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(54) **Control device, power conditioner, distributed power supply system, program, and control method**

(57) A control device (100) includes a selector (106) that selects one of a first voltage detector and a second voltage detector and a reduction controller (108) that performs reduction control in order to reduce a rise of an output voltage at the power conditioner based on a first

voltage or a second voltage. The first voltage or the second voltage is acquired from one of the first and second voltage detectors, and one of the first and second voltage detectors is selected by the selector.

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Description

TECHNICAL FIELD

5 **[0001]** The present invention relates to a control device, a power conditioner, a distributed power supply system, a program, and a control method.

RELATED ART

10 **[0002]** Japanese Unexamined Patent Publication No. 2003-9399 discloses a grid-interconnection power generation system in which a line voltage at a trunk line is reflected during output control of a power generation facility grid-interconnected with a commercial power source.

15 **[0003]** Like Japanese Unexamined Patent Publication No. 2003-9399, in the case where voltage-rise reduction control is performed to a power conditioner based on a voltage acquired from a voltage sensor provided in a distribution panel, occasionally it is necessary to provide a new wiring between the distribution panel and the power conditioner in order to transmit a voltage signal from the voltage sensor. However, for example, occasionally the additional wiring is hardly provided between the distribution panel and the power conditioner depending on installation places of the distribution panel and the power conditioner.

20 SUMMARY

25 **[0004]** In accordance with a first aspect of the present invention, a control device includes: a first voltage acquisition unit configured to acquire a first voltage from a first voltage detector, the first voltage detector detecting the first voltage corresponding to a line voltage at a power conditioner on a side of a system power supply, the power conditioner being interconnected with the system power supply; a second voltage acquisition unit configured to acquire a second voltage from a second voltage detector, the second voltage detector detecting the second voltage corresponding to a line voltage at a load on the side of the power conditioner, the load being provided between the power conditioner and the system power supply; a selector configured to select one of the first voltage detector and the second voltage detector; and a reduction controller configured to perform reduction control in order to reduce an output voltage at the power conditioner based on the first voltage or the second voltage, the first voltage or the second voltage being acquired from one of the first voltage detector and the second voltage detector, the first voltage detector and the second voltage detector being selected by the selector.

35 **[0005]** In the control device, the selector may select the second voltage detector when the second voltage satisfies a predetermined condition, and the selector may select the first voltage detector when the second voltage does not satisfy the predetermined condition.

40 **[0006]** In the control device, the selector may select the second voltage detector when a condition that the second voltage falls within a predetermined voltage range is satisfied, and the selector may select the first voltage detector when the condition that the second voltage falls within the predetermined voltage range is not satisfied.

45 **[0007]** In the control device, the second voltage detector may include: a non-inverting input terminal to which a voltage at a neutral line of the load on the side of the power conditioner and a reference voltage are inputted; an inverting input terminal to which a voltage at a voltage line of the load on the side of the power conditioner is inputted; and an output terminal from which a potential difference between the voltage inputted from the non-inverting input terminal and the voltage inputted from the inverting input terminal is outputted as the second voltage, and the voltage range may previously be fixed based on the reference voltage.

50 **[0008]** In the control device, the selector may select the second voltage detector when a current outputted from the power conditioner and the second voltage satisfy an inversely proportional relationship, and the selector may select the first voltage detector when the current output from the power conditioner and the second voltage do not satisfy the inversely proportional relationship.

55 **[0009]** In accordance with a second aspect of the present invention, a power conditioner includes: the control device; the first voltage detector; the second voltage detector; and an inverter configured to interconnect power from a distributed power supply with power from the system power supply. In the power conditioner, the reduction controller performs the reduction control by controlling an output of the inverter.

60 **[0010]** The power conditioner may further include a member that is provided while detachably attached to the power conditioner. In the power conditioner, the member may include a terminal unit configured to connect the second voltage detector and a voltage line and a neutral line of the load on the side of the power conditioner.

65 **[0011]** In accordance with a third aspect of the present invention, a distributed power supply system includes: the power conditioner; and the distributed power supply.

70 **[0012]** In accordance with a fourth aspect of the present invention, a program is configured to cause a computer to

act as the control device.

[0013] In accordance with a fifth aspect of the present invention, a control method includes: a step of acquiring a first voltage from a first voltage detector, the first voltage detector detecting the first voltage corresponding to a line voltage at a power conditioner on a side of a system power supply, the power conditioner being interconnected with the system power supply; a step of acquiring a second voltage from a second voltage detector, the second voltage detector detecting the second voltage corresponding to a line voltage at a load on the side of the power conditioner, the load being provided between the power conditioner and the system power supply; a step of selecting one of the first voltage detector and the second voltage detector; and a step of performing reduction control in order to reduce an output voltage at the power conditioner based on the first voltage or the second voltage, the first voltage or the second voltage being acquired from one of the first voltage detector and the second voltage detector, the first voltage detector and the second voltage detector being selected in the selecting step.

[0014] All the features necessary for the present invention are not described in the summary of the present invention. A sub-combination of a feature group is also included in the present invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015]

Fig. 1 is a system configuration diagram illustrating an example of an entire configuration of a photovoltaic system according to an embodiment;

Fig. 2 is a view illustrating an example of a circuit configuration of a voltage detector;

Fig. 3 is a view illustrating a functional block of a control device; and

Fig. 4 is a flowchart illustrating an example of a voltage detector selection procedure used to determine whether voltage-rise reduction control is performed.

DETAILED DESCRIPTION

[0016] Hereinafter, an embodiment of the present invention will be described. However, the present invention according to the claims is not limited to the embodiment. All combinations of features described in the embodiment are not necessary for the means for solving the problem.

[0017] Fig. 1 is a system configuration diagram illustrating an example of an entire configuration of a photovoltaic system of the embodiment. The photovoltaic system includes a photovoltaic array 200 and a power conditioner 10. A plurality of photovoltaic strings in which a plurality of photovoltaic modules are connected in series are connected in parallel in the photovoltaic array 200. The photovoltaic array 200 is an example of the distributed power supply. For example, a gas engine, a gas turbine, a micro gas turbine, a fuel cell, a wind generation device, an electric automobile, and an electricity storage system may be used as the distributed power supply.

[0018] The power conditioner 10 boosts a DC voltage outputted from the photovoltaic array 200, converts the boosted DC voltage into an AC voltage, and outputs the AC voltage onto a side of a system power supply 300. The power conditioner 10 includes a capacitor C1, a boost circuit 20, a capacitor C2, an inverter 40, a coil L, a capacitor C3, a relay 50, a power supply 60, a voltage detector 70, and a control device 100.

[0019] Both ends of the capacitor C1 are electrically connected to a positive electrode terminal and a negative electrode terminal of the photovoltaic array 200, respectively, and the capacitor C1 smoothes the DC voltage outputted from the photovoltaic array 200. The boost circuit 20 may be what is called a chopper switching regulator. The boost circuit 20 boosts the voltage outputted from the photovoltaic array 200. For example, the boost circuit 20 may be constructed by an insulation type boost circuit, such as a half-bridge boost circuit and a full-bridge boost circuit, which has a transformer winding.

[0020] The capacitor C2 smoothes the DC voltage outputted from the boost circuit 20. The inverter 40 includes a switch, and converts the DC voltage outputted from the boost circuit 20 into the AC voltage by turning on and off the switch to output to the system power supply 300. For example, the inverter 40 may be constructed by a single-phase full-bridge PWM inverter including four bridge-connected semiconductor switches. In one pair out of the four semiconductor switches, the semiconductor switches are connected in series. In the other pair out of the four semiconductor switches, the semiconductor switches are connected in series. The other pair of semiconductor switches is connected in parallel to the one pair out of semiconductor switches.

[0021] The coil L and the capacitor C3 are provided between the inverter 40 and the system power supply 300. The coil L and the capacitor C3 remove a noise from the AC voltage outputted from the inverter 40. The relay 50 is provided between the capacitor C3 and the system power supply 300. The relay 50 switches whether the inverter 40 and the system power supply 300 are electrically disconnected from each other. The power conditioner 10 and the system power supply 300 are electrically connected to each other by turning on the relay 50, and the power conditioner 10 and the

system power supply 300 are electrically disconnected from each other by turning off the relay 50.

[0022] The power conditioner 10 includes output terminals 52, 54, and 56. The output terminals 52 and 56 are connected to both the ends of the capacitor C3. A first voltage line 250u through which a U-phase current passes is connected to the output terminal 52. A neutral line 250o through which an O-phase current passes is connected to the output terminal 54. A second voltage line 250w through which a W-phase current passes is connected to the output terminal 56.

[0023] The first voltage line 250u includes a resistor Ru1 and a resistor Ru2. The neutral line 250o includes a resistor Ro1 and a resistor Ro2. The second voltage line 250w includes a resistor Rw1 and a resistor Rw2. A distribution panel 260 is provided among the resistor Ru1, the resistor Ro1, and the resistor Rw1 and the resistor Ru2, the resistor Ro2, and the resistor Rw2 on the first voltage line 250u, the neutral line 250o, and the second voltage line 250w. A wattmeter 270 is provided on the side of the system power supply 300 of the resistor Ru2, the resistor Ro2, and the resistor Rw2 on the first voltage line 250u, the neutral line 250o, and the second voltage line 250w. The distribution panel 260 and the wattmeter 270 are examples of the load. The resistor Ru1, the resistor Ro1, and the resistor Rw1 indicate resistances of wirings connecting the power conditioner 10 and the distribution panel 260. The resistor Ru2, the resistor Ro2, and the resistor Rw2 indicate resistances of wirings connecting the distribution panel 260 and the wattmeter 270.

[0024] For example, the power supply 60 is constructed by a power supply IC chip. The power supply 60 is connected onto an output side of the boost circuit 20. The power supply 60 generates power, which indicates a predetermined voltage supplied to the control device 100, from the DC voltage taken out from the boost circuit 20, and the power supply 60 supplies the generated power to the control device 100. The power supply 60 may directly use the power from the system power supply 300 to generate the power supplied to the control device 100.

[0025] In order to obtain the maximum power from the photovoltaic array 200, the control device 100 controls the switching operations of the boost circuit 20 and the inverter 40, boosts the DC voltage outputted from the photovoltaic array 200, converts the boosted DC voltage into the AC voltage, and outputs the AC voltage onto the side of the system power supply 300.

[0026] The power conditioner 10 also includes voltage sensors 12 and 16 and current sensors 14, 18, and 19. The voltage sensor 12 detects a voltage V1 corresponding to a potential difference between both the ends of the photovoltaic array 200. The voltage sensor 16 detects a voltage V2 corresponding to a potential difference between both the ends on the output side of the boost circuit 20. The current sensor 14 detects a current I1, which is outputted from the photovoltaic array 200 and passes onto the input side of the boost circuit 20. The current sensor 18 detects a current I2 outputted from the boost circuit 20. The current sensor 19 detects a current Io outputted from the inverter 40.

[0027] A U-phase voltage Vu1, an O-phase voltage Vo1, and a W-phase voltage Vw1 at the power conditioner 10 on the side of the system power supply 300 are inputted to the voltage detector 70. That is, the voltage Vu1, the voltage Vo1, and the voltage Vw1 at the output terminals 52, 54, and 56 are inputted to the voltage detector 70. A U-phase voltage Vu2, an O-phase voltage Vo2, and a W-phase voltage Vw2 at the distribution panel 260 on the power conditioner side are also inputted to the voltage detector 70. That is, the voltage Vu2, the voltage Vo2, and the voltage Vw2 at terminals 262, 264, and 264, which are included in the distribution panel 260 and connected to the power conditioner 10, are also inputted to the voltage detector 70.

[0028] The voltage detector 70 detects a voltage Vuo1 corresponding to a line voltage ($Vu1 - Vo1$) indicating the potential difference between the voltage Vu1 and the voltage Vo1 and a voltage Vwo1 corresponding to a line voltage ($Vw1 - Vo1$) indicating the potential difference between the voltage Vw1 and the voltage Vo1. The voltage detector 70 detects a voltage Vuo2 corresponding to a line voltage ($Vu2 - Vo2$) indicating the potential difference between the voltage Vu2 and the voltage Vo2. The voltage detector 70 detects a voltage Vwo2 corresponding to a line voltage ($Vw2 - Vo2$) indicating the potential difference between the voltage Vw2 and the voltage Vo2.

[0029] It is necessary for the power conditioner 10 having the above configuration to control the voltage such that the voltage outputted onto the side of the system power supply 300 is less than an upper-limit voltage. For example, the power conditioner 10 may control the output of the power conditioner 10 such that the voltage indicating the potential difference between the output terminal 52 and the output terminal 54 and the voltage indicating the potential difference between the output terminal 56 and the output terminal 54 are less than the upper-limit voltage. The power conditioner 10 may control the output of the power conditioner 10 such that the voltage indicating the potential difference between the terminal 262 and the terminal 264, which are included in the distribution panel 260, and the voltage indicating the potential difference between the terminal 266 and the terminal 264, which are included in the distribution panel 260, are less than the upper-limit voltage. Alternatively, the power conditioner 10 may control the output of the power conditioner 10 such that the voltage indicating the potential difference between a terminal 272 and a terminal 274, which are included in the wattmeter 270 and connected to the distribution panel 260, and the voltage indicating the potential difference between a terminal 276 and the terminal 274, which are included in the wattmeter 270 and connected to the distribution panel 260, are less than the upper-limit voltage. As used herein, the upper-limit voltage means a value that is fixed based on an upper limit defined by a grid-interconnection code.

[0030] The control device 100 determines whether reduction control is performed in order to reduce a rise of the output voltage at the power conditioner 10 based on the voltage detected by the voltage detector 70. When determining that

the reduction control is performed, for example, the control device 100 increases reactive power supplied onto the side of the system power supply 300 by adjusting a phase difference between a current phase and a voltage phase, which are outputted from the inverter 40. Alternatively, the control device 100 decreases active power by adjusting a current amplitude outputted from the inverter 40. Therefore, the control device 100 performs the control until the voltage outputted from the power conditioner 10 is less than the upper-limit voltage.

[0031] The control device 100 determines whether the voltage-rise reduction control is performed in order to reduce the rise of the output voltage at the power conditioner 10 based on at least one of the voltage V_{uo1} and the voltage V_{wo1} , which are detected by the voltage detector 70, or at least one of the voltage V_{uo2} and the voltage V_{wo2} , which are detected by the voltage detector 70.

[0032] In the case where the control device 100 determines whether the voltage-rise reduction control is performed based on at least one of the line voltage ($V_{u2} - V_{o2}$) indicating the potential difference between the terminal 262 and the terminal 264 of the distribution panel 260 and the line voltage ($V_{w2} - V_{o2}$) indicating the potential difference between the terminal 262 and the terminal 264 of the distribution panel 260, the control device 100 can determine whether the voltage-rise reduction control is performed in consideration of a voltage drop caused by the resistor R_{u1} , the resistor R_{o1} , and the resistor R_{w1} on the first voltage line 250u, the neutral line 250o, and the second voltage line 250w.

[0033] For example, the voltage detector 70 may electrically be connected to the first voltage line 250u, the neutral line 250o, and the second voltage line 250w of the wattmeter 270 on the power conditioner side. The voltage detector 70 may be connected to the terminals 272, 274, and 276 included in the wattmeter 270. In this case, the control device 100 can determine whether the voltage-rise reduction control is performed based on at least one of the line voltages ($V_{u2} - V_{o2}$) and ($V_{w2} - V_{o2}$), which are derived in consideration of the voltage drop caused by the resistor R_{u1} , the resistor R_{o1} , the resistor R_{w1} , the resistor R_{u2} , the resistor R_{o2} , and the resistor R_{w2} .

[0034] However, occasionally an electric cable that electrically connects the voltage detector 70 and the first voltage line 250u, the neutral line 250o, and the second voltage line 250w is hardly provided depending on installation places of the power conditioner 10 and the distribution panel 260. For example, in the case where the installation places of the power conditioner 10 and the distribution panel 260 are close to each other, occasionally the resistor R_{u1} , the resistor R_{o1} , and the resistor R_{w1} have a little influence on the voltage drop because of small impedances of the resistor R_{u1} , the resistor R_{o1} , and the resistor R_{w1} . Occasionally it is not suitable to provide the electric cable that electrically connects the voltage detector 70 and the first voltage line 250u, the neutral line 250o, and the second voltage line 250w.

[0035] Therefore, in the present embodiment, the control device 100 determines whether the reduction control is performed in order to reduce the rise of the output voltage at the power conditioner 10 based on at least one of the voltage V_{uo1} and the voltage V_{wo1} , which are detected by the voltage detector 70, or at least one of the voltage V_{uo2} and the voltage V_{wo2} , which are detected by the voltage detector 70. That is, one of the voltage at the power conditioner 10 on the side of the system power supply 300 and the voltage at the distribution panel 260 on the side of the power conditioner 10 can be selected as the voltage used to determine whether the voltage-rise reduction control is performed.

[0036] For example, even if the electric cable that electrically connects the voltage detector 70 and the first voltage line 250u, the neutral line 250o, and the second voltage line 250w is hardly provided, whether the voltage-rise reduction control is performed can be determined. In the case where the voltage drop is not generated too much between the power conditioner 10 and the distribution panel 260 because of a short distance between the power conditioner 10 and the distribution panel 260, whether the voltage-rise reduction control is performed can be determined even if the new electric cable is not provided. Therefore, an installation cost can be prevented from increasing beyond necessity.

[0037] According to the present embodiment, for example, a detection point of the voltage used to determine whether the voltage-rise reduction control is performed can be changed according to the installation places of the power conditioner 10 and the distribution panel 260.

[0038] Fig. 2 is a view illustrating an example of a circuit configuration of the voltage detector 70. The voltage detector 70 includes operational amplifiers 72, 74, 76, and 78. Each of the operational amplifiers 72, 74, 76, and 78 includes a non-inverting input terminal, an inverting input terminal, and an output terminal.

[0039] The voltage detector 70 also includes a terminal unit 71. The terminal unit 71 electrically connects the operational amplifiers 76 and 78 and the first voltage line 250u, the neutral line 250o, and the second voltage line 250w. The terminal unit 71 may be detachably attached to the power conditioner 10.

[0040] As described above, whether the operational amplifiers 76 and 78 and the first voltage line 250u, the neutral line 250o, and the second voltage line 250w are electrically connected to each other can be selected according to the installation place of the power conditioner 10 and the distribution panel 260. In the case where the operational amplifiers 76 and 78 are electrically connected to the first voltage line 250u, the neutral line 250o, and the second voltage line 250w, because the terminal unit 71 is unnecessary, the power conditioner 10 and the distribution panel 260 may be installed while the terminal unit 71 is detached from the power conditioner 10. In addition to the connection terminal, at least some elements constituting the voltage detector 70 may be detachably attached to the power conditioner 10. A member that is detachably attached to the power conditioner 10 may include at least the terminal unit 71. The member may include at least some element constituting the voltage detector 70 in addition to the terminal unit 71.

[0041] The voltage Vo1 is inputted to the non-inverting input terminal of the operational amplifier 72 through a resistor R2. A reference voltage Vref is inputted to the non-inverting input terminal of the operational amplifier 72 through a resistor R1. The voltage Vu1 is inputted to the inverting input terminal of the operational amplifier 72 through the resistor R2.

[0042] The voltage Vuo1 outputted from the output terminal of the operational amplifier 72 is fed back to the inverting input terminal of the operational amplifier 72 through the resistor R1.

[0043] The voltage Vo1 is input to the non-inverting input terminal of the operational amplifier 74 through the resistor R2. The reference voltage Vref is inputted to the non-inverting input terminal of the operational amplifier 74 through a resistor R1. The voltage Vw1 is inputted to the inverting input terminal of the operational amplifier 74 through the resistor R2.

[0044] The voltage Vwo1 outputted from the output terminal of the operational amplifier 74 is fed back to the inverting input terminal of the operational amplifier 74 through the resistor R1.

[0045] The voltage Vo2 is inputted to the non-inverting input terminal of the operational amplifier 76 through a resistor R4. The reference voltage Vref is inputted to the non-inverting input terminal of the operational amplifier 76 through a resistor R3. The voltage Vu2 is inputted to the inverting input terminal of the operational amplifier 76 through the resistor R4.

[0046] The voltage Vuo2 outputted from the output terminal of the operational amplifier 76 is fed back to the inverting input terminal of the operational amplifier 76 through the resistor R3.

[0047] The voltage Vo2 is inputted to the non-inverting input terminal of the operational amplifier 78 through the resistor R4. The reference voltage Vref is inputted to the non-inverting input terminal of the operational amplifier 78 through a resistor R3. The voltage Vw2 is inputted to the inverting input terminal of the operational amplifier 78 through the resistor R4.

[0048] The voltage Vwo2 outputted from the output terminal of the operational amplifier 78 is fed back to the inverting input terminal of the operational amplifier 78 through the resistor R3.

[0049] At this point, the voltages Vuo1, Vwo1, Vuo2, and Vwo2 can be expressed by equations (1) to (4).

$$V_{uo1} = R1/R2 \times (V_{u1} - V_{o1}) + V_{ref} \quad \dots \quad (1)$$

$$V_{wo1} = R1/R2 \times (V_{w1} - V_{o1}) + V_{ref} \quad \dots \quad (2)$$

$$V_{uo2} = R3/R4 \times (V_{u2} - V_{o2}) + V_{ref} \quad \dots \quad (3)$$

$$V_{wo2} = R3/R4 \times (V_{w2} - V_{o2}) + V_{ref} \quad \dots \quad (4)$$

[0050] Therefore, the operational amplifier 72 outputs the voltage Vuo1 corresponding to the potential difference between the voltage Vu1 at the first voltage line 250u and the voltage Vo1 at the neutral line 250o of the power conditioner 10 on the side of the system power supply 300. The operational amplifier 74 outputs the voltage Vwo1 corresponding to the potential difference between the voltage Vw1 at the second voltage line 250w and the voltage Vo1 at the neutral line 250o of the power conditioner 10 on the side of the system power supply 300. The operational amplifier 76 outputs the voltage Vuo2 corresponding to the potential difference between the voltage Vu2 at the first voltage line 250u and the voltage Vo2 at the neutral line 250o of the distribution panel 260 on the side of the power conditioner 10. The operational amplifier 78 outputs the voltage Vwo2 corresponding to the potential difference between the voltage Vw2 at the second voltage line 250w and the voltage Vo2 at the neutral line 250o of the distribution panel 260 on the side of the power conditioner 10.

[0051] In the present embodiment, the voltage Vu1, the voltage Vo1, the voltage Vw1, the voltage Vu2, the voltage Vo2, and the voltage Vw2 are directly inputted to the operational amplifier 72, the operational amplifier 74, the operational amplifier 76, and the operational amplifier 78. However, the voltage Vu1, the voltage Vo1, the voltage Vw1, the voltage Vu2, the voltage Vo2, and the voltage Vw2 may be inputted to the operational amplifier 72, the operational amplifier 74, the operational amplifier 76, and the operational amplifier 78 after stepped down by a transformer. Therefore, the operational amplifier 72, the operational amplifier 74, the operational amplifier 76, and the operational amplifier 78 can be insulated from the first voltage line 250u, the neutral line 250o, and the second voltage line 250w.

[0052] Fig. 3 illustrates an example of a functional block of the control device 100 of the present embodiment. The

control device 100 includes a first voltage acquisition unit 102, a second voltage acquisition unit 104, a selector 106, and a reduction controller 108.

[0053] The first voltage acquisition unit 102 acquires the voltages V_{u01} and V_{w01} corresponding to the line voltages ($V_{u1} - V_{o1}$) and ($V_{w1} - V_{o1}$) at the power conditioner 10, which is interconnected with the system power supply 300, on the side of the system power supply 300 through the operational amplifiers 72 and 74.

[0054] The second voltage acquisition unit 104 acquires the voltages V_{u02} and V_{w02} corresponding to the line voltages ($V_{u2} - V_{o2}$) and ($V_{w2} - V_{o2}$) at the distribution panel 260 on the side of the power conditioner 10 through the operational amplifiers 76 and 78.

[0055] The selector 106 selects one of the operational amplifiers 72 and 74 and the operational amplifiers 76 and 78 as the voltage detector used to determine whether the voltage-rise reduction control is performed.

[0056] The reduction controller 108 performs the reduction control in order to reduce the rise of the output voltage at the power conditioner 10 when the voltage V_{u01} , the voltage V_{w01} , the voltage V_{u02} , or the voltage V_{w02} is greater than or equal to a threshold voltage. The voltage V_{u01} , the voltage V_{w01} , the voltage V_{u02} , or the voltage V_{w02} is acquired by one of the operational amplifiers 72 and 74 and the operational amplifiers 76 and 78, and the operational amplifiers 72 and 74 or the operational amplifiers 76 and 78 are selected by the selector 106. For example, the reduction controller 108 controls the reactive power or the active power, which is outputted from the power conditioner 10, by controlling the turn-on and -off of each switch included in the inverter 40, thereby performing the reduction control.

[0057] The selector 106 may select one of the operational amplifiers 72 and 74 and the operational amplifiers 76 and 78 based on whether the voltage detector 70 is electrically connected to the first voltage line 250u, the neutral line 250o, and the second voltage line 250w. The selector 106 may select the operational amplifiers 76 and 78 when the voltage detector 70 is electrically connected to the first voltage line 250u, the neutral line 250o, and the second voltage line 250w. The selector 106 may select the operational amplifiers 76 and 78 when the voltage detector 70 is not electrically connected to the first voltage line 250u, the neutral line 250o, and the second voltage line 250w.

[0058] The selector 106 may select the operational amplifiers 76 and 78 in the case where the voltage V_{u02} or the voltage V_{w02} satisfies a predetermined condition, and the selector 106 may select the operational amplifiers 72 and 74 in the case where the voltage V_{u02} or the voltage V_{w02} does not satisfy the predetermined condition.

[0059] In the case where the voltage detector 70 is not electrically connected to the first voltage line 250u, the neutral line 250o, and the second voltage line 250w, the voltage V_{u02} or the voltage V_{w02} , which is outputted from the operational amplifiers 76 and 78, falls within a relatively narrow range based on the reference voltage V_{ref} .

[0060] Therefore, in the case where the voltage V_{u02} or the voltage V_{w02} falls within the predetermined range based on the reference voltage V_{ref} , the selector 106 may determine that the voltage detector 70 is not electrically connected to the first voltage line 250u, the neutral line 250o, and the second voltage line 250w, and the selector 106 may select the operational amplifiers 72 and 74. On the other hand, in the case where the voltage V_{u02} or the voltage V_{w02} does not fall within the relatively narrow range based on the reference voltage V_{ref} , the selector 106 may determine that the voltage detector 70 is electrically connected to the first voltage line 250u, the neutral line 250o, and the second voltage line 250w, and the selector 106 may select the operational amplifiers 76 and 78. The predetermined voltage range may be a voltage range fixed around the reference voltage V_{ref} .

[0061] In the case where the voltage detector 70 is electrically connected to the first voltage line 250u, the neutral line 250o, and the second voltage line 250w, the voltage drop caused by the impedances of the resistor R_{u1} and the resistor R_{w1} increases with increasing current I_o outputted from the inverter 40.

[0062] Therefore, in the case where the voltage V_{u02} or the voltage V_{w02} decreases with increasing current I_o detected by the current sensor 19, the selector 106 may determine that the voltage detector 70 is electrically connected to the first voltage line 250u, the neutral line 250o, and the second voltage line 250w, and the selector 106 may select the operational amplifiers 76 and 78. On the other hand, in the case where the voltage V_{u02} or the voltage V_{w02} hardly changes according to the change in current I_o detected by the current sensor 19, the selector 106 may determine that the voltage detector 70 is not electrically connected to the first voltage line 250u, the neutral line 250o, and the second voltage line 250w, and the selector 106 may select the operational amplifiers 72 and 74. That is, the selector 106 may select the operational amplifiers 76 and 78 when the current I_o and the voltage V_{u02} or the voltage V_{w02} satisfy an inversely proportional relationship. On the other hand, the selector 106 may select the operational amplifiers 72 and 74 when the current I_o and the voltage V_{u02} or the voltage V_{w02} do not satisfy the inversely proportional relationship.

[0063] The selector 106 may receive a selection signal through a switchable member, such as a dip switch, which can manually be switched. For example, in the case where a worker installs the power conditioner 10, the worker may select the voltage detector, which is used to determine whether the voltage-rise reduction control is performed, in consideration of the positional relationship between the power conditioner 10 and the distribution panel 260. The worker may transmit the selection signal indicating the operational amplifiers 72 and 74 or the operational amplifiers 76 and 78 to the selector 106 through the dip switch. The worker may transmit the selection signal indicating the operational amplifiers 72 and 74 or the operational amplifiers 76 and 78 to the selector 106 using a setter such as a personal computer.

[0064] Fig. 4 is a flowchart illustrating an example of a voltage detector selection procedure, which is performed by

the selector 106 and used to determine whether the voltage-rise reduction control is performed.

[0065] When the power conditioner 10 is started up, the second voltage acquisition unit 104 acquires the voltage V_{uo2} and the voltage V_{wo2} through the operational amplifiers 76 and 78 (S100). The selector 106 determines whether the voltage V_{uo2} and the voltage V_{wo2} fall within the predetermined voltage range (S102).

[0066] When at least one of the voltage V_{uo2} and the voltage V_{wo2} does not fall within the predetermined voltage range, the selector 106 selects the operational amplifiers 72 and 74 as the first voltage detector (S104). On the other hand, when the voltage V_{uo2} and the voltage V_{wo2} fall within the predetermined voltage range, the selector 106 selects the operational amplifiers 76 and 78 as the second voltage detector (S106).

[0067] As described above, according to the present embodiment, one of the voltage at the power conditioner 10 on the side of the system power supply 300 and the voltage at the distribution panel 260 on the side of the power conditioner 10 can be selected as the voltage used to determine whether the voltage-rise reduction control is performed. Therefore, for example, the detection point of the voltage used to determine whether the voltage-rise reduction control is performed can be changed according to the installation places of the power conditioner 10 and the distribution panel 260.

[0068] Each unit included in the control device 100 of the present embodiment may be constructed by installing a program, which is recorded in a computer-readable recording medium to perform various pieces of processing related to the voltage-rise reduction control of the power conditioner 10, and by causing the computer to execute the program. That is, the computer acts as each unit included in the control device 100 by causing the computer to execute the program, which performs various pieces of processing related to the voltage-rise reduction control of the power conditioner 10, whereby the control device 100 may be constructed.

[0069] The computer includes a CPU, various memories such as a ROM, a RAM, and an EEPROM (registered trademark), a communication bus, and an interface, and the CPU reads and executes sequentially the processing program previously stored in the ROM as firmware, whereby the computer acts as the control device 100.

[0070] Although the embodiment of the present invention is described above, the technical scope of the present invention is not limited to the scope of the embodiment. It is clear for those skilled in the art that various changes and modifications can be made in the present invention. It is clear from the claims that the changes and modifications are also included in the technical scope of the present invention.

[0071] In the performance sequence of pieces of processing such as the operations, the procedures, the steps, and the stages in the device, the system, the program, and the method in the claims, the description, and the drawings, "before" or "prior to" is not described unless otherwise noted, and it is noted that the pieces of processing are performed in any performance sequence as long as the output of the preceding processing is used in the subsequent processing. In the operation flow of the claims, the description, and the drawings, for the sake of convenience, it is not always necessary that the pieces of processing be performed in this order even if "at first" or "then" is used.

Claims

1. A control device (100) comprising: a first voltage acquisition unit (102) configured to acquire a first voltage from a first voltage detector, the first voltage detector detecting the first voltage corresponding to a line voltage at a power conditioner (10) on a side of a system power supply (300), the power conditioner being interconnected with the system power supply;
a second voltage acquisition unit (104) configured to acquire a second voltage from a second voltage detector, the second voltage detector detecting the second voltage corresponding to a line voltage at a load (260, 270) on the side of the power conditioner, the load being provided between the power conditioner and the system power supply;
a selector (106) configured to select one of the first voltage detector and the second voltage detector; and
a reduction controller (108) configured to perform reduction control in order to reduce an output voltage at the power conditioner based on the first voltage or the second voltage, the first voltage or the second voltage being acquired from one of the first voltage detector and the second voltage detector, the first voltage detector and the second voltage detector being selected by the selector.
2. The control device (100) according to claim 1, wherein the selector (106) selects the second voltage detector when the second voltage satisfies a predetermined condition, and the selector selects the first voltage detector when the second voltage does not satisfy the predetermined condition.
3. The control device (100) according to claim 1 or 2, wherein the selector (106) selects the second voltage detector when a condition that the second voltage falls within a predetermined voltage range is satisfied, and the selector selects the first voltage detector when the condition that the second voltage falls within the predetermined voltage range is not satisfied.

4. The control device (100) according to claim 3, wherein the second voltage detector comprises: a non-inverting input terminal to which a voltage at a neutral line of the load (260,270) on the side of the power conditioner (10) and a reference voltage are inputted; an inverting input terminal to which a voltage at a voltage line of the load on the side of the power conditioner is inputted; and an output terminal from which a potential difference between the voltage inputted from the non-inverting input terminal and the voltage inputted from the inverting input terminal is outputted as the second voltage, and the voltage range is previously fixed based on the reference voltage.
5. The control device (100) according to any one of claims 1 to 4, wherein the selector (106) selects the second voltage detector when a current outputted from the power conditioner (10) and the second voltage satisfy an inversely proportional relationship, and the selector selects the first voltage detector when the current outputted from the power conditioner and the second voltage do not satisfy the inversely proportional relationship.
6. A power conditioner (10) comprising: the control device (100) according to any one of claims 1 to 5; the first voltage detector; the second voltage detector; and an inverter (40) configured to interconnect power from a distributed power supply with power from the system power supply (300), wherein the reduction controller (108) performs the reduction control by controlling an output of the inverter.
7. The power conditioner (10) according to claim 6, further comprising a member that is provided while detachably attached to the power conditioner, wherein the member comprises a terminal unit (71) configured to connect the second voltage detector and a voltage line and a neutral line of the load on the side of the power conditioner.
8. A distributed power supply system comprising: the power conditioner according to claim 6 or 7; and the distributed power supply.
9. A program configured to cause a computer to act as the control device according to any one of claims 1 to 5.
10. A control method comprising: a step of acquiring a first voltage from a first voltage detector, the first voltage detector detecting the first voltage corresponding to a line voltage at a power conditioner (10) on a side of a system power supply (300), the power conditioner being interconnected with the system power supply; a step of acquiring a second voltage from a second voltage detector, the second voltage detector detecting the second voltage corresponding to a line voltage at a load on the side of the power conditioner, the load being provided between the power conditioner and the system power supply; a step of selecting one of the first voltage detector and the second voltage detector; and a step of performing reduction control in order to reduce an output voltage at the power conditioner based on the first voltage or the second voltage, the first voltage or the second voltage being acquired from one of the first voltage detector and the second voltage detector, the first voltage detector and the second voltage detector being selected in the selecting step.

FIG. 1

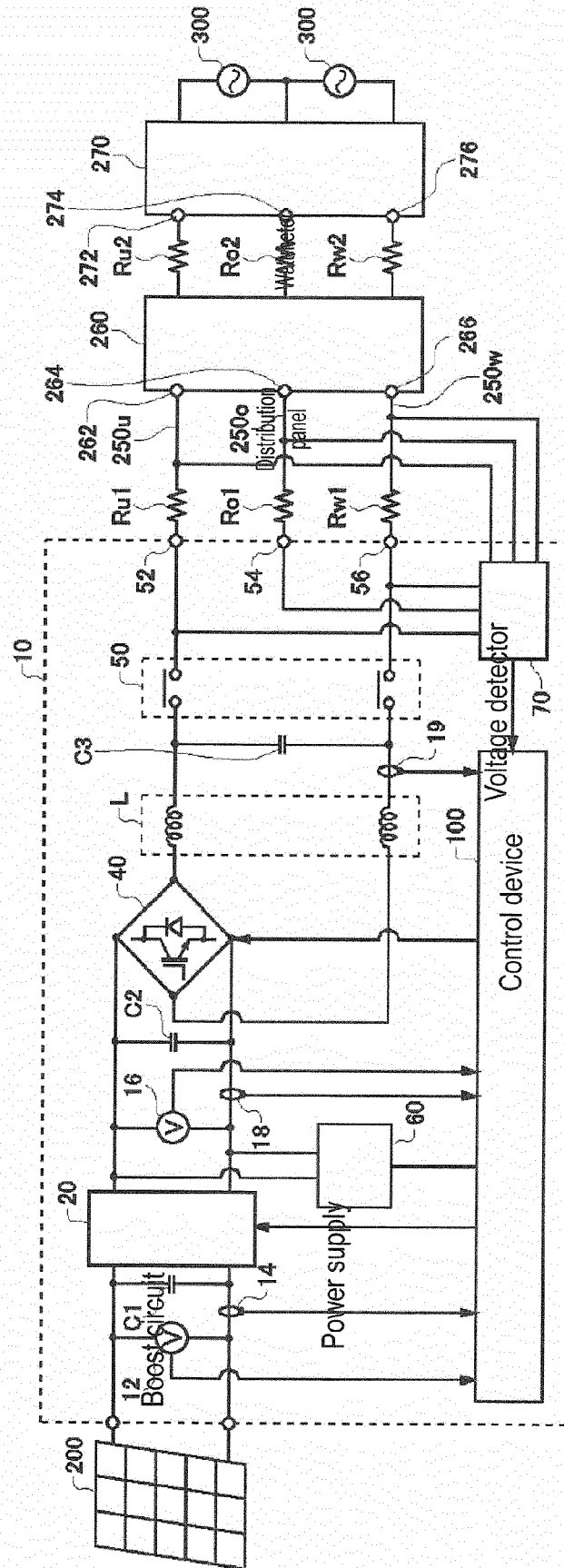


FIG. 2

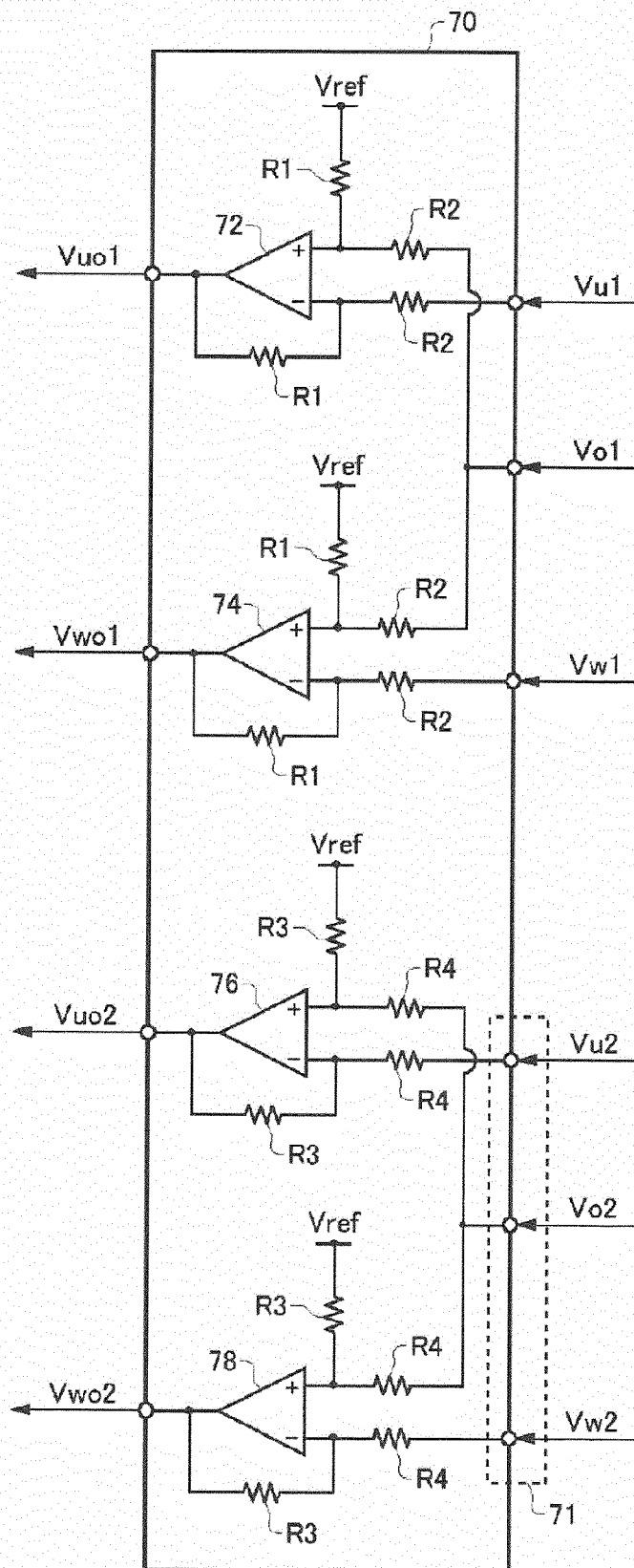


FIG. 3

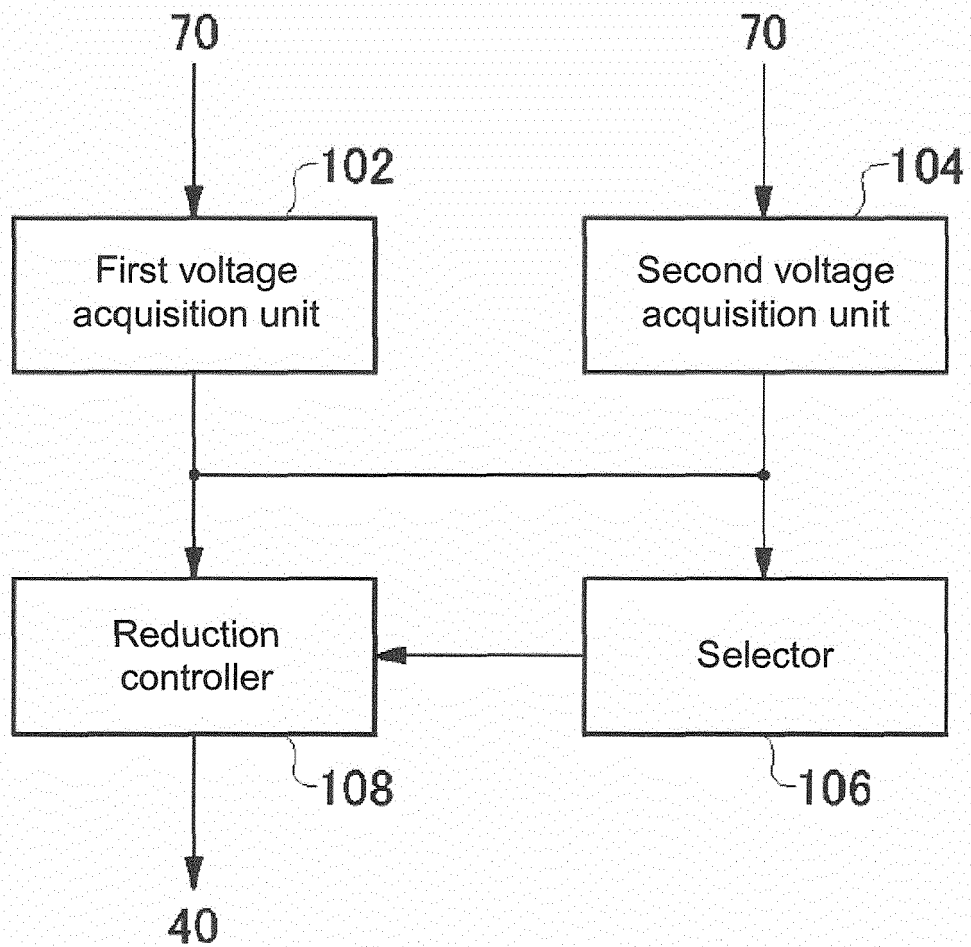
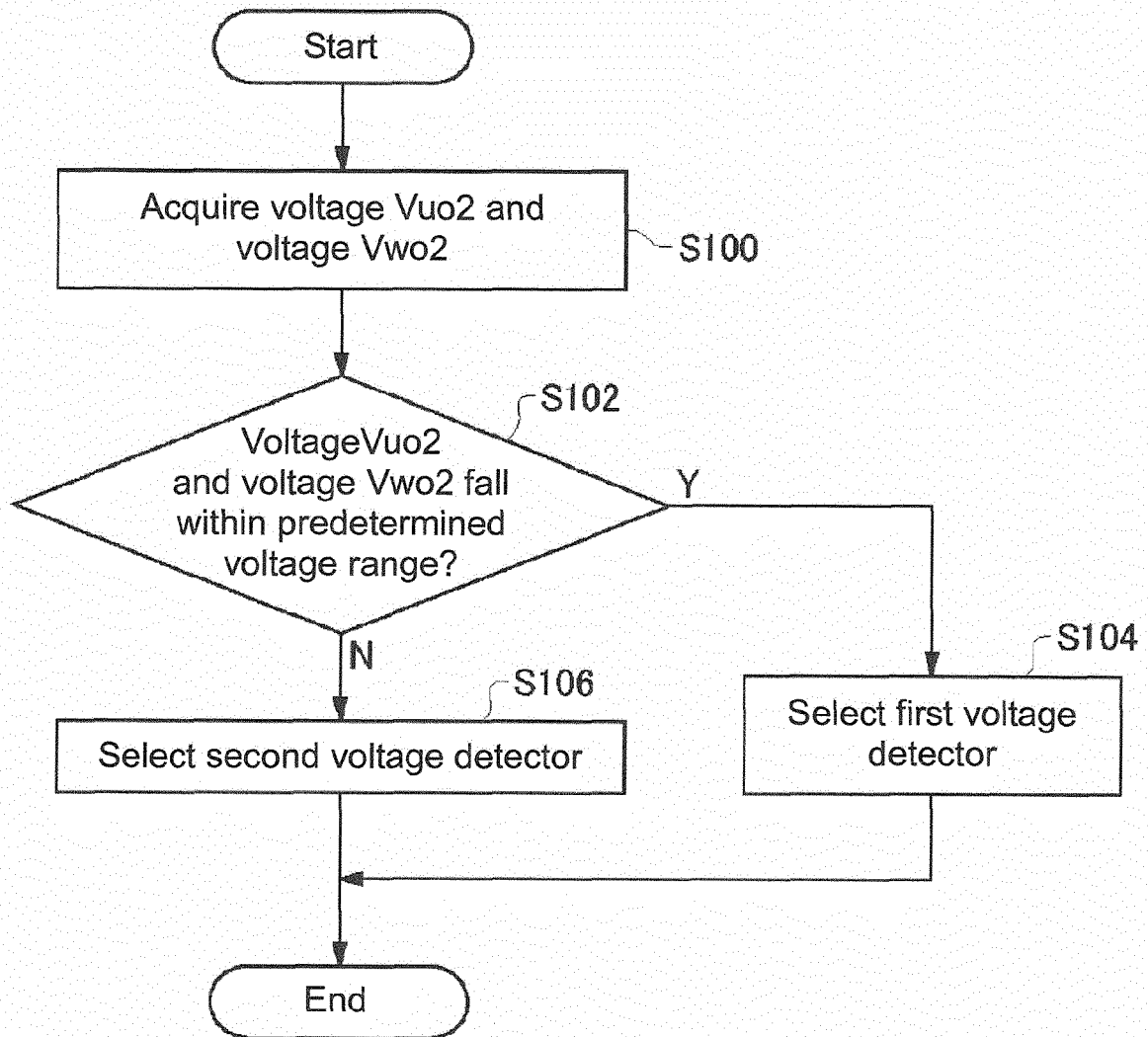


FIG. 4



REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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