WHAT IS CLAIMED IS:

1. A short circuit detection circuit for a multi-phase rectifier, the multi-phase rectifier having a plurality of bridges connected in parallel, each bridge having two rectifying elements connected in series and a phase signal point (PSP) configured between the two rectifying elements, each PSP receiving an alternating current (AC) signal, each AC signal having a same frequency, the multi-phase rectifier rectifying the AC signals to output a full-wave rectified (FWR) signal, and the short circuit detection circuit comprising:

a spectrum analyzing unit, receiving the FWR signal and analyzing a spectrum of the FWR signal in the frequency domain based on the same frequency of the AC signals to generate a detected signal indicating an amplitude of the same frequency of the AC signals; and

a determination unit, electrically connected to the spectrum analyzing unit and receiving the detected signal and a reference signal to determine whether the detected signal is greater than or equal to the reference signal;

wherein when the determination unit determines that the detected signal is greater than or equal to the reference signal, the determination unit outputs a result signal indicating that a short circuit condition exists among one of the rectifier elements within the bridges.

2. The short circuit detection circuit according to claim 1, wherein when the determination unit determines that the detected signal is less than the reference signal, the determination unit outputs no signal.

3. The short circuit detection circuit according to claim 1, wherein the spectrum

analyzing unit comprises:

an analog-to-digital (AD) converter, receiving the FWR signal and digitizing the FWR signal to generate a digital FWR signal;

a spectrum calculator, electrically connected to the AD converter and calculating the spectrum of the digital FWR signal in the frequency domain; and

a frequency selector, electrically connected to the spectrum calculator and selecting the same frequency of the AC signals in the spectrum of the FWR signal to output the detected signal.

4. The short circuit detection circuit according to claim 3, wherein the frequency selector selects the same frequency of the AC signals in the spectrum of the FWR signal according to one of the AC signals.

5. The short circuit detection circuit according to claim 1, wherein the spectrum analyzing unit comprises:

a frequency selector, generating a select signal indicating the same frequency of the AC signals according to one of the AC signals;

an AD converter, receiving the FWR signal and digitizing the FWR signal to generate a digital FWR signal; and

a digital filter, electrically connected to the frequency selector and the AD converter, filtering the digital FWR signal based on the select signal to output the detected signal.

6. The short circuit detection circuit according to claim 1, wherein the spectrum analyzing unit comprises:

a frequency selector, generating a select signal indicating the same frequency

of the AC signals according to one of the AC signals; and

an analog filter, electrically connected to the frequency selector, receiving the FWR signal and the select signal, and filtering the FWR signal based on the select signal to output the detected signal.

7. The short circuit detection circuit according to claim 6, wherein the determination unit is an operational amplifier (op-amp) having a non-inverting end, an inverting end, and an output end, wherein the non-inverting end receives the detected signal, the inverting end receives the reference signal, and the output end outputs the result signal according to the detected signal and the reference signal.

8. The short circuit detection circuit according to claim 1, wherein the multi-phase rectifier includes a three-phase rectifier, the three-phase rectifier has three bridges connected in parallel, each bridge has two rectifying elements connected in series and the PSP is configured between the two rectifying elements, each PSP receives the AC signal having the same frequency, and the three-phase rectifier rectifies the AC signals to output the FWR signal.

9. The short circuit detection circuit according to claim 8, wherein the AC signals are generated by a first stator winding, a second stator winding, and a third stator winding, respectively, wherein one end of the first stator winding, one end of the second stator winding, and one end of the third stator winding are electrically connected with each other, and another end of the first stator winding, another end of the second stator winding, and another end of the third stator winding are respectively connected to the PSP of the corresponding bridges.

10. The short circuit detection circuit according to claim 1, wherein the short

circuit detection circuit is configured in one of an alternator and an integrated starter generator (ISG), and the same frequency of the AC signals is calculated by an equation:

$$\omega = RPM_{alt} * \#pole\ pairs/60$$

wherein ω is the same frequency of the AC signals, RPM_{alt} is an operational speed of the alternator or the ISG, and #pole pairs is a number of pole pairs in the alternator or the ISG.

11. A short circuit detection method for a multi-phase rectifier rectifying AC signals to output a full-wave rectified (FWR) signal, the short circuit detection method comprising:

receiving the FWR signal and analyzing a spectrum of the FWR signal in a frequency domain based on a same frequency of the AC signals to generate a detected signal indicating an amplitude of the same frequency of the AC signals; and

receiving the detected signal and a reference signal to determine whether the detected signal is greater than or equal to the reference signal;

wherein when the detected signal is greater than or equal to the reference signal, outputting a result signal indicating that a short circuit condition exists in the multi-phase rectifier.

12. The short circuit detection method according to claim 11, wherein when the detected signal is less than the reference signal, no signal is outputted.

13. The short circuit detection method according to claim 11, wherein the step after receiving the FWR signal, further comprises:

digitizing the FWR signal to generate a digital FWR signal;

calculating the spectrum of the digital FWR signal in the frequency domain; and

selecting the same frequency of the AC signals in the spectrum of the FWR signal to output the detected signal.

14. The short circuit detection method according to claim 13, wherein the same frequency of the AC signals in the spectrum of the FWR signal is selected according to one of the AC signals.

15. The short circuit detection method according to claim 11, wherein the step after receiving the FWR signal, further comprises:

generating a select signal according to one of the AC signals;

digitalizing the FWR signal to generate a digital FWR signal; and

filtering the digital FWR signal based on the select signal to output the detected signal.

16. The short circuit detection method according to claim 11, wherein the step after receiving the FWR signal, further comprises:

generating a select signal according to one of the AC signals;

filtering the FWR signal based on the select signal to output the detected signal.

17. The short circuit detection method according to claim 11, wherein the multi-phase rectifier includes a three-phase rectifier receiving and rectifying three AC signals, each AC signal has the same frequency, the three-phase rectifier has three bridges connected in parallel, each bridge has two rectifying elements connected

in series and a phase signal point (PSP) configured between the two rectifying elements, and each PSP receives one of the three AC signals.

18. The short circuit detection method according to claim 17, wherein the AC signals are generated by a first stator winding, a second stator winding, and a third stator winding, respectively, wherein one end of the first stator winding, one end of the second stator winding, and one end of the third stator winding are electrically connected with each other, and another end of the first stator winding, another end of the second stator winding, and another end of the third stator winding are respectively connected to the PSP of the corresponding bridges.

19. A short circuit detection circuit for a multi-phase rectifier rectifying AC signals to output a full-wave rectified (FWR) signal, the short circuit detection circuit comprising:

an analyzing unit, receiving the FWR signal and analyzing a spectrum of the FWR signal in the frequency domain based on a same frequency of the AC signals to generate a detected signal indicating an amplitude of the same frequency of the AC signals; and

a determination unit, electrically connected to the analyzing unit and comparing the detected signal with a reference signal to determine whether the multi-phase rectifier has a short circuit condition.

20. The short circuit detection circuit according to claim 19, wherein when the determination unit determines that the detected signal is greater than or equal to the reference signal, the determination unit outputs a result signal indicating that the multi-phase rectifier has a short circuit condition, and when the determination unit determines that the detected signal is less than the reference signal, the

determination unit outputs no signal.