

SPECIFICATION

Electro-optical display device and method of energising the same

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This invention relates to electro-optic display devices and to a method of energising such devices and in particular to a driving arrangement for an electrochromic display. Such electrochromic display cells can be utilized to display figures, letters, symbols and the like in a timepiece, calculator, meter or the like.

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In recent years, a great deal of interest has been shown in the provision of electrochromic displays having, for example, a digital or analog read out such as is described in US Patent Nos. 3,908,355 and 3,987,433. Other prior art patent specifications of interest include US Patent Nos. 3,932,860, 3,881,311, 3,797,255, 3,949,242, 3,807,832 and 3,839,857. These prior art patents are typical of the art showing passive electro-optic display devices and other pertinent references may exist.

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From the prior art, it is known to write selected segments by applying a voltage of one potential (usually having a negative polarity) with respect to a common electrode for a period to completely write the selected segments, and then removing said potential from the written segments. Similarly, erasing of a segment is effected by applying a voltage of opposite polarity with respect to the common electrode for a period to completely erase the selected segments and thereafter removing said voltage.

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Thus, the written and erased electrode-segments were open-circuited upon completion of each transition period, relying on the inherent memory or "persistent electrochromism" of the electrochromic layer to maintain its charge-potential and, therefore, its state of colouration and transparency respectively.

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It has been found that the open-circuited electrode-segments utilized in the prior art driving arrangements tend to gain or lose charge as a result of leakage and, therefore, tend to slowly fade (if written) or to colour (if erased).

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With continuous application of the write voltage to a written electrode-segment, the colour becomes so dark as to make it very difficult to erase. And leaving the erase voltage connected for a prolonged period such as to the hour or day/date indicia, may result in a shortening of the useful life of the display.

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According to the invention there is provided an electro-optical display comprising a first transparent substrate with a selectively actuatable transparent electrode thereon and a layer of electrochromic material on said transparent electrode, a second substrate, a counterelectrode, electrolyte means sealed between the first and second substrates and in contact with said counterelectrode and said electrochromic layer, and means for selectively applying a transition write potential and a maintain write potential between said transparent electrode and said counterelectrode.

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In a preferred embodiment of the invention, a

driving arrangement is provided for the display, which driving arrangement has means for applying a transition potential across a segment to be written (V_{wt}) and/or erased (V_{et}) for approximately a pre-determined transition period after which maintaining potentials, i.e., V_{wm} and V_{em} , are applied to the written and/or erased segment to substantially maintain the desired potential or charge on said segment. The respective transition and maintaining voltage-potentials are selected such that $V_{wt} > V_{wm}$ and $V_{et} > V_{em}$. It is thus possible to provide an electro-optical display device which maintains a desired level of segment colouration over extended periods of time. Similarly, a desired state of segment transparency may be maintained.

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In order that the invention may be better understood, two embodiments thereof will now be described by way of example only and with reference to the accompanying drawings in which:-

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Figure 1 is a circuit diagram illustrating the driving arrangement in accordance with the invention for a passive display element;

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Figure 2 is a circuit diagram of one embodiment of the driving arrangement in accordance with the invention;

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Figure 3 is a circuit diagram of a second embodiment of the driving arrangement in accordance with the invention;

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Figure 4 is a pulse train diagram illustrating the relation between the activation and maintenance periods of the pulses applied to the circuit shown in *Figure 3*; and

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Figure 5 is a wave form diagram illustrating the potentials applied across, for example, any two segments S, Y or an EC display as shown in *Figure 3* and also the potentials applied to the segments A and B illustrated in *Figure 2* to update or change the indicia or information being displayed by a seven segment display indicia arrangement.

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Referring now to *Figure 1* of the drawings the preferred embodiment of the present invention comprises an electrochromic display structure 1 being actuated from a multiple voltage supply 2 by means of a switch device or segment driver control means 3. The essential elements of the electrochromic display (ECD) comprises an electrochromic (EC) layer or segment 4 deposited on an electrode 5 formed on a glass substrate 6 such as commercially available NESA glass, an electrolyte-separator layer 7 contacting the EC layer 4 and a common counterelectrode 8. The counterelectrode 8 is formed, for example, by oxidizing and partial reducing a tungsten on a glass or ceramic substrate 9. To enhance contrast between the coloured and uncoloured states, a pigment may be added to the electrolyte-separator layer 7. White TiO_2 pigment is suitable.

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The display is preferably an electrochromic device using a well known phenomenon such as is described in U.S. Patent Nos. 3,704,057, 3,708,220 and 3,807,832.

Briefly stated, these electro-optical devices exhibit the phenomenon whereby the light absorbing ability of the activated area is varied by the application of an electric voltage to the electrochromic

material turning it darker, for example, decreasing its light transmitting ability over the area of the electrode-segment activated. Generally, application of a voltage of one polarity, for example negative with respect to the counterelectrode, to the electrochromic layer causes it to increase its light absorption, i.e. to turn darker or write. Application of a voltage of opposite polarity causes bleaching or erasing. The activated electrode-segment retains, in a memory-like manner this varied light absorbing characteristic written or erased for a period of time until the application of a voltage of opposite polarity.

Typically in the prior art after writing or erasing, the written or erased segment-electrode was disconnected from the writing or erasing potentials and allowed to float. However, loss of charge on the segments may result, causing fading of the written segments and/or colouration of the erased segment.

This undesirable characteristic of the prior art electrochromic display devices can result in a lowering of the contrast ratio between the written and erased segments causing a less distinct display.

In an embodiment of the present invention, a driving arrangement is provided for an electrochromic display cell 1 in which writing or erasing of a segment or segments 4 is effected by the application of a (relatively high) transition write voltage V_{wr} or transition erase voltage V_{er} respectively. Transition voltages/potentials are selected so as to effect transition, i.e., colouration or bleaching, as rapidly as possible without causing undesirable electrochemical reactions leading to degradation of the display. After a transition period, which is sufficiently long to effect substantially adequate colouration or bleaching of the segment 4, the written or erased segment 4 is stabilized or maintained at a desired state of colouration or transparency by the application of a maintaining write voltage V_{wm} or a maintaining erase voltage V_{em} . The maintaining voltages V_{wm} , V_{em} which are at a lower potential level with respect to the counterelectrode than the respective transition voltages V_{wr} , V_{er} are chosen such that the write or erase charge on the segment 4 is substantially maintained at the desired level and, therefore, maintains the colouration or transparency of the segment 4. In this manner, an equilibrium is effected whereby a loss of charge on a segment is replenished to thereby maintain substantially the desired level of segment colouration and/or transparency.

In operation, if segment 4 is to be written, a transition write voltage V_{wr} is applied, as shown, to the electrode 5, via switches 3 and 10, making the EC layer 4 negative with respect to the electrode 8, for a predetermined (write) transition period. The transition period is selected, either empirically or by calculation, to cause segment 4 to turn substantially to the desired darkness. After the predetermined transition write period, the segment 4, via switch 3, is disconnected from the transition write voltage V_{wr} and is then coupled to the maintain write voltage V_{wm} to maintain the desired perceived darkness or colouration of the segment 4.

If segment 4 is to be erased, electrode 5 is disconnected from the maintain write voltage V_{wm} and coupled, via switches 3 and 10, shown in dot-dash lines, to the transition erase voltage V_{er} , making the

EC layer 4 positive with respect to the common electrode 8, for a predetermined transition (erase) period. After the predetermined transition erase period, the electrode 5, via switch 3, is disconnected from the transition erase voltage V_{er} and is then coupled to the maintain erase voltage V_{em} to maintain the desired perceived transparency or unwritten state of segment 4.

Switch 3, although illustrated as a manually actuatable switch may comprise electronic switching means well known in the art. Switch 10 is shown for illustrative purposes only to facilitate understanding. The device will operate properly if switch 10 is omitted, and points A, B and the common electrode 8 are connected together.

Referring now to Figure 2, a block diagram of the electronic circuitry for an embodiment of this invention is shown. An electrochromic display 50 is actuated by electronic circuitry which generally consists of a time base 51, counter and decoder 52 and a segment driver control means 3. In the embodiment illustrated in Figure 2, the multiple voltage supply 2 provides four separate voltage levels V_{wr} , V_{wm} , V_{er} and V_{em} to each of a plurality of segment drive control means 3 for selectively energizing the segments, for example a through g of each indicia of the display. The segment drive control means 3 may take the form of a plurality of transistor switches which are responsive to control signals from a comparator 53. The comparator 53 is provided for sensing the state, i.e. written or erased, of each segment-electrode a through g of the display indicia and compares the same with the counter and decoder 52 (segment) command signal 54 to avoid reapplication of a transition voltage to a segment which is required to be maintained in the desired written or erased state called for by the incoming command signal 54. The comparator 53 by comparing the command signal 54 with the state of the segment to be written or erased, controls the segment driver control means 3 to apply the proper voltage potentials to the selected electrode to either write, erase or maintain the selected segment in the desired state. The comparator may take the form of an operational amplifier known to those skilled in the art.

The arrangement of Figure 1 uses separate write and erase voltage supplies. A circuit using only one voltage supply and employing switching of the common electrode with a square wave signal of duty cycle K (as defined below) and appropriate amplitude is depicted in Figure 3. A series of waveform diagrams illustrating the operation of the circuit of Figure 3 is shown in Figures 4 and 5.

Two segments, X and Y are shown, and corresponding elements carry the same number designations, with unprimed numbers being used for segment X and primed n numbers being used for segment Y. Each segment (for instance segment X) is connected to four switches such as transmission gates 12, 30, 14 and 32, which respectively allow

coupling of that segment to the write transition voltage V_{wt} , the write maintain to the write transition voltage V_{wt} , the write maintain voltage V_{wm} , the erase transition voltage V_{et} or the erase maintain voltage V_{em} , as the case may be. These voltages are obtained from a single voltage supply, for instance by means of a voltage divider (not shown). The values of these voltages are so chosen with respect to the high and low levels V_H and V_L respectively of a square wave ϕ applied to a common electrode 49, that the appropriate voltage differences exist between each segment and the common electrode to effect the desired write or erase transition or maintain voltages. Suitable values are:

- 15 ϕ at V_H : Write Transition: $V_{wt} - V_H \approx -0.35$ Volt
- ϕ at V_H : Write Maintain : $V_{wm} - V_H \approx -0.1$ Volt
- ϕ at V_L : Erase Transition : $V_{et} - V_L \approx +0.8$ Volt
- ϕ at V_L : Erase Maintain : $V_{em} - V_L \approx +0.4$ Volt

20 Not that when ϕ is high (at V_H) a segment connected to either V_{wt} or V_{wm} is negative with respect to the common electrode 49 and will colour. When ϕ is low (at V_L) a segment connected to either V_{et} or V_{em} is positive with respect to the common electrode 49 and will bleach. Note also that the potentials appearing between each segment and the common electrode are significantly smaller for the maintain condition than for the transition condition whether it be in a write or erase mode.

30 Transmission gates 12, 14, 30 and 32 are respectively controlled by two input AND gates 16, 17, 40 and 41, and are conducting when the output of these gates is at logic 1 (high); otherwise they are open.

35 Inputs 18 and 42, respectively, of gates 16 and 40 are connected to receive the square wave ϕ , while inputs 20 and 44, respectively, of gates 17 and 41 are connected to a square wave $\bar{\phi}$ which is 180 degrees out of phase with square wave ϕ . The second input 19 of gate 16 is connected to signal means (for instance a decoder) commanding a write transition, by making line 19 go high. The second input 43 of gate 40 is connected to signal means commanding a write maintain condition by making line 42 go high. Similarly, the second input 21 of gate 17 is connected to signal means commanding an erase transition. The second input 45 of gate 42 is connected to signal means commanding the erase maintain condition.

50 In operation, if segment X is to be written and segment Y to be erased, the appropriate write and erase transition command causes lines 19 and 21' to go high. Then when square wave ϕ goes high (to V_H), the output of AND gate 16 goes high, closing gate 12 and applying V_{wt} to segment X, causing it to start colouring since it is now at negative voltage with respect to common electrode 49. All other gates connected to X are open: gate 30 because input 43 of AND gate 40 is low; gates 14 and 32 because inputs 20 and 44 of AND gates 17 and 41 respectively are connected to square wave ϕ , which is low at this time. Similar conditions show that all of the gates 12', 30', 14' and 32' are open, leaving segment Y disconnected.

When square wave ϕ goes low, gate 12 opens and segment X is disconnected. Since line 21' is high and square wave $\bar{\phi}$ is high, gate 14' closes and connects segment Y to V_{et} , causing it to start bleaching.

70 The process continues during the transition period, until adequate contrast is reached on segment X and bleaching is complete on Y. When the maintain condition begins, line 43 goes high, while line 19 goes low. During the time when square wave ϕ is high (at V_H), segment X is connected to V_{wm} via gate 30, while segment Y is floating. Then, when square wave $\bar{\phi}$ goes high (square wave ϕ at V_H) segment X is disconnected and segment Y is coupled to V_{em} via gate 32, because line 43 is high. This condition continues until a command signal for a change is received from the decoder and comparator.

80 Sketches of the voltage wave forms appearing at segments during transition and maintain conditions are shown in Figure 5.

85 The frequency of the square wave ϕ and, therefore, the square wave $\bar{\phi}$, i.e. the interleaving frequency f , is predetermined such that during a cycle thereof the write and erase transition potentials provided have a duration or duty-cycle such that only partial or incomplete writing and erasing of the selected segments are effected. Therefore, the segments to be written and erased are caused to partially fade-in and fade-out, respectively, during each cycle of the ϕ and $\bar{\phi}$ signals, and to complete fade-in and fade-out after several cycles so as to give the appearance of simultaneous transition or update of the display characters.

100 During updating (i.e. change of display) the writing of segments previously erased and the erasing of segments previously written may be alternated at a rapid rate between 2 Hz and 4 KHz, to effect substantially simultaneous fade-in and fade-out of segments undergoing change. This procedure, in accordance with the teaching of U.S. Patent No. 3,987,433, minimizes ambiguity or the display of meaningless characters as explained in detail in referenced patent.

105 Briefly stated, the writing and erasing (transition) voltages, i.e. V_{wt} and V_{et} , are applied alternately in rapid succession during time intervals which are short compared to those required for complete writing or erasing. In each of these several successive intervals, only partial writing or erasing is achieved. The transition voltage-potentials are applied across the selected segments for a time interval called the transition period. Each application of a write or erase voltage-potential effects only incomplete writing or erasing. However, the effect is cumulative, and writing and erasing are perceived to occur simultaneously, minimizing the display of meaningless symbols.

115 In a display so operated, a switch 3 as shown in Figure 1 is provided for each segment. Consider two segments, designated in Figure 3 respectively as X and Y, where segment X is to be written and segment Y is to be erased. The associated switches are designated as 3X and 3Y respectively. Assume that the inter-leaving frequency f is 32 Hz. Then

switch 3X couples terminal 13 to segment X for a time KT , where $T = 1/32$ second and K is a fraction less than 1. During this KT interval, segment X is partially written at the write transition voltage V_w .

During the same interval switch 3Y is coupled to a terminal position 0, i.e., gates 12', 30', 14' and 32' are open, disconnecting segment Y. Then during the remainder $(1-K)T$ of the period T switch 3X is placed in position 0, i.e. gates 12, 30, 14 and 32 are open, and switch 3Y operates to couple terminal 15' to segment Y, causing partial erasure of segment Y at the erase transition voltage V_e . The process is repeated during successive periods T , achieving progressive colouration of segment X and bleaching of segment Y. After the transition period (typically 0.5 to 2 seconds), colouration of segment X has progressed to the desired contrast ratio and bleaching of segment Y is complete. The circuit is now changed to the maintain condition. During the interval KT , switch 3X couples terminal 31 to segment X in order to maintain segment X at the desired contrast ratio, while switch 3Y is coupled to terminal position 0, disconnecting or floating segment X. Then during interval $(1-K)T$, switch 3X is coupled to terminal position 0, floating segment X, while switch 3Y is coupled to terminal 33', maintaining segment Y in the bleached state. This maintaining condition continues until a command from the counter-decoder orders a change in the condition of the segments.

CLAIMS

1. An electro-optical display comprising a first transparent substrate with a selectively actuatable transparent electrode thereon and a layer of electrochromic material on said transparent electrode, a second substrate, a counterelectrode, electrolyte means sealed between the first and second substrates and in contact with said counterelectrode and said electrochromic layer and means for selectively applying a transition write potential and a maintain write potential between said transparent electrode and said counterelectrode.

2. An electro-optical display as claimed in claim 1 wherein the transition write potential is at a relatively high level with respect to the maintain write potential to effect colouration of the electrochromic material, and the maintain write potential is at a level such as to maintain a predetermined state of colouration of the electrochromic material after being coloured by the transition write potential.

3. An electro-optical display as claimed in either one of claims 1 or 2 further comprising means for selectively applying a transition erase potential and a maintain erase potential between said transparent electrode and said counterelectrode.

4. An electro-optical display as claimed in claim 3 wherein the transition erase potential is at a relatively high level with respect to the maintain erase potential to effect bleaching of the electrochromic material, and the maintain erase potential is at a level such as to maintain a predetermined state of transparency of the electrochromic material, after

being bleached by the transition erase potential.

5. An electro-optical display as claimed in either one of claims 3 or 4 wherein the means for selectively applying a transition write potential and

a maintain write potential and for selectively applying a transition erase potential and a maintain erase potential together comprise a switching and holding circuit having circuit means for providing said transition write signal and said maintain write

signal and said transition erase signal and said maintain erase signal, alternating signal means for applying to said counterelectrode an alternating signal having a write signal level and an erase signal level, control means coupled to said circuit

means and to said alternating signal means and controlled by said transition write signal and the write signal level of said alternating signal to provide a transition write voltage to said segment in

coincidence with the write signal level of said alternating signal being applied to said counterelectrode in order, in turn, to provide a transition write potential between said counterelectrode and said segment, said control means also being controlled by said maintain write signal and the write signal

level of said alternating signal to provide a maintain write voltage to said segment in coincidence with the write signal level of said alternating signal being applied to said counterelectrode in order, in turn, to provide a maintain write potential between

said counterelectrode and said segment, said control means also being controlled by said transition erase signal and the erase signal level of said alternating signal to provide a transition erase voltage to said segment in coincidence with the erase signal level of said alternating signal being applied to

said counterelectrode in order, in turn, to provide a transition erase potential between said counterelectrode and said segment, said control means also being controlled by said maintain erase signal and the erase signal level of said alternating signal to provide a maintain erase voltage to said segment in coincidence with the

erase voltage to said segment in coincidence with the erase signal level of said alternating signal being applied to said common electrode in order, in turn to provide a maintain erase potential between said counterelectrode and said segment.

6. An electro-optical display as claimed in claim 5 wherein the electrochromic material exhibits colouration and bleaching by control of the polarity of a transition electric field for a substantially predetermined duration and exhibits substantially stabilized states of colouration and bleaching by control

of the polarity of a maintain electric field; the alternating signal comprises a square wave signal which varies between said write signal level and said erase signal level and having a period such that each said write signal level has a duration which is less than the duration required to effect a predetermined colouration and each erase signal level has a duration such that said transition erase potential is applied for duration which is less than the predetermined duration required to effect com-

being bleached by the transition erase potential.

7. An electro-optical display as claimed in claim 6 wherein the alternating signal has a period such that each said write signal level has a duration which is less than the duration required to effect a predetermined colouration and each erase signal level has a duration such that said transition erase potential is applied for duration which is less than the predetermined duration required to effect com-



switch 3X couples terminal 13 to segment X for a time K T, where $T = 1/32$ second and K is a fraction less than 1. During this K T interval, segment X is partially written at the write transition voltage V_w .

- 5 During the same interval switch 3Y is coupled to a terminal position 0, i.e., gates 12', 30', 14' and 32' are open, disconnecting segment Y. Then during the remainder (1-K) T of the period T switch 3X is placed in position 0, i.e. gates 12, 30, 14 and 32 are open, and switch 3Y operates to couple terminal 15' to segment Y, causing partial erasure of segment Y at the erase transition voltage V_e . The process is repeated during successive periods T, achieving progressive colouration of segment X and bleaching of segment Y. After the transition period (typically 0.5 to 2 seconds), colouration of segment X has progressed to the desired contrast ratio and bleaching of segment Y is complete. The circuit is now changed to the maintain condition.
- 10 During the interval K T, switch 3X couples terminal 31 to segment X in order to maintain segment X at the desired contrast ratio, while switch 3Y is coupled to terminal position 0, disconnecting or floating segment X. Then during interval (1-K) T, switch 3X is coupled to terminal position 0, floating segment X, while switch 3Y is coupled to terminal 33', maintaining segment Y in the bleached state. This maintaining condition continues until a command from the counter-decoder orders a change in the condition of the segments.

CLAIMS

1. An electro-optical display comprising a first transparent substrate with a selectively actuatable transparent electrode thereon and a layer of electrochromic material on said transparent electrode, a second substrate, a counterelectrode, electrolyte means sealed between the first and second substrates and in contact with said counterelectrode and said electrochromic layer and means for selectively applying a transition write potential and a maintain write potential between said transparent electrode and said counterelectrode.
2. An electro-optical display as claimed in claim 1 wherein the transition write potential is at a relatively high level with respect to the maintain write potential to effect colouration of the electrochromic material, and the maintain write potential is at a level such as to maintain a predetermined state of colouration of the electrochromic material after being coloured by the transition write potential.
3. An electro-optical display as claimed in either one of claims 1 or 2 further comprising means for selectively applying a transition erase potential and a maintain erase potential between said transparent electrode and said counterelectrode.
4. An electro-optical display as claimed in claim 3 wherein the transition erase potential is at a relatively high level with respect to the maintain erase potential to effect bleaching of the electrochromic material, and the maintain erase potential is at a level such as to maintain a predetermined state of transparency of the electrochromic material, after

being bleached by the transition erase potential.

5. An electro-optical display as claimed in either one of claims 3 or 4 wherein the means for selectively applying a transition write potential and a maintain write potential and for selectively applying a transition erase potential and a maintain erase potential together comprise a switching and holding circuit having circuit means for providing said transition write signal and said maintain write signal and said transition erase signal and said maintain erase signal, alternating signal means for applying to said counterelectrode an alternating signal having a write signal level and an erase signal level, control means coupled to said circuit means and to said alternating signal means and controlled by said transition write signal and the write signal level of said alternating signal to provide a transition write voltage to said segment in coincidence with the write signal level of said alternating signal being applied to said counterelectrode in order, in turn, to provide a transition write potential between said counterelectrode and said segment, said control means also being controlled by said maintain write signal and the write signal level of said alternating signal to provide a maintain write voltage to said segment in coincidence with the write signal level of said alternating signal being applied to said counterelectrode in order, in turn, to provide a maintain write potential between said counterelectrode and said segment, said control means also being controlled by said transition erase signal and the erase signal level of said alternating signal to provide a transition erase voltage to said segment in coincidence with the erase signal level of said alternating signal being applied to said counterelectrode in order, in turn, to provide a transition erase potential between said counterelectrode and said segment, said control means also being controlled by said maintain erase signal and the erase signal level of said alternating signal to provide a maintain erase voltage to said segment in coincidence with the erase signal level of said alternating signal to provide a maintain erase potential between said counterelectrode and said segment.
6. An electro-optical display as claimed in claim 5 wherein the electrochromic material exhibits colouration and bleaching by control of the polarity of a transition electric field for a substantially predetermined duration and exhibits substantially stabilized states of colouration and bleaching by control of the polarity of a maintain electric field; the alternating signal comprises a square wave signal which varies between said write signal level and said erase signal level and having a period such that each said write signal level has a duration which is less than the duration required to effect a predetermined colouration and each erase signal level has a duration such that said transition erase potential is applied for duration which is less than the predetermined duration required to effect com-



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plete bleaching; the circuit means selectively provides the transition write signal and the transition erase signal having a duration such as to enable said switching and holding circuit over a several cycle duration of the alternating signal to selectively effect a complete colouration or a complete bleaching of the segment.

7. An electronic timepiece comprising an electro-optical display as claimed in either one of claims 5 or 1, said display having a plurality of said segments representing indicating indicia, and a counterelectrode; display control means responsive to said alternating signal and said transition write signal to provide a transition write voltage to a first segment in coincidence with the write signal level of said alternating signal being applied to said counterelectrode whereby a transition write potential is provided across said counterelectrode and said first segment, said display control means being responsive to said maintain write signal and said alternating signal to provide a maintain write voltage to said first segment in coincidence with the write signal level of said alternating signal being applied to said counterelectrode whereby a maintain write potential is provided across said counterelectrode and said first segment, said display control means being responsive to said alternating signal and said transition erase signal to provide a transition erase voltage to a second segment in coincidence with the erase signal level of said alternating signal being applied to said counterelectrode whereby a transition erase potential is provided across said counterelectrode and said second segment, said display control means being responsive to said alternating signal and said maintain erase signal to provide a transition erase voltage to the second segment in coincidence with the erase signal level of said alternating signal being applied to said counterelectrode whereby a maintain erase potential is provided across said counterelectrode and the second segment.

8. An electro-optical display substantially as hereinbefore described with reference to the accompanying drawings.

9. A method of energizing an electro-optical display of the type claimed in any one of the preceding claims, said method comprising the steps of selectively applying to said segment a transition write potential to effect writing of said segment to a desired state of colouration and applying to said segment a maintain write potential to maintain the written segment at the desired state of colouration.

10. A method of energizing an electro-optical display of the type claimed in any one of the preceding claims, said method comprising the steps of selectively applying across said segment a transition erase potential to effect erasing of said segment to a desired state of transparency; applying across said segment a maintain erase potential to maintain the erased segment at the desired state of transparency.