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(54) **SEMICONDUCTOR INTEGRATED CIRCUIT**

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(57) **ABSTRACT**

A semiconductor integrated circuit in which multiphase clock signals having the same phase difference are supplied from a multi-stage differential ring oscillator to other circuits, the multiphase clock signals can be prevented from being degraded in waveform due to electrostatic coupling between wirings of the multiphase clock signals and also wired in as small an area as possible. The semiconductor integrated circuit includes: multiple stages of amplifier circuits, connected in a ring form, for performing oscillating operation; a logic circuit for performing logic operation on the basis of predetermined ones of output signals of the multiple stages of amplifier circuits to output a plurality of clock signals having different phases from each other and duties not equal to 0.5; and a plurality of wirings for transmitting the plurality of clock signals output from the logic circuit.

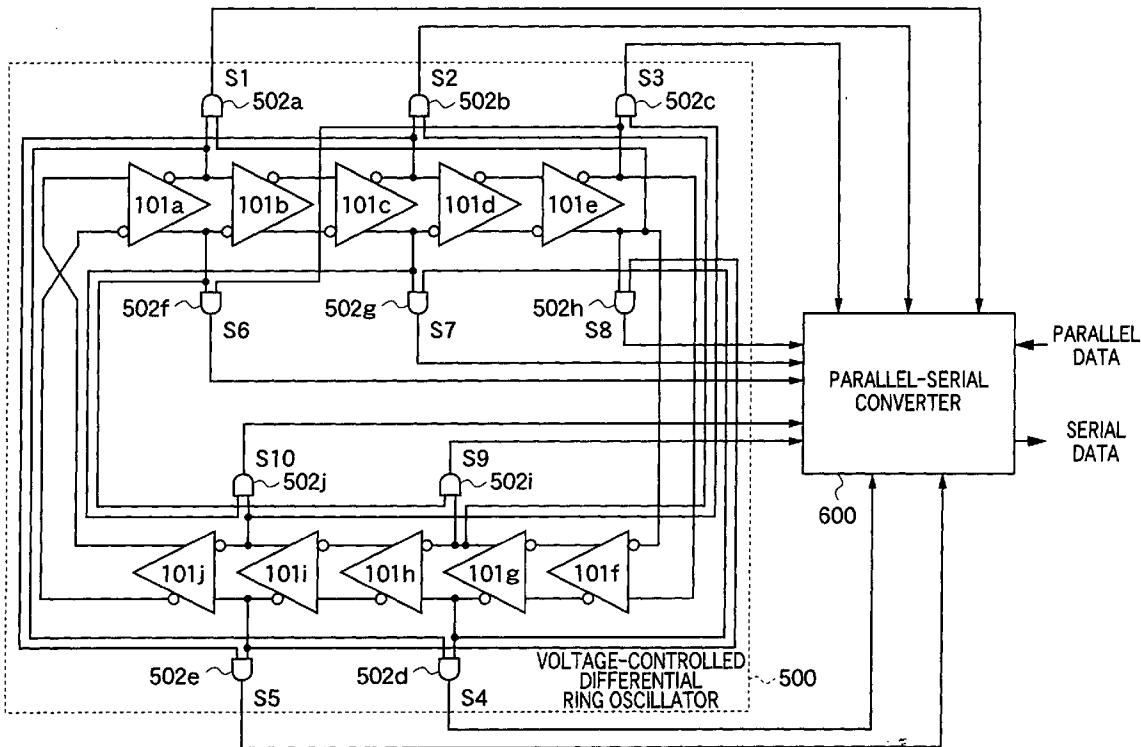


FIG. 1
PRIOR ART

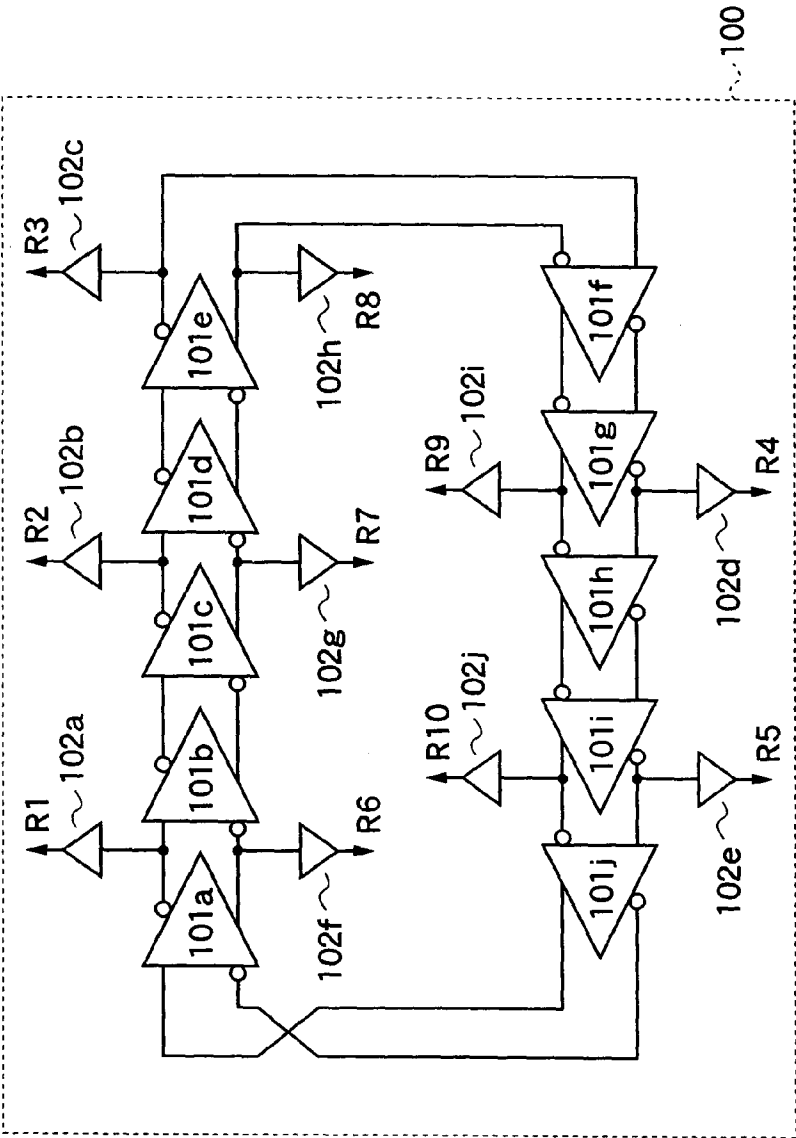


FIG.2
PRIOR ART

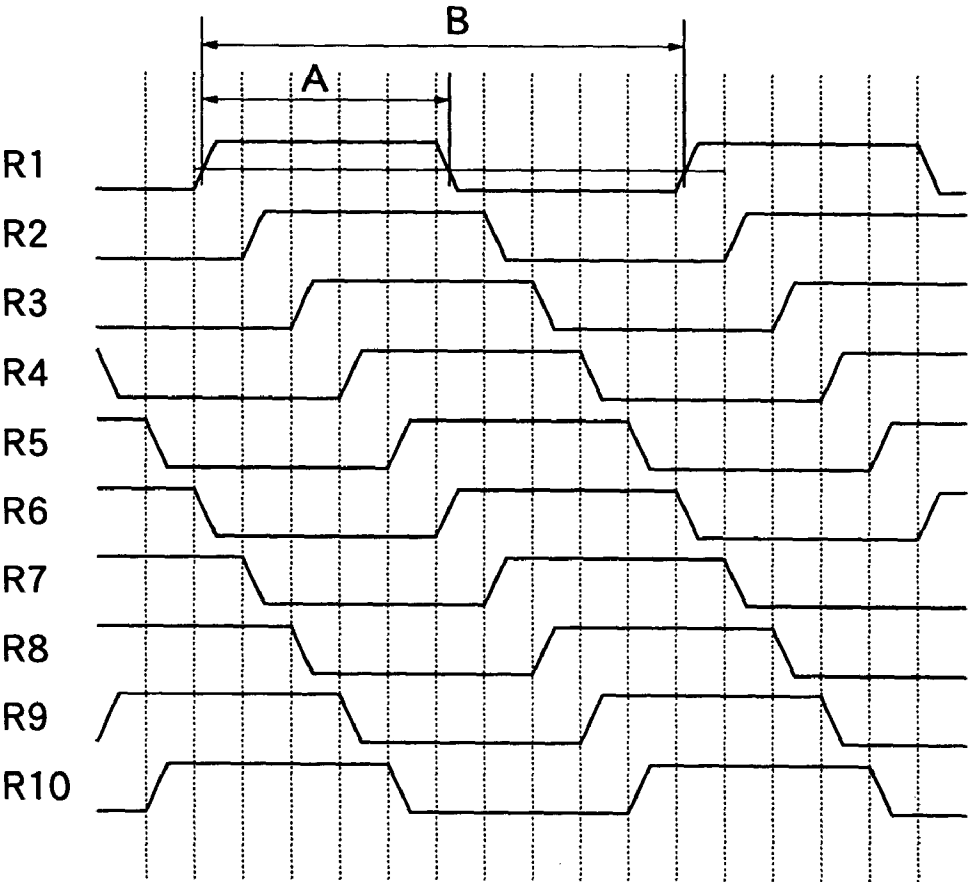


FIG.3A
PRIOR ART

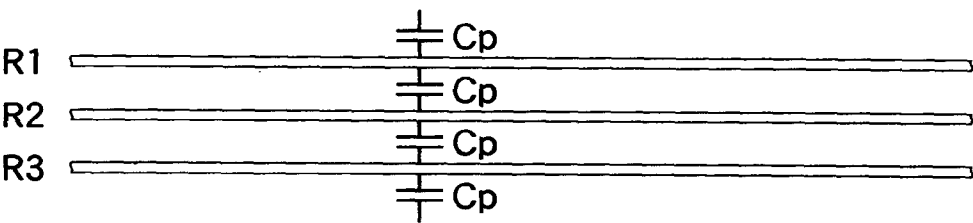


FIG.3B
PRIOR ART

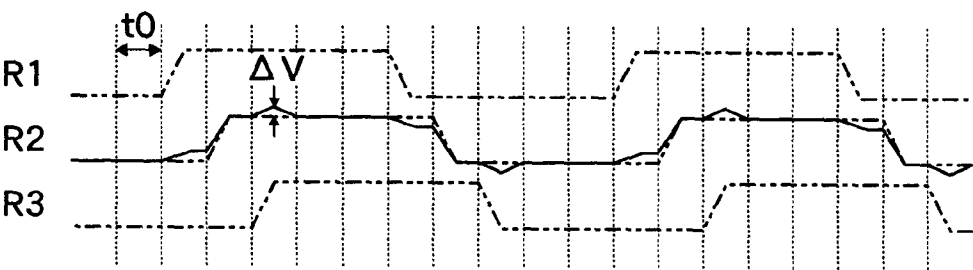


FIG.4A
PRIOR ART

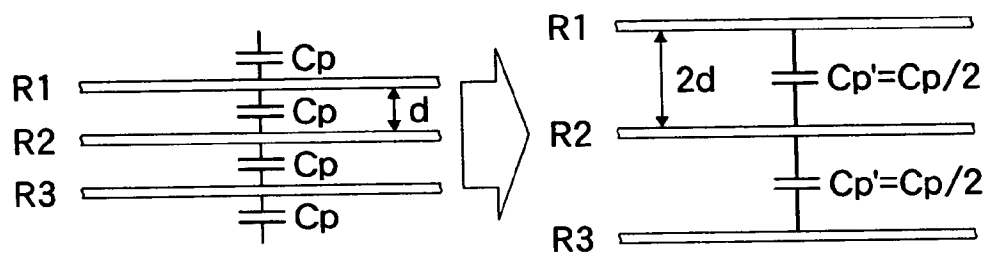


FIG.4B
PRIOR ART

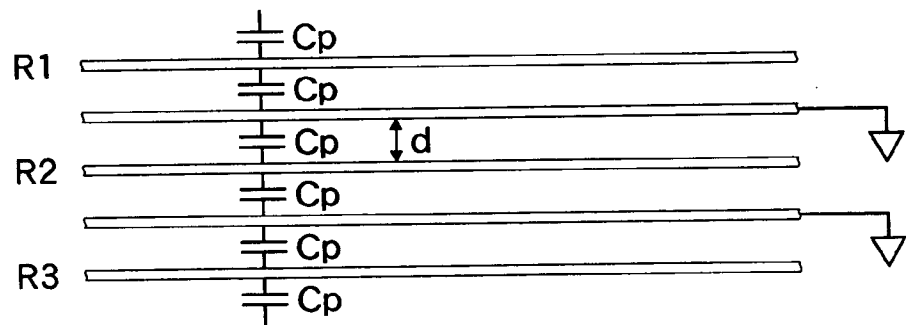


FIG.5

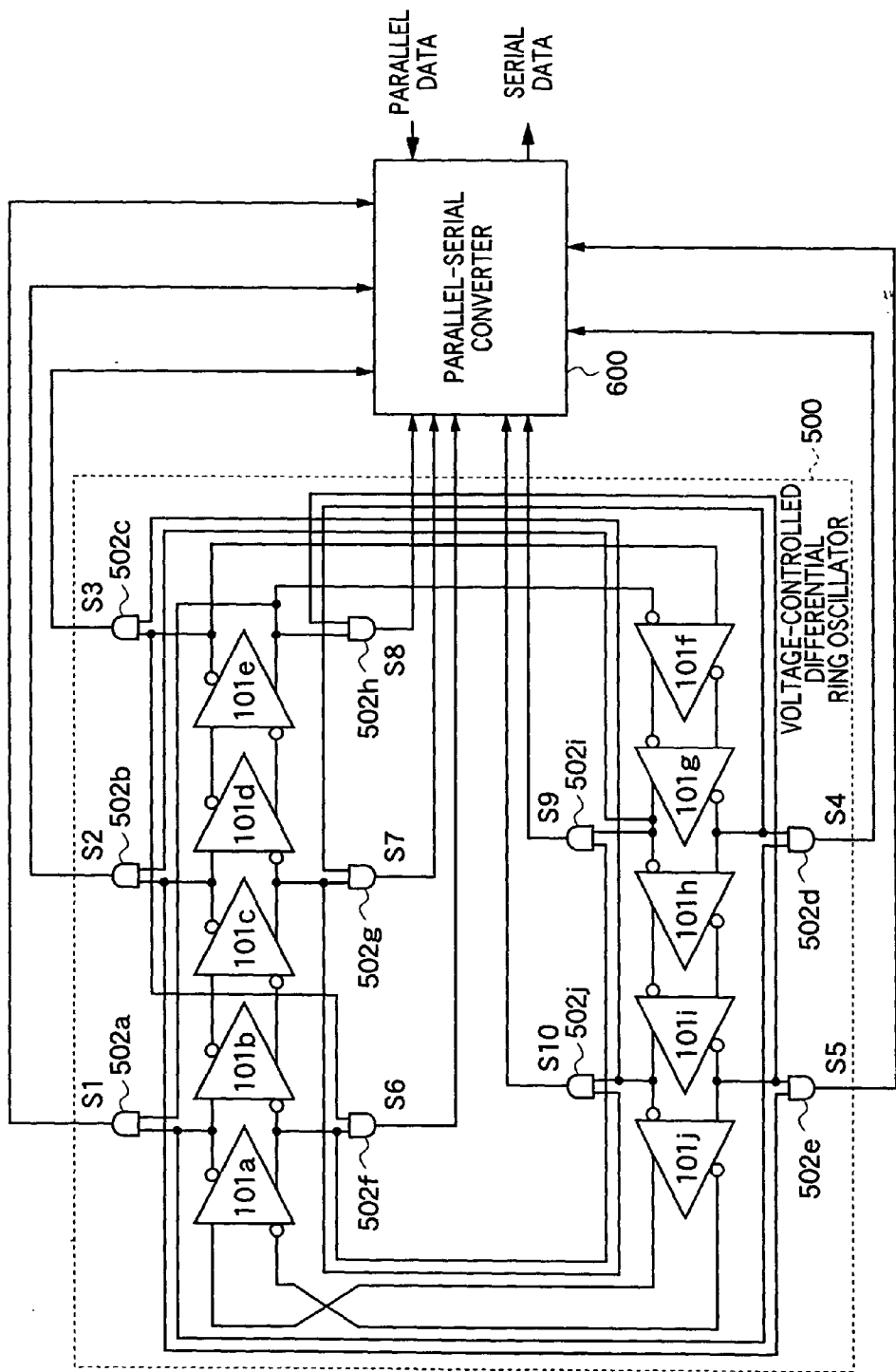


FIG. 6

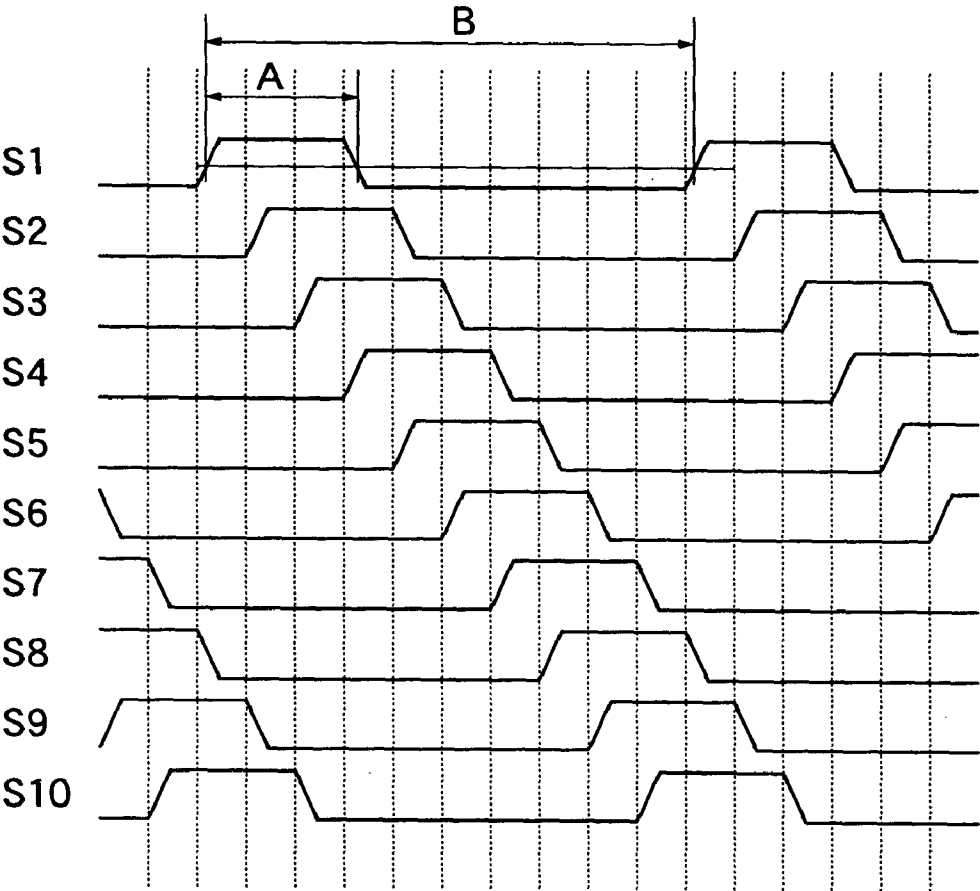


FIG.7A

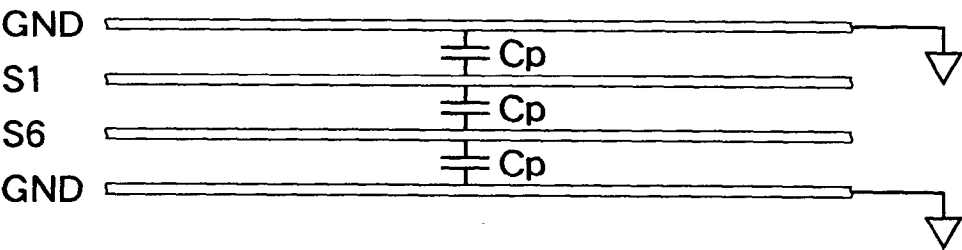


FIG.7B

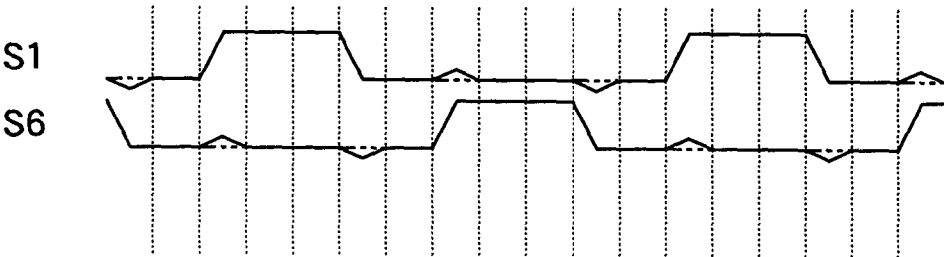


FIG.8A

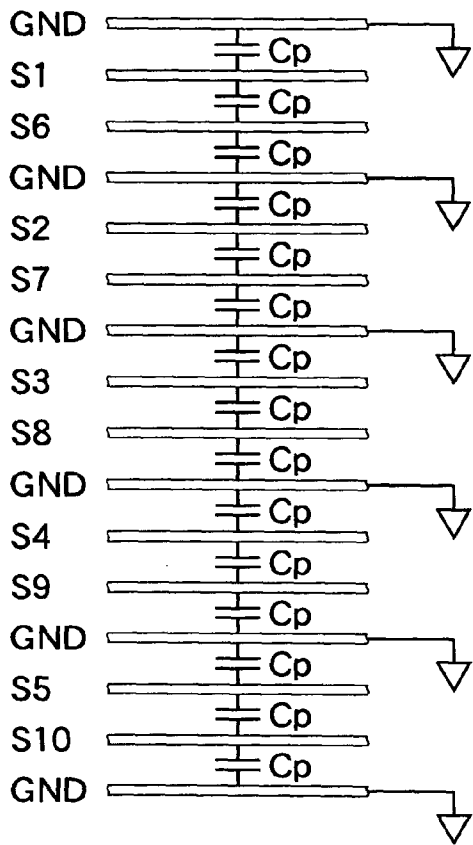


FIG.8B

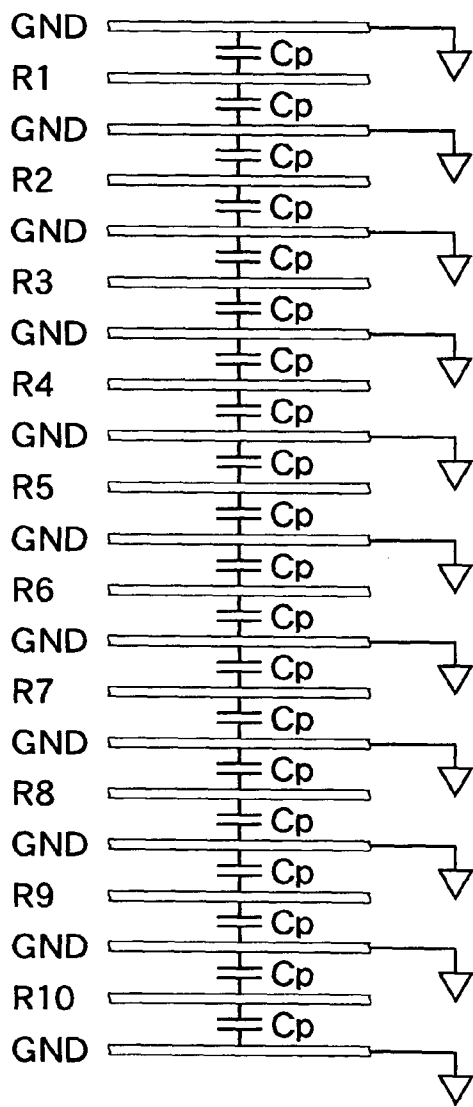


FIG.9

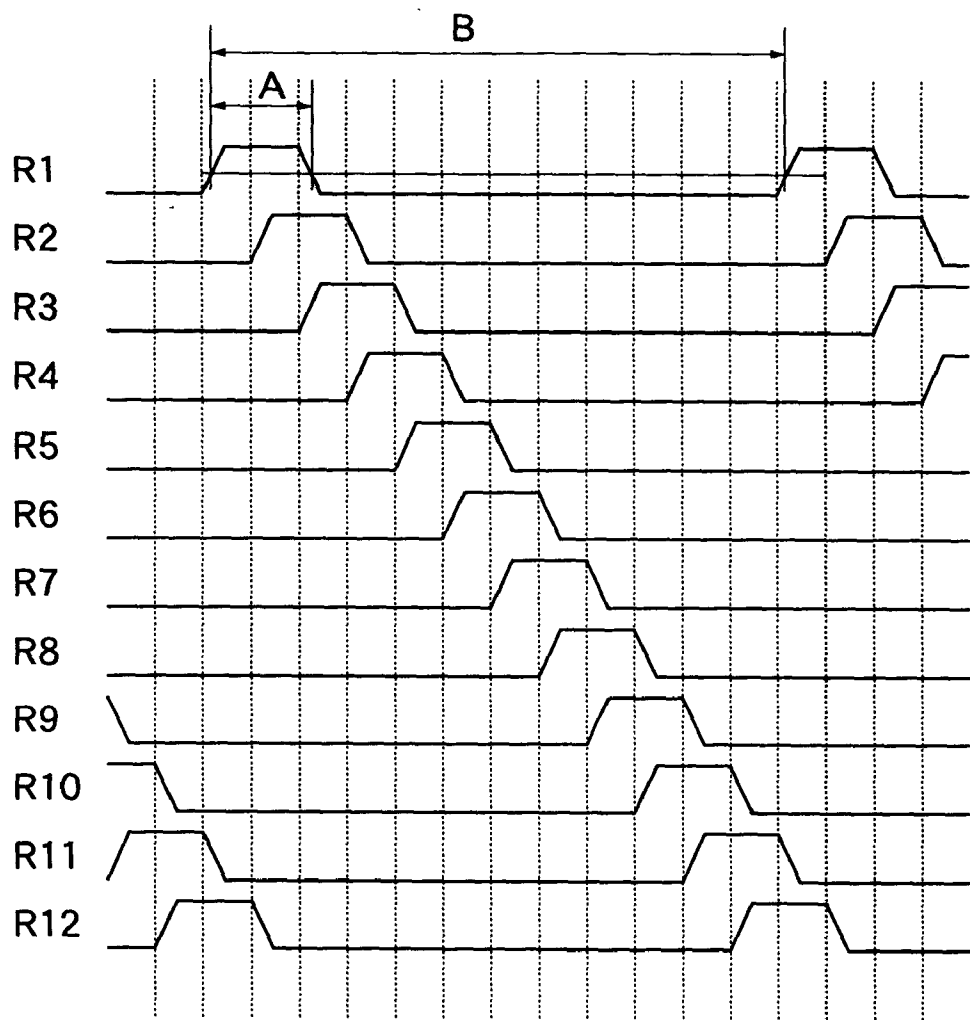


FIG.10A

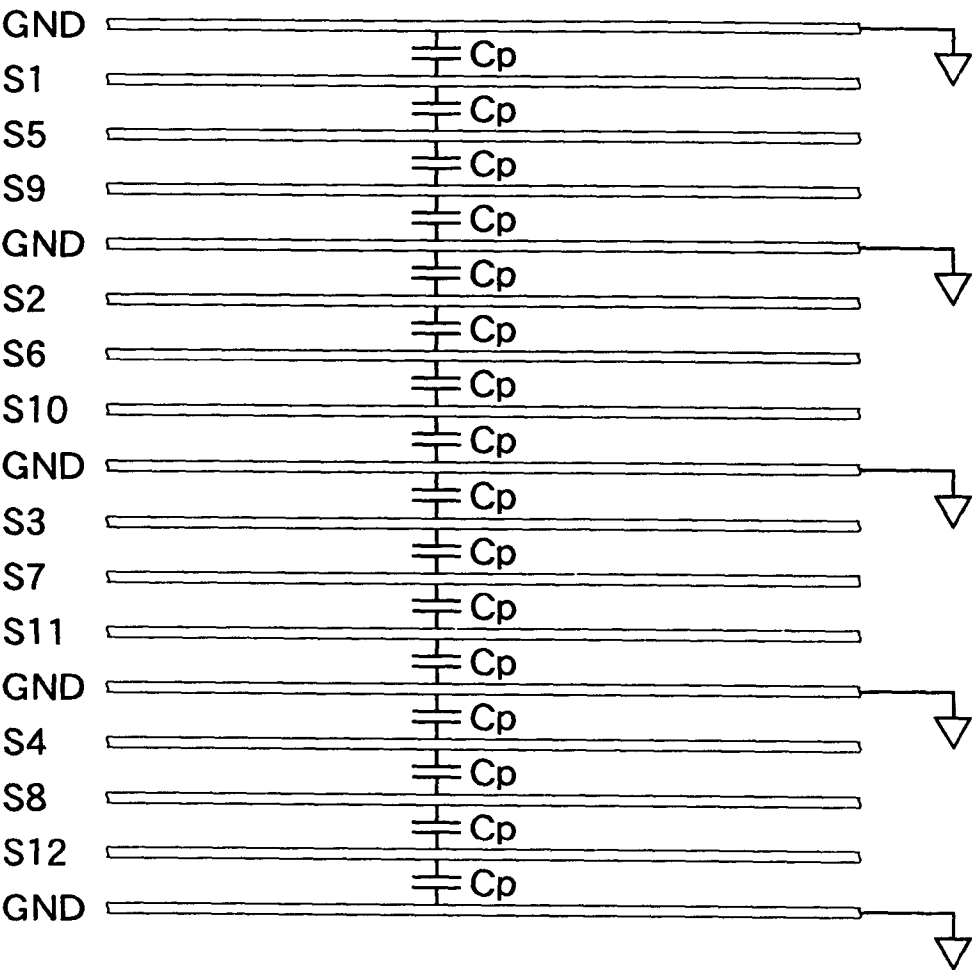


FIG.10B

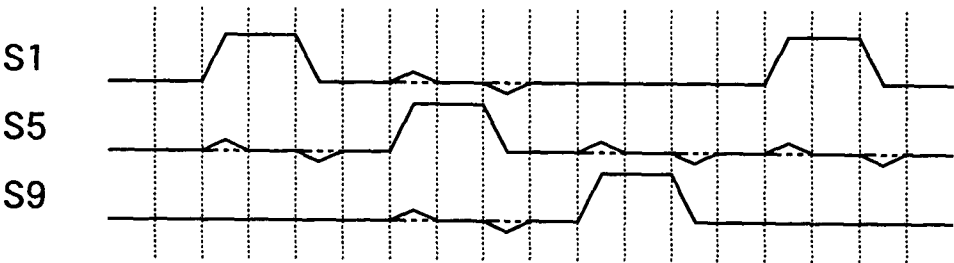


FIG.11

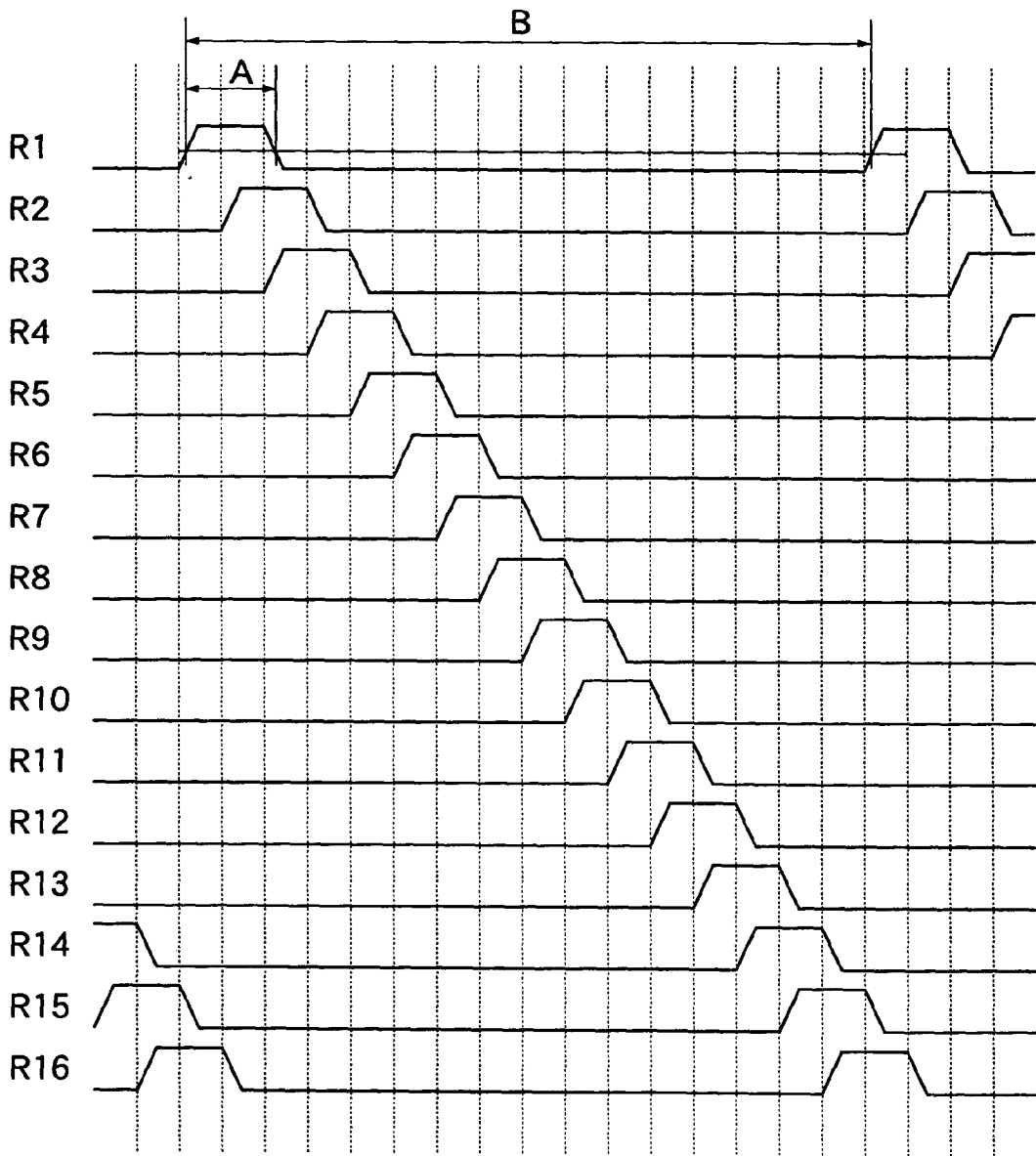


FIG.12A

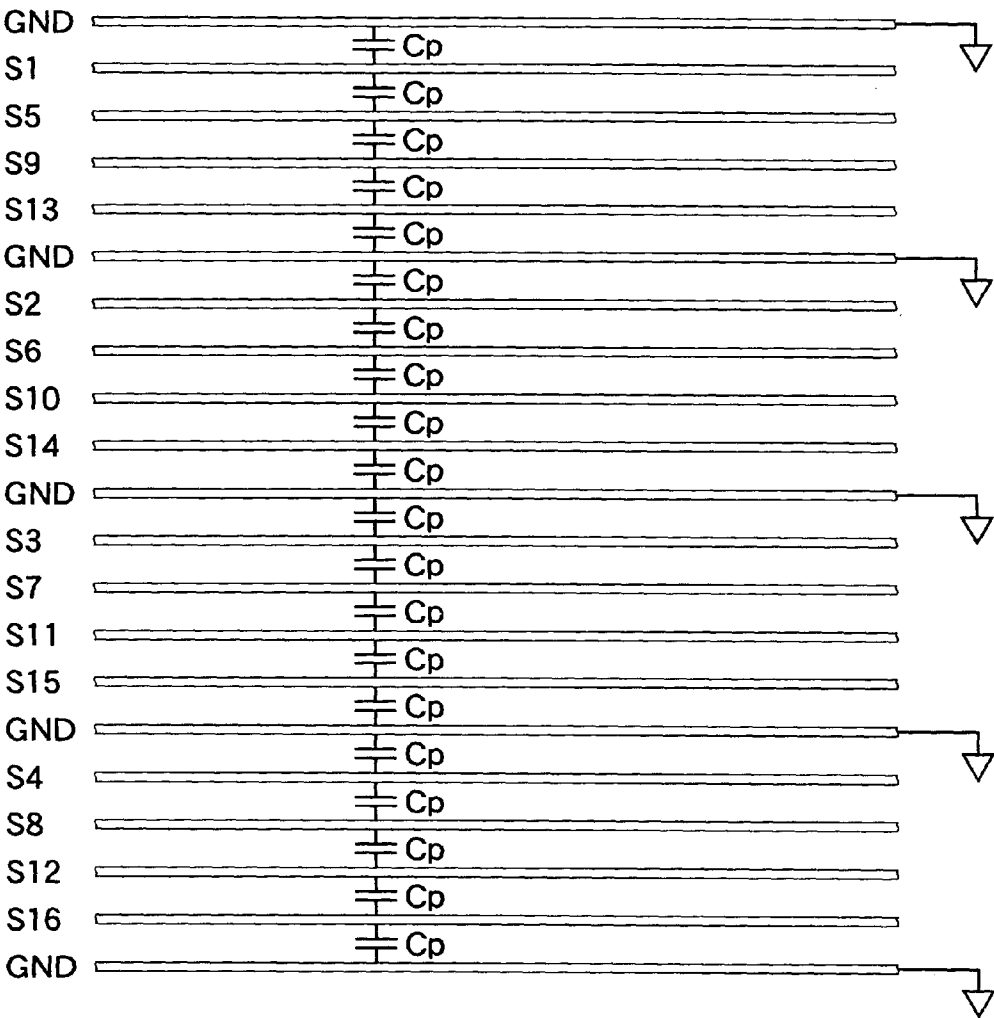
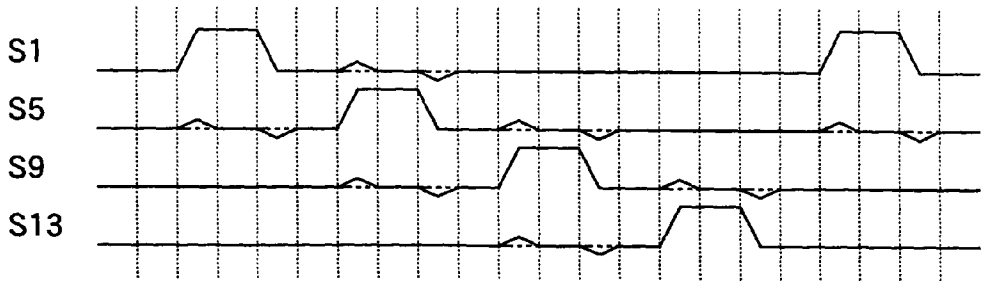


FIG.12B



SEMICONDUCTOR INTEGRATED CIRCUIT

TECHNICAL FIELD

[0001] The present invention relates generally to a semiconductor integrated circuit and more particularly to a semiconductor integrated circuit including a differential ring multiphase oscillator.

BACKGROUND ART

[0002] For signal transmission among devices, a technique employing high-speed and small-amplitude serial signals has been in use in recent years. Compared with a technique that transmits digital signals in parallel, this technique needs only a small number of cables and also can minimize electromagnetic interference (EMI) caused by the digital signal transmission.

[0003] To realize a high-speed serial communication, a parallel-serial converter is required on a transmit side which converter converts parallel data into serial data by using sub-clock signals having multiple phases (hereinafter, such clock signals are referred to as multiphase clock signals). The multiphase clock signals are synchronous with a base clock signal and have the same phase difference. Further, a multiphase clock generator is required which generates the multiphase clock signals and supplies them to the parallel-serial converter.

[0004] An example of the multiphase clock generator is a voltage-controlled or current-controlled differential ring oscillator having multiple stages of delayed differential inverted amplifiers connected in a ring form. By using such a ring oscillator, it is possible to easily draw multiphase clock signals having the same phase difference out of the multi-staged amplifiers. However, in the case of designing wiring layout for the multiphase clock signals having precisely equal phase differences from the high-speed ring oscillator to the parallel-serial converter, the influences of electrostatic coupling between different wirings must be made uniform.

[0005] FIG. 1 shows a voltage-controlled differential ring oscillator used in conventional semiconductor integrated circuits. As shown in FIG. 1, the voltage-controlled differential ring oscillator 100 includes N stages of delayed differential inverted amplifiers 101a-101j which perform oscillating operation and output amplifiers 102a-102j which buffer output signals of the delayed differential inverted amplifiers 101a-101j to output multiphase clock signals. Shown here is a case of N=10. The output amplifiers 102a-102j buffer oscillation signals output from every other delayed differential inverted amplifiers 101a-101j connected in a ring form and supply them as multiphase clock signals R1-R10 to the parallel-serial converter.

[0006] FIG. 2 shows voltage waveforms of the multiphase clock signals R1-R10 output from the voltage-controlled differential ring oscillator as shown in FIG. 1. In FIG. 2, an abscissa represents time and an ordinate represents voltage. When we let "A" stand for a duration in which each clock signal is a high level and "B" for a cycle of the clock signal, a duty of each clock signal is set at $D=A/B=0.5$.

[0007] FIG. 3A shows wirings or interconnects for three clock signals R1, R2, R3 formed in a semiconductor integrated circuit and capacitors C_p equivalently representing

stray capacities between these wirings. FIG. 3B shows how crosstalks due to stray capacities degrade the voltage waveforms of the clock signals. As shown in FIG. 3B, a clock signal R2 undergoes voltage variations under the influence of crosstalks due to stray capacities each time the adjacent clock signals R1 and R3 change their voltage levels. An amount of voltage variation ΔV increases with the stray capacity C_p . In clock signals, information at the transition point is important, and therefore, crosstalk near the transition point has great effects on precision of the clock signals.

[0008] To generate high-speed and small-amplitude serial signals, it is necessary to use multiphase clock signals having high frequencies. The use of multiphase clock signals having increased frequencies, however, results in that the phase difference to between the multiphase clock signals as shown in FIG. 3B becomes shorter, which in turn makes a transition waveform of the clock signal R2 more likely to be degraded by voltage variations due to the crosstalk induced when the adjacent clock signals R1 and R3 perform voltage level transitions. It is therefore desired that the circuit for generating high-speed and small-amplitude serial signals be designed to have as small stray capacities C_p as possible.

[0009] The stray capacities C_p can be reduced, for example, by increasing the distance between the multiphase clock signal wirings as shown in FIG. 4A. FIG. 4A shows an example in which an interval of the multiphase clock signal wirings is increased by two times to halve the stray capacities. This method, however, increases a wiring area for the multiphase clock signals.

[0010] Another technique for reducing the electrostatic coupling between adjacent two clock signal wirings may involve arranging another wiring between the adjacent two clock signal wirings as shown in FIG. 4B. FIG. 4B shows the new wiring added between adjacent two clock signal wirings and the new wiring is grounded. Alternatively, the new wiring may be supplied with a stable voltage. Such a technique can shield the adjacent two clock signal wirings electrostatically from one another and prevent possible degradations of clock signal waveforms which would otherwise be caused by level transitions of the adjacent clock signals. This technique, however, requires an additional area for laying the new wirings, increasing the wiring area for the multiphase clock signals.

[0011] On the other hand, a number of multiphase clock signals having the same phase difference tends to increase at an accelerating rate in the future for a higher-speed serial communication. Hence, arranging wirings for the multiphase clock signals using the above-mentioned conventional technique requires a large wiring area, giving rise to a problem of an increased semiconductor substrate area. Under these circumstances, there are growing demands for a semiconductor integrated circuit that can prevent degradation of waveforms of multiphase clock signals without increasing the wiring area.

DISCLOSURE OF THE INVENTION

[0012] It is therefore an object of the present invention to provide a semiconductor integrated circuit that can prevent multiphase clock signals having the same phase difference, which signals are generated by a multi-stage differential ring oscillator and transmitted to other circuits, from being degraded in waveform due to electrostatic coupling between

wirings thereof and that enables the multiphase clock signals to be wired in as small an area as possible.

[0013] To achieve the above object, a semiconductor integrated circuit according to the present invention comprises: multiple stages of amplifier circuits, connected in a ring form, for performing oscillating operation; a logic circuit for performing logic operation on the basis of predetermined ones of output signals of the multiple stages of amplifier circuits to output a plurality of clock signals having different phases from each other and duties not equal to 0.5; and a plurality of wirings for transmitting the plurality of clock signals output from the logic circuit.

[0014] According to the present invention, it is possible to prevent degradations of multiphase clock signal waveforms due to stray capacities without increasing the wiring area of the multiphase clock signals.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] Advantages and features of the present invention will become apparent when taken in conjunction with the following detailed description and the accompanying drawings. In these drawings, the same reference number represents identical constitutional elements.

[0016] **FIG. 1** is a circuit diagram showing a configuration of a voltage-controlled differential ring oscillator used in conventional semiconductor integrated circuits.

[0017] **FIG. 2** is a waveform diagram showing voltage waveforms of multiphase clock signals output from the voltage controlled differential ring oscillator as shown in **FIG. 1**.

[0018] **FIG. 3A** is a schematic diagram showing multiphase clock signal wirings in a conventional semiconductor integrated circuits and equivalents of stray capacities between these wirings, and **FIG. 3B** is a waveform diagram showing how the voltage waveform of a clock signal is degraded by crosstalk due to the stray capacity.

[0019] **FIGS. 4A and 4B** show wirings in the conventional semiconductor integrated circuit which are modified to prevent degradations of waveforms of the multiphase clock signals.

[0020] **FIG. 5** shows a configuration of a semiconductor integrated circuit according to a first embodiment of the present invention.

[0021] **FIG. 6** is a waveform diagram showing voltage waveforms of multiphase clock signals output from a voltage-controlled differential ring oscillator as shown in **FIG. 5**.

[0022] **FIG. 7A** shows an example arrangement of wirings in the semiconductor integrated circuit according to the first embodiment of the present invention, and **FIG. 7B** shows voltage waveforms of clock signals in the example arrangement of wirings as shown in **FIG. 7A**.

[0023] **FIG. 8A** shows an arrangement of multiphase clock signal wirings in the semiconductor integrated circuit according to the first embodiment of the present invention, and **FIG. 8B** shows an example arrangement of multiphase clock signal wirings in a conventional semiconductor integrated circuit.

[0024] **FIG. 9** is a waveform diagram showing voltage waveforms of multiphase clock signals output from a voltage-controlled differential ring oscillator in a semiconductor integrated circuit according to a second embodiment of the present invention.

[0025] **FIG. 10A** shows an arrangement of multiphase clock signal wirings in the semiconductor integrated circuit according to the second embodiment of the present invention, and **FIG. 10B** shows voltage waveforms of the multiphase clock signals in the arrangement as shown in **FIG. 10A**.

[0026] **FIG. 11** is a waveform diagram showing voltage waveforms of multiphase clock signals output from a voltage-controlled differential ring oscillator in a semiconductor integrated circuit according to a third embodiment of the present invention.

[0027] **FIG. 12A** shows an arrangement of multiphase clock signal wirings in the semiconductor integrated circuit according to the third embodiment of the present invention, and **FIG. 12B** shows voltage waveforms of the multiphase clock signals in the wiring arrangement as shown in **FIG. 12A**.

BEST MODE FOR CARRYING OUT THE INVENTION

[0028] **FIG. 5** shows a configuration of a semiconductor integrated circuit according to a first embodiment of the present invention. As shown in **FIG. 5**, this semiconductor integrated circuit includes a voltage-controlled differential ring oscillator **500** for outputting multiphase clock signals and a parallel-serial converter **600** for converting received parallel data into serial data on the basis of the multiphase clock signals. The parallel-serial converter **600** may be provided on the outside of the semiconductor integrated circuit.

[0029] The voltage-controlled differential ring oscillator **500** includes N stages of delayed differential inverted amplifiers **101a**, **101b**, . . . for performing oscillating operation and logic circuits **502a**, **502b**, . . . for performing logic operation on the basis of output signals of the delayed differential inverted amplifiers **101a**, **101b**, . . . to output clock signals having M phases. Generally, it is preferred that N is a positive even number and M is an even number within a range from 2 to N. Here, we will take a case of N=M=10 for example.

[0030] Each of the delayed differential inverted amplifiers **101a-101j** amplifies a difference between a signal applied to a non-inverted input terminal and a signal applied to an inverted input terminal and supplies the amplified differential signal to a non-inverted output terminal and an inverted output terminal. The delayed differential inverted amplifiers **101a-101j** are connected in a ring form so that a non-inverted output terminal of the previous stage is connected to an inverted input terminal of the subsequent stage and an inverted output terminal of the previous stage is connected to a non-inverted input terminal of the subsequent stage. It is noted, however, that a non-inverted output terminal of a delayed differential inverted amplifier **101j** is connected to a non-inverted input terminal of a delayed differential inverted amplifier **101a** and that an inverted output terminal of the delayed differential inverted amplifier **101j** is connected to

an inverted input terminal of the delayed differential inverted amplifier 101a. With this arrangement, a signal phase is inverted after passing through the ring once. The delay time of each of the delayed differential inverted amplifiers 101a-101j is controlled by an applied control voltage or control current, allowing the oscillation frequency of the voltage-controlled differential ring oscillator 500 to be adjusted.

[0031] In this embodiment, the logic circuits include M AND gates 502a-502j. An AND gate 502a has one input terminal connected to the inverted output terminal of the delayed differential inverted amplifier 101a and the other input terminal connected to the non-inverted output terminal of the delayed differential inverted amplifier 11e. One input terminal of an AND gate 502b is connected to the inverted output terminal of the delayed differential inverted amplifier 101c and the other input terminal is connected to the non-inverted output terminal of the delayed differential inverted amplifier 101g. The subsequent AND gates 502c-502j are connected in the similar manner. Thus, the AND gates 502a-502j produce multiphase clock signals S1-S10 as shown in FIG. 6.

[0032] In FIG. 6, when a duration in which the clock signal is high is denoted as "A" and a cycle of the clock signal as "B", then a duty of the clock signal $D=A/B$ is expressed as follows:

$$D=(0.5-2/N) \quad (1)$$

[0033] If $N=10$, equation (1) results in $D=0.3<0.5$. Hence, two clock signal wirings can be combined such that one clock signal transits from a low level to a high level or from the high level to the low level when another clock signal is maintained at the low level (in this embodiment, ground potential). In this embodiment, sets of combined clock signal wirings (S1, S6), (S2, S7), (S3, S8), (S4, S9), and (S5, S10) are used.

[0034] Among the above sets of clock signal wirings, a set of clock signal wirings (S1, S6) is shown in FIG. 7A as an example of wiring arrangement. In FIG. 7A, a wiring for a clock signal S1 and a wiring for a clock signal S6 are arranged in parallel on a semiconductor substrate. On the outside of these wirings, ground wirings GND are arranged for electrostatic shielding. FIG. 7B shows voltage waveforms of the clock signals S1 and S6 in the wiring arrangement as shown in FIG. 7A.

[0035] As described above, the set of clock signal wirings (S1, S6) is so arranged that one clock signal changes its level when another clock signal is maintained at a low level (at a ground voltage level). The clock signal wiring at the ground voltage level has a sufficiently small impedance compared with an impedance of a crosstalk source, and therefore, it has a function of electrostatic shield in the same way as a ground wiring GND. For example, when the clock signal S6 has the ground voltage level, a wiring for the clock signal S1 is shielded by a ground wiring GND and a wiring for the clock signal S6. Therefore, as shown in FIG. 7B, if the clock signal S1 changes its level in this period, its waveform is protected against being deformed at that time.

[0036] Similarly, as to other sets of clock signal wirings, in a period when one of the two clock signal wirings is at a low level, the other of the two clock signal wirings is virtually shielded. Therefore, by arranging clock signal

wirings with ground wirings for shielding every set of clock signal wirings as described above, it is possible to prevent waveform deformations of multiphase clock signals that would otherwise be caused by electrostatic coupling between the wirings.

[0037] FIG. 8A shows an arrangement of multiphase clock signal wirings according to this embodiment and, for comparison, FIG. 8B shows an example of conventional arrangement of multiphase clock signal wirings. In this embodiment as shown in FIG. 8A, the sets of clock signal wirings (S1, S6), (S2, S7), (S3, S8), (S4, S9) and (S5, S10) each has two clock signal wirings arranged parallel to each other on the semiconductor substrate are arranged with ground wirings GND inserted between respective two sets of clock signal wirings. On the other hand, in the conventional arrangement as shown in FIG. 8B, clock signal wirings R1-R10 and ground wirings GND are alternately arranged on the semiconductor substrate. Comparison between FIG. 8A and FIG. 8B shows that the wiring area of the semiconductor substrate in this embodiment is about 25% less than that in the conventional technique.

[0038] Next, a semiconductor integrated circuit according to a second embodiment of the present invention will be described. The second embodiment uses the N-stage voltage-controlled differential ring oscillator as shown in FIG. 5 in a condition of $N=12$.

[0039] FIG. 9 shows voltage waveforms of multiphase clock signals S1-S12 output from the 12-stage voltage-controlled differential ring oscillator. In this embodiment, the duty D of each clock signal is obtained from equation (1) as $D=0.167$. Hence, clock signal wirings are grouped into plural sets of three clock signal wirings and, in each set of three clock signal wirings, it is possible that when one clock signal changes its level, both of the other two clock signals are maintained at a low level. For example, in this embodiment, clock signals are grouped into plural sets of three clock signals by using plural sets of clock signal wirings (S1, S5, S9), (S2, S6, S10), (S3, S7, S11) and (S4, S8, S12). In each set of clock signal wirings, when one of the three clock signals changes its level, the other two clock signals can be certainly maintained at a low level.

[0040] FIG. 10A shows an arrangement of multiphase clock signal wirings in the semiconductor integrated circuit according to this embodiment. As shown in FIG. 10A, in each of the sets of clock signal wirings (S1, S5, S9), (S2, S6, S10), (S3, S7, S11) and (S4, S8, S12), three clock signal wirings are arranged parallel to each other on the semiconductor substrate, with ground wirings GND interposed between respective two sets of clock signal wirings.

[0041] FIG. 10B shows voltage waveforms of clock signals S1, S5, S9 in the semiconductor integrated circuit of this embodiment. As shown in FIG. 10B, when the clock signal S5 performs a voltage level transition, the clock signals S1 and S9 are certainly maintained at a low level. Therefore, the wiring for the clock signal S5 is virtually shielded by the wirings for the clock signals S1 and S9 and no voltage waveform deformation is observed with the clock signal S5 at that time. Further, when the clock signal S1 or S9 changes its voltage level, the clock signal S5 is certainly maintained at a low level, so that wiring for the clock signal S1 or S9 is virtually shielded by wiring for the clock signal S5 and a ground wiring GND.

[0042] As described above, according to this embodiment, the wiring area of the semiconductor substrate can be reduced by approximately 36% compared with that of the conventional arrangement in which clock signal wirings and ground wirings are alternately arranged.

[0043] Next, a semiconductor integrated circuit according to a third embodiment of the present invention will be described. The third embodiment uses the N-stage voltage-controlled differential ring oscillator as shown in FIG. 5 in a condition of N=16.

[0044] FIG. 11 shows voltage waveforms of multiphase clock signals S1-S16 output from the 16-stage voltage-controlled differential ring oscillator. In this embodiment, the duty D of each clock signal is obtained from equation (1) as $D=0.125$. Hence, clock signal wirings are grouped into plural sets of four clock signal wirings and, in each set of four clock signal wirings, it is possible that when one clock signal changes its level, the remaining three clock signals are maintained at a low level. For example, in this embodiment, clock signals are grouped into plural sets of four clock signals by using plural sets of four clock signal wirings (S1, S5, S9, S13), (S2, S6, S10, S14), (S3, S7, S11, S15) and (S4, S8, S12, S16).

[0045] FIG. 12A shows an arrangement of multiphase clock signal wirings in the semiconductor integrated circuit according to this embodiment. As shown in FIG. 12A, in each set of clock signal wirings (S1, S5, S9, S13), (S2, S6, S10, S14), (S3, S7, S11, S15) and (S4, S8, S12, S16), four clock signal wirings are arranged parallel to each other on the semiconductor substrate, with ground wirings GND interposed between respective two sets of clock signal wirings.

[0046] FIG. 12B shows voltage waveforms of clock signals S1, S5, S9, S13 in the semiconductor integrated circuit according to this embodiment. As shown in FIG. 12B, when one of the clock signals in each set performs a voltage level transition, the remaining three clock signals are certainly maintained at a low level. Therefore, wiring of the level-changing clock signal is virtually shielded by wirings of the adjacent clock signal wirings and no voltage waveform deformation is observed with the level-changing clock signal at that time.

[0047] As described above, according to this embodiment, the wiring area of the semiconductor substrate can be reduced by approximately 37% compared with that of the conventional arrangement in which clock signal wirings and ground wirings are alternately arranged.

[0048] Although a ground wiring for electrostatic shielding is arranged between respective two set of clock signal wirings as a technique for preventing degradation of signals due to electrostatic coupling between respective two sets of clock signal wirings in the above embodiments, a technique for preventing degradation of signals between respective two sets of clock signal wirings is not limited to this arrangement. The present invention can also be realized by employing other techniques. An example of such techniques involves increasing a distance between respective two sets of clock signal wirings to reduce stray capacities between adjacent two sets of clock signal wirings.

[0049] Although the voltage-controlled differential ring oscillator has been employed in the above embodiments, the

present invention can be applied to and implemented by any oscillator as long as it generates multiphase clock signals having the same phase difference. Thus, the present invention is not limited to the voltage-controlled differential ring oscillator and can be modified within a scope of claims.

[0050] According to the present invention, it is possible to prevent degradations of signal waveforms due to electrostatic coupling between multiphase clock signal wirings while reducing the wiring area of a semiconductor substrate for the multiphase clock signal wirings.

INDUSTRIAL APPLICABILITY

[0051] The present invention can be applied to semiconductor integrated circuits having a multi-stage ring oscillator that generates multiphase clock signals having the same phase difference.

1. A semiconductor integrated circuit comprising:

multiple stages of amplifier circuits, connected in a ring form, for performing oscillating operation;

a logic circuit for performing logic operation on the basis of predetermined ones of output signals of said multiple stages of amplifier circuits to output a plurality of clock signals having different phases from each other and duties not equal to 0.5; and

a plurality of wirings for transmitting said plurality of clock signals output from said logic circuit.

2. A semiconductor integrated circuit according to claim 1, further comprising a parallel-serial conversion circuit for converting input parallel data into serial data on the basis of said plurality of clock signals.

3. A semiconductor integrated circuit according to claim 1, wherein each of said multiple stages of amplifier circuits amplifies a difference between a signal applied to a non-inverted input terminal and a signal applied to an inverted input terminal and supplies a differential signal thus obtained to a non-inverted output terminal and an inverted output terminal.

4. A semiconductor integrated circuit according to claim 1, wherein a delay time of each of said multiple stages of amplifier circuits is controlled by one of a control voltage and a control current.

5. A semiconductor integrated circuit according to claim 1, wherein said multiple stages of amplifier circuits include N stages of differential circuits and said logic circuit outputs M clock signals having different phases from each other, where N is a positive even number and M is an even number within a range from 2 to N.

6. A semiconductor integrated circuit according to claim 5, wherein said logic circuit includes M AND gates, each obtaining logical multiply of two of the output signals of said multiple stages of amplifier circuits to output one clock signal.

7. A semiconductor integrated circuit according to claim 1, wherein a first wiring and a second wiring are arranged parallel to each other and said first wiring undergoes voltage transition between a first voltage and a second voltage when said second wiring has the second voltage.

8. A semiconductor integrated circuit according to claim 7, wherein said second voltage is a ground voltage.

9. A semiconductor integrated circuit according to claim 1, wherein:

- a first wiring and at least one wiring together form a set of wirings and said first wiring undergoes voltage transition between a first voltage and a second voltage when said at least one wiring has the second voltage; and
- a distance between a wiring included in said set and a wiring not included in said set is larger than a distance between two adjacent wirings included in said set.
- 10.** A semiconductor integrated circuit according to claim 9, wherein said second voltage is a ground voltage.
- 11.** A semiconductor integrated circuit according to claim 9, wherein another wiring is arranged between said wiring included in said set and said wiring not included in said set.
- 12.** A semiconductor integrated circuit according to claim 10, wherein said another wiring is grounded.
- 13.** A semiconductor integrated circuit according to claim 1, wherein said multiple stages of amplifier circuits include N stages of differential circuits and said logic circuit outputs M clock signals having different phases from each other and duties not larger than $(0.5-2/N)$, where N is a positive even number and M is an even number within a range from 2 to N.
- 14.** A semiconductor integrated circuit according to claim 13, wherein said logic circuit includes M AND gates, each obtaining logical multiply of two of the output signals of said multiple stages of amplifier circuits to output one clock signal.
- 15.** A semiconductor integrated circuit according to claim 13, wherein a first wiring and a second wiring are arranged parallel to each other and said first wiring undergoes voltage transition between a first voltage and a second voltage when said second wiring has the second voltage.
- 16.** A semiconductor integrated circuit according to claim 15, wherein said second voltage is a ground voltage.
- 17.** A semiconductor integrated circuit according to claim 13, wherein:
- a first wiring and at least one wiring together form a set of wirings and said first wiring undergoes voltage transition between a first voltage and a second voltage when said at least one wiring has the second voltage; and
- a distance between a wiring included in said set and a wiring not included in said set is larger than a distance between two adjacent wirings included in said set.
- 18.** A semiconductor integrated circuit according to claim 17, wherein said second voltage is a ground voltage.
- 19.** A semiconductor integrated circuit according to claim 17, wherein another wiring is arranged between said wiring included in said set and said wiring not included in said set.
- 20.** A semiconductor integrated circuit according to claim 19, wherein said another wiring is grounded.

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