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(54) **Control method for a cold start of a liquid crystal display and control unit therefor**

Verfahren und Einrichtung zum Steuern des Kaltstarts eines Flüssigkristallanzeigegeräts

Méthode et dispositif de commande d' un démarrage à froid d' un dispositif d'affichage à cristaux liquides

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Description

[0001] The invention relates to a method of enhancing the response of a liquid crystal display at relatively low temperatures, and a control unit therefor. In particular, but not exclusively, the invention relates to a method of enhancing the response of a liquid crystal display of the type suitable for use in a vehicle to display a warning or other status signal to the driver of the vehicle.

[0002] A liquid crystal display (LCD) typically includes two glass plates which are separated by between 5 to 10 μm, and which define a cell which is filled with a liquid crystal material. Two polarisers are arranged, one on each side of the cell, with their polarisation axes oriented at 90 degrees to one another. The inner surfaces of the glass plates may be coated with transparent electrodes, typically formed from indium tin oxide, which define the characters, symbols or other patterns to be displayed. Between the glass plates and the liquid crystal material, alignment or orientation layers of polymeric material are treated to induce the adjacent liquid crystal molecules to maintain a defined orientation angle. If the alignment or orientation layers are arranged at 90 degrees to one another, the molecules of the liquid crystal material introduced between the plates will be caused to twist through a 90 degree helix and the polarised light passing through the cell will be guided by the molecules through the 90 degree helix so that the polarisation axis is rotated by 90 degrees.

[0003] By applying an electric field applied across the cell, the polarisation properties of the cell can be varied as the liquid crystal molecules are caused to align with the electric field and the 90 twist in the optic axis is distorted. By varying the electric field applied across the cell, incident polarised light will therefore either have its polarisation axis aligned with that of the exit polariser (an ON state), in which case light is transmitted through the device, or will have its polarisation axis orthogonal to the exit polariser (an OFF state) in which case light is not transmitted through the device. In a multiplexed liquid crystal device, multiplex drive electrodes are arranged in a matrix on the glass plates. Selective addressing of the electrode matrix provides a means of varying the characters, graphics or others symbols to be displayed, as molecules in only selected segments of the cell are caused to align with the applied electric field.

[0004] As the viscosity of liquid crystal material increases at decreasing temperatures, the switching response time of liquid crystal displays is reduced at low temperatures. By way of example, when a nematic liquid crystal display is operated at room temperature, the application of an electric field across the cell can cause twisting of the liquid crystal molecules in a timescale of between 50 and 100 ms. However, when operated at temperatures below -20° C, the response time can be of the order of minutes. At even lower temperatures (around -40° C), it may not be possible to twist the liquid crystal molecules at all such that the display is inactive.

[0005] A known technique for increasing the response time of a liquid crystal display is to provide a heating element at the rear of the display which is activated when the temperature of the liquid crystal material falls below a certain value. It has been found that the use of a heating element on a liquid crystal display operating at a temperature of -20° C gives a satisfactory response time for some applications. At lower temperatures, around -40°C, it has been found that, even when a heater is provided, the response time may nevertheless be as high as 70 to 80 seconds.

[0006] If the liquid crystal display is to be used in a vehicle to display information to the driver about the status of the vehicle, it may be essential to display such information as soon as possible after the driver enters the vehicle. For example, if the liquid crystal display provides a warning signal to the driver in the event that the oil level in the engine is too low, it is essential that the warning signal is displayed before the engine is started, otherwise serious engine damage will occur. Although the use of a heating element on the liquid crystal display can enable faster device response times, for the purpose of providing certain warning signals to a driver, this solution is unsatisfactory.

[0007] EP 1113412 discloses a method for driving liquid crystal display devices, such as an optical compensated bend LCD, in which a transition of liquid crystal molecules from an initial alignment to a displayable alignment is required. The method disclosed aims to shorten the transition period.

[0008] US 6232937 discloses a display system having a liquid crystal display with an internal heating system to allow the system to be used at low temperatures.

[0009] JP 2001-235729 discloses a display device incorporating a liquid crystal device which maintains its colour performance with changes in the temperature of the operating environment.

[0010] It is an object of the present invention to provide a method of controlling operation of a liquid crystal display which overcomes the aforementioned problems.

[0011] According to the present invention, there is provided a method of enhancing the response time of a liquid crystal display in accordance with that claimed in independent claim 1.

[0012] For the purpose of this specification, the "response time" of the liquid crystal display shall be taken to have its usual meaning, i.e. the time taken, following application of a drive voltage to the liquid crystal material, for the liquid crystal material to switch state so as to display a demanded image.

[0013] Preferably, the step of applying the negative bias voltage comprises applying a maximum negative bias voltage for the voltage source associated with the liquid crystal display. For example, if the display is used in a vehicle to display various engine and/or vehicle operating parameters, the maximum negative bias voltage which can be derived from the engine battery is, typically, around -13.5 V..

[0014] More preferably, the method includes the additional step of applying a heating effect to the liquid crystal material if the temperature of the liquid crystal material falls below the predetermined temperature.

[0015] Preferably the heater is activated in the event that the measured temperature of the liquid crystal material falls below the predetermined temperature.

[0016] Typically, the predetermined temperature is between 0°C and -25°C and, preferably, is substantially -20 °C.

[0017] Also according to the present invention, there is provided a control unit in accordance with that claimed in independent claim 11.

[0018] Preferably, the liquid crystal material may be a twisted nematic (TN) or a super twisted nematic (STN) material. The liquid crystal display may be of the type comprising a double STN cell (DSTN) having an active cell to which drive signals are applied, in use, to display a demanded image, and a passive cell which is provided for the purpose of improving the contrast ratio of the display.

[0019] The method may comprise the step of determining the frame refresh frequency by reference to a look up table or a data map comprising pre-calibrated frame refresh frequency values as a function of the measured liquid crystal temperature.

[0020] Alternatively, the method may comprise the step of determining the frame refresh frequency in real time.

[0021] The method enables the response time of the liquid crystal display to be increased significantly at relatively low temperatures by applying a 'cold kick' to the liquid crystal material. The 'cold kick' is achieved by applying a negative bias voltage to the liquid crystal material for a period of time determined by the temperature of the material and, in addition, by reducing the frame refresh frequency to a value dependant upon the temperature of the liquid crystal material.

[0022] It will be appreciated that the method steps of the invention may be implemented in software on a computer processor or control unit of the associated engine.

[0023] According to the present invention, there is further provided a control unit as defined in claim 11 below.

[0024] Optional but preferred method steps as defined in the dependent claims below may also be implemented in software on a computer processor or control unit of the associated engine.

[0025] The invention provides a particular advantage when used to enhance the response time of a liquid crystal display in a motor vehicle where the display is used to provide warning or other status signals to the driver. It has been found that, even at temperatures as low as -40°C, the response time of the display can be increased to around 10 to 12 seconds. Thus, if the liquid crystal display is used to display a warning signal to indicate a low level of engine oil, the driver can be alerted in good time to prevent the vehicle from being driven. The invention provides a significant advantage over the known technique for enhancing the response time of a liquid crystal display through use of a heater, for which the response time has been found to be between 70 and 80 seconds at - 40°C.

[0026] The invention may also be useful for the purpose of driving liquid crystal displays of the type used in Global Positioning System (GPS) devices, and in particular on hand-held GPS devices, for which enhanced display response times at low temperatures may be particularly desirable.

[0027] The invention will now be described, by way of example only, with reference to the accompanying drawings in which;

Figure 1 is a schematic side view of a double STN (DSTN) liquid crystal display,

Figure 2 is a perspective view of the double STN (DSTN) liquid crystal display shown in Figure 1,

Figure 3 is a flow diagram to illustrate the method steps of a main background control loop for displaying an image on the liquid crystal display in Figures 1 and 2,

Figure 4 is a flow diagram to illustrate a 'cold kick' sub-control loop in accordance with an embodiment of the present invention,

Figure 5 is a timing sub-control loop to determine the length of time for which the 'cold kick' is applied,

Figure 6 is a flow diagram to illustrate a 'frame refresh adjust' sub-control loop for selecting the frame refresh frequency depending on liquid crystal temperature, and

Figure 7 is a graph to show frame refresh frequency data as a function of liquid crystal temperature, for use in the sub-control loop illustrated in Figure 6.

[0028] Referring to Figures 1 and 2, there is shown a liquid crystal display device of the type comprising a first, active cell 10 and a second, passive cell 12. The active cell 10 includes front and rear glass plates (only the rear one 19 of which is shown in Figure 2), between which a liquid crystal material is provided such as, for example, a super twisted nematic material. The passive cell 12 is of similar construction and the two cells 10, 12 are bonded together by means of a bonding layer 13 in a conventional manner to form a double-cell arrangement, commonly referred to as a double super twisted nematic (DSTN) device. A heating element 14 formed from a layer of indium tin oxide (ITO) extends through the passive cell 12, in contact with the liquid crystal material. Front and rear device polarisers 18, 20 are arranged on the front face of the active cell 10 and the rear face of the passive cell 12 respectively and are oriented such that their polarisa-

tion axes are orthogonal to one another. A temperature sensor (not shown) is provided on the device to continuously monitor the temperature of the liquid crystal material within the active cell 10.

[0029] The DSTN device shown in Figures 1 and 2 is of the type suitable for use in a vehicle to display information to the driver regarding the status of the vehicle and/or the engine. Typically, the display may be used to provide a warning signal if one of the doors is open, if the boot is not closed or if the driver seat belt is not fastened. Additionally, the display may be used to provide an indication of engine speed, engine temperature, fuel economy or a warning signal that engine oil level is low, or may be used to display Global Positioning System (GPS) information.

[0030] An appropriate matrix of electrodes (not shown) is provided on the active cell 10, to which appropriate drive voltage signals are applied, in use, from an associated voltage source (not shown) by means of first and second driver chips 22, 24 mounted on the glass plate 19. Typically, the driver chips 22, 24 are off-the-shelf chips such as, for example, SED157As. Cell 12 remains passive and is provided to improve the contrast of the display.

[0031] An Electronic Interface Unit of the display is operated under the control of an Electronic Control Unit. Appropriate drive voltage signals to the active cell electrode matrix are applied in response to "Build Display Request" signals provided by the Electronic control unit, the Build Display Request signals being input to the driver chips 22, 24 through respective connector wires 26, 27. When used in the aforementioned automotive application, the display will typically be a high information density display, for example 386 x 64 pixels, and may be driven to display the demanded image using a multiplex addressing technique in a manner which would be familiar to a person skilled in the art.

[0032] In use, current is supplied to the heating element 14 of the DSTN device through an H-bridge circuit (not shown) by means of a first connection 16 (as shown in Figure 2) and a second connection through the second connector 26. The use of an H-bridge circuit ensures minimal DC offset is applied to the heating element 14, which may otherwise degrade the performance of the liquid crystal device. The heating element 14 is switched on and off by applying a ramped PWM drive voltage through the H-bridge circuit. Ramping of the PWM drive voltage to the heating element 14 is advantageous in that large currents are not rapidly drawn from the voltage source (for example, the engine battery) which may otherwise effect the DSTN drive voltages derived from the same voltage source. Typically, the power "ON" ramp for the heating element 14 from zero to maximum current takes 1.6 seconds and the power "OFF" ramp takes 3.2 seconds.

[0033] Figures 3 to 6 show the control method steps for activating the liquid crystal device. As shown in Figure 3, at the onset of the main program control loop a check is made as to whether a Build Display Request command signal has been generated by the Electronic Control Unit. If there is no Build Display Request the main control loop exits and is re-entered again after a predetermined period (typically 160 ms). If a Build Display Request has been generated by the Electronic Control Unit, the appropriate display data are input to a buffer (step 32) for the driver chips 22, 24. The data is input to the driver chips 20, 24 at step 34 and the demanded drive voltage signals are applied to the electrode matrix of the active cell 10 to display the demanded image. The image is refreshed a number of times each second (referred to as the 'frame refresh frequency') in a conventional manner.

[0034] At step 36, a 'cold kick' sub-control loop 36 is implemented for each frame refresh. Figure 4 shows the method steps of the cold kick sub-control loop 36. For each Build Display Request, the temperature of the liquid crystal material is compared with a predetermined temperature, for example -20°C (step 38). If the measured temperature is greater than -20°C, the cold kick sub-control loop 36 exits and the main program control loop is restarted.

[0035] If the temperature of the liquid crystal material is less than -20°C, two steps are carried out to enhance the response of the liquid crystal display. Generally, the two steps may be referred to as (i) a 'cold kick bias voltage step' in which a relatively large magnitude negative bias voltage is applied to the active cell 10 for a period of time, $T_{coldkick}$, where $T_{coldkick}$ depends upon the measured temperature and (ii) a 'frame refresh adjust step' in which the frame refresh frequency is adjusted in accordance with the measured liquid crystal temperature. In a practical embodiment, it is envisaged that the ITO heating element and frame refresh frequency adjustments will be employed until a temperature of +7C is reached.

[0036] In order to implement steps (i) and (ii), a check is made (step 40) as to whether a cold kick timer is already running, such as would be the case if the measured temperature of the liquid crystal material was less than -20°C for the preceding Build Display Request. If the cold kick timer is not running, the cold kick time period, $T_{coldkick}$, is determined at step 42.

[0037] The cold kick time period, $T_{coldkick}$ is determined by multiplying the absolute value of the measured liquid crystal temperature by a predetermined factor, F. It has been found that, for a cold kick timer sub-control loop having a repeat time of 80 milliseconds, the appropriate predetermined factor, F, is [5 x 80] milliseconds. Thus, for example, if the measured temperature of the liquid crystal material, T_{LC}, is -30°C, the cold kick time period is set to 12 seconds. Conveniently, the step 42 of determining the duration for which the cold kick timer is running is carried out by reference to a look-up table or a data map having pre-stored calibrated data relating the cold kick time period to the measured temperature, T_{LC}, of the liquid crystal material. Alternatively, for each cold kick sub-control loop, the cold kick time period may be calculated in real time using the aforementioned relationship.

[0038] The cold kick bias voltage step (ii) is applied at step 44 by applying negative bias voltage across the liquid crystal material of the active cell 10 for the duration of the cold kick time period. The negative bias voltage is preferably the maximum negative voltage capable of being supplied by the associated voltage source which, for a normal car battery, is typically -13.5 V, but may be as low as -20 V. At step 46, a kick timer running flag is set 'TRUE' to indicate that the cold kick sub-control loop 36 is operational. It is this flag which is used at step 40 to determine whether the cold kick timer is running, as mentioned previously.

[0039] Figure 5 shows the control loop for the cold kick time period count down. A check is made at step 45 whether the cold kick timer is running and, if so (i.e. if the cold kick sub-control loop flag is set 'TRUE'), the timer is decremented (step 47) until the cold kick time period has expired. When the cold kick time period expires, at step 48, the cold kick timer is reset to zero (step 50) and the maximum negative bias voltage applied to the liquid crystal device is switched off allowing the main bias voltage control loop to resume normal control and apply the normal bias voltage for the current measured operating conditions.

[0040] As can be seen in Figure 4, if, at step 40, it is found that the cold kick timer is already running when a new Build Display Request is received and the cold kick sub-control loop receives an input from the Electronic Interface Unit that the temperature of the liquid crystal material is still less than -20°C, the cold kick timer is reset at step 54 and the bias voltage applied to the device is switched off (step 56). A time delay of one second is introduced (step 58) before the next cold kick time period is determined (step 42) for the subsequent Build Display Request.

[0041] The frequency with which the display is refreshed is also altered in accordance with the measured temperature (the frame refresh adjust step) by means of a frame refresh frequency control loop, as shown in Figure 6, which is run in parallel with the main control loop. For each 160 millisecond period, a new frame refresh frequency is selected depending upon the current measured temperature of the liquid crystal material. If the frame refresh frequency is not equal to the value for the proceeding 160 millisecond time period, a new frame refresh frequency is generated.

[0042] Figure 7 is a graph to show the relationship between optimum frame refresh frequency and temperature for the DSTN device in Figures 1 and 2. It can be seen that the optimum frame refresh frequency increases for increasing liquid crystal temperatures and, at relatively low temperatures (typically below - 10°C), the optimum frame refresh frequency decreases. As the LCD becomes warmer, a higher frame refresh frequency is required to operate the display, otherwise the display will flicker. The frame refresh frequency at normal temperatures, is carefully selected, so as not to cause beat frequencies with the LED backlighting and street lighting. The cold kick frame refresh sub-control loop illustrated in Figure 6 is conveniently implemented in software by reference to a look up table or data map storing pre-calibrated values of frame refresh frequency as a function of liquid crystal temperature. The use of data maps and look up tables in control software is commonly used and would be familiar to a person skilled in the art of Electronic Control System design.

[0043] It has been found that the application of a relatively large magnitude negative bias voltage to the liquid crystal display device, in combination with an adjustment to the frame refresh frequency depending upon measured temperature, has the effect of enhancing the response time of the display when a Build Display Request is generated. The response time is enhanced further if current is supplied to the heating element 14 (as shown in Figures 1 and 2) when the temperature of the liquid crystal material falls below a predetermined amount. If the steps of applying a heating effect to the liquid crystal material, of reducing the frame refresh frequency and of applying a maximum negative bias voltage across the device are applied in combination, it has been found that the response time of the device may be as low as 12 seconds for a device operating at -40°C. Using conventional addressing techniques, even with the use of a heating element 14, the response time of a liquid crystal display at a temperature of -40°C is usually at least 70 seconds. For applications in which it is important to display an image or character on the liquid crystal display as quickly as possible, the method of the present invention provides a significant advantage over conventional LC control techniques.

[0044] It will be appreciated that the temperature values, bias voltage values and frame refresh frequencies referred to previously are given by way of example only and will vary depending on the particular configuration, material and performance characteristics of the liquid crystal display device. For liquid crystal materials of different type, for example ferroelectric materials as opposed to nematic materials, operating characteristics will be different and the predetermined temperature at which the cold kick sub-control loop is activated may be different to that described previously. Additionally, if the display device is driven through a voltage source other than a normal car battery, the maximum negative bias voltage which may be applied to the device may be significantly greater than -13.5 V.

[0045] It will be appreciated that the liquid crystal display device to which the control method of the present invention is applied may take the form of a single cell liquid crystal display, and need not be a double cell arrangement such as that shown in Figures 1 and 2. In a single cell device, the heating element may conveniently be provided on the rear glass plate of the liquid crystal cell. It will further be appreciated that the method is applicable to a display of any size (for example 8×1, 64×1, 64×64, or 256×256 pixels), and including a simple ON/OFF display, and is compatible with both multiplex

drive or direct drive control methods.

[0046] It is envisaged that in embodiments of the invention, a control means may be included for controlling the degree of heating supplied by the heating element. The control means may control the heating such that the LCD temperature is raised to above +7 degrees C. Above 7 degrees C the LCD display will function normally. The ITO Heating element control may include a control algoirthm which estimates the required amount of I2Rt energy required for the heating cycle and limits the energy applied to the ITO heater. The heater current and voltage may also be monitored to ensure that the RMS current is maintained below 1.5 amps, even when the supply voltage changes.

Claims

1. A method of enhancing the response time of a liquid crystal display at a temperature that is less than a predetermined temperature, the liquid crystal display comprising a liquid crystal material, the response time of the display being the time taken to switch between a state in which light is transmitted through the device and a state in which light is not transmitted through the device or vice versa, the method comprising the steps of, for each frame refresh :

measuring the temperature of the liquid crystal material;
generating a drive voltage requiring the use of a normal bias voltage;
applying said drive voltage, during normal operation, to the liquid crystal material at a selected frame refresh frequency so as to display an image;

characterised by the steps of:

comparing the measured temperature with the predetermined temperature (38) and selecting the frame refresh frequency depending upon the result of said comparison,
wherein, if the measured temperature is less than the predetermined temperature, said step of selecting the frame refresh frequency comprises determining a cold kick time period (42), which is dependent upon the measured temperature and for which a negative bias voltage is applied across the liquid crystal material, and
applying a negative bias voltage (44) across the liquid crystal material for the duration of the cold kick time period
wherein the negative bias voltage applied across the liquid crystal material is of greater magnitude than the normal bias voltage required for operating the liquid crystal display.

2. The method as claimed in Claim 1, wherein the negative bias voltage is derived from a voltage source associated with the liquid crystal display, the method comprising the step of applying a maximum negative bias voltage derivable from the voltage source for the duration of the cold kick time period.

3. The method as claimed in Claim 2, comprising the step of applying a negative bias voltage of around -13.5 V.

4. The method as claimed in any of Claims 1 to 3, comprising the further step of applying a heating effect to the liquid crystal material if the temperature of the liquid crystal material falls below the predetermined temperature.

5. The method as claimed in any of Claims 1 to 4, wherein the predetermined temperature is between 0°C and -25°C.

6. The method as claimed in any of Claims I to 5, comprising the step of determining the selected frame refresh frequency by reference to a look up table or data map comprising pre-calibrated frame refresh frequency values as a function of the measured temperature.

7. The method as claimed in any of Claims 1 to 5, comprising the step of determining the selected frame refresh frequency in real time.

8. The method as claimed in any of Claims 1 to 7, wherein the liquid crystal display comprises a super twisted nematic liquid crystal material.

9. The method as claimed in any of Claims 1 to 8, wherein the liquid crystal display is comprised within a Global Positioning System (GPS) device.

10. The method as claimed in any of Claims 1 to 8, wherein the liquid crystal display is in a vehicle.

11. A control unit for enhancing the response time of a liquid crystal display at a temperature that is less than a predetermined temperature, the liquid crystal display having a liquid crystal material, the response time of the display being the time taken to switch between a state in which light is transmitted through the device and a state in which light is not transmitted through the device or vice versa, the device comprising, for each frame refresh:

means for measuring the temperature of the liquid crystal material;
means for applying a drive voltage (22, 24) to the liquid crystal material at a selected frame refresh frequency so that the liquid crystal ma-

terial can display an image, said means requiring, in normal operation, the use of a bias voltage for generating said drive signals;

characterised by:

means for comparing the measured temperature with a predetermined temperature and for selecting the frame refresh frequency depending upon the result of said comparison wherein, if the measured temperature is less than the predetermined temperature, said comparison and selecting means being arranged to determine a cold kick time period which is dependent upon the measured temperature and for which a negative bias voltage is applied across the liquid crystal material; and
means for applying a negative bias voltage across the liquid crystal material for the duration of the cold kick time period

wherein the negative bias voltage applied across the liquid crystal material is of greater magnitude than the normal bias voltage required for operating the liquid crystal display.

12. The control unit according to claim 11, comprising means for further applying a heating effect (14) to the liquid crystal material if the temperature of the liquid crystal material falls below the predetermined temperature.

13. The control unit according to claim 11, comprising means for determining the selected frame refresh frequency by reference to a look up table or data map comprising pre-calibrated frame refresh frequency values as a function of the measured temperature.

Patentansprüche

1. Verfahren zum Verbessern der Reaktionszeit einer Flüssigkristallanzeige bei einer Temperatur, die niedriger ist als eine vorgegebene Temperatur, wobei die Flüssigkristallanzeige ein Flüssigkristallmaterial aufweist, wobei die Reaktionszeit der Anzeige die Zeit ist, um zwischen einem Zustand, in dem Licht durch die Vorrichtung übertragen wird, und einem Zustand umzuschalten, in dem kein Licht durch die Vorrichtung übertragen wird, oder umgekehrt, wobei das Verfahren für jede Rahmenaktualisierung die Schritte aufweist:

Messen der Temperatur des Flüssigkristallmaterials;
Erzeugen einer Ansteuerspannung, welche die Verwendung einer normalen Bias-Spannung erfordert;
Anlegen der Ansteuerspannung, während eines normalen Betriebs, auf das Flüssigkristallmaterial bei einer gewählten Rahmenaktualisierungshäufigkeit, um ein Bild anzuzeigen;
gekennzeichnet durch die Schritte:

Vergleichen der gemessenen Temperatur mit der vorgegebenen Temperatur (38) und Auswählen der Rahmenaktualisierungshäufigkeit abhängig von dem Ergebnis des Vergleichs,

wobei, wenn die gemessene Temperatur niedriger ist als die vorgegebene Temperatur, der Schritt des Auswählens der Rahmenaktualisierungshäufigkeit aufweist ein Bestimmen einer Kaltstart-Zeitdauer (42), die von der gemessenen Temperatur abhängig ist und für die eine negative Bias-Spannung an das Flüssigkristallmaterial angelegt wird, und
Anlegen einer negativen Bias-Spannung (44) an das Flüssigkristallmaterial während der Dauer der Kaltstart-Zeitdauer,
wobei die negative Bias-Spannung, die an das Flüssigkristallmaterial angelegt wird, größer ist als die normale Bias-Spannung, die zum Betrieb der Flüssigkristallanzeige erforderlich ist.

2. Verfahren gemäß Anspruch 1, wobei die negative Bias-Spannung von einer Spannungsquelle abgeleitet ist, die zu der Flüssigkristallanzeige gehört, wobei das Verfahren den Schritt aufweist eines Anlegens einer maximalen negativen Bias-Spannung, die von der Spannungsquelle abgeleitet werden kann, während der Dauer der Kaltstart-Zeitdauer.

3. Verfahren gemäß Anspruch 2, das den Schritt eines Anlegens einer negativen Bias-Spannung von ungefähr -13,5 V aufweist.

4. Verfahren gemäß einem der Ansprüche 1 bis 3, das weiter den Schritt aufweist eines Anwenden eines Erwärmen-Effekts auf das Flüssigkristallmaterial, wenn die Temperatur des Flüssigkristallmaterials unter die vorgegebene Temperatur fällt.

5. Verfahren gemäß einem der Ansprüche 1 bis 4, wobei die vorgegebene Temperatur zwischen 0°C und -25 °C ist.

6. Verfahren gemäß einem der Ansprüche 1 bis 5, das den Schritt aufweist eines Bestimmens der gewählten Rahmenaktualisierungshäufigkeit durch Referenz zu einer Verweistabelle oder einer Daten-Abbildung, die vorkalibrierte Rahmenaktualisierungshäufigkeitswerte als eine Funktion der gemessenen Temperatur aufweist.

7. Verfahren gemäß einem der Ansprüche 1 bis 5, das den Schritt aufweist eines Bestimmens der gewählten Rahmenaktualisierungshäufigkeit in Echtzeit.

8. Verfahren gemäß einem der Ansprüche 1 bis 7, wobei die Flüssigkristallanzeige ein STN(Super Twisted Nematic)-Flüssigkristallmaterial aufweist.

9. Verfahren gemäß einem der Ansprüche 1 bis 8, wobei die Flüssigkristallanzeige in einer GPS(Global Positioning System)-Vorrichtung enthalten ist.

10. Verfahren gemäß einem der Ansprüche 1 bis 8, wobei die Flüssigkristallanzeige in einem Fahrzeug ist.

11. Steuerungseinheit zum Verbessern der Reaktionszeit einer Flüssigkristallanzeige bei einer Temperatur, die niedriger ist als eine vorgegebene Temperatur, wobei die Flüssigkristallanzeige ein Flüssigkristallmaterial aufweist,
wobei die Reaktionszeit der Anzeige die Zeit ist, um zwischen einem Zustand, in dem Licht durch die Vorrichtung übertragen wird, und einem Zustand umzuschalten, in dem kein Licht durch die Vorrichtung übertragen wird, oder umgekehrt, wobei die Vorrichtung für jede Rahmenaktualisierung aufweist:

Mittel zum Messen der Temperatur des Flüssigkristallmaterials;
Mittel zum Anlegen einer Ansteuerspannung (22, 24) auf das Flüssigkristallmaterial bei einer gewählten Rahmenaktualisierungshäufigkeit, so dass das Flüssigkristallmaterial ein Bild anzeigen kann, wobei das Mittel, bei normalem Betrieb, die Verwendung einer Bias-Spannung zum Erzeugen des Ansteuersignals erfordert;
gekennzeichnet durch:

Mittel zum Vergleichen der gemessenen Temperatur mit einer vorgegebenen Temperatur und zum Auswählen der Rahmenaktualisierungshäufigkeit abhängig von dem Ergebnis des Vergleichs,

wobei, wenn die gemessene Temperatur niedriger ist als die vorgegebene Temperatur, das Mittel zum Vergleichen und Auswählen ausgebildet ist, eine Kaltstart-Zeitdauer zu bestimmen, die von der gemessenen Temperatur abhängig ist und für die eine negative Bias-Spannung an das Flüssigkristallmaterial angelegt wird; und
Mittel zum Anlegen einer negativen Bias-Spannung an das Flüssigkristallmaterial während der Dauer der Kaltstart-Zeitdauer,
wobei die negative Bias-Spannung, die an das Flüssigkristallmaterial angelegt wird, größer ist als die normale Bias-Spannung, die zum Betrieb der Flüssigkristallanzeige erforderlich ist.

12. Steuerungseinheit gemäß Anspruch 11, die Mittel aufweist zum weiteren Anwenden eines Erwärmen-Effekts (14) auf das Flüssigkristallmaterial, wenn die Temperatur des Flüssigkristallmaterials unter die vorgegebene Temperatur fällt.

13. Steuerungseinheit gemäß Anspruch 11, die Mittel aufweist zum Bestimmen der gewählten Rahmenaktualisierungshäufigkeit durch Referenz zu einer Verweistabelle oder einer Daten-Abbildung, die vorkalibrierte Rahmenaktualisierungshäufigkeitswerte als eine Funktion der gemessenen Temperatur aufweist.

Revendications

1. Procédé pour améliorer le temps de réponse d'un affichage à cristaux liquides à une température qui est inférieure à une température prédéterminée, l'affichage à cristaux liquides comprenant un matériau formant cristaux liquides, le temps de réponse de l'affichage étant le temps pris pour commuter entre un état dans lequel la lumière est transmise à travers le dispositif et un état dans lequel la lumière n'est pas transmise à travers le dispositif ou vice versa, le procédé comprenant les étapes consistant à, pour chaque rafraîchissement de trame :

mesurer la température du matériau formant cristaux liquides ;
générer une tension de pilotage nécessitant l'utilisation d'une tension de polarisation normale ;
appliquer ladite tension de pilotage pendant le fonctionnement normal au matériau formant cristaux liquides à une fréquence de rafraîchissement de trame choisie de manière à afficher une image ;

caractérisé par les étapes consistant à :

comparer la température mesurée à la température prédéterminée (38) et choisir la fréquence de rafraîchissement de trame en dépendance du résultat de ladite comparaison,
dans lequel, si la température mesurée est inférieure à la température prédéterminée, ladite étape de choix de la fréquence de rafraîchissement de trame comprend la détermination d'une période temporelle de "démarrage à froid" (cold kick) (42), qui dépend de la température mesurée et pour laquelle une tension de polarisation négative est appliquée de part et d'autre du matériau formant cristaux liquides, et
appliquer une tension de polarisation négative

(44) de part et d'autre du matériau formant cristaux liquides pendant la durée de la période temporelle de "démarrage à froid",
dans lequel la tension de polarisation négative appliquée de part et d'autre du matériau formant cristaux liquides présente une amplitude plus forte que la tension de polarisation normale requise pour le fonctionnement de l'affichage à cristaux liquides.

2. Procédé selon la revendication 1, dans lequel la tension de polarisation négative est dérivée d'une source de tension associée à l'affichage à cristaux liquides, le procédé comprenant l'étape consistant à appliquer une tension de polarisation négative maximum susceptible d'être dérivée de la source de tension pendant la durée de la période temporelle de "démarrage à froid".

3. Procédé selon la revendication 2, comprenant l'étape consistant à appliquer une tension de polarisation négative d'environ - 13,5 V.

4. Procédé selon l'une quelconque des revendications 1 à 3, comprenant en outre l'étape consistant à appliquer un effet de chauffage sur le matériau formant cristaux liquides si la température du matériau formant cristaux liquides tombe au-dessous de la température prédéterminée.

5. Procédé selon l'une quelconque des revendications 1 à 4, dans lequel la température prédéterminée est entre 0°C et -25°C.

6. Procédé selon l'une quelconque des revendications 1 à 5, comprenant l'étape consistant à déterminer la fréquence de rafraîchissement de trame choisie par référence à une table de lecture ou à une carte de données comprenant des valeurs de fréquence de rafraîchissement de trame préalablement calibrées en fonction de la température mesurée.

7. Procédé selon l'une quelconque des revendications 1 à 5, comprenant l'étape consistant à déterminer la fréquence de rafraîchissement de trame choisie en temps réel.

8. Procédé selon l'une quelconque des revendications 1 à 7, dans lequel l'affichage à cristaux liquides comprend un matériau formant cristaux liquides nématique à matrice passive dit "super twisted".

9. Procédé selon l'une quelconque des revendications 1 à 8, dans lequel l'affichage à cristaux liquides est compris dans un appareil GPS (Global Positioning System).

10. Procédé selon l'une quelconque des revendications 1 à 8, dans lequel l'affichage à cristaux liquides se trouve dans un véhicule.

11. Unité de commande pour améliorer le temps de réponse d'un affichage à cristaux liquides à une température qui est inférieure à une température prédéterminée, l'affichage à cristaux liquides ayant un matériau formant cristaux liquides, le temps de réponse de l'affichage étant le temps pris pour commuter entre un état dans lequel la lumière est transmise à travers le dispositif et un état dans lequel la lumière n'est pas transmise à travers le dispositif ou vice versa, le dispositif comprenant, pour chaque rafraîchissement de trame :

des moyens pour mesurer la température du matériau formant cristaux liquides ;
des moyens pour appliquer une tension pilote (22, 24) au matériau formant cristaux liquides à une fréquence de rafraîchissement de trame choisie de telle sorte que le matériau formant cristaux liquides peut afficher une image, lesdits moyens nécessitant, en fonctionnement normal, l'utilisation d'une tension de polarisation pour générer lesdits signaux pilotes ;
caractérisée par
des moyens pour comparer la température mesurée avec une température prédéterminée et pour choisir la fréquence de rafraîchissement de trame en dépendance du résultat de ladite comparaison, dans laquelle, si la température mesurée est inférieure à la température prédéterminée, lesdits moyens de comparaison et de choix sont agencés pour déterminer une période temporelle "de démarrage" (cold kick) qui dépend de la température mesurée et pendant laquelle une tension de polarisation négative est appliquée de part et d'autre du matériau formant cristaux liquides ; et
des moyens pour appliquer une tension de polarisation négative de part et d'autre du matériau formant cristaux liquides pendant la durée de la période temporelle "de démarrage à froid",
dans laquelle la tension de polarisation négative appliquée de part et d'autre du matériau formant cristaux liquides présente une amplitude plus forte que la tension de polarisation normale pour le fonctionnement de l'affichage à cristaux liquides.

12. Unité de commande selon la revendication 11, comprenant des moyens pour appliquer en outre un effet de chauffage (14) au matériau formant cristaux liquides si la température du matériau formant cristaux liquides tombe au-dessous de la température prédéterminée.

13. Unité de commande selon la revendication 11, com-

prenant des moyens pour déterminer la fréquence de rafraîchissement de trame choisie par référence à une table de lecture ou à une carte de données comprenant des valeurs de fréquence de rafraîchissement de trame préalablement calibrées en fonction de la température mesurée.

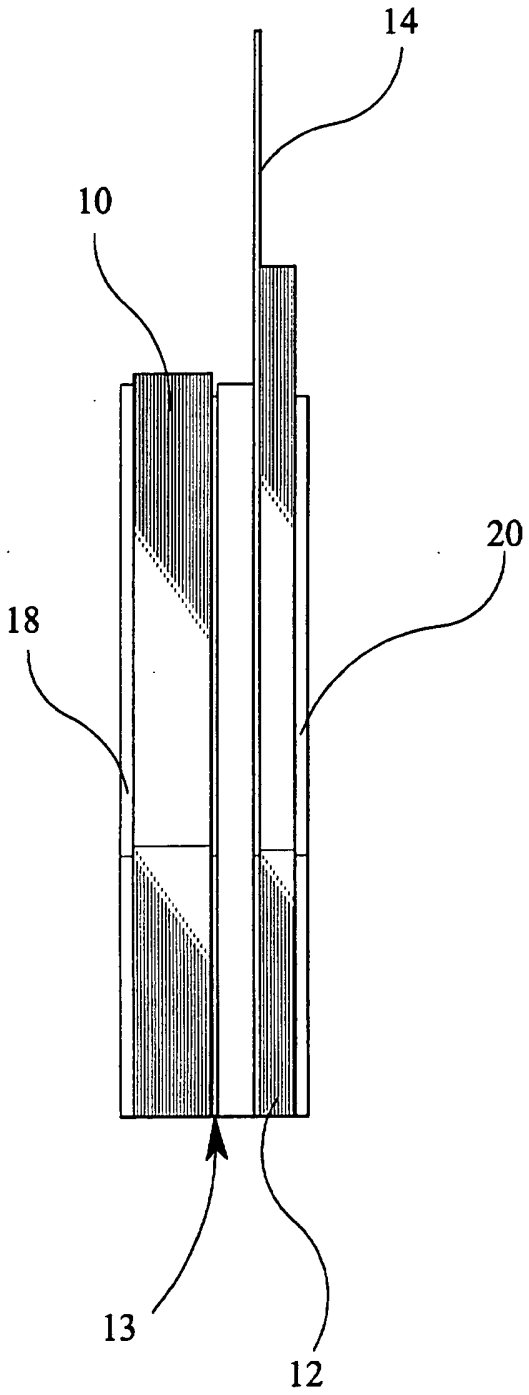


FIG 1

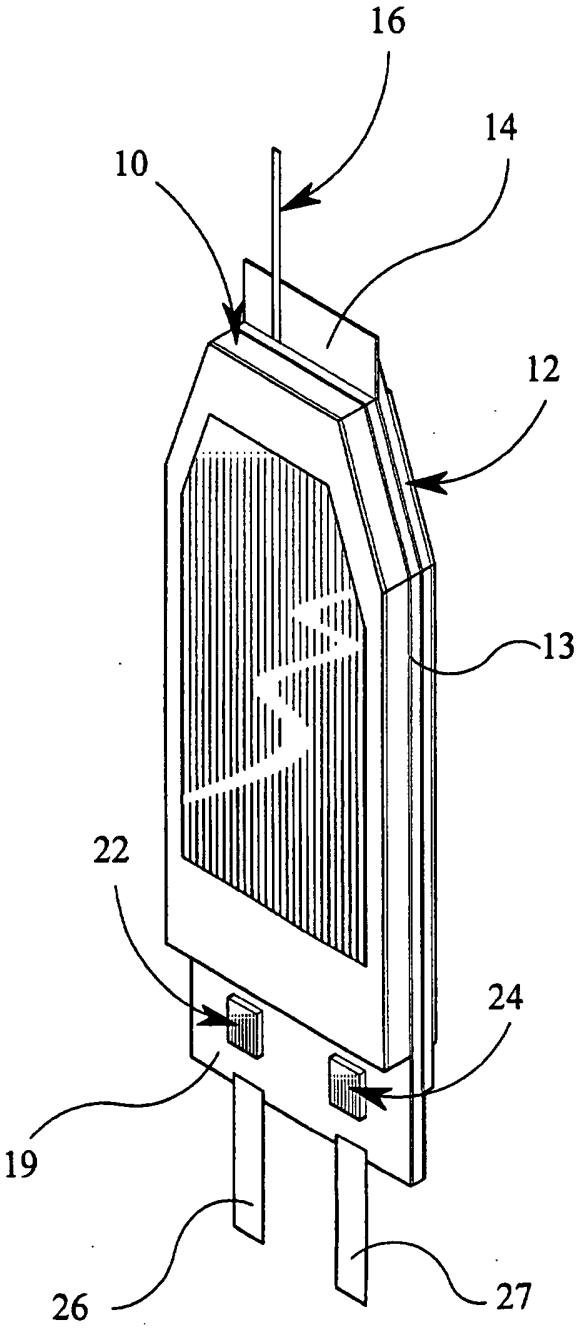


FIG 2

FIG 3

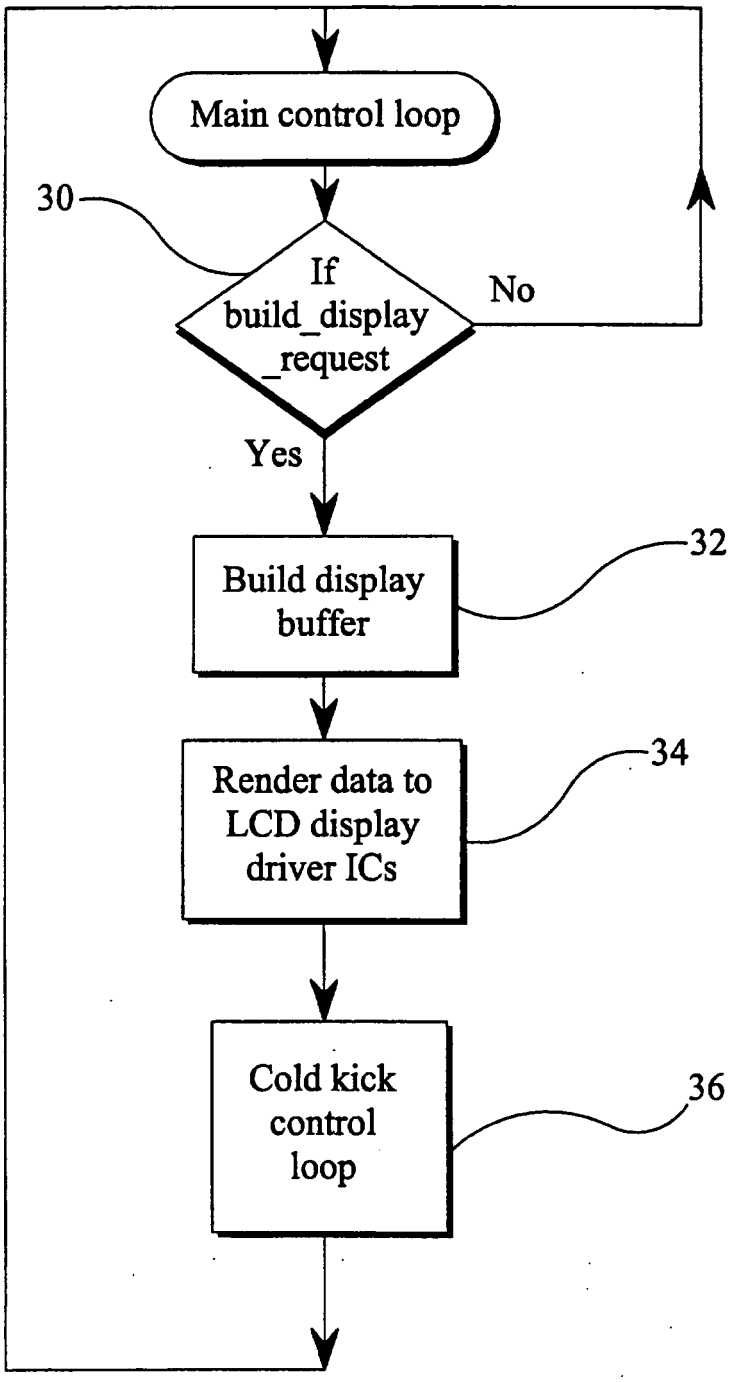
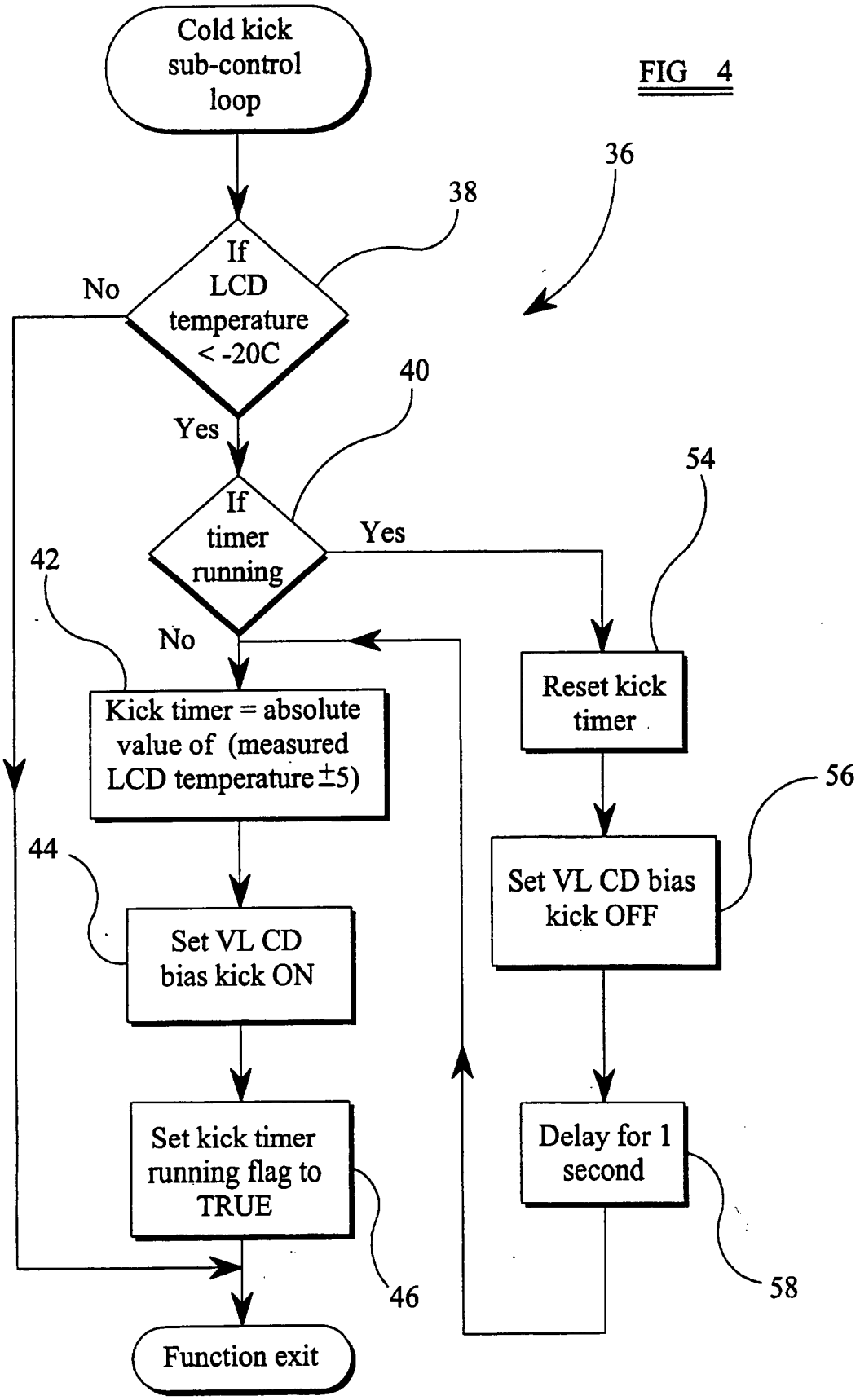

Main control loop
30
If build_display _request
No
Yes
Build display buffer
32
Render data to LCD display driver ICs
34
Cold kick control loop
36

FIG 4


Cold kick sub-control loop
36
38
If LCD temperature < -20C
No
Yes
40
If timer running
Yes
54
42
No
Kick timer = absolute value of (measured LCD temperature ±5)
Reset kick timer
56
44
Set VL CD bias kick OFF
Set VL CD bias kick ON
Set kick timer running flag to TRUE
Delay for 1 second
46
58
Function exit

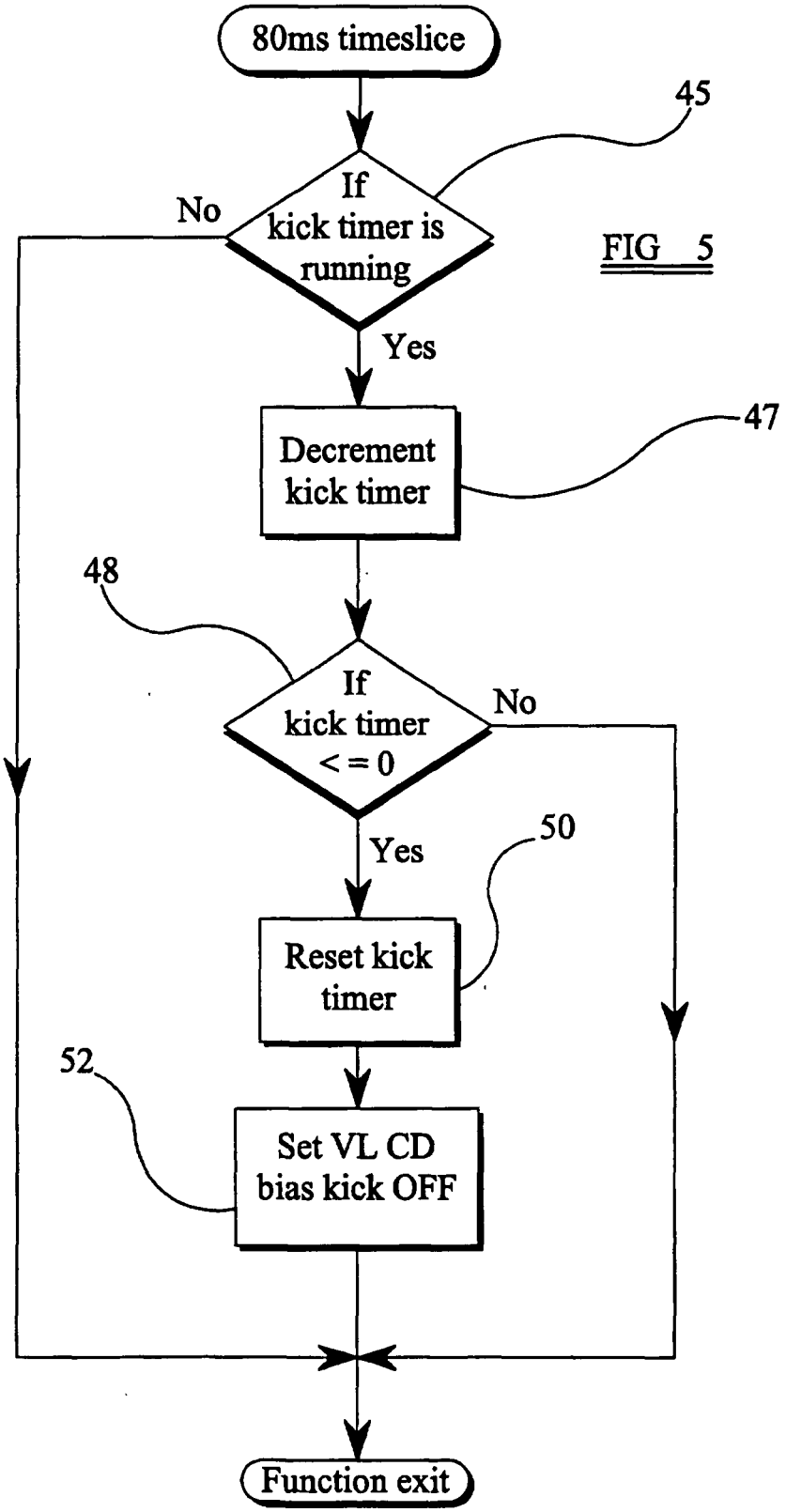

80ms timeslice
45
If kick timer is running
No
Yes
47
Decrement kick timer
48
If kick timer <= 0
No
Yes
50
Reset kick timer
52
Set VL CD bias kick OFF
Function exit

FIG 5

FIG 6

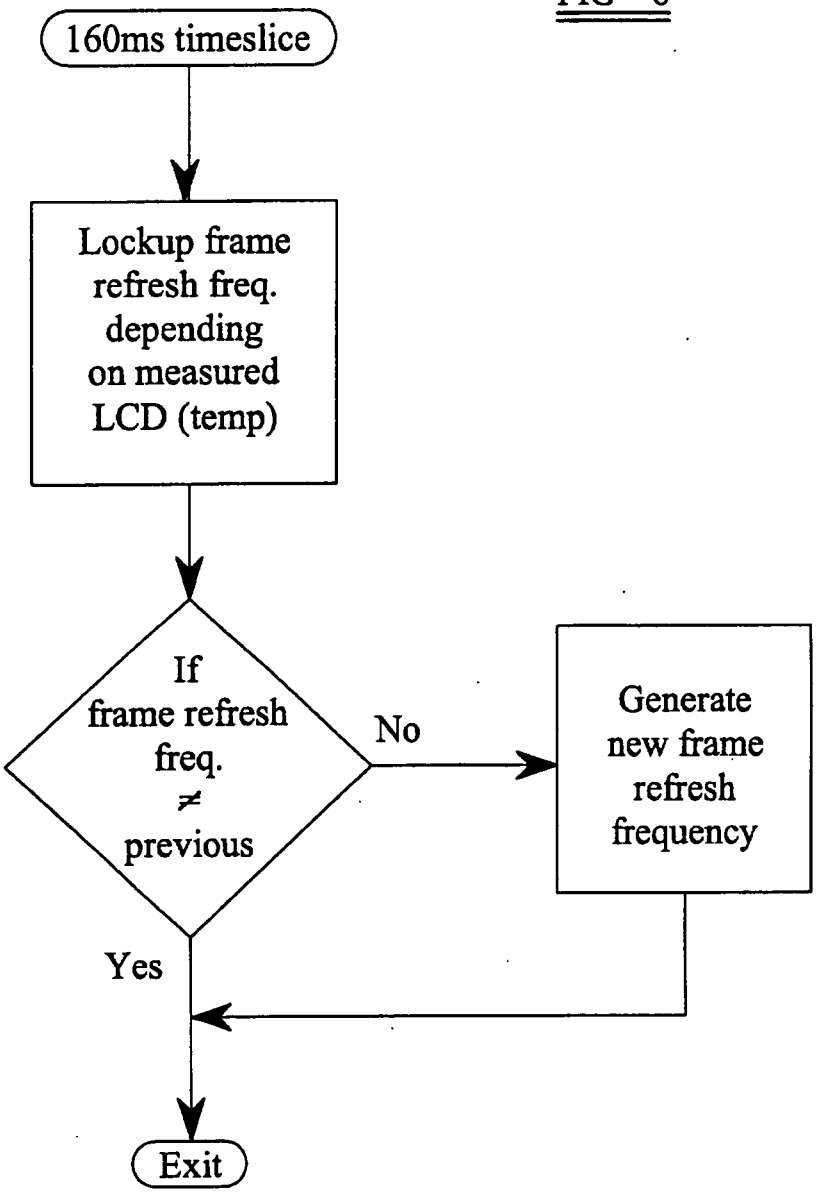
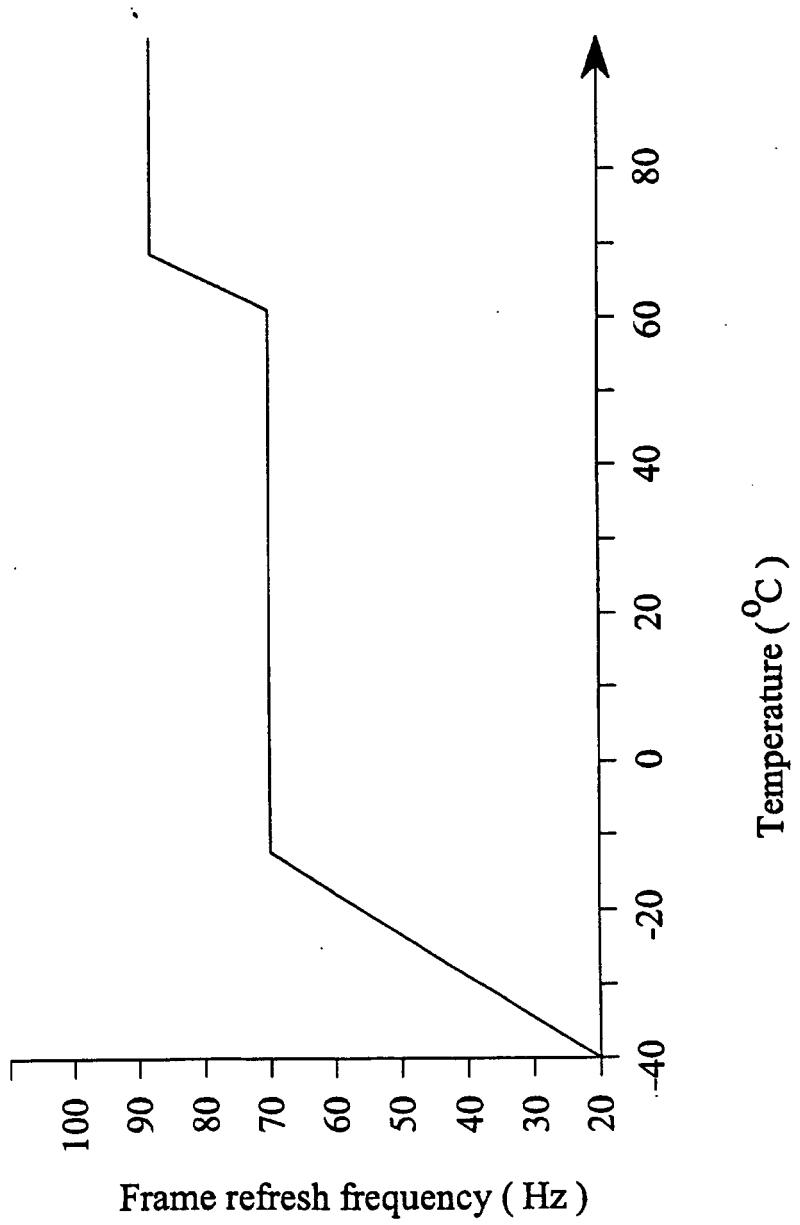

160ms timeslice
Lockup frame refresh freq. depending on measured LCD (temp)
If frame refresh freq. ≠ previous
No
Generate new frame refresh frequency
Yes
Exit

FIG 7


100
90
80
70
60
50
40
30
20
Frame refresh frequency (Hz)
-40
-20
0
20
40
60
80
Temperature (°C)

REFERENCES CITED IN THE DESCRIPTION

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