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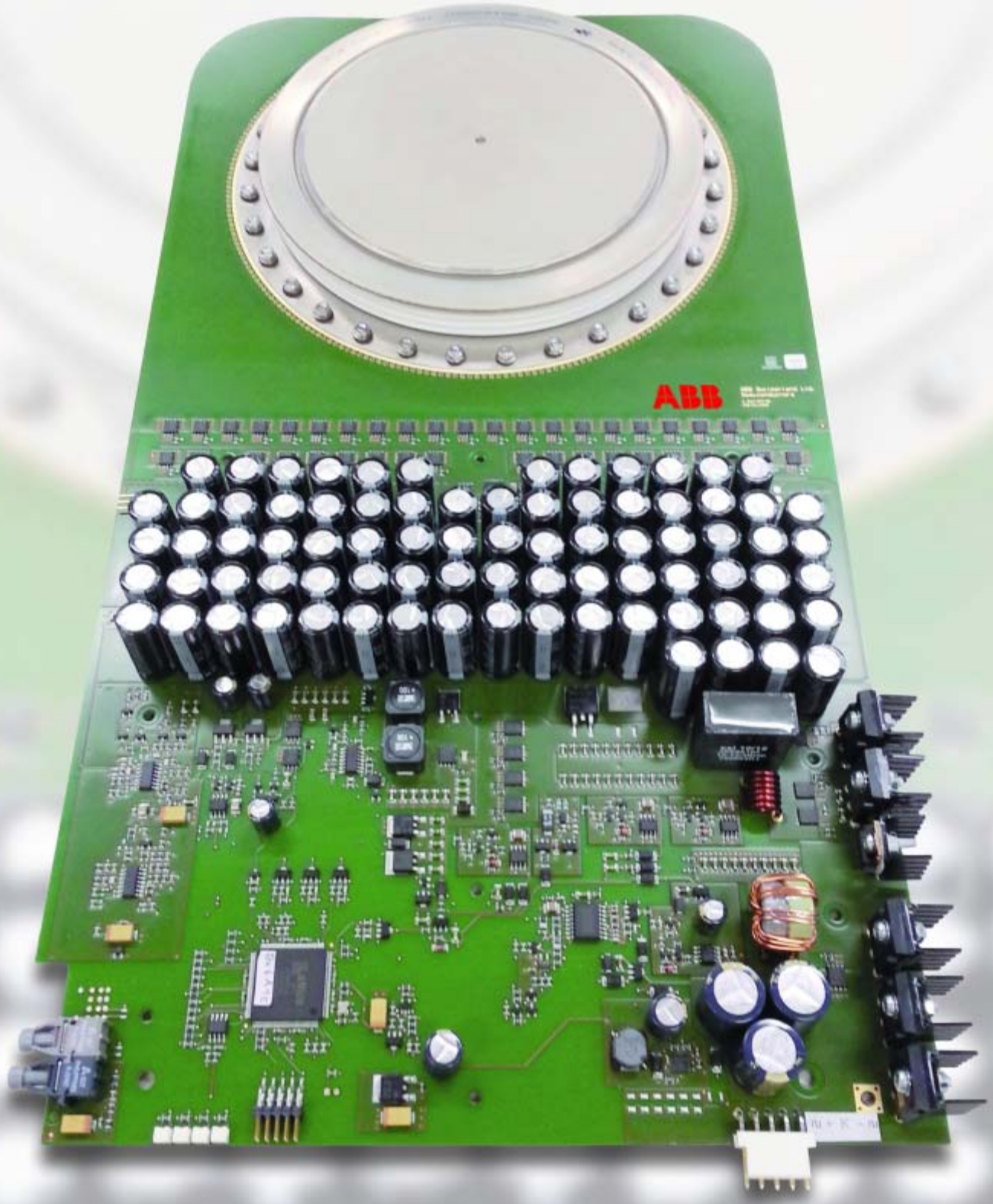

ABB IGCTs: Benchmark Performance with Developments on Many Fronts

Innovative Solution to Connect Stator Main Windings in Rotating Machines via Circular Laminated Busbars.

To cope with the global challenges of competition, the growing needs of electricity and the strengthening of energy efficiency reglementations, rotating machines manufacturers need to optimize their designs and production processes in order to both improve the energy efficiency of their motors and generators and reduce their costs. A major axis to get such competitive advantages lies on the optimization of the stator main windings connection. Since no real industrial alternative has been proposed throughout time to improve this connection, most companies have been still relying on the same historical constructions as their old models of rotating machines. This is to fill this gap and make a technological breakthrough that Mersen has developed a cutting edge solution to connect the stator main windings by integrating a circular laminated busbar.

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Definition and Overview

Mersen circular busbar is a 100% custom electrical interconnection part for motors and generators that substitutes the stator main windings, generally made of a set of cables or coppers bars, by a single customized device. Indeed, the stator windings in rotating machines can be either wire-wound (also called random-wound) or bar-wound (also called form-wound). Thus, the stator main windings also tend to use one of these two options often leading to costly, complex assembly processes with several parts to manage and requiring a large amount of space at the stator end.

The circular busbar system provides a set of benefits targeted to reach an overall lower cost of the rotating machine through the decrease of the assembly time, the avoidance of wiring errors, the stock management of fewer parts, the ability to save space and the improvement of the electrical performances such as low inductance and low voltage drop.

Application field

Taking into account the previous benefits, this results in saying that the more complex the stator main winding system is, the more interesting gains the circular busbar will achieve. That is why this system is the most widely used in three phase induction and synchronous machines present in wind, industrial or transportation applications, with a power starting from a few kVA to several MVA. Indeed, in this case the main winding system will have to ensure at least the connection of all the stator coils for each one of the three phases in order to make the three output phases (U, V, W). Thus, the complexity is directly function of the number of coils to connect per phase. Moreover, the main winding system may have to consider an additional neutral (N) output or to double the three output phases (U1,U2 ; V1,V2 ; W1,W2). This last point depends on the electrical specifications and the requirement to have a star, a delta configuration or to keep the configuration flexible at the terminal box level. Finally, internal coil connections without associated outputs can also be considered and integrated in the circular busbar.

Whether the three phase machine is synchronous or asynchronous does not influence the conception of the circular busbar since the stator remains the same for both of these types, the difference being in the rotor construction. It may be useful to mention that the circular busbar can also fit for DC or single phase machines.

Circular Busbar Characteristics

The circular busbar custom design is based on several electrical standards such as IEC 60950-1, EN 50124-1 and UL840. It is also UL94V0 approved and RoHS compliant.

The choice of the conducting materials depends on the stator design requirements. Most of the time, copper will be chosen for its outstanding electrical and thermal conductivity. However, aluminium conductors can sometimes be preferred because they can offer larger cost savings especially when current is high and gets closer to 1000A. But on the other hand, aluminium is approximately 60% as conductive as copper according to the IACS, requiring larger conductors to carry the same amount of current as copper conductors, and thus taking more space in the stator.

The insulation materials are sized to satisfy most of the rotating machines insulation classes, such as Y, A, E, B, F and H. These classes determine the maximum admissible temperature on the rotating machine windings, and thus on the busbar. For instance, an H insulation class means that the circular busbar should be able to withstand a maximum operating temperature of 180°C. Moreover, information on the rotating machine

environment is important for the best choice of the insulation material. So, the pollution degree or the percentage of humidity will also impact the selection of insulation among a wide range such as PET (polyethylene terephthalate), aramid paper, PEN (polyethylene naphtalate), PVF (polyvinyl fluoride) or PI (polyimide). Epoxy glass or resin can also be used to close the busbar edges. Indeed, these solutions may be preferred in some circumstances, for instance when the available space inside the stator is insufficient to allow an overlap of the insulation material in order to take into account the creepage distance.

Planar Shape *Rolled Shape* *Polygonal Shape*

Figure 1: Overview the circular busbar various shapes

Different shapes can be proposed for the circular busbar to answer at best the rotating machine specifications, in particular for saving the biggest amount of space according to the available space inside the stator. Thus, the optimized busbar can adopt either a planar shape, a rolled shape or also a polygonal one.

The connection between the busbar and the stator is also a critical point in the simplification of the assembly process. Thus, depending on a sharp analysis of the stator parameters such as the section and number of coils, the available space, the stator diameter or the existing assembly process, the coils will be connected to the circular busbar using various ways. Among these solutions we can find tin soldering, silver brazing, special crimping processes or also screwing.

Conclusion:

As world competition and energy efficiency requirements continue to increase, rotating machines manufacturers need to find solutions to decrease their production costs and improve the performance of their motors and generators. Mersen circular laminated busbar is a smart way to achieve this goal, by optimizing the connection of the stator main windings using a single customized device. Such a solution provides the opportunity of a technical breakthrough compared to cables or copper bars solutions, which often require a large amount of space at the stator extremity and rely on costly, time-consuming assembly processes. Indeed, for instance in the case of a three-phase machine of multi-hundreds of kVA, many manufacturing operations are required to achieve a cable-wound stator main connection system. Depending on the manufacturing process, the output leads of the coils that compose the stator will have to be stripped, combined together, soldered or crimped, wrapped with plastic sheaths and eventually with additional tape insulation. Thus, the assembly process rapidly becomes complex and the amount of material such as insulation contributes to the space consumption at the stator end.

Thanks to its optimized shape, the circular busbar is aimed to reach significant cost savings through the simplification of the manufacturing process and the stock management, the improvement of electrical performances, the reduction of the stator space and thus the size of the rotating machine.

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