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 pigment (dichromatic) 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 t, the period T required for re-writing a display format is equal to $(4 \times t \times N)$, 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 prevent blackening of transparent electrodes, dis-colouration of double colour pigment and deterioration of liquid crystal material and to enable re-writing of display format within a short period of time.

The present invention also seeks to hold the response condition of pixels stably by the AC stabilising effect and to improve display contrast.

According to 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 pulse applied to the two sets of electrodes combine to result in a saturating pulse to set the optical element to the saturated response condition followed by a reverse saturating pulse, different only in polarity from the former pulse group, to set the optical element to the saturated reverse response condition, followed by another pulse group either to hold the reverse response condition of the optical element or to set the optical element to desired response condition, said another pulse group consisting of pulses which are the same in waveform and number, but different in polarity, and thereafter followed by high frequency AC pulses of constant amplitude stably to hold the condition of the optical element by the AC stabilising effect.

Preferably the ferro-electric liquid crystal has negative dielectric anisotropy in the frequency range of the high frequency AC pulses.

Advantageously, the two sets of electrodes are scanning and control electrodes, respectively, and, to produce the saturating and reverse saturating pulse groups, initialisation signals are sequentially applied to the scanning electrodes, followed by selection signals to produce said another pulse group and by non-selection signals applied when neither initiation nor selection signals are applied, to produce high frequency AC pulse groups, other signals being applied to the control electrodes resulting in signal pulse combinations, which have a mean zero voltage, are the same in waveform and number but different in polarity.

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

From another aspect, the invention includes 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 a set of scanning electrodes and a set of control electrodes between which sets 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 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, the initialisation signal pulse combination resulting in a saturating pulse group to set the optical element to the saturated response condition followed by a reverse saturating pulse, different only in polarity from the former pulse group, to set the optical element to the saturated reverse response condition, the selection signal pulse combination serving either to hold the reverse response condition of the optical element or to set the optical element to the response condition, the selection signal pulse combination consisting of pulses which are the same in waveform and number, but different in polarity, and the non-selection signal pulse combination consisting of high frequency AC pulses of constant amplitude stably to hold

the condition of the optical element by the AC stabilising effect, each signal pulse combination having a mean zero voltage, the pulses being the same in waveform and number, but different in polarity.

A further aspect of the invention is a method for driving a liquid crystal optical apparatus, in a matrix liquid crystal optical apparatus forming a plurality of pixels in the form of matrix by providing ferro-electric liquid crystal having AC stabilising effect between scanning electrode group and control electrode group, wherein: after application of a first pulse to setting the ferro-electric liquid crystal to the saturated response condition depending on voltage difference of signals to be supplied to the scanning electrode and a control electrode, second pulse which is different only in the polarity from the first pulse is applied to the pixels in order to set the liquid crystal to the saturated reverse response condition, the second pulse group consisting of pulses which are the same in the waveform and number but different in polarities is subsequently supplied in order to hold the saturated reverse response condition of ferro-electric liquid crystal or set the liquid crystal to the desired response condition, and therafter high frequency AC pulses of constant amplitude are applied to stably hold such response condition by the AC stabilising effect.

A yet further aspect is a method for driving a liquid crystal optical apparatus, in a matrix liquid crystal optical apparatus forming a plurality of pixels in the form of matrix by providing ferro-electric liquid crystal having AC stabilising effect between scanning electrode group and control electrode group, wherein: initialisation signals are sequentially supplied to the scanning electrode group, selection signal is then

applied thereto following such initialisation signals and non-selection signal is supplied when the initialisation signals and the selection signal are not supplied, desired signals are supplied to the control electrode group, a pulse group is applied to initialise the ferro-electric liquid crystal to saturated response condition and then to saturated reverse response condition depending on voltage difference between said desired signal and initialisation signals, a response pulse group for setting ferro-electric liquid crystal to the saturated response condition or a non-response pulse group which does not change the initialisation saturated reverse response condition is subsequently applied depending on voltage difference between the desired signal and selection signal, high frequency AC pulses of constant amplitude are then supplied in order to stably hold the response condition of the ferro-electric liquid crystal by the AC stabilising effect depending on voltage difference between the desired signal and non-selection signal, and the pulse group for initialisation to be applied to the pixels, response pulse group and non-response pulse group are formed by the pulses of mean voltage level 0 which are the same in waveform and the number but different in polarities.

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 a voltage waveform one example of a driving method according to the present invention;

Figure 3 shows signal application timings to adjacent scanning electrode lines in the example of Figure 2;

Figure 4 shows pulse groups applied to the response and reverse response pixels in the example of Figure 2;

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

Figures 6 and 7 illustrate by means of voltage waveforms, a further example of a driving method according to the present invention;

Figure 8 illustrates by means of voltage waveforms yet another example of a driving method according to the present invention;

Figure 9 shows signal application timings to adjacent scanning electrode lines in the example of Figure 8; and

Figure 10 shows waveforms indicating pulse groups applied to response and reverse response pixels in the example of Figure 8.

The display device represented in Figure 1 comprises a first set of substantially transparent scanning electrodes L1 to LN and a set of crossing substantially transparent control electrodes R1 to RX associated with a layer (not shown) of ferro-electric liquid crystal material, being an electro-optical modulation substance having different response conditions in accordance with the direction of the electric fields to which it is subjected. This layer is situated between the above mentioned two sets of electrodes. A selection circuit SE (Figure 1) produces an initialisation signal RS1 followed by a selection signal S1 (Figure 2) for sequentially selecting on a time sharing basis, one of the electrodes L1 to Ln and which also produces a non-selection signal NS1 when neither an initialisation nor a selection signal is supplied. The initialisation signal RS1 (Figure 3) sequentially initialises adjacent scanning electrodes Ln to Ln+1 and the selection signal S1 selects the scanning electrode Ln, whilst the next electrode Ln+1 is initialised by the signal RS1. The initialisation signal RS1 is formed by the voltages $VR^{\pm}H$ and $-VR^{\pm}H$, the selection signal S1 is formed by the voltages $\pm V$ and the non-selection signal NS1 is formed by the voltages $\pm H$.

A drive control circuit DR (Figure 1) produces a response signal D1 and a reverse response signal RD1 (Figure 2) for the electrodes R1 to RX. Either the response signal D1 or the reverse response signal RD2 is supplied to individual control electrodes of the set of electrodes R1 to RX in accordance with the desired display condition of the pixel at the crossing point of the scanning electrode to which the selection signal S1 is applied. The response signal D1 is supplied to those of the control electrodes which cross the selected

scanning line at crossing points where the pixel is to give the desired response display and reverse response signal RD1 is supplied to the other control electrodes which cross the selected scanning line where the pixel is to give the desired reverse response display.

The combination of the initialisation signal RS1 applied to a scanning electrode and the response signal D1 to a control electrode is a pulse group P1 (Figure 4) and is applied across the crossing point, so that the pixel is initialised to the saturated reverse response condition. Thereafter, the combination of the selection signal S1 applied to the scanning electrode and the response signal D1 applied to the control electrode, results in a pulse group P3. Because the high frequency AC pulse element is 0 in the pulse group P3, the AC stabilising effect is not effective, and the liquid crystal is switched to the saturated reverse response condition and then to the saturated response condition by the voltages -V and +V. Thereafter, the combination of the non-selection signal NS1 applied to the scanning electrode and the response signal D1 applied to the control electrode is a series of high frequency AC pulses of the pulse group P5 and the response condition is stably held by the AC stabilising effect.

Meanwhile, in the case of the reverse response pixels, the liquid crystal material is initialised to the saturated response condition by the supply of the initialisation signal RS1 to the scanning electrode and the reverse response signal RD1 to the relevant control electrodes, resulting in a pulse group P2. Thereafter, the pulse group P4 is supplied to the reverse response pixels by the combination of a selection signal S1 to the scanning electrode and the reverse response signal RD1 to the control electrodes. The pulse group P4 is

composed of the low frequency AC pulse of the voltages $\pm V$ and high voltage high frequency AC pulse of the voltages $\pm 2H$ superposed thereon. This pulse does not initialise the pixels to the saturated response condition due to the AC stabilising effect of the voltages $\pm 2H$ and holds the initialisation saturated reverse response condition. After the pulse group P4 is supplied, the combination of the non-selection signal NS1 to the scanning electrode and the reverse response signal RD1 to the control electrodes results in the application of a high frequency AC pulse group P6, holding the saturated reverse response condition by the AC stabilising effect.

Figure 4 shows an example of waveforms applied to these response and reverse response pixels.

Because the pulse groups applied to the pixels are composed of pulses of the same waveform and number but different in the polarities, blackening of transparent electrodes, deterioration of liquid crystal material and dis-colouration of double colour pigment can be eliminated. Moreover, use of initialisation signals enables initialisation of the next scanning electrode line simultaneously with the supply of the selection signal to the scanning electrode line, thereby curtailing re-writing time of display format. In the case of this example, the time T for re-writing a matrix display format where $\underline{t}$ is the time for writing a pixel, and N is the number of scanning lines per format, can be expressed as $2 \times \underline{t} \times N$ and is one half of the time in the prior art. In addition, because the pulse groups P5 and P6 applied during the non-selection periods do not include a low frequency pulse element, the response condition is held with considerable stability and high contrast display can be achieved.

The frequency and pulse amplitude or voltage V of the response pulse group P3 can be determined so that the saturated reverse response condition and saturated response condition are obtained in relation to the magnitude of self generating polarisation of ferro-electric liquid crystal material and display cell thickness.

The frequency of the high frequency AC pulse components in groups P1, P2, P4, P5 and P6 is desirably double the frequency of the response of pulse group P3, 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.

Further, the initialisation response voltage VR of the initialisation pulse group P1 or P2 is so determined that stable response and reverse response conditions can be ensured even when high frequency AC pulses of voltage $\pm H$ are superposed.

For the production of gradation or intermediate tone display effects, the signals applied to the control electrodes are modified as illustrated in Figure 5. Control signals C applied individually to the control electrodes R1 to RX are high frequency AC pulses of voltage $\pm\underline{h}$ control depending on the gradation desired.

The supply of the initialisation signal RS1 to the scanning electrode and a control signal C to a control electrode results in a pulse group P7 applied to the pixel at the crossing point for initialisation to saturated reverse response condition after the saturated response condition and thereafter the supply of selection signal S1 to the scanning electrode results in a pulse group P8. During the first half of the pulse

group P8, the saturated reverse response condition initialised by the pulse group P7 is held by the pulse of voltage -V with superposed high frequency AC pulses of voltage $\pm\underline{h}$. During the second half of pulse group P8, an unsaturated response condition (intermediate tone) is displayed by the application of unsaturated response pulse of voltage +V with superposed high frequency AC pulses of voltage $\pm\underline{h}$.

Thus, the saturated response condition would be displayed by a pulse voltage V, but the unsaturated response condition is achieved by controlling the high frequency AC pulses superposed on the pulse voltage V.

Thereafter, the combination of the non-selection signal NS'1 and the control signals C results in a high frequency AC pulse group P9 to hold the intermediate tone response condition. The non-selection signal NS'1 is changed in the phase from the non-selection signal NS1 of Figure 2 in order to stabilise the AC stabilising effect during non-selection periods.

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 width. 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 selection signal S1 and control signal C. If the pulse group for displaying the intermediate tone is applied without prior initialisation, stable and reliable display of intermediate tone cannot be achieved because the response condition may change due to a display condition before application of the pulse group. However, in the example of Figure 5, because initiali-sation to a saturated reverse response condition is carried out

before re-writing of display, stabilised intermediate tone can be displayed in spite of the preceding response condition.

In the previously described examples, the display is re-written by re-writing scanning electrode lines sequentially line by line. In the following example, the re-writing is effected in blocks of scanning electrode lines. In this display method, scanning electrodes are initialised in blocks, each consisting of a plurality of electrodes (for example, M electrodes) and the scanning electrode group in the initialised blocks are sequentially selected on a time sharing basis for display.

An initialisation signal RS2 (Figure 6) consisting of voltages $\pm VR$ is applied to a plurality of scanning electrodes (for example L1 to LM) among the scanning electrode groups L1 to LN of Figure 1 and a non-initialisation signal NRS (Figure 6) consisting of high frequency AC pulses of voltages $\pm H$ is applied to the other scanning electrodes. An initialisation control signal CR (Figure 6) is supplied to all the control electrodes R1 to RX.

Upon the application of such signals, the pixels of the M scanning electrodes to which the initialisation signal RS2 is applied are first initialised to the saturated response condition because they combine to form the pulse group P10 and then the pixels are initialised to the saturated reverse response condition. The other pixels do not change their display condition, because the high frequency AC pulse group P11 is applied to them.

Subsequently, a selection signal S2 (Figure 7) consisting of voltages $\pm V$ is sequentially applied to the initialised scanning electrode group and the non-

selection signal NS2 (Figure 7) consisting of voltages $\pm H$ is supplied to the scanning electrodes to which the selection signal is not applied.

At the same time, a response signal D2 or a reverse response signal RD2 (Figure 7) is supplied to the individual control electrodes R1 to RX, depending on the desired display condition of the pixels on the scanning electrode lines to which the selection signal S2 is applied.

Upon the application of such signals, the combination of selection signal S2 and response signal D2 results in the pulse group P12 being applied to the response pixels, and these pixels are switched to the saturated reverse response condition and then to the saturated response condition by pulse of voltages -V and +V, thereafter the combination of non-selection signal NS2 and response signal D2 results in the high frequency AC pulse group P14 being applied and thereby the response pixels are held in the response condition. On the other hand, the combination of the selection signal S2 and the reverse response signal RD2 results in the pulse group P13 being applied to the reverse response pixels. The pulse group P13 is formed by superposing high voltage high frequency AC pulses of voltages $\pm 2H$ upon low frequency AC pulses of voltage $\pm V$. Accordingly, the response condition does not change and the saturated reverse response condition achieved by initialisation is held due to the AC stabilising effect $\pm 2H$. Thereafter, the saturated reverse response condition is held by the combination of the non-selection signal NS2 and the reverse response signal RD2 resulting in the pulse group P15.

When the time sharing scanning for M electrodes is completed, initialisation and time sharing scanning are

carried out sequentially for the following blocks of M electrodes.

In this case, each pulse group is composed of the pulses of the same waveform and number but different polarities.

The re-writing time T of one display frame can be expressed as

$T = (2 \times t \times N/M) + (2 \times t \times N) = 2 \times t(N + NM)$ and the re-writing time can be reduced by making large a value of M.

Moreover, as in the example described with reference to Figure 5, intermediate tones can also be displayed by controlling the high frequency AC pulses superposed on the low frequency pulses.

In the previous examples, initialisation is effected in a time period equal to that of selection. In the following example, the time period during which initialisation is effected is extended. In this example (Figure 8), the pulse voltage for initialisation is lowered by extending the application period of the initialisation signal. The response signal D2, reverse response signal RD2, selection signal S2 and non-selection signal NS2 are the same as those used in the example of Figure 7. In the example of Figure 8, the application period of initialisation signals RS3 and RS4 is doubled compared with that of the example of Figure 7 and the voltage $\pm Vr$ of the low frequency component thereof is set to a voltage lower than the voltage VR of the examples of Figures 2 and 5, whilst the high frequency AC pulses have the same voltage $\pm H$.

With the application of such signals, a pulse groups P16 is applied to the response pixels (Figure 10) by the application of the initialisation signal RS3 and response signal D2, thereby initialising the pixels to

the saturated response condition. Thereafter, the pulse group P18 is applied by the application of the initialisation signal RS4 to initialise to the saturated reverse response condition. The pulse group P20 is thereafter applied by the selection signal S2 and response signal D2. Because the pulse group P20 has no high frequency AC pulse component, it does not have AC stabilising effect and therefore the preceding saturated reverse response condition is switched to the saturated response condition by the pulses of voltages -V and +V. Thereafter, high frequency AC pulses of pulse group P22 is applied by the application of the non-selection signal NS2 to stably hold the response condition owing to the AC stabilising effect.

On the other hand, after initialisation to the saturated response condition by application of the pulse group P17 resulting from the combination of the initialisation signal RS3 and reverse response signal RD2, the reverse response pixels (Figure 10) are further initialised to the saturated reverse response condition by application of the pulse group P19 resulting from initialisation signal RS4. Pulse group P21 is then applied by the selection signal S2 and reverse response signal RD2. The pulse group P21 is formed by superposing high voltage high frequency AC pulses of voltages $\pm 2H$ upon the low frequency AC pulses of voltages $\pm V$. The pixels are not changed to the saturated response condition because of the AC stabilising effect of $\pm 2H$ and are held in the initialised saturated reverse response condition. After application of the pulse group P21, a high frequency AC pulse group P23 resulting from the combination of non-selection signal NS2 and reverse response signal RD2 is applied and the saturated reverse response condition is held by AC stabilising

effect.

Figure 9 shows examples of waveforms applied to the adjacent scanning electrode lines Ln and Ln+1. Because the application period of initialisation signal is doubled, the initialisation of signal voltage can be lower than that in the previous examples. Moreover, because the pulse groups P22 or P23 applied during non-selection periods NS2 are formed by high frequency AC pulses with no bias component, the response condition is stably held and high contrast display can be achieved.

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

In the foregoing description, the term "response" is used for the positive voltage and the term "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" may be used for negative voltage.

The signals to be supplied to respective electrodes are not limited only to those mentioned above and various modifications are allowed. The bias voltage may be applied as required, except during the high frequency AC pulses for holding the response condition during the non-selection period.

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 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.

Because the pulse groups applied to the pixels are composed of pulses of the same waveform and number but different polarities, blackening of transparent electrodes, dis-colouration of double colour pigment and deterioration of liquid crystal material are no longer caused, even after driving for a long period of time. Moreover, the AC stabilising effect can be achieved sufficiently during the non-selection period by applying only the high frequency AC pulse with no bias component and thereby the response condition of the pixels can be held stably. Therefore, a high contrast display can be achieved.

The re-writing period of one display frame can be reduced by initialising the pixels to the saturated reverse response condition with the initialisation pulse.

Moreover, initialisation to the saturated reverse response condition can be achieved perfectly even with a low initialisation response voltage Vr by employing a plurality of initialisation signals and thereby ensuring a large driving margin.

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C L A I M S

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 pulse applied to the two sets of electrodes combine to result in a saturating pulse to set the optical element to the saturated response condition followed by a reverse saturating pulse, different only in polarity from the former pulse group, to set the optical element to the saturated reverse response condition, followed by another pulse group either to hold the reverse response condition of the optical element or to set the optical element to desired response condition, said another pulse group consisting of pulses which are the same in waveform and number, but different in polarity, and thereafter followed by high frequency AC pulses of constant amplitude stably to hold the condition of the optical element by the AC stabilising effect.

2. A method as claimed in claim 1, wherein the ferro-electric liquid crystal has negative dielectric anisotropy in the frequency range of the high frequency AC pulses.

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3. A method as claimed in claim 1 or 2, wherein the two sets of electrodes are scanning electrodes and control electrodes, respectively, and wherein, to produce the saturating and reverse saturating pulse groups, initialisation signals are sequentially applied to the scanning electrodes, followed by selection signals to produce said another pulse group and by non-selection signals applied when neither initialisation nor selection signals are applied, to produce high frequency AC pulse groups, other signals being applied to the control electrodes resulting in signal pulse combinations, which have a mean zero voltage, are the same in waveform and number but different in polarity.

4. A method as claimed in claim 3, wherein the selection signal applied to one scanning electrode overlaps in time the initialisation signal applied to the next scanning electrode.

5. A method of driving an electro-optical apparatus substantially as hereinbefore described with reference to Figures 1, 2, 3 and 4 of the accompanying drawings.

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

7. A method of driving an electro-optical apparatus substantially as hereinbefore described with reference to Figures 1, 6 and 7 of the accompanying drawings.

8. A method of driving an electro-optical apparatus substantially as hereinbefore described with reference to Figures 1, 8, 9 and 10 of the accompanying drawings.

9. 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

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accordance with the direction of application of the field, the electric field being applied by signal pulses applied to a set of scanning electrodes and a set of control electrodes between which sets 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 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, the initialisation signal pulse combination resulting in a saturating pulse group to set the optical element to the saturated response condition followed by a reverse saturating pulse, different only in polarity from the former pulse group, to set the optical element to the saturated reverse response condition, the selection signal pulse combination serving either to hold the reverse response condition of the optical element or to set the optical element to the response condition, the selection signal pulse combination consisting of pulses which are the same in waveform and number, but different in polarity, and the non-selection signal pulse combination consisting of high frequency AC pulses of constant amplitude stably to hold the condition of the optical element by the AC stabilising effect, each signal pulse combination having a mean zero voltage, the pulses being the same in waveform and number, but different in polarity.

10. A method for driving a liquid crystal optical

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apparatus, in a matrix liquid crystal optical apparatus forming a plurality of pixels in the form of matrix by providing ferro-electric liquid crystal having AC stabilising effect between scanning electrode group and control electrode group, wherein: after application of a first pulse to setting the ferro-electric liquid crystal to the saturated response condition depending on voltage difference of signals to be supplied to the scanning electrode and a control electrode, second pulse which is different only in the polarity from the first pulse is applied to the pixels in order to set the liquid crystal to the saturated reverse response condition, the second pulse group consisting of pulses which are the same in the waveform and number but different in polarities is subsequently supplied in order to hold the saturated reverse response condition of ferro-electric liquid crystal or set the liquid crystal to the desired response condition, and therafter high frequency AC pulses of constant amplitude are applied to stably hold such response condition by the AC stabilising effect.

11. A method for driving a liquid crystal optical apparatus, in a matrix liquid crystal optical apparatus forming a plurality of pixels in the form of matrix by providing ferro-electric liquid crystal having AC stabilising effect between scanning electrode group and control electrode group, wherein: initialisation signals are sequentially supplied to the scanning electrode group, selection signal is then applied thereto following such initialisation signals and non-selection signal is supplied when the initialisation signals and the selection signal are not supplied, desired signals

are supplied to the control electrode group, a pulse group is applied to initialise the ferro-electric liquid crystal to saturated response condition and then to saturated reverse response condition depending on voltage difference between said desired signal and initialisation signals, a response pulse group for setting ferro-electric liquid crystal to the saturated response condition or a non-response pulse group which does not change the initialisation saturated reverse response condition is subsequently applied depending on voltage difference between the desired signal and selection signal, high frequency AC pulses of constant amplitude are then supplied in order to stably hold the response condition of the ferro-electric liquid crystal by the AC stabilising effect depending on voltage difference between the desired signal and non-selection signal, and the pulse group for initialisation to be applied to the pixels, response pulse group and non-response pulse group are formed by the pulses of mean voltage level 0 which are the same in waveform and the number but different in polarities.