor 13 can control the control unit 11 in such a way that the flicker is minimized. When a screen as shown in Fig. 2 is used, a not well-adjusted common voltage can be detected by the human eye, as the frequency is low enough. Furthermore, the different between positive and negative polarity is emphasized by using a pattern as shown in Fig. 2 and as it is possible to securely minimize a flicker for any kind of liquid crystal display. By using one screen the different possible inversion schemes used in liquid crystal displays can be recognized and an eventual flicker can be minimized.

Claims

1. A liquid crystal display control system comprising:

   - a liquid crystal display (10) comprising a first region (21) in which, in every second row, a voltage determining a light transmission applied to each pixel is inverted between two image frames, whereas the voltage is kept constant for the other rows, the liquid crystal display comprising a second region (22) in which in every second pixel of a row the voltage determining the light transmission applied to each pixel is inverted between two image frames, whereas the voltage is kept constant for the other pixels of said row,
   - a control unit configured to adapt a common voltage applied to each pixel.

2. The liquid crystal display control system according to claim 1, wherein , in the second region (22), in an adjacent row of said row, the voltage distribution applied to the different pixels in said adjacent row is shifted by one column compared to the pixels of said row, resulting in a chequered pattern of pixels.

3. The liquid crystal display control system according to claim 1 or 2, wherein the first region (21) comprises a first part (21a) and a second part (21b), wherein the voltage distribution applied to the different pixels of the second part is shifted by one row compared to the voltage distribution applied to the different pix-

els of the first part.

4. The liquid crystal display control system according to any of the preceding claims, wherein the second region (22) comprises a first part (22a) and a second part (22b), wherein the voltage distribution applied to the different pixels of the second part is shifted by one row compared to the first part.

5. The liquid crystal display control system according to any of the preceding claims, wherein the voltage that is kept constant is zero.

6. The liquid crystal display control system according to any of the preceding claims, wherein in the first region (21), the voltage applied to every second row is inverted for every second row in one image frame.

7. The liquid crystal display control system according to any of the preceding claims, further comprising an optical sensor (13) detecting an intensity modulation of the liquid crystal display, the optical sensor controlling the control unit in such a way that the intensity modulation is minimised.

8. The liquid crystal display control system according to any of the preceding claims, wherein the inverted voltage applied to the different pixels is selected in such a way that the modulus of the applied voltage is between 30°% and 70 % von the maximum voltage applied to the pixels.

9. A method for controlling a liquid crystal display comprising the following steps:

- providing a first region on the liquid crystal display in such a way that in every second row, a voltage determining a light transmission applied to each pixel is inverted between two image frames, whereas the voltage is kept constant for the other rows,
- providing a second region on the liquid crystal display in such a way that in every second pixel of a row, the voltage determining the light transmission applied to each pixel is inverted between two image frames, whereas the voltage is kept constant for the other pixels of said row,
- adapting a common voltage applied to each pixel in such way that an intensity modulation of the display is minimised.

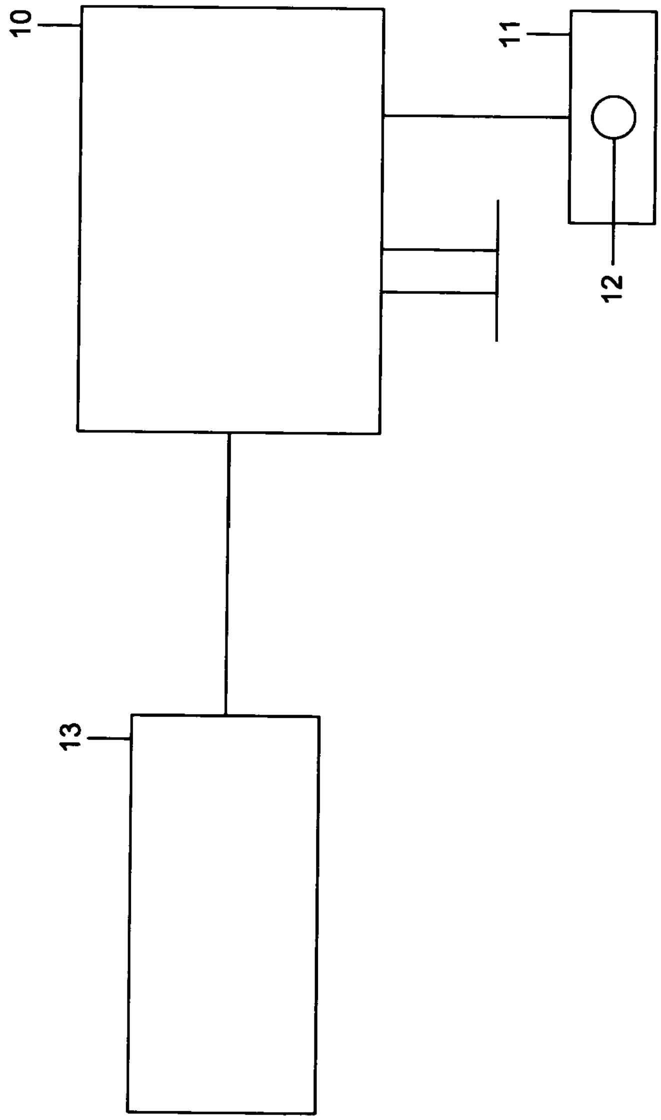

FIG. 1

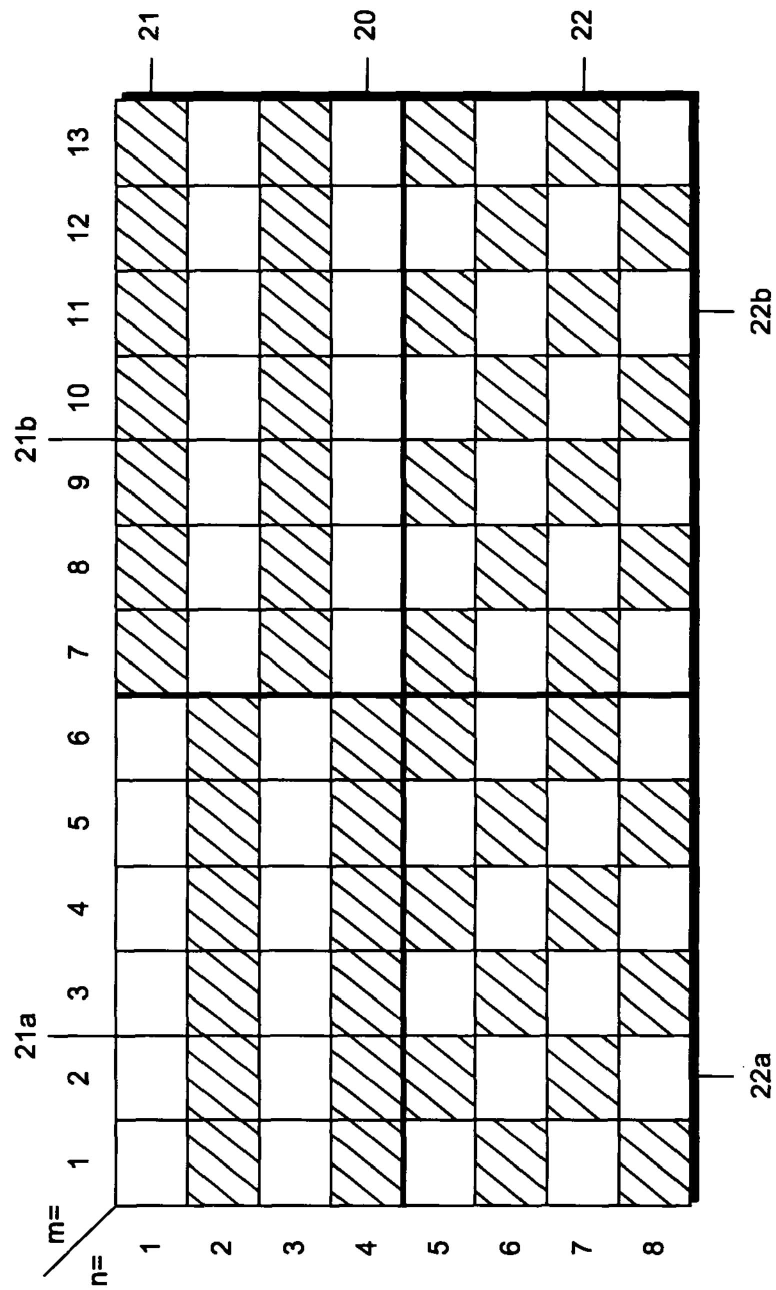

FIG. 2

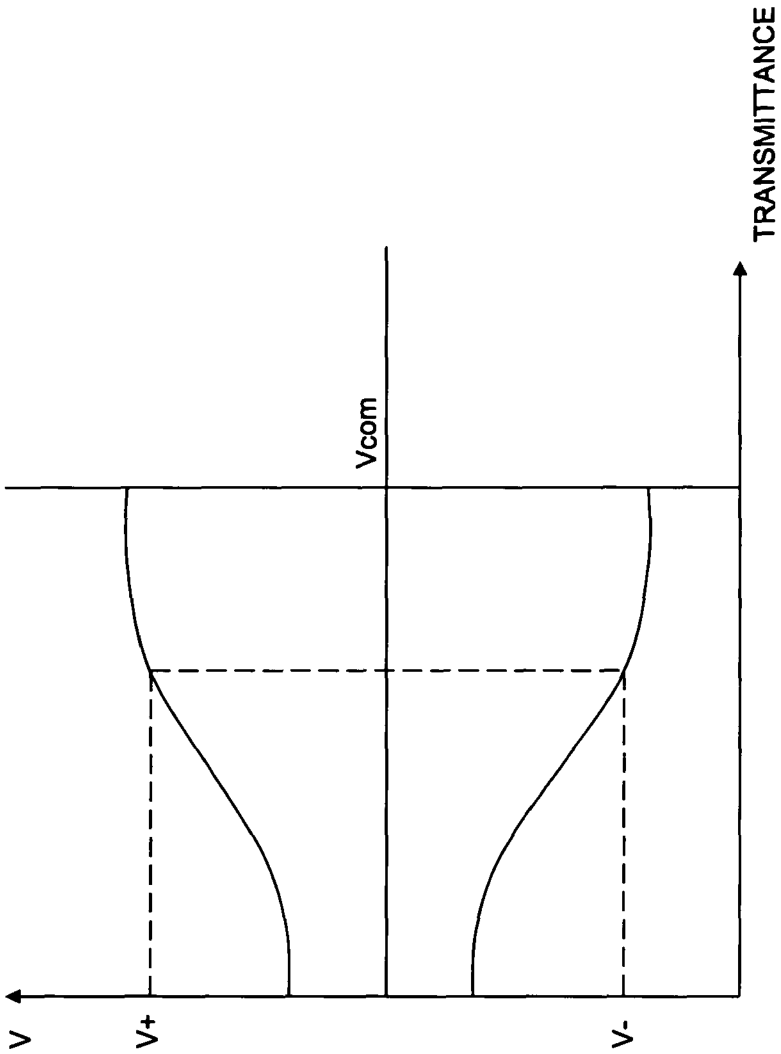

FIG. 3

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EUROPEAN SEARCH REPORT

Application Number
EP 08 01 6775

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	US 2005/162365 A1 (AOKI TORU [JP]) 28 July 2005 (2005-07-28) * the whole document * -----	1-9	INV. G09G3/36
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A	US 2005/259092 A1 (AOKI TORU [JP]) 24 November 2005 (2005-11-24) * paragraphs [0002], [0017], [0076] - [0080], [0084] - [0088]; figures 8,9 * -----	1-9	
			TECHNICAL FIELDS SEARCHED (IPC)
			G09G

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	12 February 2009	Auracher, Stefan

CATEGORY OF CITED DOCUMENTS

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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 08 01 6775

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12-02-2009

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