Since their development in the 1980s, IGBTs have become established as the standard component in many different power electronics applications. They cover a performance range from a few hundred watts to several megawatts. In the course of their development, different IGBTs have separated out into different packages so that, for example, there are now IGBTs as discrete components in, for example, TO-247 packages, IGBT in high-power modules, and complex designs that include both IGBTs and other electronic components and functions.

The aim of this book is to make the basics specific to IGBTs as they interact with the application accessible to readers. In many published works, practical details and expert knowledge are often left out or are not presented in a way that clearly shows how they relate to the application. This book brings together detailed information about power electronics in relation to IGBTs, supplemented and complemented by our own experience in the field.

After explaining the internal structure and the IGBT variants derived from the prototype or basic model, we then examine how the package technology is constructed. Then, the book discusses electrical and thermal matters, getting to grips with gate drives for IGBTs, including their specific application and parallel connection. This broad coverage of the applications also includes the practicalities of the switching behaviour of IGBTs, basic circuit arrangements, application examples, and rules of design. To complement that, we also look at measurement engineering and signal electronics. The conclusion deals with the requirements of IGBTs and IGBT modules in terms of quality and reliability.

In presenting each chapter, we have tried as far as possible to present information visually and avoid using more equations than necessary. There are more than 500 figures and tables. However, equations are used if they are the best way to explain basic principles or are relevant to the everyday use of IGBTs. We hope thereby to have achieved a good balance between pure theory and practice-oriented application.

We owe a particular debt of thanks to our families and friends, as work on this book – during our already limited leisure time – took several years.

We would also like to thank Professor Leo Lorenz, Jost Wendt, Hubert Ludwig and Martin Hierholzer, as well as Infineon Technologies, for their support in making this book a reality.

Warstein, summer 2010

Andreas Volke
Michael Hornkamp

Although utmost care has been taken to ensure accuracy in presentation and content, no work can claim to be error-free and complete. Therefore, suggestions for improvement are cordially welcomed.
The arrival and consistent development of MOS-controlled power semiconductor components has helped the entire field of power electronics towards a breakthrough regarding high power density and system efficiency. It has also improved reliability and made economical technical solutions possible. The key technology, facilitating the wide power range of a few tens of watts up to the region of many megawatts, has been the IGBT (insulated gate bipolar transistor), the exceptional technical properties of which mean that it has replaced all previous fully controllable power semiconductor components in existing systems and opened up completely new fields of application. However, a fundamental understanding of component technology, the requirements of the fields of application and operation, and tried and tested designs for the drive and protection functions, are essential for fail-safe and reliable operation across the entire power range, and in order to take the optimisation of system costs into account.

An analysis of the literature currently available reveals a large number of highly qualified papers and books on the topic of power electronics converters, switching topologies and systems, and several comprehensive works that present the semiconductor physics and cellular structures of the major new power semiconductor components both in theory and from the technological and realisation point of view.

What makes this book unique is that it is tailor-made to fill the gap that still existed between semiconductor physics and power electronics systems technology, and provides valuable support to users of these components.

Given the work done in this area over the last twenty years, the two authors, who were involved in applying and spreading this new technology, deserve special commendation: They did not balk at the effort of putting all the knowledge gathered so far in readable form. By fortunate coincidence, both authors have been involved in developing innovative application guidelines for the whole spectrum of power IGBTs and are familiar with – indeed helped to shape – major drive and protection designs, measurement methods for high performance IGBTs and many applications.

This book will provide students of power electronics with valuable information about the main contemporary power semiconductor components and their application while development engineers targeting power electronic converters will find all the essentials of selecting, dimensioning and applying IGBT modules laid out clearly and comprehensively.

I would like to thank the authors for their hard work and express my hope that this book will become a new milestone and a standard work in the development of energy electronics.

Munich, summer 2010

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