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(54) **GAMMA VOLTAGE CONVERSION DEVICE**

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G09G 3/36 (2006.01)

(52) **U.S. Cl.** **345/89**; 345/94; 345/204; 345/210; 345/211; 349/41

(58) **Field of Classification Search** 345/87, 345/89, 94, 204, 210, 211; 349/41
See application file for complete search history.

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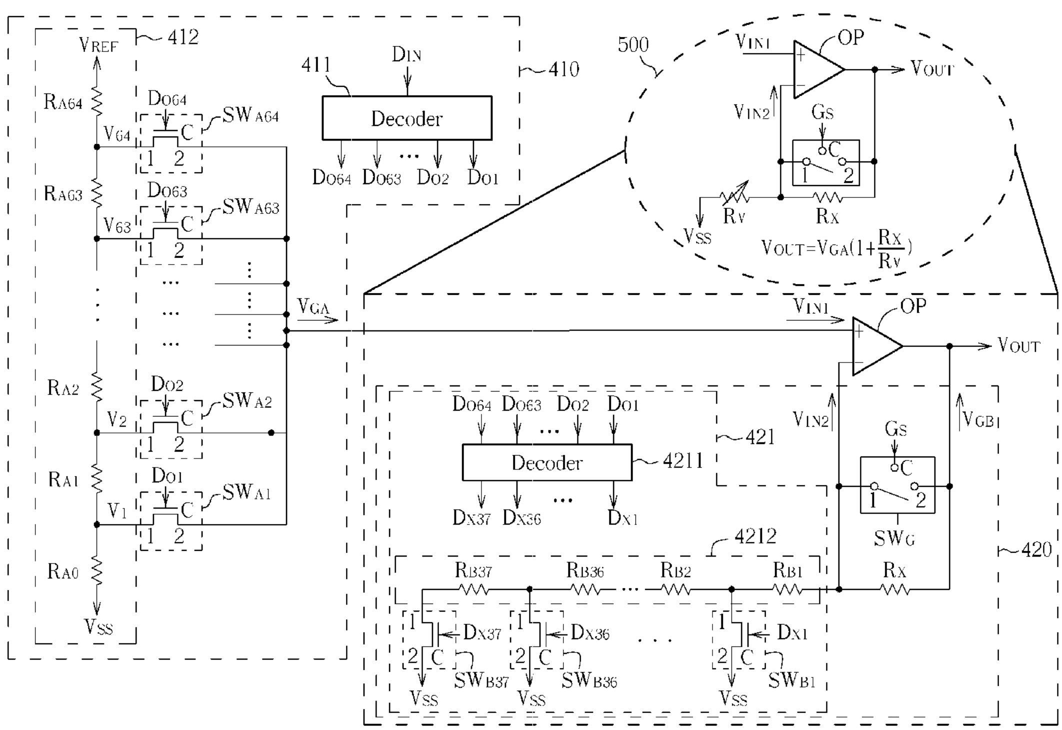
(57) **ABSTRACT**

Gamma voltage conversion device includes a gamma voltage conversion circuit, an amplifier, and a gamma voltage adjusting circuit. The gamma voltage conversion circuit generates a first gamma voltage conformed to a first gamma curve according to a grey level. The amplifier includes a first input end receiving the first gamma voltage, a second end, and an output end. The amplifier outputs the first or a second gamma voltage conformed to a second gamma curve according to the grey level according to the first and the second ends of the amplifier. The gamma voltage adjusting circuit coupled between the second input end and the output end of the amplifier controls the amplifier to output the first or the second gamma voltage as the gamma driving voltage according to the grey level and a gamma curve selection signal.

13 Claims, 8 Drawing Sheets



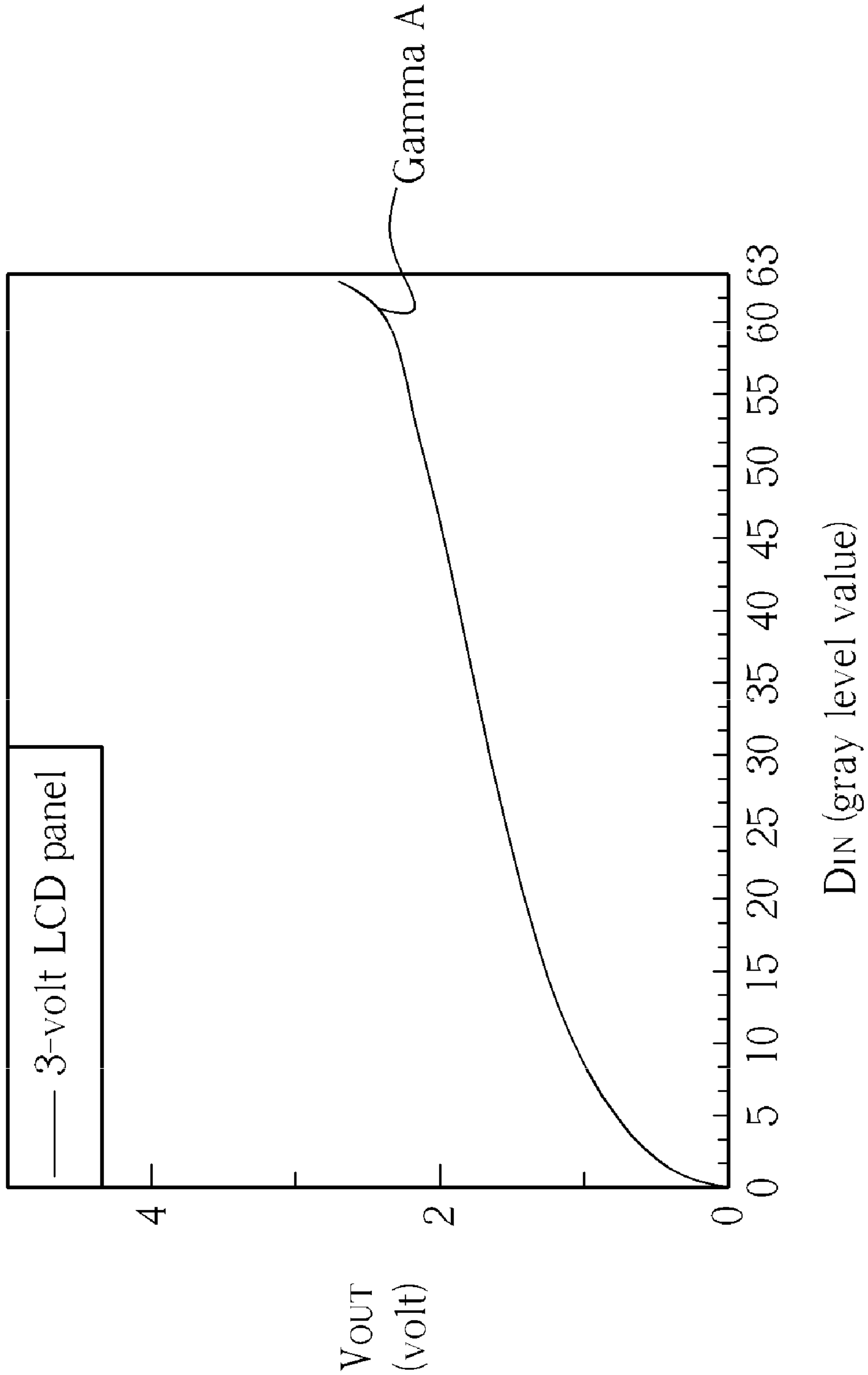


FIG. 1 PRIOR ART

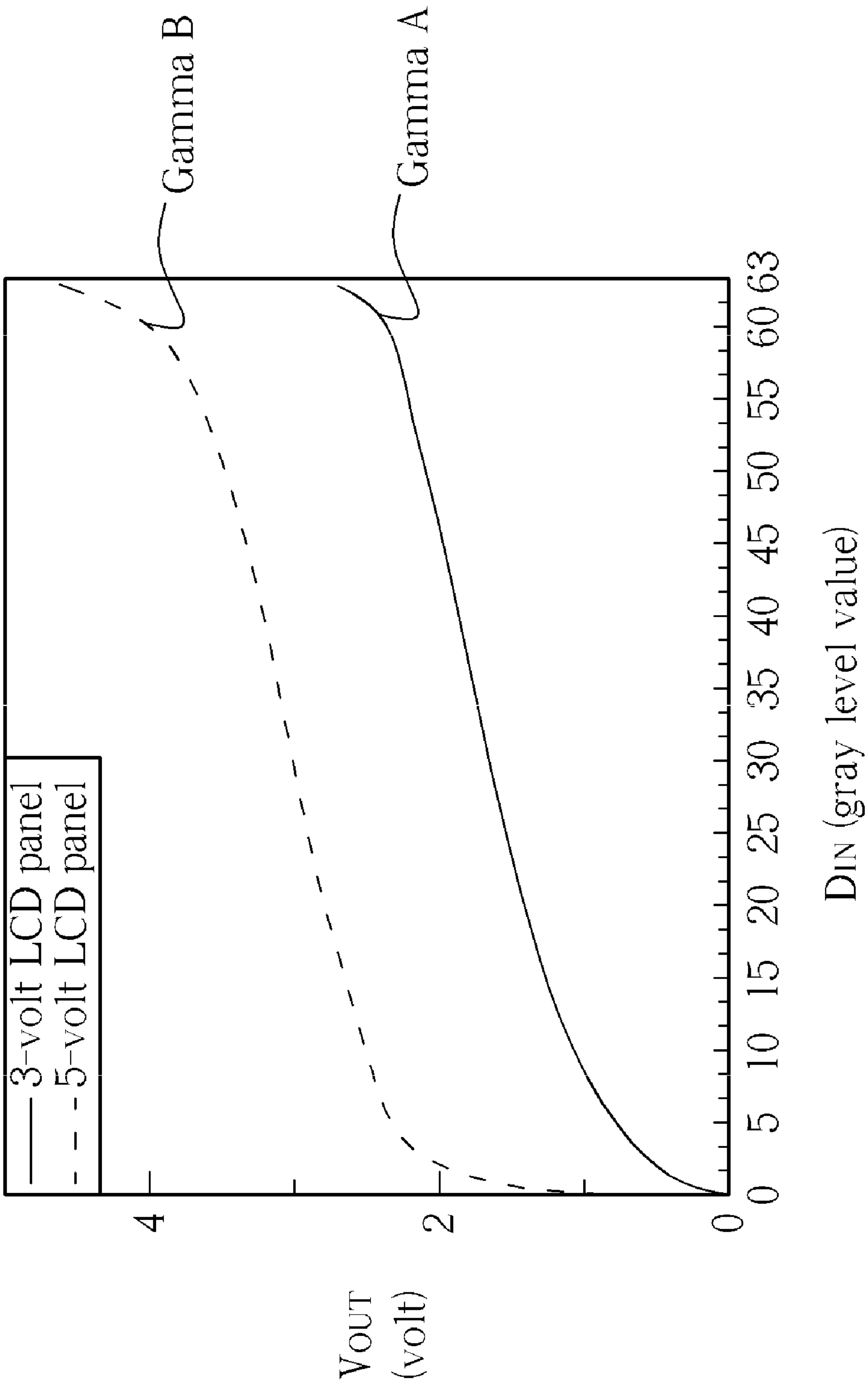

Gamma B
Gamma A
3-volt LCD panel
5-volt LCD panel
0 5 10 15 20 25 30 35 40 45 50 55 60 63
DIN (gray level value)
0
2
4
VOUT (volt)

FIG. 2

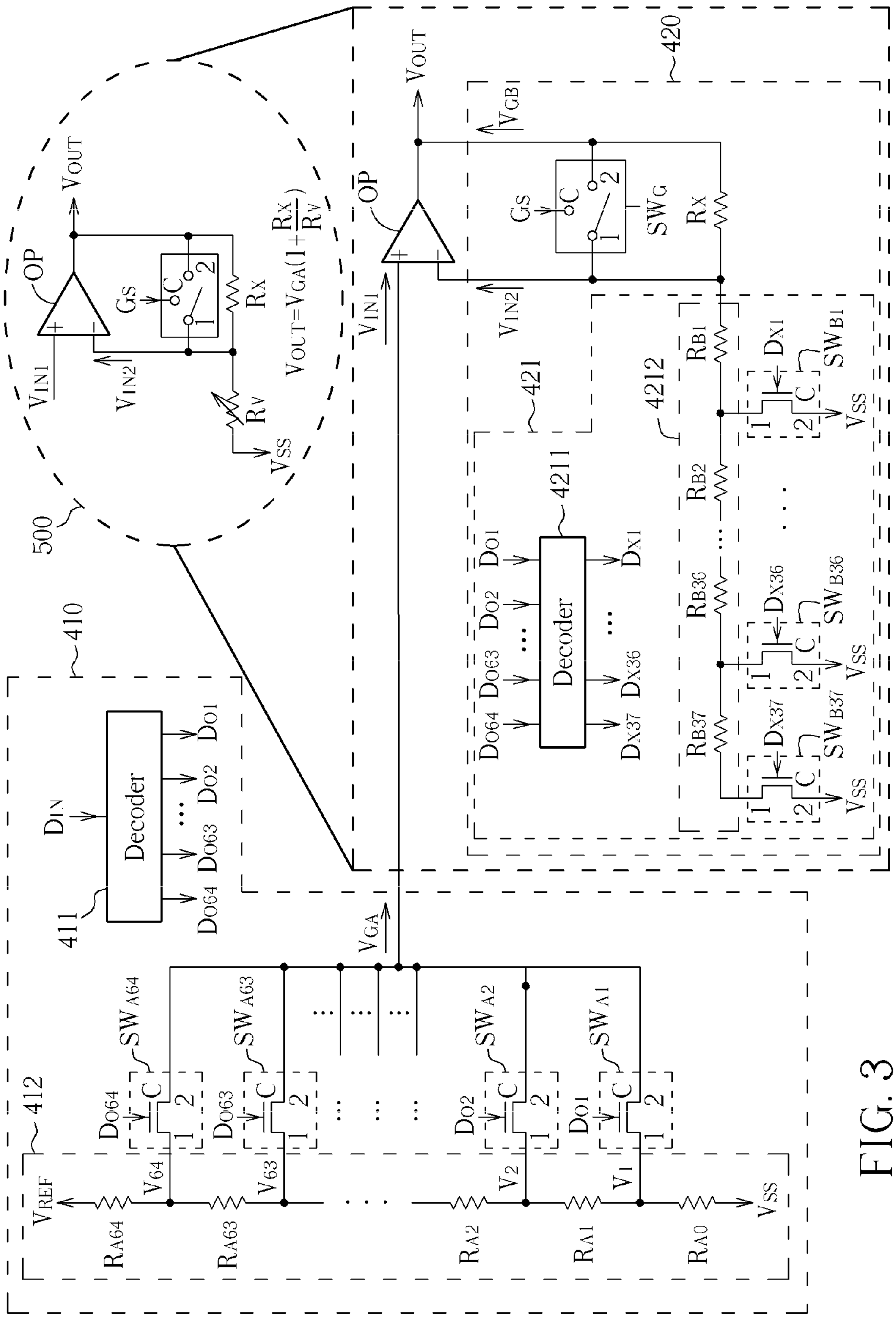

500
410
411
412
420
421
4211
4212
Decoder
Decoder
OP
Gs
SWG
RX
RV
VOUT
VIN1
VIN2
VGA
VGB1
VREF
VSS
VOUT=VGA(1+RX/RV)

FIG. 3

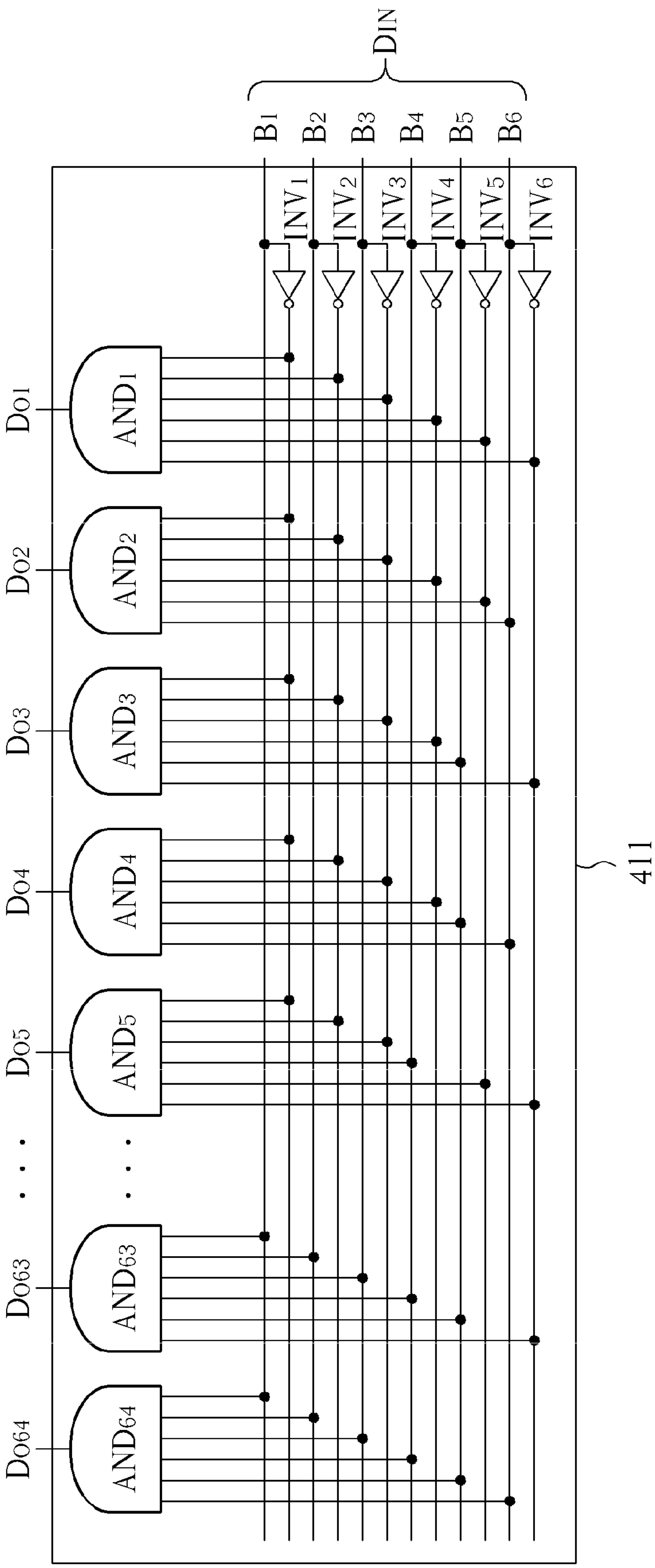

DIN
B1
B2
B3
B4
B5
B6
INV1
INV2
INV3
INV4
INV5
INV6
DO1
AND1
DO2
AND2
DO3
AND3
DO4
AND4
DO5
AND5
DO63
AND63
DO64
AND64
411

FIG. 4

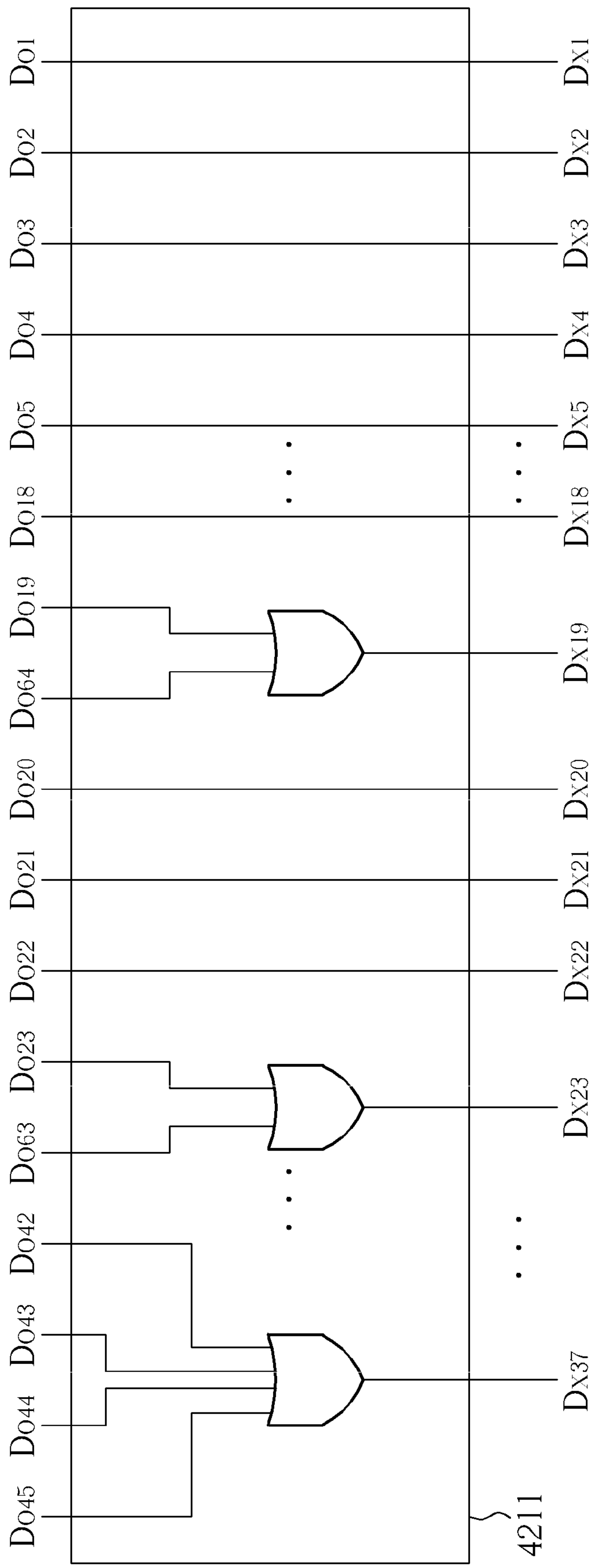

DO1
DO2
DO3
DO4
DO5
DO18
DO19
DO64
DO20
DO21
DO22
DO23
DO63
DO42
DO43
DO44
DO45
DX1
DX2
DX3
DX4
DX5
DX18
DX19
DX20
DX21
DX22
DX23
DX37
4211

FIG. 5

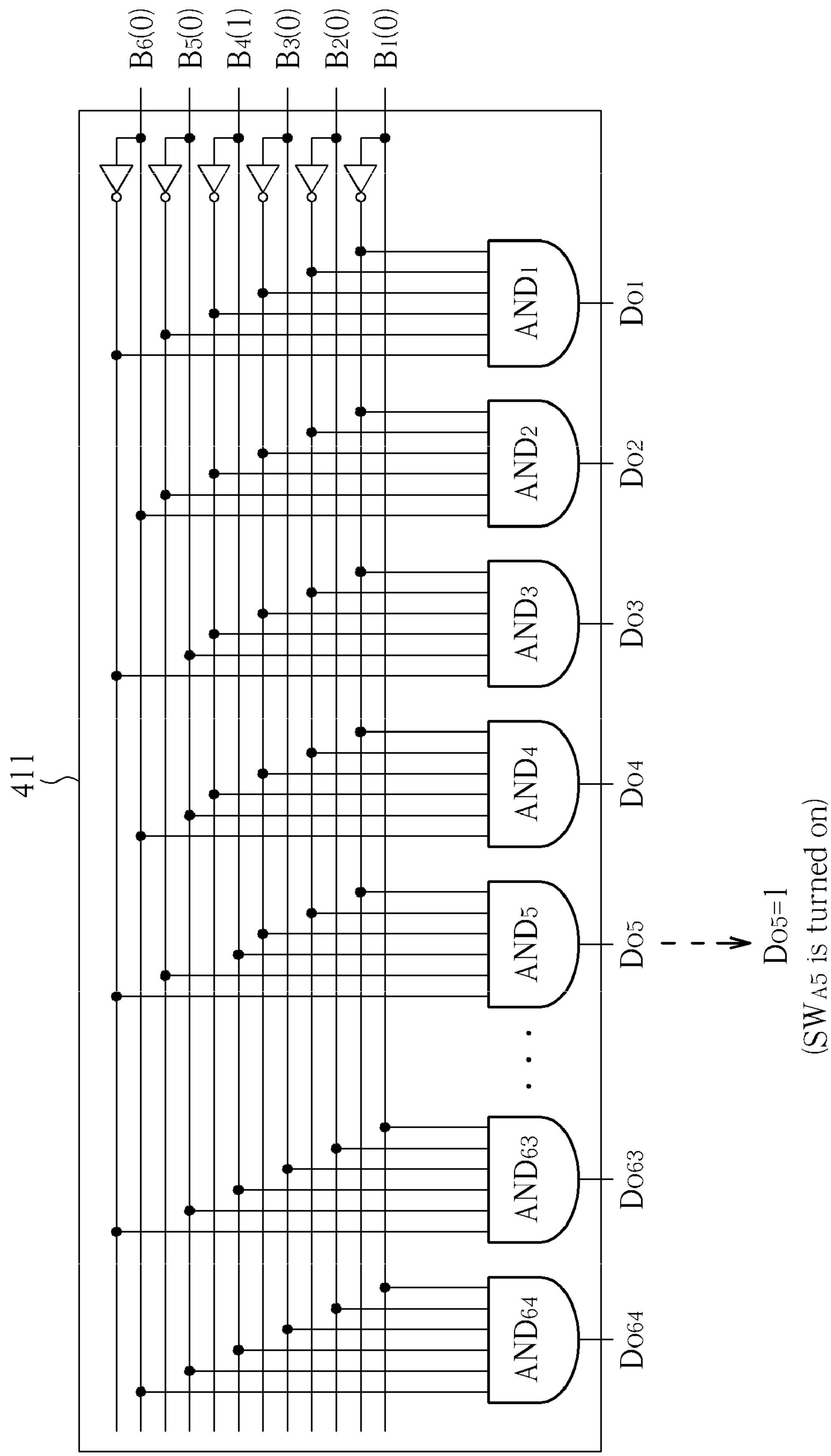

B6(0)
B5(0)
B4(1)
B3(0)
B2(0)
B1(0)
411
AND1
AND2
AND3
AND4
AND5
AND63
AND64
DO1
DO2
DO3
DO4
DO5
DO63
DO64
DO5=1
(SWA5 is turned on)

FIG. 6

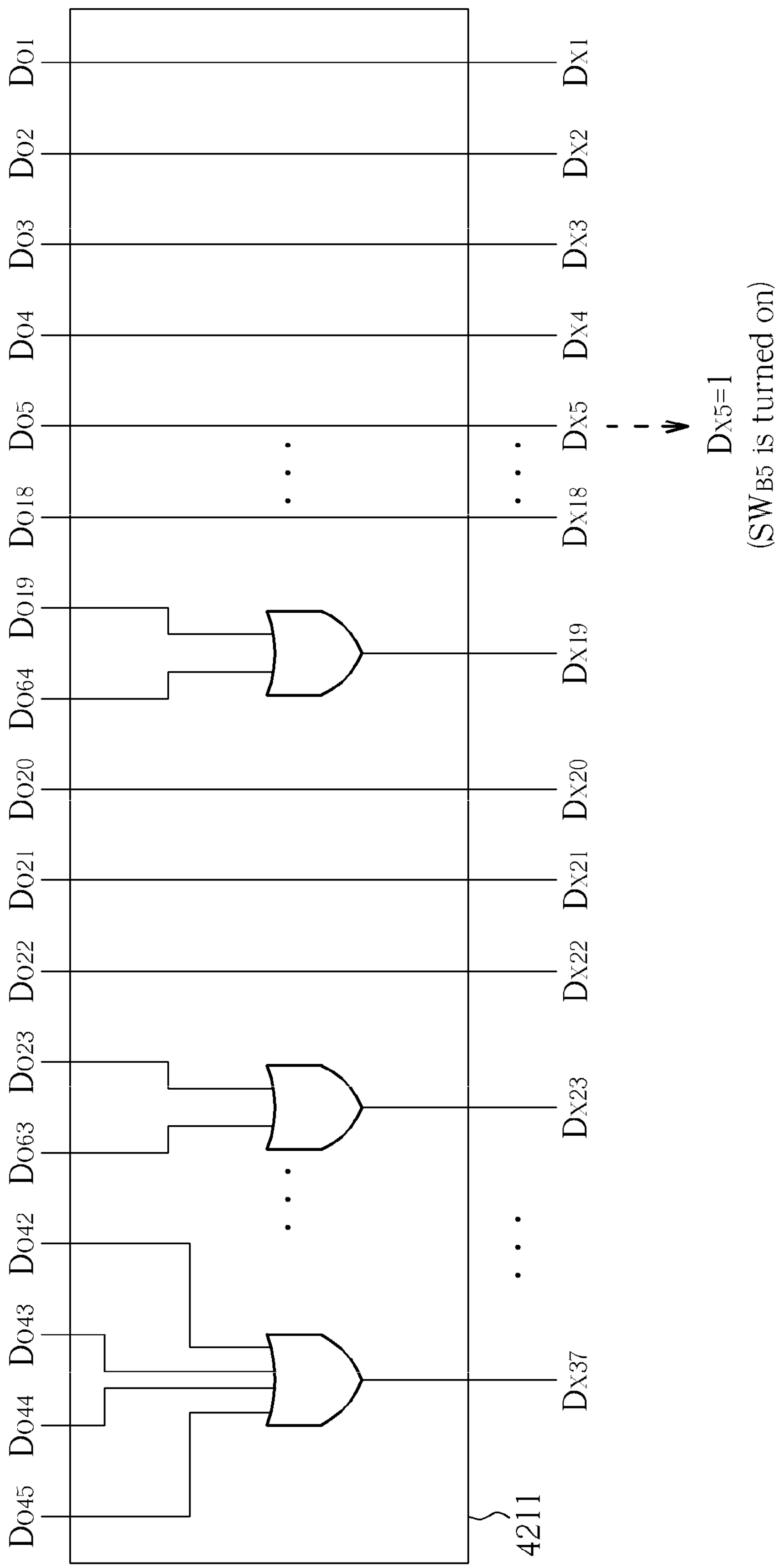
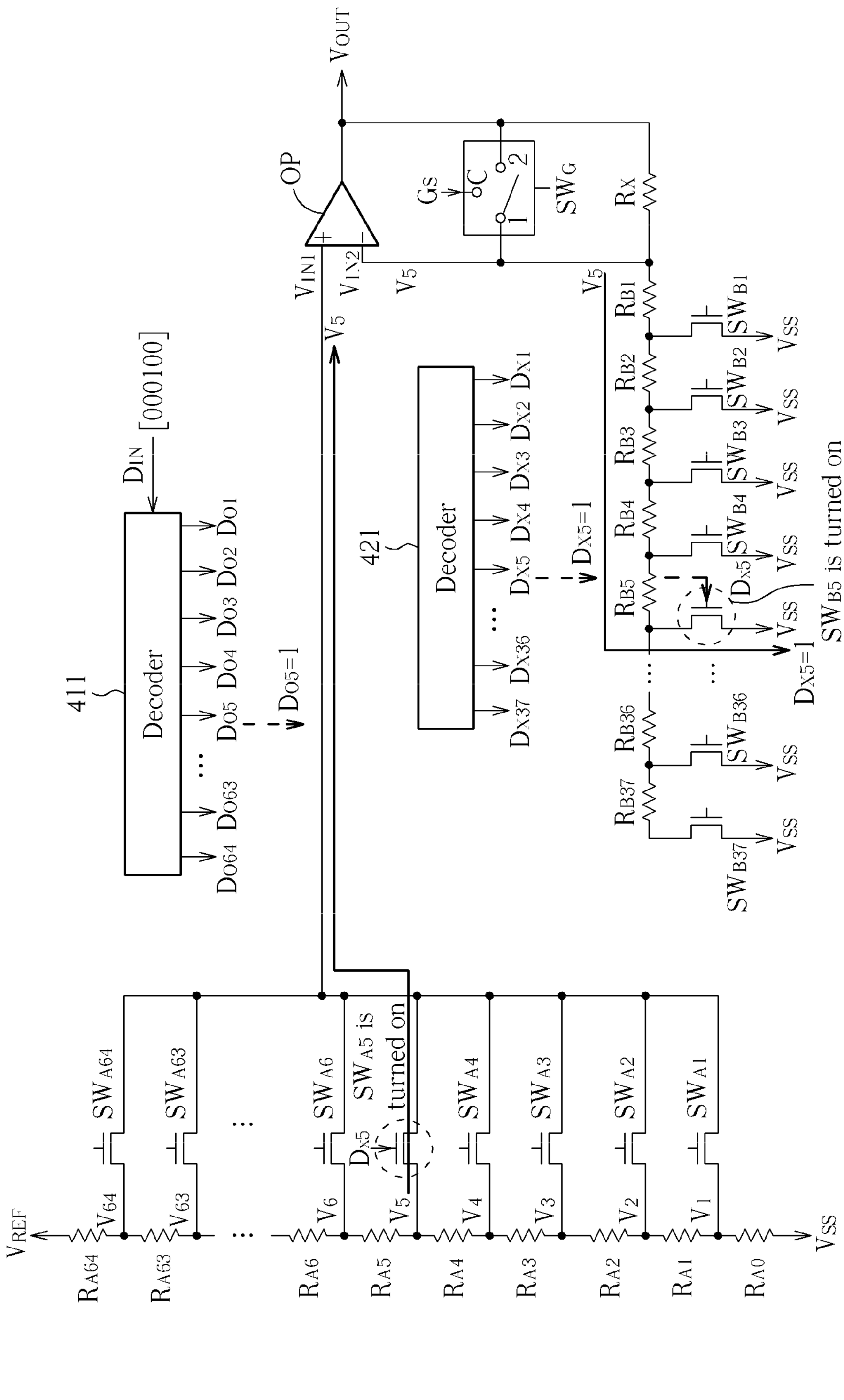

D_{O1}
D_{O2}
D_{O3}
D_{O4}
D_{O5}
D_{O18}
D_{O19}
D_{O64}
D_{O20}
D_{O21}
D_{O22}
D_{O23}
D_{O63}
D_{O42}
D_{O43}
D_{O44}
D_{O45}
D_{X1}
D_{X2}
D_{X3}
D_{X4}
D_{X5}
D_{X18}
D_{X19}
D_{X20}
D_{X21}
D_{X22}
D_{X23}
D_{X37}
$D_{X5}=1$
(SW_{B5} is turned on)
4211

FIG. 7



VOUT
OP
GS
C
1
2
SWG
RX
VIN1
VIN2
V5
DIN
[000100]
411
Decoder
DO1 DO2 DO3 DO4 DO5 DO63 DO64
DO5=1
421
Decoder
DX1 DX2 DX3 DX4 DX5 DX36 DX37
DX5=1
RB1 RB2 RB3 RB4 RB5 RB36 RB37
SWB1 SWB2 SWB3 SWB4 SWB36 SWB37
VSS
SWB5 is turned on
VREF
RA64 RA63 RA6 RA5 RA4 RA3 RA2 RA1 RA0
V64 V63 V6 V5 V4 V3 V2 V1
SWA64 SWA63 SWA6 SWA4 SWA3 SWA2 SWA1
SWA5 is turned on

FIG. 8

GAMMA VOLTAGE CONVERSION DEVICE

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a gamma voltage conversion device, and more particularly, to a gamma voltage conversion device capable of transforming a gray level signal to be a gamma voltage conformed to a gamma curve or another gamma curve.

2. Description of the Prior Art

Please refer to FIG. **1**. FIG. **1** is a diagram illustrating a gamma curve. In FIG. **1** the gamma curve gamma A is applied for a 3-volt LCD panel, the horizontal axis represents the gray level signal D_{IN}, the vertical axis represents the gamma driving voltage V_{OUT}, and the gray level signal D_{IN} is a 6-bit digital signal. Therefore, according to the gamma curve gamma A shown in FIG. **1**, the magnitude of the gamma driving voltage V_{OUT} corresponding to the gray level signal D_{IN} can be derived for driving the 3-volt LCD panel.

However, the conventional gamma conversion device is only capable of converting the gray level signal D_{IN} to the gamma driving voltage V_{OUT}, which is only conformed to one gamma curve (gamma A). However, not all of the gamma curves, applied for the LCD panels of other types, are the same as the gamma curve gamma A. For instance, a gamma curve gamma B is applied for a 5-volt LCD panel. Hence, the conventional gamma conversion device can only applied for the 3-volt LCD panel but not for the 5-volt LCD panel, causing a great inconvenience.

SUMMARY OF THE INVENTION

The present invention provides a gamma voltage conversion device for generating a gamma driving voltage according to a gray level signal. The gray level signal and the gamma driving voltage are conformed to a first gamma curve or a second gamma curve. The gamma voltage conversion device comprises a gamma voltage conversion circuit, an operational amplifier, and a gamma voltage adjusting circuit. The gamma voltage conversion circuit is utilized for generating a first gamma voltage according to the gray level signal. The gray level signal and the first gamma voltage are conformed to the first gamma curve. The operational amplifier comprises a first input end coupled to the gamma voltage conversion circuit for receiving the first gamma voltage, a second input end, and an output end. The operational amplifier outputs the first gamma voltage or a second gamma voltage as the gamma driving voltage according to the first input end of the operational amplifier and the second input end of the operational amplifier. The gray level signal and the second gamma voltage are conformed to the second gamma curve. The gamma voltage adjusting circuit is coupled between the second input end of the operational amplifier and the output end of the operational amplifier for controlling the operational amplifier outputting the first gamma voltage or the second gamma voltage as the gamma driving voltage according to the gray level signal and a gamma curve selection signal.

These and other objectives of the present invention will no doubt become obvious to those of ordinary skill in the art after reading the following detailed description of the preferred embodiment that is illustrated in the various figures and drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a diagram illustrating a gamma curve.

FIG. **2** is a diagram illustrating two different gamma curves.

FIG. **3** is a diagram illustrating the gamma voltage conversion device of the present invention.

FIG. **4** is a diagram illustrating an embodiment of the decoder of the present invention.

FIG. **5** is a diagram illustrating an embodiment of another decoder of the present invention.

FIG. **6**, FIG. **7** and FIG. **8** are diagrams illustrating the operating principle when a gray level signal is inputted to the gamma voltage conversion device of the present invention.

DETAILED DESCRIPTION

Please refer to FIG. **2**. FIG. **2** is a diagram illustrating two gamma curves. In FIG. **2**, the gamma curve gamma A is applied for a 3-volt LCD panel and the gamma curve gamma B is applied for a 5-volt LCD panel. The horizontal axis represents the gray level signal D_{IN} and the vertical axis represents the gamma driving voltage V_{OUT}, wherein the gray level signal D_{IN} is a 6-bit digital signal. As a result, according to the gamma curve gamma A shown in FIG. **2**, the magnitude of the gamma driving voltage V_{OUT} corresponding to the gray level signal D_{IN} can be derived so as to drive the 3-volt LCD panel. In addition, according to the gamma curve gamma B shown in FIG. **2**, the magnitude of the gamma driving voltage V_{OUT} corresponding to the gray level signal D_{IN} can be derived as well so as to drive the 5-volt LCD panel.

Please refer to FIG. **3**. FIG. **3** is a diagram illustrating the gamma voltage conversion device **400** of the present invention. As shown in FIG. **3**, the gamma voltage conversion device **400** comprises a gamma voltage conversion circuit **410**, a gamma voltage adjusting circuit **420**, and an operational amplifier OP. According to the requirement, the gamma voltage conversion device **400** can selects the proper gamma curve, gamma A or gamma B, so as to output the suitable gamma voltage for driving the 3-volt LCD panel or the 5-volt LCD panel.

The gamma voltage conversion circuit **410** is utilized for, according to a gray level signal D_{IN}, outputting a gamma voltage V_{GA} conformed to the gamma curve gamma A, as the input voltage V_{IN1}, to the operational amplifier OP. The gray level signal D_{IN} abovementioned is a 6-bit digital signal, for example. The gamma voltage conversion circuit **410** comprises a decoder **411**, sixty-four switches SW_{A1}~SW_{A64} and a resistor series **412**.

The resistor series **412** is coupled between a reference voltage source V_{REF} and a constant voltage source V_{SS} (a ground end). The resistor series **412** comprises sixty-five resistors R_{A0}~RA_{64} connected in series, wherein every resistor has a predetermined resistance for providing a resistor partial voltage (the resistor partial voltages V_1~V_{64} are shown in FIG. **3**, and therefore totally sixty-four resistor partial voltages are provided). The relation between the resistor partial voltages provided by the resistors and the corresponding gray level signals are conformed to the gamma curve gamma A. For instance, when the gray level signal D_{IN} is [000000], according to the gamma curve gamma A, the corresponding resistor partial voltage is V_1. When the gray level signal D_{IN} is [000001], the corresponding resistor partial voltage, according to the gamma curve gamma A, is V_2. When the gray level signal D_{IN} is [111111], the corresponding resistor partial voltage, according to the gamma curve gamma A, is V_{64}.

The decoder **411** is utilized for receiving the gray level signal D_{IN} and accordingly decoding the received gray level signal D_{IN} to be the decoded signal D_{O1}~D_{O64} with the corresponding values. As described above, the gray level signal D_{IN} is a 6-bit signal. When the gray level signal D_{IN} is [000000], only the decoded signal D_{O1} is logic "1" and the rest decoded signals are logic "0". When the gray level signal D_{IN} is [111111], only the decoded signal D_{O64} is logic "1" and the rest decoded signals are logic "0".

The switches SW_{A1}~SW_{A64} are utilized for transmitting the resistor partial voltage provided by the resistor series **412** to the operational amplifier OP according to the decoded signals D_{O1}~D_{O64} of the decoder **411**, respectively. Each of the switches SW_{A1}~SW_{A64} comprises a first end **1**, a second end **2** and a control end C. Each first end of the switch SW_{A1}~SW_{A64} is coupled to the corresponding resistor in the resistor series **212** for receiving the corresponding resistor partial voltage. Each second end **2** of the switches SW_{A1}~SW_{A64} is coupled to a first input end (the positive input end) of the operational amplifier OP for transmitting the received resistor partial voltage (the gamma voltage V_{GA} outputted by the gamma voltage conversion circuit **410**) to the operational OP as the input voltage V_{IN1}. Each control end C of the switches SW_{A1}~SW_{A64} is coupled to the corresponding output end of the decoder **411** for receiving the corresponding decoded signal so as to accordingly control the first ends **1** of the switches SW_{A1}~SW_{A64} coupling to the second ends **2**, respectively. More particularly, all the switches SW_{A1}~SW_{A64} are short-circuited to the first input end of the operational amplifier OP. For example, when the gray level signal D_{IN} is [000000], only the decoded signal D_{O1} is logic "1" and the rest decoded signals are logic "0", and therefore, only the switch SW_{A1} is turned on so as to transmit the resistor partial voltage V_1 to the first input end of the operational amplifier OP. It means that the gamma voltage V_{GA} outputted by the gamma voltage conversion circuit **410** is V_1 and is served as the input voltage V_{IN1} for the operational amplifier OP. When the gray level signal D_{IN} is [000001], only the decoded signal D_{O2} is logic "1" and the rest decoded signals are logic "0", and therefore, only the switch SW_{A2} is turned on so as to transmit the resistor partial voltage V_2 to the first input end of the operational amplifier OP. It means that the gamma voltage V_{GA} outputted by the gamma voltage conversion circuit **410** is V_2 and is served as the input voltage V_{IN1} for the operational amplifier OP. When the gray level signal D_{IN} is [111111], only the decoded signal D_{O64} is logic "1" and the rest decoded signals are logic "0", and therefore, only the switch SW_{A64} is turned on so as to transmit the resistor partial voltage V_{64} to the first input end of the operational amplifier OP. It means that the gamma voltage V_{GA} outputted by the gamma voltage conversion circuit **410** is V_{64} and is served as the input voltage V_{IN1} for the operational amplifier OP.

The operational amplifier OP comprises a first input end (the positive input end), a second input end (the negative input end) and an output end. The first input end (the positive input end) of the operational amplifier OP is utilized for receiving the input voltage V_{IN1}. The second end (the negative input end) of the operational amplifier OP is utilized for receiving the input voltage V_{IN2}. The output end of the operational amplifier OP is utilized for outputting the gamma driving voltage V_{OUT}. In FIG. **3**, the input voltage V_{IN1} is equal to the gamma voltage V_{GA} outputted from the gamma conversion circuit **410**. Because of the characteristic of the operational amplifier OP, the input voltage V_{IN1} on the first input end (the positive input end) is actually equal to the input voltage V_{IN2} on the second input end (the negative input end).

The gamma voltage conversion circuit **420** comprises a gamma curve selection switch SW_G, a resistor R_X, and a variable resistance circuit **421**.

The variable resistance circuit **421** comprises a decoder **4211**, a resistor series **4212**, and thirty-seven switches SW_{B1}~SW_{B37}.

The decoder **4211** is utilized for generating the decoded signals D_{X1}~D_{X37} according to the decoded signals D_{O1}~D_{O64} decoded from the decoder **411**.

The switches SW_{B1}~SW_{B37} are utilized for, according the decoded signals D_{X1}~D_{X37} decoded from the decoder **4211**, controlling the equivalent resistance of the resistor series **4212** to the operational amplifier OP. More precisely, the resistor series **4212** can be treated as a variable resistor R_V, coupled between the second input end of the operational amplifier OP and the voltage source V_{SS} (the ground end). The switches SW_{B1}~SW_{B37} are utilized for controlling the resistance of the variable resistor R_V. Each of the switches SW_{B1}~SW_{B37} comprises a first end **1**, a second end **2** and a control end C. Each first end **1** of the switches SW_{B1}~SW_{B37} is coupled to the corresponding resistor in the resistor series **4212**. Each second end **2** of the switches SW_{B1}~SW_{B37} is coupled to the voltage source V_{SS} (the ground end). Each control end C of the switches SW_{B1}~SW_{B64} is coupled to the corresponding output end of the decoder **4211** for receiving the decoded signal so as to control the first ends **1** of the switches SW_{B1}~SW_{B37} coupling to the second ends **2** of the switches SW_{B1}~SW_{B37}, respectively.

The resistor series **4212** is coupled between the second input end (the negative input end) of the operational amplifier OP and the switches SW_{B1}~SW_{B37}. The resistor series **4212** comprises thirty-seven resistors R_{B1}~R_{B37} connected in series, wherein each resistor has a predetermined resistance. As described above, the resistor series **4212** can be treated as a variable resistor R_V coupled between the second input end (the negative input end) of the operational amplifier OP and the voltage source V_{SS} (the ground end). The switches SW_{B1}~SW_{B37} are utilized for controlling the resistance of the variable resistor R_V. For instance, when the decoded signal D_{X1} is logic "1", the switch SW_{B1} is turned on so that the resistance of the variable resistor R_V is equal to the resistance of the resistor R_{B1}. When the decoded signal D_{X2} is logic "1", the switch SW_{B2} is turned on so that the resistance of the variable resistor R_V is equal to the sum of the resistances of the resistors (R_{B1}+R_{B2}). When the decoded signal D_{X3} is logic "1", the switch SW_{B3} is turned on so that the resistance of the variable resistor R_V is equal to the sum of the resistances of the resistors (R_{B1}+R_{B2}+R_{B3}). When the decoded signal D_{X37} is logic "1", the switch SW_{B37} is turned on so that the resistance of the variable resistor R_V is equal to the sum of the resistances of the resistors (R_{B1}+R_{B2}+R_{B3}+ . . . +R_{B37}).

The resistor R_X is coupled between the output end of the operational amplifier OP and the second input end (the negative input end) of the operational amplifier OP. The gamma curve selection switch SW_G is also coupled between the output end of the operational amplifier OP and the second input end (the negative input end) of the operational amplifier OP. According to the gamma curve selection signal G_S, the gamma curve selection switch SW_G determines if the output end of the operation amplifier OP is short-circuited to the second input end (the negative input end) of the operational amplifier. If the gamma curve selection switch SW_G determines the output end of the operation amplifier OP is short-circuited to the second input end (the negative input end) of the operational amplifier OP, the gamma voltage conversion device **400** of the present invention outputs the gamma driving voltage V_{OUT} conformed to the gamma curve gamma A for driving the 3-volt LCD panel. If the gamma curve selection switch SW_G determines the output end of the operation amplifier OP is not short-circuited to the second input end (the negative input end) of the operational amplifier OP, the gamma voltage conversion device **400** of the present invention outputs the gamma driving voltage V_{OUT} conformed to the gamma curve gamma B for driving the 5-volt LCD panel. The operating principle is illustrated as below.

Please continue referring to FIG. **3**. In FIG. **3**, the gamma voltage conversion circuit **420** and the operational amplifier can be treated as a voltage conversion circuit **500**. When the gamma curve selection switch SW_G determines that the output end of the operational amplifier OP is short-circuited to the second input end of the operational amplifier OP, the gamma voltage conversion device **400** of the present invention therefore can be treated as the conventional gamma voltage conversion device **200** so as to transform the gray level signal D_{IN} to be the gamma driving voltage V_{OUT}, in the way conformed to the gamma curve gamma A, to drive the 3-volt LCD panel. Furthermore, when the gamma curve selection switch SW_G determines that the output end of the operational amplifier OP is not short-circuited to the second input end of the operational amplifier OP, the gamma driving voltage V_{OUT} outputted by the gamma voltage conversion device **400** of the present invention can be derived according to the following formulas:

$$V_{OUT}=[1+(R_X/R_V)]\times V_{IN2} \quad (1);$$

$$V_{IN2}=V_{IN1} \quad (2);$$

$$V_{IN1}=V_{GA} \quad (3);$$

where V_{IN2} represents the voltage on the second input end (the negative input end) of the operational amplifier OP. In such way, according to the resistance of the variable resistor R_V, the gamma driving voltage V_{OUT} can be adjusted to be conformed to the gamma curve gamma B. Since the resistance of the variable resistor R_V is controlled by the decoded signals D_{X1}~D_{X37}, which are decoded from the decoder **4211** according to the decoded signals D_{O1}~D_{O64} decoded from the gray level signal D_{IN}, the gamma driving voltage V_{OUT} adjusted by the variable resistor R_V is ensured to be conformed to the gamma curve gamma B so as to drive the 5-volt LCD panel.

In addition, it is noticeable that since the gray level signal is a 6-bit signal, the resistor series **412** requires sixty-four (2^6) resistors for generating the gamma voltage V_{GA} corresponding to each level of the gray level signal according to the gamma curve gamma A. Theoretically, the resistor series **4212** of the present invention should require the same number of resistors connected in series. However, in the 6-bit gray level signal D_{IN}, some levels correspond to the same resistance of the variable resistor R_V. As a result, the resistor series **4212** and the decoder **4211** do not require the same number of resistors, switches and decoded signals for effectively transforming each level of the 6-bit gray level signal D_{IN} to be the gamma driving voltage V_{OUT} conformed to the gamma curve gamma B so as to drive the 5-volt LCD panel.

Please refer to FIG. **4**. FIG. **4** is a diagram illustrating an embodiment of the decoder **411** of the present invention. As shown in FIG. **4**, the decoder **411** can be realized with sixty-four AND gates AND_1~AND_{64} and six inverters INV_1~INV_6. In this way, the decoder **411** can correctly decode the decoded signals D_{O1}~D_{O64} as required according to the 6-bit (B_1, B_2, B_3, B_4, B_5, B_6) gray level signal D_{IN}.

Please refer to FIG. **5**. FIG. **5** is a diagram illustrating an embodiment of the decoder **4211** of the present invention. As shown in FIG. **5**, the decoder **4211** can be realized with a plurality of OR gates. In this way, the decoder **4211** can correctly decode the decoded signal D_{O1}~D_{O64} as required according to the decoded signals D_{X1}~D_{X37}.

Please refer to FIG. **6**, FIG. **7** and FIG. **8**. FIG. **6**, FIG. **7** and FIG. **8** are diagrams illustrating the operating principle when a gray level signal is inputted to the gamma voltage conversion device **400** of the present invention. In FIG. **6**, FIG. **7** and FIG. **8**, the input gray level signal D_{IN} is set as [000100]. In FIG. **6**, it can be seen that when the gray level signal D_{IN} is [000100], among the decoded signals decoded from the decoder **411**, only the decoded signal D_{O5} is logic "1". Therefore, in the gamma voltage conversion circuit **410**, the switch SW_{A5} is turned on to output the resistor partial voltage V_5, which the resistor series **412** corresponds to, as the gamma voltage V_{GA}. The gamma voltage V_{GA} is then transmitted to the first input end of the operational amplifier OP as the input voltage V_{IN1}. In FIG. **7**, it can be seen that only when the decoded signal D_{O5} is logic "1", among the decoded signals decoded from the decoder **411**, only the decoded signal D_{X5} is logic "1". Thus, in the gamma voltage adjusting circuit **420**, the switch SW_{B5} is turned on so that the resistor, which the resistor series **4212** corresponds to, becomes (R_{B1}+R_{B2}+R_{B3}+R_{B4}+R_{B5}) so as to be served as the resistance of the variable resistor R_V. Hence, in FIG. **8**, if the gamma curve selection switch SW_G determines that the output end of the operational amplifier OP is short-circuited to the second end of the operational amplifier OP, the gamma voltage conversion device **400** of the present invention outputs the gamma driving voltage V_{OUT} with a magnitude of V_5, wherein the gamma driving voltage V_{OUT} with a magnitude of V_5 and the gray level signal D_{IN} with a value of [000100] are conformed to the gamma curve gamma A. On the contrary, if the gamma curve selection switch SW_G determines that the output end of the operational amplifier OP is not short-circuited to the second end of the operational amplifier OP, the gamma driving voltage V_{OUT} outputted by the gamma voltage conversion device **400** of the present invention can be calculated out according to the formulas (1), (2) and (3) as below:

$$V_{IN1}=V_{GA}=V_5 \quad (1);$$

$$V_{IN2}=V_{IN1} \quad (2);$$

$$V_{OUT}=[1+(R_X/R_V)]\times V_{IN2}=[1+R_X/(R_{B1}+R_{B2}+R_{B3}+R_{B4}+R_{B5})]\times V_5 \quad (3);$$

the gamma driving voltage V_{OUT} and the gray level signal D_{IN} with the value of [001000] derived according to the formulas above, are conformed to the gamma curve gamma B.

In summary, by means of the gamma voltage conversion device provided by the present invention, the gamma curves can be selected as required so as to drive various LCD panels. It is not necessary to redesign gamma voltage conversion device when the type of LCD panel is changed, which reduces the cost of manufacture and causes great convenience.

Those skilled in the art will readily observe that numerous modifications and alterations of the device and method may be made while retaining the teachings of the invention.

What is claimed is:

1. A gamma voltage conversion device for generating a gamma driving voltage according to a gray level signal, the gray level signal and the gamma driving voltage are conformed to a first gamma curve or a second gamma curve, the gamma voltage conversion device comprising:

a gamma voltage conversion circuit for generating a first gamma voltage according to the gray level signal, comprising:

a first decoder for receiving the gray level signal so as to accordingly generate a plurality of first decoded signals;

a first resistor series, coupled between a reference voltage source and a ground end, the first resistor series comprising a plurality of resistors connected in series;

wherein each resistor of the plurality of the resistors of the first resistor series has a predetermined resistance and provides a corresponding resistor partial voltage according to the reference voltage source;

a plurality of first switches, each of the plurality of the first switches comprises:

a first end, coupled to a corresponding resistor of the plurality of the first resistor series, for receiving the corresponding resistor partial voltage provided by the corresponding resistor;

a second end, coupled to the first input end of the operational amplifier; and

a control end, coupled to the first decoder, for receiving a corresponding first decoded signal of the plurality of first decoded signals;

wherein the first switch couples the first end of the first switch to the second end of the first switch according to the received first decoded signal so as to transmit the corresponding resistor partial voltage to the first input end of the operational amplifier;

wherein a resistor partial voltage transmitted from one of the plurality of first switches to the operational amplifier is served as the first gamma voltage;

wherein the gray level signal and the first gamma voltage are conformed to the first gamma curve;

an operational amplifier, comprising:

a first input end, coupled to the gamma voltage conversion circuit, for receiving the first gamma voltage;

a second input end; and

an output end;

wherein the operational amplifier outputs the first gamma voltage or a second gamma voltage as the gamma driving voltage according to the first input end of the operational amplifier and the second input end of the operational amplifier;

wherein the gray level signal and the second gamma voltage are conformed to the second gamma curve; and

a gamma voltage adjusting circuit, coupled between the second input end of the operational amplifier and the output end of the operational amplifier, for controlling the operational amplifier outputting the first gamma voltage or the second gamma voltage as the gamma driving voltage according to the gray level signal and a gamma curve selection signal.

2. The gamma voltage conversion device of claim **1**, wherein the first decoder is realized with a plurality of AND gates.

3. The gamma voltage conversion device of claim **2**, wherein input ends of the plurality of AND gates of the first decoder are utilized for receiving the gray level signal, and an output end of one of the plurality of AND gates of the first decoder is utilized for outputting a corresponding first decoded signal.

4. A gamma voltage conversion device for generating a gamma driving voltage according to a gray level signal, the gray level signal and the gamma driving voltage are conformed to a first gamma curve or a second gamma curve,

the gamma voltage conversion device comprising:

a gamma voltage conversion circuit for generating a first gamma voltage according to the gray level signal;

wherein the gray level signal and the first gamma voltage are conformed to the first gamma curve;

an operational amplifier, comprising:

a first input end, coupled to the gamma voltage conversion circuit, for receiving the first gamma voltage;

a second input end; and

an output end;

wherein the operational amplifier outputs the first gamma voltage or a second gamma voltage as the gamma driving voltage according to the first input end of the operational amplifier and the second input end of the operational amplifier;

wherein the gray level signal and the second gamma voltage are conformed to the second gamma curve; and

a gamma voltage adjusting circuit, coupled between the second input end of the operational amplifier and the output end of the operational amplifier, for controlling the operational amplifier outputting the first gamma voltage or the second gamma voltage as the gamma driving voltage according to the gray level signal and a gamma curve selection signal, the gamma voltage adjusting circuit comprising:

a first resistor with a first resistance, coupled between the second input end of the operational amplifier and the output end of the operational amplifier;

a second switch, coupled between the second input end of the operational amplifier and the output end of the operational amplifier, for coupling the second input end of the operational amplifier to the output end of the operational amplifier according to the gamma curve selection signal; and

a variable resistance circuit, coupled between the operational amplifier and a ground end, for generating a second resistance according to the gray level signal;

wherein the relation between the second gamma voltage and the first gamma voltage can be represented by a formula below:

$V_{G2}=(1+R_1/R_2)\times V_{G1}$, wherein V_{G2} represents the second gamma voltage, V_{G1} represents the first gamma voltage, R_1 represents the first resistance, and R_2 represents the second resistance.

5. The gamma voltage conversion device of claim **4**, wherein the variable resistance circuit comprises:

a second resistor series, coupled to the second input end of the operational amplifier, the second resistor series comprising a plurality of resistor connected in series;

wherein each resistor of the second resistor series has a predetermined resistance;

a second decoder, coupled to the first decoder, for receiving the plurality of first decoded signals so as to generate a plurality of second decoded signals;

a plurality of third switches, each of the plurality of the third switches comprises:

a first end, coupled to a corresponding resistor of the second resistor series;

a second end, coupled to the ground end, and

a control end, coupled to the second decoder, for receiving a corresponding second decoded signal of the plurality of second decoded signals;

wherein the third switch couples the first end of the third switch to the second end of the third switch according to the received second decoded signal so as to coupled the corresponding resistor of the second resistor series to the ground end;

wherein one of the plurality of third switches couples a corresponding resistor of the second resistor series to the ground end so that the sum of resistances of the resistors of the second resistor series, which are the resistors before the resistor coupled to the ground end, is the second resistance.

6. The gamma voltage conversion device of claim **5**, wherein the second decoder is realized with a plurality of OR gates.

7. The gamma voltage conversion device of claim **6**, wherein each of input ends of the plurality of OR gates of the second decoder is coupled to an output end of a corresponding AND gate of the first decoder, and the each of output ends of the plurality of OR gates is utilized for outputting a corresponding second decoded signal.

8. A gamma voltage conversion device for generating a gamma driving voltage according to a gray level signal, the gray level signal and the gamma driving voltage are conformed to a first gamma curve or a second gamma curve, the gamma voltage conversion device comprising:

a gamma voltage conversion circuit for generating a first gamma voltage according to the gray level signal, comprising:

a first decoder for receiving the gray level signal so as to accordingly generate a plurality of first decoded signals;

a first resistor series, coupled between a reference voltage source and a ground end, the first resistor series comprising a plurality of resistors connected in series;

wherein each resistor of the plurality of the resistors of the first resistor series has a predetermined resistance and provides a corresponding resistor partial voltage according to the reference voltage source;

a plurality of first switches, each of the plurality of the first switches comprises:

a first end, coupled to a corresponding resistor of the plurality of the first resistor series, for receiving the corresponding resistor partial voltage provided by the corresponding resistor;

a second end, coupled to the first input end of the operational amplifier; and

a control end, coupled to the first decoder, for receiving a corresponding first decoded signal of the plurality of first decoded signals;

wherein the first switch couples the first end of the first switch to the second end of the first switch according to the received first decoded signal so as to transmit the corresponding resistor partial voltage to the first input end of the operational amplifier;

wherein a resistor partial voltage transmitted from one of the plurality of first switches to the operational amplifier is served as the first gamma voltage;

wherein the gray level signal and the first gamma voltage are conformed to the first gamma curve;

an operational amplifier, comprising:

a first input end, coupled to the gamma voltage conversion circuit, for receiving the first gamma voltage;

a second input end; and

an output end;

wherein the operational amplifier outputs the first gamma voltage or a second gamma voltage as the gamma driving voltage according to the first input end of the operational amplifier and the second input end of the operational amplifier;

wherein the gray level signal and the second gamma voltage are conformed to the second gamma curve; and

a gamma voltage adjusting circuit, coupled between the second input end of the operational amplifier and the output end of the operational amplifier, for controlling the operational amplifier outputting the first gamma voltage or the second gamma voltage as the gamma driving voltage according to the gray level signal and a gamma curve selection signal, the gamma voltage adjusting circuit comprising:

a first resistor with a first resistance, coupled between the second input end of the operational amplifier and the output end of the operational amplifier;

a second switch, coupled between the second input end of the operational amplifier and the output end of the operational amplifier, for coupling the second input end of the operational amplifier to the output end of the operational amplifier according to the gamma curve selection signal; and

a variable resistance circuit, coupled between the operational amplifier and a ground end, for generating a second resistance according to the gray level signal;

wherein the relation between the second gamma voltage and the first gamma voltage can be represented by a formula below:

$V_{G2}=(1+R_1/R_2)\times V_{G1}$, wherein V_{G2} represents the second gamma voltage, V_{G1} represents the first gamma voltage, R_1 represents the first resistance, and R_2 represents the second resistance.

9. The gamma voltage conversion device of claim **8**, wherein the first decoder is realized with a plurality of AND gates.

10. The gamma voltage conversion device of claim **9**, wherein input ends of the plurality of AND gates of the first decoder are utilized for receiving the gray level signal, and an output end of one of the plurality of AND gates of the first decoder is utilized for outputting a corresponding first decoded signal.

11. The gamma voltage conversion device of claim **8**, wherein the variable resistance circuit comprises:

a second resistor series, coupled to the second input end of the operational amplifier, the second resistor series comprising a plurality of resistor connected in series;

wherein each resistor of the second resistor series has a predetermined resistance;

a second decoder, coupled to the first decoder, for receiving the plurality of first decoded signals so as to generate a plurality of second decoded signals;

a plurality of third switches, each of the plurality of the third switches comprises:

a first end, coupled to a corresponding resistor of the second resistor series;

a second end, coupled to the ground end, and

a control end, coupled to the second decoder, for receiving a corresponding second decoded signal of the plurality of second decoded signals;

wherein the third switch couples the first end of the third switch to the second end of the third switch according to the received second decoded signal so as to coupled the corresponding resistor of the second resistor series to the ground end;

wherein one of the plurality of third switches couples a corresponding resistor of the second resistor series to the ground end so that the sum of resistances of the resistors of the second resistor series, which are the resistors before the resistor coupled to the ground end, is the second resistance.

12. The gamma voltage conversion device of claim **11**, wherein the second decoder is realized with a plurality of OR gates.

13. The gamma voltage conversion device of claim **12**, wherein each of input ends of the plurality of OR gates of the second decoder is coupled to an output end of a corresponding AND gate of the first decoder, and the each of output ends of the plurality of OR gates is utilized for outputting a corresponding second decoded signal.

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