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WARP Speed™ IGBTs -- Their Advantages and Application

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Introducing the WARP Speed™ IGBTs

By now, you should be becoming familiar with the WARP Speed IGBT. In this article, International Rectifier (IR) will share with you the details of the advantages of this new series of devices, as well as some of the things that you will encounter in actual applications.

Advantages

Remember, the WARP Speed family is a cost saving to you, compared to large power MOSFETs. This saving is smaller for devices such as a 500V, 8A type which would be replaced by the IRG4BC20W, but becomes greater for higher voltages and larger current ratings. For example, for an industry-standard 500V, 14A device, the IRG4BC30W may offer more than 15-20% savings in cost.

And could anyone else do this? IR's WARP Speed IGBTs offer more than 50% better Ets (switching loss) than the nearest IGBT devices. See insert for WARP Speed IGBTs replacement information for your reference.

In-Circuit Experiences

The WARP Speed™ IGBTs have made it easy for the designer to save cost in his power supply (which we have demonstrated in actual power supplies here in our own labs in El Segundo). In a typical desk-top 250 Watts PC power supply design, a single switch power MOSFET is commonly used in the power factor correction boost converter circuitry (switching frequency at 100khz). The power switch is a 500V, 0.4 ohm Rds(on), 14A, TO-247 package device which generates a switching loss of 11 Watts and the conduction loss of 4.5 Watts. The total loss is at 15.5 Watts.

Replacing the power MOSFET with an IRG4BC30W WARP Speed IGBT in this typical PFC circuitry results in a switching loss of 11.2 Watts and the conduction loss of 4.7 Watts. The total loss becomes 15.9 Watts. This is a small 2% increase compared to the MOSFET under the full load condition, resulting in a 10°C difference in case temperature. (Figure 1 below shows the turn-off waveform comparison under actual circuit conditions.) The IGBT's 19°C higher junction temperature is due to higher thermal resistance in the smaller TO-220 package. In this case, IGBT's Tj = 93 °C, which is still a 57 °C margin from its maximum junction temperature. In return for this trade, the IGBT allows the designer to use a less expensive device in a TO-220 package.

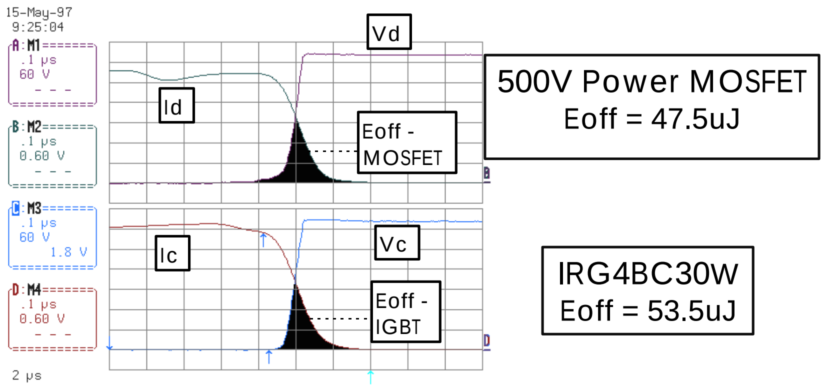

Figure 1. Turn-off Switching Loss (Eoff) Comparison Between Power MOSFETs and WARP Speed™ IGBTs

Drop-in or not?

Is the WARP Speed IGBT a "drop-in" replacement? NO. Well, maybe. We don't want to set your expectation that it is (even though it will be in many cases). It may take a try or two to get the IGBT working correctly, the pinouts are the same, the switching behavior is essentially the same, and the power dissipation is essentially the same. If your design has a good, clean gate-drive design, chances are the IGBT will work well on the first try.

You should note that a gate voltage of 12V minimum is required to fully turn the IGBT on. Some power MOSFET users have historically used only 10V -- but experience has shown that 10V is marginal even for a power MOSFET. 12 to 15V is a better choice to ensure optimum efficiency. Also, changing the gate resistor value (Rg) relative to the original value does not usually have a large impact on the IGBT's switching characteristics.

Finally, pay close attention to good layout practices. This means short, wide PC board traces, etc. This is good advice even for power MOSFET designs.

Other things you'll see in applications.

In power conversion applications, MOSFETs have a conduction loss versus switching loss ratio of about 3:1. The higher conduction losses are caused by higher Rds(on) value when compared with IGBTs. On the other hand, IGBT's ratio is approximately 1:4 . The higher switching losses are caused by current tail at turn-off.   In the end, all that is important to you is that the IGBT total losses are similar to or even less than those of the power MOSFET it is replacing.

When replacing a power MOSFET with an IGBT, not only can cost (and possibly space) savings of up to 20% be realized (dependant upon device rating), but also the smaller die size of the IGBT will reduce gate drive currents, too.

You will also find that the diode used in parallel with the gate resistor for helping fast turn-off in MOSFET can now be eliminated and the smaller di/dt value from the MOSFET's side of IGBT during turn-off will also help to reduce EMI level.

Summary.

We've shown you here that these devices can save you money -- and at the same time, they are very simple to use. We hope that you have found the in-circuit examples here to be useful in preparing you for what you'll encounter with in circuit performance.