



UNIVERSITI
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5G TECHNOLOGY

ORTHOGONAL FREQUENCY DIVISION MULTIPLEXING
SYSTEMS AND PEAK TO AVERAGE POWER RATIO
MITIGATION TECHNIQUES



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Preface

The rapid evolution of wireless communication has been driven by the ever-increasing demand for high-speed data, seamless connectivity, and advanced multimedia services. The emergence of 5G technology represents a significant milestone in this progression, introducing new waveform designs and transmission techniques to support higher data rates, low latency, and improved spectral efficiency. Among these technologies, Cyclic Prefix Orthogonal Division Multiplexing (CP-OFDM) and its filtered variant, F-CP-OFDM, play a central role in the physical layer of 5G systems. However, their practical implementation is challenged by high Peak-to-Average Power Ratio (PAPR), which reduces power amplifier efficiency and increases energy consumption. This book addresses these challenges by presenting the fundamental concepts, analytical frameworks, and practical solutions for PAPR mitigation using codeword shift mapping techniques while also exploring the integration of filtering methods to further enhance system performance in 5G networks. Intended for students, researchers, and practising engineers, it provides a structured and comprehensive understanding of modern Orthogonal Frequency Division Multiplexing (OFDM) based 5G technologies, emphasising energy-efficient design and performance optimisation.

The insights presented in this book are expected to benefit both academia and industry. As OFDM continues to play a critical role in wireless communication systems, the demand for effective and efficient PAPR reduction techniques becomes increasingly important. Telecommunication companies adopting the approaches

WIRELESS COMMUNICATION SYSTEM

INTRODUCTION

This chapter discusses the role of wireless communication in modern communication systems and the technologies that enable high-performance 5G networks. The transition from wired to flexible and scalable wireless connectivity has supported the growing demand for services such as Internet access, multimedia streaming, and mobile computing. To meet the requirements of high data rates, efficient bandwidth utilisation, and reliable performance in challenging channel conditions, advanced transmission techniques are essential. OFDM, together with higher-order digital modulation schemes such as Quadrature Amplitude Modulation (QAM), forms the foundation of 5G physical-layer design by providing high spectral efficiency, robustness against multipath fading, and improved data throughput.

THE EMERGENCE OF WIRELESS COMMUNICATION

Wireless communication is the most preferred, efficient, and convenient method of communication. The development of wireless technology has been driven by the rise in mobile customers, the growing demand for multimedia applications, and the need for higher data speeds. In recent years, the majority of existing research has

This book presents a comprehensive overview of modern wireless communication systems, focusing on 5G-technology and its future evolution. It explains the fundamental principles of wireless communication and highlights how 5G meets the growing demand for high-speed, reliable, and energy-efficient connectivity. The book emphasises advanced physical-layer technologies, particularly OFDM and higher-order modulation schemes such as QAM, which enable high spectral efficiency and improved data throughput.

It examines important OFDM variants, including F-CP-OFDM, and discusses their advantages in bandwidth utilisation and system performance. A key focus is the challenge of PAPR in multicarrier systems and its impact on power amplifier efficiency and transmission quality. Various PAPR reduction techniques are analysed, with results showing that probabilistic codeword shift mapping methods, especially GCS applied to F-CP-OFDM, provide significant performance improvements. The book concludes by outlining future research directions aimed at enhancing waveform design, reducing energy consumption and supporting 5G and emerging 6G technologies.



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