METHOD OF DRIVING AN ELECTRO-OPTICAL ~~DISPLAY~~ APPARATUS

The present invention relates to methods of driving electro-optical apparatus comprising ferro-electric liquid crystal material.

Recently, ferro-electric liquid crystal material has been studied as a replacement for TN type liquid crystal material commonly used at present in display apparatus.

The display mode of ferro-electric liquid crystal material includes the complex refraction type display mode and guest host type display mode. The driving methods customarily used to drive devices having TN type liquid crystal material, cannot be employed for driving devices with ferro-electric liquid crystal material, because display conditions (contrast) in ferro-electric liquid crystal material is controlled by changing the direction of the applied electric field. Special methods are, therefore, required.

Moreover, when the service life of display apparatus is considered, it is undesirable to apply DC voltage for a long period to the display element so a driving method avoiding this is sought.

A driving method not requiring application of such DC voltage to a display element for a long period is disclosed in the "SID'85 Digest" (1985) (pages 131 to 134). Moreover, Japanese Laid-Open Patent Specification No. 60-176097 also discloses a method of driving display apparatus utilising ferro-electric liquid crystal material which achieves bi-stability of display with a driving electrical signal having an AC stabilising effect.

However, both driving methods involve such serious

disadvantages that stable display of intermediate tone is impossible.

The latter driving method also has a problem in that the transparent electrodes for display are reduced and blackened, the double colour (dichromatic) pigment is dis-coloured and the liquid crystal material deteriorates, because the DC voltage is sometimes allowed to be applied to the pixels for a long period of time. Whilst the former driving method may be free from the problem of deterioration of the liquid crystal material, another problem arises in that when the period required for writing a pixel is $\underline{t}$, the period T required for re-writing a display format is equal to ($4 \times \underline{t} \times N$), where N is the number of scanning lines in the format, so that the re-writing period T is long and the method is undesirable for the display of dynamic pictures.

The present invention seeks to achieve a stable display of intermediate tone.

The present invention also seeks to provide a driving method which does not result in blackening of transparent electrodes, dis-colouration of double colour pigment and deterioration of liquid crystal material, even after driving for a long period of time.

The present invention further seeks to enable a dynamic picture display by shortening the re-writing period of single display format and to enable a increase of the scanning line numbers in the same re-writing period.

According to one particular aspect of the present invention, there is provided a method of driving an electro-optical apparatus of the kind in which desired optical condition is obtained by applying an electric field to a liquid crystal material having different response conditions in accordance with the direction of

application of the field, the electric field being applied by signal pulses applied to two sets of electrodes between which the material is located, in which the material is ferro-electric liquid crystal material subject to a stabilising effect from AC between the two sets of electrodes, and in which the signal pulses combine to form a first pulse group to initialise the optical elements to the saturated reverse response condition, a second pulse group or a third pulse group follows the first pulse group, the second pulse group changing the optical element to the saturated response condition, whilst the third pulse group includes AC pulses superposed upon the second pulse group, and an AC pulse group is thereafter formed to hold the optical element in the desired condition, the mean voltage level of the first and second pulse groups and the mean voltage level of the first and third pulse groups being zero.

Preferably, the second pulse group has AC pulses superposed thereupon, whose amplitude and/duration is controlled to determine the optical tone of the optical element.

Advantageously the second pulse group is the same in waveform as the first pulse group, but opposite in polarity.

Conveniently, the ferro-electric liquid crystal material exhibits negative dielectric anisotropy in the frequency range of the AC pulses.

With advantage, the first pulse group comprises a DC pulse component, and the second pulse group comprises a DC pulse component symmetrical to, but of opposite polarity to, the first pulse group DC pulse component.

It is preferred that the two sets of electrodes are scanning electrodes and control electrodes,

respectively, and wherein initialisation signals are sequentially applied to the scanning electrodes, followed by selection signals and by non-selection signals when neither initialisation nor selection signals are applied, other signals being applied to the control electrodes resulting in signal pulse combinations, which have a mean zero voltage.

In this case, the selection signal applied to one scanning electrode may overlap in time the initialisation signal applied to the next scanning electrode.

The invention also extends to a method for driving a liquid crystal optical apparatus, forming pixels in the form of a matrix, by providing the ferro-electric liquid crystal having AC stability effect between scanning electrode group and control electrode group wherein a first pulse is applied to the pixels in order to initialise the ferro-electric liquid crystal to saturated reverse response condition depending on voltage difference between signal applied to the scanning electrode group and signal applied to the control electrode group, second pulse or third pulse where AC pulse is superposed to the second pulse is thereafter applied, said second pulse turns the ferro-electric liquid crystal to saturated response condition and said third pulse turns the ferro-electric liquid crystal to the desired response condition including intermediate tone, an AC pulse group is then applied to hold the condition of the ferro-electric liquid crystal, a mean voltage level of the first and second pulses and a mean voltage level of the first and third pulses are zero, and the AC pulse superposed to the second pulse is controlled in accordance with the desired optical tone.

The invention further extends to a method for

driving a liquid crystal optical apparatus comprising pixels providing ferro-electric liquid crystal having AC stabilising effect between two electrodes, where a pulse including the DC pulse element for initialising the pixels to saturated reverse response condition, a pulse superposing AC pulse to the DC pulse of reverse polarity which is symmetrical with the DC pulse element in order to initialise the ferro-electric liquid crystal to the desired response condition including intermediate tone, and AC pulse to hold the desired response condition are sequentially applied to the pixels, and said AC pulse superposed to the DC element is controlled depending on the optical tone.

The invention still further extends to a method for driving a liquid crystal optical apparatus forming a matrix of pixels by providing ferro- electric liquid crystal having AC stabilising effect between scanning electrode group and control electrode group, where initialisation signals are sequentially applied to the scanning electrode group, selection signal is supplied thereto following the initialisation signals and non-selection signal is supplied when the initialisation signals and selection signal are not supplied, desired signal is supplied to the control electrode group, after the ferro-electric liquid crystal is initialised to the saturated reverse response condition depending on voltage difference between the desired signal and initialisation signals, a pulse superposing AC pulse to the DC pulse is applied in order to initialise the ferro-electric liquid crystal to the desired response condition depending on the voltage difference between the desired signal and selection signal, AC pulse which holds the desired response condition of the ferro-electric liquid crystal is applied depending on the

voltage difference between the desired signal and non-selection signal, mean voltage level applied to the ferro-electric liquid crystal is zero, and said AC pulse super posed to the DC pulse is controlled depending on the optical tone.

How the invention can be carried into effect is hereinafter particularly described with reference to the accompanying drawings, in which:-

Figure 1 shows, schematically, an example of a liquid crystal display device for which the methods of the invention are intended;

Figure 2 illustrates by means of voltage waveforms one example of a driving method according to the present invention;

Figure 3 illustrates by means of voltage waveforms another example of a driving method according to the present invention;

Figure 4 shows timings of pulse groups to be applied to the pixels in the example of Figure 3;

Figure 5 illustrates by means of voltage waveforms yet another example of a driving method according to the present invention;

Figure 6 shows timings of pulse groups to be applied to the pixels in the example of Figure 5;

Figure 7 illustrates by means of voltage waveforms

a further example of a driving method according to the present invention;

Figure 8 shows signal application timings to adjacent scanning electrodes in the example of Figure 7;

Figure 9 shows pulse groups applied to the response and reverse response pixels in the example of Figure 7;

Figure 10 illustrates by means of voltage waveforms a yet further example of a driving method according to the present invention; and

Figure 11 illustrates by means of voltage waveforms an additional example of a driving method according to the invention.

The display device represented in Figure 1 comprises a first set of substantially transparent scanning electrodes L1 to L7 and a set of crossing substantially transparent control electrodes R1 to R5 associated with a layer (not shown) of a ferro-electric liquid crystal material, being an electro-optical modulation substance having different response conditions in accordance with the direction of the electric field to which it is subjected. This layer is situated between the above mentioned two sets of electrodes. A selection circuit SE (Figure 1) produces signals to be applied to the scanning electrode L1 to L7 and a drive control circuit DR produces signals to be applied to the control electrodes R1 to R5.

A selection signal S (Figure 2) from the selection circuit SC is applied sequentially on a time sharing basis to individual scanning electrodes of the set L1 to L7. Non-selection signals NS from the selection circuit SE are applied hen the selection signal S is not applied to an electrode.

The selection signal S is composed of low

frequency pulses of equal and opposite voltage $\pm V$ and the non-selection signal NS is composed of high frequency pulses of equal and opposite voltages $\pm H$.

At the same time, the drive control circuit DR generates response signals D and reverse response signals RD and applies these signals selectively to the control electrodes R1 to R5. The response signal D is applied to a control electrode when there is to be a response display in the pixel at the crossing point of the control electrode and the selected scanning electrode to which the signal S is applied. The reverse response signal RD is applied to a control electrode when there is to be a reverse response display at the crossing point with the selected scanning electrode. The response signal D is zero voltage, whilst the reverse response signal is initially zero voltage followed by high frequency pulses of equal and opposite voltages $\pm 2H$.

The combination of these signals results in a pulse group P1 being applied to the response pixels and results in a pulse group P2 to the reverse response pixels. In the case of pulse group P1, the liquid crystal material is first initialised to the saturated reverse response condition by the DC pulse of the voltage -V and is then initialised to the saturated response condition by the supply of DC pulse of the voltage V. On the other hand, in the case of pulse group P2, the liquid crystal is first initialised to the saturated reverse response condition of a DC pulse of the voltage -V and is not initialised to the saturated response condition owing to the AC stabilising effect of the high frequency AC pulse but is kept at the saturated reverse response condition because high frequency AC pulses of voltages $\pm 2H$ are superposed upon the voltage

V.

After application of such pulse group P1 or P2, a high frequency AC pulse group P3 or P4 is applied by the combination of the non-selection signal NS and response signal D or reverse response signal RD, so that the condition of the pixels is held by the AC stabilising effect. The pulse groups P1, P3 and P4 are composed of AC pulses of the same waveform and number but different in polarity, and the pulse group P2 has a mean voltage level of zero. Accordingly, blackening of transparent electrodes, deterioration of liquid crystal and discolouration of double colour pigment are no longer caused.

Moreover, because each line can be scanned within a short period of time (the selection signal is applied within a short period of time) and the writings for response and reverse response are carried out simultaneously in the same line, the re-writing period for single display format can be reduced.

Pulse width and pulse amplitude of the response pulse group P1 are chosen to be adequate to obtain the saturated reverse response condition and saturated response condition in relation to magnitude of self-generating polarisation of ferro-electric liquid crystal material and display cell thickness.

Moreover, the frequency of the high frequency AC pulse components in groups P2, P3 and P4 is desirably double the frequency of the response pulse P1 or more, and, most preferably, an integral multiple of four times. The pulse amplitude or voltage H is determined so as to stably hold the response condition in relation to magnitude of dielectric anisotropy of the ferro-electric liquid crystal material.

For the production of gradation by intermediate

tone display effects, the signals applied to the control electrodes are modified as illustrated in Figure 3.

The selection signal S applied to the scanning electrodes is the same as that in the example of Figure 2 whilst non-selection signal NS' is an inverted NS. Control signals C applied individually to the control electrodes of the set R1 to R5 are similar to reverse response signals RD but include high frequency AC pulses of voltages $\pm\underline{h}$ controlled depending on the gradation desired. The liquid crystal pixel is first initialised to the saturated reverse response condition because a DC pulse of -V is applied by the pulse group P5 resulting from the voltage difference between the first halves of the selection signal S and the control signal C. There after the intermediate tone is displayed because the second half of the control signal C superposes high frequency AC pulses of $\pm\underline{h}$ on the DC pulse V to provide unsaturated response pulses. The saturated response condition is displayed first with the DC pulse of voltage V but unsaturated response condition can be displayed by controlling the AC stabilising effect of the high frequency AC pulse. Thereafter, a high frequency AC pulse P6 is applied resulting from the non-selection signal NS' and the control signal C, in order to hold the response condition. The non-selection signal NS' is changed in phase by 180° from the non-selection signal NS of Figure 2, in order to stabilise the AC stabilising effect during non-selection periods.

Figure 4 illustrates the timing of the pulse groups applied to the pixels by the supply of the above signals.

The pulse group of the control signal C for displaying intermediate tone can be modulated, not only in voltage $\underline{h}$, but also in pulse duration. In either

case, it is important to first initialise to the saturated reverse response condition before the application of the pulse group for displaying the intermediate tone, that is the combination of the second halves of the selection signal S and the control signal C. If the pulse group for displaying intermediate tone is applied without prior initialisation, the response condition may change depending on the display condition before application of the pulse group, so that stable display of intermediate tone is impossible.

In the example of Figure 3, intermediate tone can be displayed stably without reference to the preceding response condition, because the liquid crystal is initialised pixel is initialised to the saturated reverse response condition before the re-writing of display.

In the example of a driving method according to the present invention illustrated in Figure 5, a signal for initialising the display is applied in the time period before the application of a selection signal. A selection signal S1 consisting of a high frequency pulse group of voltages $-V \pm H$ is sequentially applied to individual electrodes of the scanning electrodes L1 to L7, but an initialisation signal RS consisting of a high frequency pulse group of voltages $V \pm H$ is supplied in the preceding time period. After the selection of signal until the next initialisation signal, that is during the non-selection period, non-selection signal NS1 consisting of a high frequency pulse group of voltages $\pm H$ is supplied.

At the same time, a control signal C1 consisting of a high frequency pulse group of voltages $\pm h$ is supplied to individual electrodes of the control electrodes R1 to R5 depending on the desired intermediate tone.

The initialisation signal RS combined with the control signal C1 results in a pulse group P7 supplied to the pixel first as shown in Figure 6. The pulse group P7 is formed by superposing the high frequency AC pulse group of voltages $\pm(\underline{h} - H)$ upon the DC pulse -V. After the initialisation of display to the saturated reverse response condition by application of the pulse group P7, the intermediate tone is displayed by application of an unsaturated response pulse P8 resulting from the selection signal S1 and the control signal C1. Thereafter, the intermediate tone is held by application of a high frequency pulse group P9 resulting from the non-selection signal NS1 and the control signal C1.

Because the initialisation signal for one scanning electrode can occur simultaneously with the selection signal for the preceding scanning electrode, the supply period of signals is reduced to 1/2 of that in the previous example, so that the number of digits which can be scanned in the same period can be doubled. In other words, the re-writing speed of single display format can be doubled for the display of the same number of scanning digits.

In order to reduce further the re-writing period, a plurality of initialisation signals may be used as in the following example.

A sequence of three initialisation signals RS1, RS2 and RS3 initialise, on a time sharing basis, the scanning electrodes and the subsequent selection signal S2 selects, on a time sharing basis, the scanning electrode. The signals are generated from the selection circuit SE, timed as shown in Figure 8, and a non-selection signal NS2 is generated when such initialisation signals and selection signal are not supplied.

The initialisation signal RS1 is composed of a high frequency pulse group of voltages ($-VR^{\pm}H$), the initialisation signal RS2 is composed of a high frequency pulse group of voltages ($VR^{\pm}H$), the initialisation signal RS3 is composed of a high frequency pulse group of voltages ($V^{\pm}H$), the selection signal S2 is a DC pulse of voltage (-V) and the non-selection signal NS2 is composed of a high frequency pulse group of voltages ($^{\pm}H$).

At the same time, a response signal D1 of zero voltage or a reverse response signal RD1 composed of a high frequency pulse group of voltages $^{\pm}2H$, is generated from the drive control circuit DR depending on the desired display condition of the pixel at the crossing point of the control electrode and the scanning electrode to which the selection signal S2 is applied. These signals are supplied individually to the control electrodes.

With the supply of these signals, a pulse group P10 is applied to the response pixels by the supply of the initialisation pulse RS1. Thereafter, a pulse group P12 and a pulse group P14 are applied by the supply of the initialisation signals RS2 and RS3 to initialise the pixels to the saturated response condition. Then a pulse group P16 is applied thereto by the selection signal S2 and response signal D1. Because there is no high frequency AC component in the pulse group P16, it does not have any AC stabilising effect and the pixels are driven to the saturated response condition by the pulse of voltage V. Thereafter, a pulse group P18 is applied by the supply of non-selection signal NS2, and is composed of a high frequency pulse group of voltages $^{\pm}H$. This holds the response condition of the pixel due to AC stabilising effect.

The pulse group P10 is formed by superposing a high frequency AC pulse group of voltage ±H upon a DC pulse of voltage VR, the pulse group P12 is formed by superposing a high frequency AC pulse group of voltages ±H upon a DC pulse of voltage -VR, the pulse group P14 is formed by superposing a high frequency AC pulse group of voltages ±H upon a DC pulse of voltage -V, and the pulse P16 is a DC pulse of voltage V.

Therefore, respective pulse groups have a DC element but the mean voltage applied to the pixels can be made zero when the pulse group P10, pulse group P12, pulse group P14 and pulse group P16 are applied. Thus, the area of the voltage waveform on the positive side becomes equal to the area of the voltage waveform on the negative side. After application of the pulse P16, the high frequency AC pulse group P18 is applied to the non-selection signal NS2 and the response condition can be stably held by the AC stabilising effect.

On the other hand, a pulse group P11 is applied to the reverse response pixels by the supply of the initialisation signal RS1 and the reverse response signal RD1. Thereafter, a pulse group P13 and a pulse group P15 are applied by the supply of initialisation signals RS2 and RS3 to the reverse response pixels to initialise them to the saturated reverse response condition. Thereafter, a pulse group P17 is applied thereto by the selection signal S2 and the reverse response signal RC1. Because the pulse group P17 is formed by superposing the high voltage high frequency AC pulse group of voltages ±2H upon the DC pulse of voltage V, the pixels are not changed to the saturated response condition by the AC stabilising effect of ±2H and are held in the saturated reverse response condition. After application of pulse group P17, a high frequency AC

pulse group P19 is applied by supply of the non-selection signal NS2 and the pixels are held in the reverse response condition by the AC stabilising effect. In this case, the pulse group P11, pulse group P13, pulse group P15 and the pulse group P17 are applied and the mean voltage level applied to the pixels becomes zero.

Figure 8 shows the timing of the application of the signals to adjacent scanning lines Ln and Ln+1 from which it will be seen how initialisation of one line overlaps in time the selection of the preceding line.

Figure 9 shows waveforms applied to the response and reverse response pixels. By the use of initialisation signals, initialisation of one line can occur simultaneously with the supply of the selection signal and scanning of the preceding line of the DC pulse. Thus, the re-writing period of display can be shortened. The use of a plurality of initialisation signals improves the initialisation of pixels to the saturated reverse response condition, enabling the driving margin to become large, and achieving stable driving even if cell thickness fluctuates.

In the above example, the pixels are initialised to the saturated response condition and saturated reverse response condition in order to explain the driving principle. An example of operations for display of intermediate tone is described in relation to Figure 10.

In the example of Figure 10, the initialisation signals RS1, RS2 and RS3, and the selection S2 are the same as those used in the example of Figure 7, but control signals C2 composed of a high frequency AC pulse group of voltages $\pm h$ are supplied to individual control electrodes, the voltages being controlled depending on

the intermediate colour tone desired. The non-selection signal NS'2 is the inverse of the signal NS2.

After application of a pulse group P20 to the pixels by the supply of initialisation signal RS1 and control signal C2, pulse groups P21 and P22 are applied subsequently by the supply of initialisation signals RS2 and RS3 and control signal C2, so that pixels are initialised to the saturated reverse response condition. Thereafter, a pulse group P23 is applied by the supply of the selection signal S2 and the control signal C2. The pulse group P23 is formed by superposing high frequency AC pulses of voltages $\pm\underline{h}$ upon the DC pulse of voltage V and an unsaturated response condition (intermediate tone) can be displayed by applying this pulse group.

Thus, the display, which would be changed to the saturated response condition by a pulse of voltage V, is changed to the unsaturated response condition by controlling the AC stabilising effect of the high frequency AC pulses superposed upon such voltage.

Thereafter, a high frequency AC voltage group P24 is applied by the supply of the non-selection signal NS2 and the control signal C2 so that the response condition can be held. The non-selection signal NS'2 is changed in phase by 180° from the non-selection signal NS2 of the example of Figure 7, in order to stabilise the AC stabilising effect during the non-selection period. In displaying intermediate tone, not only can the voltages $\pm\underline{h}$ of the control signal be modulated, but also, or alternatively, the pulse duration can be modulated.

Whilst the example of Figure 7 provided three initialisation signals, the example of Figure 11 has only two. The initialisation signals have different signal waveforms, but effect driving in a manner similar

to that of the example of Figure 7 though the number of initialisation signals is reduced. In this example, the pixel is initialised to the saturated reverse response condition by the second initialisation signal RS5.

Imbalance of voltage applied to the pixels by the supply of the second initialisation signal RS5 and the selection signal S2 is adjusted by the first initialisation signal RS4 and thereby the mean voltage level applied to the pixels is set to zero. The first initialisation signal RS4 is composed of a high frequency pulse group of voltages $\pm H$ superposed upon a DC pulse of voltage -(VR-V). The second initialisation signal RS5 is composed of a high frequency pulse group of voltages $\pm H$ superposed upon a DC pulse voltage VR. The selection signal S2, non-selection signal NS2, response signal D1 and reverse response signal RD1 are the same as those used in the example of Figure 7.

In the case of the example of Figure 11, intermediate tone can be displayed by supplying the control signal C2 of Figure 10 in place of the response signal D1 and reverse response signal RD1 and then controlling the voltage or duty thereof.

The frequency range of the high frequency AC pulses is preferably chosen so that the ferro-electric liquid crystal shows negative dielectric anisotropy in that range.

In the foregoing description, the term "response" is used for the positive voltage and "reverse response" for the negative voltage, but because response and reverse response are only relative terms, the term "reverse response" may be used for positive voltage and "response" for the negative voltage.

The signals to be supplied to the respective electrodes are not limited only to those mentioned above

and various modifications are allowed within the scope of the claims. The bias voltage may be applied as required.

Furthermore, the embodiments described above refer to the matrix type display illustrated in Figure 1, but the invention is not limited only to such matrix type display and the present invention can be adopted for driving a liquid crystal shutter array for an optical printer where the optical shutter array is arranged in the form of a line divided into a plurality of blocks and these are wired like a matrix. In this case, high contrast can be realised by setting the reverse response condition to the dark condition of display.

The present invention is capable of achieving a display of intermediate tone by controlling the voltages of the high frequency AC pulses and ensures stable display of intermediate tone by initialising the display to the saturated reverse response condition before the pulse for displaying the intermediate tone. Because a mean voltage level of the pulse groups applied to the pixels is zero, blackening of transparent electrodes, dis-colouration of double colour pigments and deterioration of liquid crystal material are no longer caused, even after driving for a long period of time. The method of supplying initialisation signal before the supply of selection signal, initialises one line simultaneously with the supply of the selection signal to the previous line. Thus, the period required for re-writing of display can be shortened and large effect can be obtained in the field of picture display. In other words, the number of scanning digits in the same period can be increased and high precision display can also be achieved. In addition, improved initialisation to the saturated reverse response condition can be achieved by using a plurality of initialisation signals. Thereby, a

large driving margin can be ensured and stable driving can be achieved even if cell thickness fluctuates.

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1. A method of driving an electro-optical apparatus of the kind in which desired optical condition is obtained by applying an electric field to a liquid crystal material having different response conditions in accordance with the direction of application of the field, the electric field being applied by signal pulses applied to two sets of electrodes between which the material is located, in which the material is ferro-electric liquid crystal material subject to a stabilising effect from AC between the two sets of electrodes, and in which the signal pulses combine to form a first pulse group to initialise the optical elements to the saturated reverse response condition, a second pulse group or a third pulse group follows the first pulse group, the second pulse group changing the optical element to the saturated response condition, whilst the third pulse group includes AC pulses superposed upon the second pulse group, and an AC pulse group is thereafter formed to hold the optical element in the desired condition, the mean voltage level of the first and second pulse groups and the mean voltage level of the first and third pulse groups being zero.

2. A method as claimed in claim 1, wherein the second pulse group has AC pulses super posed thereupon, whose amplitude and/or duration is controlled to determine the optical tone of the optical element.

3. A method as claimed in claims 1 or 2, wherein the second pulse group is the same in waveform as the first pulse group, but opposite in polarity.

4. A method as claimed in claims 1, 2 or 3, wherein the ferro-electric liquid crystal material exhibits negative dielectric anisotropy in the frequency range of

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the AC pulses.

5. A method as claimed in any preceding claim, wherein the first pulse group comprises a DC pulse component, and the second pulse group comprises a DC pulse component symmetrical to, but of opposite polarity to, the first pulse group DC pulse component.

6. A method as claimed in any preceding claim, wherein the two sets of electrodes are scanning electrodes and control electrodes, respectively, and wherein initialisation signals are sequentially applied to the scanning electrodes, followed by selection signals and by non-selection signals when neither initialisation nor selection signals are applied, other signals being applied to the control electrodes resulting in signal pulse combinations, which have a mean zero voltage.

7. A method as claimed in claim 6, wherein the selection signal applied to one scanning electrode overlaps in time the initialisation signal applied to the next scanning electrode.

8. A method of driving an electro-optical display apparatus substantially as hereinbefore described with reference to Figures 1 and 2 of the accompanying drawings.

9. A method of driving an electro-optical display apparatus substantially as hereinbefore described with reference to Figures 1, 3 and 4 of the accompanying drawings.

10. A method of driving an electro-optical display apparatus substantially as hereinbefore described with reference to Figures 1, 5 and 6 of the accompanying drawings.

11. A method of driving an electro-optical display apparatus substantially as hereinbefore described with

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reference to Figures 1, 7, 8 and 9 of the accompanying drawings.

12. A method of driving an electro-optical display apparatus substantially as hereinbefore described with reference to Figures 1 and 10 of the accompanying drawings.

13. A method of driving an electro-optical display apparatus substantially as hereinbefore described with reference to Figures 1 and 11 of the accompanying drawings.

14. A method for driving a liquid crystal optical apparatus, forming pixels in the form of a matrix, by providing the ferro-electric liquid crystal having AC stability effect between scanning electrode group and control electrode group wherein a first pulse is applied to the pixels in order to initialise the ferro-electric liquid crystal to saturated reverse response condition depending on voltage difference between signal applied to the scanning electrode group and signal applied to the control electrode group, second pulse or third pulse where AC pulse is superposed to the second pulse is thereafter applied, said second pulse turns the ferro-electric liquid crystal to saturated response condition and said third pulse turns the ferro-electric liquid crystal to the desired response condition including intermediate tone, an AC pulse group is then applied to hold the condition of the ferro-electric liquid crystal, a mean voltage level of the first and second pulses and a mean voltage level of the first and third pulses are zero, and the AC pulse superposed to the second pulse is controlled in accordance with the desired optical tone.

15. A method for driving a liquid crystal optical apparatus comprising pixels providing ferro-electric

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liquid crystal having AC stabilising effect between two electrodes, where a pulse including the DC pulse element for initialising the pixels to saturated reverse response condition, a pulse superposing AC pulse to the DC pulse of reverse polarity which is symmetrical with the DC pulse element in order to initialise the ferro-electric liquid crystal to the desired response condition including intermediate tone, and AC pulse to hold the desired response condition are sequentially applied to the pixels, and said AC pulse superposed to the DC element is controlled depending on the optical tone.

16. A method for driving a liquid crystal optical apparatus forming a matrix of pixels by providing ferro-electric liquid crystal having AC stabilising effect between scanning electrode group and control electrode group, where initialisation signals are sequentially applied to the scanning electrode group, selection signal is supplied thereto following the initialisation signals and non-selection signal is supplied when the initialisation signals and selection signal are not supplied, desired signal is supplied to the control electrode group, after the ferro-electric liquid crystal is initialised to the saturated reverse response condition depending on voltage difference between the desired signal and initialisation signals, a pulse superposing AC pulse to the DC pulse is applied in order to initialise the ferro-electric liquid crystal to the desired response condition depending on the voltage difference between the desired signal and selection signal, AC pulse which holds the desired response condition of the ferro-electric liquid crystal is applied depending on the voltage difference between the desired signal and non-selection signal, mean voltage

level applied to the ferro-electric liquid crystal is zero, and said AC pulse super posed to the DC pulse is controlled depending on the optical tone.

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