Laminated bus plate technology revolutionizes energy distribution

Next generation low-voltage switchgear

Energy consumption has already for some time been disrupted by increasingly higher energy demands. Globally, the need for electrical energy is increasing in line with world population growth, industrialization and urbanization. The increase in consumption stems from recently introduced businesses, such as the e-mobility sector, and people using electric cars.

The main challenge is still there, how to distribute the same amount of energy within smaller spaces, in a more efficient way, with lower energy losses. This increases the level of requirements on currently utilized technologies and requires us to look into new ways of how existing products could be redesigned to provide an answer to these well-known challenges.

Energy distribution in low-voltage systems starts with the busbar system, which is defined by horizontal and vertical busbars, from where the energy is further distributed to components. Today, there are new ways to approach making energy distribution more efficient. One of them is laminated bus plate technology. This technology is currently used in ABB's newest low-voltage switchgear NeoGear. NeoGear has unleashed the full potential of this new technology application, the basics of which will be further introduced in this article.

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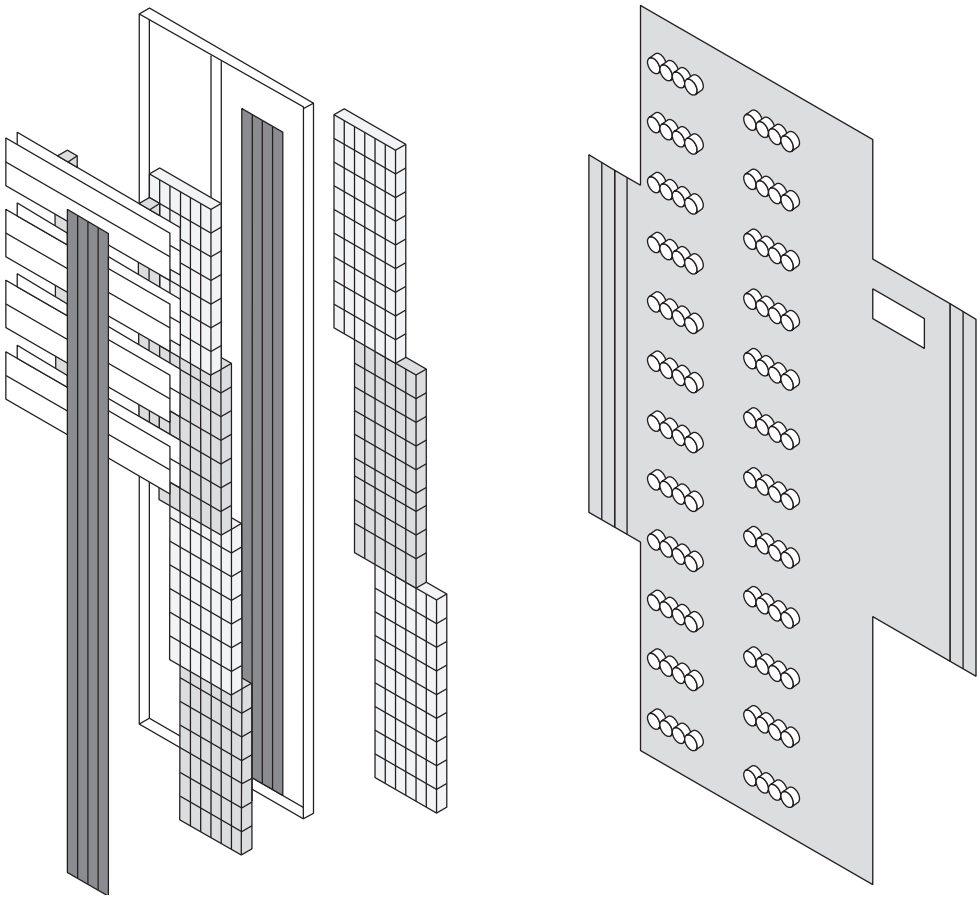
What is laminated bus plate or laminated busbar?

A laminated bus plate (LBP), or laminated busbar (LBB) system, is a composite component consisting of two main materials, copper plates and sheet-molded compound material (SMC).

The copper components have the conductive function and the SMC material has the insulating function. These two components are bonded together in a special technological process, creating a sandwich structure merging the horizontal and vertical distribution busbar functionality into one single component ready for installation into switchgear panels.

In Figure 1, you can see a traditional horizontal and vertical busbar system in low-voltage switchgear, and on the right an example of laminated bus plate. Both have the same functionality.



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Traditional horizontal and vertical busbar system (left) vs. laminated bus plate (right)

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Why are laminated bus plates optimal for energy distribution?

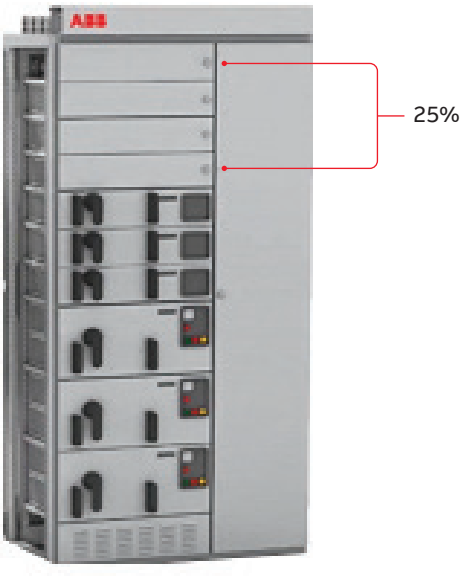
The laminated bus plate provides great improvement in energy distribution. Let’s take an analogy: a train that consists of a locomotive in the front and ten wagons behind it.

The bottleneck here is the connection between the locomotive and the wagons. Even if the locomotive could pull double the amount of the wagons, the connection would break when more than ten wagons are pulled. Now imagine such connection, where you could use the full potential of the locomotive and could even use two locomotives to pull even more than double amount of the wagons. You can consider this connection as the new laminated bus plate.

The current that flows through electrical components generates heat. The force that the wagon connection can withstand, is equivalent to a temperature limit that the IEC standard specifies to the manufacturers. The manufacturers are not allowed to exceed this limit specified by the standard.

Furthermore, imagine also the switchgear’s feeder panel as a locomotive, and a motor control center (MCC) panel as a wagon. The LBP can distribute large amounts of current to large amounts of MCC sections without overheating. With this analogy the LBP is a connection that can pull multiple times more wagons with two or more locomotives.

Laminated technology brings a lot of additional benefits, as it results in less space occupied by the bus plate, compared to a traditional copper busbar system. This opens up more space for modules and their stocking density. The number of modules, which are used for operating end devices, can thus be higher in comparison to a traditional MCC panel with a traditional busbar system.



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Traditional MCC panel using traditional busbar system (left) vs. NeoGear MCC panel using LBP, which has 25% more space for additional modules (right)

Is this laminated bus plate reliable?

The laminated bus plate has been tested in a wide spectrum of electrical tests according to IEC 60664-1 and IEC 61439-(1,2), mechanical and environmental tests according to IEC 60721-3-(1, 2, 3, 6), IEC 60721-4-(1, 2, 3, 6) and IEC 60068-2-(6, 64, 27, 29) and climatic tests according to IEC 60664-1, simulating possible worst-case scenarios in energy distribution.

Even before the LBP was available as a prototype, several numerical simulations on the electrical, as well as the mechanical, behavior were performed. Various basic testing of materials and their applications were also investigated.

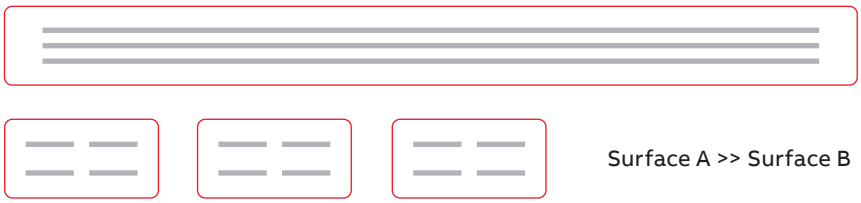
When the first functional prototypes were available, the LBP went through a multitude of various tests, and we were able to verify that the LBP in tests required by the IEC standard were all successfully passed.

Especially testing thermal shocks in a climate chamber followed by impulse testing brought an outstanding result and confirmed, that the laminated bus plate is really a unique component.

Further, we have pilot installations in the field since 2018 in various locations.

What are the physics behind making the lamination so much better?

Compared to a traditional busbar system, the LBP provides a much larger surface, through which it is possible to transfer heat to the surroundings through ambient air see Figure 3.



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Comparison between LBP outer surface and traditional busbar outer surface

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Current density distribution indicated for traditional 2500A busbar cross section

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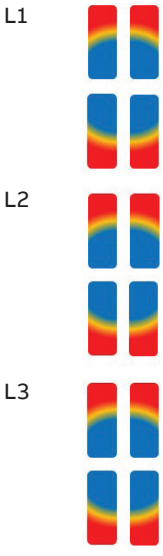
Numerical simulation of inductive heat sources (left) and temperature rise (right)

The performance of the laminated bus plate was reached by numerical simulations and extensive testing. It is commonly understood that the current density is closer to the surface in a standard conductor (see Figure 4), which increases heat generation.



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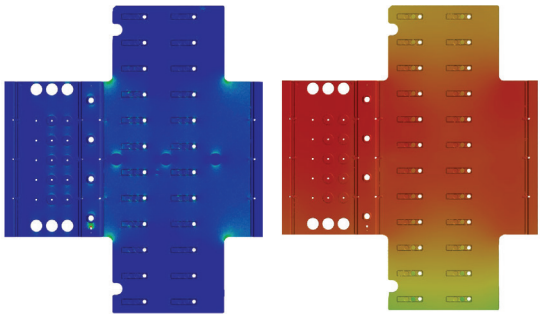
The LBP, on the other hand, is fully able to use the cross-section, by reducing the distances between the phases, the thickness of the conductor and increasing its height.

In this case the skin and proximity effects do not occur and the current is evenly distributed, see Figure 5. Moreover, eddy current losses were reduced by 20 percent with reduced conductor distance in the LBP.



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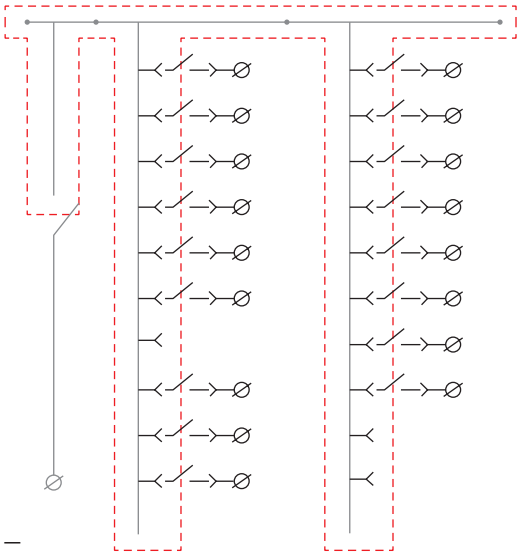
Besides performance benefits are there any other major advantages?

There are many more benefits for the LBP users, such as the fully insulated busbar system by default, classified as an arc-ignition protection zone in accordance with the prerequisites set out by the IEC TR 61641 (ed. 3) chapter 6. The LBP also offers ingress protection IP4x, which means it cannot be penetrated by a solid object of 1.0mm (0.04in.) or more in diameter. In the arc proof design version even IP42, which further means it offers protection against water drops falling vertically over a 15° range.

The LBP is designed in such a way to fulfil the highest demands on safety; keeping operators' hands safe from live parts by utilizing pin guards installed on the connection between modules and LBP in the MCC section. The Contact Guard system is designed to prevent accidentally touching the live part.

All these features allow us to claim that LBP is defined within Arc Ignition Protected Zone (AIPZ) inside the LV switchgear.

Arc Ignition Protected Zone means that an arc will never occur in such a place. Application of AIPZ in ABB's NeoGear low-voltage switchgear is shown in Figure 6.



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Schematically pictured arc ignition protected zone in ABB's NeoGear (1xDC2BP and 2xMCC panels)

Where can the laminated bus plate be used?

The laminated bus plate is applicable basically everywhere where you would like to save space and transfer large currents. Today laminated busbar is used in various fields, for example, in power electronics where it is used by inverters, in aerospace satellite systems, and in electric vehicles. Using the laminated bus plate is also imaginable in other segments, where space and performance play a major role, such as in transportation.

ABB has applied the newly developed LBPs in low-voltage (LV) switchgear to increase safety, space savings, and to achieve larger density of modules, with various sizes, in motor-controlled centers.

Unlocking the value of laminated bus plate

The laminated bus plate was developed to efficiently transport current within LV switchgear.

It combines high capability of transporting high current in a compact size and allows the switchgear manufacturer or panel builder to increase the number, or size, of features that are important to the end user.

This is especially beneficial in motor-controlled centers in LV switchgear, where the size of the modules influences the number of components that fit into it. This means it is directly influencing the functionality of each module and the whole switchgear system. Through its design it offers unique safety features that avoid arc ignition making it the safest switchgear on the market.

Laminated bus plates are utilized in the newly introduced switchgear ABB NeoGear™.

Learn more about laminated bus plate and NeoGear. You can learn more about the behavior of laminated bus plate within this document ("Thermal analysis and design of laminated bus plate based low voltage switchgear").

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