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A method and circuit for driving an active matrix of a positive type liquid crystal display device

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G09G 3/36

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Fig.1.

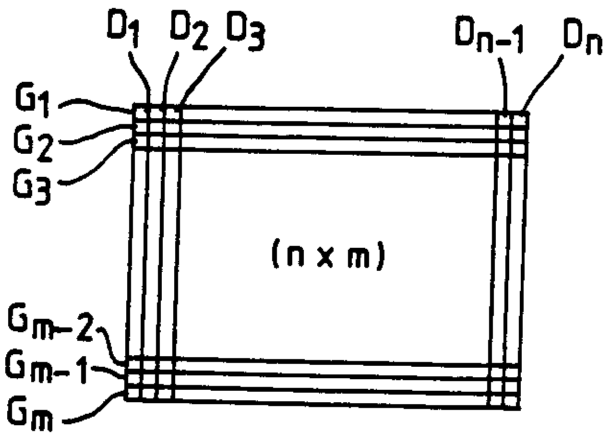
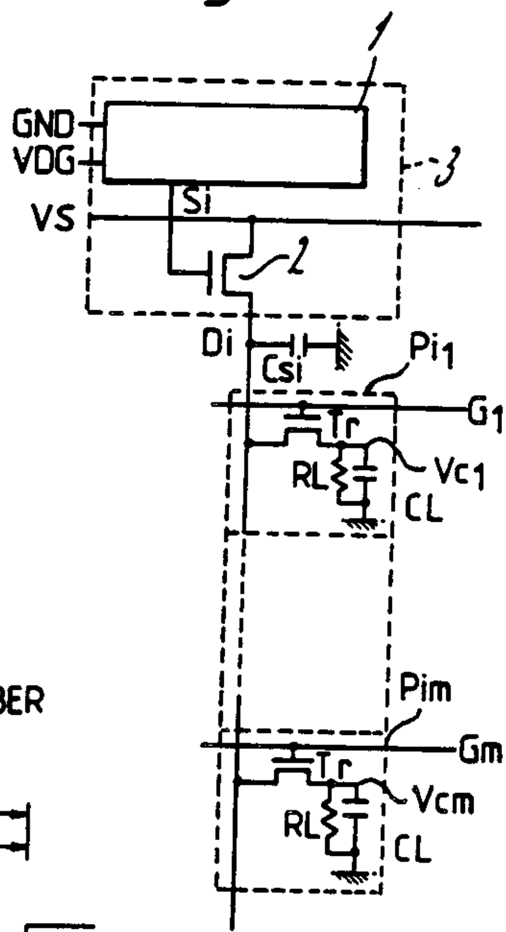


Fig.2.



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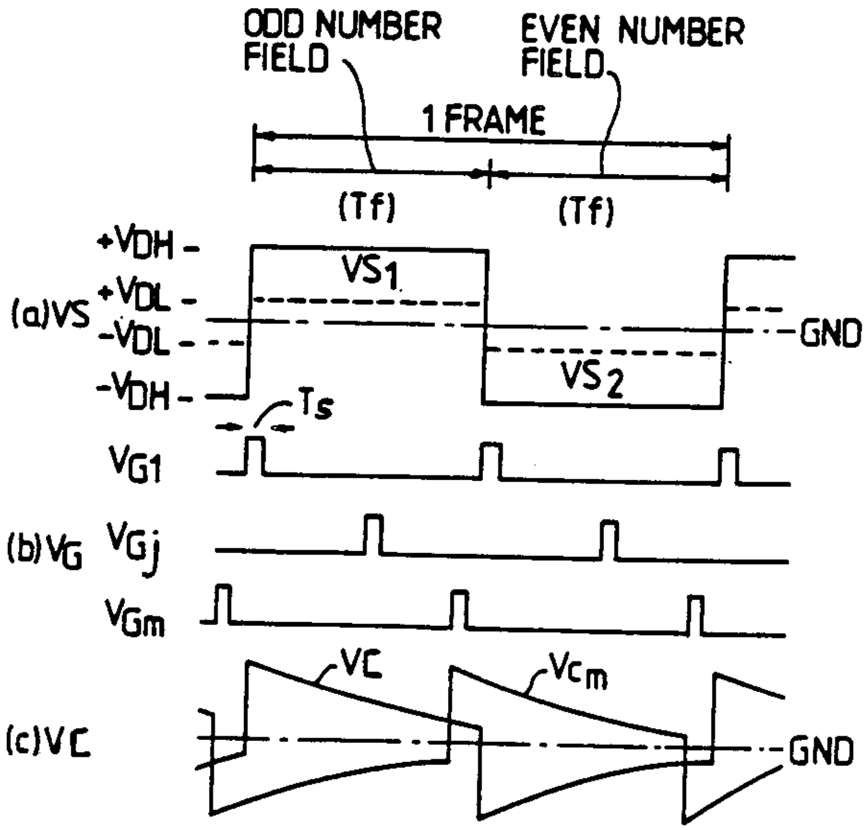

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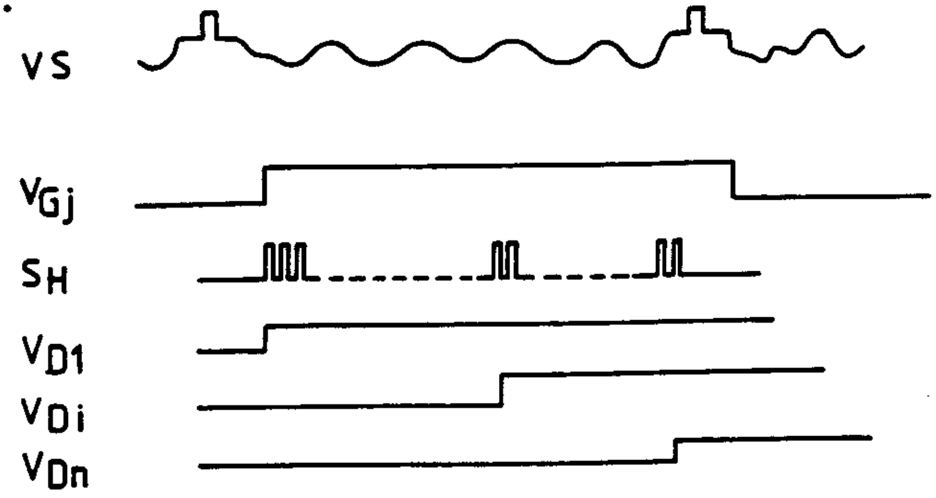
Fig.4.



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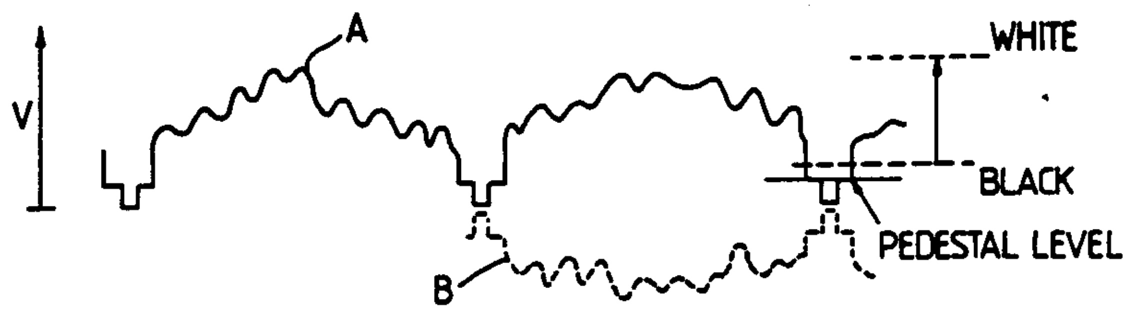

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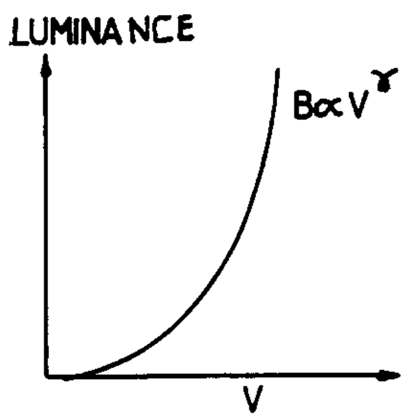

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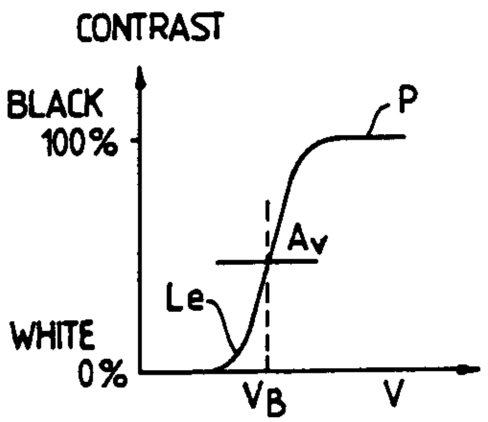

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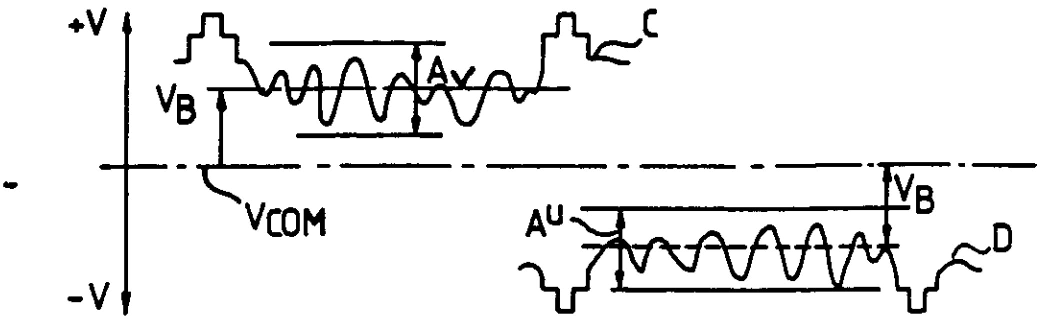

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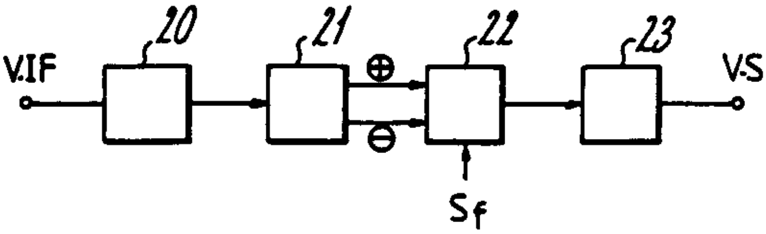

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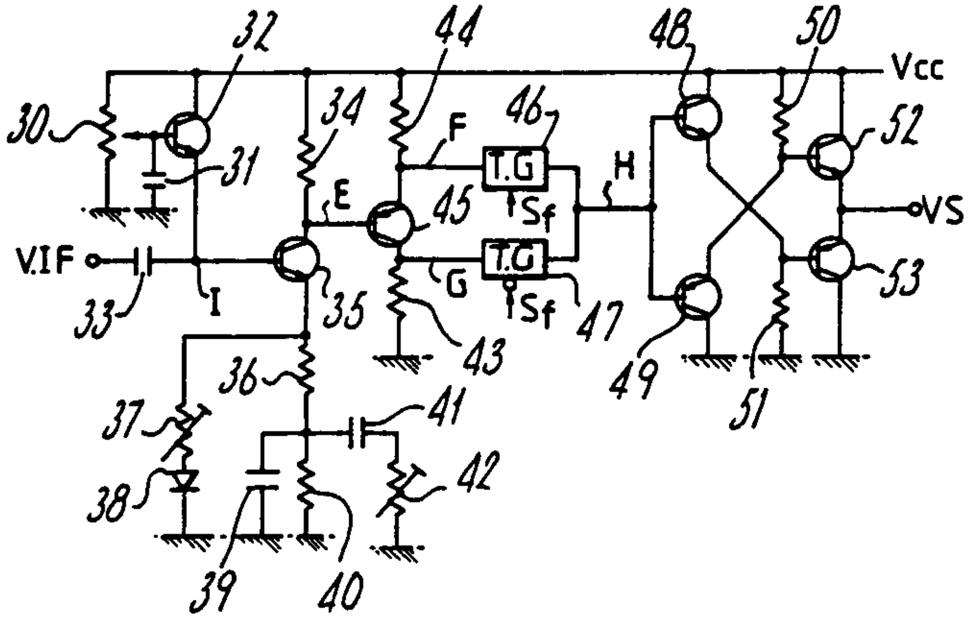

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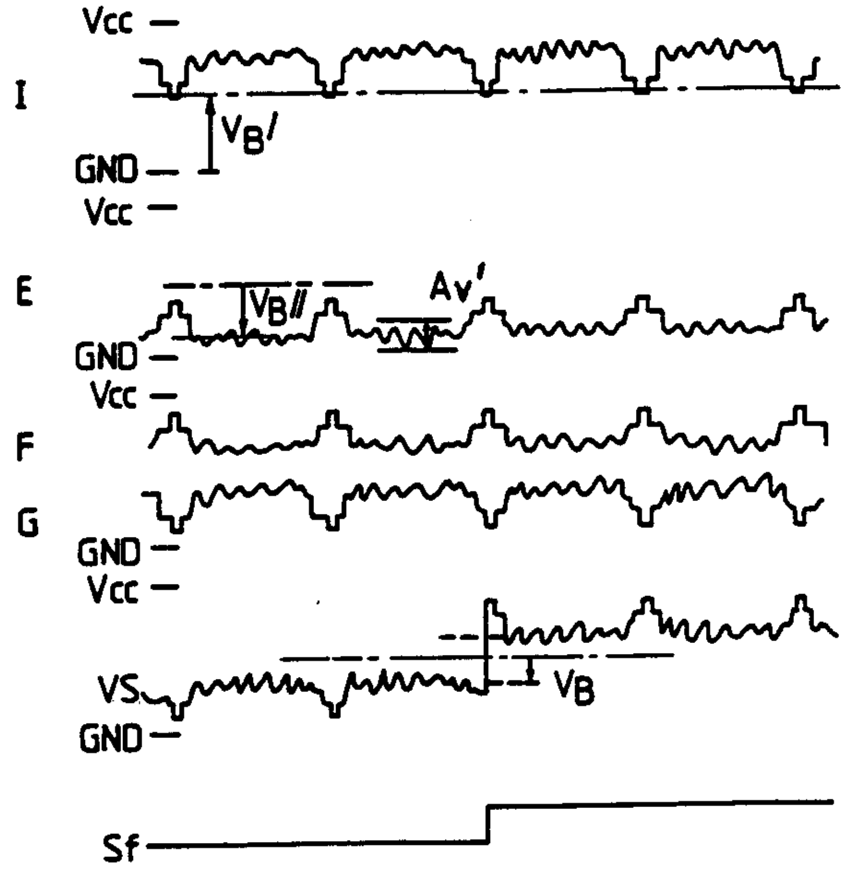
Fig.11.



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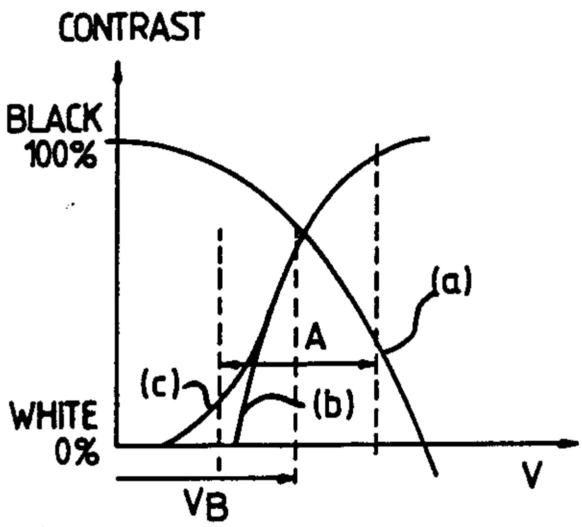
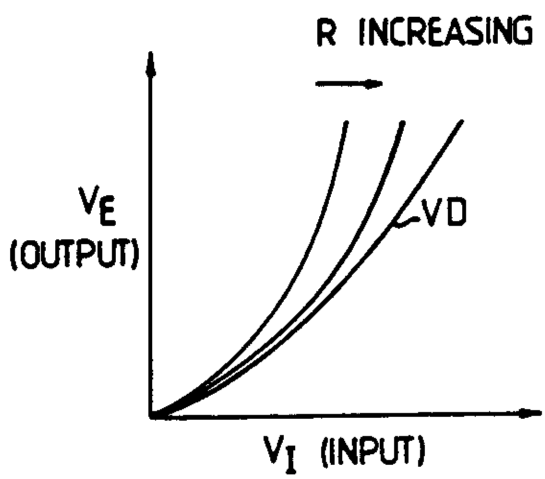


Fig.13.



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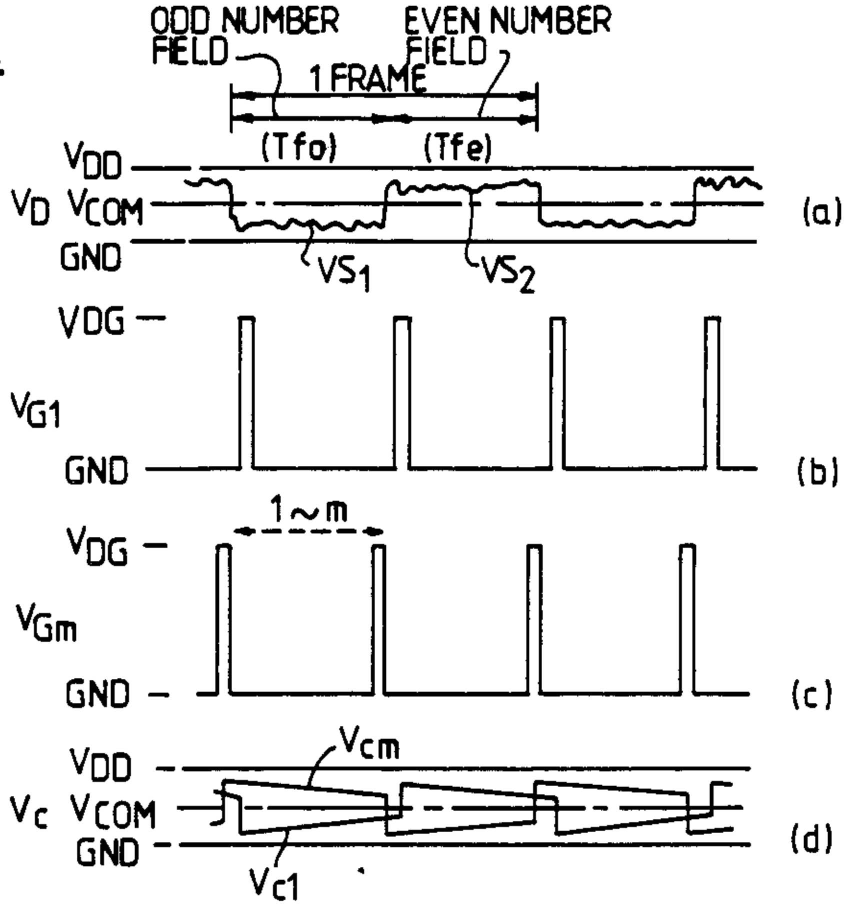
ODD NUMBER FIELD
EVEN NUMBER FIELD
1 FRAME
(Tfo)
(Tfe)
VDD
VD VCOM
GND
VS1
VS2
(a)
VDG
VG1
GND
(b)
1 ~ m
VDG
VGm
GND
(c)
VDD
Vcm
Vc VCOM
GND
Vc1
(d)

Fig.15.

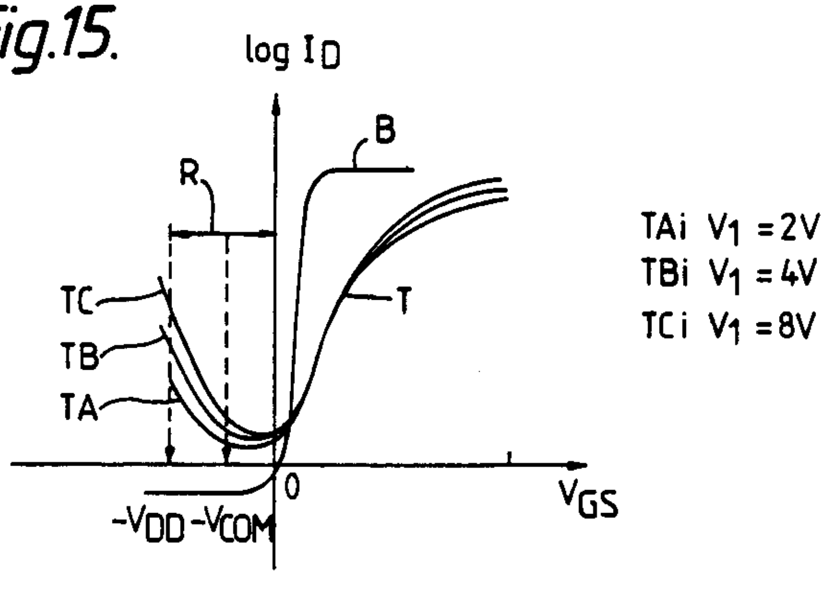
log ID
B
R
TC
TB
TA
T
0
VGS
-VDD -VCOM
TAi V1 = 2V
TBi V1 = 4V
TCi V1 = 8V

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Fig.16.

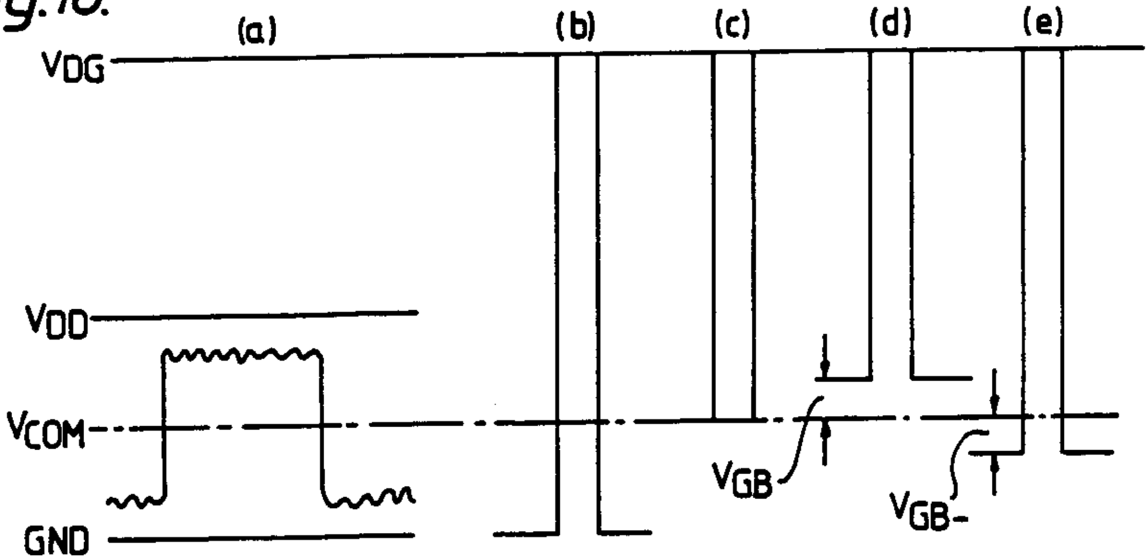


Fig.17.

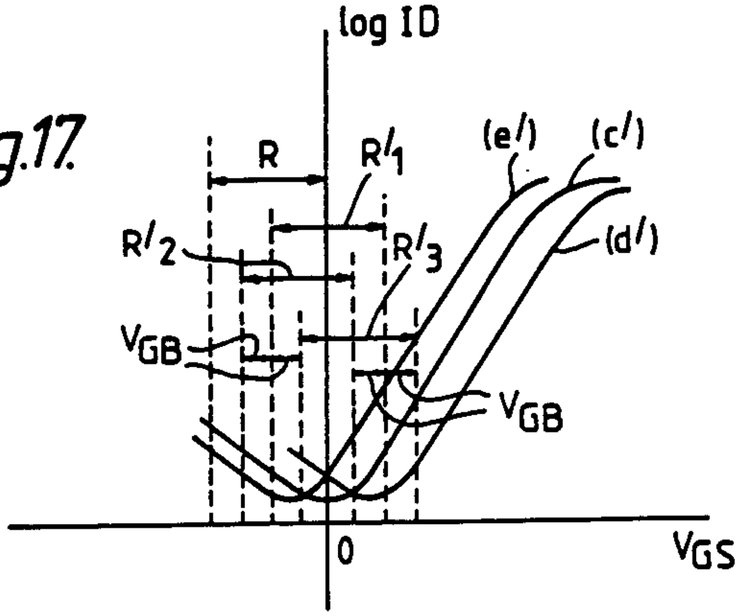


Fig.18.

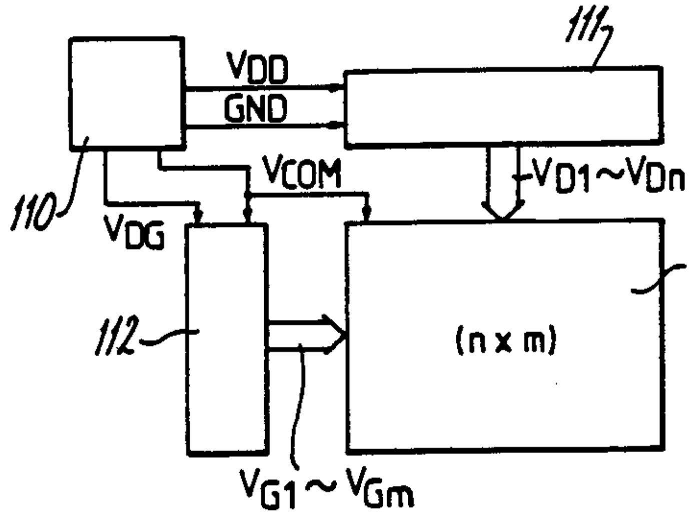


Fig.19.

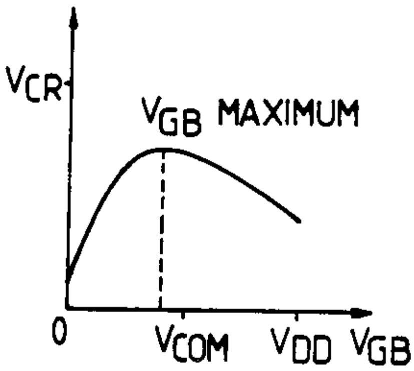


Fig.20.

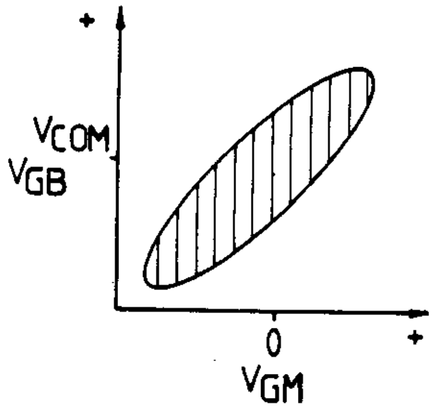


Fig.21.

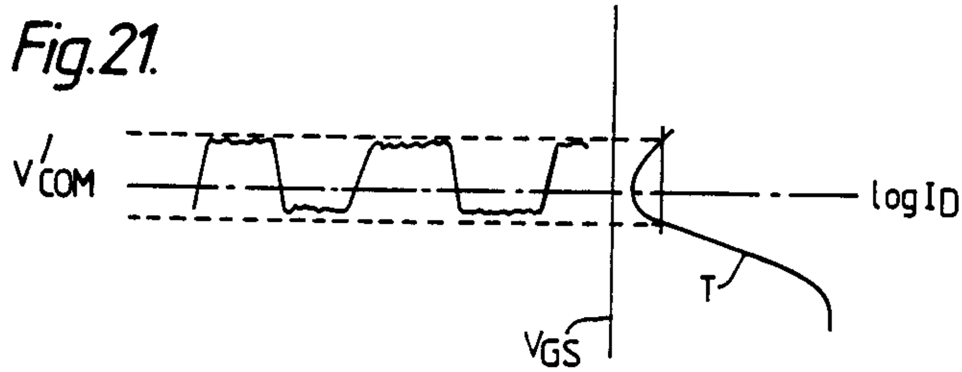
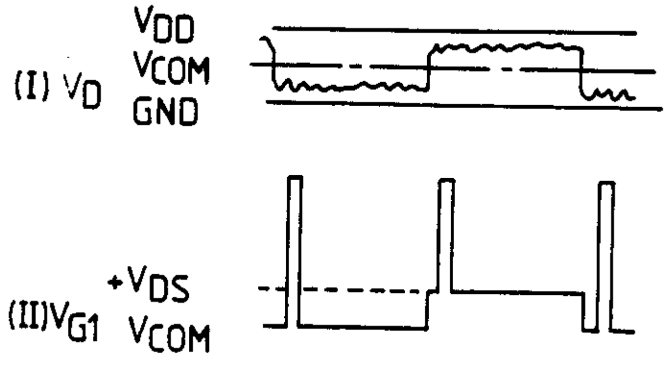


Fig.22.



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A METHOD AND CIRCUIT FOR DRIVING AN ACTIVE MATRIX OF A POSITIVE TYPE LIQUID CRYSTAL DISPLAY DEVICE

This invention relates to a method and circuit for driving an active matrix of a positive type liquid crystal display device.

Liquid crystal displays have been used for small displays for instance in a timepiece, but it is now desired to use a liquid crystal display for a large display device such as a computer terminal or a pocket TV where the liquid crystal display needs to have a large capacity. In a conventional generalised AC amplitude selected multiplexing driving method, the limit of driving duty is 1/30 - 1/50 and it is difficult to realise a large capacity driving duty of, for instance, 1/500. In order to improve the driving duty, it has been suggested to use a transistor such as a thin film transistor (TFT) or an active element such as a metal-insulator-metal (MIM) element (strictly speaking, MIM is not active but in this specification it is defined to be an active element) for writing and holding data in every picture element of the display device.

According to a first aspect of the present invention, there is provided a method of driving an active matrix of a positive type liquid crystal display device in which a video signal suitable for a cathode ray tube is used to write into an element of the display device via a transistor during a selected period and is held in the element during a non-selected period, voltage levels corresponding to shades in the grey scale being reversed by inversion of the video signal about a selected voltage level to produce a reversed voltage level video signal, symmetrically amplifying the reversed voltage level video signal to produce two negative video signals, the second of which is obtained as the inversion of the reversed voltage level video signal about another selected voltage level, and applying the negative video signals alternately to write into the element.

Preferably, a gate voltage applied to a gate of the transistor during the non-selected period lies within the voltage range of the negative video signal.

Preferably, the voltage range in the negative video signal corresponding to shades in the lighter end of the grey scale is extended.

In one embodiment, the other selected voltage lever is that applied to a common electrode of the display device.

In another embodiment, the other selected voltage level differs from that applied to a common electrode of the display device.

A gate voltage applied to the gate of the transistor when the negative video signal comprises the reversed voltage level video signal, may differ from that applied thereto when the negative video signal comprises the second negative video signal.

According to another aspect of the present invention there is provided a circuit for driving an active matrix of a positive type liquid crystal display device in which a video signal suitable for a cathode ray tube is used to write into an element of the display device *via* a transistor during a selected period, and is held in the element during a non-selected period, the circuit comprising input means for receiving the video signal, an inverter for reversing the voltage levels of the video signal corresponding to shades in the grey scale by inversion about a selected voltage level to produce a reversed voltage level video signal, symmetrical amplifier means for the reversed voltage level video signal to produce two negative video signals, the second of which is obtained as the inversion of the reversed voltage level video signal about another selected voltage level, and output means for applying the negative video signals alternately to write into the element.

Preferably, the circuit is arranged so that a gate voltage applied to a gate of the transistor during the non-selected period lies within the voltage range of the negative video signal.

The circuit may further comprise means for extending the voltage range in the negative video signal corresponding to shades in the lighter end of the grey scale.

This invention will now be illustrated, merely by way of example, with reference to the accompanying drawings, in which:-

Figure 1 shows an *n* x *m* matrix of a liquid crystal display device;

Figure 2 shows the structure of part of a matrix such as that shown in Figure 1,

Figures 3 and 4 show waveforms of signals applied to a matrix such as that shown in Figures 1 and 2,

Figure 5 shows a typical video signal applied to a matrix such as that shown in Figures 1 and 2,

Figure 6 shows the illuminance-voltage characteristic of a video signal such as that shown in Figure 5,

Figure 7 shows the contrast-voltage characteristic of a positive type liquid crystal display device,

Figure 8 shows a video signal such as that produced by a method according to the present invention,

Figure 9 is a block diagram of a circuit for producing the video signal shown in Figure 8,

Figure 10 is a circuit diagram of part of the circuit shown in Figure 9,

Figure 11 shows waveforms of signals at points marked in the diagram of Figure 10,

Figure 12 shows contrast-voltage characteristics corresponding to signals such as those shown in Figure 11,

Figure 13 is a diagram showing the relationship between input and output voltages of a transistor forming part of the circuit shown in Figure 10,

Figure 14 shows waveforms of signals applied to a matrix such as that shown in Figures 1 and 2 in a preferred method according to the present invention,

Figure 15 shows voltage-current characteristics of two types of transistors,

Figure 16 shows waveforms of a video signal and of gate signals which may be used in the preferred method,

Figure 17 shows further voltage-current characteristics of a transistor to the type used in the preferred method,

Figure 18 is a block diagram of a circuit which may be operated in accordance with the preferred method,

Figures 19 and 20 are graphs showing effects of using the preferred method,

Figure 21 shows a waveform of a video signal used in a further preferred method according to the present invention, and

Figure 22 shows waveforms used in a yet further preferred embodiment according to the present invention.

Figure 1 shows an active matrix in which picture elements are arranged in an n x m matrix. Picture elements in a cell are selected by selecting signals on m gate lines G_1 to G_m and data signals are then written into the selected picture elements _via_ n data lines D_1 to D_n and held there.

Figure 2 shows the structure of part of an active matrix using TFT receiving data from a data line Di. m picture elements Pi1-Pim are arranged in a column connected to the data line Di as shown in Figure 2. A transistor Tr of a picture element is turned ON by a selecting signal on a corresponding gate line and display data on a data line is then written into a picture element via the transistor Tr. After writing data, the transistor Tr is turned OFF again and the written data is held until the next time the transistor is selected. Each picture element includes a liquid crystal display device which is represented by a resistance RL and a capacitance CL connected to the transistor Tr. The data line Di is connected to a data driver 3. In the data driver 3, a video signal VS is sampled by a transistor 2 in synchronism with a selecting signal Si produced by a shift register 1 and held in a capacitor Csi on the data line Di. This driving method is known as a point-at-a-time method.

Figure 3 illustrates waveforms applied to picture elements in a point-at-a-time driving method. According to Figure 3(a), one frame is divided into two fields with a positive video signal VS1 in an odd number field and a negative video signal VS2 in an even number field are applied to a data line Di. A liquid crystal display device produces maximum contrast when the level of the video signal reaches VDH and produces no contrast when the level of the video signal falls below VDL. Thus, an image in a grey scale can be produced in a liquid crystal display when video signal VS is within the range VDH to VDL. Figure 3(b) shows scanning signals which are shifted sequentially with respect to each other from VG1 to VGm and which are applied to gates of transistors from the gate line G1 to the gate line Gm. If there are 200 lines in one TV image a period TS of scanning on one gate line is 60 μsec and the time for the formation of one field of an image is 16msec. Thus, a video signal can be written into a picture element within 60μsec by applying a scanning signal to a gate of the transistor Tr and is held in the picture element for 16msec. Figure 3(c) shows a waveform VC applied to a picture element in each field and kept in a picture element during a non-selected period. Waveform VC1 is formed on a picture element Pi1 during one field and waveform VCm is formed on a picture element Pim.

Figure 4 shows waveforms formed during a period of one horizontal scanning line. Video signal VS is sampled at transistor 2, shown in Figure 2, in synchronism with clock signal SH during the period a gate signal VGj is applied to gate line Gj. Voltage levels VD1 - VDn sampled from the video signal are held on data lines D1-Dn respectively during one period of horizontal scanning.

Figure 5 shows a typical video signal applied to a picture element, where in signal A a high voltage level relative to the pedestal level corresponds to a high level of luminance intensity. This relationship between the signal level and luminance level comes from the characteristic curve of a video signal used to drive a cathode ray tube. As shown in Figure 6, the signal voltage V to the power of γ (gamma) is proportional to the luminance intensity B.

Figure 7 shows the relationship between contrast and onset voltage for a twisted nematic , positive type liquid crystal device. In such a device, the contrast approaches 100%, i.e. there is a high degree of blackness, with increasing onset voltage of the liquid crystal. Thus, a video signal reproduced by a twisted nematic positive type liquid crystal display device driven by a video signal for a CRT is inverted, that is a negative image in which black and white areas are reversed is produced. Such inversion does not occur when a guest-host negative type liquid crystal device is used. However, the quality of image reproduced by using a guest-host negative type liquid crystal device is inferior to that produced by a twisted nematic positive type liquid crystal device. Furthermore, in order to drive a liquid crystal device by an AC drive signal, a video signal B as shown in Figure 5, which is produced by inverting the signal A, has to be used. Video signals A and B are then applied to the liquid crystal device alternately in each field. It is, of course, disadvantageous that the grey scale of a video image reproduced in a liquid crystal display of the twisted nematic positive type is inverted.

This invention seeks to provide a method of driving a positive type liquid crystal for reproducing the grey scale of a video image more naturally.

Figure 8 illustrates a waveform applied to a liquid crystal in a method according to this invention. First, a negative video signal C is produced by inverting the level of whiteness, grey and blackness of a video signal A such as that shown in Figure 5. Secondly, a video signal D is formed by inverting the negative video signal C, these signals being symmetrical about a voltage level VCOM. Finally, a composite video signal is formed by synthesising signals C and D so that they alternate in each field. A bias voltage VB and amplitude level A_v are also adjusted to suitable levels in accordance with the voltage-contrast curve shown in Figure 7, so as to produce a display having the desired quality.

Figure 9 shows a block diagram of a circuit for generating a negative composite video signal used in a method according to this invention. A video signal VIF from an external circuit (not shown) is supplied to an inverter 20 where the signal is inverted to produce a negative video signal. This negative video signal is applied to a symmetrical amplifier 21 which generates two different types of negative video signal. The bias voltages and amplitudes of these negative video signals are symmetrical with respect to the common level VCOM. Both types of negative video signal are applied to a selector 22 where the signals are selected alternately in each field in synchronism with a frame signal S_f so as to form a composite negative video signal. The composite negative video signal VS is finally applied to a picture element *via* a buffer amplifier ~~93~~ 23.

Figure 10 is a diagram of a circuit for generating a negative composite video signal, and Figure 11 shows waveforms of signals at points marked in the diagram. A video signal VIF from an external circuit (not shown) is supplied to an inverter 20 through a capacitor 33. A pedestal clamp level VB' of the video signal at a point I shown in Figure 11 can be adjusted by a transistor 32, a variable resistor 30, and a capacitor 31. This clamp level VB' determines the bias voltage VB of the composite negative video signal VS. The inverter 20 is composed of the transistor 35, a collector side load resistor 34, and emitter side load resistors 36 and 40. The amplitude Av' of a negative video signal at point E can be varied by controlling the impedance of an emitter side circuit composed of a capacitor 41 and a variable resistor 42. This means that the amplitude Av' of the composite video signal VS can be controlled by adjusting variable resistor 42. The symmetrical amplifier 21 is composed of a transistor 45, and resistors 43 and 44. This symmetrical amplifier generates two types of video signal F and G which, as shown in Figure 11, are inverted with respect to each other. Transmission gates 46 and 47 composed of CMOS bi-lateral switches select video signals F and G alternately every field in synchronism with the frame signal Sf. and generate the composite negative video signal VS. This composite negative video signal VS is amplified by a video buffer amplifier 23 composed of transistors 48, 49, 52, 53 and resistors 50 and 51. The video signal VIF from an external circuit is produced to drive a CRT so its polarity is different from that of the negative composite video signal. The waveform of the negative composite video signal has to be further adjusted because of the difference between the voltage luminance curves of the liquid crystal display and a CRT display. As shown in Figure 6, the voltage level of the video signal VIF to the power of γ (gamma) is proportional to luminance when this video signal is designed to drive a CRT. The video signal VIF thus has a voltage-contrast characteristic as shown by a curve (a) in Figure 12. By utilizing this video signal VIF, a negative composite video signal VS can be generated and the voltage-contrast characteristic of this signal is shown by the curve (b) in Figure 12 when the bias level VB and amplitude Av are set appropriately. A comparison of the curve (b) with the curve P of a twisted nematic liquid crystal as shown in Figure 7, shows that the curvatures of these curves resemble each other towards the higher levels of contrast, and differ from each other towards the lower levels of contrast. The reproduction of the video signal is therefore extremely poor in the lighter end of the grey scale, that is between light grey and white, if a video signal having the characteristic curve (b) is directly applied to the liquid crystal device. It is thus desirable to "stretch" the voltage in this range particularly around point Le shown in Figure 7 to improve the reproduction of the video image, that is the range of voltages used to correspond to the lighter end of the grey scale should be expanded. By this means, the characteristic curve (b) can be adjusted so as to have the form of a characteristic curve (c) shown in Figure 12. Thus, the voltage difference applied across the liquid crystal in order to produce a specified contrast in the lighter end of the grey scale is increased by reducing the voltage level of the signal ~~VP~~ VS. A variable resistor 37 and diode 38 in the circuit shown in Figure 10 are used to "stretch" the voltage of the video signal in this manner. Figure 13 shows the relationship between an input voltage level VI applied to transistor 35 and an output level VE thereof. The curvature of curve VD is affected by adjustment of the resistor 37 and the output level VE is "stretched" in the high level range of the input VI. Thus, the voltage characteristic curve (c) can be obtained by utilizing the non-linearity of diode 38 and controlling the resistance of variable resistor 37. Therefore, high level of amplitude, namely the range of whiteness side, of the video signal is more "stretched" on both negative and positive regions.

The method described above may be used to drive a positive twisted nematic liquid crystal device to produce a high quality display in which the natural grey scale of the image is reproduced. Such a display is particularly suitable for use in a compact television.

Figure 14 shows waveforms applied to picture elements in a point-at-a-time driving method in a preferred embodiment of the invention. According to Figure 14(a), one frame is divided into two fields where a negative video signal VS1 in an odd number field and a positive video signal VS2 in an even number field are applied to a data line Di. Video signals VS vary according to the level of the grey scale of the image to be formed and are inverted alternately in the two fields about a level VCOM within the range of GND to VDD. Figures 14(b) and (c) show scanning signals of data lines G1 and Gm which are applied to the gate of a transistor Tr. In the case of an N type TFT, + VDG is applied to the gate when selecting a picture element Pi1-Pim ~~Pi-Pim~~ and GND when the picture element is not selected. Accordingly, the voltage between the gate and source of the transistor during an odd field term is relatively low compared with that during an even field term since a negative video signal is applied to the source of the transistor in the odd field. Figure 14(d) shows a waveform Vc which is applied to a picture element in each field. This voltage is written into the picture element and kept therein during a non-selected period. Waveform Vc1 ~~Vc1~~ is written into a cell

Pil and waveform Vcm into a cell Pim as shown in Figure 2.

Figure 15 shows V-I characteristics of two types of transistors (drain current ID to gate ~~date~~-source voltage VGS). The characteristic curve B indicates a conventional transistor composed of a silicon monocrystal substrate. The curve T shows a thin film transistor composed of a polycrystalline or amorphous thin film.

Curve B has a favourable characteristic as the drain current ID rises steeply with an increase in the gate-source voltage VGS in the positive region, and the leak current ID is extremely small and constant in the zero or negative region. However, if a conventional transistor is used for an active matrix display, it is disadvantageous as the liquid crystal materials used must be of the guest-host type or dynamic scattering type since a mono-crystalline silicon substrate is opaque. If a twisted nematic type liquid crystal is used, then a transparent substrate is required in order to produce the highest quality display. A thin film transistor may be provided on a glass substrate or an SiO_2 quartz substrate and transistors using a silicon thin film such as polycrystal-silicon or amorphous silicon have been developed. However, the TFT has a disadvantageous characteristic curve T as shown in Figure 15. As this Figure shows, the drain current increases only gradually in the positive region and leakage current varies in dependence upon the negative bias voltage VGS and is relatively large even at the minimum point in the negative region. Therefore, the use of this type of transistor for driving liquid crystal devices in the manner shown in Figure 14 has the following disadvantages:

(1) During a non selected period, electric charge in each picture element leaks away to a data line via the transistor, or charge on a data line flows into the picture element since the leakage level is relatively large in the OFF state of the transistor. Thus, the quality of contrast in the display is deteriorated.

(2) The range R shown in Figure ~~4~~ 15 is the operating range of the transistor during a non-selected period. The leakage current in the even field, is, of course, relatively large compared with that in the odd field since the maximum amplitude of the video signal in the even field approaches VDD. Furthermore, in the final scanning line of the even field, leakage current accumulates where the polarity of the video signal of the data line is inverted in the next field, since the potential difference between the picture element and the data line reaches a maximum value and the voltage between the source and the drain is also at a maximum. In Figure 15, TA, TB and TC show variations in characteristic curve T in dependence on the different values of the voltage between the source and drain

(TA, TB and TC corresponding to voltage differences of 2V, 4V and 8V, respectively). The effective voltage applied to the picture element in the lower end portion decreases and this causes the display to be non-uniform.

(3) A ~~data~~ gate voltage VG has to be relatively large in order to obtain the same level of drain current compared with that of a monocrystal substrate transistor. This means that VDG has to be larger and sometimes exceed the break-down voltage of the driver integrated circuit or increases the power consumption.

This embodiment seeks to eliminate the above disadvantages and produce a high quality display.

This embodiment provides means for biasing the voltage level of the gate to some degree during the non-selected periods within the voltage range of a power source of the data line driver integrated circuit. In prior art arrangements, the potential level during non-selected periods is set to be the zero level (GND level) of the data line driver integrated circuit thereof.

Figure 16 shows the waveform of a video signal (a) and of a gate signal, where waveform (b) is that used in the prior art, and (c), (d), or (e) may be used in the preferred embodiment of this invention.

Video signal (a) is set to be a waveform symmetrical about a common level VCOM in each field. The source voltage of the driver circuit of the data lines is set to be within the range GND to VDD. The level of onset voltage applied to a gate line during a non-selected period is set to be around VCOM as shown in Figure 16(c). As a result, the operating range R of the transistor during a non-selected period is shifted to the range ~~R1~~ R'1 which is centred around the zero level, as shown in Figure 17. This bias shift contributes towards a decrease in leakage current. Furthermore, the dependency of leakage current on source drain voltage described before can be avoided by biasing the non-selected level of the gate voltage. By this means, the accumulation of leakage current at the final line of the even field and deterioration in image contrast from the upper portion to the lower portion of a field can be avoided. Thus, an image of uniform quality over an entire field can be obtained. Also, the amplitude of the gate voltage is VDG - VCOM which is lower by the amount VCOM than that used in the prior art, but produces the same level of ON current.

As shown in Figure 17(c), (d) and (e), there are differences between V-I characteristics, particularly in relation to minimum points of drain current, due to variations in conditions during the manufacturing process by which the transistors are made. ~~R1~~ R'1 is the operating range of a transistor having the characteristic curve c'. ~~R2~~ R'2 is the operating range of a transistor having the characteristic curve e'. ~~R3~~ R'3 is the operating range of a transistor having a characteristic curve of d'. Thus, there is a need for compensation to reduce these differences. If, for example, the non-selected level of gate voltage is biased by +VGB (or -VGB) about VCOM as shown in Figure 16(d) or (e), the minimum point of the drain current is located in the positive region (or negative region for -VGB) as shown by characteristics d' and e'. This biasing can contribute further to the decrease of leakage current.

Figure 18 shows a block diagram of a driving circuit for driving an active matrix in the manner described above. In Figure 18, a driver 111 for data lines and a driver 112 for gate lines are connected to a panel 113 comprising a matrix substrate. In the above construction, the driver 111 has a driving output of VD1 - VDn, and the driver 112 has a driving output of VG1 - VGm. A power circuit 110 generates a power voltage, VDD and ~~VND~~ GND being applied to a sample and hold circuit of driver 111 for data lines and to a shift register. The amplitude of video signals VS is within the range of VDD - GND. The power circuit 110 also generates voltage levels for the gate lines, VCOM being the non-selected level and VDG the selected level. VCOM is also the potential of the common electrode on the opposite side of the active matrix panel.

Figure 19 is a graph demonstrating the effects of using the driving method described above. In Figure 19, the average root-mean-square value VCR of every picture element is plotted against the bias value VGB for a video signal of specified level applied to one picture element and stored there for 16msec. The root-mean-square value VCR is taken relative to a minimum at the time when VGB is equal to zero as in a conventional method. In the described driving method, VGB is set to be around the value of VCOM and this corresponds to a maximum of the root-mean-square value VCR as shown in Figure 19 and produces an image display of high quality.

In Figure 20, VGM is the value of gate-source voltage VGS which produces the minimum value of current having TFT characteristics. Figure 20 shows the range of non-selected levels of VGB against VGM. VGB is the value which minimises the decrease in the root-mean-square value VCR so providing good contrast in the liquid crystal display. As shown in Figure 20, it is necessary to adjust the non-selected level of VGB in accordance with VGM depending on TFT characteristics.

Figure 1 shows a waveform of a video signal which may be used in another embodiment of a driving method according to this invention. In this case, the characteristic T of TFT is non-symmetrical with respect to VGS, so the voltage level for driving a data line is set to be non-symmetrical with respect to V'COM. This arrangement can be considered in two ways. One is that a level is set so that only the amplitude or the bias of the video signal VS is non-symmetrical with respect to V'COM in each field by controlling the gain of the amplifier or controlling the TC output level of the amplifier. The other is that the level is set so that the power source electrical potentials are non-symmetrical with respect to VCOM.

It is more suitable that the data line is set to be non-symmetrical in accordance with the characteristics of the TFT. It is also possible for the non-selected level of the gate to be set to be biased by $\pm$ VGB with respect to V'COM.

Figure 22 shows a signal wave which is used in a yet further embodiment of a method according to the present invention. In this embodiment, the non-selected level of the gate voltage is changed every field as the polarity of the video signal is inverted. This can reduce the range of variation of VGS (gate-source voltage) according to the variation of level of the video signal by approximately one-half. As a result, a root-mean-square value of a picture element is more suitable. In this embodiment, a non-selected level of the gate voltage is VCOM in an odd field and +VDS in an even field.

The method described above produces the following effects and thereby enables a liquid crystal television having a high quality display to be produced.

(1) As the most suitable root-mean-square value of a picture element is provided, a display corresponding to

the original video signal can be obtained. Therefore, the most suitable display contrast can be offered.

(2) The decrease in the root-mean-square value of a picture element in the side of the last scanning line, accompanied with an increase in the OFF current with a negative bias between gate and source can be prevented. Accordingly, a uniform voltage can be written into the picture element in any scanning line and a uniform root-mean-square value of the picture elements can be obtained in any scanning line thereby eliminating uneveness in the display.

(3) As the amplitude of the gate line voltage can be reduced, the driver integrated circuit can be designed more easily and power consumption may be reduced.

The method described above is also the subject of co-pending divisional application for Letters Patent No. 8510710 (Serial No. 2161970).

CLAIMS

1. A method of driving an active matrix of a positive type liquid crystal display device, in which a video signal suitable for a cathode ray tube is used to write into an element of the display device via a transistor during a selected period and is held in the element during a non-selected period, the voltage levels corresponding to shades in the grey scale being reversed by inversion of the video signal about a selected voltage level to produce a reversed voltage level video signal, symmetrically amplifying the reversed voltage level video signal to produce two negative video signals, the second of which is obtained as the inversion of the reversed voltage level video signal about another selected voltage level, and applying the negative video signals alternately to write into the element.

2. A method as claimed in claim 1, in which a gate voltage applied to a gate of the transistor during the non-selected period lies within the voltage range of the negative video signal.

3. A method as claimed in claim 1 or 2, in which the voltage range in the negative video signal corresponding to shades in the lighter end of the grey scale is extended.

4. A method according to any preceding claim, in which the other selected voltage level is that applied to a common electrode of the display device.

5. A method according to claim 1, 2 or 3 in which the other selected voltage level differs from that applied to the common electrode of the display device.

6. A method as claimed in claim 4 or 5, in which a gate voltage applied to the gate of the transistor when the negative video signal comprises the reversed voltage level video signal, differs from that applied thereto when the negative video signal comprises the second negative video signal.

7. A method as claimed in any preceding claim, in which the voltage level applied to the gate of the transistor, which is a thin film transistor, during a non-selected period is different during alternate positive and negative fields.

8. A circuit for driving an active matrix of a positive type liquid crystal display device, in which a video signal suitable for a cathode ray tube is used to write into an element of the display device <u>via</u> a transistor during a selected period and is held in the element during a non-selected period, the circuit comprising input means for receiving the video signal, an inverter for reversing the voltage levels of the video signal corresponding to the shades in the grey scale by inversion about a selected voltage level to produce a reversed voltage level video signal, symmetrical amplifier means for the reversed voltage level video signal to produce two negative video signals, the second of which is obtained as the inversion of the reversed voltage level video signal about another selected voltage level, and output means for applying the negative video signals alternately to write into the element.

9. A circuit as claimed in claim 8, arranged so that a gate voltage applied to a gate of the transistor during the non-selected period lies within the voltage range of the negative video signal.

10. A circuit as claimed in claim 8 or 9 further comprising means for extending the voltage range in the negative video signal corresponding to shades in the lighter end of the grey scale.

11. A method according to claim 1, substantially as hereinbefore described with reference to the accompanying drawings.

12. A circuit according to claim 8, substantially as hereinbefore described with reference to the accompanying drawings.

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