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A new topology and control method for electromagnetic transmitter power supplies

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As essential equipment for electromagnetic exploration, electromagnetic transmitter reverse the steady power supply with desired frequency and transmit the power through grounding electrodes. To obtain effective geophysical data during deep exploration, the transmitter needs to be high-voltage, high-current, with high-accuracy output, and yet compact and light. The researches on the power supply technologies for high-voltage high-power electromagnetic transmitter is of significant importance to the deep geophysical explorations. Therefore, the performance of electromagnetic transmitter is mainly subject to the following two aspects: the performance of emission current and voltage, and the power density. These requirements bring technical difficulties to the development of power supplies. Conventionally, high-frequency switching power supplies are applied in the design of a high-power transmitter power supply. However, the structure of the topology is complicate, which may reduce the controllability of the output voltage and the reliability of the system. Without power factor control, the power factor of the structure is relatively low. Moreover high switching frequency causes high loss.

With the development of the PWM (pulse width modulation) technique, its merits of simple structure, low loss, convenient control and unit power factor have made it popular in electrical energy feedback, active filter, and power factor compensation. Studies have shown that using PWM converters and space vector modulation have become the trend in designing transmitter power supply. However, the earth load exhibits different impedances at different frequencies. Thus ensuing high-accuracy and a stable output from a transmitter power supply in harsh environment has become a key topic in the design of geophysical exploration instruments.

Based on SVPWM technology, an electromagnetic transmitter power supply has been designed and its control strategy has been studied. The transmitting system is composed of power supply, SVPWM converter, and power inverter units. The functions of the units are as follows: (1) power supply: a generator providing power with three phase; (2) SVPWM converter: convert AC to DC output; (3) power inverter unit: the inverter is used to convert DC to AC output whose frequency, amplitude and waveform are variable.

In the SVPWM technique, the active current and the reactive current are controlled separately, and each variable is analyzed individually, thus the power factor of the system is improved. Through controlling the PWM converter at the generation side, we can get any power factor. Usually the power factor of the generation side is set to 1.

Finally, simulation and experimental results validate both the correctness of the established model and the effectiveness of the control method. We can acquire unity power factor for the input and steady current for the output. They also demonstrated that the electromagnetic transmitter power supply designed in this study can meet the practical needs of field geological exploration. We can improve the utilization of the transmitter system.