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(54) **Mixed Monochrome and Colour Display Driving Technique**

Steuertechnik für eine gemischtfarbige und monochromatische Anzeige

Technique de commande pour affichage mixte couleur et monochrome

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Description

[0001] The present invention relates to the field of liquid crystal display and, particularly, to the field of multi-mode operation of a liquid crystal display screen.

[0002] The use of high resolution displays combined with high refresh rates to provide a video/animation/graphical user experience can significantly increase the load on a handheld's power system. The current result is that end-users are able to enjoy a highly graphical experience at the expense of reduced battery life and/or increased battery mass and size. High resolution displays with high refresh rates are susceptible to substantial power losses due to switching inefficiencies associated with driving many pixels on a display at high frequency. For example, 80-90% of power requirements of a field-sequential display, excluding backlight illumination, are related to switching losses associated when the screen is refreshed at a rate such as 2500 Hz. Field-sequential display switching power losses are 5 to 10 times greater than the power losses in conventional liquid crystal displays based on colour filters.

[0003] US2003/0063077 discloses an Organic Light Emitting Diode ("OLED") based display system that can operate at low power consumption. The device can display gray scale images by quantizing grays into discrete levels and associating each level with a binary number. The gray level to be displayed at each pixel is thus stored in memory as a binary number and transferred to the display using a parallel mechanism. The device can reduce power consumption by reducing the number of bits associated with gray scale images. The display comprises an emissive display based on OLEDs.

[0004] WO/019198 which corresponds to US2004/0140972 discloses an LCD display capable of alternating between a transmissive mode and a reflective mode. The device performs as a transmissive display by field sequential driving, resulting in a multi-gradation colour display, and as a reflective display by frame driving, resulting in a black and white display. The field sequential driving is performed by displaying each of the three primary colors in sequence. Accordingly, each pixel must be scanned at least three times to complete its display.

[0005] EP0852371 discloses a method for constructing high resolution displays to overcome the problem of high rewriting speeds.

[0006] EP11148468 discloses how to reduce electric power consumption by a LCD device which includes colour filters.

[0007] US2004/0027364 discloses a display device in which a display mode of the device can be switched between a full screen mode and a partial display mode. In the partial display mode an image is only partially displayed in the display area but is not displayed in a background display area of the partial display mode.

[0008] Thus, it would be desirable to reduce the switching power loss in a liquid crystal display. Also, to provide greater versatility for the user in a video/animation/graphical environment, it would be desirable to provide different viewing modes simultaneously on the display screen.

SUMMARY

[0009] This invention addresses the problem of reducing the switching losses and, therefore, power requirements of a display while maintaining or increasing visual quality.

[0010] In one main aspect, the present invention provides a method for generating a frame of an image on an LCD screen of a handheld wireless communication device having a plurality of light-sources, said method comprising the steps of: scanning a first region of contiguous lines of field sequentially driven liquid crystal pixels to produce a colour region on the LCD screen, using a source driver and a gate driver driven at a first frequency; scanning a second region of contiguous lines of field sequentially driven liquid crystal pixels to produce a monochrome region on the LCD screen, using said source driver and said gate driver driven at a second frequency less than said first frequency, wherein said colour region is produced by scanning, in said frame, said first region a first number of times; and wherein said monochrome region is produced by scanning said second region a second number of times such that said first number of times is N times said second number of times, such that switching power of pixels in said monochrome region is less than switching power of pixels in said colour region; and activating said light sources during a portion of said frame. wherein the number of pixel lines and the starting pixel line of the monochrome and colour regions are allocated depending on the data being displayed. Switching losses associated with refreshing the screen at high rates can be reduced if the active area of the display can be categorized into regions such that each region can be electrically driven differently.

[0011] In cases where the active area of a display can be categorized into regions, this invention reduces switching losses by driving pixels in each region by an algorithm that minimizes power consumption while maintaining optical performance appropriate to the region's category. In this way, dynamic, high-power, high-refresh requirements can be isolated to regions containing colour or video, while low power, low refresh rates are applied to regions containing static "black and white" or monochrome text.

[0012] In the case of field-sequential displays, the active area may be categorized into different regions, such as colour and monochrome regions. Therefore, images containing both types of regions can be driven in "Partial Colour Mode." The regions may be of different bit colour depths and different refresh rates.

[0013] Normally, the field-sequential display is updated at 2500 Hz and regions driven at this rate are capable of full colour video at 83 Hz. This dynamic, full colour capability, however, is not required to display monochrome text. In monochrome regions, the refresh rate

can be safely reduced to 250 Hz (possibly 55 Hz) without loss in visual quality. In fact, visual quality may be improved if the driving waveforms are optimized to improve contrast in monochrome regions to benefit the display of data such as text.

[0014] The use of different driving schemes allows total power consumption to be reduced depending on the data being displayed while maintaining visual quality. In the case of field-sequential display, the switching losses are decreased by a factor of 10 within monochrome regions and overall power savings are proportional to the percentage of the active area categorized as monochrome. Up to 90% of switching losses can be eliminated by operating in "Partial Colour Mode" if the monochrome region occupies the entire display to yield a display device with power consumption similar to displays that use colour filters.

[0015] Partial Colour Mode can be implemented by a gate driver and controller to allow certain gate lines to be activated less frequently to reduce the refresh rate on the associated portions of the display.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] Embodiments of present invention will now be described by way of example with reference to attached figures, wherein:

FIG. 1 is a block diagram that illustrates pertinent components of a wireless communications device that communicates within a wireless communication network according to the present invention;
FIG. 2 is a more detailed diagram of a preferred wireless communications device of FIG. 1 according to the present invention;
FIG. 3 illustrates an embodiment of a backlit liquid crystal display of the present invention;
FIG. 4 illustrates an embodiment of the liquid crystal display and liquid crystal display controller of the present invention;
FIG. 5 illustrates a flow chart of a method of the present invention;
FIG. 6 illustrates an exemplary division of a display screen in accordance with the present invention;
FIG. 7 illustrates a block diagram of an LCD and LCD controller of an embodiment;
FIG. 8 illustrates a timing scheme for the light source and the display scans;
FIG. 9 illustrates an embodiment of the relative timing between the light source and the LCD;
FIG. 10 illustrates an alternate embodiment of the relative timing between the light source and the LCD;
FIG. 11 illustrates a specific embodiment with optional off regions;
FIG. 12 illustrates an embodiment of a section of the gate line driver;
FIG. 13 illustrates a flow chart for scanning the specific embodiment of FIG. 11;
FIG. 14 illustrates a general overview of the method of Figure 13; and
FIG. 15 illustrates further detail of an embodiment of the scanning for one colour within one frame.

DETAILED DESCRIPTION

[0017] The present invention relates to a method and device, especially a mobile station such as a handheld communications device, that practices the method for reducing power switching losses in a display. Preferably, the display is a liquid crystal display and the light source includes light emitting diodes (LEDs) of different colours. The liquid crystal display may be operated at a rate of 30 or more frames per second. The LCD controller provides a train of pulses during each frame that may be varied in number or length or both. The number of pulses or pulse width of a single pulse may be used to vary the grey scale of a pixel. The LEDs of the light source preferably will include red, green, and blue colours. Other colour schemes, such as cyan, magenta, and yellow, are contemplated by the present invention. The present invention may be implemented by adapting the LCD controller to drive the gate lines differently in a frame. Although the present invention is directed to a liquid crystal display per se, the preferred use of the LCD is in a mobile station.

[0018] FIG. 1 is a block diagram of a communication system 100 that includes a mobile station 102 that communicates through a wireless communication network. Mobile station 102 preferably includes a visual display 112, a keyboard 114, and perhaps one or more auxiliary user interfaces (UI) 116, each of which is coupled to a controller 106. Controller 106 is also coupled to radio frequency (RF) transceiver circuitry 108 and an antenna 110.

[0019] Typically, controller 106 is embodied as a central processing unit (CPU) which runs operating system software in a memory component (not shown). Controller 106 will normally control overall operation of mobile station 102, whereas signal processing operations associated with communication functions are typically performed in RF transceiver circuitry 108. Controller 106 interfaces with device display 112 to display received information, stored information, user inputs, and the like. Keyboard 114, which may be a telephone type keypad or full alphanumeric keyboard, is normally provided for entering data for storage in mobile station 102, information for transmission to network, a telephone number to place a telephone call, commands to be executed on mobile station 102, and possibly other or different user inputs.

[0020] Mobile station 102 sends communication signals to and receives communication signals from the wireless network over a wireless link via antenna 110. RF transceiver circuitry 108 performs functions similar to those of a base station and a base station controller (BSC) (not shown), including for example modulation/demodulation and possibly encoding/decoding and encryp-

tion/decryption. It is also contemplated that RF transceiver circuitry 108 may perform certain functions in addition to those performed by a BSC. It will be apparent to those skilled in art that RF transceiver circuitry 108 will be adapted to particular wireless network or networks in which mobile station 102 is intended to operate.

[0021] Mobile station 102 includes a battery interface (IF) 134 for receiving one or more rechargeable batteries 132. Battery 132 provides electrical power to electrical circuitry in mobile station 102, and battery IF 132 provides for a mechanical and electrical connection for battery 132. Battery IF 132 is coupled to a regulator 136 which regulates power to the device. When mobile station 102 is fully operational, an RF transmitter of RF transceiver circuitry 108 is typically keyed or turned on only when it is sending to network, and is otherwise turned off to conserve resources. Similarly, an RF receiver of RF transceiver circuitry 108 is typically periodically turned off to conserve power until it is needed to receive signals or information (if at all) during designated time periods.

[0022] Mobile station 102 operates using a Subscriber Identity Module (SIM) 140 which is connected to or inserted in mobile station 102 at a SIM interface (IF) 142. SIM 140 is one type of a conventional "smart card" used to identify an end user (or subscriber) of mobile station 102 and to personalize the device, among other things. Without SIM 140, the mobile station terminal is not fully operational for communication through the wireless network. By inserting SIM 140 into mobile station 102, an end user can have access to any and all of his/her subscribed services. SIM 140 generally includes a processor and memory for storing information. Since SIM 140 is coupled to SIM IF 142, it is coupled to controller 106 through communication lines 144. In order to identify the subscriber, SIM 140 contains some user parameters such as an International Mobile Subscriber Identity (IMSI). An advantage of using SIM 140 is that end users are not necessarily bound by any single physical mobile station. SIM 140 may store additional user information for the mobile station as well, including datebook (or calendar) information and recent call information.

[0023] Mobile station 102 may consist of a single unit, such as a data communication device, a multiple-function communication device with data and voice communication capabilities, a personal digital assistant (PDA) enabled for wireless communication, or a computer incorporating an internal modem. Alternatively, mobile station 102 may be a multiple-module unit comprising a plurality of separate components, including but in no way limited to a computer or other device connected to a wireless modem. In particular, for example, in the mobile station block diagram of FIG. 1, RF transceiver circuitry 108 and antenna 110 may be implemented as a radio modem unit that may be inserted into a port on a laptop computer. In this case, the laptop computer would include display 112, keyboard 114, one or more auxiliary UIs 116, and controller 106 embodied as the computer's CPU. It is also contemplated that a computer or other equipment not normally capable of wireless communication may be adapted to connect to and effectively assume control of RF transceiver circuitry 108 and antenna 110 of a single-unit device such as one of those described above. Such a mobile station 102 may have a more particular implementation as described later in relation to mobile station 202 of FIG. 2.

[0024] FIG. 2 is a detailed block diagram of a preferred mobile station 202. Mobile station 202 is preferably a two-way communication device having at least voice and advanced data communication capabilities, including the capability to communicate with other computer systems. Depending on the functionality provided by mobile station 202, it may be referred to as a data messaging device, a two-way pager, a cellular telephone with data messaging capabilities, a wireless Internet appliance, or a data communication device (with or without telephony capabilities). Mobile station 202 may communicate with any one of a plurality of fixed transceiver stations 200 within its geographic coverage area.

[0025] Mobile station 202 will normally incorporate a communication subsystem 211, which includes a receiver, a transmitter, and associated components, such as one or more (preferably embedded or internal) antenna elements and, local oscillators (LOs), and a processing module such as a digital signal processor (DSP) (all not shown). Communication subsystem 211 is analogous to RF transceiver circuitry 108 and antenna 110 shown in FIG. 1. As will be apparent to those skilled in field of communications, particular design of communication subsystem 211 depends on the communication network in which mobile station 202 is intended to operate.

[0026] Network access is associated with a subscriber or user of mobile station 202 and therefore mobile station 202 requires a Subscriber Identity Module or "SIM" card 262 to be inserted in a SIM IF 264 in order to operate in the network. SIM 262 includes those features described in relation to FIG. 1. Mobile station 202 is a battery-powered device so it also includes a battery IF 254 for receiving one or more rechargeable batteries 256. Such a battery 256 provides electrical power to most if not all electrical circuitry in mobile station 202, and battery IF 254 provides for a mechanical and electrical connection for it. The battery IF 254 is coupled to a regulator (not shown) which provides power V+ to all of the circuitry.

[0027] Mobile station 202 includes a microprocessor 238 (which is one implementation of controller 106 of FIG. 1) which controls overall operation of mobile station 202. Communication functions, including at least data and voice communications, are performed through communication subsystem 211. Microprocessor 238 also interacts with additional device subsystems such as a display 222, a flash memory 224, a random access memory (RAM) 226, auxiliary input/output (I/O) subsystems 228, a serial port 230, a keyboard 232, a speaker 234, a microphone 236, a short-range communications subsystem 240, and any other device subsystems generally designated at 242. Some of the subsystems shown in

FIG. 2 perform communication-related functions, whereas other subsystems may provide "resident" or on-device functions. Notably, some subsystems, such as keyboard 232 and display 222, for example, may be used for both communication-related functions, such as entering a text message for transmission over a communication network, and device-resident functions such as a calculator or task list. Operating system software used by microprocessor 238 is preferably stored in a persistent store such as flash memory 224, which may alternatively be a read-only memory (ROM) or similar storage element (not shown). Those skilled in the art will appreciate that the operating system, specific device applications, or parts thereof, may be temporarily loaded into a volatile store such as RAM 226.

[0028] Microprocessor 238, in addition to its operating system functions, preferably enables execution of software applications on mobile station 202. A predetermined set of applications which control basic device operations, including at least data and voice communication applications, will normally be installed on mobile station 202 during its manufacture. A preferred application that may be loaded onto mobile station 202 may be a personal information manager (PIM) application having the ability to organize and manage data items relating to the user such as, but not limited to, instant messaging (IM), e-mail, calendar events, voice mails, appointments, and task items. Naturally, one or more memory stores are available on mobile station 202 and SIM 262 to facilitate storage of PIM data items and other information.

[0029] The PIM application preferably has the ability to send and receive data items via the wireless network. In a preferred embodiment, PIM data items are seamlessly integrated, synchronized, and updated via the wireless network, with the mobile station user's corresponding data items stored and/or associated with a host computer system thereby creating a mirrored host computer on mobile station 202 with respect to such items. This is especially advantageous where the host computer system is the mobile station user's office computer system. Additional applications may also be loaded onto mobile station 202 through network 200, an auxiliary I/O subsystem 228, serial port 230, short-range communications subsystem 240, or any other suitable subsystem 242, and installed by a user in RAM 226 or preferably a non-volatile store (not shown) for execution by microprocessor 238. Such flexibility in application installation increases the functionality of mobile station 202 and may provide enhanced on-device functions, communication-related functions, or both. For example, secure communication applications may enable electronic commerce functions and other such financial transactions to be performed using mobile station 202.

[0030] In a data communication mode, a received signal such as a text message, an e-mail message, or web page download will be processed by communication subsystem 211 and input to microprocessor 238. Microprocessor 238 will preferably further process the signal for output to display 222, to auxiliary I/O device 228 or both as described further herein below with reference to Figures 3-7. A user of mobile station 202 may also compose data items, such as e-mail messages, for example, using keyboard 232 in conjunction with display 222 and possibly auxiliary I/O device 228. Keyboard 232 is preferably a complete alphanumeric keyboard and/or telephone-type keypad. These composed items may be transmitted over a communication network through communication subsystem 211.

[0031] For voice communications, the overall operation of mobile station 202 is substantially similar, except that the received signals would be output to speaker 234 and signals for transmission would be generated by microphone 236. Alternative voice or audio I/O subsystems, such as a voice message recording subsystem, may also be implemented on mobile station 202. Although voice or audio signal output is preferably accomplished primarily through speaker 234, display 222 may also be used to provide an indication of the identity of a calling party, duration of a voice call, or other voice call related information, as some examples.

[0032] Serial port 230 in FIG. 2 is normally implemented in a personal digital assistant (PDA)-type communication device for which synchronization with a user's desktop computer is a desirable, albeit optional, component. Serial port 230 enables a user to set preferences through an external device or software application and extends the capabilities of mobile station 202 by providing for information or software downloads to mobile station 202 other than through a wireless communication network. The alternate download path may, for example, be used to load an encryption key onto mobile station 202 through a direct and thus reliable and trusted connection to thereby provide secure device communication.

[0033] Short-range communications subsystem 240 of FIG. 2 is an additional optional component which provides for communication between mobile station 202 and different systems or devices, which need not necessarily be similar devices. For example, subsystem 240 may include an infrared device and associated circuits and components, or a Bluetooth™ communication module to provide for communication with similarly-enabled systems and devices. Bluetooth™ is a registered trademark of Bluetooth SIG, Inc.

[0034] In accordance with an embodiment of the invention, mobile station 202 is a multitasking handheld wireless communications device configured for sending and receiving data items and for making and receiving voice calls. To provide a user-friendly environment to control the operation of mobile station 202, an operating system resident on station 202 (not shown) provides a GUI having a main screen and a plurality of sub-screens navigable from the main screen.

[0035] The liquid crystal display cell 222 is shown in greater detail in Figure 3 in which a light source formed from multiple LEDs 322, 324, 326 is used as a backlight. LCD controller 316 provides a voltage to the common

electrode(s) 308 and the active elements 310 of the active matrix. The active elements are preferably thin film transistors. The common electrode(s) 308 and active elements are supported on substrates 306 and 312, respectively. The LCD preferably contains a brightness enhancing film or layer 304 to optimize the distribution of light for a viewer. As the preferred liquid crystal material is super twisted nematic, polarizers 302 and 314 are used. The LCD controller 316 sets the pixel grey scale of the LCD. An optional processor 318 may coordinate synchronization of the LCD controller 316 with the light source controller 320. Preferably, the LCD controller 316 and the processor 318 are integrated into a single device 317, which may simply be referred to as an LCD controller having the capability of controlling a light source controller 320. The light source may be implemented by using red, green, and blue LEDs 322, 324, 326. In a specific embodiment, four green, four red, and two blue LEDs are used to provide full colour and/or black and white display. The LED controller 320 may sequence the three colours or may simultaneously energized LEDs of all of the colours and terminate power to the LEDs simultaneously. Other combinations of LEDs are contemplated by the present invention. The light guide 328 may have a tapered block construction and may have approximately a trapezoidal form to more evenly distribute the light into the LCD. The light guide may also have uneven areas 330, 332 that scatter the light so as to avoid shadowing effects in the LCD image. Although uneven area 330 is shown to project out from the surface of the light guide 328 and uneven area 332 is shown to project inward to the surface of the light guide 328, the uneven areas may be arranged differently so long as the arrangement effectively scatters the light from the LEDs 322, 324, 326. The uneven areas may be abraded, molded, corrugated, chemically etched, or the like. Preferably, to maximize the utilization of light, the LEDs 322, 324, 326 and the light guide 328 are partially enclosed by a reflector such that the only opening is fully bounded by the light transmissive area of the LCD.

[0036] Figure 4 illustrates an embodiment of the LCD controller 402 and LCD 430 for the method of the present invention. The LED controller may be internally adapted to provide a sequence of lights each centered on a specific wavelength according to the LEDs energized, followed by light generated simultaneously from all LEDs or at least two LEDs generating light centered on two different wavelengths. In Figure 4, in synchronization with the LED controller, the LCD controller 402 creates a grey scale pattern for each light centred on a specific wavelength according to column driver 410 (source driver) and row selectors 412-422 (gate driver) in a X-Y matrix arrangement. For a red light pattern, only pixels selectable by the column driver 410 may be set to a transmissive state to provide a desired pattern. Pixels that do not have a red component of light are turned off. For green and blue light patterns, similar procedures are followed. When all red, green, and blue colours are transmitted through a given pixel, that pixel may have a white or whitish appearance because of the blending of the three primary colours perceived by a viewer. Advantages in using the light source to determine colours include elimination of a colour filter layer, thus enhancing brightness of the display by reducing a light absorbing layer, and increasing the resolution as only one pixel is needed to provide full colour instead of separate red, green, and blue pixels. The size of a pixel is allowed to increase while resolution is improved; in other words, using the light source and not the LCD to determine colour optimizes substrate real estate usage.

[0037] The method of the present invention is generally shown in Figure 5. Although this embodiment is directed to the division of the LCD screen into monochrome and colour regions, other schemes are contemplated such as high bit rate colour, low bit rate colour, mono colour, etc. A processor designates certain lines as colour 502 or monochrome 504. Remaining lines are considered to be in an off state 506. If the display screen is operational in a display mode 508, then all colour lines are scanned 510 before any monochrome lines are scanned 512. The reason the colour lines are scanned first is because they have a clocking scheme that is different than the monochrome lines. In other embodiments, monochrome lines may be scanned before colour lines. If the monochrome and/or colour lines are to be changed 514, the new configuration is determined by repeating steps 502-506. Scanning in a colour region involves a first sweep of each line in the region before any of the lines in the colour region are swept a second or successive time.

[0038] Figure 6 illustrates an embodiment of the general display screen in the present invention. The top and bottom regions of the display 602, 612 are turned off. The colouration of the off region is dependent upon the characteristics of the unbiased liquid crystal material and the orientation of any polarizers. In the exemplary division of the display screen, a colour region 604, a monochrome region 606, another colour region 608, and another monochrome region 610 are located between the top and bottom off regions 602, 612. Many other arrangements are clearly possible; however, in the present invention, the display screen is basically divided into horizontal bands that are in one of three modes: colour, monochrome, or off. For example, the display screen may be divided into a monochrome region and an off region, a monochrome region and a colour region, or a colour region and an off region.

[0039] Figure 7 illustrates a block diagram an embodiment of the LCD controller elements and the LCD. The grey level for the pixels is provided through the source driver 704. A memory 712 is used to provide image data. The memory may be volatile, such as random access memory, or non-volatile, such as read only memory. The image data is used to access a bit pattern for providing grey scale or toggling for a pixel through a lookup table. Lookup table A 708 provides a pattern of multiple bits representing or correlating to a grey scale value. Prefer-

ably, the bits in a pattern number at least six and may be eight, ten, twelve, or sixteen in number. Lookup table B 710 provides a single bit or bit sequence representing an on or off state for a pixel in a monochrome region or line on the display screen. Optionally, an off state value may be provided in which the source driver will not bias the liquid crystal display pixel selected by switch (i.e., multiplexer) 706. The gate line driver operates to sweep each of the two types of scannable regions separately. That is, the colour region scan sequence storage element 724 will be accessed and used to scan the designated portions of the display screen 702 before or after the monochrome sequence storage element 726 is accessed for scanning. The monochrome scan sequence storage element 726 is scanned at a rate different than the rate for the colour sequence storage element 724. Switch 722 provides the correct sequence to the gate driver 720, and, optionally during the remaining time, disables the gate for OFF regions.

[0040] Figure 8 illustrates a colour only mode in which either the entire display screen is in colour or the non-colour portion of the display screen is in the off state. In operation, pixel grey scale is achieved through pulses written to a pixel during scanning. Each colour frame 802 is divided into three parts (or fields) 804, 806, 808 for the three colours in full colour mode. Each pixel to be illuminated by a specific colour of light achieves a grey scale value from a pulse pattern into the source of the thin film transistor providing charge to the pixel. The pulse pattern (i.e., colour scans) includes multiple high and/or low pulses for each pixel. One pulse is applied to each colour pixel during a scan of the colour region that includes the colour pixel. During the colour region scan (or sweep) 832, the actual scanning occupies most of the time allotted 830 for a given colour. It is the successive scans of the colour pixels during a frame that establishes a grey scale value. A smaller portion of the time allotted in a scan period is idle time 834. During most of the scan period, the light source is turned off 814. In alternative embodiments, the light source may remain on for most or all of the scan period and/or the actual scanning may occupy a different portion of the time allotted for a given colour. Once the final grey scale value for a row or line of pixels is fairly well established, the light source (e.g., light emitting diode) is turned on 812. In some embodiments, during the light source turn on time, the common electrode of the display is inverted from a first voltage bias level 822 to a second voltage bias level 824 to prevent charge buildup in the liquid crystal that would degrade performance and damage the display. The inversion of the common electrode voltage occurs for each colour for each frame. Thus, for a red, green, and blue pixel LCD, the common electrode voltage is inverted three times. Other inversion modes are contemplated by the present invention such as line inversion and pixel inversion. In line inversion, a given line may be alternately supplied through the source driver with voltages from a first set of a polarity and then supplied with voltages from a second set of a polarity opposite to that of the first set; that is, a non-inverting pair of voltages may be applied and an inverting pair of voltages may later be applied. In pixel inversion, alternate columns may be supplied for each row with voltage sets of opposing polarities.

[0041] The power savings advantage of the present invention arises from the reduction of switching in the monochrome region. Figures 9 and 10 illustrate two embodiments for a single frame of the display having both monochrome and colour regions. In Figure 9, the monochrome scan 916 occurs in which each pixel is activated once. During the monochrome scan, one clock pulse is used to set an on or off value for the monochrome pixels, resulting in less switching power dissipation. Then, the grey scale values are developed 914 by multiple pulses from the gate line driver in which the source driver is loaded with new data during the multiple scans corresponding to a single colour in a field. During most of the scan time, there is no illumination 906. Toward the end of the scan, the light source of the designated colour is turned on 904 while the gate driver becomes idle 912. Figure 10 represents an alternative embodiment in which the monochrome and colour scans 1016, 1014 are the same as in Figure 9, but the light source is operated at lower power for a longer period of time 1004, 1008 with a short LED OFF time 1006.

[0042] Figure 11 represents a more specific embodiment of the present invention in which the display screen is divided into relatively few regions in which pixels are activated by source driver 1102 and gate driver 1104. At the top and bottom of the display screen are off regions 1108, 1116. At the center of the display screen is a monochrome region 1112 between two colour regions 1110, 1114. Two output shift registers (e.g., serial in/ parallel out shift registers) A, B, as illustrated in Figure 12, are used for scanning the two colour regions. Shift register A 1210 and shift register B 1208 contain initialization values for the gate shift register of regions A and B, respectively. They preferably contain a one-hot encoding of the starting line number of their respective regions. (As used in an embodiment of the invention, one-hot encoding refers to a single active bit that is shifted through the shift register such that only one line at a time of pixels is written to from the source driver.) First shift register A 1210 is loaded and then used to sweep the first colour region once, then shift register B 1208 is loaded and then used to sweep the second colour region once. The shift registers alternate until the number of scans in that frame have all been completed. During the colour regions scan time, the clock rate COLOUR LINE CLOCK is relatively high. For example, a 10 MHz clock may be used. After the colour regions are scanned, the monochrome region is scanned using a slower clock MONO LINE CLOCK to enter a binary value into the pixel to cause the pixel to be on or off. A switch 1228 may be used to transfer either COLOUR LINE CLOCK or MONO LINE CLOCK to storage elements 1218, 1226 according to the region by the REGION SELECT signal in FIG. 7. The storage elements

1218, 1226 may be latches that latch data on the rising or falling edges of a clock, D type flip flops, or the like. Counters 1202-1206 are used to hold the number of lines in each region. In an alternate embodiment, each colour region is scanned multiple times before any other colour region is scanned. In another embodiment, the monochrome region(s) is scanned before the colour region(s) is scanned.

[0043] Figure 14 illustrates an overview of the embodiment of a method of the present invention corresponding to the display scanning system of Figure 12. In the general method, initialization occurs 1404 (e.g., registers are initialized) and the three colour fields are cycled through 1406-1410 through successive scans during a frame. Mono regions may be updated during all, some, or a single one of the colour fields.

[0044] Figure 13 illustrates a more detailed embodiment of the method of Figure 14. Initially, the gate clock is set equal to the COLOUR LINE CLOCK through switch 1228. The LOAD SOURCE PATTERN of FIG. 12 is deasserted 1302 to enable the OUTPUT SHIFT REGISTER to shift its data. The counters 1202-1206 are loaded, the number of scannings per colour are loaded, and the colour and monochrome storage elements 1208-1210 are loaded 1304. The light source is turned off 1306. Colour region B's count 1204 is loaded 1308. For each count of the counter, as long as the counter has not timed out 1310: the gate clock is switched at the COLOUR LINE CLOCK rate 1312, the gate shift register is initialized 1314 to start scanning at the beginning of colour region B 1114 by using switch A and B (FIG. 12) and asserting LOAD SOURCE PATTERN (FIG. 12), and a succession of gate clocks causes each row of colour region B 1114 to receive a new source pattern 1507 which is used to load unique lines (rows) in colour region B 1114 of the display screen 1316. Then, colour region A's counter is loaded and a similar process is repeated but for region A 1110 for each count of the counter, as long as the counter has not timed out 1320, 1322, 1324, 1326. After the colour regions have been sufficiently scanned in order to establish their grey scale values, the light source is turned on 1328, 1330. After the colour regions have been completely scanned (i.e., the pulse sequence plane is zero) 1332, 1334, the common electrodes polarity is inverted 1346. If it is determined that the monochrome region is to be refreshed 1336, a counter is loaded with the number of lines count M 1338 in the monochrome region and the monochrome region is scanned 1344 once, if the count is not zero, at a reduced clock rate 1342 that is determined by dividing the line clock by the number of scans per field to yield the MONO LINE CLOCK. The reduced clock rate may be established by other means and may occupy the idle time period.

[0045] The method of Figure 13 may be entered in a variety of other ways. In one embodiment, in normal mode, the serial in/ parallel out shift registers A, B may be loaded with counts, and then the mode is switched to partial colour. After the first line is referenced, the gate driver output is disabled. Then, when mono start is retrieved, the gate driver output is enabled. The gate clock is slowed. Each line of the monochrome region is driven until the end of the monochrome region is reached. The clock is switched to a fast gate clock relative to the monochrome region clock rate. Each line of the colour region B is driven until the end of colour region B. The output shift register is reset to SIPO A. Each line of colour region A is driven until the end of colour region A. Then, the output shift register is reset to SIPO B unless the predetermined number of scans to achieve grey scale has been performed for the frame. If the predetermined number of scans has been reached, then the gate clock is disabled, the light source is turned on, and the common electrode is inverted. A determination is made as to whether to resume normal mode. If not, then partial colour mode is maintained and the processing begins again by slowing down the gate clock. Otherwise, normal mode is assumed in which the fast gate clock is used to control the pixel gates of the display and the gate driver output is disabled until the first line is ready for data transfer. By illustrative example, if M represents a monochrome region scan and BA represents a scan of colour regions B and A, then the process may be depicted as: M BA BA BA BA BA BA BA BA BA BA BA BA invert wait - in which the light is turned on during the last one or last few of the colour region BA scans, the invert period, and the wait period.

[0046] Figure 15 illustrates a more detailed embodiment of a scan for a field. The gate line driver is shifted once 1504. The load pattern is deasserted 1506. A new source pattern is loaded 1507. The source lines on the display matrix are driven 1508. The line count is reduced by one 1510. As long as the counter does not expire (e.g., the line count remains greater than zero in a count down mode) 1512, scanning resumes at step 1504.

[0047] The above-described embodiments of the present application are intended to be examples only. Those of skill in the art may effect alterations, modifications and variations to the particular embodiments without departing from the scope of the application. The invention described herein in the recited claims intends to cover and embrace all suitable changes in technology.

Claims

1. A method for generating a frame of an image on a field sequential liquid crystal display, LCD, (222, 430) of a handheld wireless communication device (102, 202) having a plurality of light-sources (322, 324, 326), said method comprising the steps of:

   scanning a first region of contiguous lines of pixels of the LCD (222, 430) to produce a colour region on the LCD (222, 430), using a first scanning frequency;
   scanning a second region of contiguous lines of

pixels of the LCD (222, 430) pixels to produce a monochrome region on the LCD (222, 430) using a second scanning frequency less than the first scanning frequency;
wherein said colour region is produced by scanning said first region a first number of times; and wherein said monochrome region is produced by scanning said second region a second number of times, wherein said first number of times is N times said second number of times,
wherein during scanning said monochrome region, each pixel in said region is activated once and a clock pulse is used to enter a binary value into a pixel to cause the pixel to be on or off for the pixels in said monochrome region, and
activating said light sources (322, 324, 326) during a portion of said frame,
wherein the number of pixel lines and the starting pixel line of the monochrome and colour regions are allocated depending on the data being displayed.

2. The method of Claim 1 wherein N is a positive integer and obeys a selected one of the following relationships: i) N is greater than 3; ii) N is between six and sixteen, inclusive: iii) N is between six and twelve inclusive; iv) N is equal to six; v) N is equal to eight; and vi) N is equal to ten.

3. The method of Claim 1, further comprising scanning a third region of contiguous lines of pixels to produce a second colour region on the LCD (222, 430).

4. The method of Claim 3, wherein said second colour region is performed by scanning in said frame, said third region by a third number of times and said third number of times is the same as said first number of times.

5. The method of Claim 3, wherein said second colour region is different from said first colour region.

6. The method of claim 5, where at least one of said first colour region, said second colour region and said monochrome region comprises a bit rate colour scheme different from a bit rate colour scheme of at least one other region.

7. The method of any one of Claims 1 to 6, further comprising leaving at least one line of pixels in an off state.

8. The method of any one of Claims 1 to 7 wherein said monochrome region is comprised of black and white.

9. The method of Claim 1 further comprising the steps of:

receiving a source pattern for said frame for presenting on the LCD (222, 430), said pattern including at least said first region and said second region;
receiving a number of lines respective to each region, each of said lines including a plurality of pixels;
receiving a pulse sequence per region corresponding to a settled state for that region wherein one of said pulse sequences consumes less power than at least one other of said pulse sequences;
receiving a light sequence corresponding to each said region;
scanning each liquid crystal pixel in each line respective to each region according to said pulse sequence respective to that region; and
activating said light sources (322, 324, 326) according to said light sequence respective to each said region.

10. The method of Claim 9, wherein said light sources (322,324, 326) are comprised of three separate colours red, green and blue or cyan, magenta, and yellow.

11. The method of Claim 10, wherein said light sequence is comprised of three sequential parts respective to each said colour.

12. The method of Claim 11, wherein each said colour is turned on during all of its respective sequence.

13. The method of Claim 11, wherein each said colour is turned on during a portion of its sequence said respective part.

14. The method of any one of Claims 9 to 13, wherein said scanning step comprises scanning one of said regions before scanning another of said regions.

15. The method of any one of claims 9 to 13, said pattern including a third region of contiguous lines of pixels of said field sequentially driven liquid crystal display to produce a second colour region on the LCD (222, 430), wherein said scanning step comprises simultaneously scanning said first region and said third region.

16. A wireless communication device (102, 202) comprising:

a field sequential liquid crystal display, LCD, (222, 430) having multiple lines of liquid crystal pixels arranged in a matrix; said LCD (222, 430) operable to generate a frame of an image having at least one colour region and at least one monochrome region;

a source driver (410) and a gate driver (412-422) activating pixels on said LCD, for scanning said liquid crystal pixels according to a pulse sequence per region corresponding to a settled pixel state for that region,
said pixels being scanned at a first scanning frequency to produce said colour region, and scanned at a second scanning frequency less than said first scanning frequency to produce said monochrome region,
wherein during scanning said monochrome region, each pixel in said region is activated once and a clock pulse is used to enter a binary value into a pixel to cause the pixel to be on or off in said monochrome region, and
wherein said monochrome region is produced by scanning said second region a second number of times such that said first number of times is N times said second number of times, and
a plurality of light sources (322, 324, 326) operable according to a light sequence corresponding to each said region,
wherein the number of pixel lines and the starting pixel line of the monochrome and colour regions are allocated depending on the data being displayed.

17. The wireless communications device (102, 202) of Claim 16, wherein said light sources include light emitting diodes (322, 324, 326).

18. The wireless communications device (102, 202) of Claim 17, wherein a first one of said light emitting diodes emits red light, a second one of said light emitting diodes emits green light, and a third one of said light emitting diodes emits blue light or a first one emits cyan light, a second one emits magenta light, and a third one emits yellow light.

19. The wireless communications device (102, 202) of any one of Claims 16 to 18, wherein each pixel in one of said regions is capable of being scanned between two and sixteen times, inclusive, for every time any pixel in another of said regions is scanned.

20. The wireless communications device (102, 202) of any one of Claims 17 to 19, wherein said source driver (410) is loaded with values to drive source lines of a sequentially selected row of said pixels by shifting a bit through a shift register to drive gates in said matrix; and wherein said sequential selection of rows is accomplished by selectively loading one of said output shift registers (1208, 1210) selected from a plurality of shift registers.

21. A machine readable medium (224) comprising computer code means executable on a processor (238) of the wireless communications device (102, 202) of any one of Claims 16 to 20 for implementing the method of any one of Claims 1 to 15.

22. A communications system (100) comprising at least one wireless communications device (102, 202) according to any one of Claims 16 to 20.

Patentansprüche

1. Ein Verfahren zum Erzeugen eines Rahmens eines Bilds auf einer teilbildsequentiellen Flüssigkristallanzeige (LCD - liquid crystal display) (222, 430) einer handgehaltenen drahtlosen Kommunikationsvorrichtung (102, 202) mit einer Vielzahl von Lichtquellen (322, 324, 326), wobei das Verfahren die Schritte aufweist:

Abtasten eines ersten Bereichs von aneinandergrenzenden Zeilen von Pixeln der LCD (222, 430), um einen Farbbereich auf der LCD (222, 430) zu erzeugen, unter Verwendung einer ersten Abtastfrequenz;
Abtasten eines zweiten Bereichs von aneinandergrenzenden Zeilen von Pixeln der LCD(222, 430)-Pixel, um einen monochromen Bereich auf der LCD (222, 430) zu erzeugen, unter Verwendung einer zweiten Abtastfrequenz, die geringer ist als die erste Abtastfrequenz;
wobei der Farbbereich durch Abtasten des ersten Bereichs eine erste Anzahl von Malen erzeugt wird; und
wobei der monochrome Bereich durch Abtasten des zweiten Bereichs eine zweite Anzahl von Malen erzeugt wird, wobei die erste Anzahl von Malen N mal die zweite Anzahl von Malen ist,
wobei während des Abtastens des monochromen Bereichs jedes Pixel in dem Bereich einmal aktiviert wird und ein Taktpuls verwendet wird zum Eingeben eines binären Werts in ein Pixel, um zu veranlassen, dass das Pixel ein oder aus ist für die Pixel in dem monochromen Bereich, und
Aktivieren der Lichtquellen (322, 324, 326) während eines Teils des Rahmens,
wobei die Anzahl von Pixelzeilen und die Anfangspixelzeile der monochromen und Farbbereiche abhängig von den angezeigten Daten zugeteilt sind.

2. Das Verfahren gemäß Anspruch 1, wobei N eine positive Ganzzahl ist und einer ausgewählten der folgenden Beziehungen folgt: i) N ist größer als 3; ii) N ist zwischen sechs und sechzehn, einschließlich; iii) N ist zwischen sechs und zwölf, einschließlich; iv) N ist gleich sechs; v) N ist gleich acht; und vi) N ist gleich zehn.

3. Das Verfahren gemäß Anspruch 1, das weiter aufweist ein Abtasten eines dritten Bereichs von aneinandergrenzenden Zeilen von Pixeln, um einen zweiten Farbbereich auf der LCD (222, 430) zu erzeugen.

4. Das Verfahren gemäß Anspruch 3, wobei der zweite Farbbereich durchgeführt wird durch Abtasten, in dem Rahmen, des dritten Bereichs um eine dritte Anzahl von Malen und die dritte Anzahl von Malen dieselbe ist wie die erste Anzahl von Malen.

5. Das Verfahren gemäß Anspruch 3, wobei der zweite Farbbereich von dem ersten Farbbereich verschieden ist.

6. Das Verfahren gemäß Anspruch 5, wobei zumindest einer des ersten Farbbereichs, des zweiten Farbbereichs und des monochromen Bereichs ein Bitrate-Farbschema verschieden von einem Bitrate-Farbschema von zumindest einem anderen Bereich aufweist.

7. Das Verfahren gemäß einem der Ansprüche 1 bis 6, das weiter aufweist, dass zumindest eine Zeile von Pixeln in einem Aus-Zustand gelassen wird.

8. Das Verfahren gemäß einem der Ansprüche 1 bis 7, wobei der monochrome Bereich aus schwarz und weiß besteht.

9. Das Verfahren gemäß Anspruch 1, das weiter die Schritte aufweist:

Empfangen eines Quellenmusters für den Rahmen zum Darstellen auf der LCD (222, 430), wobei das Muster zumindest den ersten Bereich und den zweiten Bereich umfasst;
Empfangen einer Anzahl von Zeilen entsprechend jedem Bereich, wobei jede der Zeilen eine Vielzahl von Pixeln umfasst;
Empfangen einer Pulssequenz pro Bereich entsprechend einem eingestellten Zustand für diesen Bereich, wobei eine der Pulssequenzen weniger Energie verbraucht als zumindest eine andere der Pulssequenzen;
Empfangen einer Lichtsequenz entsprechend jedem Bereich;
Abtasten jedes Flüssigkristallpixels in jeder Zeile entsprechend jedem Bereich gemäß der Pulssequenz entsprechend diesem Bereich; und
Aktivieren der Lichtquellen (322, 324, 326) gemäß der Lichtsequenz entsprechend jedem Bereich.

10. Das Verfahren gemäß Anspruch 9, wobei die Lichtquellen (322, 324, 326) aus drei getrennten Farben rot, grün und blau oder cyan, magenta und gelb bestehen.

11. Das Verfahren gemäß Anspruch 10, wobei die Lichtsequenz aus drei sequentiellen Teilen entsprechend jeder Farbe besteht.

12. Das Verfahren gemäß Anspruch 11, wobei jede Farbe während ihrer gesamten entsprechenden Sequenz eingeschaltet ist.

13. Das Verfahren gemäß Anspruch 11, wobei jede Farbe eingeschaltet ist während eines Teils ihrer Sequenz des jeweiligen Teils.

14. Das Verfahren gemäß einem der Ansprüche 9 bis 13, wobei der Schritt des Abtastens ein Abtasten eines der Bereiche vor einem Abtasten eines anderen der Bereiche aufweist.

15. Das Verfahren gemäß einem der Ansprüche 9 bis 13, wobei das Muster einen dritten Bereich von aneinandergrenzenden Zeilen von Pixeln der teilbildsequentiellen Flüssigkristallanzeige umfasst, um einen zweiten Farbbereich auf der LCD (222, 430) zu erzeugen, wobei der Schritt des Abtastens ein gleichzeitiges Abtasten des ersten Bereichs und des dritten Bereichs aufweist.

16. Eine drahtlose Kommunikationsvorrichtung (102, 202), die aufweist:

eine teilbildsequentielle Flüssigkristallanzeige (LCD - liquid crystal display) (222, 430) mit mehreren Zeilen von Flüssigkristallpixeln angeordnet in einer Matrix; wobei die LCD (222, 430) betriebsfähig ist zum Erzeugen eines Rahmens eines Bilds mit zumindest einem Farbbereich und zumindest einem monochromen Bereich;
einen Source-Treiber (410) und einen Gate-Treiber (412-422) zum Aktivieren von Pixeln auf der LCD, zum Abtasten der Flüssigkristallpixel gemäß einer Pulssequenz pro Bereich entsprechend einem eingestellten Pixelzustand für diesen Bereich,
wobei die Pixel mit einer ersten Abtastfrequenz abgetastet werden, um den Farbbereich zu erzeugen, und mit einer zweiten Abtastfrequenz, die geringer ist als die erste Abtastfrequenz, abgetastet werden, um den monochromen Bereich zu erzeugen,
wobei während des Abtastens des monochromen Bereichs jedes Pixel in dem Bereich einmal aktiviert wird und ein Taktpuls verwendet wird zum Eingeben eines binären Werts in ein Pixel, um zu veranlassen, dass das Pixel in dem monochromen Bereich ein oder aus ist, und
wobei der monochrome Bereich erzeugt wird durch Abtasten des zweiten Bereichs eine zwei-

te Anzahl von Malen derart, dass die erste Anzahl von Malen N mal die zweite Anzahl von Malen ist,
und
eine Vielzahl von Lichtquellen (322, 324, 326), die gemäß einer Lichtsequenz entsprechend jedem Bereich betriebsfähig sind,
wobei die Anzahl von Pixelzeilen und die Anfangspixelzeile der monochromen und Farbbereiche abhängig von den angezeigten Daten zugeteilt werden.

17. Die drahtlose Kommunikationsvorrichtung (102, 202) gemäß Anspruch 16, wobei die Lichtquellen lichtemittierende Dioden (322, 324, 326) umfassen.

18. Die drahtlose Kommunikationsvorrichtung (102, 202) gemäß Anspruch 17, wobei eine erste der lichtemittierenden Dioden rotes Licht emittiert, eine zweite der lichtemittierenden Dioden grünes Licht emittiert und eine dritte der lichtemittierenden Dioden blaues Licht emittiert oder eine erste cyanfarbiges Licht emittiert, eine zweite magenta-farbiges Licht emittiert und eine dritte gelbes Licht emittiert.

19. Die drahtlose Kommunikationsvorrichtung (102, 202) gemäß einem der Ansprüche 16 bis 18, wobei jedes Pixel in einem der Bereiche zwischen zwei und sechzehn Mal, einschließlich, abgetastet werden kann für jedes Mal, wenn ein Pixel in einem anderen der Bereiche abgetastet wird.

20. Die drahtlose Kommunikationsvorrichtung (102, 202) gemäß einem der Ansprüche 17 bis 19, wobei der Source-Treiber (410) mit Werten geladen ist zum Ansteuern von Source-Zeilen einer sequentiell ausgewählten Zeile der Pixel durch Verschieben eines Bits durch ein Verschieberegister zum Ansteuern von Gates in der Matrix; und wobei die sequentielle Auswahl von Zeilen erreicht wird durch selektives Laden eines der Ausgangsverschieberegister (1208, 1210), ausgewählt aus einer Vielzahl von Verschieberegistern.

21. Ein maschinenlesbares Medium (224), das Computercodemittel aufweist, ausführbar auf einem Prozessor (238) der drahtlosen Kommunikationsvorrichtung (102, 202) gemäß einem der Ansprüche 16 bis 20 zum Implementieren des Verfahrens gemäß einem der Ansprüche 1 bis 15.

22. Ein Kommunikationssystem (100), das zumindest eine drahtlose Kommunikationsvorrichtung (102, 202) gemäß einem der Ansprüche 16 bis 20 aufweist.

Revendications

1. Procédé pour générer une trame d'une image sur un afficheur à cristaux liquides, LCD, à séquence de champ (222, 430) d'un dispositif de communication sans fil portatif (102, 202) ayant une pluralité de sources de lumière (322, 324, 326), ledit procédé comprenant les étapes de :

balayage d'une première région de lignes contiguës de pixels du LCD (222, 430) pour produire une région couleur sur le LCD (222, 430), en utilisant une première fréquence de balayage ;
balayage d'une deuxième région de lignes contiguës de pixels du LCD (222, 430) pour produire une région monochrome sur le LCD (222, 430) en utilisant une deuxième fréquence de balayage inférieure à la première fréquence de balayage ;
ladite région couleur étant produite en balayant ladite première région un premier nombre de fois ; et
ladite région monochrome étant produite en balayant ladite deuxième région un deuxième nombre de fois, ledit premier nombre de fois étant N fois ledit deuxième nombre de fois,
où, au cours du balayage de ladite région monochrome, chaque pixel dans ladite région est activé une fois et une impulsion d'horloge est utilisée pour entrer une valeur binaire dans un pixel pour amener le pixel à être allumé ou éteint pour les pixels dans ladite région monochrome, et
activation desdites sources de lumière (322, 324, 326) au cours d'une partie de ladite trame, le nombre de lignes de pixels et la ligne de pixels de départ des régions monochrome et couleur étant allouées en fonction des données qui sont affichées.

2. Procédé selon la revendication 1, dans lequel N est un entier positif et obéit à une relation sélectionnée parmi les relations suivantes : i) N est supérieur à 3'; ii) N se situe entre six et seize, inclus ; iii) N se situe entre six et douze inclus ; iv) N est égal à six ; v) N est égal à huit ; et vi) N est égal à dix.

3. Procédé selon la revendication 1, comprenant en outre le balayage d'une troisième région de lignes contigües de pixels pour produire une deuxième région couleur sur le LCD (222, 430).

4. Procédé selon la revendication 3, dans lequel ladite deuxième région couleur est réalisée en balayant, dans ladite trame, ladite troisième région par un troisième nombre de fois et ledit troisième nombre de fois est le même que ledit premier nombre de fois.

5. Procédé selon la revendication 3, dans lequel ladite deuxième région couleur est différente de ladite première région couleur.

6. Procédé selon la revendication 5, dans lequel au moins une parmi ladite première région couleur, ladite deuxième région couleur et ladite région monochrome comprend un schéma de couleur de débit binaire différent d'un schéma de couleur de débit binaire d'au moins une autre région.

7. Procédé selon l'une quelconque des revendications 1 à 6, comprenant en outre le fait de laisser au moins une ligne de pixels dans un état éteint.

8. Procédé selon l'une des revendications 1 à 7, dans lequel ladite région monochrome est composée de noir et de blanc.

9. Procédé selon la revendication 1, comprenant en outre les étapes de :

réception d'un motif source pour ladite trame pour la présentation sur le LCD (222, 430), ledit motif comprenant au moins ladite première région et ladite deuxième région ;
réception d'un nombre de lignes par rapport à chaque région, chacune desdites lignes comprenant une pluralité de pixels ;
réception d'une séquence d'impulsions par région correspondant à un état établi pour cette région dans laquelle une desdites séquences d'impulsions consomme moins d'énergie qu'au moins une autre desdites séquences d'impulsions ;
réception d'une séquence de lumière correspondant à chaquedite région ;
balayage de chaque pixel de cristaux liquides dans chaque ligne par rapport à chaque région selon ladite séquence d'impulsions par rapport à cette région ; et
activation desdites sources de lumière (322, 324, 326) selon ladite séquence de lumière par rapport à chaquedite région.

10. Procédé selon la revendication 9, dans lequel lesdites sources de lumière (322, 324, 326) sont composées de trois couleurs distinctes rouge, vert et bleu ou cyan, magenta, et jaune.

11. Procédé selon la revendication 10, dans lequel ladite séquence de lumière est composée de trois parties séquentielles par rapport à chaquedite couleur.

12. Procédé selon la revendication 11, dans lequel chaquedite couleur est allumée au cours de la totalité de sa séquence respective.

13. Procédé selon la revendication 11, dans lequel chaquedite couleur est allumée au cours d'une partie de sa séquence respective.

14. Procédé selon l'une quelconque des revendications 9 à 13, dans lequel ladite étape de balayage comprend le balayage d'une desdites régions avant le balayage d'une autre desdites régions.

15. Procédé selon l'une quelconque des revendications 9 à 13, ledit motif comprenant une troisième région de lignes contiguës de pixels dudit afficheur à cristaux liquides à séquence de champ pour produire une deuxième région couleur sur le LCD (222, 430), dans lequel ladite étape de balayage comprend le balayage simultané de ladite première région et de ladite troisième région.

16. Dispositif de communication sans fil (102, 202) comprenant :

un afficheur à cristaux liquides, LCD, à séquence de champ (222, 430) ayant de multiples lignes de pixels de cristaux liquides agencées dans une matrice ; ledit LCD (222, 430) ayant pour fonction de générer une trame d'une image ayant au moins une région couleur et au moins une région monochrome ;
un pilote de source (410) et un pilote de grille (412-422) activant des pixels sur ledit LCD, pour balayer lesdits pixels de cristaux liquides selon une séquence d'impulsions par région correspondant à un état de pixel établi pour cette région,
lesdits pixels étant balayés à une première fréquence de balayage pour produire ladite région couleur, et balayés à une deuxième fréquence de balayage inférieure à ladite première fréquence de balayage pour produire ladite région monochrome,
dans lequel au cours du balayage de ladite région monochrome, chaque pixel dans ladite région est activé une fois et une impulsion d'horloge est utilisée pour entrer une valeur binaire dans un pixel pour amener le pixel à être allumé ou éteint dans ladite région monochrome, et
dans lequel ladite région monochrome est produite en balayant ladite deuxième région un deuxième nombre de fois de sorte que ledit premier nombre de fois soit N fois ledit deuxième nombre de fois,
et
une pluralité de sources de lumière (322, 324, 326) exploitable selon une séquence de lumière correspondant à chaquedite région,
dans lequel le nombre de lignes de pixels et la ligne de pixels de départ des régions monochrome et couleur sont allouées en fonction des don-

nées qui sont affichées.

17. Dispositif de communications sans fil (102, 202) selon la revendication 16, dans lequel lesdites sources de lumière comprennent des diodes électroluminescentes (322, 324, 326).

18. Dispositif de communications sans fil (102, 202). selon la revendication 17, dans lequel une première desdites diodes électroluminescentes émet une lumière rouge, une deuxième desdites diodes électroluminescentes émet une lumière verte, et une troisième desdites diodes électroluminescentes émet une lumière bleue ou une première émet une lumière cyan, une deuxième émet une lumière magenta, et une troisième émet une lumière jaune.

19. Dispositif de communications sans fil (102, 202) selon l'une quelconque des revendications 16 à 18, dans lequel chaque pixel dans une desdites régions est susceptible d'être balayé entre deux et seize fois, inclus, à chaque fois qu'un pixel quelconque dans une autre desdites régions est balayé.

20. Dispositif de communications sans fil (102, 202) selon l'une quelconque des revendication 17 à 19, dans lequel ledit pilote de source (410) est chargé avec des valeurs pour piloter des lignes de source d'une rangée sélectionnée séquentiellement desdits pixels en décalant un bit à travers un registre à décalage pour piloter des grilles dans ladite matrice ; et dans lequel ladite sélection séquentielle de rangées est accomplie en chargeant sélectivement un desdits registres à décalage de sortie (1208, 1210) sélectionné parmi une pluralité de registres à décalage.

21. Support lisible par machine (224) comprenant des moyens de code informatique exécutables sur un processeur (238) du dispositif de communications sans fil (102, 202) selon l'une quelconque des revendications 16 à 20 pour mettre en oeuvre le procédé selon l'une quelconque des revendications 1 à 15.

22. Système de communications (100) comprenant au moins un dispositif de communications sans fil (102, 202) selon l'une quelconque des revendications 16 à 20.

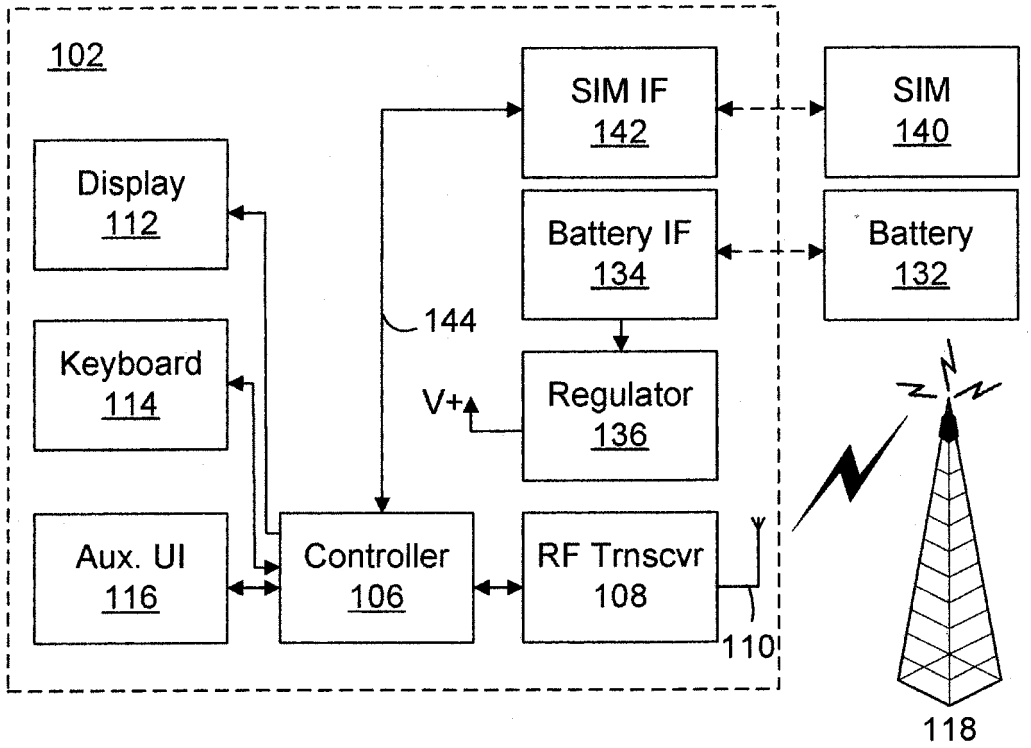
102
SIM IF
142
SIM
140
Display
112
Battery IF
134
Battery
132
144
Keyboard
114
V+
Regulator
136
Aux. UI
116
Controller
106
RF Trnscvr
108
110
118

FIG. 1

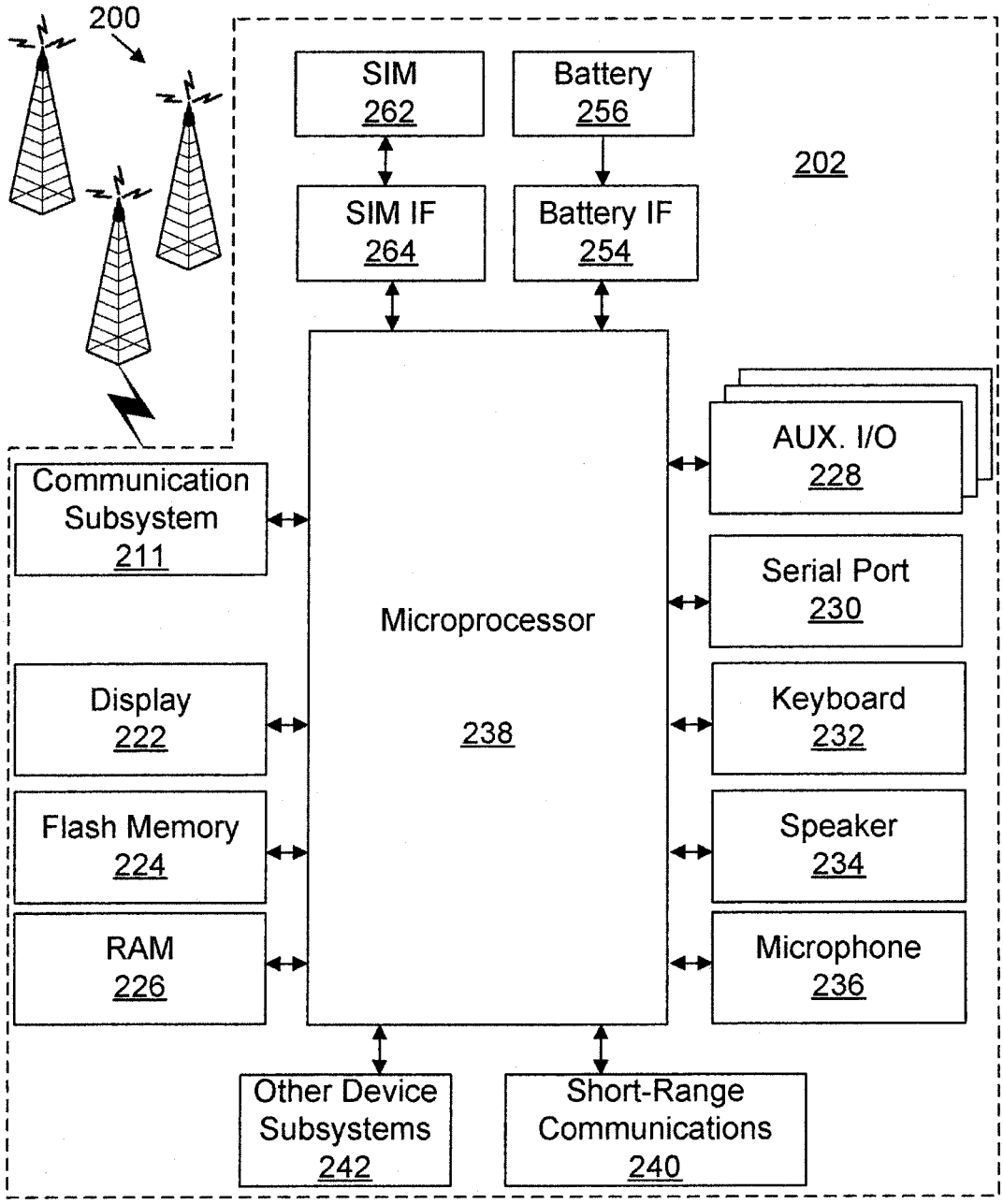
200
SIM
262
Battery
256
202
SIM IF
264
Battery IF
254
AUX. I/O
228
Communication
Subsystem
211
Microprocessor
238
Serial Port
230
Display
222
Keyboard
232
Flash Memory
224
Speaker
234
RAM
226
Microphone
236
Other Device
Subsystems
242
Short-Range
Communications
240

FIG. 2

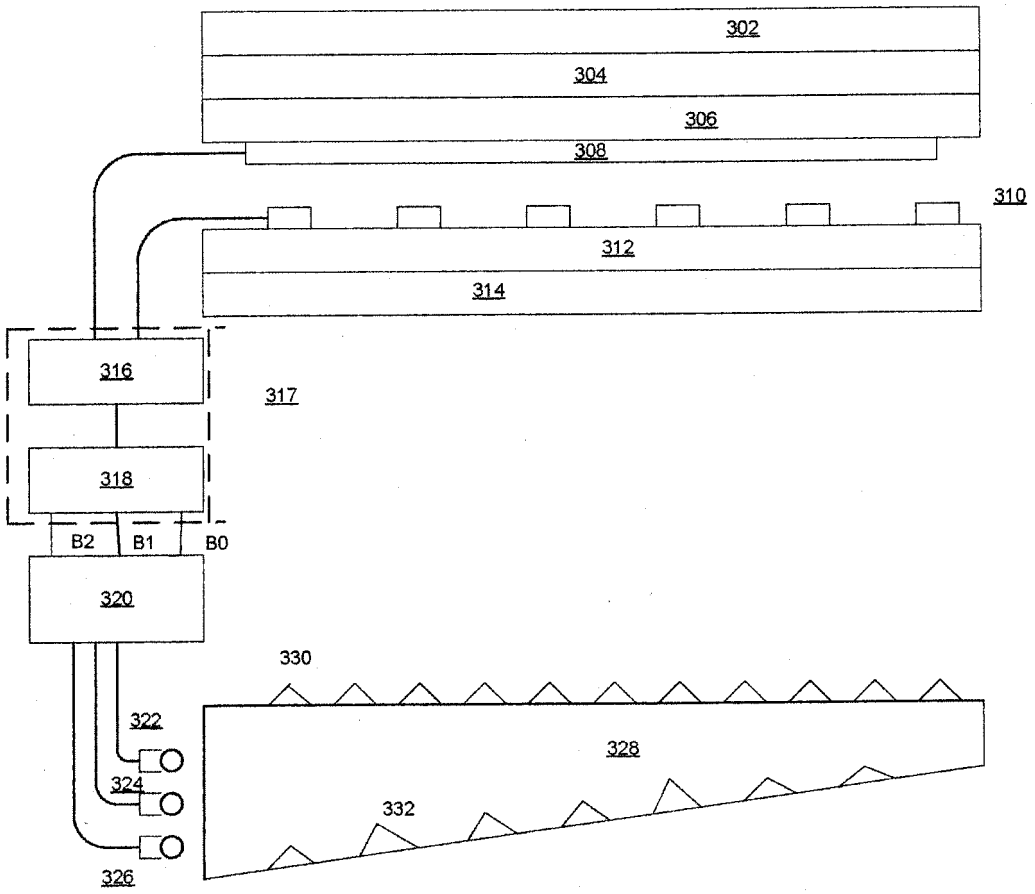
302
304
306
308
310
312
314
316
317
318
B2
B1
B0
320
330
322
328
324
332
326

FIG. 3

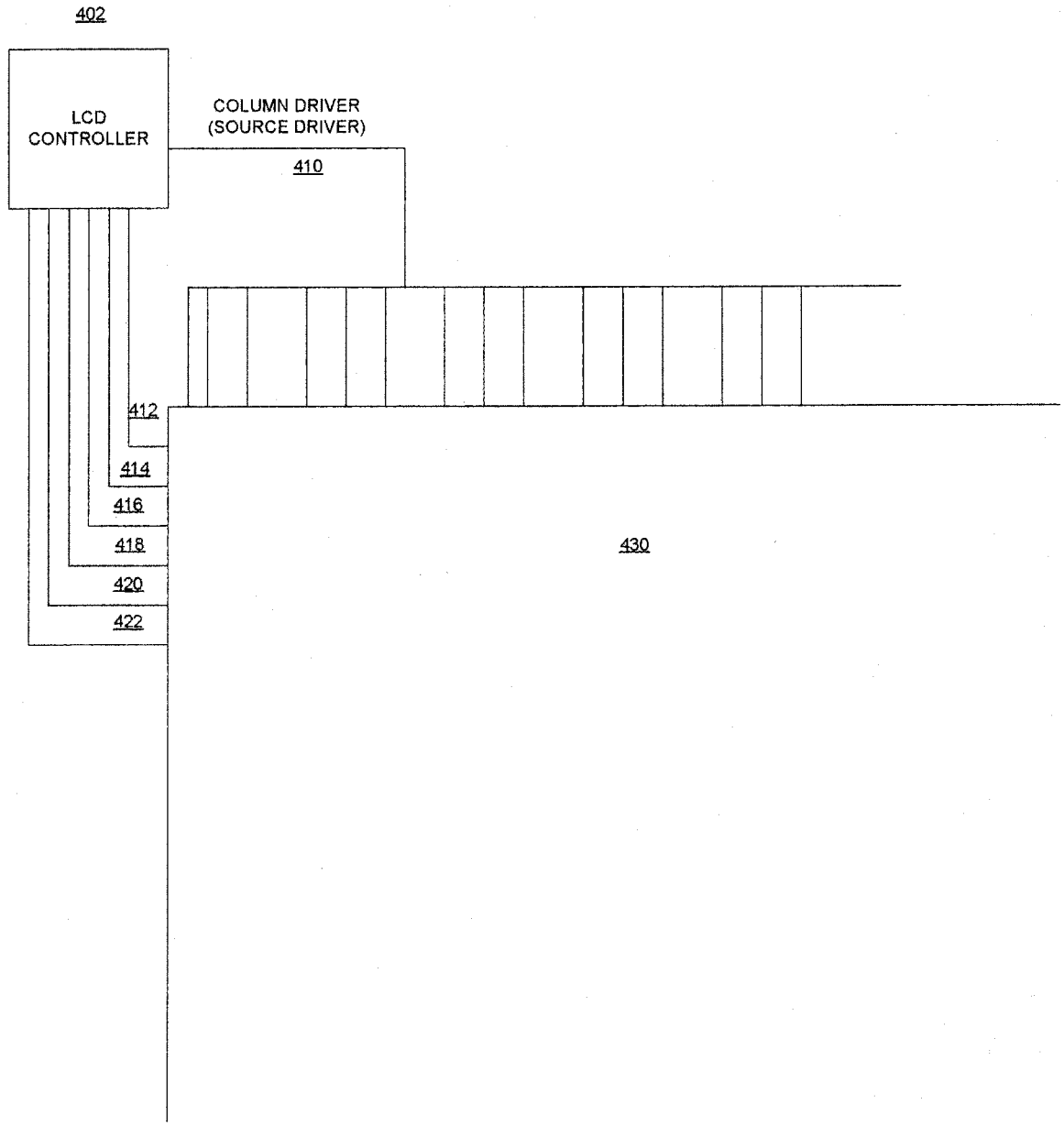
402
LCD CONTROLLER
COLUMN DRIVER (SOURCE DRIVER)
410
412
414
416
418
420
422
430

FIGURE 4

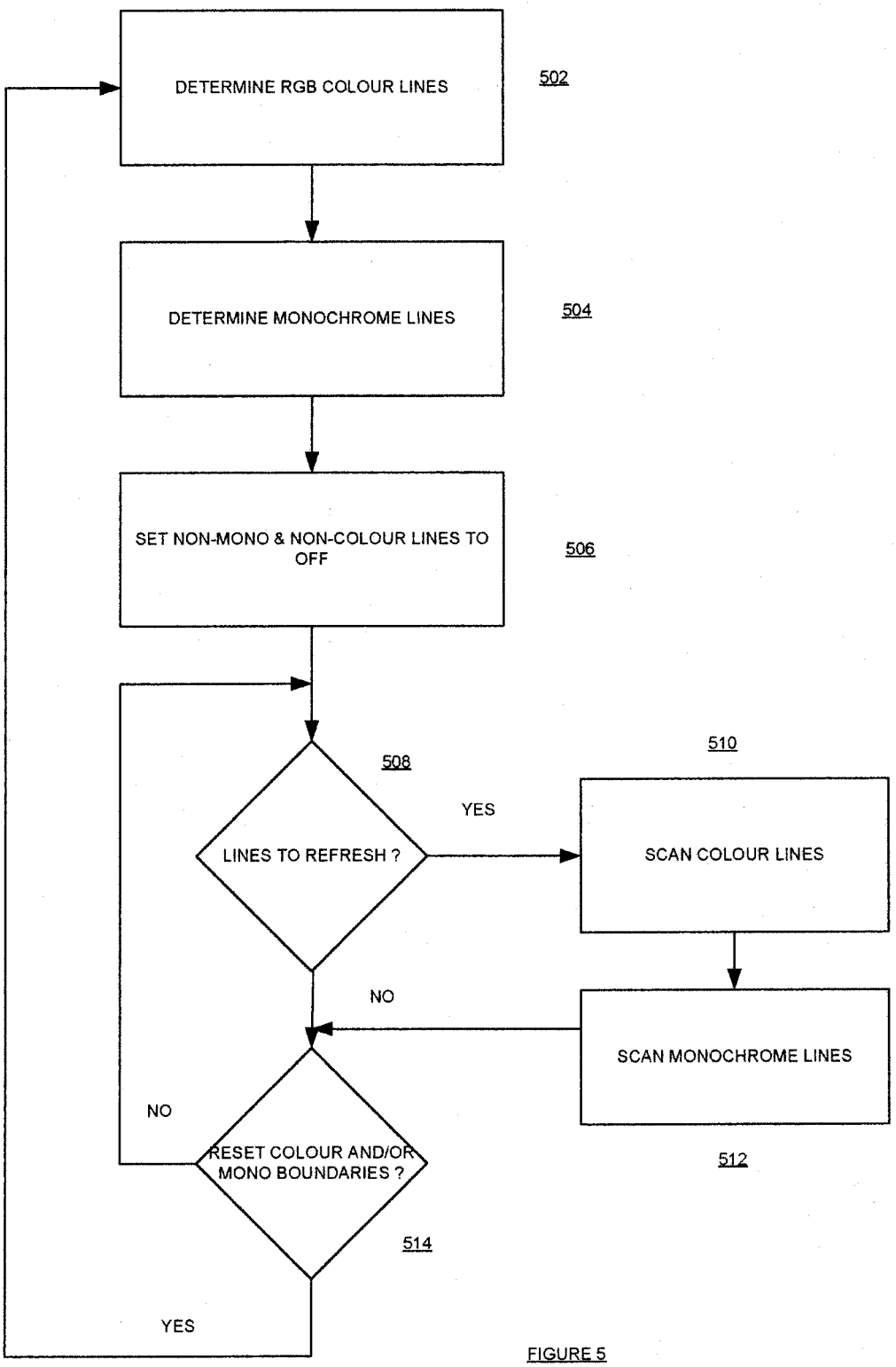
DETERMINE RGB COLOUR LINES
502
DETERMINE MONOCHROME LINES
504
SET NON-MONO & NON-COLOUR LINES TO OFF
506
508
LINES TO REFRESH ?
YES
510
SCAN COLOUR LINES
NO
SCAN MONOCHROME LINES
512
NO
RESET COLOUR AND/OR MONO BOUNDARIES ?
514
YES

FIGURE 5

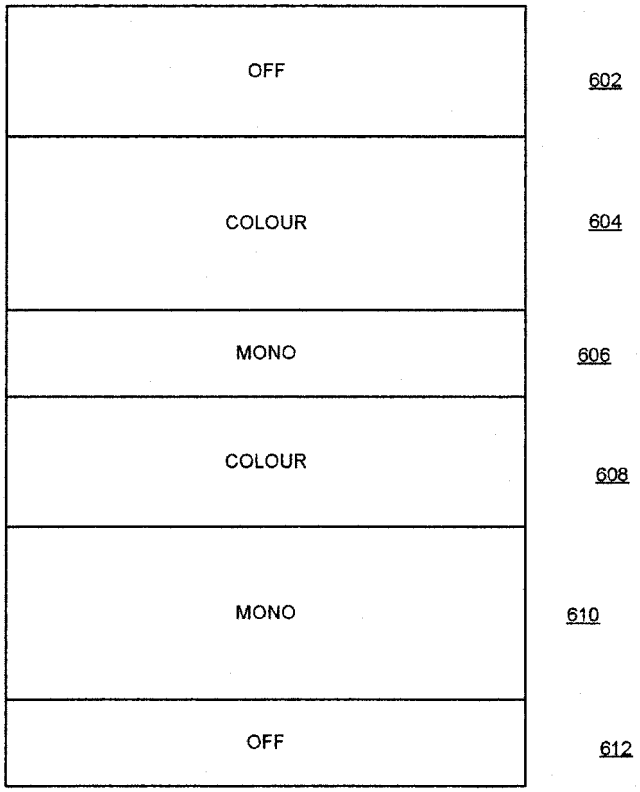

FIGURE 6

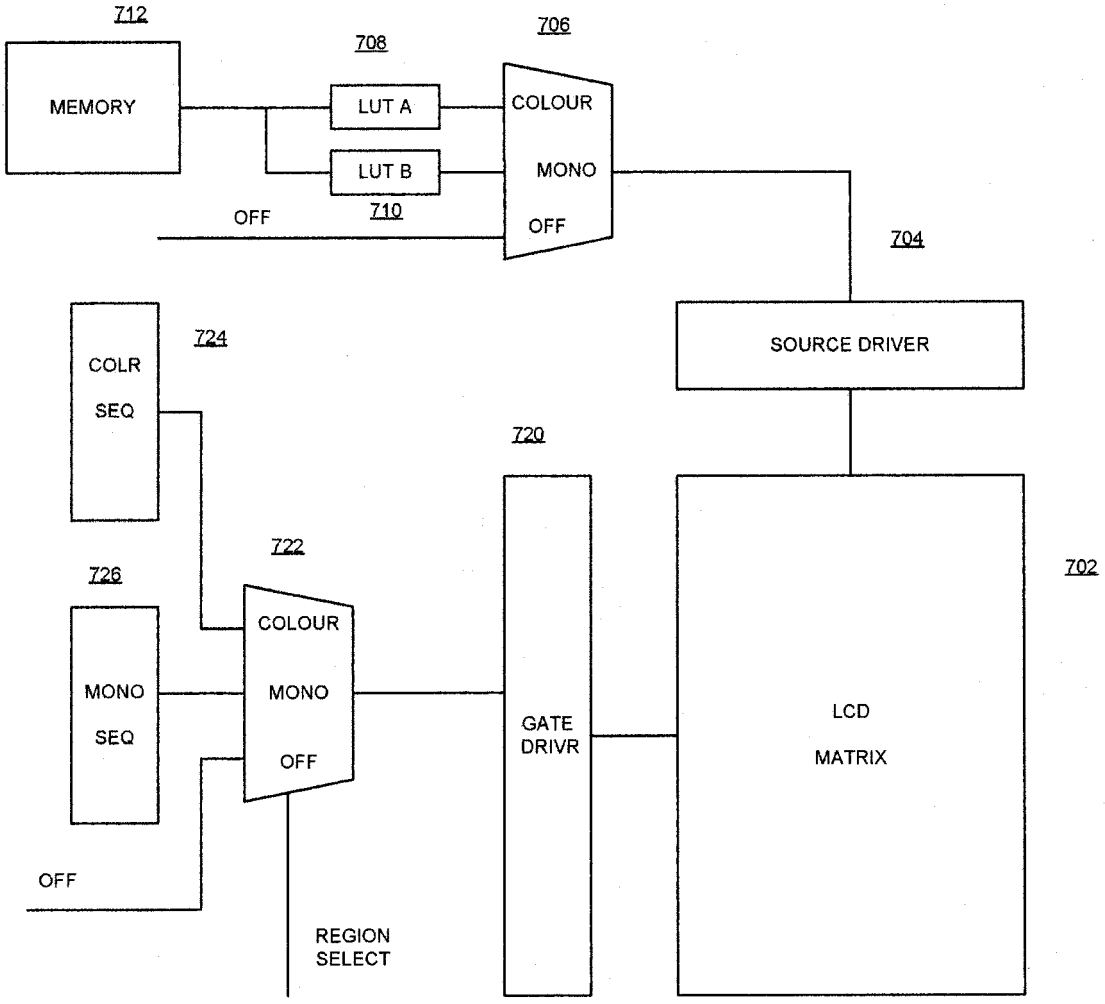
712
MEMORY
708
LUT A
LUT B
710
OFF
706
COLOUR
MONO
OFF
704
SOURCE DRIVER
724
COLR
SEQ
720
726
MONO
SEQ
722
COLOUR
MONO
OFF
OFF
REGION
SELECT
GATE
DRIVR
LCD
MATRIX
702

FIGURE 7

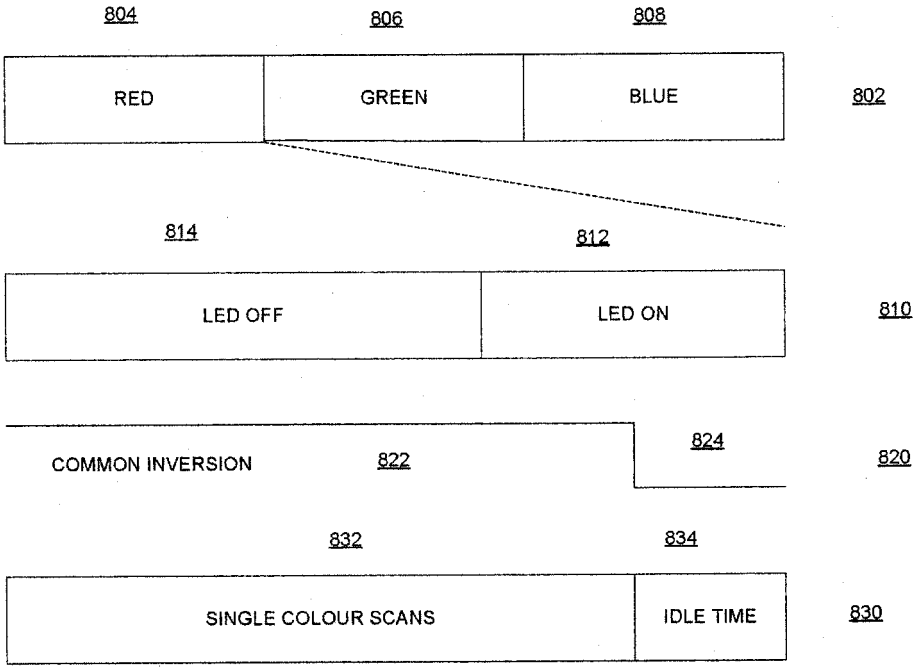

FIGURE 8

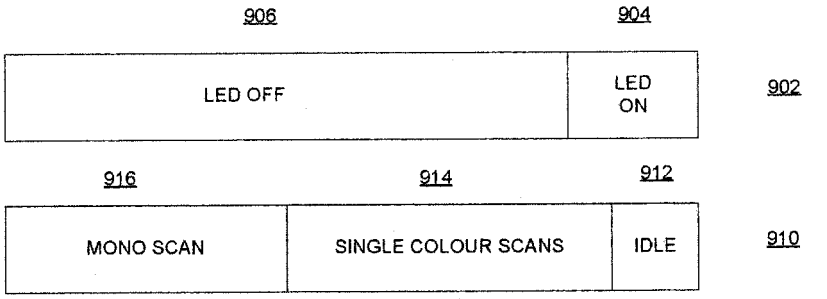

FIGURE 9

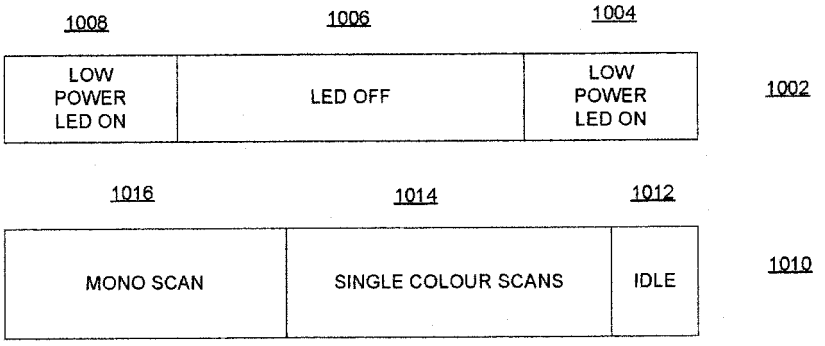

FIGURE 10

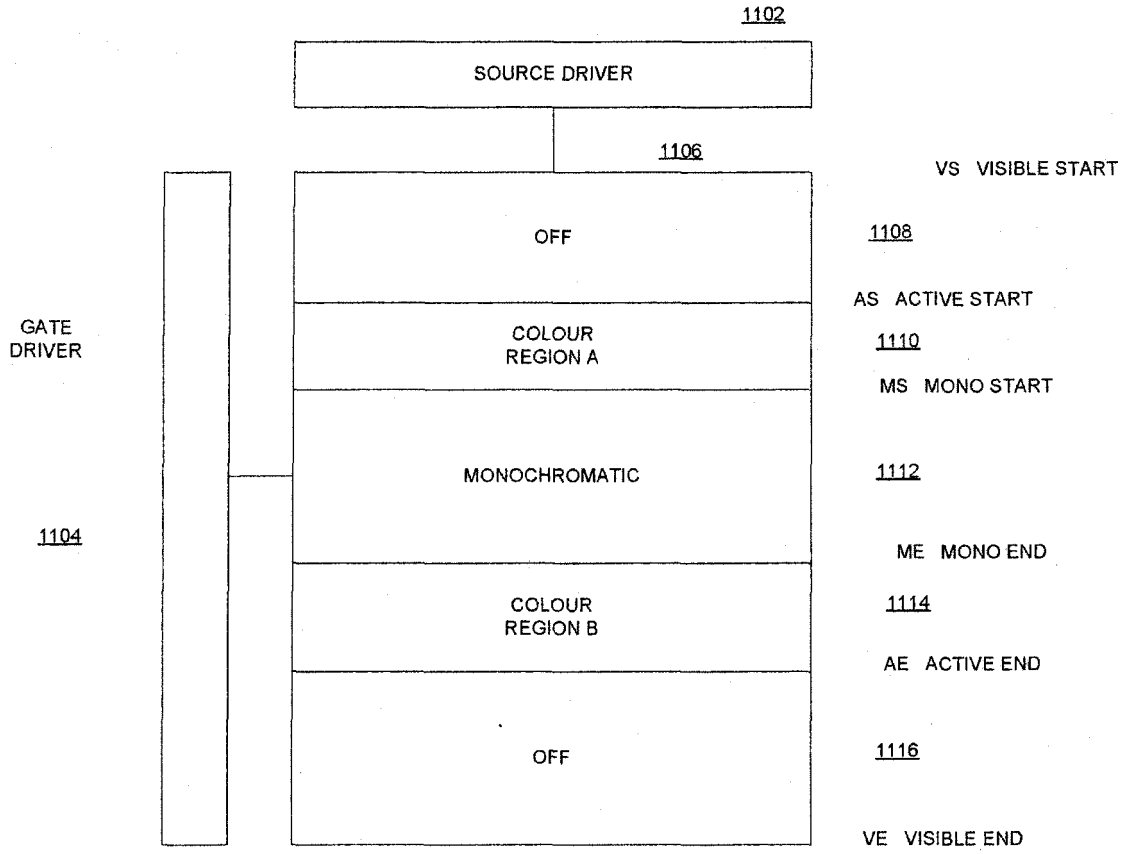
1102
SOURCE DRIVER
1106
VS VISIBLE START
OFF
1108
AS ACTIVE START
GATE DRIVER
COLOUR REGION A
1110
MS MONO START
MONOCHROMATIC
1112
1104
ME MONO END
COLOUR REGION B
1114
AE ACTIVE END
OFF
1116
VE VISIBLE END

FIGURE 11

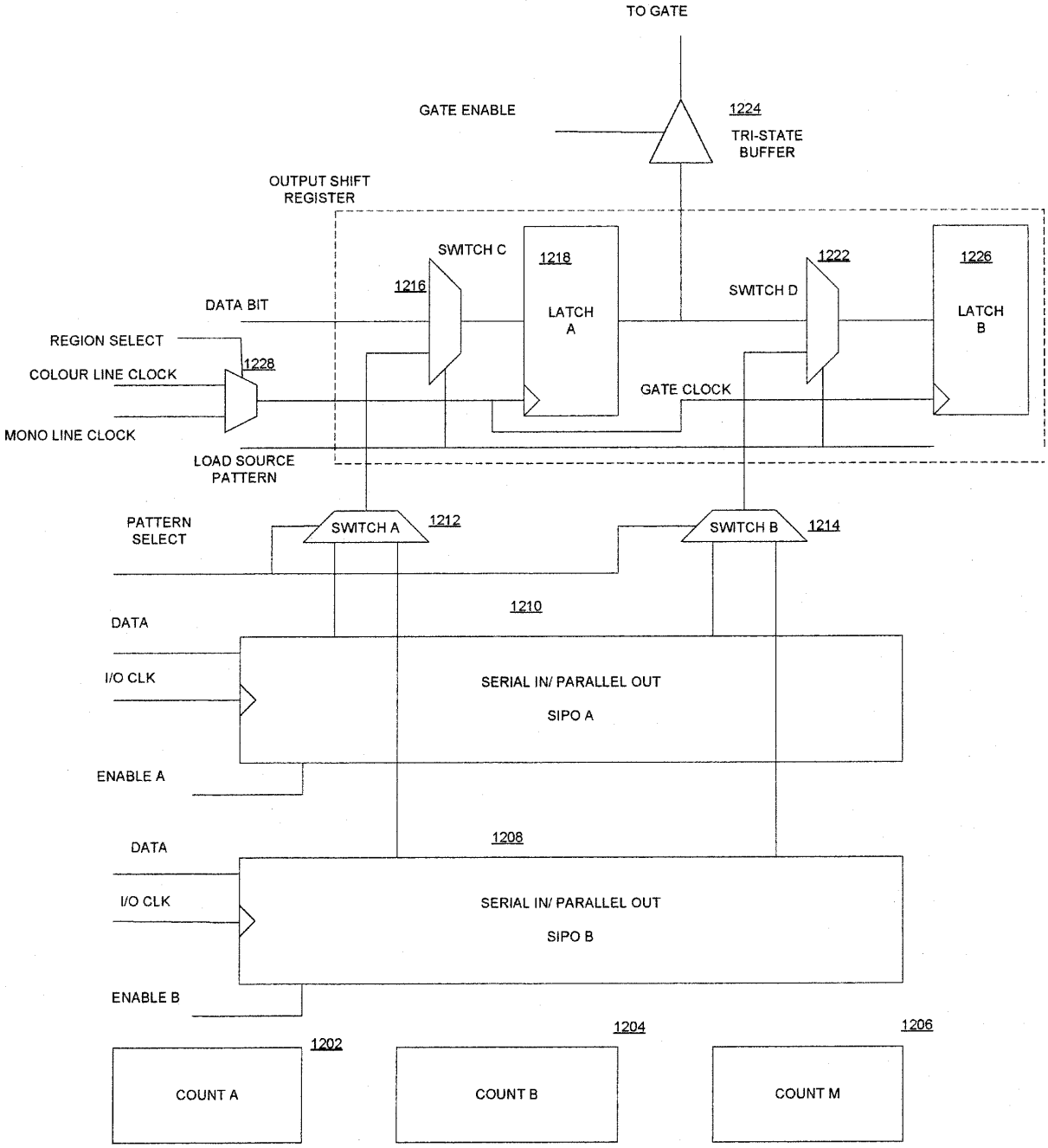
TO GATE
GATE ENABLE
1224
TRI-STATE BUFFER
OUTPUT SHIFT REGISTER
SWITCH C
1216
1218
LATCH A
1222
SWITCH D
1226
LATCH B
DATA BIT
REGION SELECT
1228
COLOUR LINE CLOCK
MONO LINE CLOCK
GATE CLOCK
LOAD SOURCE PATTERN
PATTERN SELECT
SWITCH A
1212
SWITCH B
1214
1210
DATA
I/O CLK
SERIAL IN/ PARALLEL OUT
SIPO A
ENABLE A
1208
DATA
I/O CLK
SERIAL IN/ PARALLEL OUT
SIPO B
ENABLE B
1202
1204
1206
COUNT A
COUNT B
COUNT M

FIGURE 12

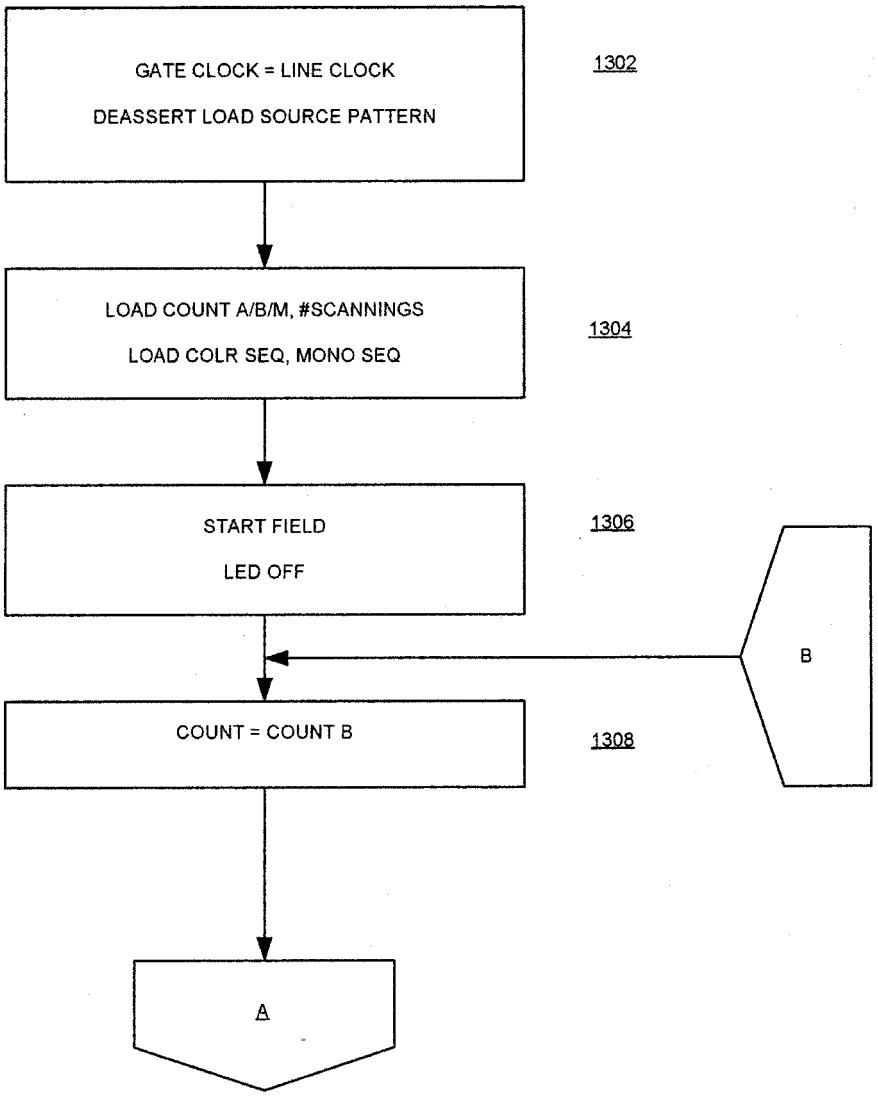
GATE CLOCK = LINE CLOCK
DEASSERT LOAD SOURCE PATTERN
1302
LOAD COUNT A/B/M, #SCANNINGS
LOAD COLR SEQ, MONO SEQ
1304
START FIELD
LED OFF
1306
B
COUNT = COUNT B
1308
A

FIGURE 13

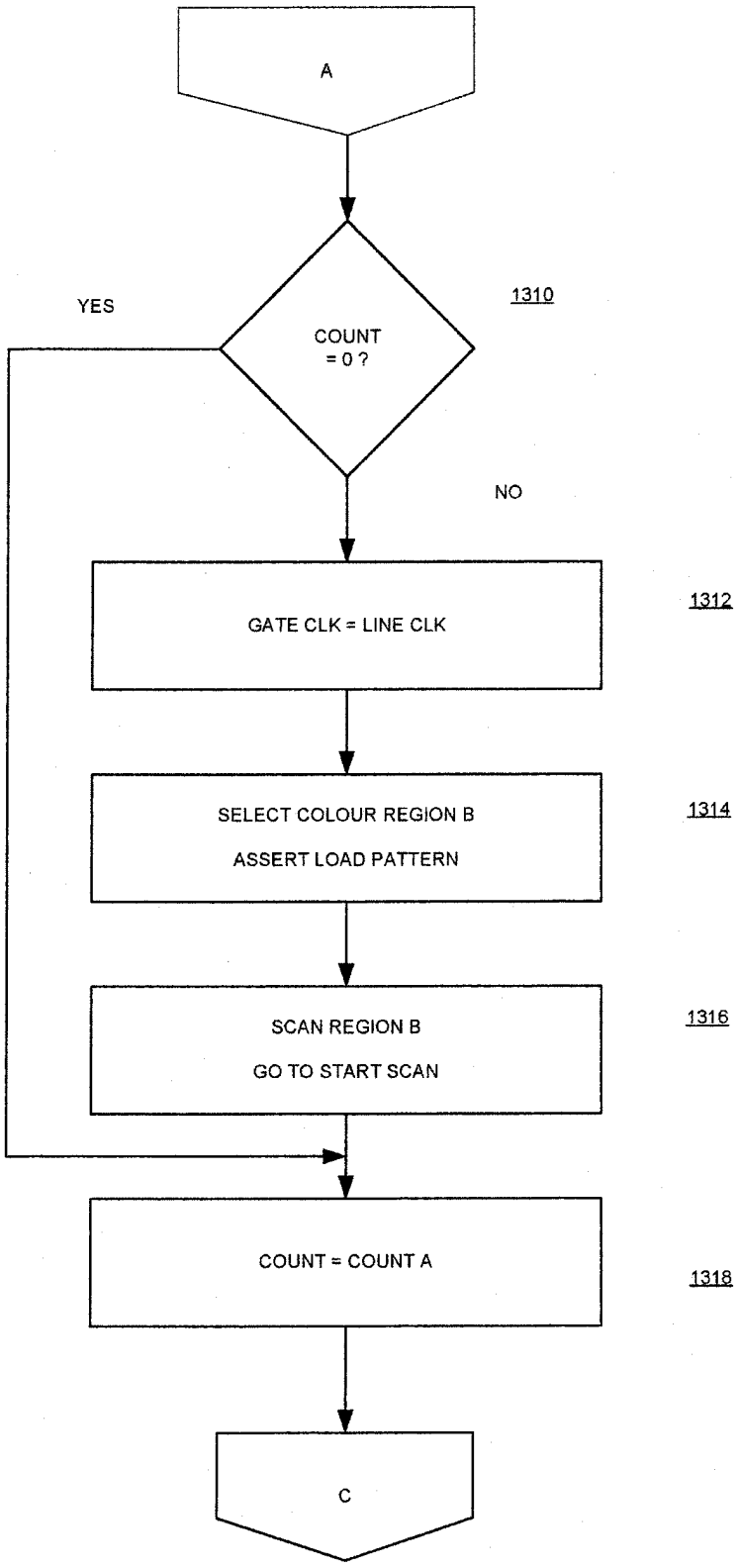
A
COUNT
= 0 ?
1310
YES
NO
GATE CLK = LINE CLK
1312
SELECT COLOUR REGION B
ASSERT LOAD PATTERN
1314
SCAN REGION B
GO TO START SCAN
1316
COUNT = COUNT A
1318
C

FIGURE 13

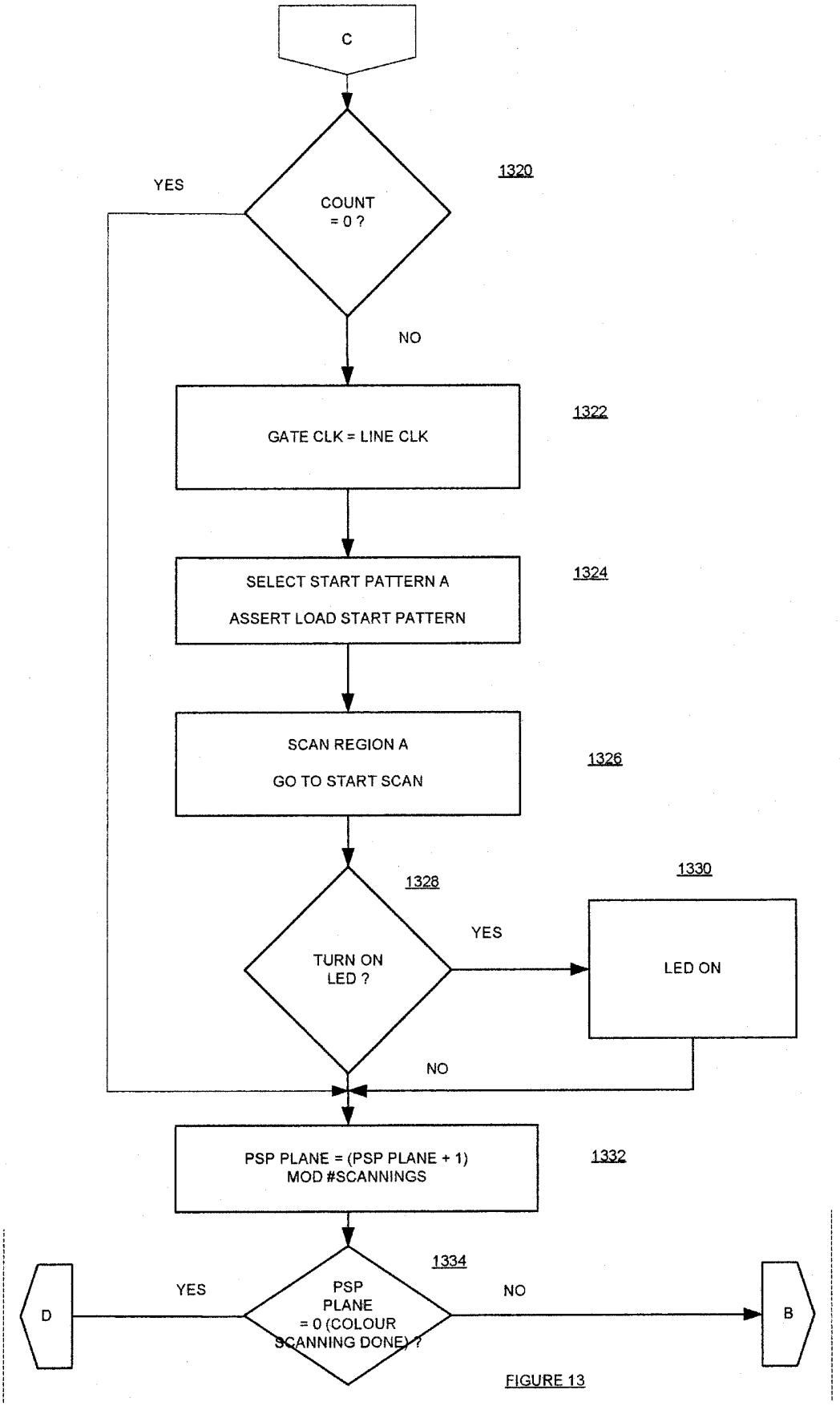
C
COUNT = 0 ?
1320
YES
NO
GATE CLK = LINE CLK
1322
SELECT START PATTERN A
ASSERT LOAD START PATTERN
1324
SCAN REGION A
GO TO START SCAN
1326
1328
TURN ON LED ?
YES
1330
LED ON
NO
PSP PLANE = (PSP PLANE + 1) MOD #SCANNINGS
1332
1334
PSP PLANE = 0 (COLOUR SCANNING DONE) ?
YES
NO
D
B

FIGURE 13

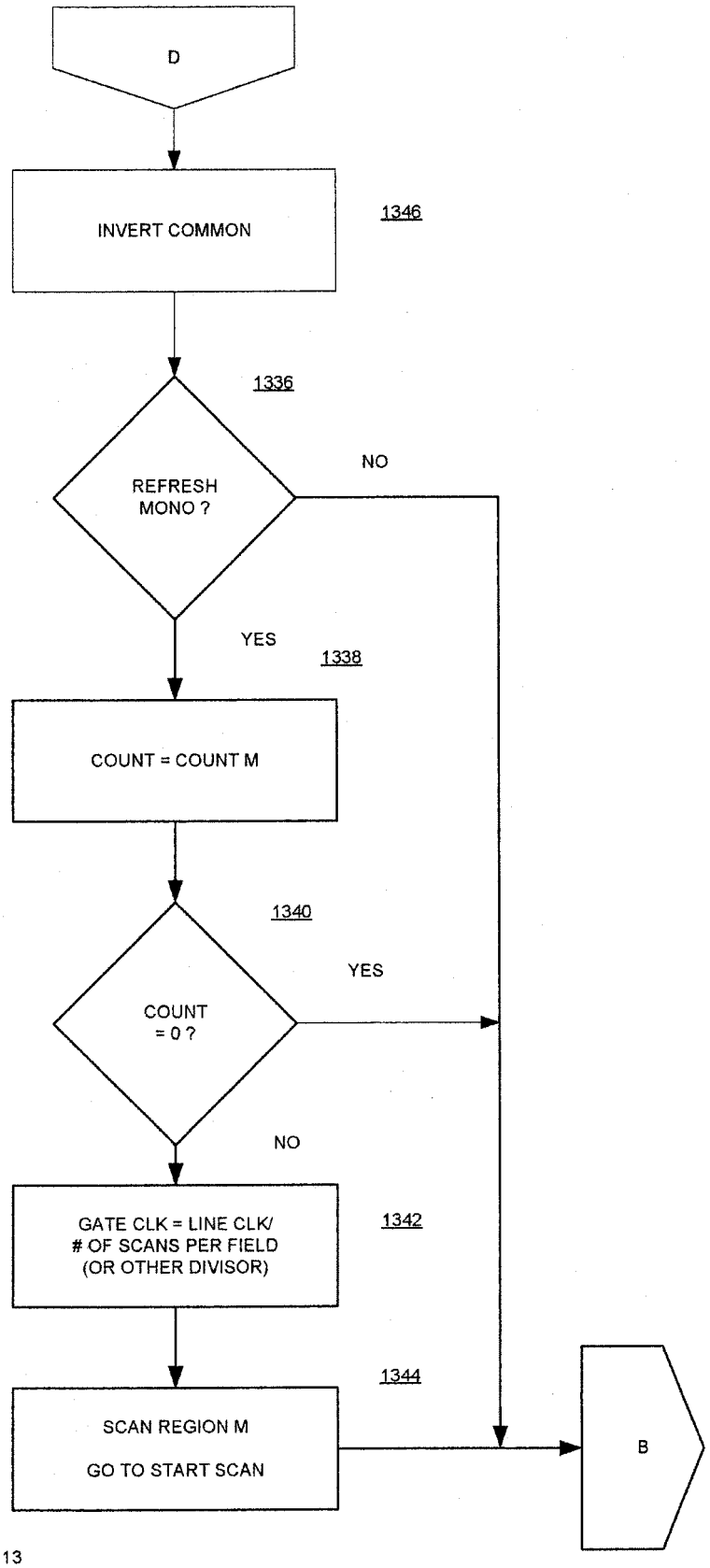
D
INVERT COMMON
1346
1336
REFRESH MONO ?
NO
YES
1338
COUNT = COUNT M
1340
COUNT = 0 ?
YES
NO
GATE CLK = LINE CLK/ # OF SCANS PER FIELD (OR OTHER DIVISOR)
1342
1344
SCAN REGION M
GO TO START SCAN
B

FIGURE 13

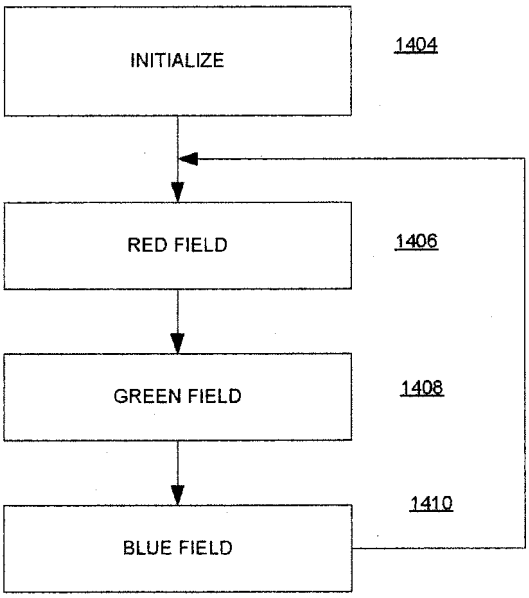
INITIALIZE
1404
RED FIELD
1406
GREEN FIELD
1408
1410
BLUE FIELD

FIGURE 14

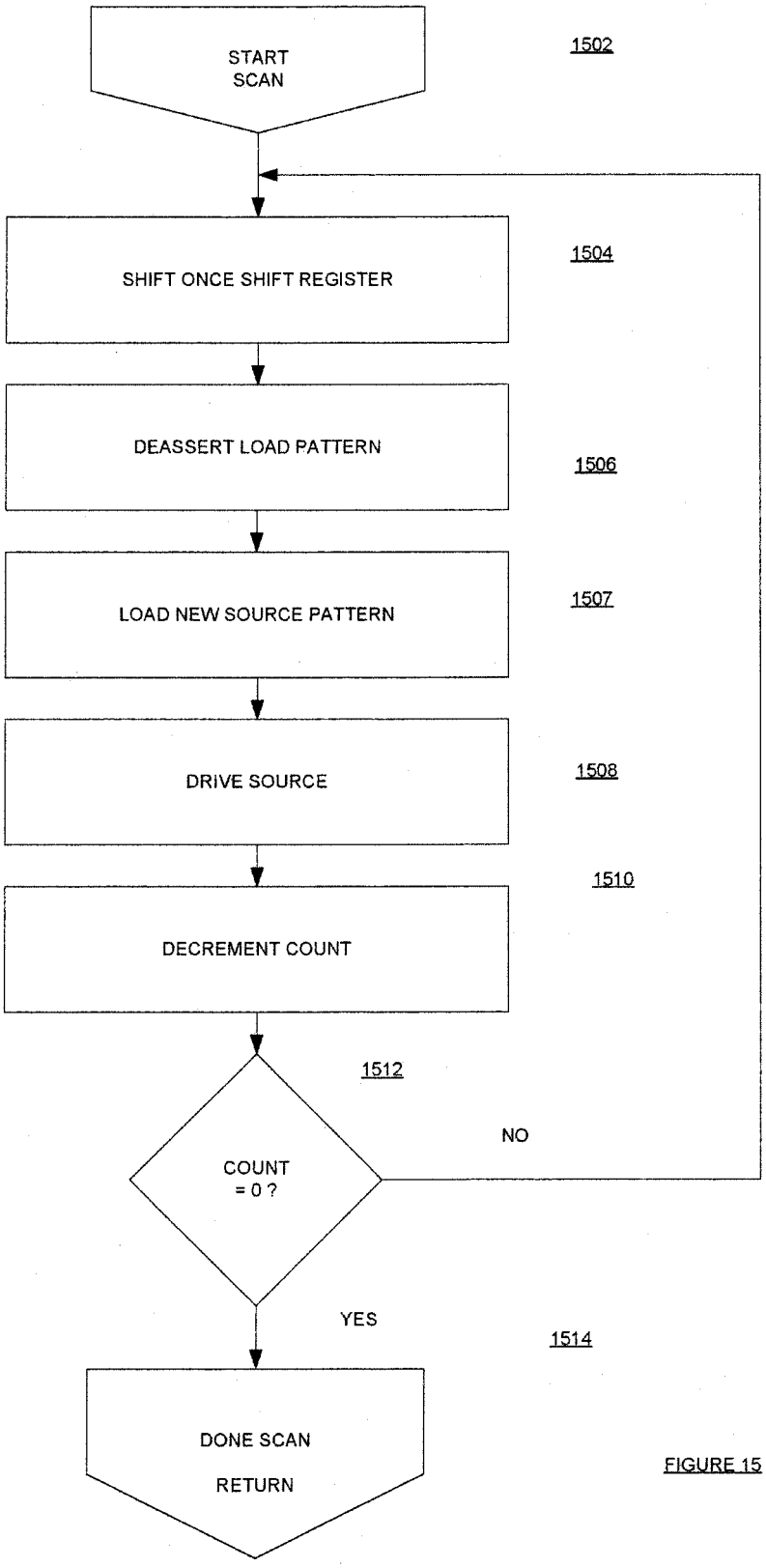
START SCAN
1502
SHIFT ONCE SHIFT REGISTER
1504
DEASSERT LOAD PATTERN
1506
LOAD NEW SOURCE PATTERN
1507
DRIVE SOURCE
1508
DECREMENT COUNT
1510
1512
COUNT = 0 ?
NO
YES
1514
DONE SCAN
RETURN

FIGURE 15

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- US 20030063077 A **[0003]**
- WO 019198 A **[0004]**
- US 20040140972 A **[0004]**
- EP 0852371 A **[0005]**
- EP 11148468 A **[0006]**
- US 20040027364 A **[0007]**