IXAN0070

Drive with the IXYS XPT IGBT

IXYS used its expertise to design the optimal IGBT for motor drives applications

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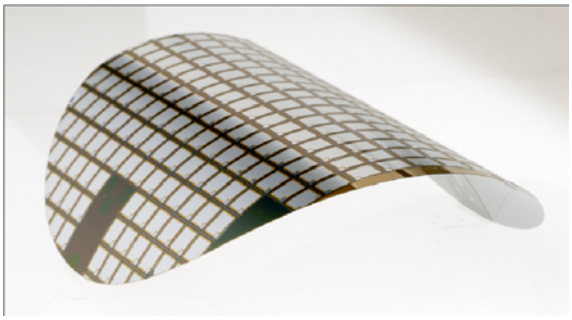
IXYS introduces the XPT IGBT, IXYS newest generation of short-circuit rated IGBTs with paralleling capabilities and competitive performance. Implementation of innovative cell designs and new process technologies resulted in improved IGBT characteristics. Combination of the XPT IGBT with the recently introduced IXYS SONIC diode delivers fast and soft switching behavior. The XPT IGBT has been optimized for motor drives, UPS, solar and inverter applications. The first IGBT products are in the 1200V range from 10A to 50A. These IGBTs will also be integrated in the IXYS line of modules, in bridge configuration for higher power applications.

XPT Technology – Going Thin!

Moving from punch through technology to XPT (extreme light punch through) IXYS follows the well established trend in IGBT manufacturing towards decreasing wafer thickness using bulk float zone Si wafers. The challenge of processing wafers with thicknesses down to 70µm (e.g. 600V XPT IGBT in Figure 1) is merited by a reduction in thermal resistance as well as on-state voltage of the IGBT thus enabling higher current densities. This in turn leads to a reduced chip size for a given current rating, improving packaging capabilities.

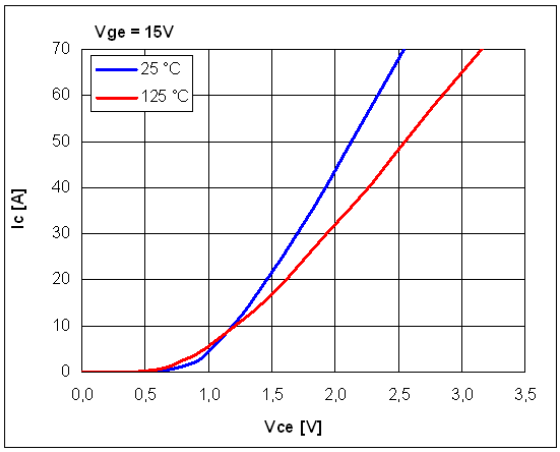


<<Figure 1: 70µm thick XPT IGBT-Wafer showing flexibility due to low Si-thickness>>

The XPT technology uses adjustable emitter efficiency via controlled p-emitter/n-buffer concentration on the anode side of the IGBT, which leads to easy IGBT paralleling due to positive temperature coefficient of the on state voltage. The benefits of merging the IXYS cell design with XPT thin wafer technology can be clearly seen in the following IGBT characteristics, detailing the competitive static and dynamic behaviour as well as the rugged and reliable response during power turn-off testing.

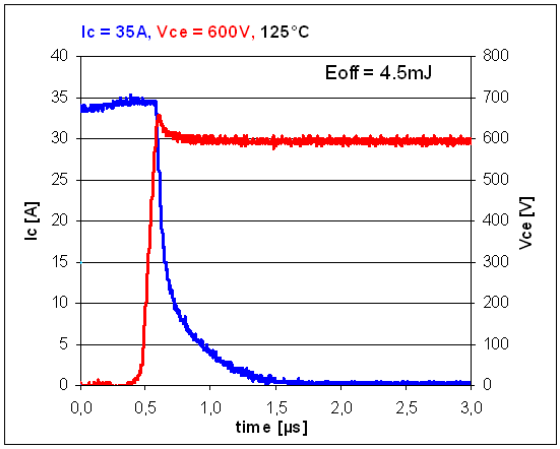
XPT Characteristics

The XPT IGBT was designed to provide low switching losses while retaining low on-state voltage. This was achieved with improved SOA and short circuit ruggedness ratings. The output characteristics at different temperatures are shown in Figure 2.



<<Figure 2: XPT IGBT output characteristic>>

The XPT IGBT has a low Vce(sat) (1.8V @ I_{nom}&25°C & 2.1V @I_{nom}&125°C). The positive temperature coefficient of the XPT IGBT provides a negative feedback, making the XPT suitable for paralleling in modules or circuits. In addition to the low Vce(sat) the XPT IGBT also has a low off-state leakage current at 15O°C (<75µA @1200V). The switching characteristics of the 35A, 1200V XPT IGBT are shown in figures 3 & 4.



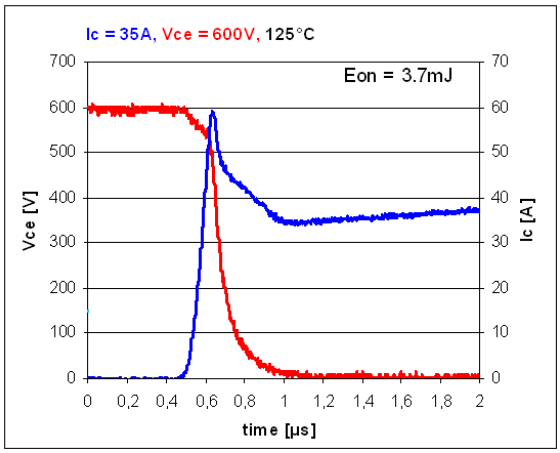
SMOOTH THE GRAPH ON THE END

<<Figure 3: XPT IGBT turn-off characteristic>>

As can be seen in figure 3 the current waveform has smooth switching behaviour reducing EMI and resulting in small over voltage transients. The linear voltage rise and short tail current during turn-off, leads to reduced losses (Eoff = 4.5mJ). The XPT IGBT has a low gate charge (110nC @15V), requiring lower gate drive power, when compared to trench IGBTs

XPT and SONIC – the perfect match

The optimal match for reduced turn-on losses is achieved when the XPT IGBT is paired with the IXYS Sonic diode, which also has a low on-state voltage with excellent temperature behaviour.
The Sonic diode has soft recovery characteristics, which allows the XPT IGBT to be turned on at very high di/dt's even at low current and temperature conditions where usually diode snappiness can occur. The Sonic diode retains soft switching behaviour during turn-off of freewheeling currents nullifying EMI problems.

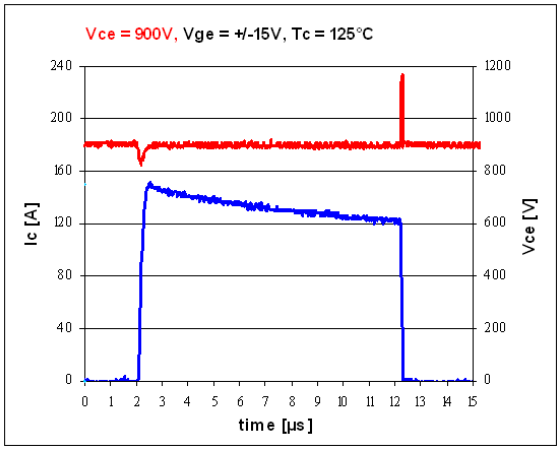


<<Figure 4: XPT IGBT turn-on characteristic>>

Sonic diodes combine a low reverse recovery current along with a short reverse recovery time, as shown in figure 4 to minimise the turn-on energy of the XPT IGBT (Eon = 3.7mJ). The Sonic diode Vf is less sensitive to temperature resulting in better suitability for parallel operation of diodes and minimising switching losses.

Rugged XPT Characteristics

The IGBT behaviour under short circuit conditions is a very important issue relating to motor drives applications and the IXYS XPT IGBT has shown extremely rugged performance during short circuit testing. The chip design was optimised with a low forward transconductance, therefore providing an approximate short circuit current of 4x nominal current, to ensure robust short circuit performance.



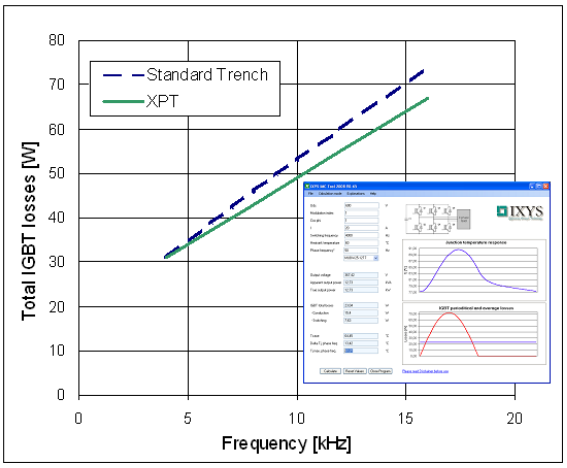
<<Figure 5: XPT IGBT short circuit characteristic>>

Figure 5 shows the 35A, 1200V XPT IGBT during short circuit with a gate voltage of +/-15V at 125°C for 10µs. Characterisation of the XPT IGBT technology showed extreme ruggedness during short circuit of the device at elevated voltages and temperatures for 10µs without any detriment to the IGBT characteristics. The IXYS XPT IGBT has a square RBSOA at 1200V up to two times nominal current at very high temperatures.

XPT modules – losses calculation

The XPT IGBT modules' losses and junction temperature during operation in a three phase drive application can be calculated by the user, at their operating conditions, using the IXYS IMC-Tool (IGBT Module Calculation Tool). Calculation models for all the copper baseplate XPT modules are available in the latest version of the IMC-Tool. The IGBT losses and consequently its junction temperature are calculated with respect to the heating effect of the conduction and switching losses during the phase frequency. The IMC-Tool calculates, within seconds, the impact on the thermal response (Tj) over a range of different phase frequencies (e.g. 2 to 50Hz). The IGBT losses and

junction temperature over a period, once thermal stabilization has been achieved, are also graphically displayed.

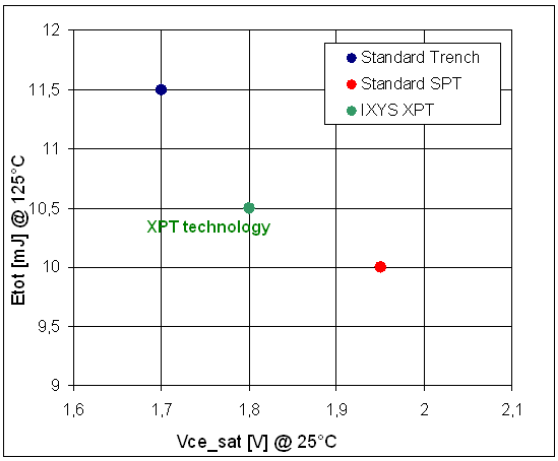


LOOK IF POSSIBLE TO ADD SPT

<<Figure 6: Frequency dependence of the total losses calculated with the IMC Tool>>

A comparison of XPT and trench technologies over a range of phase frequencies can be easily calculated using the IMC tool, as shown in Figure 6. The application conditions are shown in the IMC-Tool snapshot also in Figure 6 (U_{dc}=700V, f_{phase}=50Hz, I=25A, T_{hs}=60°C). In this example a 35A CBI module (MIXA35WB1200TED) was used as the basis for the calculation. Figure 6 clearly illustrates that for applications up to 4 kHz the difference in total losses between the two technologies is neglectable, whereas above 4 kHz the XPT excellent switching behavior reduces the total losses significantly resulting in lower junction temperatures, therefore making the XPT IGBT module clearly the device of choice.

Comparison of the XPT modules regarding on-state voltage versus total switching losses with IXYS modules (IXYS E2-Pack), using Trench and SPT technologies, can be seen in figure 7.



<<Figure 7: Comparison XPT IGBT>>

The XPT IGBT module has a significantly lower voltage drop compared with the standard SPT (MWI50-12E7) and lower switching losses than the standard Trench (MWI50-12T7T). This shows that merging XPT IGBT technology with Sonic diodes results in a competitive IGBT module compared to the currently available modules.

XPT Products

The introduced 1200V XPT IGBT are rated at 10A, 15A, 35A and 50A. These IGBTs will be available in standard discrete and modules as well as customer specific designs. The XPT IGBT / Sonic combination range is available in CBI and six-pack topologies in 3 different package sizes. Diode

bridge input rectifier with break chopper supplement the 3-phase inverter six-pack stage in the CBI configuration. On the ceramic substrate an NTC temperature sensor is also integrated, to signal the heatsink temperature near the chips. The IXA35IF1200HB is an example of a discrete co-pack, containing the XPT IGBT and the Sonic diode, integrated in the ISOPLUS 247 package.

Configuration	Package	Voltage [V]	Current [A]	Part number
	TO220	1200	20	IXA20IF1200PB
	ISOPLUS247	1200	50	IXA50IF1200HJ
	TO220	1200	14	IXA14IF1200PB
	ISOPLUS247	1200	15	IXA15IF1200HJ
	ISOPLUS247	1200	35	IXA35IF1200HJ
	TO247	1200	40	IXA40IF1200HB
	E2-Pack	1200	35	MIXA35W1200TED
	E2-Pack	1200	50	MIXA50W1200TED
	MiniPack2	1200	10	MIXA10WB1200TMH
	MiniPack2	1200	15	MIXA15WB1200TMH
	E2-Pack	1200	15	MIXA15WB1200TED
	E2-Pack	1200	35	MIXA35WB1200TED
	E3-Pack	1200	50	MIXA50WB1200TEH

<<Figure 8: Selected product overview>>

In figure 8 the first targeted products are listed. In the near future the range will be extended with four new IGBTs, the 25A, 75A and 100A in 1200V and the 100A in 1700V. The complete XPT IGBT range will cover 3A to 150A in 600V, 1200V and 1700V.

Conclusion

With the introduction of the XPT IGBT IXYS expands its IGBT product range to meet market demands for highly rugged, low loss devices with easy paralleling possibility. Electrical as well as thermal characteristics of first available products prove that matching the new XPT IGBT with IXYS Sonic diodes delivers competitive solutions with respect to existing IGBT technologies.