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THE DESIGN OF DC POWER BUS BAR FOR SOLID STATE POWER AMPLIFIER IN NSRRC

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Abstract

The National Synchrotron Radiation Research Center (NSRRC) has developed a 320 kW solid-state amplifier based on an 80 kW solid-state amplifier. In the design of the 80 kW amplifier, the DC power supply and solid-state amplifier racks were separated, with the DC power supply providing power to the solid-state amplifier power terminals through cables. This separation allows the DC power supply rack to be movable and not take up space in the solid-state amplifier rack. However, this design requires additional ground space to accommodate the DC power supply rack and requires significant staff and time to wire the cable connections.

The 320 kW solid-state amplifier incorporates a bus bar design, which significantly reduces wiring space and time while also having a simpler appearance.

INTRODUCTION

Adopting the bus bar design in the 320 kW solid-state amplifier has resulted in significant space and time savings, and the equipment now looks neat and clean. Furthermore, measuring the output current is much easier with the bus bar design with cable wiring. Additionally, maintenance and inspection work in the future will be much simpler and more convenient with the bus bar design.

MOTIVATION

In the design of the 80 kW solid-state amplifier, cable wiring was used to connect the DC power supply and the power input terminal of the solid-state amplifier [1]. Figure 1 shows that the DC power supply rack occupied part of the floor area, and the cable length was long and complex, making it relatively unfriendly for future maintenance and inspection. To address these issues, when building a 320 kW solid-state amplifier, the DC power supply rack was placed above the solid-state amplifier rack and connected by a bus bar to save floor space and simplify wiring. Figure 2 shows that the bus bar design is neater and cleaner compared to the cable routing, and it can also save installation time and make future maintenance and inspection work simpler and more convenient.

RESEARCH METHOD

To maximize the space efficiency, the NSRRC adopted a bus bar wiring design method to minimize the amount of space required for wiring.

When using the bus bar design, it is important to ensure that the bus is capable of withstanding current. In the case of the 320 kW solid-state power amplifier, it consists of four towers, each of which is divided into two parts: left and right. Based on the conversion efficiency of the solid-state power amplifier, which is around 50%, the DC output power of the power supply system on each side can be calculated using Eq. (1), resulting in 80 kW for each side. With the power supply voltage set to 52 V, Eq. (2) can be used to calculate the maximum current on the bus bar, which is approximately 1,538 A. The rating data for the copper bus bar with a size of 120*10 mm indicates that it can withstand a DC current of 2,285 A inside the chassis [2]. Therefore, the bus bar for the 320 kW solid-state amplifier is designed with a size of 120*10 mm to ensure that it can handle the required current.

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Figure 1: The 80 kW solid-state amplifier with two separate power supply racks.

Figure 2: The 320 kW solid-state power amplifier racks.

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$$P_{part} = \frac{\left(\frac{RF\ Power}{4Tower*2Part}\right)}{SSPA\ Efficiency} = 80\ kW \qquad (1)$$

$$C_{Busbar} = \frac{P_{part}}{V_{Busbar}} = 1538\ A. \qquad (2)$$

To save wiring space, the circuit breaker is installed on a positive copper bus bar. The connection between the positive copper bus bar and the circuit breaker also adopts the bus bar design, which saves a significant amount of wiring time and space. This design method is illustrated in Fig. 3.

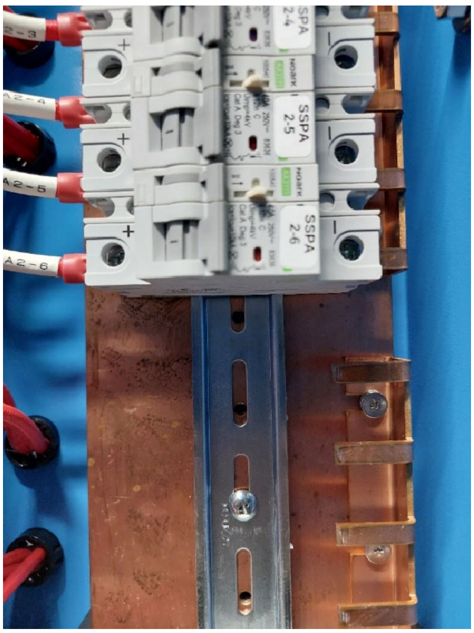

Figure 3: The bus bar integrated circuit breaker design.

The voltage and current of the bus bar are both monitored and displayed on the front panel of the equipment, as shown in Fig. 4. The bus bar current is detected using a hall-effect current transducer with a model of CTG-202HS, and a maximum measurement current value of 2000 A according to the specification, as shown in Fig. 5 [3]. The voltage and current values on the bus bar are displayed using a voltage measurement meter from Trumeter Company with a model of APM-VOLT-ANO, as shown in Fig. 4. The backlight of the meter turns red to remind and warn when the voltage or current exceeds the estimated value [4].

Figure 4: The voltage and current monitors.

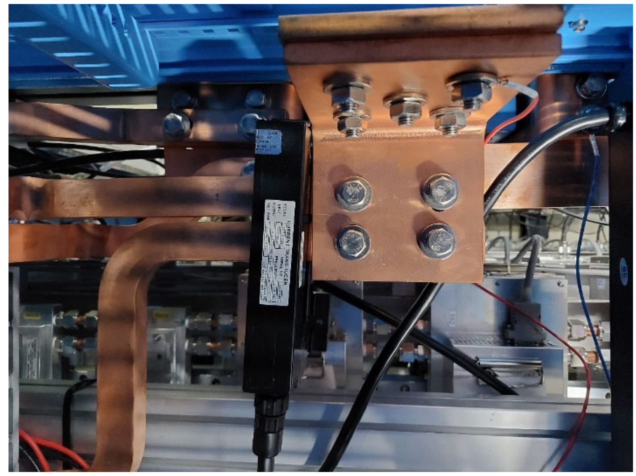

Figure 5: The hall-effect current transducer.

CONCLUSION

The bus bar design greatly reduces the amount of wiring required, saving time and space. This design also simplifies the process of adding, repairing, and replacing the current transducer. The clean and clear wiring makes it easy to visually inspect and identify any problem points. Additionally, this design simplifies future maintenance and repair procedures, making them more convenient.

If you plan to use the bus bar design, it is crucial to have a clear understanding of the available installation space. It is recommended to use simulation software for design and planning to avoid any issues with size and position during installation. Avoid overly complex shapes on the exterior that may not be feasible to produce. Ensure to evaluate the installation method during the design phase to avoid situations in which cannons can be assembled. When using bus bar design, ample time should be dedicated to bus bar shape design and installation planning.

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