

Design of Switch Mode Power Supply for ESP

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Abstract: In this paper we describe the design of Switch Mode Power Supply for Electrostatics Precipitator. The Supply can work at any point in the square area of 80kv-1000mA. It has several Working Modes, such as Spark-Rate, Pulse, Approach Back Corona etc.

Keywords: ESP, Switch Mode Power, IGBT, DSP

1 INTRODUCTION

As the emission standard goes strict, the traditional SCR power supply for ESP is not available for a few emission field. People are looking for the solution which can decrease the ripple of secondary voltage. The fashion method is three phase SCR and switch mode. But three phase has a weakness, its spark energy is strong than the single phase SCR system. So we choose the second method, it can decrease the ripple efficiently and the spark energy is small than the other power supply.

2 WORKING PRINCIPLE

The system principle shows in Fig. 1. AC input is rectified to DC, then transform a high frequency AC by the inverter, the transformer boost the voltage and then the double voltage rectify circuit obtain a high voltage source to the ESP.

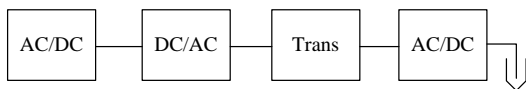


Fig. 1 Working Principle

3 ELECTRIC TOPOLOGY

In this Figure we can know three phase 380 V AC input than rectify to a 530 V DC, then across a big DC inductance supply to the DS BUS. Fig. 2 is the DC BUS section scheme.

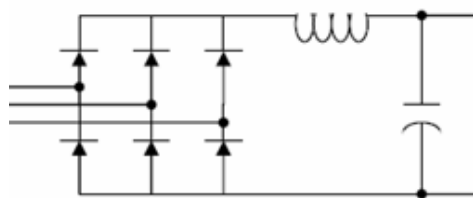


Fig. 2 DC BUS Section

Designing of DC BUS need decrease the stray inductance as low as possible. The relation of overshoot voltage and stray inductance show in equation (1).

$$V_{overshoot} = L_{stray} \times \frac{di}{dt} \tag{1}$$

The voltage of the IGBT CE pole is calculate by the equation (2).

$$V_{CE} = V_{overshoot} + V_{DC-link} \tag{2}$$

If the V_{CE} is over the maxim rating of IGBT, it will damage the IGBT permanent.

We can decrease the stray inductance by optimize the structure of the DC BUS. Fig. 3 is the photo of DC BUS in our design.

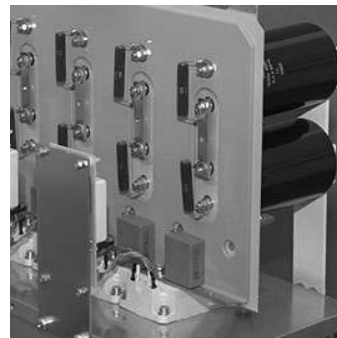


Fig. 3 Photo of DC BUS

We use the leakage of the transformer, lead to a serial resonant. Serial capacitor is the most important component in the system. The rating volt need high than 4000 V, it is very important. Heat sink we use the cycle liquid. Fig. 4 shows the full bridge invert and serial resonant.

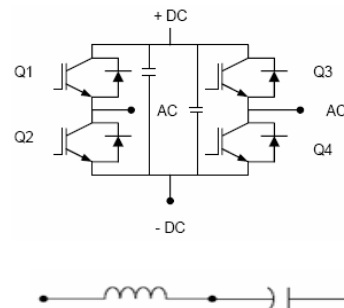


Fig. 4 Full bridge invert and serial resonant

The transformer design should notice the frequency of iron core. The exothermal degree is very important should less than Curie temperature.

The coil should choose the cable little skin effect. Clutch gold or excitation cable is good decision.

The high volt rectified circuit, we choose double volt rectified structure. Fig. 5 is the schematic diagram.

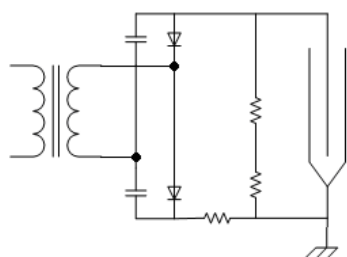


Fig. 5 Double volt rectified circuit

4 CONTROL SYSTEM

The control core CPU choose the product of Texas Instrument(TI). We use the 5.7 inch 320-240 dot touch panel LCD as the human machine interface. The communication interface choose the Controller Area Net (CAN), it is very popular in the automobile area. The baud of it reach up to 1 M@ 1 Km.

The output control is volt and current double close loop. The control arithmetic is simple fuzzy method. The spark respond is very quickly, less than 10us, and the time recharge to ESP is less than 1ms, so the average volt is higher than the other power supply.

5 TEST CURVE

Fig. 6 show the secondary voltage and current wave in the rating output. We can know the output is very smooth. And the ripple is very slow. It will help rise the average secondary volt and output more power to the ESP.

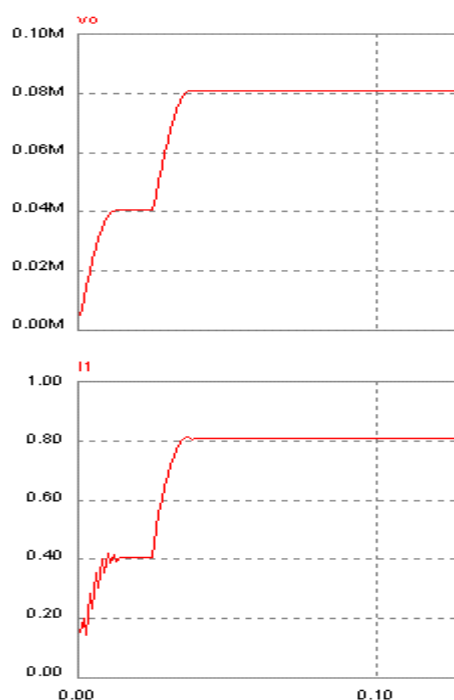


Fig. 6 The output wave of secondary volt and current

6 AUXILIARY FUNCTION

The control integrate the simple oscillator function. This is useful to the field engineer. It has 5 M Sample Rate, and draw high solution real time wave of secondary volt and current. Also it can provide the wave before fault as long as 1 minute. It will help engineer to solve many field fault.

The rapper can be combined with the power supply, so we can power control rapper. This is very useful to clean the electrode and decrease the time of rap.

Opacity optimize is another function in the system, the opacity meter is connect to the power supply, it can control to the opacity to the set value to save the power consumption.

7 CONCLUSIONS

This power supply can working at any point in the square area of 80 kV-1000mA. The plentiful auxiliary function will increase its competitive strength. It will play important pole in the ESP power supply.