

VOLTAGE SAG PROTECTOR FOR THREE-PHASE SERVO DRIVER

【Technical Field】

5 The present invention relates generally to a voltage sag protector (VSP) and, more particularly, to a VSP for a three-phase servo driver using a single-phase VSP.

【Background Art】

 A three-phase servo driver is a power supply that boosts or reduces input three-phase alternating current (AC) power (e.g., AC 220V, AC 380V, etc.) to
10 different three-phase AC power required on a load side such as a three-phase servo motor and outputs the boosted or reduced three-phase AC power.

 FIG. 1 is a block diagram showing a configuration of a typical three-phase servo driver disclosed in Patent Document 1.

 As shown in FIG. 1, the conventional three-phase servo driver 10 includes a
15 converter 11, an inverter 12, and a drive controller 13.

 The converter 11 includes a diode bridge rectifier that rectifies three-phase AC power input from an external power supply into pulsating current power, and a smoothing capacitor that smoothes the pulsating current power output from the diode bridge rectifier into necessary direct current (DC) power.

20 In the diode bridge rectifier, three diode pairs, each of which is made up of two diodes connected in series, are connected in parallel to R, S, and T phase power lines respectively, and convert the three-phase AC power input from an external power supply into the pulsating current power.

In the inverter 12, a full bridge switching circuit whose switch on/off operation is controlled by a drive control signal (e.g., a pulse width modulation (PWM) control signal) converts the DC power which the converter 11 outputs into different three-phase AC power required on a load side such as a three-phase servo motor M, and supplies the converted three-phase AC power to the load side.

In the full bridge switching circuit, three power device pairs, each of which is made up of two power devices connected in series, are connected in parallel, are connected to R, S, and T phase power lines of the load side respectively, convert the DC power into another three-phase AC power required on the load side, and supply the converted three-phase AC power to the load side.

The drive controller 13 outputs a drive control signal (e.g., a PWM control signal) according to a result of detecting a variation in the three-phase AC power supplied to the load side such as the three-phase servo motor M, and controls the switch on/off operation of the inverter 12. Thereby, the three-phase AC power required on the load side such as the three-phase servo motor M is supplied.

For example, the drive controller 13 may output a PWM control signal based on a result of detecting either a variation in electric current supplied to the three-phase servo motor M or a variation in a rotational speed of the three-phase servo motor M, and control the switch on/off operation of the inverter 12. Thereby, the drive controller 13 can control the rotational speed of the three-phase servo motor M.

Meanwhile, the conventional three-phase servo driver 10 uses a circuit breaker (CB) that is installed on an input side of an external power supply from which the three-phase AC power is input in order to prevent over current, and an uninterruptible power supply (UPS) that stably supplies emergency power to the load

side even when the three-phase AC power input from the external power supply momentarily fails.

However, the UPS used for the conventional three-phase servo driver 10 frequently fails due to an inrush current generated from peripheral apparatuses, and supplies control power to a load for an excessive time without distinction between a 5 momentary power failure and a permanent power failure. Considerable maintenance expenses are required to periodically check batteries used for the UPS, which is economically inefficient.

Therefore, there is a need for a new voltage sag protector for a three-phase 10 servo driver which resolves the above drawbacks and problems of the UPS.

Documents of Related Art

[Patent Document 1] Korean Patent No. 10-0618236

[Patent Document 2] Korean Patent No. 10-1009483

【Disclosure】

15 【Technical Problem】

Accordingly, the inventor of the present invention has developed a new voltage sag protector for a three-phase servo driver using a single-phase voltage sag protector (see Patent Document 2) that has been well known as a voltage sag protector that resolves drawbacks and problems of a conventional uninterruptible 20 power system (UPS) and has already been developed by the inventor.

The present invention is directed to a voltage sag protector for a three-phase servo driver, in which: a power cutoff switch (hereinafter referred to as a “first power cutoff switch”) is installed on any one of R, S, and T phase power lines connecting an external power supply from which three-phase alternating current (AC) power is

input and a three-phase servo driver; a power cutoff switch (hereinafter referred to as a “second power cutoff switch”) of a single-phase voltage sag protector is installed on one of the other two phase power lines on which the first power cutoff switch is not installed apart from the first power cutoff switch; when a momentary power failure occurs due to a short circuit on a power system or a lightning strike, the first and second power cutoff switches are switched off together, interrupt electrical connection between the external power supply from which the three-phase AC power is input and the three-phase servo driver, and simultaneously supply single-phase AC power of the single-phase voltage sag protector prepared to compensate for the momentary power failure to the three-phase servo driver; and thereby the three-phase servo driver converts the input single-phase AC power into different three-phase AC power required on a load side and outputs the converted three-phase AC power.

The present invention is also directed to a voltage sag protector for a three-phase servo driver, in which, when a momentary power failure is resolved, first and second power cutoff switches that have been switched off are switched on together again, supply three-phase AC power input from an external power supply to the three-phase servo driver, and thereby the three-phase servo driver converts the input single-phase AC power into different three-phase AC power required on a load side and outputs the converted three-phase AC power.

The present invention is also directed to a voltage sag protector for a three-phase servo driver, in which first and second power cutoff switches are switched on or off together by a controller of a single-phase voltage sag protector.

The present invention is also directed to a voltage sag protector for a three-phase servo driver, in which, when a first power cutoff switch is installed on an R or T phase power line, a second power cutoff switch is installed on an S phase power

line, and when the first power cutoff switch is installed on the S phase power line, the second power cutoff switch is installed on the R or T phase power line.

【Technical Solution】

Accordingly to an aspect of the present invention, there is provided a voltage sag protector for a three-phase servo driver, which includes: a first power cutoff switch that is installed on any one of R, S, and T phase power lines connecting an external power supply from which three-phase alternating current (AC) power is input and the three-phase servo driver, is switched on before a momentary power failure occurs, and is switched off when the momentary power failure occurs so as to interrupt the electrical connection between the external power supply from which the three-phase AC power is input and the three-phase servo driver; and a single-phase voltage sag protector having: a second power cutoff switch that is installed either on the S phase power line when the first power cutoff switch is installed on the R or T phase power line or on the R or T phase power line when the first power cutoff switch is installed on the S phase power line, is switched on along with the first power cutoff switch before the momentary power failure occurs, and is switched off along with the first power cutoff switch when the momentary power failure occurs so as to interrupt the electrical connection between the external power supply from which the three-phase AC power is input and the three-phase servo driver; a controller that simultaneously switches on the first and second power cutoff switches before the momentary power failure occurs, simultaneously switches off the first and second power cutoff switches when the momentary power failure occurs, and simultaneously outputs a preliminary power supply drive control signal; an inverter that converts preliminary direct current (DC) power which a preliminary power supply outputs into necessary single-phase AC power in order to compensate for the

momentary power failure when the preliminary power supply drive control signal of the controller is input; and a transformer that boosts or reduces the single-phase AC power which the inverter outputs to necessary single-phase AC power, supplies the boosted or reduced single-phase AC power to the three-phase servo driver via the power line on which the second power cutoff switch is installed, and thereby causes the three-phase servo driver to convert the input single-phase AC power into different three-phase AC power required on a load side and to output the converted three-phase AC power.

【Advantageous Effects】

As described above, the voltage sag protector for a three-phase servo driver can be easily and inexpensively manufactured using the single-phase voltage sag protector the resolves drawbacks and problems of a conventional uninterruptible power system (UPS).

【Description of Drawings】

FIG. 1 is a block diagram showing a configuration of a typical three-phase servo driver.

FIG. 2 is a block diagram showing a configuration of a voltage sag protector for a three-phase servo driver according to the present invention.

FIG. 3 shows an embodiment in which only a second power cutoff switch is installed on an R phase power line among R, S, and T phase power lines along which three-phase alternating current (AC) power is input.

FIG. 4 shows an embodiment in which the second power cutoff switch is installed on the R phase power line among the R, S, and T phase power lines along

which the three-phase AC power is input, and a first power cutoff switch is installed on the S phase power line.

【Mode for Invention】

Exemplary embodiments of the present invention will be described in greater
5 detail below with reference to the attached drawings.

Referring to FIG. 2, a voltage sag protector 100 for a three-phase servo driver according to the present invention includes a first power cutoff switch 110 installed on an R phase power line or one of S and T phase power lines, all of which connect an external power supply from which three-phase alternating current (AC) power is
10 input and the three-phase servo driver 10, and a single-phase voltage sag protector 120 that supplies single-phase AC power to the three-phase servo driver 10 when a momentary power failure (or a momentary voltage sag) occurs.

The first power cutoff switch 110 is installed on the R phase power line or any one of the S and T phase power lines, each of which connects the external power
15 supply from which the three-phase AC power is input and the three-phase servo driver 10, is switched on before the momentary power failure occurs, and is switched off when the momentary power failure occurs so as to interrupt electrical connection between the external power supply from which the three-phase AC power is input and the three-phase servo driver 10.

20 As shown in FIG. 2, the first power cutoff switch 110 is preferably configured as a silicon controlled rectifier (SCR) in which two diodes are connected in parallel in opposite directions.

The single-phase voltage sag protector 120 includes a second power cutoff switch 121, a controller 122, a preliminary power supply 123, an inverter 124, and a
25 transformer 125.

When the first power cutoff switch 110 is installed on the R or T phase power line, the second power cutoff switch 121 is installed on the S phase power line. When the first power cutoff switch 110 is installed on the S phase power line, the second power cutoff switch 121 is installed on the R or T phase power line. In this state, before the momentary power failure occurs, the first and second power cutoff switches 110 and 121 are simultaneously switched on. When the momentary power failure occurs, the first and second power cutoff switches 110 and 121 are simultaneously switched off, thereby interrupting the electrical connection between the external power supply from which the three-phase AC power is input and the three-phase servo driver 10.

As shown in FIG. 2, the second power cutoff switch 121 is preferably configured as an SCR in which two diodes are connected in parallel in opposite directions.

The controller 122 switches on or off the first and second power cutoff switches 110 and 121 together.

Before the momentary power failure occurs, the controller 122 switches on the first and second power cutoff switches 110 and 121 together. When the momentary power failure occurs, the controller 122 switches off the first and second power cutoff switches 110 and 121 together, and simultaneously outputs a preliminary power supply drive control signal.

When the momentary power failure is resolved, the controller 122 interrupts the output of the preliminary power supply drive control signal to stop an operation of the inverter 124. Thereby, the controller 122 interrupts the single-phase AC power supplied to the three-phase servo driver 10 through the transformer 125, and simultaneously switches on the first and second power cutoff switches 110 and 121

that have been switched off so as to supply the three-phase AC power input from the external power supply to the three-phase servo driver 10. Thereby, the three-phase servo driver 10 converts the input three-phase AC power into different three-phase AC power required on a load side, and outputs the converted three-phase AC power.

5 When the preliminary power supply drive control signal of the controller 122 is input, the inverter 124 converts preliminary direct current (DC) power which the preliminary power supply 123 outputs into a necessary single-phase AC power in order to compensate for the momentary power failure, and outputs the converted single-phase AC power.

10 As the preliminary power supply 123, either a battery supplying the preliminary DC power or a capacitor capable of charging the preliminary DC power may be used.

 The transformer 125 boosts or reduces the single-phase AC power which the inverter 124 outputs to necessary single-phase AC power, and supplies the boosted or
15 reduced single-phase AC power to the three-phase servo driver 10 via the power line on which the second power cutoff switch 121 is installed. Thereby, the three-phase servo driver 10 converts the input single-phase AC power into different three-phase AC power required on the load side, and outputs the converted three-phase AC power.

20 The voltage sag protector 100 for a three-phase servo driver which is configured as described above in accordance with the present invention is operated as follows.

 FIG. 2 is a block diagram showing a configuration of the voltage sag protector 100 for a three-phase servo driver according to the present invention. As
25 illustrated in FIG. 2, the first power cutoff switch 110 is installed on the S phase

power line, and the second power cutoff switch 121 of the single-phase voltage sag protector 120 is installed on the R phase power line.

As shown in FIG. 2, the voltage sag protector 100 for a three-phase servo driver according to the present invention uses the first power cutoff switch 110 and
5 the second power cutoff switch 121 of the single-phase voltage sag protector 120 in order to interrupt the electrical connection between the external power supply from which the three-phase AC power is input and the three-phase servo driver 10. The reason these power cutoff switches are used is as follows.

First, it is assumed that, as shown in FIG. 3, only the second power cutoff
10 switch 121 of the single-phase voltage sag protector 120 is installed on the R phase power line, and the first power cutoff switch 110 is not installed on the S phase power line.

The three power lines through which the three-phase AC power is input, i.e. the R, S, and T power lines, are connected in a delta type as shown in FIG. 3(a), or in
15 a star type as shown in FIG. 3(b). In either case, when the second power cutoff switch 121 is switched off, only the R phase power line is completely electrically disconnected from the three-phase servo driver 10 and is kept insulated. The remaining S and T phase power lines are electrically connected to the three-phase servo driver 10, and thus are still not supplied with the S and T phase AC power
20 during the momentary power failure.

As described above, in the state in which only the second power cutoff switch 121 of the single-phase voltage sag protector 120 is installed on the R phase power line, and the first power cutoff switch 110 is not installed on the S phase power line, when the momentary power failure occurs at the external power supply from which
25 the three-phase AC power is input due to a short circuit on a power system or a

lightning strike, the controller 122 of the single-phase voltage sag protector 120 switches off the second power cutoff switch 121 and simultaneously outputs the preliminary power supply drive control signal.

Subsequently, when the inverter 124 converts the preliminary DC power
5 which the preliminary power supply 123 outputs into the necessary single-phase AC power in order to compensate for the momentary power failure and outputs the converted single-phase AC power, the transformer 125 boosts or reduces the output single-phase AC power of the inverter 124 to the necessary single-phase AC power and supplies the boosted or reduced single-phase AC power to the three-phase servo
10 driver 10 through the R phase power line on which the second power cutoff switch 121 is installed. Thereby, the three-phase servo driver 10 converts the input single-phase AC power into the different three-phase AC power required on the load side and outputs the converted three-phase AC power.

Thus, even in the situation of the momentary power failure, the three-phase
15 servo driver 10 is normally operated to supply the three-phase AC power required on the load side such as the three-phase servo motor M to the load side.

Here, a diode bridge rectifier included in the converter 11 of the three-phase servo driver 10 operates only a diode pair made up of two diodes connected to the R phase power line, rectifies the input single-phase AC power into pulsating current
20 power.

The pulsating current power is converted into necessary DC power by a smoothing capacitor installed on an output side of the diode bridge rectifier, and is applied to the inverter 12. The inverter 12 converts the input DC power into different three-phase AC power required on the load side, and supplies the converted
25 three-phase AC power to the load side.

In this way, when the momentary power failure is resolved while the three-phase servo driver 10 is normally operated in the situation of the momentary power failure and supplies the three-phase AC power required on the load side such as the three-phase servo motor M to the load side, the controller 122 of the single-phase voltage sag protector 120 interrupts the output of the preliminary power supply drive control signal and stops the operation of the inverter 124, thereby interrupting the single-phase AC power supplied to the three-phase servo driver 10 through the transformer 125.

Further, the controller 122 of the single-phase voltage sag protector 120 switches on the second power cutoff switch 121 that has been switched off again, and supplies the three-phase AC power input from the external power supply to the three-phase servo driver 10. Thereby, the three-phase servo driver 10 converts the input three-phase AC power into different three-phase AC power required on the load side, and outputs the converted three-phase AC power.

However, for a time from immediately after the momentary power failure is resolved as described above to when the second power cutoff switch 121 that has been switched off is switched on again, a phenomenon in which phases of the respective phase powers input to the three-phase servo driver 10 through the R, S, and T phase power lines connecting the external power supply from which the three-phase AC power is input and the three-phase servo driver 10 are different from one another momentarily takes place.

Actually, for a time from immediately after the momentary power failure is resolved as described above to when the second power cutoff switch 121 that has been switched off is switched on again, the single-phase AC power output from the single-phase voltage sag protector 120 is supplied to the three-phase servo driver 10

through the R phase power line connected to the three-phase servo driver 10. Further, the S phase AC power of the three-phase AC power input from the external power supply is supplied to the three-phase servo driver 10 through the S phase power line, and the T phase AC power of the three-phase AC power input from the external power supply is supplied to the three-phase servo driver 10 through the T phase power line.

Thus, a phase of the output single-phase AC power of the single-phase voltage sag protector 120 which is input to the three-phase servo driver 10 through the R phase power line for such a time is different from that of the R phase AC power of the three-phase AC power input from the external power supply from immediately after the momentary power failure is resolved. Otherwise, a phase difference between the output single-phase AC power of the single-phase voltage sag protector 120 and the S or T phase AC power of the three-phase AC power input from the external power supply from immediately after the momentary power failure is resolved does not have a normal difference of 120 degrees. For this reason, a surge phenomenon in which current or voltage is momentarily increased immediately after the second power cutoff switch 121 is switched on again takes place to electrically exert a negative influence on the three-phase servo driver 10.

In conclusion, when only the second power cutoff switch 121 of the single-phase voltage sag protector 120 is installed on the R phase power line, and the first power cutoff switch 110 is not installed on the S phase power line, the electrical connection between the external power supply from which the three-phase AC power is input and the three-phase servo driver 10 is completely interrupted and fails to maintain an insulated state. As such, such a surge phenomenon takes place, and electrically exerts a negative influence on the three-phase servo driver 10.

Therefore, the voltage sag protector 100 for a three-phase servo driver according to the present invention uses the first power cutoff switch 110 and the second power cutoff switch 121 of the single-phase voltage sag protector 120 to interrupt the electrical connection between the external power supply from which the three-phase AC power is input and the three-phase servo driver 10, thereby resolving a problem that the surge phenomenon takes place to electrically exert a negative influence on the three-phase servo driver 10.

FIG. 4 illustrates a state in which the second power cutoff switch 121 of the single-phase voltage sag protector 120 is installed on the R phase power line among the R, S, and T phase power lines along which the three-phase AC power is input, and the first power cutoff switch 110 is installed on the S phase power line.

The three external power lines, i.e. the R, S, and T phase power lines, along which the three-phase AC power is input are connected in a delta type as shown in FIG. 4(a) or in a star type as shown in FIG. 4(b). In this case, when the second power cutoff switch 121 is switched off, the R phase power line is completely electrically disconnected from the three-phase servo driver 10, and is kept insulated. When the first power cutoff switch 110 is switched off, the remaining S and T phase power lines are completely electrically disconnected from the three-phase servo driver 10, and are kept insulated.

In the state as shown in FIG. 4, when the momentary power failure occurs at the external power supply from which the three-phase AC power is input due to a short circuit on a power system or a lightning strike, the controller 122 of the single-phase voltage sag protector 120 switches off the first and second power cutoff switches 110 and 121 together and simultaneously outputs the preliminary power supply drive control signal.

Subsequently, when the inverter 124 converts the preliminary DC power which the preliminary power supply 123 outputs into the necessary single-phase AC power in order to compensate the momentary power failure and outputs the converted single-phase AC power, the transformer 125 boosts or reduces the output
5 single-phase AC power of the inverter 124 to the necessary single-phase AC power and supplies the boosted or reduced single-phase AC power to the three-phase servo driver 10 through the R phase power line on which the second power cutoff switch 121 is installed. Thereby, the three-phase servo driver 10 converts the input single-phase AC power into the different three-phase AC power required on the load side
10 and outputs the converted three-phase AC power.

Thus, even in the situation of a momentary power failure, the three-phase servo driver 10 is normally operated to supply the three-phase AC power required on the load side such as the three-phase servo motor M to the load side.

Here, a diode bridge rectifier included in the converter 11 of the three-phase
15 servo driver 10 operates only a diode pair made up of two diodes connected to the R phase power line, rectifies the input single-phase AC power into pulsating current power.

The pulsating current power is converted into necessary DC power by a smoothing capacitor installed on an output side of the diode bridge rectifier, and is
20 applied to the inverter 12. The inverter 12 converts the input DC power into different three-phase AC power required on the load side, and supplies the converted three-phase AC power to the load side.

In this way, when the momentary power failure is resolved while the three-phase servo driver 10 is normally operated in the situation of the momentary power
25 failure and supplies the three-phase AC power required on the load side such as the

three-phase servo motor M to the load side, the controller 122 of the single-phase voltage sag protector 120 interrupts the output of the preliminary power supply drive control signal and stops the operation of the inverter 124, thereby interrupting the single-phase AC power supplied to the three-phase servo driver 10 through the
5 transformer 125.

Further, the controller 122 of the single-phase voltage sag protector 120 switches on the first and second power cutoff switches 110 and 121 that have been switched off together again, and supplies the three-phase AC power input from the external power supply to the three-phase servo driver 10. Thereby, the three-phase
10 servo driver 10 converts the input three-phase AC power into different three-phase AC power required on the load side, and outputs the converted three-phase AC power.

However, for a time from immediately after the momentary power failure is resolved as described above to when the first and second power cutoff switches 110
15 and 121 that have been switched off are switched on together again, the single-phase AC power output from the single-phase voltage sag protector 120 is supplied to the three-phase servo driver 10 only through the R phase power line connected to the three-phase servo driver 10.

Further, the R, S, and T phase AC powers of the three-phase AC power input
20 from the external power supply are supplied to the three-phase servo driver 10 through the R, S, and T phase power lines connected to the three-phase servo driver 10 from immediately after the first and second power cutoff switches 110 and 121 that have been switched off are switched on together again.

Thus, the R, S, and T phase AC powers of the three-phase AC power supplied
25 to the three-phase servo driver 10 have a normal phase difference of 120 degrees. As

such, a surge phenomenon in which current or voltage is momentarily increased immediately after the first and second power cutoff switches 110 and 121 are switched on again does not take place, so that a negative influence is not electrically exerted on the three-phase servo driver 10.

5 It is apparent that the aforementioned voltage sag protector for a three-phase servo driver according to the present invention is not limited to the aforementioned embodiments, but various modifications thereof may be made without departing from the gist of the present invention. Thus, it is intended that the present invention covers all such modifications provided they come within the scope of the appended
10 claims and their equivalents.

【CLAIMS】

1. A voltage sag protector for a three-phase servo driver comprising:
 - a first power cutoff switch (110) that is installed on any one of R, S, and T
5 phase power lines connecting an external power supply from which three-phase
alternating current (AC) power is input and the three-phase servo driver (10), is
switched on before a momentary power failure occurs, and is switched off when the
momentary power failure occurs so as to interrupt the electrical connection between
the external power supply from which the three-phase AC power is input and the
10 three-phase servo driver (10); and
 - a single-phase voltage sag protector (120) having:
 - a second power cutoff switch (121) that is installed either on the S phase
power line when the first power cutoff switch (110) is installed on the R or T phase
power line or on the R or T phase power line when the first power cutoff switch
15 (110) is installed on the S phase power line, is switched on along with the first power
cutoff switch (110) before the momentary power failure occurs, and is switched off
along with the first power cutoff switch (110) when the momentary power failure
occurs so as to interrupt the electrical connection between the external power supply
from which the three-phase AC power is input and the three-phase servo driver (10);
 - 20 a controller (122) that switches on the first and second power cutoff
switches (110 and 121) together before the momentary power failure occurs,
switches off the first and second power cutoff switches (110 and 121) together when
the momentary power failure occurs, and simultaneously outputs a preliminary
power supply drive control signal;

an inverter (124) that converts preliminary direct current (DC) power which a preliminary power supply (123) outputs into necessary single-phase AC power in order to compensate for the momentary power failure when the preliminary power supply drive control signal of the controller (122) is input; and

5 a transformer (125) that boosts or reduces the single-phase AC power which the inverter (124) outputs to necessary single-phase AC power, supplies the boosted or reduced single-phase AC power to the three-phase servo driver (10) via the power line on which the second power cutoff switch (121) is installed, and thereby causes the three-phase servo driver (10) to convert the input single-phase AC

10 power into different three-phase AC power required on a load side and to output the converted three-phase AC power.

2. The voltage sag protector of claim 1, wherein, when the momentary power failure is resolved, the controller (122) of the single-phase voltage sag protector

15 (120) interrupts the output of the preliminary power supply drive control signal, stops an operation of the inverter (124) to thereby interrupt the single-phase AC power supplied to the three-phase servo driver (10) via the transformer (125), switches on the first and second power cutoff switches (110 and 121) that have been switched off together again, supplies the three-phase AC power which is input from the external

20 power supply to the three-phase servo driver (10) to thereby cause the three-phase servo driver (10) to convert the input three-phase AC power into the different three-phase AC power required on the load side and to output the converted three-phase AC power.

3. The voltage sag protector of claim 1, wherein the controller (122) of the single-phase voltage sag protector (120) simultaneously switches on or off the first and second power cutoff switches (110 and 121).