# FEATURED PRODUCTS TECHNOLOGY AND TREND

## Featured Products Technology and Trend

The IGBT and IPM products in this data book feature the 3rd Generation H-Series IGBT chip and a new generation free-wheel diode. A brief description of this technology and trend follows.

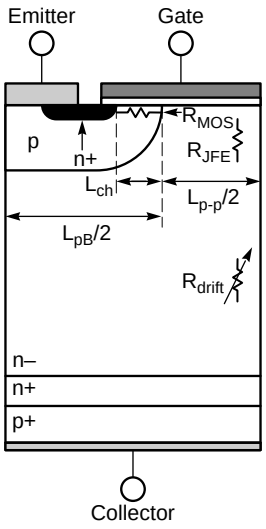
### Third Generation H-series IGBT

Mitsubishi Electric through a process of continuous improvement and new development strategy designed to meet existing and future customer requirements developed and introduced the H-Series IGBT to the market in the 4th quarter of 1992.

The **Mitsubishi** third generation IGBT module realizes significantly improved switching and conduction losses over second generation (E-Series) devices. The on-state voltage was lowered by using advanced processing techniques such as shallow diffusion, reduced cell size, and optimized layout. A new cell pattern was developed in order to maintain the same short circuit durability as E-Series devices. Figure I.1 is a comparison of the second and third generation IGBT cell dimensions. Figure I.2 shows the newly developed cell pattern. The improved saturation voltage versus fall time characteristic of the new device is shown in Figure I.3.

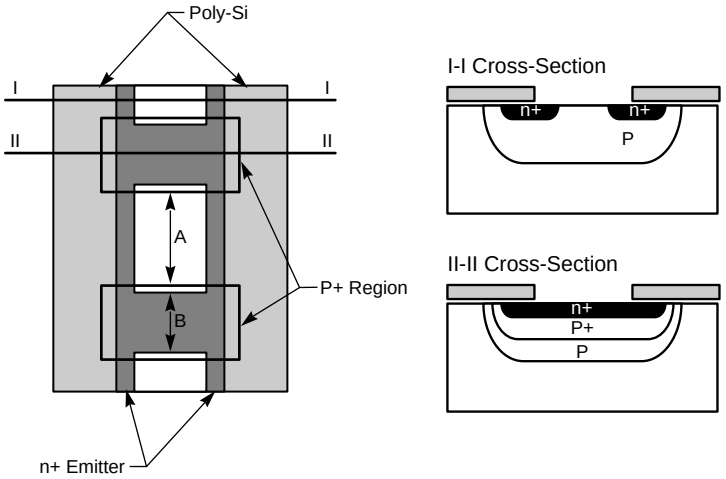
In order to further reduce switching losses, a new free-wheel diode was developed for the H-Series IGBT module. The new diode is a fast, soft recovery device optimized for operation with the H-Series IGBT in hard switching applications. The total reverse recovery charge ($Q_{rr}$) of the new diode is less than one fourth of the value exhibited by the E-Series diode. The recovery time ($t_{rr}$) and peak recovery current ($I_{rr}$) have been cut in half.

**Figure I.1 Comparison of Cell Dimensions (Normalized) and IGBT Cell Cross Section**




| | Type-1 Conventional | Type-2 New Generation |
|---|---|---|
| $L_{ch}$ | 1.0 | 0.3 |
| $L_{pb}$ | 1.0 | 0.5 |
| $L_{p-p}$ | 1.0 | 1.4 |

**Figure I.2 New Pattern for Cell Surface Region**



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## IGBT Module Future Trend

The H-Series IGBT family featured in this publication is the 3rd Generation of IGBT development. It is now in widespread use as the preferred IGBT product on the market. However, the fine pattern and shallow surface diffusion technologies responsible for the features that make the H-Series a market leading technology are now near their limit.

A new IGBT architecture in which the MOS transistor is formed on the wall of a deep, narrow trench is expected to achieve the next performance breakthrough. Figure I.4 provides a glance at the output characteristics of the trench IGBT.

The trench IGBT output characteristics approach those of a diode and offer the promise of on-state loss reduction providing ample potential for future miniaturization.

**For the first time 250V IGBT modules using this new structure are presented in this data book. The new IGBTs have an on-state voltage of 1.2V at rated current.**

**Figure I.3 Improved Saturation Voltage vs. Fall Time Characteristics**

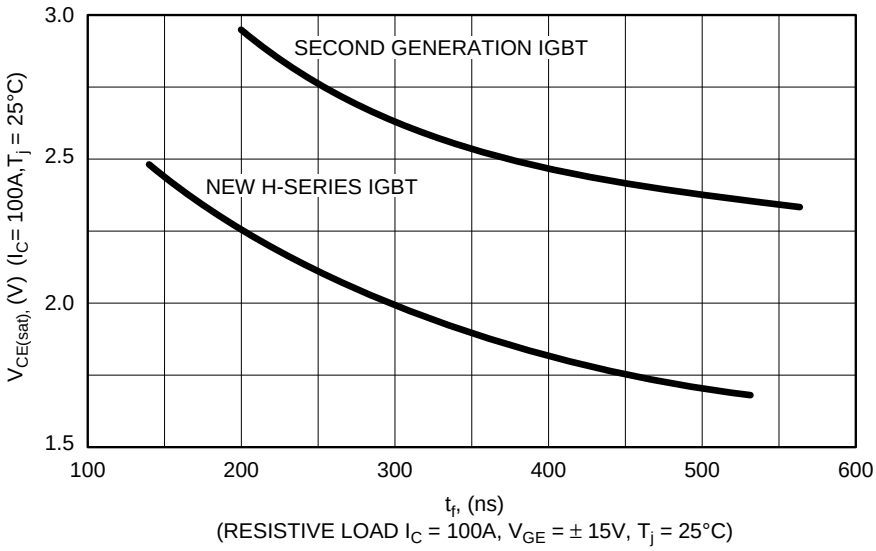
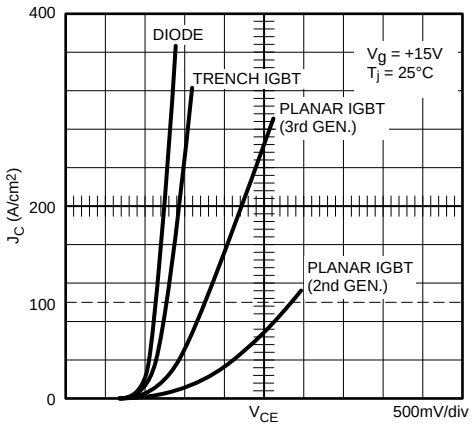



**Figure I.4 Output Characteristics of a Trench IGBT, Planar IGBTs and a Diode**



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**IPM Future Trend**

In the future, the IPM is expected to grow extensively covering a very wide portion of the power and function integration plane as shown in Figure I.5. However, in order to achieve this expansion, we must have future advancement in IPM support technologies. Areas such as the trench IGBT power chip, the IC including the LSI, processing, packaging, system simulation, testing and software need addressed. Advancement of these core technologies is expected to enhance IPM growth in two directions:

1. Growth toward a high power/ high performance region where the IPM would feature further performance enhancement of their integrated power elements.
2. Growth toward a high volume low-power/multi-functionality region, where the increased use of inverters is expected to become essential, as a growing need for energy conservation is required.

In the high power area, the IPM technology is expected to grow extensively by combining MOS gated switches (primarily IGBT) with a dedicated control and protection system. This will allow for extracting the optimum performance from the MOS gated switch.

**Figure I.5 Power vs. Integrated Function for Various Devices**

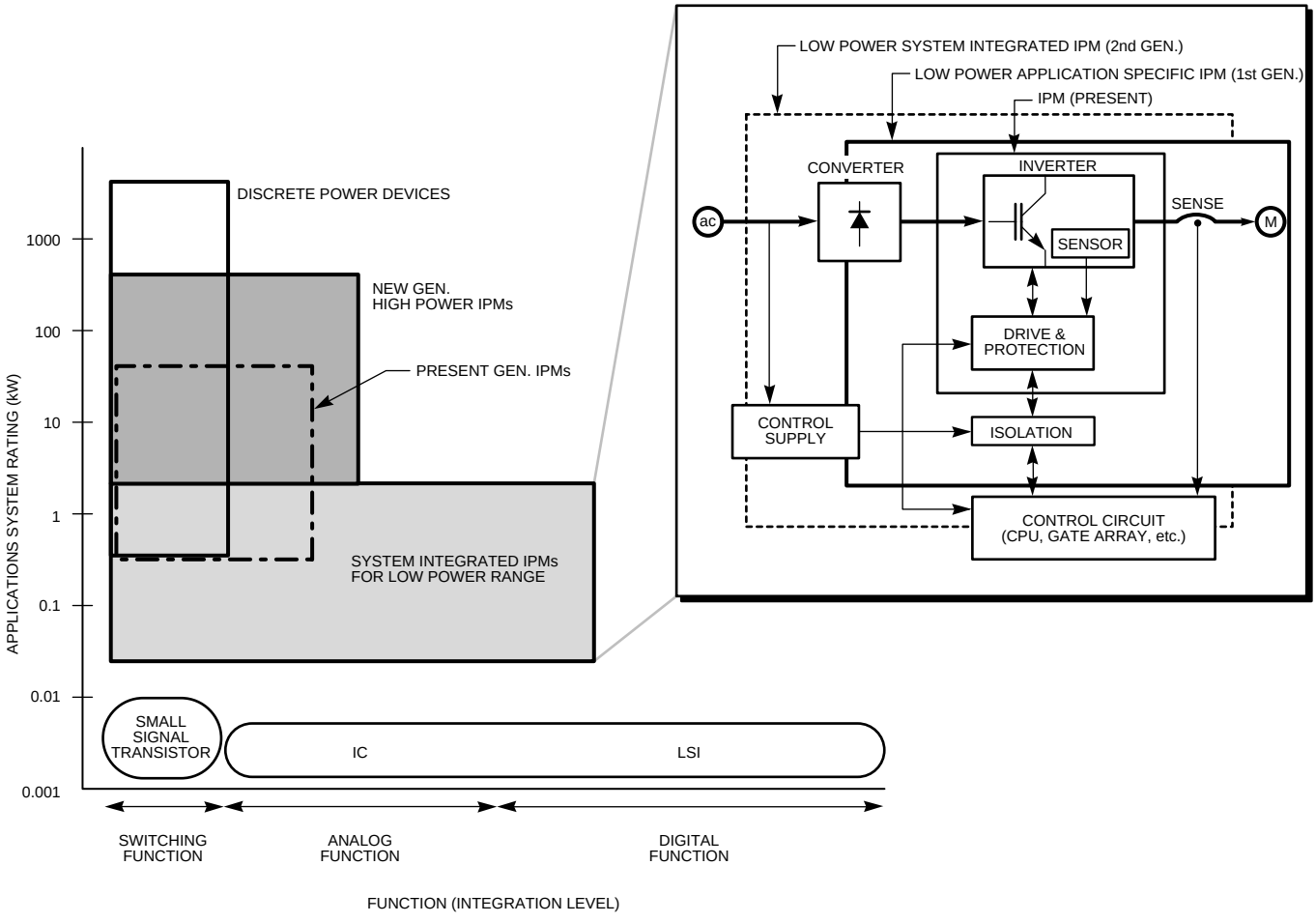




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Figure I.6 shows a proposed concept for future high power IPMs. This proposed concept would employ new technologies to allow IPMs to be applied in applications currently served by large capacity devices such as GTOs and thyristors.

**Figure I.6 Proposed Concept for Future High Power IPM (1500 - 4500V, 200 - 1200A)**