

Preface

Since the inception of wireless systems, engineers have continuously strived to develop systems that utilize higher frequencies, in pursuit of numerous advantages that it may offer to particular applications. As a result, the components that constitute a typical wireless system—that is, the antenna and the analog and digital front ends—have been fiercely studied and remarkable developments have surfaced in the last century. While millimeter-wave systems are relatively new (only experiencing any real development since the 70s), they are arguably one of the fastest growing fields in wireless research. Rapidly developing standards and component technology have two major driving forces behind the tremendous growth that we have come to witness in the past decade.

For researchers and designers entering this field, the vast extent of information, research results and systems that exist can be gruesomely overwhelming, which is where this text is intended to assist. This text is heavily focused on current research, and it is designed to cover as many different antenna configurations and applications as possible. It should therefore enable a designer (or researcher, for that matter) to make an informed decision on one of the most critical components of a wireless system. As the text progresses, the reader will notice that special attention is paid to measurement techniques and practical results. While fundamental concepts form the baseline of each system that we intend to discuss, there are a multitude of other books that intensely cover relevant theory. Nonetheless, where it is deemed applicable, this text does attempt to cover fundamental theory, but it is assumed that the reader has sound understanding of wireless systems and antenna concepts.

Discussions in the introductory chapter are intended to provide an idea of development trends witnessed in millimeter-wave systems, and stretches from the earliest stage of the field up until modern times, leaving the reader ready to expand into the next six chapters. A second key part of the introductory chapter is a discussion on spectrum management and allocation, which is the first and perhaps the most crucial component necessary to develop any wireless system. Following this, there is no prescribed order in which the next five chapters should be

approached, although there are minor references between said chapters, it is written so that the reader never feels disconnected from the core concept of the text.

Chapters 2–5 focus on typical antenna types that are scalable to millimeter-wave dimensions. We begin with leaky-wave and surface-wave antennas in Chap. 2, a fundamental branch of millimeter-wave antennas, and one whose principles resonate through the remainder of the book. We cover some basic design principles and concepts unique to leaky-wave antennas, which can be synthesized from a number of different structures, such as rectangular waveguides and microstrip arrays. Various types of printed antennas are discussed in Chap. 3, where we once again spend a short amount of time to cover some fundamental theory, before delving into recently publications on the millimeter-wave scaling of these antennas. Printed antennas are highly desirable in applications with severe space constraints, and these antennas are typically capable of mechanical self-support. To cope with the extreme mechanical tolerances at such high frequencies, several configurations have been developed that, in some ways, mitigate the implications of these tolerances, along with changes in approach to fabrication.

In Chap. 4, one of the most actively developed fields at the moment, integrated antennas, is discussed. The requirements of developing radio standards in the 60, 77, and 94 GHz bands—compact size, low power, and the ability to mass produce—are truly well catered for by integrated solutions where the antenna is fabricated on the same substrate as supporting circuitry. As a result, a strong emphasis is placed on 60 GHz radio standards and the accompanying developments. Chapter 5 is the final one where the antenna is the focal point, discussing millimeter-wave reflector and lens systems. Highlights of this chapter include the shift away from traditional reflector configurations (such as the popular parabolic dish) toward more compact structures such as reflectarrays and lenses. Furthermore, we discuss beam forming systems implemented with lens antennas and their many potential advantages in the domain of short-range wireless links.

The last two chapters are intended to tackle the antenna question from a systems perspective, overviewing supporting circuitry and providing a detailed look into millimeter-wave applications. In conclusion, based on numerous discussions on manufacturing, design principles, and practical results from leading research groups, this text should aid designers and researchers to better understand their application and its required antenna system.

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