Maximising System Efficiency with the Latest-Generation IGBT Modules

With the recent push from both the wider industry sectors and the Government for high efficiency systems, the semiconductor industry is responding with optimised power electronics focused on increased reliability and operating performance. Dynex has released its latest generation of IGBT and Diode modules that address this challenge, thereby providing customers with state-of-the-art technology for a wide range of purposes.

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In this article we explain how the careful selection of IGBT variants, for different applications and operating conditions, achieves an improvement to overall system efficiency.

Losses in an IGBT module can be broadly classified in to two categories;

1) Conduction
2) Switching

It is well established that, for any given process at a particular voltage, efforts to decrease the conduction losses will result in a compromise in switching losses, and vice versa. As a result of this, no single module, optimised for a particular operation, can provide a one-stop solution for different application requirements across the operating window. Traditionally, semiconductor manufacturers provide one module at any voltage level, optimised to fit many applications, operating under nominal conditions. This approach limits the design flexibility and optimisation from one inverter unit to another and, in some topologies, within a single inverter unit.

Dynex's new products demonstrate how the benefits of offering IGBTs that are optimised for different operating frequencies help increase the overall system efficiency. On a 3-L NPC inverter topology, a significant efficiency improvement is demonstrated by selecting two different modules per phase, in comparison to a single module for all slots.

In the 3L NPC topology, figure 1 right, the IGBTs T1 to T4 contribute to the majority of the losses, followed by the NPC diodes D5 & D6. The losses in D1 to D4 typically contribute to a very low overall share.

The switching losses dominate overall losses of the IGBTs T1 and T4, whereas the conduction losses dominate T2 and T3.

Hence, selecting the high frequency optimised IGBT variant DIM1500ESM33-MF (referred to as MF from here onwards) for T1 and T4, and the conduction optimised DIM1500ESM33-MS (referred to as MS from here onwards) for T2 and T3, provides enhanced overall efficiencies simulated across the frequency spectrum, in comparison to any single IGBT optimised for any individual operation.

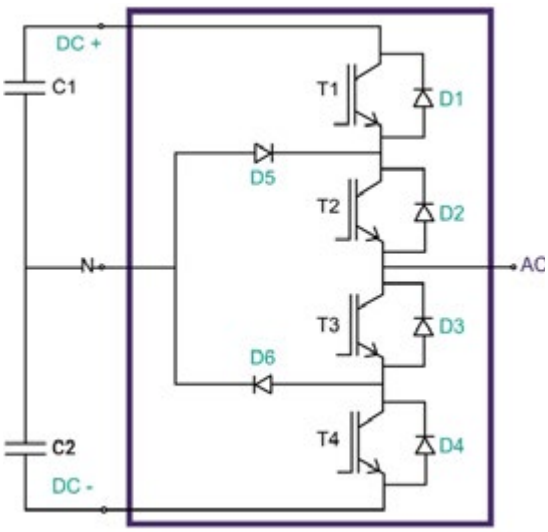

Figure 1: Content of a 3L NPC Phase Leg

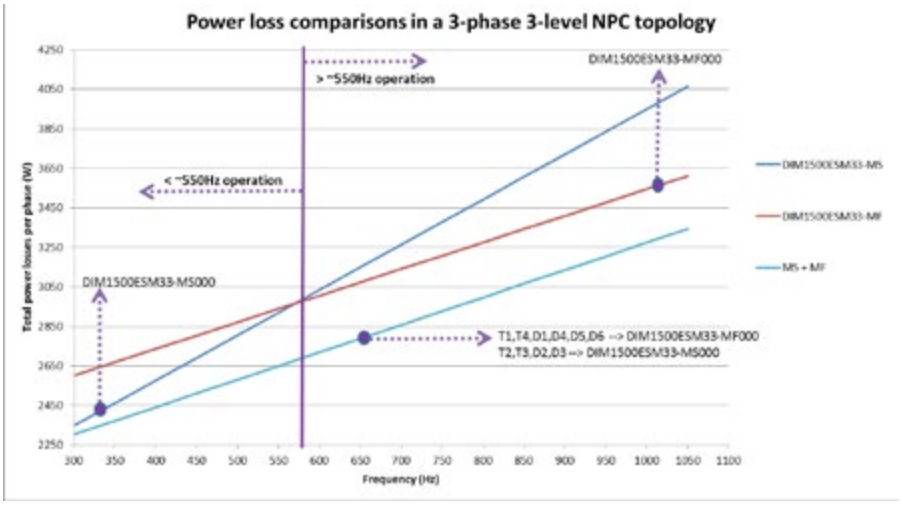

Figure 2a: Semiconductor Power losses per phase (W) Vs. Frequency (Hz) MS vs MF and optimised use of MF + MS

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- The **most robust** module package
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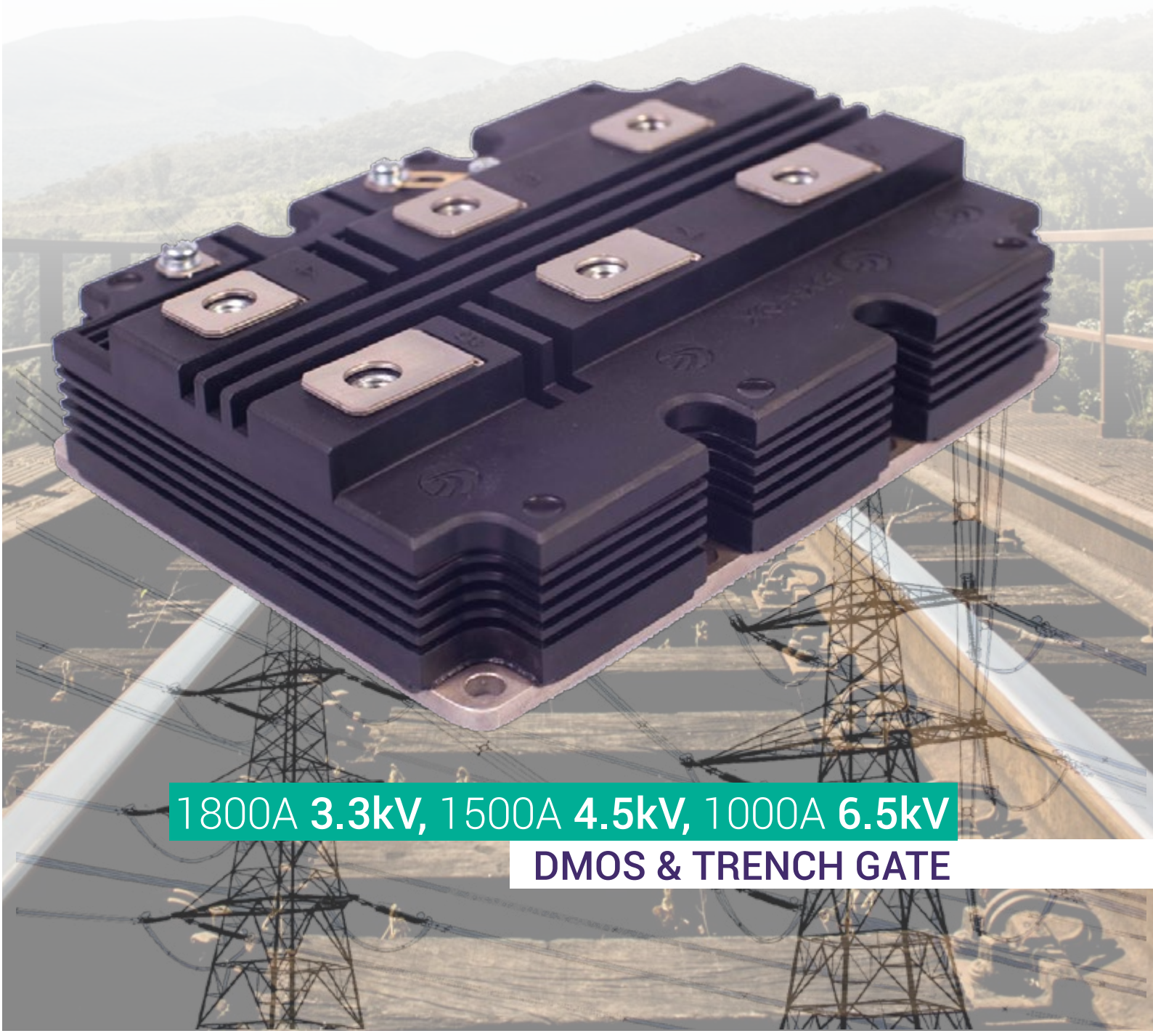

1800A **3.3kV,** 1500A **4.5kV,** 1000A **6.5kV**

DMOS & TRENCH GATE

Figure 2a demonstrates the losses per phase, contrasted between Dynex MS and MF variant modules and the MS + MF optimised combination. For further comparison, figure 2b has overlaid the same data for four competitor modules.

The Dynex IGBT optimised for conduction (DIM1500ESM33-MS) outperforms competitor modules that are designed as average switching & conduction performers, below approximately 550Hz operation. Dynex's switching-optimised variant (DIM1500ESM33-MF) similarly outperforms competitor modules above 550Hz operations, making the MS and MF variants the ideal choices for low and high frequency operation respectively. Carefully combining MS+MF modules further optimises the system performance, showing greater superiority in Dynex IGBT performance versus the established competition.

Clearly, with the ever increasing norms for higher efficiency systems, this demonstrates that designers should consider optimising not just from system to system, but within the different slots of a phase in the system, where relevant.

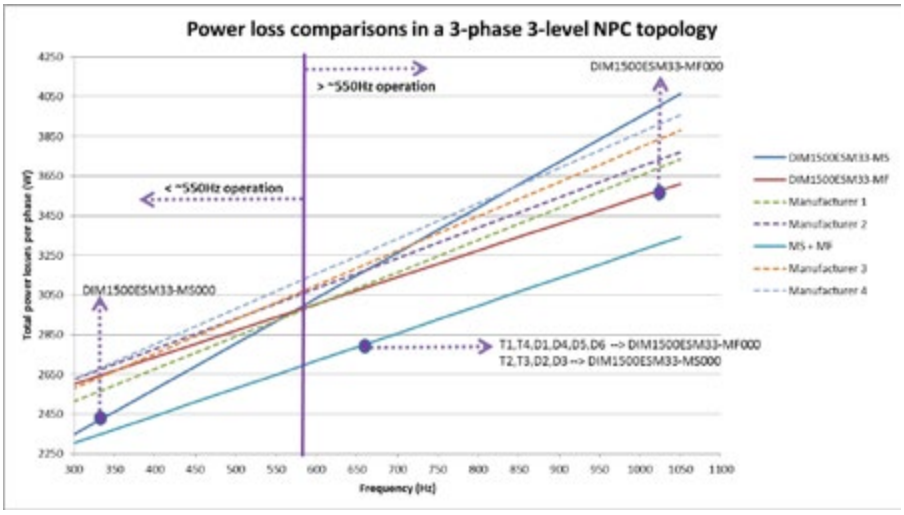

Figure 2b: Comparison of Power Losses using Dynex MS and MF variant modules vs modules from four competitors.

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