

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau



(43) International Publication Date
29 December 2010 (29.12.2010)

(10) International Publication Number
WO 2010/150607 A1

(51) International Patent Classification:
G09G 3/20 (2006.01) *H03K 17/00* (2006.01)
H03K 3/356 (2006.01) *H03K 17/687* (2006.01)

TORY CO., LTD., 398, Hase, Atsugi-shi, Kanagawa, 2430036 (JP).

(21) International Application Number:
PCT/JP2010/058687

(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(22) International Filing Date:
17 May 2010 (17.05.2010)

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, SE, SI, SK,

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
2009-150617 25 June 2009 (25.06.2009) JP

(71) Applicant (for all designated States except US): SEMICONDUCTOR ENERGY LABORATORY CO., LTD.
[JP/JP]; 398, Hase, Atsugi-shi, Kanagawa, 2430036 (JP).

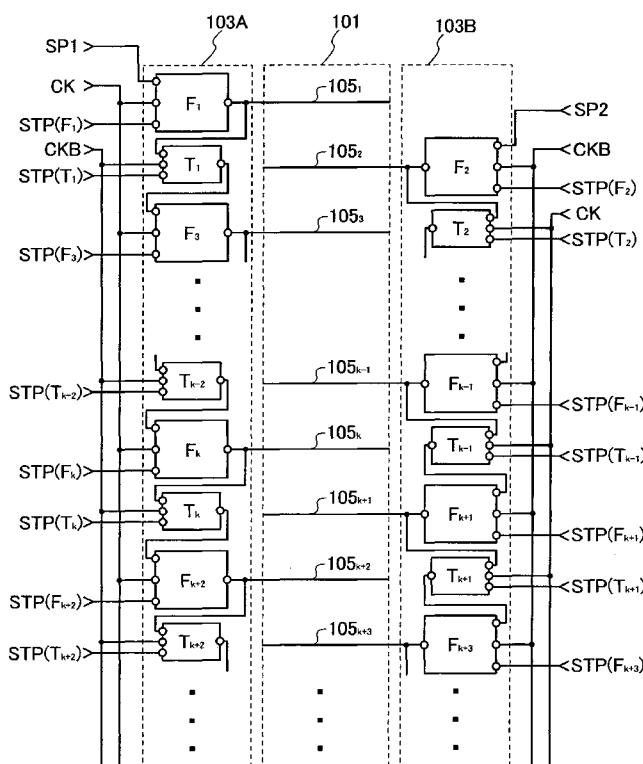
(72) Inventor; and

(75) Inventor/Applicant (for US only): UMEZAKI, Atsushi
[JP/JP]; c/o SEMICONDUCTOR ENERGY LABORA-

[Continued on next page]

(54) Title: DISPLAY DEVICE AND ELECTRONIC DEVICE

FIG. 2



(57) Abstract: It is an object to provide a display device which can favorably display a image without delayed or distorted signals. The display device includes a first gate driver and a second gate driver. The first gate driver and the second gate driver each include a plurality of flip flop circuits and a plurality of transfer signal generation circuits. Both the flip flop circuit and the transfer signal generation circuit are circuits which output a signal inputted to a first input terminal with a half clock cycle delay. In addition, an output terminal of the transfer signal generation circuit is directly connected to a first input terminal of the flip flop circuit in the next stage. Therefore, delay and distortion of the signal which is inputted from the transfer signal generation circuit to the flip flop circuit can be reduced.



SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, **Published:**
GW, ML, MR, NE, SN, TD, TG).

— *with international search report (Art. 21(3))*

DESCRIPTION

DISPLAY DEVICE AND ELECTRONIC DEVICE

5 TECHNICAL FIELD

[0001]

An embodiment of the present invention relates to a display device driven by an active matrix mode and an electronic device including the display device.

10 BACKGROUND ART

[0002]

A display device driven by an active matrix mode includes an element such as a transistor which functions as a switch in a pixel, a driving circuit (a source driver) which is electrically connected to the pixel and outputs an image signal to the pixel when the switch is on, and a driving circuit (a gate driver) which controls switching of the switch.

[0003]

Further, a transistor not only can function as a switch in pixels but also can form a gate driver. Therefore, a display device including the switches in the pixels and the gate driver which are formed using the transistors formed using a non-single-crystal semiconductor provided over an insulating substrate is developed.

[0004]

The above gate driver is provided close to a pixel portion of the display device. However, the gate driver provided close to one side of the pixel portion results in a display portion being closer to one side than to the other. Thus, a display device which has gate drivers, which are formed by dividing a gate driver, placed in both right side and left side of the pixel portion is developed (for example, see Patent Document 1).

[0005]

FIG. 10 illustrates the structure of the display device disclosed in Patent Document 1. In the display device illustrated in FIG. 10, a first gate driver 1002A and a second gate driver 1002B are provided so as to face each other with a pixel portion 1001 sandwiched therebetween. An output terminal of the first gate driver 1002A is

electrically connected to an odd-numbered gate line. An output terminal of the first gate driver 1002B is electrically connected to an even-numbered gate line. That is, the first gate driver 1002A controls an electrical connection between a source driver and a pixel which is placed in an odd-numbered line in the pixel portion 1001, while the second gate driver 1002B controls an electrical connection between the source driver and a pixel which is placed in an even-numbered line in the pixel portion 1001.

5 [0006]

Further, the first gate driver 1002A and the second gate driver 1002B each include a plurality of shift registers. An output terminal of the first shift register (SRC₁) is electrically connected to one of input terminals of a second shift register (SRC₂) through a first gate line 1003₁. An output terminal of the second shift register (SRC₂) is electrically connected to one of input terminals of a third shift register (SRC₃) through a second gate line 1003₂. In a similar manner, an output terminal of a *k*-th shift register (SRC_{*k*}) is electrically connected to one of input terminals of a (*k*+1)th shift register (SRC_{*k*+1}) through a *k*-th gate line 1003_{*k*}. That is, a signal for an electrical connection between a source driver and a pixel provided in one line is used as a start pulse signal of a shift register an output terminal of which is connected to a pixel provided in the next line.

10 [0007]

15 [Reference]

20 [Patent Document 1] Japanese Patent No. 4163416

DISCLOSURE OF INVENTION

25 [0008]

A gate line extending in the pixel portion has various parasitic capacitance and parasitic resistance. In particular, an influence of parasitic capacitances and parasitic resistances which are hold by the gate line become large as the pixel portion becomes high-quality. As described above, in the display device illustrated in FIG. 10, a start pulse signal of a shift register is inputted through a gate line. Therefore, it can be said that in the display device illustrated in FIG. 10, a signal will be highly likely to be delayed or distorted signal by increase in definition and size.

[0009]

In view of the above-described problem, it is an object of an embodiment of the present invention to provide a display device which is capable of favorably displaying an image.

5 [0010]

Further, it is an object of an embodiment of the present invention to provide a display device whose gate driver is formed using a unipolar transistor.

[0011]

Furthermore, it is an object of an embodiment of the present invention to 10 provide a display device including a gate driver whose circuit area is reduced.

[0012]

An embodiment of the present invention is a display device. The display device includes a plurality of gate lines provided so as to be parallel or approximately parallel to each other, a first gate driver which is electrically connected to each gate line 15 in odd-numbered rows, and a second gate driver which is electrically connected to each gate line in even-numbered rows. The first gate driver includes a k -th flip flop circuit and a k -th transfer signal generation circuit (k is an odd number equal to or larger than 3). In the k -th flip flop circuit, an output terminal is electrically connected to a k -th gate line, a first input terminal is electrically connected to an output terminal of a $(k-2)$ th transfer 20 signal generation circuit, a second input terminal is electrically connected to a clock signal line, and a third input terminal is electrically connected to a stop pulse signal line for the k -th flip flop circuit. In the k -th transfer signal generation circuit, an output terminal is electrically connected to a first input terminal of a $(k+2)$ th flip flop circuit, a first input terminal is electrically connected to the output terminal of the k -th flip 25 flop circuit, a second input terminal is electrically connected to an inverted clock signal line, and a third input terminal is electrically connected to a stop pulse signal line for the k -th transfer signal generation circuit. The second gate driver includes a $(k+1)$ th flip flop circuit and a $(k+1)$ th transfer signal generation circuit. In the $(k+1)$ th flip flop circuit, an output terminal is electrically connected to a $(k+1)$ th gate line, a first input terminal is 30 electrically connected to an output terminal of a $(k-1)$ th transfer signal generation circuit, a second input terminal is electrically connected to the inverted clock signal line,

and a third input terminal is electrically connected to a stop pulse signal line for the $(k+1)$ th flip flop circuit. In the $(k+1)$ th transfer signal generation circuit, an output terminal is electrically connected to a first input terminal of a $(k+3)$ th flip flop circuit, a first input terminal is electrically connected to the output terminal of the $(k+1)$ th flip 5 flop circuit, a second input terminal is electrically connected to the clock signal line, and a third input terminal is electrically connected to a stop pulse signal line for the k -th transfer signal generation circuit.

[0013]

Further, a display device in which a structure of the k -th flip flop circuit is the 10 same as a structure of the k -th transfer signal generation circuit is also an embodiment of the present invention.

[0014]

Note that the above stop pulse signal line is a wiring which inputs a stop pulse signal to each circuit.

15 [0015]

Specifically, an output signal of the k -th transfer signal generation circuit can be used as a stop pulse signal for the k -th flip flop circuit.

[0016]

Alternatively, an output signal of the $(k+1)$ th flip flop circuit can be used as a 20 stop pulse signal for the k -th flip flop circuit.

[0017]

Similarly, an output signal of the $(k+2)$ th flip flop circuit can be used as a stop pulse signal for the k -th transfer signal generation circuit.

[0018]

25 Alternatively, an output signal of the $(k+1)$ th transfer signal generation circuit can be used as a stop pulse signal for the k -th transfer signal generation circuit.

[0019]

In addition, an electronic device including a display device having the above structure is also an embodiment of the present invention.

30 [0020]

A first gate driver and a second gate driver provided in a display device of an

embodiment of the present invention include a transfer signal generation circuit which makes an inputted signal be outputted with a half clock cycle delay. Therefore, a display device which can favorably display an image without delayed or distorted signals can be provided.

5

BRIEF DESCRIPTION OF DRAWINGS

[0021]

In the accompanying drawings:

FIG. 1 illustrates a display device described in Embodiment 1;

10 FIG. 2 illustrates a structure of a gate driver described in Embodiment 1;

FIG. 3 illustrates a timing chart of a gate driver described in Embodiment 1;

FIG. 4 illustrates a specific example of a circuit structure described in Embodiment 2;

FIG. 5 illustrates a timing chart of a circuit described in Embodiment 2;

15 FIG. 6 illustrates a specific example of a circuit structure described in Embodiment 3;

FIGS. 7A and 7B each illustrate a specific example of an inverter circuit described in Embodiment 3;

20 FIG. 8 illustrates a specific example of a circuit structure described in Embodiment 4;

FIGS. 9A and 9B each illustrate a specific example of a control circuit described in Embodiment 4;

FIG. 10 illustrates a structure of a gate driver shown in Patent Document 1;

25 FIGS. 11A to 11F each illustrate a specific example of an electronic device described in Embodiment 6;

FIGS. 12A to 12D each illustrate a specific example of an electronic device described in Embodiment 6;

FIGS. 13A to 13D each illustrate a specific example of an electronic device described in Embodiment 6;

30 FIG. 14A illustrates a conventional circuit structure and FIG. 14B illustrates a circuit structure of this specification described in Example 1; and

FIG. 15 illustrates an output signal of a flip flop circuit of a conventional gate

driver and an output signal of a flip flop circuit of a gate driver disclosed in this specification which are described in Example 1.

BEST MODE FOR CARRYING OUT THE INVENTION

5

[0022]

Hereinafter, embodiments and an example of the present invention will be described in detail with reference to the accompanying drawings. Note that the present invention is not limited to the description below, and it will be easily understood by those skilled in the art that a variety of changes and modifications can be made without departing from the spirit and scope of the present invention. Therefore, the present invention should not be construed as being limited to the descriptions of the embodiments and the example below.

[0023]

15 (Embodiment 1)

Embodiment 1 describes an example of a display device which is an embodiment of the present invention. Specifically, an active-matrix display device including a first gate driver and a second gate driver is described with reference to FIG. 1, FIG. 2, and FIG. 3.

20 [0024]

[An example of a structure of a display device]

FIG. 1 illustrates an active-matrix display device 100. The display device 100 includes a pixel portion 101, a source driver 102, a first gate driver 103A, a second gate driver 103B, m (m is a positive integer) source lines 104₁ to 104 _{m} which are provided so as to be parallel or approximately parallel to each other, and n (n is a positive integer) gate lines 105₁ to 105 _{n} which are provided so as to be parallel or approximately parallel to each other. Note that a pixel portion 101 is provided in a central part of the display device 100. The source driver 102 is provided close to a side of the pixel portion 101. The first gate driver 103A and the second gate driver 103B are provided close to other sides of the pixel portion 101 and are provided so as to face each other with the pixel portion 101 therebetween. Further, the source driver 102 is electrically connected to the pixel portion 101 through the m source lines 104₁ to 104 _{m} . The first gate driver

103A is electrically connected to the pixel portion 101 through odd-numbered source lines among the n gate lines 105₁ to 105 _{n} . The second gate driver 103B is electrically connected to the pixel portion 101 through even-numbered source lines among the n gate lines 105₁ to 105 _{n} .

5 [0025]

In addition, a signal (a clock signal, a start pulse signal, or the like) is inputted from the outside to the source driver 102, the first gate driver 103A, and the second gate driver 103B through flexible printed circuits 106A and 106B.

[0026]

10 Further, the pixel portion 101 includes $n \times m$ pixels 107₁₁ to 107 _{nm} . Note that the pixels 107₁₁ to 107 _{nm} are arranged in n rows and m columns. In addition, each of the m source lines 104₁ to 104 _{m} is electrically connected to n pixels which are arranged in the same row. In other words, the pixel 107 _{ij} which is arranged in the i row and the j column (i and j are positive integers) ($1 \leq i \leq n$ and $1 \leq j \leq m$) is electrically connected to the 15 source line 104 _{j} and gate line 105 _{i} .

[0027]

That is, the source driver 102 is electrically connected to each pixel included in the pixel portion 101 through the m source lines 104₁ to 104 _{m} . The first gate driver 103A is electrically connected to each pixel arranged in odd-numbered rows in the pixel 20 portion 101 through odd-numbered gate lines among the n gate lines 105₁ to 105 _{n} . The second gate driver 103B is electrically connected to each pixel arranged in even-numbered rows in the pixel portion 101 through even-numbered gate lines among the n gate lines 105₁ to 105 _{n} .

[0028]

25 [An operation example of the display device]

In the display device 100, the source driver 102 is a circuit which outputs an image signal to the pixels 107₁₁ to 107 _{nm} included in the pixel portion 101. The first gate driver 103A and the second gate driver 103B are circuits which control electrical continuity between the source driver 102 and the pixels 107₁₁ to 107 _{nm} .

30 [0029]

The display device 100 displays an image in the pixel portion 101 by an image

signal inputted to the $n \times m$ pixels 107_{11} to 107_{nm} . A specific operation of the display device 100 is described below.

[0030]

First, the first gate driver 103A selects m pixels arranged in a first row (the source driver 102 and the m pixels arranged in the first row are electrically connected); then, an image signal is inputted to the m pixels 107_{11} to 107_{1m} arranged in the first row through the source lines 104₁ to 104 _{m} . Next, the second gate driver 103B selects m pixels arranged in a second row; then, an image signal is inputted to the m pixels 107_{21} to 107_{2m} arranged in the second row through the source lines 104₁ to 104 _{m} . After that, the first gate driver 103A and the second gate driver 103B alternately select m pixels in each row as in a similar manner. The display device 100 displays an image by the above operation subsequently performed.

[0031]

[A structural example of the gate driver]

FIG. 2 is a block diagram illustrating a detailed structural example of the first gate driver 103A and the second gate driver 103B included in the active-matrix display device 100.

[0032]

The first gate driver 103A and the second gate driver 103B each include a plurality of flip flop circuits and a plurality of transfer signal generation circuits which have at least three input terminals and one output terminal.

[0033]

In a first flip flop circuit (F₁) included in the first gate driver 103A, an output terminal is electrically connected to the first gate line 105₁, a first input terminal is electrically connected to a first start pulse signal (SP₁) line, a second input terminal is electrically connected to a clock signal (CK) line, and a third input terminal is electrically connected to a stop pulse signal (STP(F₁)) line for the first flip flop circuit .

[0034]

Further, in a first transfer signal generation circuit (T₁) included in the first gate driver 103A, an output terminal is electrically connected to a first input terminal of a third flip flop circuit (F₃), a first input terminal is electrically connected to the output terminal of the first flip flop circuit (F₁), a second input terminal is electrically

connected to an inverted clock signal (CKB) line, and a third input terminal is electrically connected to a stop pulse signal (STP(T₁)) line for the first transfer signal generation circuit.

[0035]

5 In a second flip flop circuit (F₂) included in the second gate driver 103B, an output terminal is electrically connected to the second gate line 105₂, a first input terminal is electrically connected to a second start pulse signal (SP2) line, a second input terminal is electrically connected to the inverted clock signal (CKB) line, and a third input terminal is electrically connected to a stop pulse signal (STP(F₂)) line for the
10 second flip flop circuit.

[0036]

Further, in a second transfer signal generation circuit (T₂) included in the second gate driver 103B, an output terminal is electrically connected to a first input terminal of a fourth flip flop circuit (not shown), a first input terminal is electrically connected to the output terminal of the second flip flop circuit (F₂), a second input terminal is electrically connected to the clock signal (CK) line, and a third input terminal is electrically connected to the stop pulse signal (STP(T₂)) line for the second transfer signal generation circuit.

[0037]

20 In a *k*-th (*k* is an odd number equal to or larger than three) flip flop circuit (F_{*k*}) included in the first gate driver 103A, an output terminal is electrically connected to a *k*-th gate line 105_{*k*}, a first input terminal is electrically connected to an output terminal of a (*k*-2)th transfer signal generation circuit (T_{*k*-2}), a second input terminal is electrically connected to the clock signal (CK) line, and a third input terminal is
25 electrically connected to a stop pulse signal (STP(F_{*k*})) line for a *k*-th flip flop circuit.

[0038]

Further, in a *k*-th transfer signal generation circuit (T_{*k*}) included in the first gate driver 103A, an output terminal is electrically connected to a (*k*+2)th flip flop circuit (F_{*k*+2}), a first input terminal is electrically connected to the output terminal of the *k*-th flip flop circuit (F_{*k*}), a second input terminal is electrically connected to the inverted clock signal (CKB) line, and a third input terminal is electrically connected to a stop

pulse signal (STP(T_k)) line for a k -th transfer signal generation circuit.

[0039]

In a $(k+1)$ th flip flop circuit (F_{k+1}) included in the second gate driver 103B, an output terminal is electrically connected to a $(k+1)$ th gate line 105_{k+1} , a first input terminal is electrically connected to an output terminal of a $(k-1)$ th transfer signal generation circuit (T_{k-1}), a second input terminal is electrically connected to the inverted clock signal (CKB) line, and a third input terminal is electrically connected to a stop pulse signal (STP(F_{k+1})) line for a $(k+1)$ th flip flop circuit.

[0040]

Further, in a $(k+1)$ th transfer signal generation circuit (T_{k+1}) included in the second gate driver 103B, an output terminal is electrically connected to a $(k+3)$ th flip flop circuit (F_{k+3}), a first input terminal is electrically connected to an output terminal of the $(k+1)$ th flip flop circuit (F_{k+1}), a second input terminal is electrically connected to the clock signal (CK) line, and a third input terminal is electrically connected to a stop pulse signal (STP(T_{k+1})) line for a $(k+1)$ th transfer signal generation circuit.

[0041]

The above plurality of flip flop circuits and plurality of transfer signal generation circuits included in the first gate driver 103A and the above plurality of flip flop circuits and plurality of transfer signal generation circuits included in the second gate driver 103B have similarities and differences in an electrical connection relationship. A specific difference is described below.

[0042]

First, a difference in an electrical connection relationship between the flip flop circuit and the transfer signal generation circuit included in the first gate driver, and the flip flop circuit and the transfer signal generation circuit included in the second gate driver is described below.

[0043]

In the first gate driver 103A, a second input terminal of a flip flop circuit is electrically connected to the clock signal (CK) line, and a second input terminal of a transfer signal generation circuit is electrically connected to the inverted clock signal (CKB) line. On the other hand, in the second gate driver 103B, a second input

terminal of a flip flop circuit is electrically connected to the inverted clock signal (CKB) line, and a second input terminal of a transfer signal generation circuit is electrically connected to the clock signal (CK) line.

[0044]

5 Next, the difference in an electrical connection relationship of the flip flop circuit and the transfer signal generation circuit is described below.

[0045]

As the output terminal of the first flip flop circuit (F_1) is connected to the first gate line 105_1 , an output terminal of a flip flop circuit is electrically connected to a gate line which is provided in the same row. On the other hand, as the output terminal of the first transfer signal generation circuit (T_1) is electrically connected to the first input terminal of the third flip flop circuit (F_3), an output terminal of a transfer signal generation circuit is electrically connected to a first input terminal of a flip flop circuit provided in the next stage. Note that first input terminals of the first flip flop circuit (F_1) and the second flip flop circuit (F_2), which do not have transfer signal circuits in the previous stages, are electrically connected to the first start pulse signal (SP1) line and the second start pulse signal (SP2) line, respectively.

[0046]

In addition, each of third input terminals of all the flip flop circuits and all the transfer signal generation circuits is electrically connected to corresponding stop pulse signal (STP) lines.

[0047]

[An example of operation of the gate driver]

FIG. 3 is a timing chart. Note that, in FIG. 3, a clock signal (CK), an inverted clock signal (CKB), a first start pulse signal (SP1), a second start pulse signal (SP2), an output signal of the first flip flop circuit (F_1 OUT) to an output signal of the fourth flip flop circuit (F_4 OUT), and an output signal of the first transfer signal generation circuit (T_1 OUT) to an output signal of the fourth transfer signal generation circuit (T_4 OUT) are illustrated. Note that a clock signal (CK) is a signal which oscillates between a high (hereinafter, referred to as H) level and a low (hereinafter, referred to as L) level at a constant frequency. An inverted clock signal (CKB) is a signal whose level is inverted from the level of the clock signal.

[0048]

In a period T1, the first start pulse signal (SP1) goes to an H level, and an H level signal is inputted to the first input terminal of the first flip flop circuit (F₁).

[0049]

5 In a period T2, a second start pulse signal (SP2) goes to the H level, and an H level signal is inputted to the first input terminal of the second flip flop circuit (F₂). In addition, an H level signal is outputted from the first flip flop circuit (F₁). Note that an H level signal which is outputted from the first flip flop circuit (F₁) is inputted through the first gate line 105₁ to each of the pixels 107₁₁ to 107_{1m} arranged in the first row in
10 the pixel portion 101. Accordingly, each of the pixels 107₁₁ to 107_{1m} arranged in the first row and the source driver 102 are electrically connected, so that an image signal is inputted from the source driver 102 to each of the pixels 107₁₁ to 107_{1m} arranged in the first row. Further, an H level signal outputted from the first flip flop circuit (F₁) is inputted to the first input terminal of the first transfer signal generation circuit (T₁).

15 [0050]

In a period T3, an H level signal is outputted from the second flip flop circuit (F₂). As when the output signal of the first flip flop circuit (F₁) is in the H level, an H level signal which is outputted from the second flip flop circuit (F₂) is inputted through the first gate line 105₂ to each of the pixels 107₂₁ to 107_{2m} arranged in the second row in
20 the pixel portion 101. Accordingly, each of the pixels 107₂₁ to 107_{2m} arranged in the second row and the source driver 102 are electrically connected, so that an image signal is inputted from the source driver 102 to each of the pixels 107₂₁ to 107_{2m} arranged in the second row. In addition, an H level signal is outputted from the first transfer signal generation circuit (T₁) and inputted to the first input terminal of the third flip flop circuit
25 (F₃).

[0051]

From a period T4, the above-described operations are repeated. That is, an H level signal is sequentially outputted from the next flip flop circuits from the third flip flop circuit (F₃), so that an image signal is inputted to a plurality of arranged pixels in
30 each row.

[0052]

The display device described in this embodiment is an active-matrix display

device including a first gate driver and a second gate driver. Further, the first gate driver and the second gate driver each include a plurality of flip flop circuits and a plurality of transfer signal generation circuits. Both the flip flop circuit and the transfer signal generation circuit are circuits which output a signal inputted to a first input terminal with a half clock cycle delay. In addition, an output terminal of the transfer signal generation circuit is directly connected to a first input terminal of the flip flop circuit in the next stage. Therefore, delay and distortion of the signal which is inputted from the transfer signal generation circuit to the flip flop circuit can be reduced.

10 [0053]

Note that, in this embodiment, an example of a display device including one source driver and two gate drivers are described. However, an embodiment of the present invention is not limited to this structure. For example, the following structures are also one of embodiments of the present invention: a structure where a display device only includes two gate drivers and an image signal is inputted from the outside, a structure where a display device includes two source drivers and two gate drivers and an image signal is inputted from the two source drivers, and a structure where each pixel is electrically connected to a gate driver through two gate lines.

[0054]

20 (Embodiment 2)

In Embodiment 2, a specific example of a circuit which can be applied to the flip flop circuit and the transfer signal generation circuit described in Embodiment 1 is described with reference to FIG. 4 and FIG. 5. Specifically, an example of forming a flip flop circuit and a transfer signal generation circuit using transistors is illustrated.

25 Note that since a source terminal and a drain terminal of a transistor change depending on the structure, the operating condition, and the like of the transistor, it is difficult to define which is a source terminal or a drain terminal. Therefore, one of a source terminal and a drain terminal is referred to as a first terminal and the other thereof is referred to as a second terminal for distinction, hereinafter.

30 [0055]

[An example of a circuit structure]

FIG. 4 is a diagram illustrating an example of a circuit which can be applied to

the k -th flip flop circuit (F_k) and the k -th transfer signal generation circuit (T_k) included in the first gate driver 103A described in Embodiment 1. Note that a k -th flip flop circuit (F_k) described in Embodiment 2 includes a first transistor 401 to a fourth transistor 404 and a k -th transfer signal generation circuit (T_k) includes a fifth transistor 405 to an eighth transistor 408. In addition, in Embodiment 2, an output signal (T_k OUT) of the k -th transfer signal generation circuit is used as a stop pulse signal (STP(F_k)) for the k -th flip flop circuit. An output signal (F_{k+2} OUT) of a $(k+2)$ th flip flop circuit is used as a stop pulse signal (STP(T_k)) for the k -th transfer signal generation circuit.

10 [0056]

In the first transistor 401, a gate terminal and a first terminal are electrically connected to an output terminal of a $(k-2)$ th transfer signal generation circuit (not shown).

[0057]

15 A gate terminal of the second transistor 402 is electrically connected to an output terminal of the k -th transfer signal generation circuit (T_k), a first terminal of the second transistor 402 is electrically connected to a ground potential (VSS) line, and a second terminal of the second transistor 402 is electrically connected to a second terminal of the first transistor 401.

20 [0058]

A gate terminal of the third transistor 403 is electrically connected to the second terminal of the first transistor 401 and the second terminal of the second transistor 402, a first terminal of the third transistor 403 is electrically connected to a clock signal (CK) line, and a second terminal of the third transistor 403 is electrically connected to a first input terminal of the k -th transfer signal generation circuit (T_k).

[0059]

30 A gate terminal of the fourth transistor 404 is electrically connected to the output terminal of the k -th transfer signal generation circuit (T_k), a first terminal of the fourth transistor 404 is electrically connected to the ground potential (VSS) line, and a second terminal of the fourth transistor 404 is electrically connected to the first input terminal of the k -th transfer signal generation circuit (T_k) and the second terminal of the

third transistor 403.

[0060]

A gate terminal and a first terminal of the fifth transistor 405 are electrically connected to an output terminal of the k -th flip flop circuit (F_k).

5 [0061]

A gate terminal of the sixth transistor 406 is electrically connected to an output terminal of the $(k+2)$ -th flip flop circuit (not shown), a first terminal of the sixth transistor 406 is electrically connected to the ground potential (VSS) line, and a second terminal of the sixth transistor 406 is electrically connected to a second terminal of the 10 fifth transistor 405.

[0062]

A gate terminal of the seventh transistor 407 is electrically connected to the second terminal of the fifth transistor 405 and the second terminal of the sixth transistor 406, a first terminal of the seventh transistor 407 is electrically connected to an inverted 15 clock signal (CKB) line, a second terminal of the seventh transistor 407 is electrically connected to a third input terminal of the k -th flip flop circuit (F_k) and a first input terminal of the $(k+2)$ -th flip flop circuit (not shown).

[0063]

A gate terminal of the eighth transistor 408 is electrically connected to the 20 output terminal of the $(k+2)$ -th flip flop circuit (not shown), a first terminal of the eighth transistor 408 is electrically connected to the ground potential (VSS) line, and a second terminal of the eighth transistor 408 is electrically connected to the third input terminal of the k -th flip flop circuit (F_k), the first input terminal of the $(k+2)$ -th flip flop circuit (not shown), and the second terminal of the seventh transistor 407.

25 [0064]

As illustrated in FIG. 4, the same circuit structure can be applied to the k -th flip flop circuit (F_k) and the k -th transfer signal generation circuit (T_k). Note that points described below are preferably considered when a circuit is designed.

[0065]

30 The k -th flip flop circuit (F_k) is a circuit for driving a k -th gate line. The k -th transfer signal generation circuit (T_k) is a circuit for driving the $(k+2)$ -th flip flop circuit.

The k -th gate line has various parasitic capacitance and parasitic resistance as described above. Therefore, the load of the k -th flip flop circuit (F_k) is heavier than the load of the k -th transfer signal generation circuit (T_k). That is, when the above circuit is designed, the current driving capability of the first transistor 401 is preferably higher than the current driving capability of the fifth transistor 405. For example, the channel width of the first transistor 401 may be larger than the channel width of the fifth transistor 405. For the same reason, it is preferable that the current driving capability of the second transistor 402 be higher than the current driving capability of the sixth transistor 406, the current driving capability of the third transistor 403 be higher than the current driving capability of the seventh transistor 407, and the current driving capability of the fourth transistor 404 be higher than the current driving capability of the eighth transistor 408. For example, the current driving capability can be higher by making a ratio of the channel width to the channel length (the channel width/the channel length (W/L)) larger.

15 [0066]

Further, the third transistor 403 which directly contributes to driving of the k -th gate line preferably has the highest current driving capability among the first transistor 401 to the fourth transistor 404 included in the k -th flip flop circuit (F_k). Similarly, the seventh transistor 407 which directly contributes to a driving of the $(k+2)$ th flip flop circuit preferably has the highest current driving capability among the fifth transistor 405 to the eighth transistor 408 included in the k -th transfer signal generation circuit (T_k).

[0067]

In addition, the circuit structure illustrated in FIG. 4 can be applied to the first flip flop circuit (F_1) and the first transfer signal generation circuit (T_1) included in the first gate driver 103A. Note that, in the first flip flop circuit (F_1), what is different from the structure illustrated in FIG. 4 is that the gate terminal and the first terminal of the first transistor 401 are electrically connected to the first start pulse signal (SP1) line.

[0068]

30 Further, the circuit structure illustrated in FIG. 4 can be applied to the $(k+1)$ th flip flop circuit (F_{k+1}) and the $(k+1)$ th transfer signal generation circuit (T_{k+1}) included in

the second gate driver 103B. Note that, in the $(k+1)$ th flip flop circuit (F_{k+1}) and the $(k+1)$ th transfer signal generation circuit (T_{k+1}), what is different from the structure illustrated in FIG. 4 is that the first terminal of the third transistor 403 is electrically connected to the inverted clock signal (CKB) line and that the first terminal of the seventh transistor 407 is electrically connected to the clock signal (CK) line.

5 [0069]

Furthermore, the circuit structure illustrated in FIG. 4 can be applied to the second flip flop circuit (F_2) and the second transfer signal generation circuit (T_2) included in the second gate driver 103B. Note that, in the second flip flop circuit (F_2) and the second transfer signal generation circuit (T_2), the difference from the structure in FIG. 4 is as follows: the gate terminal and the first terminal of the first transistor 401 are electrically connected to the second start pulse signal (SP2) line, the first terminal of the transistor 403 is electrically connected to the inverted clock signal (CKB) line, and the first terminal of the seventh transistor 407 is electrically connected to the clock signal (CK) line.

10 [0070]

Note that, in Embodiment 2, an output signal ($F_{k+2}\text{OUT}$) of the $(k+2)$ th flip flop circuit is used as the stop pulse ($\text{STP}(T_k)$) for the k -th transfer signal generation circuit. Therefore, for a plurality of pixels arranged in n rows, an $(n+1)$ th flip flop circuit needs 20 to be provided as a dummy circuit in the first gate driver 103A, and an $(n+2)$ th flip flop circuit needs to be provided as a dummy circuit in the second gate driver 103B. Note that as the dummy circuit, a flip flop circuit which only supplies a stop pulse signal for the transfer signal generation circuit and does not drive a gate line can be used. Alternatively, by providing a wiring (a dummy gate line) which does not contribute to 25 display together with the dummy circuit, a flip flop circuit which supplies a stop pulse signal for a transfer signal generation circuit and drives the wiring can be used as the dummy circuit.

[0071]

[An example of a circuit operation]

30 FIG. 5 is a timing chart of input signals and output signals of the k -th flip flop circuit (F_k) and the k -th transfer signal generation circuit (T_k) illustrated in FIG. 4.

Operations of the k -th flip flop circuit (F_k) and the k -th transfer signal generation circuit (T_k) are described below.

[0072]

In a period t_1 , an output signal ($T_{k-2}\text{OUT}$) of the $(k-2)$ th transfer signal generation circuit goes to an H level. Thus, the first transistor 401 which is diode-connected is turned on, and a potential of the gate terminal of the third transistor 403 is increased to the H level. Therefore, a clock signal (CK) which is in an L level in the period t_1 is outputted as an output signal ($F_k\text{OUT}$) of the k -th flip flop circuit.

[0073]

In a period t_2 , the output signal ($T_{k-2}\text{OUT}$) of the $(k-2)$ th transfer signal generation circuit goes to the L level and the clock signal (CK) goes to the H level. Thus, the first transistor 401 which is diode-connected is turned off; accordingly, a potential of the gate terminal of the third transistor 403 at a floating state is raised by an H level signal inputted to the first terminal of the third transistor 403 (a bootstrap operation) and further increased. Further, the third transistor 403 remains ON, and an H level signal is outputted as the output signal ($F_k\text{OUT}$) of the k -th flip flop circuit (F_k). This H level signal is inputted to the gate terminal and the first terminal of the fifth transistor 405. Thus, the fifth transistor 405 which is diode-connected is turned on; accordingly, a potential of the gate terminal of the seventh transistor 407 is increased up to the H level. Therefore, an inverted clock signal (CKB) which is in the L level in the period t_2 is outputted as an output signal ($T_k\text{OUT}$) of the k -th transfer signal generation circuit (T_k).

[0074]

In a period t_3 , the clock signal goes to the L level and the inverted clock signal (CKB) goes to the H level. Thus, the fifth transistor 405 which is diode-connected is turned off; accordingly, a potential of the gate terminal of the seventh transistor 407 at a floating state is raised by an H level signal inputted to the first terminal of the seventh transistor 407 (a bootstrap operation) and further increased. Further, the seventh transistor 407 remains ON, and an H level signal is outputted to the output signal ($T_k\text{OUT}$) of the k -th transfer signal generation circuit (T_k). This H level signal is inputted to the gate terminals of the second transistor 402 and the fourth transistor 404.

Thus, the second transistor 402 is turned on, and a potential of the gate terminal of the third transistor 403 goes to the L level. Therefore the third transistor 403 is turned off. In addition, since the fourth transistor 404 is turned on, the L level signal is outputted as the output signal (F_k OUT) of the k -th flip flop circuit (F_k).

5 [0075]

In a period t_4 , the output signal (F_{k+2} OUT) of the $(k+2)$ th flip flop circuit goes to the H level. Thus, the sixth transistor 406 is turned on and a potential of the gate terminal of the seventh transistor 407 goes to the L level. Therefore, the seventh transistor 407 is turned off. Further, since the eighth transistor 408 is also turned on, 10 the L level signal is outputted as the output signal (T_k OUT) of the k -th transfer signal generation circuit (T_k).

[0076]

Note that a circuit operation of the following circuits is the same as the circuit operation of the above-described k -th flip flop circuit (F_k) and k -th transfer signal generation circuit (T_k): the first flip flop circuit and the first transfer signal generation circuit, the $(k+1)$ th flip flop circuit and the $(k+1)$ th transfer signal generation circuit, and the second flip flop circuit and the second transfer signal generation circuit.

[0077]

[Modification Example]

20 In Embodiment 2, an output signal of the k -th transfer signal generation circuit (T_k) and an output signal of the $(k+2)$ th flip flop circuit (F_{k+2}) are used as a stop pulse signal ($STP(F_k)$) for the k -th flip flop circuit and a stop pulse signal ($STP(T_k)$) for the k -th transfer signal generation circuit, respectively. However, the structure of Embodiment 2 is not limited thereto.

25 [0078]

For example, an output signal of the $(k+1)$ th flip flop circuit (F_{k+1}) and an output signal of the $(k+1)$ th transfer signal generation circuit (T_{k+1}) can be used as a stop pulse signal ($STP(F_k)$) for the k -th flip flop circuit and a stop pulse signal ($STP(T_k)$) for the k -th transfer signal generation circuit, respectively. In this case, the stop pulse signal ($STP(F_k)$) for the k -th flip flop circuit and the stop pulse signal ($STP(T_k)$) for the k -th transfer signal generation circuit are delayed or distorted signals as compared with

those in the above structure. However, since an output signal of the k -th flip flop circuit (F_k) and an output signal of the k -th transfer signal generation circuit (T_k) in the period go into the L level, a delayed or distorted signal does not provide a serious problem.

5 [0079]

(Embodiment 3)

In Embodiment 3, a specific example of a circuit which can be applied to the flip flop circuit and the transfer signal generation circuit described in Embodiment 1, which is different from a specific example in Embodiment 2, is described with reference 10 to FIG. 6 and FIGS. 7A and 7B.

[0080]

[An example of a circuit structure]

FIG. 6 illustrates an example of a circuit which can be applied to the k -th flip flop circuit (F_k) and the k -th transfer signal generation circuit (T_k) included in the first 15 gate driver 103A described in Embodiment 1. In Embodiment 3, a k -th flip flop circuit (F_k) includes a first transistor 601 to a fifth transistor 605 and an inverter circuit 600, and a k -th transfer signal generation circuit (T_k) includes a sixth transistor 606 to an 20 eighth transistor 608. Note that, in other words, the circuit illustrated in FIG. 6 is made as follows: the inverter circuit 600 and the fifth transistor 605 are added to the k -th flip flop circuit (F_k) illustrated in FIG. 4 and the eighth transistor 408 is eliminated from the k -th transfer signal generation circuit (T_k) illustrated in FIG. 4.

[0081]

The electrical connection relationship between the first transistor 601, the second transistor 602, and the third transistor 603 is the same as that in the circuit 25 illustrated in FIG. 4. Therefore, the description in Embodiment 2 applies here.

[0082]

An input terminal of the inverter circuit 600 is electrically connected to a second terminal of the first transistor 601, a second terminal of the second transistor 602, and a gate terminal of the third transistor 603.

30 [0083]

A gate terminal of the fourth transistor 604 is electrically connected to an output terminal of the inverter circuit 600, a first terminal of the fourth transistor 604 is

electrically connected to a ground potential (VSS) line, and a second terminal of the fourth transistor 604 is electrically connected to a second terminal of the third transistor 603 and a first input terminal of the k -th transfer signal generation circuit (T_k).

[0084]

5 A gate terminal of the fifth transistor 605 is electrically connected to the output terminal of the inverter circuit 600, a first terminal of the fifth transistor 605 is electrically connected to the ground potential (VSS) line, and a second terminal of the fifth transistor 605 is electrically connected to the second terminal of the first transistor 601, the second terminal of the second transistor 602, the gate terminal of the third transistor 603, and the input terminal of the inverter circuit 600.

10 [0085]

15 The k -th transfer signal generation circuit (T_k) illustrated in FIG. 6 is a circuit in which the eighth transistor 408 is eliminated from the k -th transfer signal generation circuit (T_k) illustrated in FIG. 4. The electrical connection relationship between the other transistors is the same as that in the circuit illustrated in FIG. 4. Therefore, the description in Embodiment 2 applies here.

15 [0086]

Note that the circuit illustrated in FIG. 6 needs to be designed as described below.

20 [0087]

The circuit illustrated in FIG. 6 needs to be designed so that an H level signal is surely inputted to the input terminal of the inverter circuit 600 when an H level signal is inputted into the k -th flip flop circuit (F_k) (the first transistor 601 which is diode-connected). More specifically, the current driving capability of the first transistor 601 needs to be higher than the current driving capability of the fifth transistor 605. For example, the channel width of the first transistor 601 needs to be larger than the channel width of the fifth transistor 605.

[0088]

30 Further, in the period t_4 illustrated in FIG. 5, an output signal (T_k OUT) of the k -th transfer signal generation circuit goes to an L level. More specifically, the current driving capability of the eighth transistor 608 needs to be higher than the current driving capability of the seventh transistor 607. Thus, the output signal (T_k OUT) of the k -th

transfer signal generation circuit can be reduced to an L level which is equal to an inverted clock signal (CKB) level in the period t4 before the following operation: an H level signal is inputted to a gate terminal of the seventh transistor 607, the seventh transistor 607 is turned on, a ground potential (VSS) is inputted to a gate terminal of the 5 eighth transistor 608, and then, the eighth transistor 608 is turned off.

[0089]

Further, the description in Embodiment 2 is preferably taken into consideration when the circuit illustrated in FIG. 6 is designed.

[0090]

10 That is, it is preferable that the current driving capability of the first transistor 601 be higher than the current driving capability of the sixth transistor 606, the current driving capability of the second transistor 602 be higher than the current driving capability of the seventh transistor 607, and the current driving capability of the third transistor 603 be higher than the current driving capability of the eighth transistor 608.

15 [0091]

Furthermore, it is preferable that the third transistor 603 have the highest current driving capability among the first transistor 601 to the fifth transistor 605 included in the k -th flip flop circuit (F_k). In addition, it is preferable that the eighth transistor 608 have the highest current driving capability among the sixth transistor 606 to the eighth transistor 608 included in the k -th transfer signal generation circuit (T_k).

[0092]

20 Note that the circuit in FIG. 6 can also be applied to a $(k+1)$ th flip flop circuit, a $(k+1)$ th transfer signal generation circuit, and the like though FIG. 6 illustrates only the k -th flip flop circuit (F_k) and the k -th transfer signal generation circuit (T_k). Note that 25 as described in Embodiment 2, part of the electrical connection relationship of terminals is different. The description of Embodiment 2 applies to a specific difference of the connection relationship.

[0093]

FIGS. 7A and 7B are diagrams illustrating specific examples of a circuit which 30 can be applied to the inverter circuit 600 illustrated in FIG. 6. Note that in FIGS. 7A and 7B, a wiring denoted by "IN" is an input wiring and a wiring denoted by "OUT" is

an output wiring.

[0094]

An inverter circuit 600A illustrated in FIG. 7A includes a transistor 701A which is diode-connected and a transistor 702A.

5 [0095]

A gate terminal and a first terminal of the transistor 701A are electrically connected to a power supply (VDD) line, and a second terminal of the transistor 701A is electrically connected to an output terminal of the inverter circuit 600A.

[0096]

10 A gate terminal of the transistor 702A is electrically connected to an input terminal of the inverter circuit 600A, a first terminal of the transistor 702A is electrically connected to a ground potential (VSS) line, and a second terminal of the transistor 702A is electrically connected to an output terminal of the inverter circuit 600A and the second terminal of the transistor 701A.

15 [0097]

Since the inverter circuit 600A illustrated in FIG. 7A is formed using the two transistors 701A and 702B, an increase in the circuit area can be minimized.

[0098]

20 Note that, in the case where the inverter circuit 600A illustrated in FIG. 7A is applied to the inverter circuit 600 in FIG. 6, the circuit needs to be designed so that an output signal is in the L level when the transistor 702A is ON. More specifically, the current driving capability of the transistor 702A needs to be higher than the current driving capability of the transistor 701A. For example, the channel length of the transistor 702A needs to be smaller than the channel length of the transistor 701A, or 25 the channel width of the transistor 702A needs to be larger than the channel width of the transistor 701A.

[0099]

The inverter circuit 600B illustrated in FIG. 7B includes a transistor 701B which is diode-connected, a transistor 702B, a transistor 703B, and a transistor 704B.

30 [0100]

A gate terminal and a first terminal of the transistor 701B are electrically connected to the power supply (VDD) line.

[0101]

A gate terminal of the transistor 702B is electrically connected to an input terminal of the inverter circuit 600B, a first terminal of the transistor 702B is electrically connected to the ground potential (VSS) line, and a second terminal of the transistor 5 702B is electrically connected to a second terminal of the transistor 701B.

[0102]

A gate terminal of the transistor 703B is electrically connected to the second terminal of the transistor 701B and the second terminal of the transistor 702B, a first terminal of the transistor 703B is electrically connected to the power supply potential 10 (VDD) line, and a second terminal of the transistor 703B is electrically connected to an output terminal of the inverter circuit 600B.

[0103]

A gate terminal of the transistor 704B is electrically connected to the input terminal of the inverter circuit 600B, a first terminal of the transistor 704B is electrically connected to the ground potential (VSS) line, and a second terminal of the transistor 15 704B is electrically connected to the output terminal of the inverter circuit 600B and the second terminal of the transistor 703B.

[0104]

In the inverter circuit 600B illustrated in FIG. 7B, the transistor 701B which is 20 diode-connected is not directly connected to the output terminal of the inverter circuit 600B. Therefore, an output signal can be prevented from being decreased from the power supply potential (VDD) or increased from the ground potential (VSS).

[0105]

Note that, in the case where the inverter circuit 600B illustrated in FIG. 7B is 25 applied to the inverter circuit 600 illustrated in FIG. 6, the circuit needs to be designed so that the transistor 703B is turned off when the transistor 702B is ON. More specifically, the current driving capability of the transistor 702B needs to be higher than the current driving capability of the transistor 701B. For example, the channel length of the transistor 702B needs to be smaller than the channel length of the transistor 701B, 30 or the channel width of the transistor 702B needs to be larger than the channel width of the transistor 701B.

[0106]

[Difference from the circuit described in Embodiment 2]

The k -th flip flop circuit (F_k) illustrated in FIG. 6 includes the inverter circuit 600 and the fifth transistor 605 whose gate terminal is electrically connected to the output terminal of the inverter circuit 600, first terminal is electrically connected to the ground potential (VSS) line, and second terminal is electrically connected to the input terminal of the inverter circuit 600. Thus, the fifth transistor 605 which is electrically connected to the inverter circuit 600 is always ON once the fifth transistor 605 is turned on. When the fifth transistor 605 is ON, a potential of the gate terminal of the third transistor 603 is maintained at the ground potential (VSS). Therefore, even when noises enter the gate terminal of the third transistor 603, the third transistor 603 is not turned on. That is, an image or a picture of a display device is not defected and high performance of the display device can be realized.

[0107]

Since the k -th transfer signal generation circuit (T_k) illustrated in FIG. 6 is formed using the three transistors 606 to 608, the circuit area can be reduced.

[0108]

[Modification Example]

In Embodiment 3, an example of the flip flop circuit formed using the five transistors 601 to 605 and the inverter circuit 600, and the transfer signal generation circuit formed using the three transistors 606 to 608 is described. However, an embodiment is not limited to such a structure. For example, both the k -th flip flop circuit (F_k) and the k -th transfer signal generation circuit (T_k) may have the same structure as the k -th flip flop circuit (F_k) or the k -th transfer signal generation circuit (T_k) illustrated in FIG. 6. Further, the flip flop circuit and the transfer signal generation circuit can be formed by combination of the circuit in Embodiment 2 (FIG. 4) and the circuit in Embodiment 3 (FIG. 6).

[0109]

Furthermore, in Embodiment 3, the output signal of the k -th transfer signal generation circuit (T_k) and the output signal of the $(k+2)$ -th flip flop circuit (F_{k+2}) are applied to the stop pulse signal ($STP(F_k)$) for the k -th flip flop circuit and the stop pulse signal ($STP(T_k)$) for the k -th transfer signal generation circuit, respectively. However, a structure in Embodiment 3 is not limited to such a structure.

[0110]

(Embodiment 4)

In Embodiment 4, a specific example of a circuit which can be applied to the flip flop circuit and the transfer signal generation circuit described in Embodiment 1, which is different from a specific example in Embodiments 2 and 3, is described with reference to FIG. 8 and FIGS. 9A and 9B.

[0111]

[An example of a circuit structure]

FIG. 8 illustrates an example of a circuit which can be applied to the k -th flip flop circuit (F_k) and the k -th transfer signal generation circuit (T_k) included in the first gate driver 103A which is described in Embodiment 1. In Embodiment 4, a k -th flip flop circuit (F_k) includes a first transistor 801 to a fifth transistor 805 and a control circuit 800, and a k -th transfer signal generation circuit (T_k) includes a sixth transistor 806 to a ninth transistor 809. Note that, in other words, the circuit illustrated in FIG. 8 is made as follows: the control circuit 800 and the fifth transistor 805 are added to the circuit illustrated in FIG. 4 and a first terminal of the sixth transistor 806 (corresponding to the fifth transistor 405 in FIG. 4) is electrically connected to a power supply potential (VDD) line not to a gate terminal of the transistor 806.

[0112]

The electrical connection relationship between the first transistor 801, the second transistor 802, and the third transistor 803 is the same as that in the circuit illustrated in FIG. 4 and FIG. 6. Therefore, the description in Embodiment 2 applies here.

[0113]

A first input terminal of the control circuit 800 is electrically connected to a second terminal of the first transistor 801, a second terminal of the second transistor 802, and a gate terminal of the third transistor 803, and a second input terminal of the control circuit 800 is electrically connected to the clock signal (CK) line.

[0114]

A gate terminal of the fourth transistor 804 is electrically connected to an output terminal of the control circuit 800, a first terminal of the fourth transistor 804 is electrically connected to the ground potential (VSS) line, and a second terminal of the

fourth transistor 804 is electrically connected to a second terminal of the third transistor 803 and a first input terminal of the k -th transfer signal generation circuit (T_k).

[0115]

A gate terminal of the fifth transistor 805 is electrically connected to the output terminal of the control circuit 800, a first terminal of the fifth transistor 805 is electrically connected to the ground potential (VSS) line, a second terminal of the fifth transistor 805 is electrically connected to the second terminal of the first transistor 801, the second terminal of the second transistor 802, the gate terminal of the third transistor 803, and a first input terminal of the control circuit 800.

10 [0116]

A gate terminal of the sixth transistor 806 is electrically connected to an output terminal of the k -th flip flop circuit (F_k), and a first terminal of the sixth transistor 806 is electrically connected to the power supply potential (VDD) line.

[0117]

15

The electrical connection relationship between the seventh transistor 807, the eighth transistor 808, and the ninth transistor 809 is the same as that of the sixth transistor 606, the seventh transistor 607, and the eighth transistor 608 illustrated in FIG. 6. Therefore, the description in Embodiment 2 applies here.

[0118]

20

Note that the circuit illustrated in FIG. 8 needs to be designed as described below.

[0119]

25

The circuit illustrated in FIG. 8 needs to be designed so that an H level signal is surely inputted to the input terminal of the control circuit 800 when an H level signal is inputted into the k -th flip flop circuit (F_k) (the first transistor 801 which is diode-connected). More specifically, the current driving capability of the first transistor 801 needs to be higher than the current driving capability of the fifth transistor 805. For example, the channel width of the first transistor 801 needs to be larger than the channel width of the fifth transistor 805.

30 [0120]

Further, the description in Embodiment 2 is preferably taken into consideration when a circuit illustrated in FIG. 8 is designed.

[0121]

That is, it is preferable that the current driving capability of the first transistor 801 be higher than the current driving capability of the sixth transistor 806, the current driving capability of the second transistor 802 be higher than the current driving capability of the seventh transistor 807, the current driving capability of the third transistor 803 be higher than the current driving capability of the eighth transistor 808, and the current driving capability of the fourth transistor 804 be higher than the current driving capability of the ninth transistor 809.

[0122]

Furthermore, it is preferable that the third transistor 803 have the highest current driving capability among the first transistor 801 to the fifth transistor 805 included in the k -th flip flop circuit (F_k). In addition, it is preferable that the eighth transistor 808 have the highest current driving capability among the sixth transistor 806 to the ninth transistor 809 included in the k -th transfer signal generation circuit (T_k).

[0123]

The circuit in FIG. 8 can be applied to the $(k+1)$ th flip flop circuit (F_{k+1}), the $(k+1)$ th transfer signal generation circuit (T_{k+1}), and the like though FIG. 8 illustrates only the k -th flip flop circuit (F_k) and the k -th transfer signal generation circuit (T_k). Note that as described in Embodiment 2, part of the electrical connection relationship of terminals is different. The description of Embodiment 2 applies to a specific difference of the connection relationship.

[0124]

FIGS. 9A and 9B are diagrams illustrating specific examples of a circuit which can be applied to the control circuit 800 illustrated in FIG. 8. In FIGS. 9A and 9B, a wiring denoted by "IN" is a first input wiring, a wiring denoted by "CK" is a second input wiring which is electrically connected to a clock signal (CK) line, and a wiring denoted by "OUT" is an output wiring.

[0125]

The control circuit 800A illustrated in FIG. 9A includes a capacitor element 901A and a transistor 902A.

[0126]

One of terminals of the capacitor element 901A is electrically connected to the clock signal (CK) line and the other terminal is electrically connected to an output terminal of the control circuit 800A.

[0127]

5 A gate terminal of the transistor 902A is electrically connected to a first input terminal of the control circuit 800A, a first terminal of the transistor 902A is electrically connected to a ground potential (VSS) line, and a second terminal of the transistor 902A is electrically connected to the output terminal of the control circuit 800A and the other terminal of the capacitor element 901A.

10 [0128]

After the period t3 in FIG. 5, the L level signal is inputted to the first input terminal of the control circuit 800A and the transistor 902A is turned off. Accordingly, an output signal of the control circuit 800A becomes in a floating state. Therefore, as an output signal of the control circuit 800A, a signal which is tuned to the clock signal 15 (CK) is outputted.

[0129]

Note that in the case where the control circuit 800A illustrated in FIG. 9A is applied to the control circuit 800 in FIG. 8, the control circuit 800A needs to be designed so that when transition from the period t2 to the period t3 occurs, its output terminal 20 goes into a floating state after a potential of one of the terminals of the capacitor element 901A goes to an L level.

[0130]

The control circuit 800B illustrated in FIG. 9B includes a transistor 901B which is diode-connected, a transistor 902B, a transistor 903B, and a transistor 904B.

25 [0131]

A gate terminal and a first terminal of the transistor 901B are electrically connected to a clock signal (CK) line.

[0132]

30 A gate terminal of the transistor 902B is electrically connected to a first input terminal of the control circuit 800B, a first terminal of the transistor 902B is electrically connected to a ground potential (VSS) line, and a second terminal of the transistor 902B is electrically connected to a second terminal of the transistor 901B.

[0133]

A gate terminal of the transistor 903B is electrically connected to the second terminal of the transistor 901B and the second terminal of the transistor 902B, a first terminal of the transistor 903B is electrically connected to the clock signal (CK) line, 5 and a second terminal of the transistor 903B is electrically connected to an output terminal of the control circuit 800B.

[0134]

A gate terminal of the transistor 904B is electrically connected to the input terminal of the control circuit 800B, a first terminal of the transistor 904B is electrically connected to the ground potential (VSS) line, and a second terminal of the transistor 904B is electrically connected to the output terminal of the control circuit 800B and the second terminal of the transistor 903B. 10

[0135]

Note that, in the case where the control circuit 800B illustrated in FIG. 9B is applied to the control circuit 800 illustrated in FIG. 8, the circuit needs to be designed so that the transistor 903B is turned off when the transistor 902B is ON. More specifically, the current driving capability of the transistor 902B needs to be higher than the current driving capability of the transistor 901B. For example, the channel length of the transistor 902B needs to be smaller than the channel length of the transistor 901B, 20 or the channel width of the transistor 902B needs to be larger than the channel width of the transistor 901B.

[0136]

[Difference from the circuit described in Embodiments 2 and 3]

The control circuits 800A and 800B illustrated in FIGS. 9A and 9B output a 25 clock signal (CK) or a signal tuned to the clock signal (CK). Therefore, even when noises enter the gate terminal of the third transistor 803, the noises can be eliminated when the fourth transistor 804 and the fifth transistor 805 are turned on. Further, the fourth transistor 804 and the fifth transistor 805 are not always ON, whereby deterioration of the fourth transistor 804 and the fifth transistor 805 can be suppressed. 30 That is, an image of a display device is not defected, so that performance and reliability of the display device can be increased.

[0137]

[Modification Example]

In Embodiment 4, an example of the flip flop circuit formed using the five transistors 801 to 805 and the control circuit 800 and the transfer signal generation circuit formed using the four transistors 806 to 809 are described. However, an embodiment is not limited to such a structure. For example, both the k -th flip flop circuit (F_k) and the k -th transfer signal generation circuit (T_k) may have the same structure as the k -th flip flop circuit (F_k) or the k -th transfer signal generation circuit (T_k) illustrated in FIG. 8. Further, the flip flop circuit and the transfer signal generation circuit can be formed by combination of the circuit in Embodiment 2 (FIG. 4) or Embodiment 3 (FIG. 6) and the circuit in Embodiment 4 (FIG. 8).

[0138]

Furthermore, in Embodiment 4, the output signal of the k -th transfer signal generation circuit (T_k) and the output signal of the $(k+2)$ th flip flop circuit (F_{k+2}) are applied to the stop pulse signal ($STP(F_k)$) for the k -th flip flop circuit and the stop pulse signal ($STP(T_k)$) for the k -th transfer signal generation circuit, respectively. However, a structure in Embodiment 4 is not limited to such a structure.

[0139]**(Embodiment 5)**

In Embodiment 5, a specific example of a transistor included in the flip flop circuit and the transfer signal generation circuit described in Embodiments 2 to 4 is described.

[0140]

As the transistor, transistors which are formed using various materials and structures can be used. That is, there are no limitations on the type of transistors used. For example, a thin film transistor (TFT) including a non-single-crystal semiconductor film typified by a film made of amorphous silicon, polycrystalline silicon, microcrystalline (also referred to as microcrystal, nanocrystal, or semi-amorphous) silicon, or the like can be used.

[0141]

The use of the thin film transistor for manufacturing a display device has various advantages. Since a thin film transistor can be formed at temperature lower than that at which a transistor using single crystal silicon is formed, reduction in

manufacturing cost of a display device or increase in size of a manufacturing device can be realized. Further, since a thin film transistor can be manufactured at low temperature, the thin film transistor can be formed over a substrate with low heat resistance. Therefore, the transistor can be formed using a light-transmitting substrate with low heat resistance. In addition, since the thickness of the thin film transistor is thin, part of a film forming the transistor can transmit light. Accordingly, the aperture ratio can be increased.

[0142]

In addition, a MOS transistor, a junction transistor, a bipolar transistor, or the like can be used as the transistor. Note that the size of a transistor can be reduced by the use of a MOS transistor as the transistor. Alternatively, the use of a bipolar transistor as the transistor allows a large amount of current to flow. Therefore, a high-speed operation is possible. Note that a MOS transistor and a bipolar transistor may be formed over one substrate. Thus, reduction in power consumption, reduction in size, a high-speed operation, and the like can be realized.

[0143]

Note that by using a catalyst (e.g., nickel) for forming polycrystalline silicon, crystallinity can be further improved, and a thin film transistor having excellent electric characteristics can be formed. Accordingly, a gate driver circuit, a source driver circuit, and a signal processing circuit (e.g., a signal generation circuit, a gamma correction circuit, or a DA converter circuit) can be formed over the same substrate.

[0144]

Further, by using a catalyst (e.g., nickel) for forming microcrystalline silicon, crystallinity can be further improved, and a transistor having excellent electric characteristics can be formed. At this time, crystallinity can be improved by just performing heat treatment without performing laser light irradiation. As a result, a gate driver circuit and part of a source driver circuit (e.g., an analog switch) can be formed over the same substrate. Note that in the case where laser irradiation for crystallization is not performed, unevenness in crystallinity of silicon can be suppressed. Thus, an image with improved image quality can be displayed.

[0145]

Note that polycrystalline silicon or microcrystalline silicon can be formed

without use of a catalyst (e.g., nickel).

[0146]

Further, it is preferable that the entire silicon be improved in crystallinity but Embodiment 5 is not limited thereto. Only part of silicon may be improved in crystallinity. Selective increase in crystallinity can be achieved by selective laser irradiation or the like. For example, a region of a gate driver, a source driver, or the like may be irradiated with laser light. As a result, crystallinity of silicon can be improved only in a region in which a circuit needs to operate at high speed. Since a pixel portion does not need to be driven at high speed, a pixel circuit can be driven without a serious problem even when crystallinity is not improved; thus, a region where the crystallinity is improved is reduced and manufacturing process becomes shorter. Therefore, throughput is improved, so that manufacturing cost of a display device can be reduced.

[0147]

In addition, the transistor is not limited to a transistor formed using silicon. As the transistor, a transistor formed using a compound semiconductor such as silicon germanium and gallium arsenide, or an oxide semiconductor such as zinc oxide and zinc oxide including indium and gallium can be employed. Further, a thin film transistor including a thin film formed of such a compound semiconductors or oxide semiconductor can be employed. Since the thin film transistor can be manufactured at low temperature, a transistor can be formed at room temperature, for example. Accordingly, the transistor can be formed directly on a substrate with low heat resistance, such as a plastic substrate or a film substrate. Note that such a compound semiconductor or an oxide semiconductor can be used not only for a channel portion of the transistor but also for other applications. For example, such a compound semiconductor or an oxide semiconductor can be used for a wiring, a resistor, a pixel electrode, a light-transmitting electrode, or the like. Since such an element can be deposited or formed at the same time as the transistor, manufacturing cost of a display device can be reduced.

[0148]

Further, a transistor including an organic semiconductor or a carbon nanotube can be used as the transistor. Accordingly, transistors can be formed over a substrate

which can be bent. A display device using such a substrate can resist shock.

[0149]

In addition, a manufacturing method of the transistor is not limited. As the manufacturing method, a photolithography method, an inkjet method, a printing method, 5 or the like can be employed. Note that, since a mask (reticle) is not used during manufacture in an inkjet method and a printing method, a layout of a transistor can be changed with ease. Furthermore, since the transistor can be formed without use of a resist, material cost is reduced and the number of steps can be reduced. In addition, since a film can be formed where needed, a material is not wasted. Therefore, cost can 10 be reduced.

[0150]

Alternatively, as the transistor, a multi-gate transistor having two or more gate terminals can be used. With the multi-gate structure, a structure where a plurality of transistors are connected in series is obtained because channel regions are connected in 15 series. Therefore, with the multi-gate structure, off-current of a transistor is reduced and the withstand voltage of the transistor can be increased (the reliability can be improved).

[0151]

As the transistor, a transistor with a structure where gate terminals are formed 20 above and below a channel region can also be used. By providing gate terminals above and below a channel region, a structure where a plurality of transistors are connected in parallel is obtained. That is, the channel region is increased. Thus, the amount of current can be increased. Further, by employing the structure where gate terminals are formed above and below the channel region, a depletion layer is easily 25 formed; thus, an S value can be improved.

[0152]

In addition, a transistor with the following structure can be used as the transistor: a structure where a gate terminal is formed above a channel region, a structure where a gate terminal is formed below a channel region, a forward staggered 30 structure, an inverted staggered structure, a structure where a channel region is divided into a plurality of regions, a structure where channel regions are connected in parallel or in series, or the like.

[0153]

Further alternatively, as the transistor, a transistor with a structure where a source terminal or a drain terminal overlaps with a channel region (or part of it) can be used. When the structure where the source terminal or the drain terminal overlaps with the channel region (or part of it) is used, electric charges can be prevented from being accumulated in part of the channel region, which would result in an unstable operation.

[0154]

Furthermore, a structure in which an LDD region is provided can be applied to the transistor. By providing the LDD region, off-current of a transistor is reduced and the withstand voltage of the transistor can be increased (the reliability can be improved). In addition, by providing the LDD region, drain-source current is not changed very much even when drain-source voltage is changed when the transistor operates in the saturation region, so that a flat slope of voltage-current characteristics can be obtained.

[0155]

Note that the transistor can be formed using various substrates. That is, the type of a substrate is not limited to a certain type. As the substrate, a semiconductor substrate (e.g., a single crystal substrate or a silicon substrate), an SOI substrate, a glass substrate, a quartz substrate, a plastic substrate, a metal substrate, a stainless steel substrate, a substrate including stainless steel foil, a tungsten substrate, a substrate including tungsten foil, a flexible substrate, an attachment film, paper including a fibrous material, a base material film, or the like can be used, for example. As an example of a glass substrate, a barium borosilicate glass substrate, an aluminoborosilicate glass substrate, a soda lime glass substrate, or the like can be given.

For a flexible substrate, a flexible synthetic resin such as plastics typified by polyethylene terephthalate (PET), polyethylene naphthalate (PEN), and polyether sulfone (PES), or acrylic can be used, for example. Examples of an attachment film are an attachment film formed using polypropylene, polyester, vinyl, polyvinyl fluoride, polyvinyl chloride, and the like. Examples of a base film are a base film formed using polyester, polyamide, polyimide, inorganic vapor deposition film, paper, and the like.

In particular, when a transistor is formed using a semiconductor substrate, a single crystal substrate, an SOI substrate, or the like, a transistor with few variations in characteristics, size, shape, or the like, high current supply capability, and a small size

can be formed. By forming a circuit using such transistors, power consumption of the circuit can be reduced or the circuit can be highly integrated.

[0156]

Alternatively, the transistor may be formed using one substrate, and then, the 5 transistor may be transferred to and provided over another substrate. Example of a substrate to which a transistor is transferred are, in addition to the above-described substrate over which the transistor can be formed, a paper substrate, a cellophane substrate, a stone substrate, a wood substrate, a cloth substrate (including a natural fiber (e.g., silk, cotton, or hemp), a synthetic fiber (e.g., nylon, polyurethane, or polyester), a 10 regenerated fiber (e.g., acetate, cupra, rayon, or regenerated polyester), or the like), a leather substrate, a rubber substrate, and the like. By using such a substrate, transistors with excellent properties or transistors with low power consumption and a device with high durability, high heat resistance, light weight, or thin thickness can be formed.

[0157]

15 (Embodiment 6)

In Embodiment 6, examples of electronic devices including the display device described in Embodiment 1 are described with reference to FIGS. 11A to 11F, FIGS. 12A to 12D, and FIGS. 13A to 13D.

[0158]

20 FIGS. 11A to 11F and FIGS. 12A to 12D illustrate electronic devices including the display device described in Embodiment 1. These electronic devices can include a housing 5000, a display portion 5001, a speaker 5003, an LED lamp 5004, operation keys 5005 (including a power switch or an operation switch), a connection terminal 5006, a sensor 5007 (a sensor having a function of measuring force, displacement, 25 position, speed, acceleration, angular velocity, rotational frequency, distance, visible light, liquid, magnetism, temperature, chemical substance, sound, time, hardness, electric field, current, voltage, electric power, radiation, flow rate, humidity, gradient, oscillation, odor, or infrared ray), a microphone 5008, and the like. In these electronic devices, the display device described in Embodiment 1 is incorporated in the display 30 portion 5001.

[0159]

FIG. 11A illustrates a mobile computer, which can include a switch 5009, an

infrared port 5010, and the like in addition to the above objects. FIG. 11B illustrates a portable image regenerating device provided with a memory medium (e.g., a DVD regenerating device), which can include a second display portion 5002, a memory medium reading portion 5011, and the like in addition to the above objects. FIG. 11C 5 illustrates a projector, which can include a light source 5033, a projection lens 5034, and the like in addition to the above objects. FIG. 11D illustrates a portable game machine, which can include the memory medium reading portion 5011 and the like in addition to the above objects. FIG. 11E illustrates a television receiver, which can include a tuner, an image processing portion, and the like in addition to the above objects. FIG. 11F 10 illustrates a portable television receiver, which can include a charger 5017 capable of transmitting and receiving signals and the like in addition to the above objects. FIG. 12A illustrates a display, which can include a support base 5018 and the like in addition to the above objects. FIG. 12B illustrates a camera, which can include an external connecting port 5019, a shutter button 5015, an image receiving portion 5016, and the 15 like in addition to the above objects. FIG. 12C illustrates a computer, which can include a pointing device 5020, the external connecting port 5019, a reader/writer 5021, and the like in addition to the above objects. FIG. 12D illustrates a mobile phone, which can include an antenna, a tuner of one-segment (1seg digital TV broadcasts) partial reception service for mobile phones and mobile terminals, and the like in 20 addition to the above objects.

[0160]

The electronic devices illustrated in FIGS. 11A to 11F and FIGS. 12A to 12D can have a variety of functions, for example, a function of displaying a lot of information (e.g., a still image, a moving image, and a text image) on a display portion; 25 a touch panel function; a function of displaying a calendar, date, time, and the like; a function of controlling processing with a lot of software (programs); a wireless communication function; a function of being connected to a variety of computer networks with a wireless communication function; a function of transmitting and receiving a lot of data with a wireless communication function; and a function of 30 reading a program or data stored in a memory medium and displaying the program or data on a display portion. Further, the electronic device including a plurality of display portions can have a function of displaying image information mainly on one display

portion while displaying text information on another display portion, a function of displaying a three-dimensional image by displaying images where parallax is considered on a plurality of display portions, or the like. Furthermore, the electronic device including an image receiving portion can have a function of photographing a still 5 image, a function of photographing a moving image, a function of automatically or manually correcting a photographed image, a function of storing a photographed image in a memory medium (an external memory medium or a memory medium incorporated in the camera), a function of displaying a photographed image on the display portion, or the like. Note that functions which can be provided for the electronic devices 10 illustrated in FIGS. 11A to 11F and FIGS. 12A to 12D are not limited thereto, and the electronic devices can have a variety of functions.

[0161]

An example of the electronic devices incorporated in a building is described with reference to FIG. 13A and 13B.

15 [0162]

FIG. 13A illustrates an example of an electronic device incorporated in a building. The electronic device includes a housing 5022, a display portion 5023, a speaker 5025, and the like. The electronic device can be operated with a remote controller 5024. The electronic device is incorporated in the building as a 20 wall-hanging type and can be provided without requiring a large space.

[0163]

FIG. 13B illustrates an example of an electronic device incorporated in a building. The electronic device includes a display portion 5026 and is provided near a bathtub 5027, so that a person in the bathtub can view the display portion 5026.

25 [0164]

Note that although in Embodiment 6, the wall and the bathtub are given as examples of the building, Embodiment 6 is not limited to them. The display panel can be provided in a variety of building.

[0165]

30 Next, examples in which an electronic device is incorporated in a moving object are described with reference to FIGS. 13C and 13D.

[0166]

FIG. 13C illustrates an example in which an electronic device incorporated in a car. The electronic device includes a display portion 5028 is incorporated in a car body 5029. The electronic device can display information related to the operation of the car or information inputted from inside or outside of the car on demand. Note that the electronic device may have a navigation function.

5 [0167]

FIG. 13D illustrates an example of an electronic device provided in a passenger airplane. More specifically, FIG. 13D illustrates an application of the electronic device which is provided on a ceiling 5030 above a seat of the passenger airplane. The 10 electronic device is incorporated in the ceiling 5030 with a hinge portion 5032, and a passenger can view the display portion 5031 by stretching of the hinge portion 5032. The electronic device has a function of displaying information by the operation of the passenger.

15 [0168]

Note that although bodies of a car and an airplane are described as examples of moving objects in Embodiment 6, Embodiment 6 is not limited to them. The electronic devices can be provided for a variety of objects such as two-wheeled vehicles, four-wheeled vehicles (including cars, buses, and the like), trains (including monorails, railroads, and the like), and vessels.

20 [0169]

The electronic devices described in this embodiment are characterized by having a display portion for displaying some sort of information and by having the display device described in Embodiment 1 incorporated in the display portion.

[Example 1]

25 [0170]

In Example 1, suppression effect of a distorted or delayed signal in a gate driver including a transfer signal generation circuit is verified with a circuit simulation by comparison with a conventional example.

[0171]

30 FIGS. 14A and 14B respectively illustrate circuit simulation models of a conventional gate driver and a gate driver in this specification. FIG. 14A illustrates a structure of the conventional gate driver in which an output signal of each flip flop

circuit is used as a start pulse signal of the next flip flop circuit. FIG. 14B illustrates a structure of the gate driver in this specification in which a transfer signal generation circuit is provided between flip flop circuits.

[0172]

5 In Example 1, output signals of the flip flop circuits in the case where the circuit illustrated in FIG. 4 was used as the flip flop circuits and the transfer signal generation circuit were calculated by a circuit simulation. Note that calculation software which was used was PSpice. Further, it is assumed that the threshold voltage of the transistor included in a flip flop circuit and a transfer signal generation circuit was 10 8 V and the field effect mobility thereof was 0.5 cm²/Vs. In addition, it is assumed that a parasitic capacitance of 100 pF was formed in each gate line. Further, it is assumed that the voltage amplitude of a clock signal was 30 V (a potential of an H level was 30 V and a potential of an L level was 0 V), a ground voltage was 0 V, and a clock frequency was 41.7 kHz (a period was 24 μs).

15 [0173]

FIG. 15 illustrates the output signal of the flip flop circuits calculated by a circuit simulation. As FIG. 15 illustrates, it was confirmed that delayed and distorted signals are reduced in the gate driver in this specification.

20 This application is based on Japanese Patent Application serial no. 2009-150617 filed with Japan Patent Office on June 25, 2009, the entire contents of which are hereby incorporated by reference.

CLAIMS

1. A display device comprising:
 - a plurality of gate lines provided so as to be parallel or substantially parallel;
 - a first gate driver electrically connected to each of odd-numbered gate lines of the plurality of gate lines; and
 - a second gate driver electrically connected to each of even-numbered gate lines of the plurality of gate lines,
 - wherein each of the first gate driver and the second gate driver includes a plurality of flip flop circuits and a plurality of transfer signal generation circuits, and
- 5 10 wherein, in each of the first gate driver and the second gate driver, one of the plurality of flip flop circuits is electrically connected to an adjacent one of the plurality of flip flop circuits through one of the plurality of transfer signal generation circuits.
2. A display device according to claim 1, wherein the plurality of flip flop circuits and the plurality of transfer signal generation circuits which are included in the first gate driver, and the plurality of flip flop circuits and the plurality of transfer signal generation circuits which are included in the second gate driver have the same circuit structure.
- 15 20 3. An electronic device including the display device according to claim 1.
4. A display device comprising:
 - a plurality of gate lines provided so as to be parallel or substantially parallel;
 - a first gate driver electrically connected to each of odd-numbered gate lines of the plurality of gate lines; and
 - a second gate driver electrically connected to each of even-numbered gate lines of the plurality of gate lines,
 - wherein the first gate driver includes a k -th flip flop circuit and a k -th transfer signal generation circuit,
- 25 30 wherein k is an odd number equal to or larger than 3,
 - wherein the k -th flip flop circuit includes an output terminal electrically connected to a k -th gate line, a first input terminal electrically connected to an output

terminal of a $(k-2)$ th transfer signal generation circuit, a second input terminal electrically connected to a clock signal line, and a third input terminal electrically connected to a stop pulse signal line for the k -th flip flop circuit,

wherein the k -th transfer signal generation circuit includes an output terminal electrically connected to a first input terminal of a $(k+2)$ th flip flop circuit, a first input terminal electrically connected to the output terminal of the k -th flip flop circuit, a second input terminal electrically connected to an inverted clock signal line, and a third input terminal electrically connected to a stop pulse signal line for the k -th transfer signal generation circuit,

10 wherein the second gate driver includes a $(k+1)$ th flip flop circuit and a $(k+1)$ th transfer signal generation circuit,

wherein the $(k+1)$ th flip flop circuit includes an output terminal electrically connected to a $(k+1)$ th gate line, a first input terminal electrically connected to an output terminal of a $(k-1)$ th transfer signal generation circuit, a second input terminal electrically connected to the inverted clock signal line, and a third input terminal electrically connected to a stop pulse signal line for the $(k+1)$ th flip flop circuit, and

20 wherein the $(k+1)$ th transfer signal generation circuit includes an output terminal electrically connected to a first input terminal of a $(k+3)$ th flip flop circuit, a first input terminal electrically connected to an output terminal of the $(k+1)$ th flip flop circuit, a second input terminal electrically connected to the clock signal line, and a third input terminal electrically connected to a stop pulse signal line for the k -th transfer signal generation circuit.

25 5. A display device according to claim 4, wherein the flip flop circuit and the transfer signal generation circuit which are included in the first gate driver, and the flip flop circuit and the transfer signal generation circuit which are included in the second gate driver have the same circuit structure.

6. A display device according to claim 4,

30 wherein the third input terminal of the k -th flip flop circuit is electrically connected to the output terminal of the k -th transfer signal generation circuit through the

stop pulse signal line for the k -th flip flop circuit, and

wherein the third input terminal of the $(k+1)$ th flip flop circuit is electrically connected to the output terminal of the $(k+1)$ th transfer signal generation circuit through the stop pulse signal line for the $(k+1)$ th flip flop circuit.

5

7. A display device according to claim 4,

wherein the third input terminal of the k -th flip flop circuit is electrically connected to the output terminal of the $(k+1)$ th flip flop circuit through the stop pulse signal line for the k -th flip flop circuit, and

10 wherein the third input terminal of the $(k+1)$ th flip flop circuit is electrically connected to the output terminal of the $(k+2)$ th flip flop circuit through the stop pulse signal line for the $(k+1)$ th flip flop circuit.

8. A display device according to claim 4,

15 wherein the third input terminal of the k -th transfer signal generation circuit is electrically connected to the output terminal of the $(k+2)$ th flip flop circuit through the stop pulse signal line for the k -th transfer signal generation circuit, and

20 wherein the third input terminal of the $(k+1)$ th transfer signal generation circuit is electrically connected to an output terminal of the $(k+3)$ th flip flop circuit through the stop pulse signal line for the $(k+1)$ th transfer signal generation circuit.

9. A display device according to claim 4,

25 wherein the third input terminal of the k -th transfer signal generation circuit is electrically connected to the output terminal of the $(k+1)$ th transfer signal generation circuit through the stop pulse signal line for the k -th transfer signal generation circuit, and

30 wherein the third input terminal of the $(k+1)$ th transfer signal generation circuit is electrically connected to the output terminal of the $(k+2)$ th transfer signal generation circuit through the stop pulse signal line for the $(k+1)$ th transfer signal generation circuit.

10. An electronic device including the display device according to claim 4.

FIG. 1

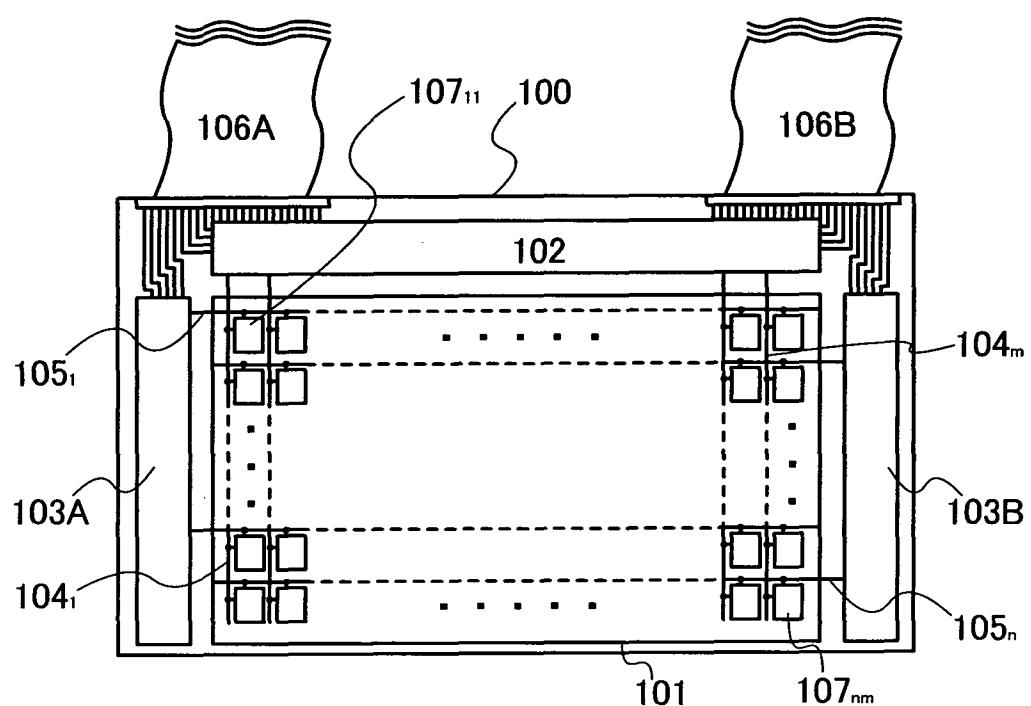


FIG. 2

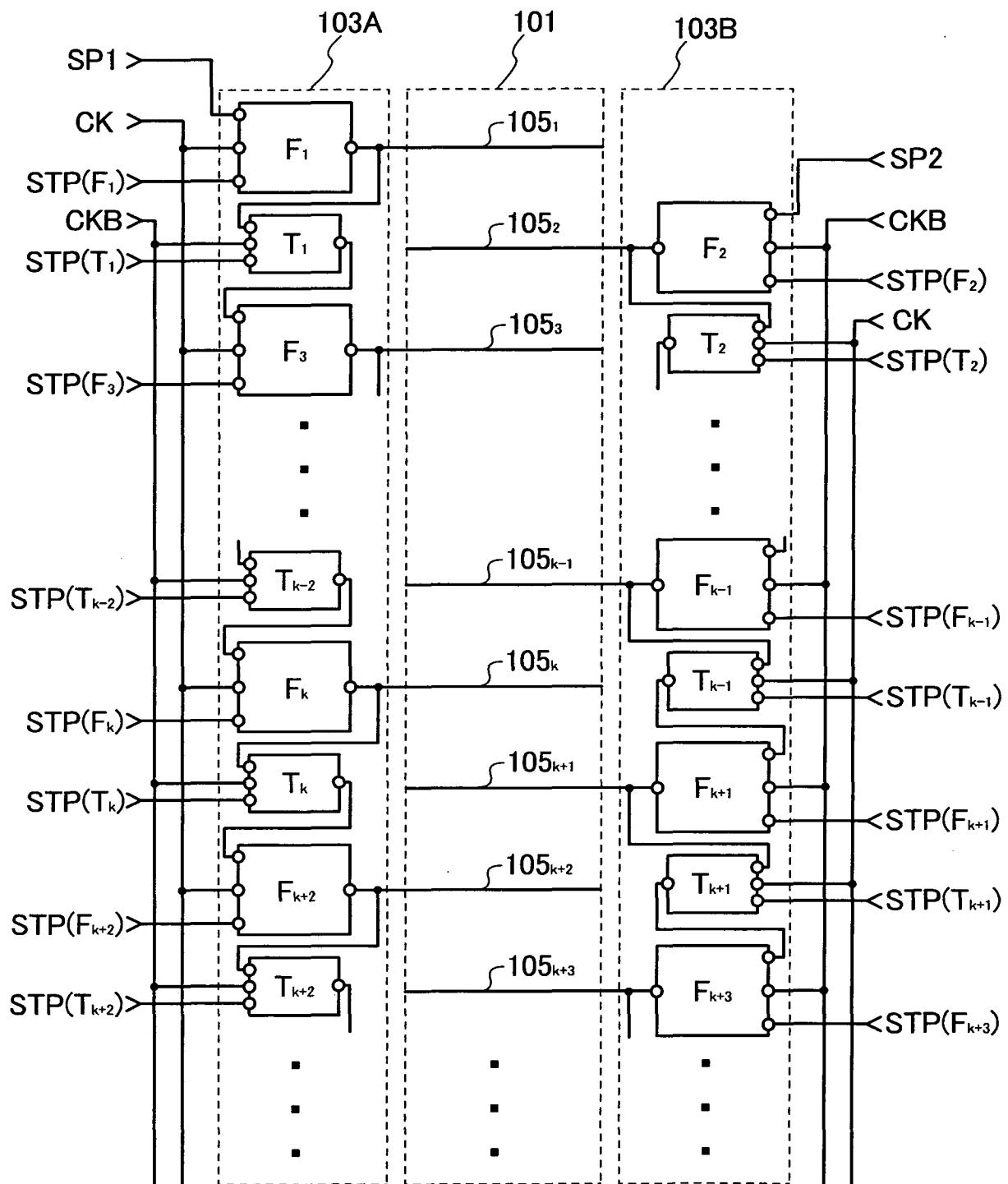


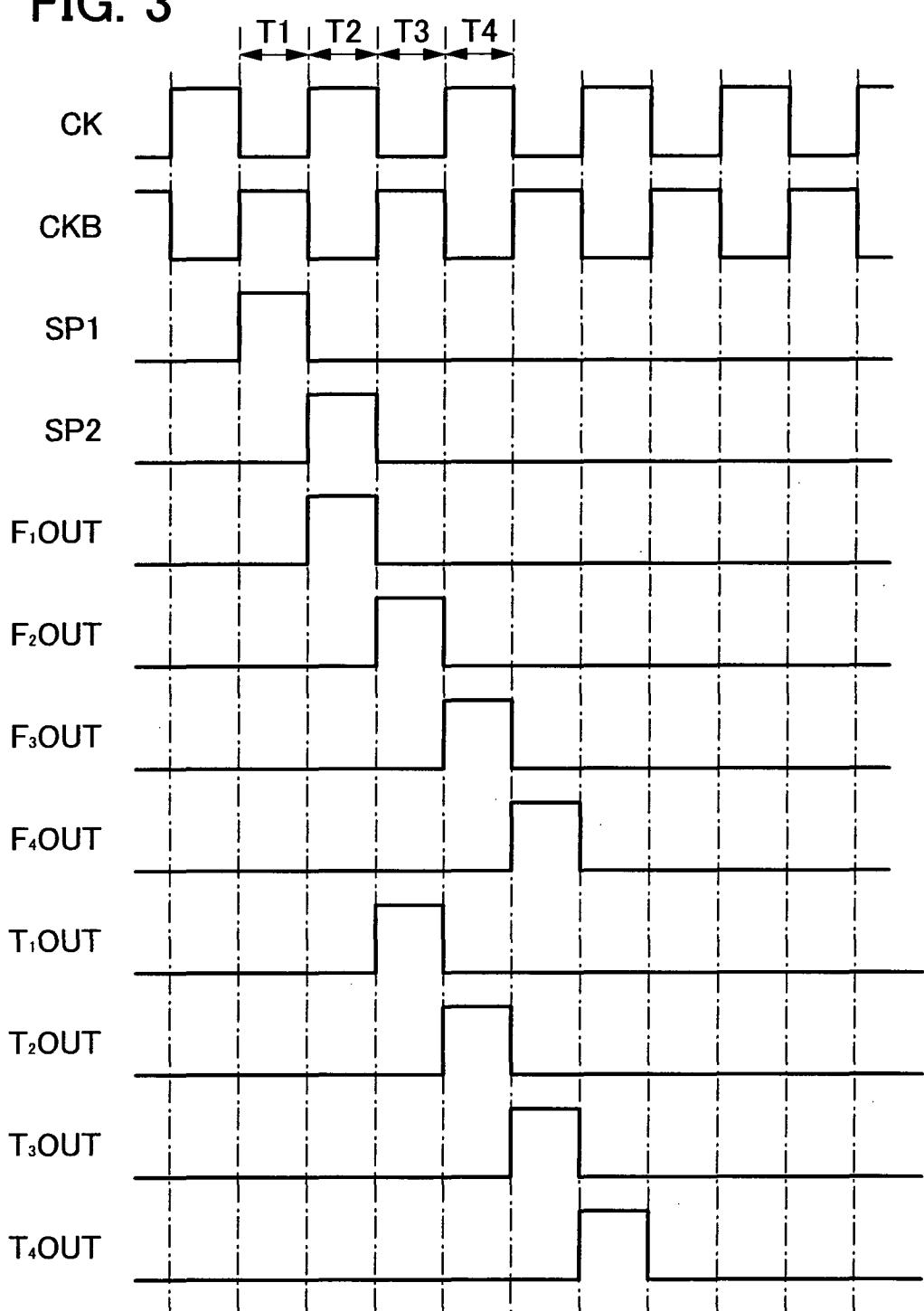
FIG. 3

FIG. 4

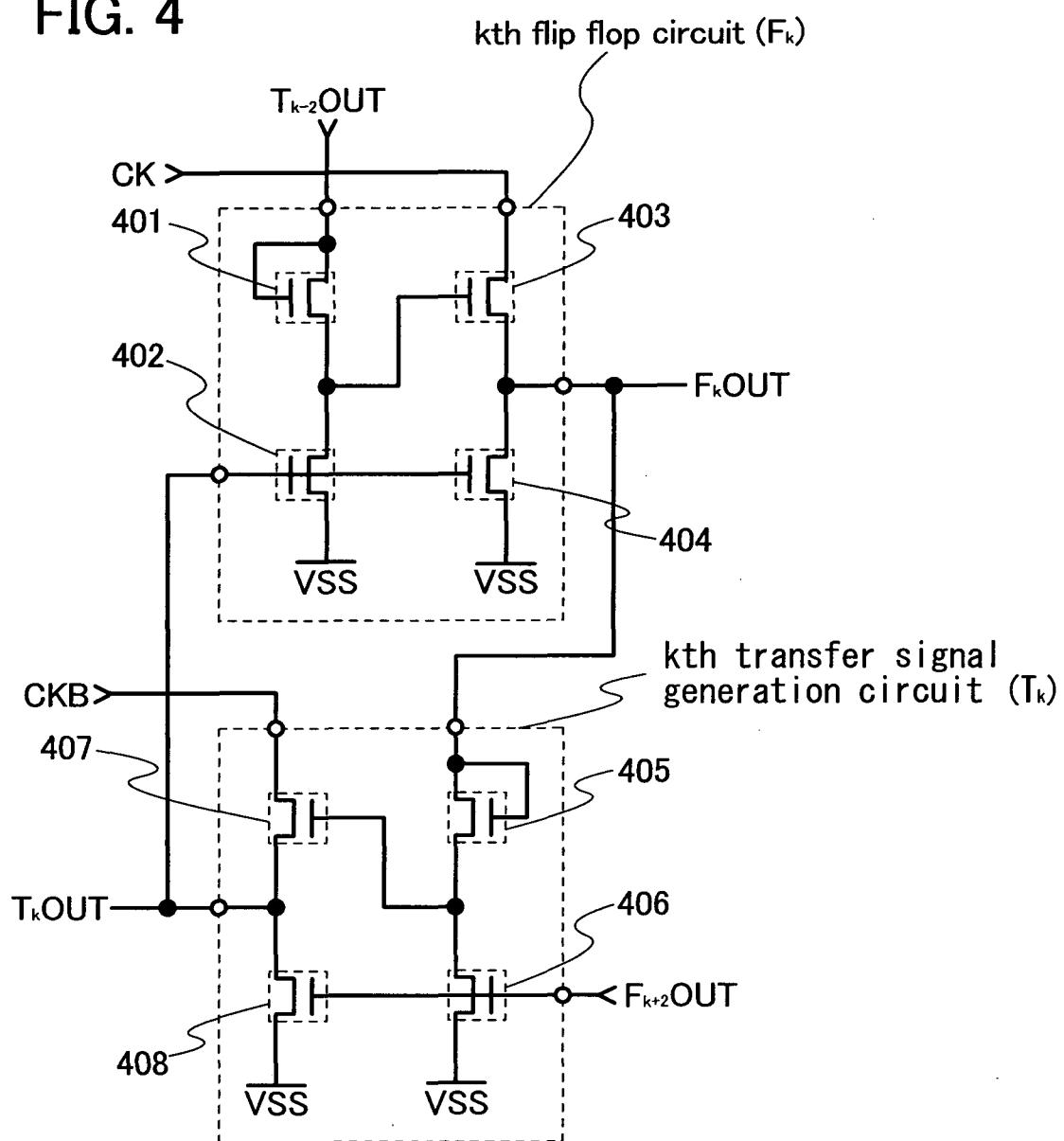


FIG. 5

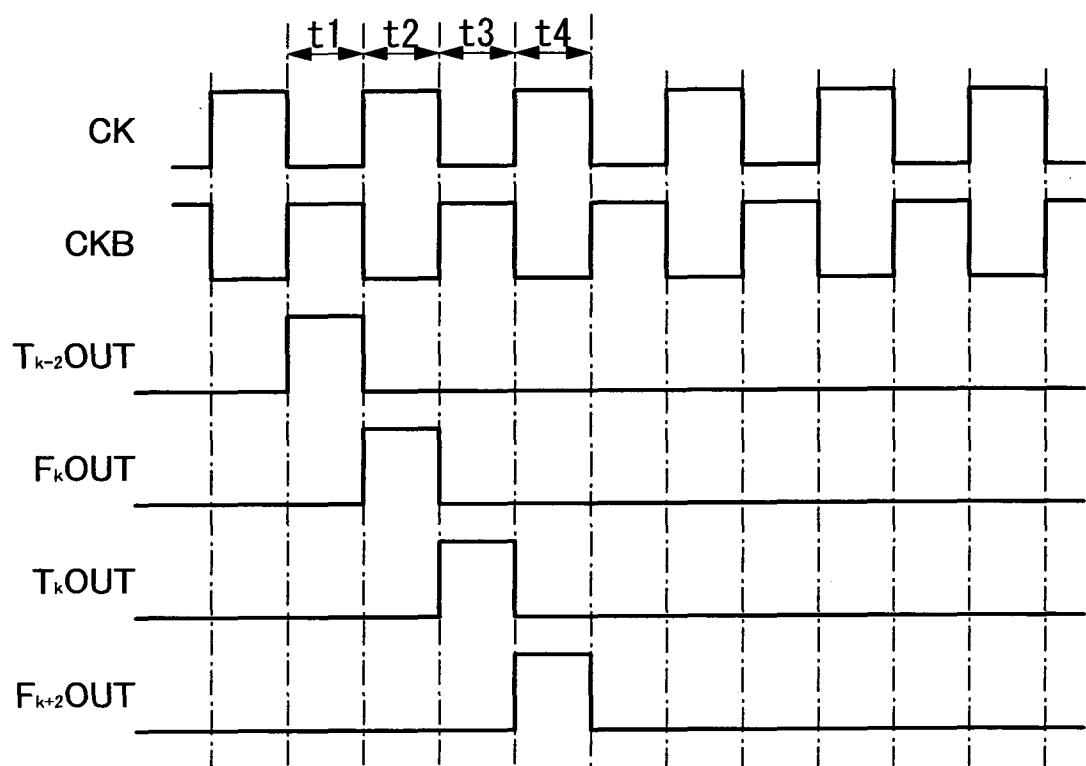


FIG. 6

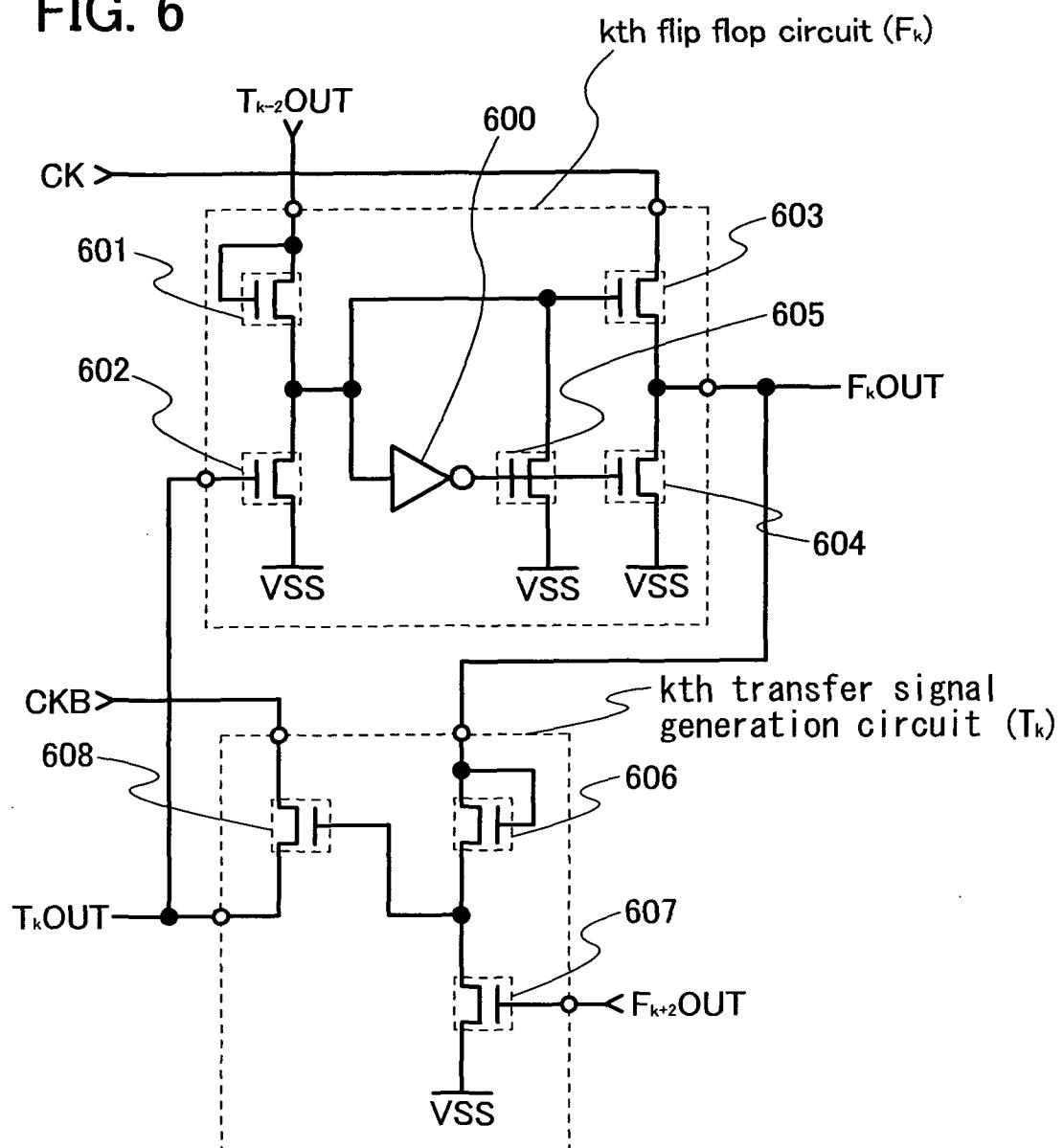


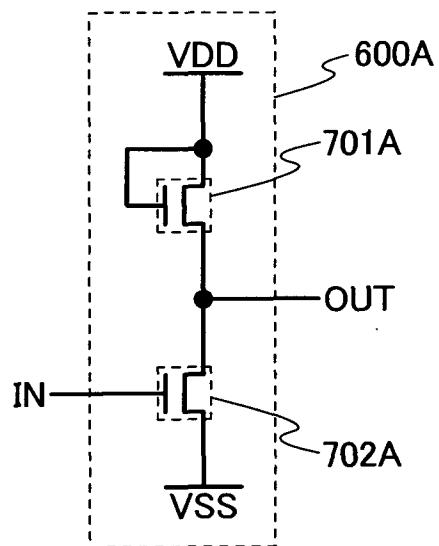
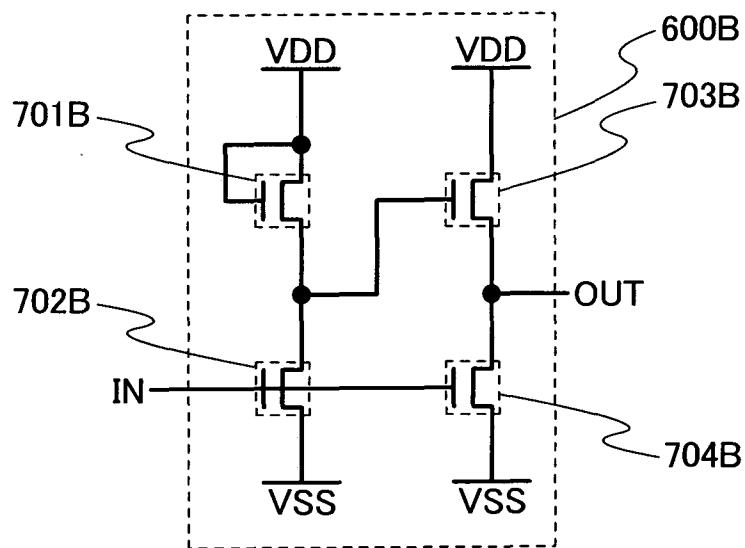
FIG. 7A**FIG. 7B**

FIG. 8

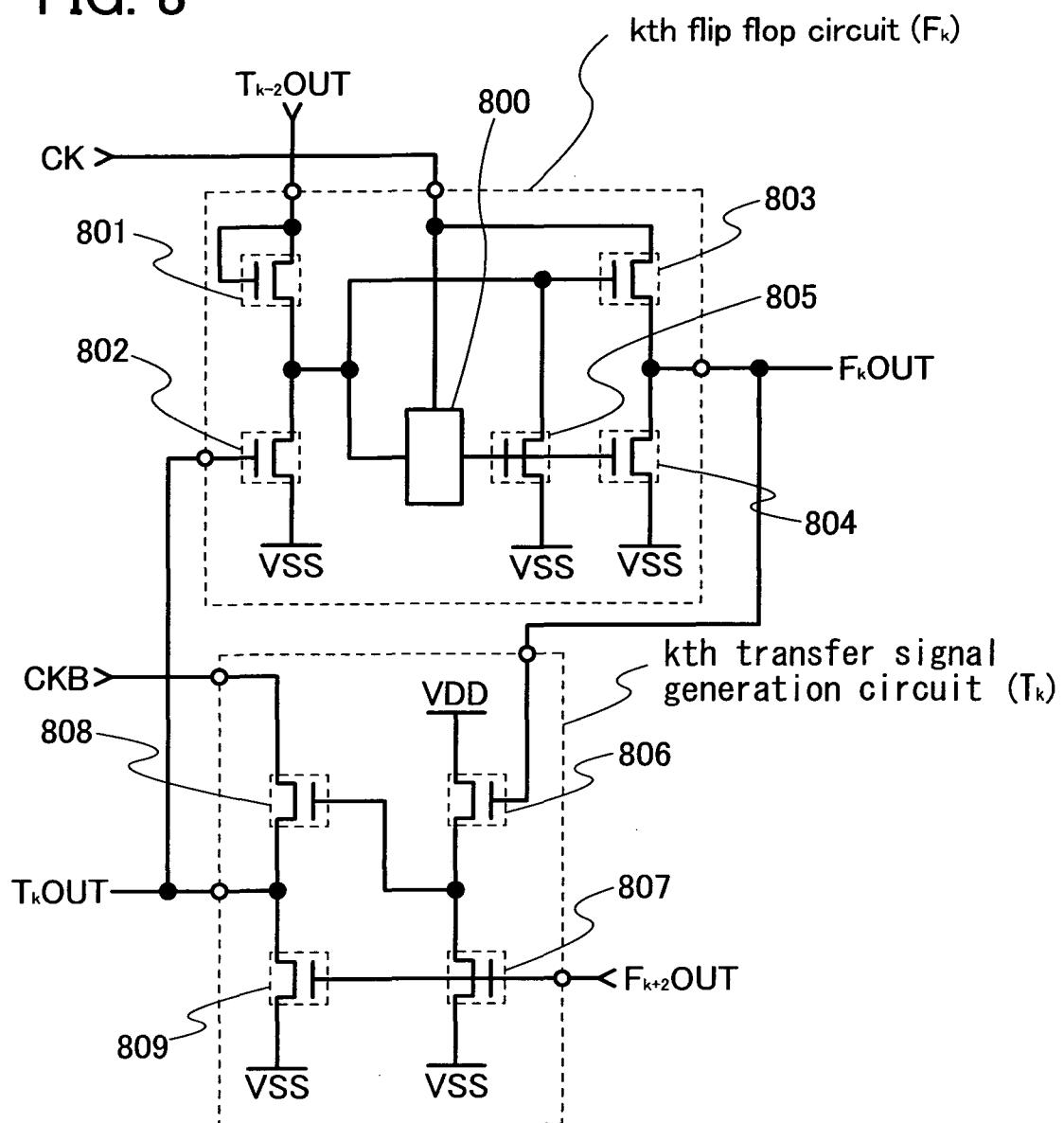


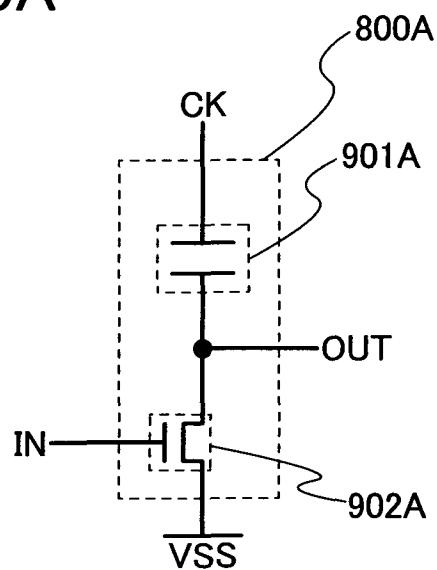
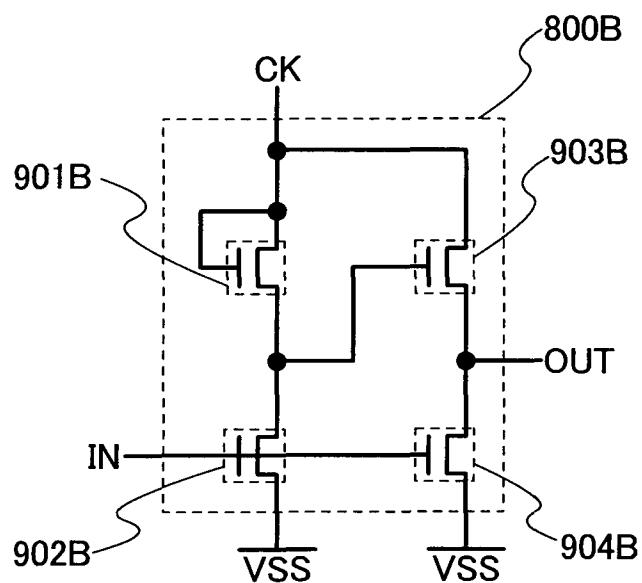
FIG. 9A**FIG. 9B**

FIG. 10

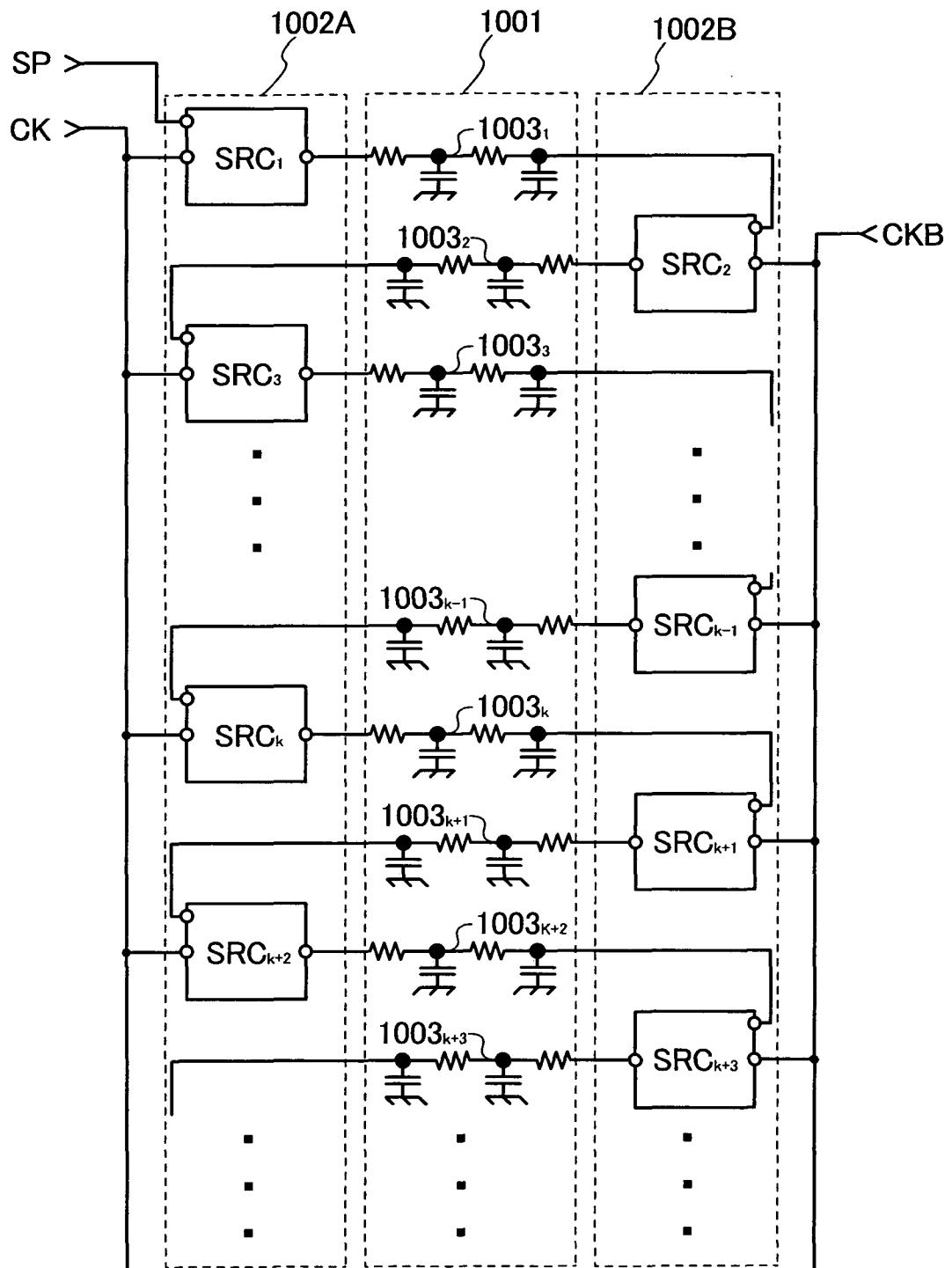


FIG. 11A

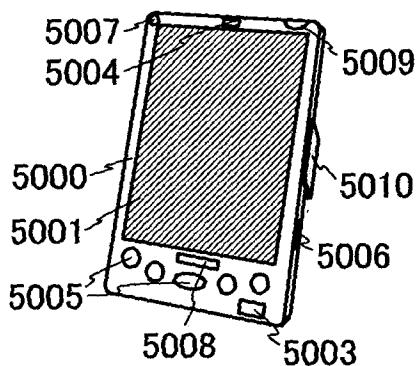


FIG. 11B

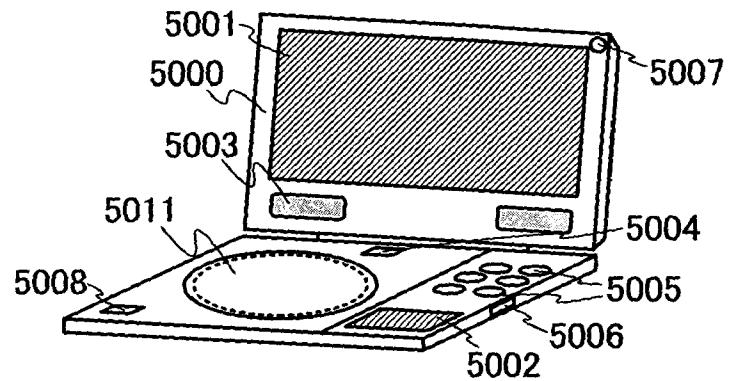


FIG. 11C

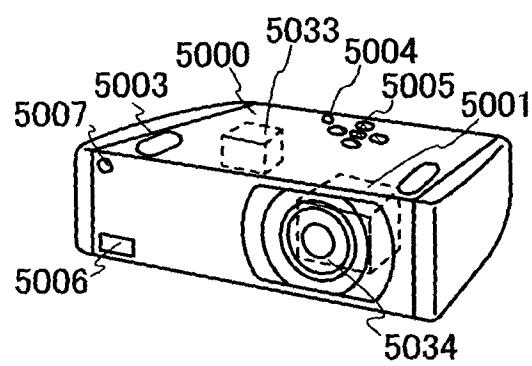


FIG. 11D

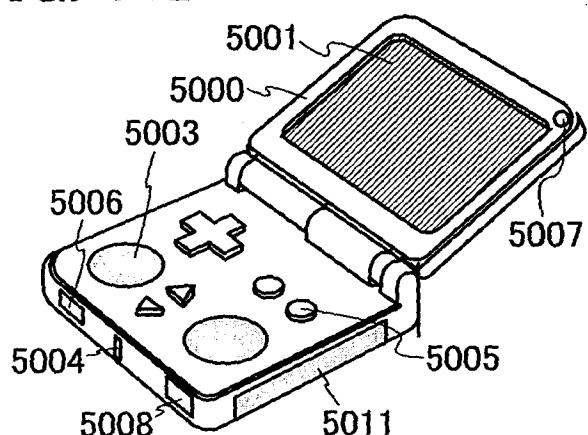


FIG. 11E

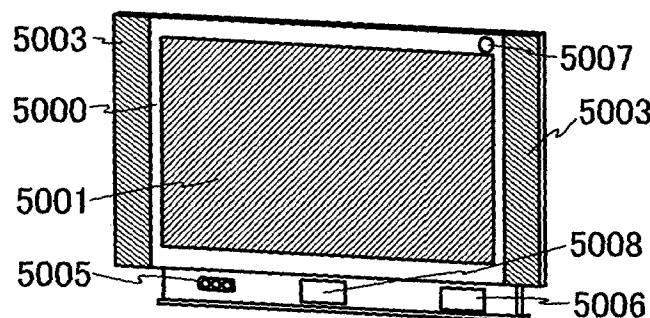


FIG. 11F

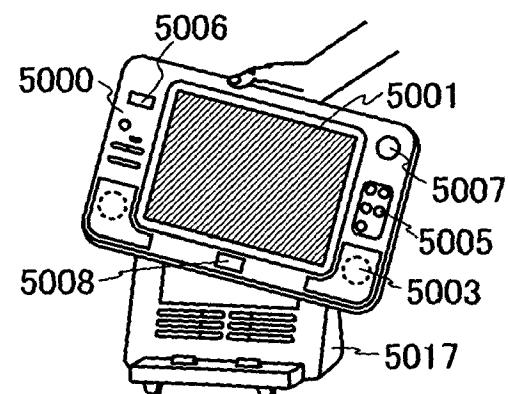


FIG. 12A

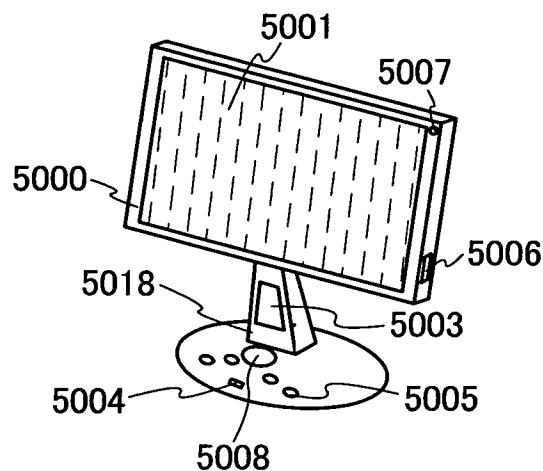


FIG. 12B

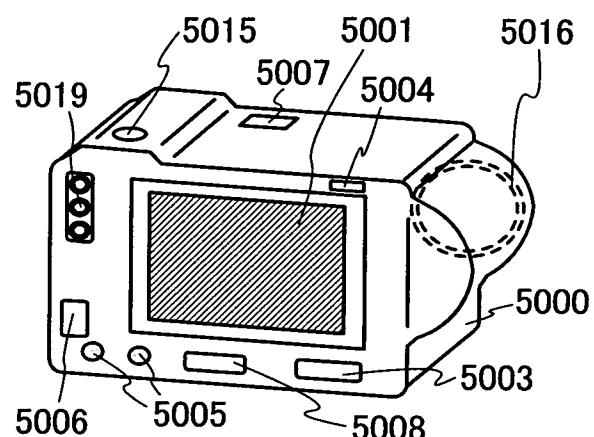


FIG. 12C

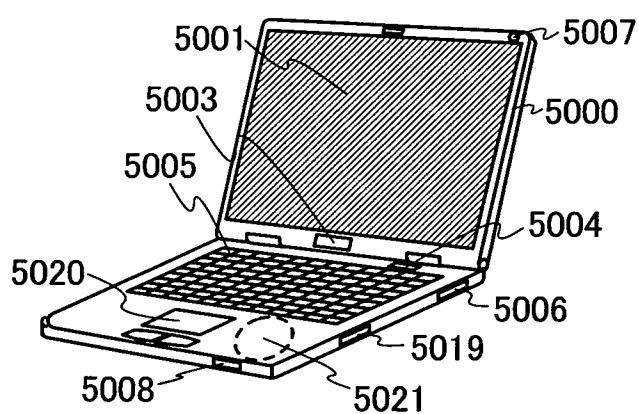


FIG. 12D

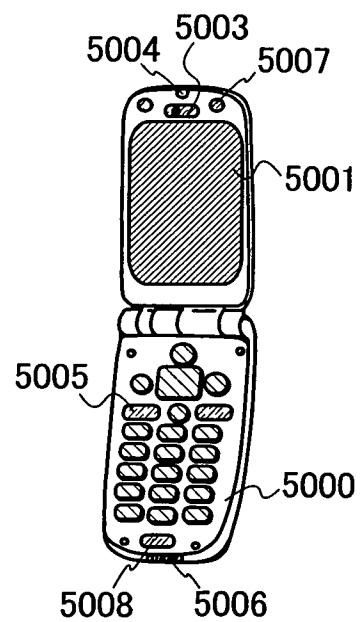


FIG. 13A

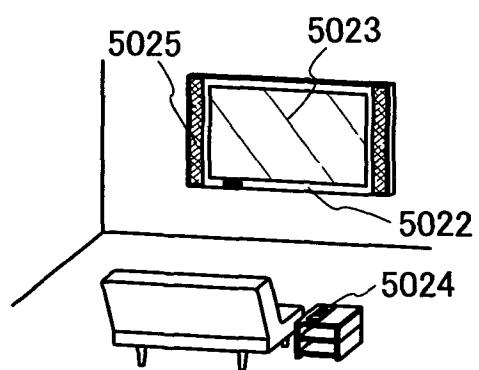


FIG. 13B

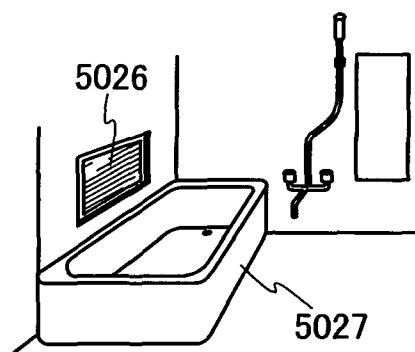


FIG. 13C

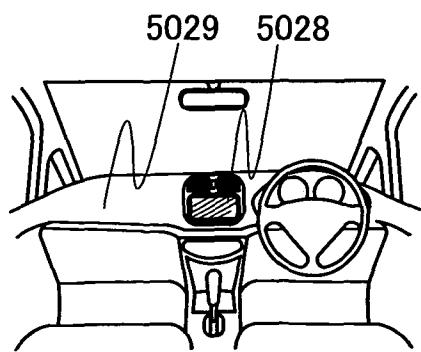


FIG. 13D

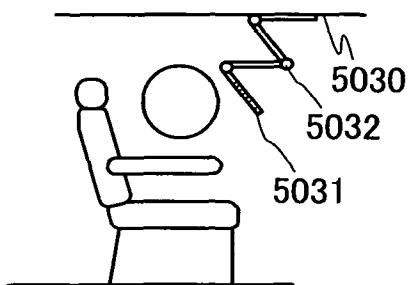


FIG. 14A

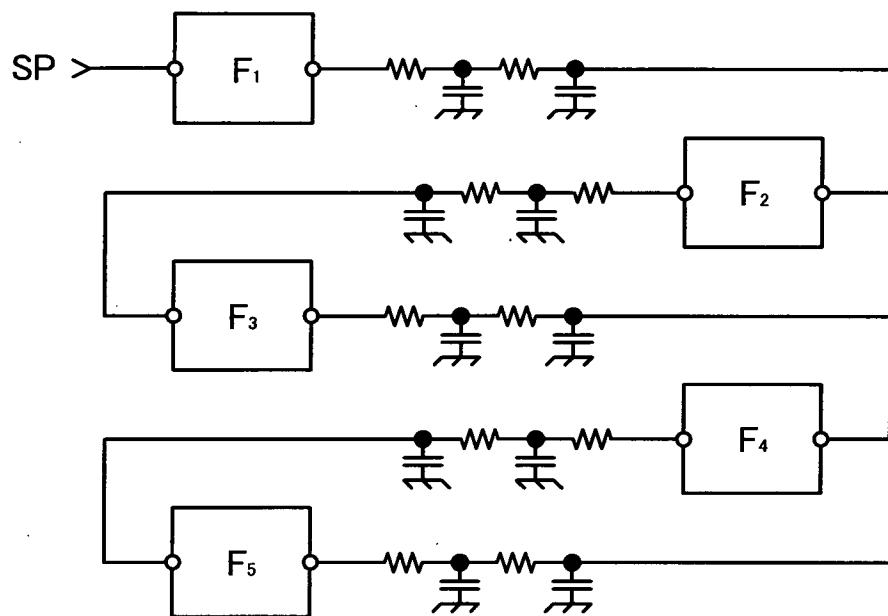


FIG. 14B

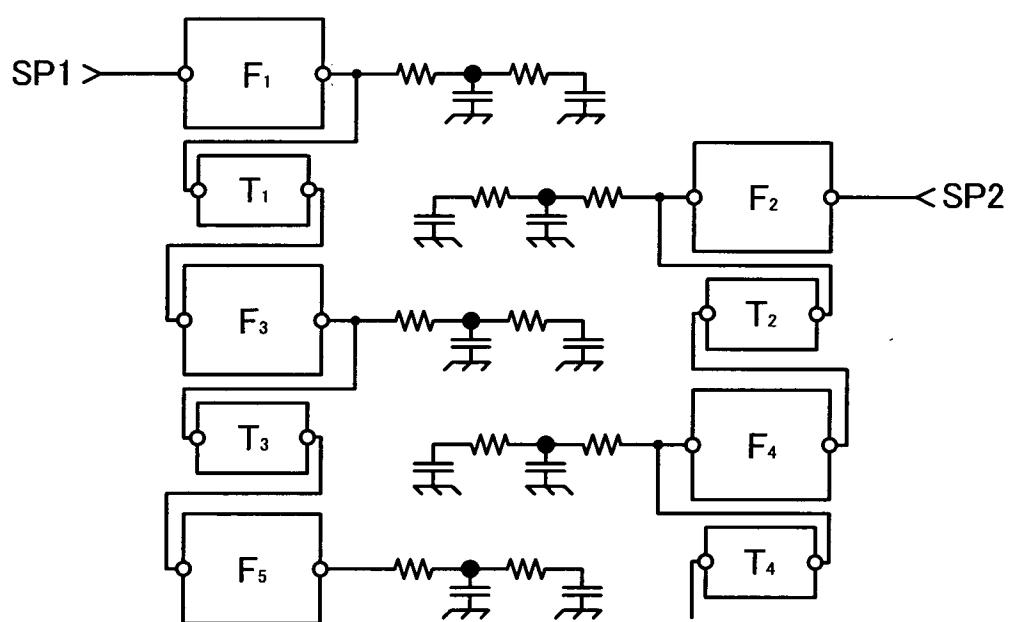
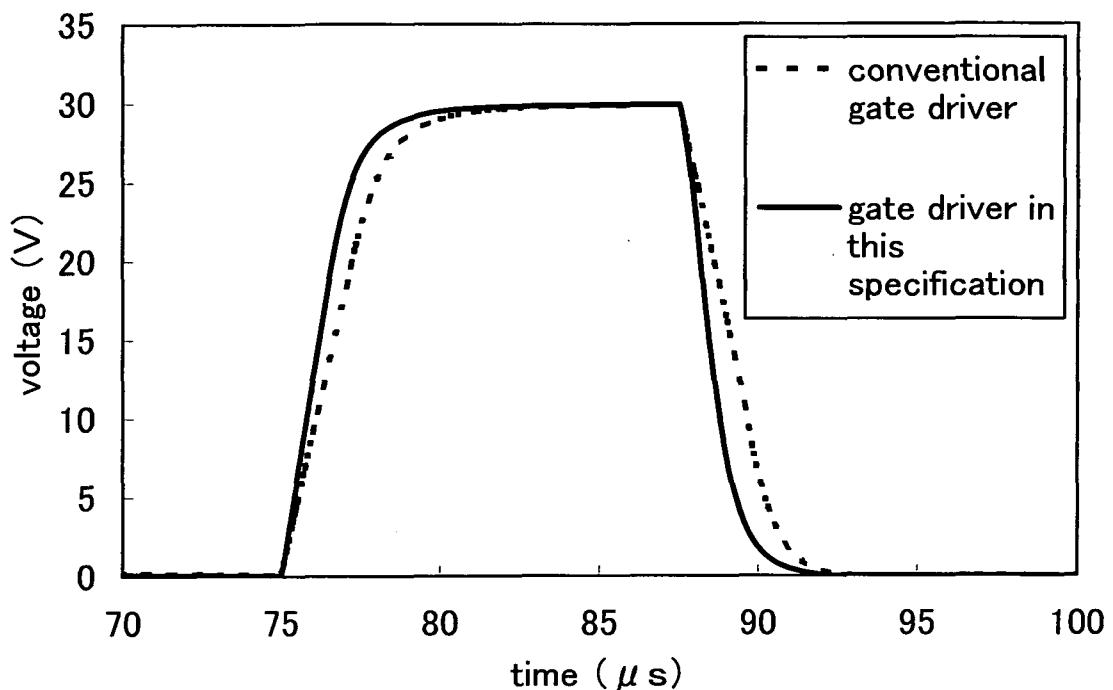


FIG. 15



REFERENCE NUMERALS

100: display device; 101: pixel portion; 102: source driver; 103A: first gate driver; 103B: second gate driver; 104₁: source line; 104_m: source line; 105₁:gate line; 105₂:gate line; 105₃:gate line; 105_n:gate line; 106A: flexible printed circuit; 106B: flexible printed circuit; 107₁₁: pixel; 107_{nm}: pixel; 401: transistor; 402: transistor; 403: transistor; 404: transistor; 405: transistor; 406: transistor; 407: transistor; 408: transistor; 600: inverter circuit; 600A: inverter circuit; 600B: inverter circuit; 601: transistor; 602: transistor; 603: transistor; 604: transistor; 10 605: transistor; 606: transistor; 607: transistor; 608: transistor; 701A: transistor; 701B: transistor; 702A: transistor; 702B: transistor; 703B: transistor; 704B: transistor; 800: control circuit; 800A: control circuit; 800B: control circuit; 801: transistor; 802: transistor; 803: transistor; 804: transistor; 805: transistor; 806: transistor; 807: transistor; 808: transistor; 809: transistor; 901A: capacitor element; 901A: transistor; 901B: transistor; 902A: transistor; 902B: transistor; 15 903B: transistor; 904B: transistor; 1001: pixel portion; 1002A: first gate driver; 1002B: second gate driver; 1003₁: gate line; 1003₂: gate line; 1003_k: gate line; 5000: housing; 5001: display portion; 5002: second display portion; 5003: speaker; 5004: LED lamp; 5005: operation key; 5006: connection terminal; 20 5007: sensor; 5008: microphone; 5009: switch; 5010: infrared port; 5011: memory medium reading portion; 5015: shutter button; 5016: image receiving portion; 5017: charger; 5018: support base; 5019: external connecting port; 5020: pointing device; 5021: reader/writer; 5022: housing; 5023: display portion; 5024: remote controller; 5025: speaker; 5026: display portion; 5027: 25 bathtub; 5028: display portion; 5029: car body; 5030: ceiling; 5031: display portion; 5032: hinge portion; 5033: light source; 5034: projection lens.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2010/058687

A. CLASSIFICATION OF SUBJECT MATTER

Int.Cl. G09G3/20 (2006.01)i, H03K3/356 (2006.01)i, H03K17/00 (2006.01)i,
H03K17/687 (2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Int.Cl. G09G3/20, H03K3/356, H03K17/00, H03K17/687

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Published examined utility model applications of Japan 1922-1996
Published unexamined utility model applications of Japan 1971-2010
Registered utility model specifications of Japan 1996-2010
Published registered utility model applications of Japan 1994-2010

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 2000-347628 A (CASIO COMPUTER CO., LTD.)	1-3
Y	2000.12.15, paragraphs [0002]-[0011]; figures 13-14 (No Family)	4-10
Y	US 2008/0219401 A1 (MITSUBISHI ELECTRIC CORPORATION) 2008.09.11 , paragraphs [0079]-[0112]; figures 2-6 & JP 2008-217902 A & KR 10-2008-0081822 A & CN 101261881 A	4-10
A	US 2008/0062112 A1 (SEMICONDUCTOR ENERGY LABORATORY CO., LTD.) 2008.03.13 , full text; all drawings & JP 2008-83692 A & EP 1895545 A2 & CN 101135791 A & KR 10-2008-0021557 A	1-10

Further documents are listed in the continuation of Box C.

See patent family annex.

* Special categories of cited documents:

“A” document defining the general state of the art which is not considered to be of particular relevance
“E” earlier application or patent but published on or after the international filing date
“L” document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
“O” document referring to an oral disclosure, use, exhibition or other means
“P” document published prior to the international filing date but later than the priority date claimed

“T” later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

“X” document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

“Y” document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
“&” document member of the same patent family

Date of the actual completion of the international search
10.08.2010

Date of mailing of the international search report
24.08.2010

Name and mailing address of the ISA/JP
Japan Patent Office
3-4-3, Kasumigaseki, Chiyoda-ku, Tokyo 100-8915, Japan

Authorized officer
Satoru TAKEDA 2G 9307
Telephone No. +81-3-3581-1101 Ext. 3226