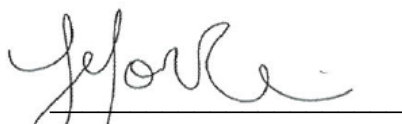


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I, Jacqueline Yorke, hereby certify that the document “D2 -- JP_H07152347_A” is, to the best of my knowledge and belief, a true and accurate translation from Japanese into English.

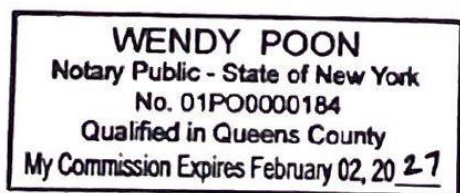


Jacqueline Yorke

Sworn to before me this
April 28, 2025



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Stamp, Notary Public

(12) **Japanese Unexamined Patent**
Application Publication (A)

(11) Japanese
Unexamined Patent
Application Publication
Number
H7-152347

(19) Japanese Patent Office (JP)

(43)Publication Date June 16, 1995

(51) Int. CL. ⁶	Identification codes	JPO file number	FI	Technical indications
G09G 3/36				
G02F 1/133	505			

Request for examination Not yet requested Number of claims 3 OL (Total of 8 pages)

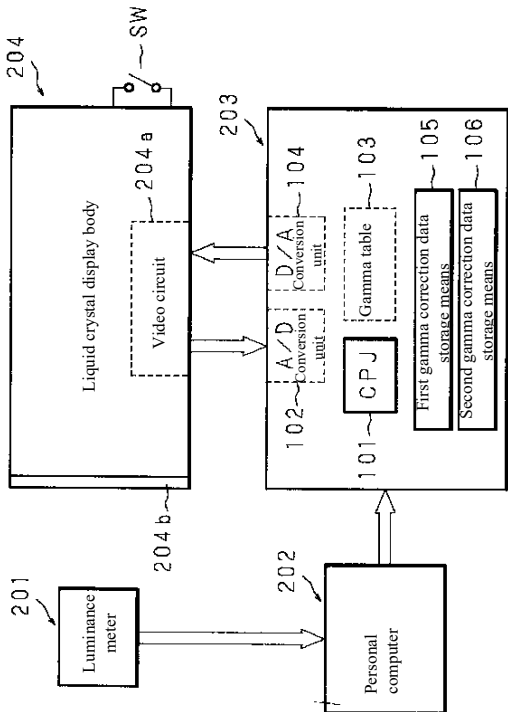
(21) Application number	Japanese Patent Application H5-298604	(71)Applicant	000001889 Sanyo Electric Co., Ltd 2-5-5 Keihan-hondori, Moriguchi-shi, Osaka-fu
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(54) (TITLE OF THE INVENTION) A gamma correction method for a liquid crystal display, and a liquid crystal display

(57) (ABSTRACT)

(PURPOSE) To correct the gamma characteristics of a liquid crystal display in consideration of the gamma characteristics of the image signal for which gamma correction has been performed.

(CONSTITUTION) Different voltages may be applied sequentially to liquid crystal panel 204b of liquid crystal display body 204 in order to change the light transmittance of liquid crystal panel 204b. The light transmittance when different voltages are applied may be measured using luminance meter 201. In consideration of the gamma characteristics of the image signal for which gamma correction has been performed based on the characteristics of the light transmittance that was measured, personal computer 202 will calculate the gamma correction data to enable linearity of the light transmittance in relation to the changes in the applied voltage, and the gamma correction data that was calculated will be written onto first gamma correction data storage means 106.



(SCOPE OF PATENT CLAIMS)

(CLAIM 1) A gamma correction method for a liquid crystal display to measure the light transmittance of a liquid crystal panel to which voltage has been applied in order to determine the gamma characteristics of the liquid crystal panel based on the light transmittance that was measured and to correct the gamma characteristics of the liquid crystal panel, wherein said gamma correction method for a liquid crystal display is characterized by the fact that it has a step to sequentially generate different voltages to be applied to said liquid crystal panel, and a step to calculate the gamma correction data that has taken into consideration the gamma characteristics of the image signal for which gamma correction has been performed by multiplying the inverse function of the gamma characteristics of the liquid crystal panel that were determined based on the light transmittance and the inverse function of the gamma characteristics of the image signal for which gamma correction has been performed.

(CLAIM 2) A liquid crystal display to use the gamma correction data to correct the gamma characteristics of a liquid crystal panel in order to perform gamma correction of the image signal, wherein said liquid crystal display is characterized by the fact that it is provided with a first storage means to store said gamma correction data for which no consideration was given to the gamma characteristics of the image signal for which no gamma correction has been performed, a second storage means to store the gamma correction data that has taken into consideration the gamma characteristics of the image signal for which gamma correction has been performed, and a means to alternatively select the first storage means and the second storage means.

(CLAIM 3) The liquid crystal display described in Claim 2 that is characterized by the fact that the configuration involves a single CPU to perform control of the gamma correction means for the individual R, B, and B image signals, said first storage means, and said second storage means.

(DETAILED DESCRIPTION OF THE INVENTION)

(0001)

(FIELD OF INDUSTRIAL APPLICATION) The present invention relates to a gamma correction method for a liquid crystal display and a liquid crystal display. More specifically, the present invention proposes a gamma correction method that takes into consideration the gamma characteristics of the image signal for which gamma correction has been performed, and a liquid crystal display that places no emphasis on gamma correction even for image signals for which no gamma correction has been performed.

(0002)

(PRIOR ART) In liquid crystal displays, so-called gamma correction is performed in order to correct the non-linearity and manufacturing variability of the voltage-light transmission characteristics of the liquid crystal elements in liquid crystal panels. Japanese Unexamined Patent Application Publication H5-064037, for example, discloses an automatic adjustment method for the gamma correction circuit in a liquid crystal display that performs this type of gamma correction. Figure 5 is a block diagram that shows the case in which this automatic adjustment method is implemented. The R (red) image signal that may be inputted into input terminal 100 will be inputted into gamma correction device 1, and the image signal that may be outputted from this device will be inputted into amplification and alternating current drive unit 112. The image signal that may be outputted from amplification and alternating current drive unit 112 will be provided to liquid crystal display element 108. This gamma correction device 1, amplification and alternating current drive unit 112, and liquid crystal element 108 constitute optical modulation device 8 for use with R (red) image signals.

(0003) Also, optical modulation device 9 for use with G (green) image signals and optical modulation device 10 for use with B (blue) image signals are provided according to the same structure as optical modulation device 8. The light that has been modulated by the R, G, and B liquid crystal display elements 108 will be optically synthesized by optical synthesis device 113. The optically synthesized modulated light will be incident on luminance meter 2. The light transmittance characteristics as measured and outputted by luminance meter 2 will be inputted into general-purpose microcomputer 4 via interface 5, and the

light transmittance data that was outputted from general-purpose microcomputer 4 will be provided to gamma correction device 1 via interface 3.

(0004) Next, the operation of the automatic adjustment method of the gamma correction circuit will be described. Based on the luminance output in relation to the input voltage of the liquid crystal display, the luminance output in relation to the change in the input voltage, or in other words, the V-T characteristic, will be measured, and the gamma correction data to appropriately correct the gamma characteristics of the liquid crystal display device based on this V-T characteristic will be calculated by general-purpose microcomputer 4. The gamma correction data of the gamma correction circuit will be automatically adjusted by storing the results of this calculation as the gamma correction data in the memory (not shown in the figure) in gamma correction device 1.

(0005)

(PROBLEM TO BE SOLVED BY THE INVENTION) However, if the gamma characteristics of the liquid crystal panel are corrected using the automatic adjustment method of the gamma correction circuit in the conventional liquid crystal display as described above, if the image signal that may be inputted has undergone gamma correction, the gamma correction of the liquid crystal panel will be performed in the state in which this gamma correction has been performed, and there is a problem that the gamma correction of the image signal will be emphasized. In addition, even when taking into consideration the gamma correction of image signals for which gamma correction has been performed, in the case of image signals for which no gamma correction has been performed, inverse gamma correction of the image signals will be performed, and there is a problem that the gamma characteristics will be emphasized in this case as well.

(0006) In light of these types of problems, the present invention is intended to provide a gamma correction method for a liquid crystal display that will obtain the gamma correction data that takes into consideration the gamma characteristics of an image signal for which gamma correction has been performed and the gamma correction data that does not take this into consideration, and a liquid crystal display that does not emphasize gamma correction in either image signals for which gamma correction has been performed or image signals for which no gamma correction has been performed.

(0007)

(MEANS FOR SOLVING THE PROBLEM) The gamma adjustment method in a liquid crystal display according to the first invention is a gamma correction method for a liquid crystal display to measure the light transmittance of a liquid crystal panel to which voltage has been applied in order to determine the gamma characteristics of the liquid crystal display based on the light transmittance that was measured and to correct the gamma characteristics of the liquid crystal panel, wherein this method is characterized by the fact that it has a step to sequentially generate different voltage to be applied to said liquid crystal panel, and a step to calculate the gamma correction data that has taken into consideration the gamma characteristics of the image signal for which gamma correction has been performed by multiplying the inverse function of the gamma characteristics of the liquid crystal panel that were determined based on the light transmittance and the inverse function of the gamma characteristics of the image signal for which gamma correction has been performed.

(0008) The liquid crystal display according to the second invention is a liquid crystal display to use the gamma correction data to correct the gamma characteristics of the liquid crystal display in order to perform gamma correction of the image signal, wherein said liquid crystal display is characterized by the fact that it is provided with a first storage means to store said gamma correction data for which no consideration was given to the gamma characteristics of the image signal for which no gamma correction has been performed, a second storage means to store the gamma correction data that has taken into consideration the gamma characteristics of the image signal for which gamma correction has been performed, and a means to alternatively select the first storage means and the second storage means.

(0009)

(OPERATION) In the first invention, a test signal will be generated and a voltage corresponding to the test signal will be applied to the liquid crystal panel. The light transmittance of the liquid crystal panel will change according to the voltage that has been applied, and the light transmittance of the liquid crystal panel that has changed will be measured. Based on the light transmittance that was measured, the gamma characteristics of the liquid crystal panel may be determined. By multiplying the inverse function of the gamma characteristics of the liquid crystal panel and the inverse function of the gamma characteristics of the image signal for which gamma correction has been performed, it will be possible to obtain the gamma correction data that has taken into consideration the gamma characteristics of the image signal for which gamma correction has been performed. As a result, it will be possible to use the test signal to automatically provide the voltage to be applied to the liquid crystal panel when measuring the light transmittance of the panel. In the case of an image signal for which gamma correction has been performed, it will be possible to obtain the gamma correction data that does not emphasize the gamma correction.

(0010) In the second invention, the gamma correction data that has given no consideration to the gamma characteristics of image signals for which no gamma correction has been performed will be written onto the first storage means, while the gamma correction data that has given consideration to the gamma characteristics will be written onto the second storage means. In the case of an image signal for which no gamma correction has been performed, gamma correction will be performed on the image signal using the gamma correction data in the first storage means. In the case of an image signal for which gamma correction has been performed, gamma correction will be performed on the image signal using the gamma correction data in the second storage means. As a result, there will be no emphasis of the gamma correction of the image signals, whether for image signals for which no gamma correction has been performed or for image signals for which gamma correction has been performed.

(0011)

(EXAMPLES OF EMBODIMENT) The present invention will be described in detail below based on the drawings. Figure 1 is a block diagram that shows the implementation status of the gamma property correction method in a liquid crystal display according to the first invention. Video circuit 204a is built into liquid crystal display body 204, which is also provided with liquid crystal panel 204b, and on the outer surface of the liquid crystal display, switch SW to select the gamma correction data storage means, which will be described later, and image signal input terminals, etc., (not shown in the figure) are provided. Liquid crystal panel 204b faces the light incident side of luminance meter 201, ensuring that the light transmittance of liquid crystal panel 204b can be measured by luminance meter 201. The measured output of luminance meter 201 will be inputted into personal computer 202.

(0012) The signal that may be outputted from personal computer 202 will be inputted into gamma correction circuit 203. The signal that may be outputted from gamma correction circuit 203 will be inputted into liquid crystal display body 204, and the signal that may be outputted from liquid crystal display body 204 will be inputted into gamma correction circuit 203. Analog/digital conversion unit (hereinafter referred to as the A/D conversion unit) 102, digital/analog conversion unit (hereinafter referred to as the D/A conversion unit) 104, CPU 101, gamma table 103 to store the gamma correction data, first gamma correction data storage means 105, and second gamma correction data storage means 106 are built into gamma correction circuit 203.

(0013) Figure 2 and Figure 3 are block diagrams that show the actual circuit of gamma correction circuit 203. The R (G, B) image signals that have been inputted from liquid crystal display body 204 into input terminals 100R_i (100G_i, 100B_i) will be inputted into A/D conversion circuit AD_R (AD_G, AD_B) of A/D conversion unit 102. The image signal that may be outputted

from A/D conversion circuit AD_R (AD_G, AD_B) after undergoing analog/digital conversion (hereinafter referred to as A/D conversion) will be inputted into the latch circuit L_R (L_G, L_B) of A/D conversion unit 102. The image signals that may be outputted from latch circuit L_R (L_G, L_B) will be inputted via selector SL_{R1} (SL_{G1}, SL_{B1}) into address terminals A₀ through A₇ of SRAM SM_R (SM_G, SM_B) of gamma table 103. The image signals that may be outputted from input/output terminals D₀ to D₇ of SRAM SM_R (SM_G, SM_B) will be inputted into D/A conversion circuit DA_R (DA_G, DA_B) of D/A conversion unit 104 via selector SL_{R2} (SL_{G2}, SL_{B2}).

(0014) Following digital/analog conversion (hereinafter referred to as D/A conversion), the image signals that may be outputted from D/A conversion circuit DA_R (DA_G, DA_B) will be outputted to output terminal 100R₀ (100G₀, 100B₀). The chip select signal that may be outputted from chip select control circuit CS_R (CS_G, CS_B) will be inputted into chip select terminal CS₂ of SRAM SM_R (SM_G, SM_B), and write signal #WR will be inputted into write enable terminal #WE. Also, the output enable signal that may be outputted from output enable control circuit OE will be inputted into output enable terminal #OE. Output enable control circuit OE will be provided with mode switching signal P10 and readout signal #RD.

(0015) The test signal data that will be described below and that may be outputted from personal computer 202 will be inputted into latch circuit L₁, while control command signals such as mode switching signal P10 and gate control signal P16 will be inputted into line driver LD. Data bus DB connects the output side of latch circuit L₁ and the input side of port P0 and latch circuit L₂ of CPU 101, the output side of program memory PGM and the input/output side of bus transceivers BTR_R, BTR_G, and BTR_B, the input side of latch circuit L₃ that is the test signal output, and the input/output terminals D₀ to D₇ of EEPROM 105_R, 105_G, 105_B and the input/output terminals D₀ to D₇ of EEPROM 106_R, 106_G, and 106_B.

(0016) Latch circuit L₃ is configured to output a test signal corresponding to the voltage to be applied to the liquid crystal panel in order to determine the light transmittance of liquid crystal panel 204b. The output side of latch circuit L₃ and the input side of one of selectors SL_{R2}, SL_{G2}, and SL_{B2} are connected by data bus DB. The data bus connects the other input/output side of bus transceiver BTR_R (BTR_G, BTR_B) to the other input side of selector SL_{R2} (SL_{G2}, SL_{B2}) and the input/output terminals D₀ through D₇ of SRAMSM_R (SM_G, SM_B). Selectors SL_{R2}, SL_{G2}, and SL_{B2} will be provided with mode switching signals P10. Bus transceivers BTR_R, BTR_G, and BTR_B will be provided with a bus transceiver control signal from gate control circuit GC. Gate control circuit GC will be provided with gate control signal P16, read signal #RD, and write signal #WR.

(0017) EEPROM 105_R, 105_G, and 105_B correspond to the R, G, and B image signals, and constitute first gamma correction data storage means 105 to store the gamma correction data that has given no consideration to the gamma characteristics of image signals that have not undergone gamma correction. Also,

EEPROM 106_R, 106_G, and 106_B correspond to the R, G, and B image signals, and constitute second gamma correction data storage means 106 to store the gamma correction data that has given consideration to the gamma characteristics of image signals that have undergone gamma correction. Output enable terminal #OE of EEPROM 105_R, 105_G, and 105_B and EEPROM 106_R, 106_G, and 106_B will be provided with read signal #RD, while write enable terminal #WE will be provided with write signal #WR. EEPROM 105_R (105_G, 105_B) and 106_R (106_G, 106_B) will also be provided with EEPROM select signal Y1 (Y2, Y3), and the R/B terminals of EEPROM 105_R (105_G, 105_B) and 106_R (106_G, 106_B) will output EEPROM READY/BUSY discrimination signal T0.

(0018) In addition, chip select terminal #CS of EEPROM 105_R, 105_G, and 105_B will be provided with switching signal S_{SL} according to the turning ON or OFF of switch SW of liquid crystal display body 204, and chip select terminal #CS of EEPROM 106_R, 106_G, and 106_B will be provided with switching signal S_{SL} via inverter INV.

(0019) The output side of line driver LD and port P1 of CPU 101 are connected by a bus. Line driver LD also provides interrupt control signal INT0 to CPU 101. Address bus ADB connects the input side of program memory PGM, the output side of latch circuit L2, the address terminal of address decoder ADD, port P2 of CPU 101, the input terminal of selectors SL_{R1}, SL_{G1}, and SL_{B1}, and address terminals A₀ to A₇ of EEPROM 105_R, 105_G, 105_B, 106_R, 106_G, and 106_B. Mode switching signal P10, gate control signal P16, read signal #RD, and write signal #WR will be outputted from CPU 101.

(0020) Also, CPU 101 will be provided with EEPROM READY/BUSY discrimination signal T0 from EEPROM 105_R, 105_G, 105_B, 106_R, 106_G, and 106_B. Address decoder ADD will provide an output control signal to output control terminal #OC of latch circuit L1. Also, EEPROM select signals Y1, Y2, and Y3, and SRAM select signals Y4, Y5, and Y6 will be outputted from address decoder ADD. SRAM select signal Y4 (Y5, Y6) and mode switching signal P10 will be provided to chip select control circuit CS_R (CS_G, CS_B). Latch control signal Y0 that may be outputted from address decoder ADD will be provided to latch circuit L3.

(0021) Next, the method for performing gamma correction of a liquid crystal display will be described. First, the power of personal computer 202 and liquid crystal display body 204 is turned on, and personal computer 202, liquid crystal display body 204, and gamma correction circuit 203 will enter into an operating state. By doing this, personal computer 202 will output the test signal data, mode switching signal, gate control signal, and other control command signals for generating test signals in response to the voltage applied to liquid crystal panel 204b, and will input these into gamma correction circuit 203. In the case of 8 bits, the number that can be expressed for this test signal data will range, for example, from 0 to 256, so A/D conversion circuits AD_R, AD_G, and AD_B will generate a voltage level that is determined to be a suitable number within this range. This test signal data will then be inputted into gamma correction circuit 203 and inputted into latch circuit L3 and CPU 101 via latch circuit L1.

(0022) The control command signal will be inputted into CPU 101 via line driver LD. As a result of the input of these signals outputs, L-level mode switching signal P10 may be outputted from CPU 101 in order to be provided to selectors SL_{R2}, SL_{G2}, and SL_{B2}. Selectors SL_{R2}, SL_{G2}, and SL_{B2} will then perform a switching operation to select latch circuit L3. Also, address decoder ADD will be controlled by CPU 101, and latch control signal Y0 that has been outputted from address decoder ADD will be provided to latch circuit L3, at which point latch circuit L3 will generate a test signal based on the test signal data. This test signal will be inputted into D/A conversion circuit D/A conversion circuit DA_{R2} (DA_{G2}, DA_{B2}) via selector SL_{R2} (SL_{G2}, SL_{B2}) in order to undergo D/A conversion. The D/A converted analog voltage will be inputted into liquid crystal display body 204 via output terminals 100R₀, 100G₀, and 100B₀ and will be applied to liquid crystal panel 204b.

(0023) As a result, liquid crystal panel 204b will change its entire surface to light transmittance according to the applied voltage. Luminance meter 201 will measure the light transmittance (luminance) of liquid crystal panel 204b. The measurement value for the light transmittance that was measured will be written to memory by personal computer 202. Subsequently, the test signal data will be changed by personal computer 202 and inputted into latch circuit L3 as described above in order to change the voltage applied to liquid crystal panel 204b, which will change the light transmission of liquid crystal panel 204b. The light transmittance will be measured by luminance meter 201, and the measurement value will be written into memory as described above. The same operation will be repeated in order to sequentially change the applied voltage of liquid crystal panel 204b from, for example, a black level to a white level in order to measure the light transmission corresponding to each of the applied voltages.

(0024) In this way, by measuring all of the light transmission from the black level to the white level results, it will be possible to determine the gamma characteristics of liquid crystal panel 204b. As a result, personal computer 202 will read the measurement values of the light transmission that has been stored in the memory, will calculate the inverse function of the gamma characteristics of liquid crystal panel 204b, and will calculate the gamma correction data in order to correct the gamma characteristics of liquid crystal panel 204b. The gamma correction data that has been calculated in this way will be stored temporarily in personal computer 202.

(0025) By the way, for example, the image signals that may be sent from the broadcasting station has gamma characteristics for which gamma correction has been performed as follows:

$$L = \{(V + 0.1115) / 1.1115\}^{(1/0.45)} \dots (1)$$

However, if $V \geq 0.0913$

$$L = V / 4.0 \dots (2)$$

However, if $V < 0.081$

(L: Relative light transmission in relation to 100% white; V: Relative applied voltage in relation to 100% white of the voltage applied to the liquid crystal panel)

(0026) Therefore, it will also be necessary to correct the gamma characteristics of the image signal for which gamma correction has been performed. Therefore, personal computer 202 will calculate the inverse function of the gamma characteristics of the image signal for which gamma correction has been performed, and will multiply the inverse function that has been calculated by the gamma correction data to correct the gamma

characteristics of the liquid crystal panel, or in other words, the inverse function of the gamma characteristics of liquid crystal panel 204b, in order to calculate the gamma correction data that has given consideration to the gamma characteristics of the image signal for which gamma correction has been performed. (0027) As a result, it will be possible to obtain gamma correction data that can correct the gamma characteristics of the liquid crystal panel and the gamma characteristics of the image signal for which gamma correction has been performed. The gamma correction data that has been calculated in this way will be stored temporarily in personal computer 202.

(0028) Next, switch SW that is provided in liquid crystal display body 204 may be turned off, for example, and switching signal S_{SL} will be set to L level for selection of EEPROM 105_R, 105_G, and 105_B. Next, after storing the gamma correction data, the control command signal that may be outputted from personal computer 202 will be inputted into gamma correction circuit 203, forcing the output of the address signal and write signal #WR from CPU 101 in order to be provided to EEPROM 105_R, 105_G, 105_B, 106_R, 106_G, and 106_B. Here, personal computer 202 will read the gamma correction data, for example, that has given no consideration to the gamma characteristics of image signals that have not undergone gamma correction for input into gamma correction circuit 203, and will write the gamma correction data to EEPROM 105_R, 105_G, and 105_B. After the writing of this gamma correction data has been completed, switch SW will be switched, changing switching signal S_{SL} to the H level in order to select EEPROM 106_R, 106_G, and 106_B. The gamma correction data that has given consideration to the gamma characteristics of the image signal that has undergone gamma correction will then be read from personal computer 202 for input into gamma correction circuit 203, after which it will be written to EEPROM 106_R, 106_G, and 106_B.

(0029) As a result, it will be possible to obtain gamma correction data that has given no consideration to the gamma characteristics of image signals for which gamma correction has been performed, and gamma correction data that has given consideration to the gamma characteristics of image signals for which gamma correction has been performed. In other words, it will be possible to obtain gamma correction data that does not emphasize the gamma correction of the image signal, whether it is an image signal for which gamma correction has been performed or an image signal for which no gamma correction has been performed.

(0030) IN THE PRESENT EXAMPLE OF EMBODIMENT, THE GAMMA CORRECTION DATA FROM PERSONAL COMPUTER 202 WILL BE WRITTEN DIRECTLY TO EEPROM 105_R, 105_G, 105_B, 106_R, 106_G, AND 106_B PARTICULARLY, BUT IT IS ALSO ACCEPTABLE TO TEMPORARILY WRITE THIS DATA TO SRAM SM_R, SM_G, AND SM_B, AND THEN TO SPECIALLY TRANSFER THE DATA TO EEPROM 105_R, 105_G, 105_B, 106_R, 106_G, AND 106_B FOR WRITING. Also, the gamma correction data that has given no consideration to the gamma characteristics of image signals for which gamma correction has been performed and the gamma correction data that has given consideration to the gamma characteristics of image signals for which gamma correction has been performed were divided for writing to first gamma correction data storage means 105 and second gamma correction data storage means 106, but for instance, the same effect may be achieved even when dividing one of the gamma correction data storage means into a first storage region and a second storage region, and writing the gamma correction data that has given no consideration to the gamma characteristics to the first storage region, while writing the gamma correction data that has given consideration to the gamma characteristics to the second storage region.

(0031) Next, the operation of the liquid crystal display consisting of liquid crystal display body 204 and gamma

correction circuit 203 will be described. Figure 4 is a block diagram of the liquid crystal display when displaying an image, wherein the configuration of liquid crystal display body 204 and gamma correction circuit 203 is the same as that of liquid crystal display body 204 and gamma correction circuit 203 in Figure 1, and the configuration of gamma correction circuit 203 is the same as that of gamma correction circuit in Figure 2.

(0032) First, the gamma correction data that has given no consideration to the gamma characteristics of image signals for which gamma correction has been performed will be stored in first gamma correction data storage means 105, and the gamma correction data that has given consideration to the gamma characteristics of image signals for which gamma correction has been performed will be stored in the second gamma correction data storage means 106 using the gamma characteristic correction method described above. Here, if the image is to be displayed by inputting an image signal that has not undergone gamma correction into liquid crystal display body 204, switch SW that has been provided in liquid crystal display body 204 will be turned OFF. When the liquid crystal display is turned ON, switching signal S_{SL} will change to the L level, selecting EEPROM 105_R, 105_G, and 105_B of first gamma correction data storage means 105.

(0033) Also, CPU 101 will start the control operation, and H-level mode switching signal P10, gate control signal P16, read signal #RD, and write signal #WR will be outputted from CPU 101. When gate control circuit GC is provided with gate control signal P16 and readout signal #RD, the gate signals will be provided to bus transceivers BTR_R, BTR_G, and BTR_B from gate control circuit GC, and bus transceiver BTR_R (BTR_G, BTR_B) will enter a state in which it will be possible to input the gamma correction data of EEPROM 105_R (105_G, 105_B) to SRAM SM_R (SM_G, SM_B).

(0034) Also, when EEPROM 105_R, 105_G, and 105_B are provided with the address signal and read signal #RD, and EEPROM select signals Y1, Y2, and Y3 are provided from address decoder ADD, the gamma correction data that has given no consideration to the gamma characteristics of the image signals that have not undergone gamma correction will be read from EEPROM 105_R (105_G, 105_B), and this data will be inputted into SRAM SM_R (SM_G, SM_B) via bus transceiver BTR_R (BTR_G, BTR_B). When mode switching signal P10 and SRAM select signal Y6 are inputted into chip select control circuits CS_R, CS_G, and CS_B, the chip select signals that may be outputted from chip select control circuits CS_R, CS_G, and CS_B will be provided to SRAM SM_R, SM_G, and SM_B, and when write signal #WR is provided to SRAM SM_R, SM_G, and SM_B, the correction data that was provided from EEPROM 105_R, 105_G, and 105_B will be written to SRAM SM_R, SM_G, and SM_B, setting the gamma correction data in gamma table 103.

(0035) Next, when selectors SL_{R1}, SL_{G1}, SL_{B1}, SL_{R2}, SL_{G2}, and SL_{B2} are provided with H-level mode switching signal P10, selector SL_{R1} (SL_{G1}, SL_{B1}) will select latch circuit L_R (L_G, L_B), and selector SL_{R2} (SL_{G2}, SL_{B2}) will perform the switching operation in order to select SRAM SM_R (SM_G, SM_B). By doing this, the image signal that has not undergone gamma correction and that was inputted into input terminal 100_{Ri} (100_{Gi}, 100_{Bi}) will undergo A/D conversion, and the image signal that has been inputted into latch circuit L_R (L_G, L_B) will be inputted into SRAM SM_R (SM_G, SM_B) via selector SL_{R1} (SL_{G1}, SL_{B1}). The voltage level of this image signal will become the address signal,

and accordingly, the image signal will undergo gamma correction based on the gamma correction data that has been stored in SRAM SM_R (SM_G, SM_B).

(0036) Further, when the output enable signal that may be outputted from output enable control circuit OE, into which mode switching signal P10 and readout signal #RD were inputted, is provided to SRAM SM_R, SM_G, and SM_B, the image signal that underwent gamma correction will be read out. The image signal that was read out will be inputted into D/A conversion circuits DA_R, DA_G, and DA_B via selectors SL_{R2}, SL_{G2}, and SL_{B2}, where the signal will undergo D/A conversion. The D/A converted analog image signal will be applied to liquid crystal panel 204b of liquid crystal display body 204 via output terminals 100R₀, 100G₀, and 100B₀ in order to display the image on the liquid crystal panel.

(0037) In this way, the image signal that has not undergone gamma correction will undergo gamma correction based on the gamma correction data that has given no consideration to the gamma characteristics of the image signal for which gamma correction has not been performed, and therefore, the image signal that may be outputted from gamma correction circuit 203 will undergo gamma correction according to the gamma characteristics of the liquid crystal panel, so there will be no emphasis on the gamma correction of the image signal.

(0038) Next, if the image is to be displayed by inputting an image signal that has undergone gamma correction, switch SW that has been provided in liquid crystal display body 204 will be turned ON. By doing this, the switching signal will change to the H level, and EEPROM 106_R, 106_G, and 106_B of second gamma corrected data storage means 106 will be selected. In this case, the gamma correction data that has given consideration to the gamma characteristics of the image signals for which gamma correction has been performed and that has been stored in EEPROM 106_R, 106_G, and 106_B as described above will be provided to and written to SRAM SM_R, SM_G, and SM_B via bus transceivers BTR_R, BTR_G, and BTR_B. As a result, there will be A/D conversion of the image signal for which gamma correction has been performed and that was inputted into input terminal 100R_i (100G_i, 100B_i), the converted image signal will be inputted into latch circuit L_R (L_G, L_B), and the image signal that may be outputted from latch circuit L_R (L_G, L_B) will be inputted into SRAM SM_R (SM_G, SM_B) via selector SL_{R1} (SL_{G1}, SL_{B1}) in order to perform gamma correction of the image signal for which gamma correction has been performed using the gamma correction data that has been stored therein.

(0039) Further, the image signal that has undergone gamma correction using the gamma correction data that has given consideration to the gamma characteristics of the image signal for which gamma correction has been performed will be read from SRAM SM_R (SM_G, SM_B), after which it will be inputted into D/A conversion circuit DA_R (DA_G, DA_B) via selector SL_{R2} (SL_{G2}, SL_{B2}). The D/A converted analog image signal will be applied to liquid crystal panel 204b of liquid crystal display body 204 via output terminal 100R₀ (100G₀, 100B₀) in order to display the image on liquid crystal panel 204b.

(0040) Because the image signal for which gamma correction has been performed that was inputted into input terminals 100R_i, 100G_i, and 100B_i will undergo gamma correction using the gamma correction data that has given consideration to the gamma characteristics of the image signal for which gamma correction has been performed, the image signal that may be outputted from output terminal 100R₀ (100G₀, 100B₀), gamma correction will be performed on both the gamma characteristics of the liquid crystal panel and the gamma characteristics of the

image signal for which gamma correction has been performed, meaning that there will be no emphasis on the gamma correction of the image signal. As a result, it will be possible to obtain a liquid crystal display that is capable of performing gamma correction in response to both image signals for which gamma correction has not been performed and image signals for which gamma correction has been performed.

(0041)

(EFFECT OF THE INVENTION) As described above, according to the first invention, when measuring the light transmittance of a liquid crystal panel, the test signal generation step will sequentially change the voltage to be applied to the liquid crystal panel based on the test signal data, enabling automation of the measurements of the light transmittance of the liquid crystal panel. In addition, it will be possible to obtain the gamma correction data that has given consideration to the gamma characteristics of the image signal for which gamma correction has been performed.

(0042) According to the second invention, it will be possible to store the gamma correction data that has given no consideration to the gamma characteristics of image signals for which gamma correction has not been performed and the gamma correction data that has given consideration to the gamma characteristics of image signals for which gamma correction has been performed, and it will be possible to provide a liquid crystal display that will not emphasize the gamma correction of the image signal for all image signals, regardless of whether gamma correction was attempted on an image signal for which gamma correction has been performed or an image signal for which no gamma correction has been performed by selecting this gamma correction data, resulting in superior effects.

(BRIEF DESCRIPTION OF THE DRAWINGS)

(FIGURE 1) This is a block diagram that shows the case when implementing the gamma correction method for a liquid crystal display.

(FIGURE 2) This diagram shows half of the block diagram showing the actual circuit of the gamma correction circuit.

(FIGURE 3) This diagram shows half of the block diagram showing the actual circuit of the gamma correction circuit.

(FIGURE 4) This is a block diagram that shows the case in which images are displayed using a liquid crystal display.

(FIGURE 5) This is a schematic block diagram of a conventional liquid crystal display.

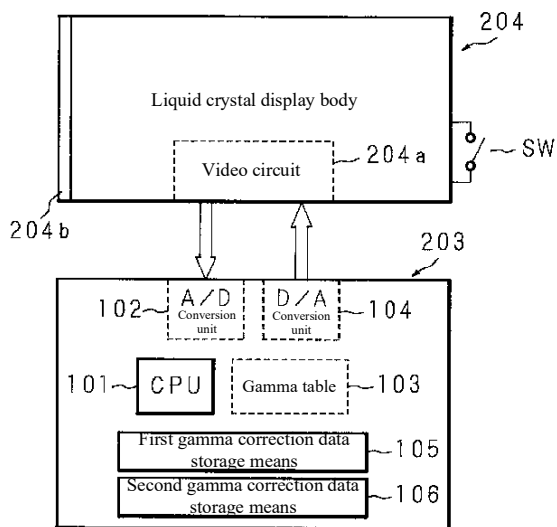
(EXPLANATION OF REFERENCES)

101 CPU
201 Luminance meter
202 Personal computer
203 Gamma correction circuit
204 Liquid crystal display body
204b Liquid crystal panel
100R_i, 100G_i, 100B_i Input terminals
105_R, 105_G, 105_B EEPROM
106_R, 106_G, 106_B EEPROM
AD_R, AD_G, AD_B ANALOG/DIGITAL CONVERSION CIRCUITS
DA_R, DA_G, DA_B DIGITAL/ANALOG CONVERSION CIRCUITS
SL_{R1}, SL_{G1}, SL_{B1} SELECTORS
SL_{R2}, SL_{G2}, SL_{B2} SELECTORS
L₁ TO L₃ LATCH CIRCUIT
INV Inverter
OE Output enable control circuit
GC Gate control circuit

FIG. 1 is a block diagram of a color calibration system. The system includes a personal computer (202) and a liquid crystal display body (204). The personal computer (202) contains a CPU (101), an A/D conversion unit (102), a D/A conversion unit (104), a gamma table (103), and two gamma correction data storage means (105 and 106). The liquid crystal display body (204) contains a video circuit (204a). A switch (SW) is connected to the liquid crystal display body (204). The luminance meter (201) is connected to the personal computer (202) and the liquid crystal display body (204).

[illegible]

(FIGURE 4)



(FIGURE 5)

