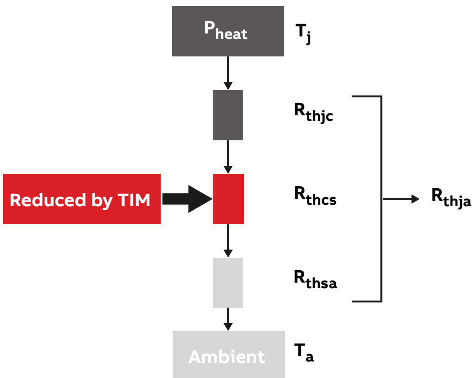
PRODUCT NOTE

LoPak1 module lifetime and performance improved using new Thermal Interface Material (TIM)

Improvements in the lifetime and electrical performance of Hitachi ABB Power Grids' 1700 V LoPak1 modules will be available for orders starting in June 2020, with the introduction of an optional pre-applied thermal interface material (TIM) which is deposited on the outside module base plate surface that contacts the heat sink.

Hitachi ABB Power Grids' LoPak 1.7 kV 450 A IGBT module

Benefits using TIM
The use of the TIM improves the thermal conduction at the module baseplate/heatsink interface ensuring more stability over long-term operation than commonly used conventional heat conductive pastes. It can increase the amount of current that can be safely switched by the IGBT and improve the module's lifetime, since the TIM's thermal resistance does not increase with the number of switching cycles.



Features

- Improves in the average thermal resistance by 11% from the case to ambient
- Is pre-applied at ABB in a paste form using automated processing ensuring volume production repeatability
- Reduces damage potential from accidental contact and makes module handling/installation easier for the customer due to solid TIM at room temperature
- Because TIM becomes viscous at operation temperature providing a homogeneous coating across the baseplate/heatsink interface

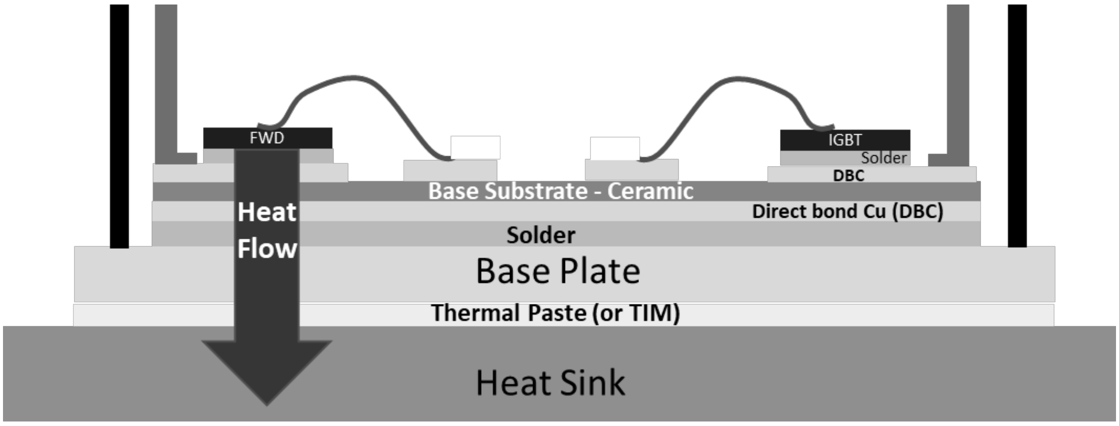
The challenge is high thermal resistance (or low conductivity) through a standard power module

Figure 1 below shows that heat generated by power losses during the operation of IGBT switches must be transported from the chip, through the module, to the heatsink to prevent the junction temperatures of the chips from rising beyond maximum allowable limits. The interface between the module baseplate and the heat sink can have the highest thermal resistance of all of the interfaces in that path, as seen in the chart on the right.

Layer	Contribution to thermal resistance
Baseplate to terminal material (thermal paste)	50%
Device	3%
Solder	6%
Base substrate - ceramic	33%
Base substrate - DBC	3%
Base plate	5%

Contributions to module thermal resistance

Figure 1 – Heat flow pathway through module and layer contributions



Properties of TIM

The use of the TIM improves the thermal conduction across this interface during long term operation supporting a more stable during long term operation than conventional heat conductive pastes, which are commonly used for this application. (Figure 2). The use of the TIM can increase the amount of current that can be safely switched by the IGBT and also improve the module's lifetime, since the TIM's thermal resistance does not increase with the number of switching cycles.

Comparison of thermal materials

Appearance	Paste	TIM
Color	white or grey	grey
Base material	silicone fluid with filler	phase change material with filler
Consistancy @ room temperature	viscous	hard
Thermal conductivity (W/(m*K)	0.8 – 3.0	5.2

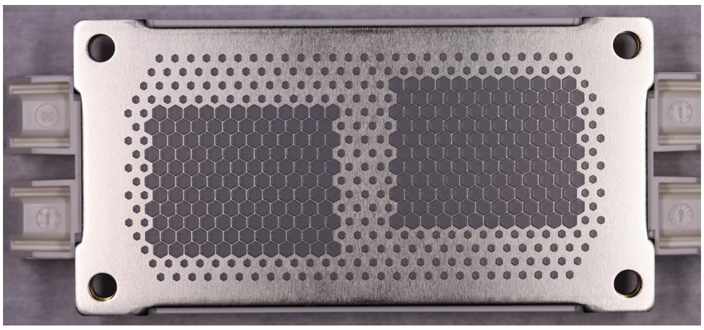


Figure 3: TIM as it look applied on the modwule

Improved performance using TIM

Significant improvement in the thermal conductivity when TIM is used is shown in figure 4. Both for the case to ambient which is also reflected through the entire flow from the chip to the ambient. This is also due to the spreading of the TIM across the interface when the module is installed and run at operation temperature.

Thermal resistance, average over 9400 cycles (K/kW)	Paste	TIM	Improvement
Junction to ambient	114.75	106.66	7%
Case to ambient	73.92	65.93	11%

Figure 4: Performance of TIM compared to heat conductive paste

The use of the TIM can increase the amount of current that can be safely switched by the IGBT because of the improvement it creates for heat transfer allows the virtual junction temperature of the IGBT to be lower for a given current level.

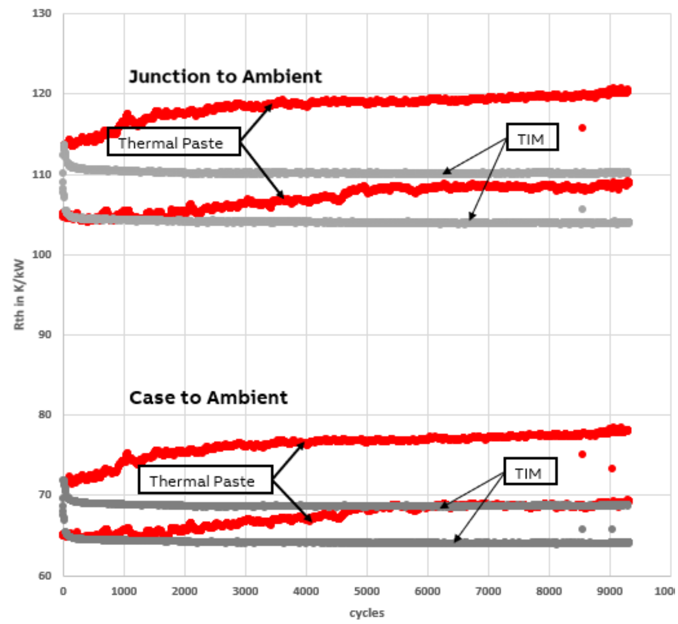


Figure 5: Comparison of TIM and heat conductive paste stability

Increased module lifetime using TIM

The ability of TIM to extend the lifetime of a module compared to standard paste can be seen in the cycling test data in Figure 5. While the initial thermal conductivity of pre-applied TIM is comparable with the heat conductive paste, the modules using TIM show no increase in thermal resistance with cycling, while those using the heat conductive paste show increasing thermal resistance during the test.

These results imply the better long-term stability of the TIM as opposed to the degradation of the thermal interface using the heat conductive paste.

About LoPak

LoPak are medium power IGBT modules which enable extra transient over-current capability by taking advantage of the IGBT module's maximum operating junction temperature of 175°C, compared to the typical 150°C. The current configuration is a 1700 V phase-leg (half-bridge) IGBT module with copper base plate, using ABB's uniquely designed SPT++ IGBT and diode devices and offered with 450 A, 300 A and 225 A current ratings.
This combination provides outstanding safe operating area (SOA) and over-temperature capability. Within its product class, LoPak benefits from Hitachi ABB Power Grids' know-how in robust electrical performance and high reliability.
The detailed design and virtual prototyping used by Hitachi ABB Power Grids makes the LoPak module's current distribution well-balanced during switching and especially controlled under overload conditions. Excellent field feedback has confirmed that the LoPak modules carries the same DNA for high reliability and robustness as the entire family of Hitachi ABB Power Grids high-power semiconductors.
The LoPak module is a key part in Hitachi ABB Power Grids' expanding catalog of products to support the renewable energy and industrial marketplace.

ABB Power Grids Switzerland Ltd
Semiconductors
A Hitachi ABB Joint Venture
Fabrikstrasse 3
5600 Lenzburg, CH
Tel: +41 58 586 14 19
Email: abbsem@hitachi-powergrids.com

hitachi-powergrids.com/semiconductors

9AKK107991A0992 Rev.A; 01-March_2021