VOLTAGE SAG PROTECTOR HAVING A REVERSE CURRENT PREVENTING FUNCTION

CROSS-REFERENCE TO RELATED APPLICATION

This application claims priority to and the benefit of Korean Patent Application No. 10-2004-0163580, filed on Nov 21, 2014, the disclosure of which is incorporated herein by reference in its entirety.

BACKGROUND

1. Field of the Invention

The present invention relates to a voltage sag protector (VSP), and more particularly, to a VSP having a reverse current preventing function.

2. Discussion of Related Art

A voltage sag protector (VSP) is installed between an external power supply which inputs an alternating current (AC) (e.g., 220 V AC or 380 V AC) and a load, and used to provide a stable standby power source to the load even when the AC input from the external power supply is sagged.

FIG. 1 is a diagram illustrating an example of a configuration of a conventional VSP.

Referring to FIG. 1, the conventional VSP 100 includes a power switch 110, a controller 120, and a power compensation device 130.

The power switch 110 is a two-way switch including silicon controlled rectifier (SCR) switches connected in parallel in opposite directions, is installed on a power line which connects an external power supply, which inputs an AC, to a load,

and is in a turn-on state until a voltage sag occurs. When the voltage sag occurs, the power switch 110 is turned off to disconnect an electrical connection between the external power supply which inputs the AC and the load.

The controller 120 controls the power switch 110 to be in a turn-on state until the voltage sag occurs, blocks gate signals of the SCR switches which constitute the two-way switch in the power switch 110 when the voltage sag occurs to turn off the power switch 110, and at the same time outputs a standby power source driving control signal for supplying a required AC to the load.

The power compensation device 130 converts a standby direct current (DC) provided for voltage sag protection into an AC required by the load to supply the required AC to the load when the standby power source driving control signal is input.

For example, when the standby power source driving control signal is input, the power compensation device 130 illustrated in FIG. 1 converts the standby DC, to which a standby power supply 131 provided for the voltage sag protection outputs, into the required AC through an inverter 132, and increases or decreases the AC output from the inverter 132 to the AC required by the load through a transformer 133 to supply the required AC to the load.

A dry cell battery which supplies the standby DC, or a condenser or a battery capable of charging the standby DC supply may be used as the standby power supply 131.

The conventional VSP 100 configured and operated as described above uses the two-way switch including the SCR switches connected in parallel in opposite directions as the power switch 110. Each of the SCR switches has a characteristic in which a turned-on state is maintained until an input voltage waveform falls to zero

potential and current does not flow when it is turned on once, and thus, even when the controller 120 blocks the gate signals of the SCR switches and turns off the power switch 110 when the voltage sag occurs, the SCR switches which constitute the power switch 110 are not immediately turned off, and actually are in a turn-off state in which a current does not flow at a moment in which a voltage of the external power supply falls to zero potential immediately after the gate signals are blocked.

For example, in the case in which a voltage waveform of the AC input from the external power supply is in a positive state, when the controller 120 blocks the gate signals of the SCR switches as the voltage sag occurs, the SCR switches which constitute the power switch 110 are in a turn-off state in which the current does not flow at a moment in which the voltage waveform of the AC input from the external power supply falls to zero potential and a phase is reversed to a negative state immediately after the gate signals are blocked.

On the other hand, in the case in which the voltage waveform of the AC input from the external power supply is in the negative state, when the controller 120 blocks the gate signals of the SCR switches as the voltage sag occurs, the SCR switches which constitute the power switch 110 are in a turn-off state in which the current does not flow at a moment in which the voltage waveform of the AC input from the external power supply falls to zero potential and the phase is reversed to the positive state immediately after the gate signals are blocked.

That is, the SCR switches which constitute the power switch 110 maintain a turn-on state which is not turned off during a time (hereinafter, an SCR turn-on maintaining time) until the voltage of the external power supply falls to zero potential immediately after the controller 120 blocks the gate signals. In general, the SCR turn-on maintaining time is in a range of several μs to tens of μs.

Therefore, during the SCR turn-on maintaining time, a reverse current which flows to the external power supply through the SCR switches is generated by the AC output from the power compensation device 130 which is operated simultaneously with the blocking of the gate signals of the SCR switches by the controller 120. As a result, there is a problem in that a voltage sag or power shortage is caused in the load.

In order to address the problem, in a method of controlling a thyristor switch disclosed in Patent Document 1, in order to prevent a compensated AC corresponding to the AC output from the power compensation device 130 during the above-described SCR turn-on maintaining time from being lost, a phase of a voltage of the compensated AC is adjusted to be faster or slower than a phase of a voltage of the AC input from the external power supply to turn off the thyristor and supply the compensated AC to the load.

However, the method of controlling the thyristor switch disclosed in Patent Document 1 has the following problems.

First, when the phase of the voltage of the compensated AC is made to be different from the phase of the voltage of the input AC and the thyristor is turned off, a change of an output frequency of the compensated AC supplied to the load occurs, and thus, a system error, that is, an abnormal power frequency, occurs in a system (e.g., in the case in which a regenerative load is used) sensitive to the change of the output frequency.

Second, it is difficult to instantaneously change the phase of the voltage of the input AC to be different from the phase of the voltage of the compensated AC due to a change of a polarity of an output load current, and thus, a reverse voltage

more than a predetermined voltage which turns off the thyristor is not generated. As a result, a problem in that it fails to turn off the thyristor is caused.

Prior Art Document

Patent Document

(Patent Document 1) KR10-2011-0071893 A

SUMMARY OF THE INVENTION

The present invention is directed to a voltage sag protector (VSP) having a reverse current preventing function, in which, when a voltage sag occurs, an output voltage of a power compensation device is formed to be higher or lower than an input voltage of an external power supply and within an acceptable range of a rated voltage of a load to supply a required alternating current (AC) to the load and turn off silicon controlled rectifier (SCR) switches which constitute a power switch during a time until the SCR switches are turned off immediately after a controller blocks a gate signal in order to turn off the SCR switches which constitute the power switch, that is, an SCR turn-on maintaining time and thus, a reverse current which flows into the external power supply through the SCR switches which maintain a turn-on state during the SCR turn-on maintaining time is prevented from being generated, and the output voltage of the power compensation device is formed to be the same as the input voltage of the external power supply to supply the required AC to the load immediately after the SCR switches are turned off.

According to an aspect of the present invention, there is provided a VSP having a reverse current preventing function, including: a power switch which is a two-way switch including SCR switches connected in parallel in opposite directions, is installed on a power line which connects an external power supply to which an AC

is input to a load, is turned on until a voltage sag occurs and is turned off when the voltage sag occurs to disconnect an electrical connection between the external power supply to which the AC is input and the load; a controller which turns on the power switch until the voltage sag occurs and blocks gate signals of the SCR switches which constitute the two-way switch in the power switch when the voltage sag occurs, and at the same time, controls an output voltage of a power compensation device to be higher or lower than an input voltage of the external power supply and within an acceptable range of a rated voltage of the load until the SCR switches are turned off immediately after the gate signals are blocked, outputs a standby power source driving control signal for supplying a required AC to the load, and turns off the SCR switches which constitute the power switch, and controls the output voltage of the power compensation device to be the same as the input voltage of the external power supply immediately after the SCR switches are turned off, outputs the standby power source driving control signal for supplying the required AC to the load, and prevents a reverse current which flows into the external power supply through the SCR switches which maintain a turn-on state during a time until the SCR switches are turned off immediately after the gate signals are blocked from being generated; and the power compensation device which converts a standby direct current (DC) provided for voltage sag protection into an AC required by the load and supplies the required AC to the load when the standby power source driving control signal is input.

BRIEF DESCRIPTION OF THE DRAWINGS

The above and other objects, features and advantages of the present invention will become more apparent to those of ordinary skill in the art by

describing in detail exemplary embodiments thereof with reference to the accompanying drawings, in which:

FIG. 1 is a diagram illustrating an example of a configuration of a conventional voltage sag protector (VSP);

FIG. 2 is a diagram for describing an operation of a VSP having a reverse current preventing function according to an embodiment of the present invention; and

FIG. 3 is a diagram for describing an operation of a VSP having a reverse current preventing function according to another embodiment of the present invention.

DETAILED DESCRIPTION OF EXEMPLARY EMBODIMENTS

Hereinafter, preferred embodiments of the present invention will be described in more detail with reference to the accompanying drawings.

Referring to FIGS. 2 and 3, each of the voltage sag protectors (VSPs) 100a having a reverse current preventing function according to embodiments of the present invention includes a power switch 110, a controller 120a, and a power compensation device 130.

The power switch 110 is a two-way switch including silicon controlled rectifier (SCR) switches connected in parallel in opposite directions, is installed on a power line which connects an external power supply, which inputs an alternating current (AC), to a load, and is turned on until a voltage sag occurs and is turned off when the voltage sag occurs to disconnect the electrical connection between the external power supply which inputs the AC and the load.

The controller 120a turns on the power switch until the voltage sag occurs and blocks gate signals of the SCR switches which constitute the two-way switch in the power switch when the voltage sag occurs, and at the same time, controls an output voltage of the power compensation device 130 to be higher or lower than an input voltage of the external power supply and within an acceptable range of a rated voltage of the load until the SCR switches are turned off immediately after the gate signals are blocked, outputs a standby power source driving control signal for supplying a required AC to the load, and turns off the SCR switches which constitute the power switch, and controls the output voltage of the power compensation device to be the same as the input voltage of the external power supply immediately after the SCR switches are turned off, outputs the standby power source driving control signal for supplying the required AC to the load, and prevents a reverse current which flows into the external power supply through the SCR switches which maintain a turn-on state during a time until the SCR switches are turned off immediately after the gate signals are blocked, that is, an SCR turn-on maintaining time from being generated.

A method in which the controller 120a, when the voltage sag occurs, controls the output voltage of the power compensation device 130 to be higher or lower than the input voltage of the external power supply and within the acceptable range of the rated voltage of the load until the SCR switches are turned off immediately after the gate signals are blocked, and outputs the standby power source driving control signal for supplying a required AC to the load may be performed by adjusting a program of a microprocessor included in the controller 120a. For example, when it is assumed that the input voltage of the AC provided from the external power supply is 220 V AC and the acceptable range of the rated voltage of the load is a range of 210 V AC

to 230 V AC, the microprocessor included in the controller 120a adjusts the output voltage of the power compensation device 130 to be higher or lower than 220 V AC by 10 V, and outputs the standby power source driving control signal for supplying the required AC to the load.

When the voltage sag occurs and a direction of a current which turns on the SCR switches which constitute the two-way switch in the power switch 110 is a direction which flows from the external power supply to the load, the controller 120a controls the output voltage of the power compensation device 130 to be higher than the input voltage of the external power supply and within the acceptable range of the rated voltage of the load and outputs the standby power source driving control signal for supplying a required AC to the load.

When the voltage sag occurs and a direction of a current which turns on the SCR switches which constitute the two-way switch in the power switch 110 is a direction which flows from the load to the external power supply, the controller 120a controls the output voltage of the power compensation device 130 to be lower than the input voltage of the external power supply and within the acceptable range of the rated voltage of the load and outputs the standby power source driving control signal for supplying a required AC to the load.

The power compensation device 130 converts a standby direct current (DC) provided, in order to prevent the voltage sag, into an AC required by the load and supplies the required AC to the load when the standby power source driving control signal is input.

For example, when the driving control signal is input, the power compensation device 130 is illustrated in FIGS. 2 and 3 to convert a standby DC output from a standby power supply 131 provided for protection against the voltage

sag into a required AC through an inverter 132, and increase or decrease the AC output from the inverter 132 to the AC required by the load through a transformer 133 to supply the required AC to the load.

A dry cell battery which supplies the standby DC, or a condenser or a battery capable of charging the standby DC may be used as the standby power supply 131.

The VSP 100a having a reverse current preventing function and configured as described above operates as follows:

FIG. 2 is a diagram for describing an operation of the VSP 100a having a reverse current preventing function according to the embodiment of the present invention when a voltage sag occurs while a current which turns on the SCR switches which constitute the two-way switch in the power switch 110 flows from the external power supply to the load.

A direction of the current i illustrated in FIG. 2 indicates a direction in which a current which turns on the SCR switches flows from the external power supply to the load.

When a power source of 220 V AC is normally input from the external power supply until the voltage sag occurs, the current i which turns on the SCR switches which constitute the power switch 110 normally flows into the load, and thus, the power source of 220 V AC is supplied to the load.

As described above, when the voltage sag occurs while the power source of 220 V AC is normally supplied to the load, the controller 120a blocks the gate signals of the SCR switches which constitute the two-way switch in the power switch 110, and at the same time, controls the output voltage of the power compensation device 130 to be higher than the input voltage of the external power supply and within an acceptable range of the rated voltage of the load and outputs the standby power

source driving control signal for supplying the required AC to the load to turn off the SCR switches during a time until the SCR switches are turned off immediately after the gate signals are blocked, that is, the above-described SCR turn-on maintaining time, and thus, prevents a reverse current which flows into the external power supply through the SCR switches which maintain a turn-on state during the SCR turn-on maintaining time from being generated.

For example, as illustrated in FIG. 2, when the voltage sag occurs while the power source of 220 V AC is normally input from the external power supply, the controller 120a controls the output voltage of the power compensation device 130 to be higher than the power source of 220 V AC the external power supply by 10 V and outputs the standby power source driving control signal for supplying the required AC to the load during the above-described SCR turn-on maintaining time.

Accordingly, the power compensation device 130 supplies a power source of 230 V AC higher than the power source of 220 V AC of the external power supply by 10 V to the load.

Based on the current i illustrated in FIG. 2, since a reverse voltage higher than the external power supply by 10 V is supplied to the SCR switches in a direction opposite the direction of the current i and the SCR switches are turned off during the above-described SCR turn-on maintaining time immediately after the voltage sag occurs, a reverse current which flows into the external power supply through the SCR switches may be prevented from being generated.

Further, immediately after the SCR switches are turned off, there is no need to continuously supply the forcibly increased AC, for example the above-described power source of 230 V AC within an acceptable range of the rated voltage of the load.

Therefore, immediately after the SCR switches are turned off, the controller 120a controls the output voltage of the power compensation device 130 to be the same as the input voltage of the external power supply and outputs the standby power source driving control signal for supplying the required AC to the load.

Accordingly, the power compensation device 130, which outputs the forcibly increased the power source of 230 V AC during the above-described SCR turn-on maintaining time and turns off the SCR switches, outputs the power source of 220 V AC in order to supply to the load immediately after the SCR switches are turned off.

FIG. 3 is a diagram for describing an operation of a VSP 100a having a reverse current preventing function according to another embodiment of the present invention when a voltage sag occurs while a current which turns on the SCR switches which constitute the two-way switch in the power switch 110 flows from the load to the external power supply.

A direction of the current i illustrated in FIG. 3 indicates a direction in which a current which turns on the SCR switch flows from the load to the external power supply.

When a power source of 220 V AC is normally input from the external power supply until the voltage sag occurs, the current i which turns on the SCR switches which constitute the power switch 110 normally flows into the load, and thus, the power source of 220 V AC is supplied to the load.

As described above, when the voltage sag occurs while the power source of 220 V AC is normally supplied to the load, the controller 120a blocks the gate signals of the SCR switches which constitute the two-way switch in the power switch 110, and at the same time, controls the output voltage of the power compensation device 130 to be lower than the input voltage of the external power supply and within an

acceptable range of a rated voltage of the load and outputs a standby power source driving control signal for supplying the required AC to the load to turn off the SCR switches during a time until the SCR switches are turned off immediately after the gate signals are blocked that is, the above-described SCR turn-on maintaining time, and thus, a reverse current which flows into the external power supply through the SCR switches which maintain a turn-on state during the SCR turn-on maintaining time is prevented from being generated.

For example, as illustrated in FIG. 3, when the voltage sag occurs while the power source of 220 V AC is normally input from the external power supply, the controller 120a controls the output voltage of the power compensation device 130 to be lower than the power source of 220 V AC of the external power supply by 10 V and outputs the standby power source driving control signal for supplying the required AC to the load during the above-described SCR turn-on maintaining time.

Accordingly, the power compensation device 130 supplies a power source of 210 V AC lower than the power source of 220 V AC of the external power supply by 10 V to the load.

Based on the current i illustrated in FIG. 3, since a reverse voltage lower than the external power supply by 10 V is supplied to the SCR switch in a direction opposite the direction of the current i and the SCR switches are turned off during the above-described SCR turn-on maintaining time immediately after the voltage sag occurs, a reverse current which flows into the external power supply through the SCR switches may be prevented from being generated.

Further, immediately after the SCR switches are turned off, there is no need to continuously supply the forcibly decreased AC, for example the above-described power source of 210 V AC within an acceptable range of the rated voltage of the load.

Therefore, immediately after the SCR switches are turned off, the controller 120a controls the output voltage of the power compensation device 130 to be the same as the input voltage of the external power supply and outputs the standby power source driving control signal for supplying the required AC to the load.

Accordingly, the power compensation device 130, which outputs the forcibly decreased the power source of 210 V AC during the above-described SCR turn-on maintaining time and turns off the SCR switch, outputs the power source of 220 V AC in order to supply to the load immediately after the SCR switches are turned off.

Although it is described that the controller 120a turns off the SCR switches during a time until the SCR switches are turned off immediately after the gate signals are blocked, that is, the SCR turn-on maintaining time, actually, the SCR switches which constitute the power switch 110 are immediately turned off after the controller 120a blocks the gate signal. As a result, a reverse current, in which the AC output from the power compensation device 130 in order to supply to the load flows into the external power supply through the SCR switches, is generated, and thus, a conventional problem in that a voltage sag or power shortage is caused by the reverse current in the load can be addressed.

For example, in the embodiments of the present invention, since the phase of the input AC and the phase of the compensated AC are the same and there is no need to change to be different unlike the method of controlling the thyristor switch disclosed in Patent Document 1, a reverse voltage more than a predetermined voltage, which turns off the SCR switches, is stably generated and the SCR switches can be successfully turned off regardless of a change of a polarity of an output load current.

According to the embodiments of the present invention, the SCR switches are turned off immediately after the controller of the VSP blocks the gate signals of

the SCR switches which constitute the power switch, and thus, the reverse current in which the AC output from the power compensation device in order to supply to the load flows into the external power supply through the SCR switches is generated. Therefore, a conventional problem in that a voltage sag or power shortage is caused by the reverse current in the load can be addressed.

The VSP having a reverse current preventing function according to the embodiments of the present invention is not limited to the above-described embodiments, and it will be understood by those of skilled in the art that various changes in form and details may be made without departing from the spirit and scope of the present invention claimed in the claims.

WHAT IS CLAIMED IS:

1. A voltage sag protector (VSP) having a reverse current preventing function, comprising:

a power switch (110) which is a two-way switch including silicon controlled rectifier (SCR) switches connected in parallel in opposite directions, is installed on a power line which connects an external power supply which inputs an alternating current (AC) to a load, is turned on until a voltage sag occurs and is turned off when the voltage sag occurs to disconnect an electrical connection between the external power supply which inputs the AC and the load;

a controller (120a) configured to turn on the power switch (110) until the voltage sag occurs and block gate signals of the SCR switches which constitute the two-way switch in the power switch (110) when the voltage sag occurs, and at the same time, control an output voltage of a power compensation device (130) to be higher than an input voltage of the external power supply and within an acceptable range of a rated voltage of the load until the SCR switches are turned off immediately after the gate signals are blocked when a direction of a current which turns on the SCR switches which constitute the two-way switch in the power switch (110) is a direction which flows from the external power supply to the load when the voltage sag occurs, output a standby power source driving control signal for supplying a required AC to the load, and turn off the SCR switches which constitute the power switch (110), and control the output voltage of the power compensation device (130) to be the same as the input voltage of the external power supply immediately after the SCR switches are turned off, output the standby power source driving control signal for supplying the required AC to the load, and prevent a

reverse current which flows into the external power supply through the SCR switches which maintain a turn-on state during a time until the SCR switches are turned off immediately after the gate signals are blocked from being generated; and

the power compensation device (130) configured to convert a standby direct current (DC) provided for voltage sag protection into an AC required by the load and supply the required AC to the load when the standby power source driving control signal is input.

2. A VSP having a reverse current preventing function, comprising:

a power switch (110) which is a two-way switch including SCR switches connected in parallel in opposite directions, is installed on a power line which connects an external power supply which inputs an AC to a load, is turned on until a voltage sag occurs and is turned off when the voltage sag occurs to disconnect an electrical connection between the external power supply which inputs the AC and the load;

a controller (120a) configured to turn on the power switch (110) until the voltage sag occurs and block gate signals of the SCR switches which constitute a two-way switch in the power switch (110) when the voltage sag occurs, and at the same time, control an output voltage of a power compensation device (130) to be lower than an input voltage of the external power supply and within an acceptable range of a rated voltage of the load until the SCR switches are turned off immediately after the gate signals are blocked when a direction of a current which turns on the SCR switches which constitute the two-way switch in the power switch (110) is a direction which flows from the load to the external power supply when the voltage sag occurs, output a standby power source driving control signal for

supplying a required AC to the load, and turn off the SCR switches which constitute the power switch (110), and control the output voltage of the power compensation device (130) to be the same as the input voltage of the external power supply immediately after the SCR switches are turned off, output the standby power source driving control signal for supplying the required AC to the load, and prevent a reverse current which flows into the external power supply through the SCR switches which maintain a turn-on state during a time until the SCR switches are turned off immediately after the gate signals are blocked from being generated; and

the power compensation device (130) configured to convert a standby DC provided for voltage sag protection into an AC required by the load and supply the required AC to the load when the standby power source driving control signal is input.