Efficiency Benefits of Full Gate CSTBT™ in PV Applications

Executive Summary

- Full Gate CSTBT™ allows you to harvest more energy than competing technologies.
- Powerex Intelligent Power Modules include gate drivers that are optimized for Full Gate CSTBT.

There are two major reasons that consumers of PV inverters focus on efficiency. First, having low power losses is a measure of the “green-ness” of a particular technology. Second, there is a real economic benefit to harvesting more of the available energy.

The power semiconductors used in the inverter play a key role in the overall system efficiency. There are two ways in which semiconductors, like IGBTs, differ from an ideal switch:

1) Conduction losses, and
2) Switching losses.

The idea is not to simply trade off one for the other, but rather to find innovative ways to reduce both.

Conduction Losses – The conduction losses of an IGBT occur when it is turned on. The figure that is typically used to characterize conduction losses is the saturation voltage, or $V_{CE(sat)}$. The non-ideal power that is lost in the on-state is equal to the output current multiplied by the saturation voltage.

Switching Losses – The switching losses of an IGBT are actually a collection of different types of losses. These are generally categorized as turn-on energy ($E_{on}$), turn-off energy ($E_{off}$), and diode reverse recovery energy ($E_{rr}$).

The non-ideal power that is lost due to switching is equal to the switching frequency multiplied by the sum of the energies. Carrier Stored Trench-gate Bipolar Transistor (CSTBT) technology was introduced to provide a rugged semiconductor that also reduced overall power losses. The unique feature of CSTBT is the “carrier stored” layer that consists of n-type semiconductor material. The carrier stored layer helps to prevent holes that are injected from the collector from penetrating into the emitter. This increases the hole density in the n-layer, which helps to lower the on-state (conduction) losses.

Full Gate CSTBT increases the cell density, which both allows the IGBT to have lower on-state losses and reduces the drain to source capacitance. To take full advantage of this technology requires careful design of the IGBT drive circuit, in order to ensure oscillation-free short-circuit withstand capability. That is why Powerex Intelligent Power Modules include optimized gate drive ICs that are designed for operation with Full Gate CSTBT.

The result is better than a simple trade-off between conduction and switching losses. Full Gate CSTBT moves the marketplace another step closer to the ideal switch.

PV Lit. # QS003 / 04-10 Rev. 0

Find Out More at…

www.pwrx.com/LibrarySearch.aspx
— Characterization Of 1200V CSTBT Optimized for Industrial Applications (Key Word 870)

— Need help with your solar inverter application? Contact us at PVhelp@pwrx.com