

## DC-DC Converter for IGBT, SiC and GaN Devices

*In recent years, the growth rate of high power converter/inverter market demand is more than 5% per year. In 2020, the global market capacity is expected to reach \$50 billion.*

*As the most mainstream power device applicable in the system, IGBT is accounting 80% of it, which is 4 billion US dollars. IGBTs are widely used in various industries including industrial control, telecommunications, rail transit, renewable energy, automotive electronics, smart grids, etc. With the revolution and rapid development in the automotive electronics and PV inverter industries, the emerging power devices such as SiC MOSFET and GaN transistor are expected to reach \$1 billion by 2020. After that, the compound growth rate of the new power devices will exceed 30% with the advantages of higher operating frequency, better temperature performance, higher power density and reasonable cost.*

*While the power devices is in the process of iteration, the control mode of them is always the same, which is having a drive circuit to manage them. Many engineers know it but they haven't realized the importance of the DC-DC power supply for the drive circuit. And we will introduce the key features of it in the following paragraph.*

### Isolation capacitor/ Transient load response

As we know, high working frequency is one of the development directions of power converters. Therefore, the isolation capacitor between the primary and secondary of the DC-DC power supply should be as small as possible to accommodate the high frequency application, which making the transformer of the DC-DC is more difficult to be designed. At present, the proper isolation capacitor of DC-DC power supply for drive circuit is between 3-10pF.

In terms of power, a 100A IGBT requests about 3.5W from the DC-DC. The power can be calculated by the following formulas:

$$I_g = Q_g \times f$$

$$P_g = (V_{CC} - V_{EE}) \times I_g$$

$I_g$ : The average value of IGBT gate current;

$V_{CC}$ : High voltage of the drive circuit ( Positive output of the DC-DC ) ;

$V_{EE}$ : Low voltage of the drive circuit ( Negative output of the DC-DC ) ;

$Q_g$ : Gate charge, which can be obtained from the technical manual of the IGBT.

In the operation, the peak power of the DC-DC could reach 10W. In order to prevent the transient spike current from damaging the DC-DC, the dynamic load

performance needs to be concerned in the component selection and circuit design stages accordingly. And, the capacitor at the output of the DC-DC should be chosen with low ESR to ensure enough drive current for the power devices.

### Proper offset output voltage

To enhance the current control ability, it tends to set a higher voltage for the power device. Taking IGBT as an example, the gate withstand voltage is generally 20V which is limited by the production process. Therefore, most engineers design the DC-DC power supply with about 15V output for reliability purpose. However, sometimes the power devices cannot be precisely controlled due to the existence of voltage losses on the layout. To solve that problem, it is recommended to have a adjustable output voltage of the DC-DC power supply or simply make it higher. The turn-on and turn-off voltages of the power devices are not identical. At present, +15/-6~-10 IGBT, +20/-4 SiC, +6/-3 GaN are the recommended DC-DC output for different device features. The asymmetrical output voltages ensure optimum drive performance and EMI. The negative output is common for rapidly turning-off the power device and maintain the off state without mistakes.

### High isolation

To avoid common mode interference and eliminate safety risks, the DC-DC power supply of the respective power devices must be isolated from each other. And it is more recommend to use separated DC-DC power supply for each power device in the system but not different output windings in the single one DC-DC.

From the application scenarios side, we have low-voltage (600-1200V) commercial applications such as medical equipment, telecommunication, solid-state lighting, etc. For medium voltage (1200-1700V) industrial applications we have UPS, photovoltaic inverter, motor drive, etc. And wind power generation, high voltage / UHV power transmission & transformation which are in high voltage (2500 -6500V) power applications.

Typical isolation voltage of the DC-DC is at least the twice of the long-term operating voltage in the system. Therefore, compared to conventional DC-DC power supply, reinforced insulation and high isolation voltage are the distinguishing features of the DC-DC in the power device drive circuit.

### Compact size

SiC and GaN devices have received wide attention because of their band-gap width,

high breakdown voltage and high thermal conductivity. The direct advantage of these features is that the power converter system can be reduced by at least 40%. As a companion device, its volume has become an important parameter as well. Currently, push-pull circuits and single-ended flyback topologies have become mainstream solutions.

## EMC

Because of the radiated emission in different systems, the stability of the design is in risk. For DC-DC power supplies, EMC optimization is mainly to improve the emission performance. The interference sources of switching power supply are the switching circuit and the rectifier circuit. Therefore, it is very important to optimize the layout such as increasing the wiring width of the large current loop, avoiding cross wiring, and separating the ground of the DC-DC power supply from the signal ground. Finally, if the shield can be added between the primary and secondary transformers and the shield is grounded, the interference signal from the primary will be greatly reduced.

This article introduced the key features of DC-DC power supplies used in high capacity power converters/inverters. As a professional power supply manufacturer, MORNSUN has a store of experience and unique patent in this area to meet the special requirements. Besides, MORNSUN own 14 highly automatic production lines which ensure the top delivery capacity in the market. For more information of power supply, please look forward to further monograph.