IGBT and diode dies

ABB Semiconductors IGBT and diode dies with state-of-the-art SPT planar technology.

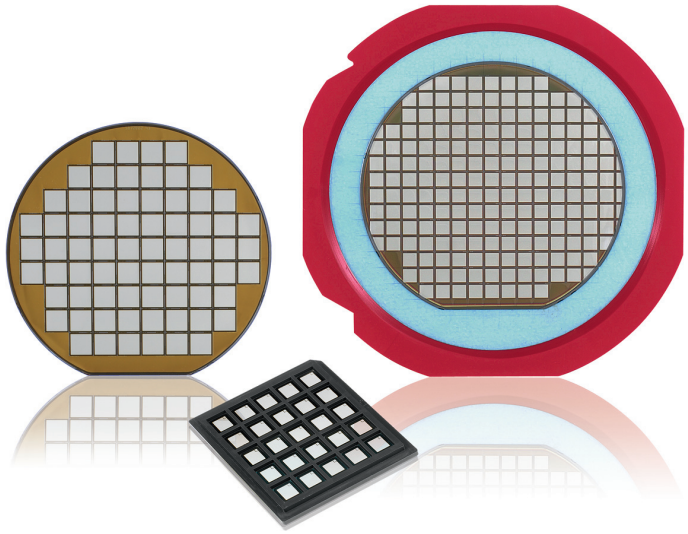


ABB Semiconductors has a well established reputation in the field of high power semiconductors for switching devices. This is reflected in the most complete product portfolio of any supplier of high power semiconductors.

ABB's power semiconductor BiMOS chipsets, i.e. IGBTs and their accompanying freewheel diodes, are best-in-class in terms of switching performance, ruggedness and reliability. Thanks to a moderate chip shrinkage and thus larger die-area, we are able to offer the highest output power per rated amp in the industry.

The newly introduced 1700 V SPT^{++} chip-set is the world's first 1700 V chip-set that offers an operational junction temperature of up to 175 °C. This allows the module designer to increase the power density of power modules significantly. The various requirements in package design and output power are supported by the broad number of different current ratings and sizes (see table).

Chipsets are all available for solder mount-down and wire bonding in modules.

This brochure shows the currently available die types and their salient features.

SPT technology

ABB produces IGBT and fast recovery diode dies in the voltage range from 1200 V to 6500 V based on the well-established SPT (soft punch-through) technology platform. SPT technology is characterized by its very well controlled (”soft”) switching performances and high safe operating areas (SOA) together with positive temperature coefficients for reliable parallel operation. The newer generation of chips, known as SPT^{+} and SPT^{++}, retains all the features of SPT but allows a 20 – 30 % reduction in $V_{CE\ SAT}$, depending on voltage class.

The IGBT

Figure 1 shows the basic difference between SPT^{+} and SPT^{++}. The development target was to reduce the on-state losses by introducing an N-enhancement layer surrounding the channel-P-well. This improves the plasma concentration on the emitter side and therefore, lowers the on-state losses. With the introduction of the SPT^{++}, the profile of the said N-enhancement layer was further optimized with the main goal to make another step in conduction losses improvement. Together with thinner silicon, a reduction in $V_{CE\ SAT}$ of half a volt was possible.

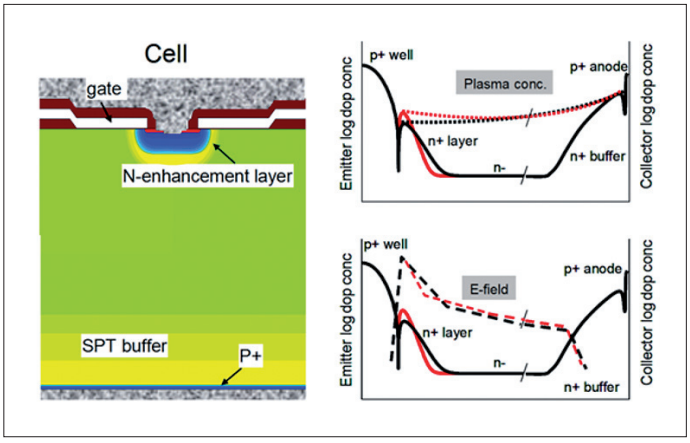


Fig. 1 SPT^{+} planar IGBT enhanced carrier profile

Figure 2 shows the on-state curves of the newest SPT^{+} IGBT chip with 150 A rating at different temperatures. The SPT^{+} IGBT shows a positive temperature coefficient of $V_{CE,on}$, already at low currents, which enables a good current sharing capability between the individual chips in the module.

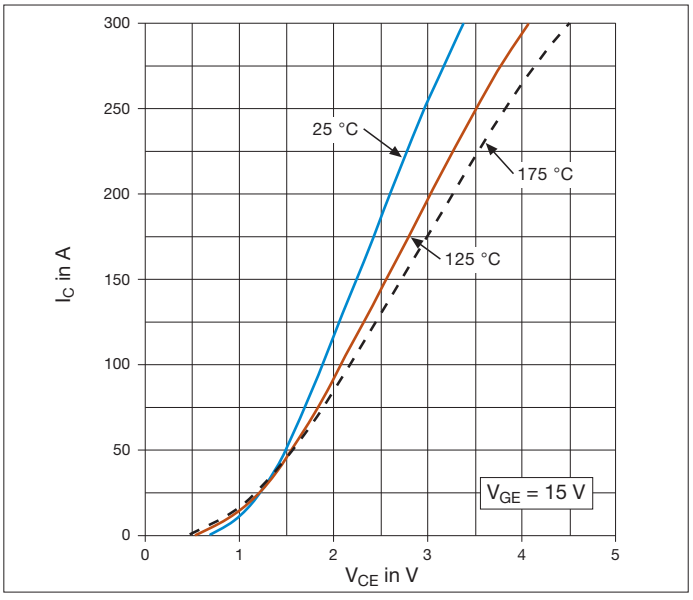


Fig. 2 On-state curves of the 150 A 1700 V SPT^{+} IGBT (module level measurements)

Figure 3 shows the turn-off of a 150 A 1700 V IGBT under nominal conditions at 175 °C. The IGBT exhibits controlled switching characteristics as well as short current tails. This behavior is enabled by the combination of SPT buffer design and silicon resistivity used in SPT^{+} technology, which provides fast switching with low losses and low overshoot.

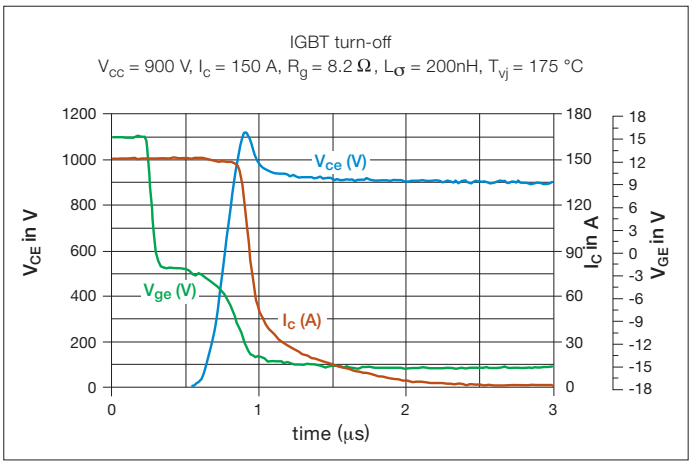


Fig. 3 IGBT turn-off of a SPT^{++} 150 A 1700 V IGBT

The diode

The diode of the new SPT^{++} chip-set is based on an advanced pin-diode design using the FSA (field shielded anode). A schematic cross-section is shown in figure 4.
In contrast to more conventional design the FSA diode has a double anode with a deep diffused p-well that shields the field from the anode and the irradiation. Thus a significant leakage reduction can be achieved without sacrificing the excellent robustness and low losses of the ABB diodes.

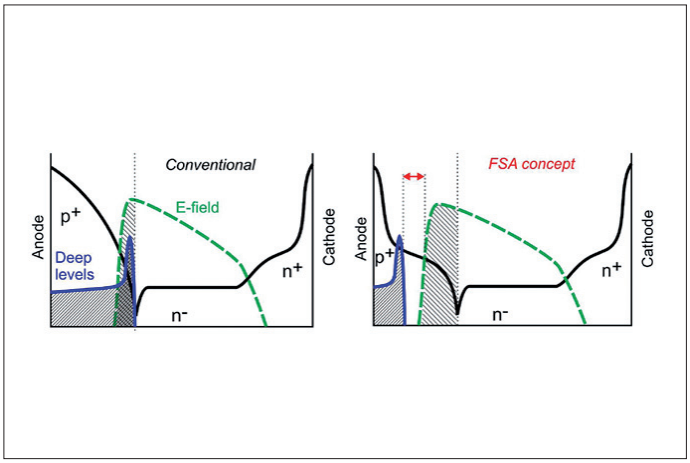


Fig. 4 Schematic cross-section of the diode

The typical forward characteristics is shown in figure 5.

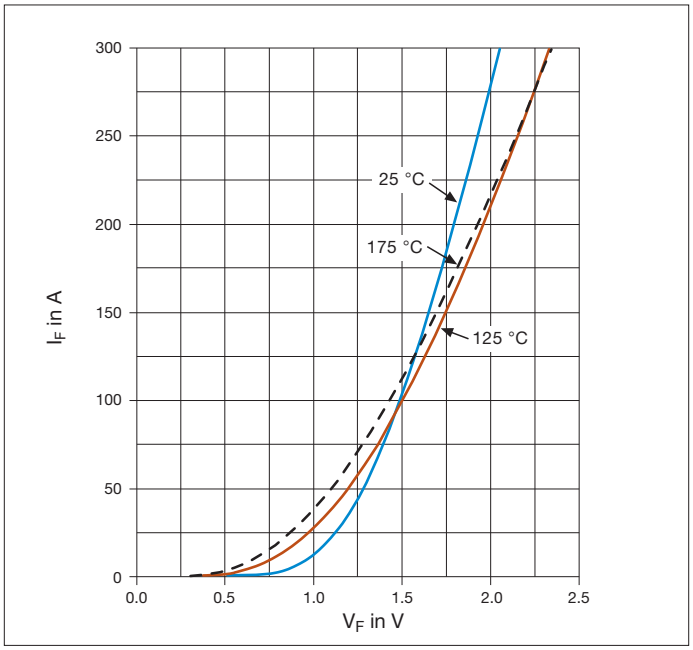


Fig. 5 V_F curve of a 150 A 1700 V FSA diode

Figure 6 shows the reverse recovery characteristic of a 150 A 1700 V diode under nominal conditions at 150 °C. The current transients during switching are very smooth and soft.

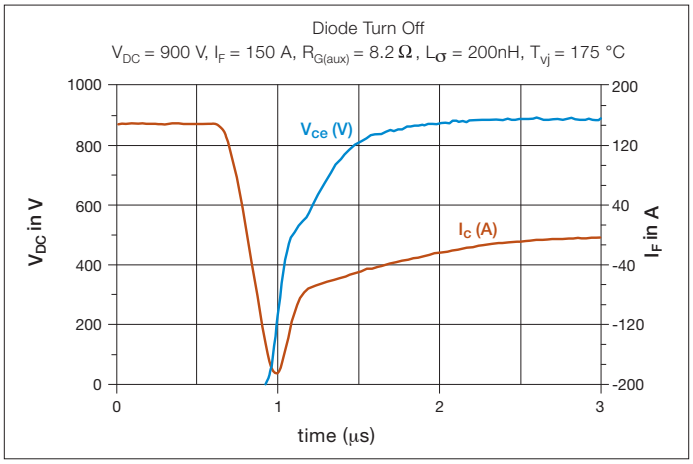


Fig. 6 Reverse recovery of a 1700 V 150 A diode

Reliability

The reliability of the chip-sets is confirmed using a combination of standard tests including HTRB (high temperature reverse bias), HTGB (high temperature gate bias), THB (temperature humidity bias), cosmic ray test and a newly developed test which combines high temperature, high humidity and high voltage.
To extend the reliability of the chipsets for extreme environmental applications, the chipset designs additionally feature a state-of-the-art double-layer passivation of silicon-nitride and polyimide. The polyimide layer has the advantage of mechanically protecting the first passivation layer, acting on the termination as a delay-barrier against humidity and ion-penetration from outside and preventing sparking across the termination during high-voltage operation.

Configurations

Please be aware that on wafer level (wafer dies or sawn wafer die), testing can only be performed at room temperature. Therefore, for these configurations all values at high temperature can only be guaranteed on a statistical basis.

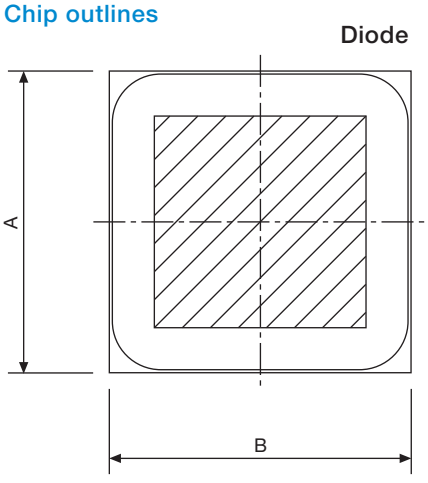
Detailed technical information

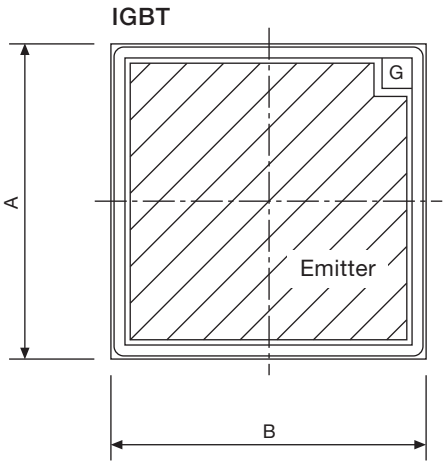
Data sheets for all die types are available on our website, **www.abb.com/semiconductors** or from our local distributor. For further information, including data sheet users guide, testing, shipment, storage, handling and assembly recommendations please refer to our Application Note SYA 2059 “Applying IGBT and diode dies” available on our website.

Price and delivery

Information on prices and delivery conditions may be obtained from our local distributor.

Chip outlines





Part number	Type	Size A x B mm	Thickness µm	V_{RRM} (V)	I_F (A)	V_F (V) typ. 125 °C	Max. dies per wafer (W) or tray (T)
Diodes							
1.2 kV							
5SLY 76/ 86E1200	SPT+	6.3 x 6.3	350	1200	50	1.85	361 (W)
5SLY 76/ 86F1200	SPT+	7.4 x 7.4	350	1200	75	1.85	257 (W)
5SLY 76/ 86G1200	SPT+	8.4 x 8.4	350	1200	100	1.85	198 (W)
5SLY 76/ 86J1200	SPT+	10.0 x 10.0	350	1200	150	1.85	137 (W)
1.7 kV							
5SLY 86E1700	SPT+	6.3 x 6.3	390	1700	50	2.1	326 (W)
5SLY 86F1700	SPT+	7.7 x 7.7	390	1700	75	2.1	237 (W)
5SLY 86G1700	SPT+	8.6 x 8.6	390	1700	100	2.1	188 (W)
5SLY 86/12J1700	SPT+	10.2 x 10.2	390	1700	150	2.1	131 (W) / 36 (T)
5SLY 86/12M1700	SPT+	13.6 x 13.6	390	1700	300	2.1	69 (W) / 25 (T)
5SLZ 86J1700	SPT++	10.2 x 10.2	370	1700	150	1.75	131 (W)
Part number	**Type**	**Size A x B mm**	**Thickness µm**	**V_{CES} (V)**	**I_C (A)**	**V_{CEsat} (V) typ. 125 °C**	**Max. dies per wafer (W) or tray (T)**
IGBTs							
1.2 kV							
5SMY 76/ 86H1280	SPT+	9.1 x 9.1	140	1200	57	2.10	166 (W)
5SMY 76/ 86J1280	SPT+	10.2 x 10.2	140	1200	75	2.10	130 (W)
5SMY 76/ 86K1280	SPT+	11.2 x 11.9	140	1200	100	2.10	98 (W)
5SMY 76/ 86M1280	SPT+	13.5 x 13.5	140	1200	150	2.20	71 (W)
1.7 kV							
5SMY 86G1721	SPT+	8.6 x 8.6	209	1700	50	3.00	186 (W)
5SMY 86/ 12J1721	SPT+	10.1 x 10.1	209	1700	75	3.00	132 (W) / 36 (T)
5SMY 86/ 12K1721	SPT+	11.4 x 11.4	209	1700	100	3.00	102 (W) / 36 (T)
5SMY 86/ 12M1721	SPT+	13.6 x 13.6	209	1700	150	3.00	69 (W) / 25 (T)
5SMY 86M1730	SPT++	13.6 x 13.6	190	1700	150	2.55	69 (W)

Dies types: 12 = Die in waffle pack; 86 = Sawn wafer die; 76 = Unsawn wafer die

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