Chapter XII
Orthogonal Complex Quadrature Phase Shift Keying (OCQPSK) Spreading for 3G W-CDMA Systems

Shailendra Mishra
Dehradun Institute of Technology, India

Nipur Singh
Dehradun Institute of Technology, India

ABSTRACT

A variety of digital modulation techniques are currently being used in wireless communication systems. In 3G (third generation) spread-spectrum systems, such as W-CDMA (3GPP) and cdma2000 (3GPP2), the handset can transmit multiple channels at different amplitude levels. Modulation schemes such as OQPSK or GMSK do not prevent zero-crossings for multiple channels and are no longer suitable. There is a need for a modulation format or a spreading technique that can accommodate multiple channels at different power levels while producing signals with low peak-to-average power ratios. OCQPSK (Orthogonal Complex Quadrature Phase Shift Keying) has been proposed as the spreading technique for W-CDMA and cdma2000. OCQPSK is a complex spreading scheme that is very different from the modulation formats commonly used until now. The objective of this Chapter is to provide an overview of OCQPSK and explain how to start making modulation quality measurements on the reverse link (uplink) of 3G spread-spectrum systems. This chapter starts with the basic structure of the reverse link (uplink) for W-CDMA and cdma2000 with no scrambling, and explains the transition through complex scrambling to OCQPSK. The block diagrams shown are generic block diagrams for OCQPSK that are not particular to either W-CDMA or cdma2000. The chapter then describes: (1) why complex scrambling is used and how it works, and (2) why OCQPSK is used and how it works. Finally, this chapter provides how to measure modulation quality on the reverse link of 3G systems and a complete downlink physical layer model showing various results of BER and BLER calculation and also various time scopes and power spectrums.

INTRODUCTION

W-CDMA in Third-Generation Systems

Communications systems based on Spread Spectrum (SS) have been in use for decades, but most of them until the last decade were implemented in military systems because of their inherent anti-jamming and low probability-of-intercept features. In the late 1980s, the use of Direct Sequence (DS) and Frequency Hopping (FH) techniques for SS became of interest for commercial use in cellular-type communications. Code Division Multiple Access (CDMA) and Wideband Code Division Multiple Access (W-CDMA) systems appear to be the first such systems to be proposed. The wideband system was envisioned as an overlay of conventional microwave signals with a spread bandwidth (SBW) larger than the currently projected W-CDMA systems (Ojanpera & Prasad, 1998; Dahlman, Gudmundson, Nilsson, & Skold, 1998).

Analog cellular systems are commonly referred to as first-generation systems. The main first-generation standards are AMPS, TACS, and NMT. The digital systems currently in use, such as GSM, PDC, cdmaOne (IS-95)—and US-TDMA (IS-136)—are second-generation systems. These systems have enabled voice communications to go wireless in many of the leading markets, and customers are increasingly also finding value in other services such as text messaging and access to data networks, which are starting to grow rapidly.

Third-generation systems are designed for multimedia communication; with them, person-to-person communication can be enhanced with high-quality images and video, and access to information and services on public and private networks will be enhanced by the higher data rates and new flexible communication capabilities of third-generation systems. This, together with the continuing evolution of the second-generation systems, will create new business opportunities not only for manufacturers and operators, but also for the providers of content and applications using these networks (3GPP TS 25.213 V2.3.0, 1999). With the introduction of the third generation (UMTS/IMT-2000), second-generation systems will create new business opportunities not only for manufacturers and operators, but also for the providers of content and applications using these networks (3GPP TS 25.213 V2.3.0, 1999). With the introduction of the third generation (UMTS/IMT-2000), second-generation capabilities (voice and low/medium rate data) are extended, adding multimedia capabilities to second- generation platforms such as support for high bit rates and introduction of packet data/IP access (3GPP TS 25.211 V5.0.0, 2002-2003).

In the standardization forums, W-CDMA technology has emerged as the most widely adopted third air interface. Its specification has been created in 3GPP (Third Generation Partnership Project), which is the joint standardization project of the standardization bodies from Europe, Japan, Korea, the United States, and China. Within 3GPP, W-CDMA is called UTRA (Universal Terrestrial Radio Access) FDD (Frequency Division Duplex) and TDD (Time Division Duplex), the name W-CDMA being used to cover both FDD and TDD operation (3GPP TS 25.211 V5.0.0, 2002-2003; 3GPP TS 25.201 V5.0.0, 2001-2002; 3GPP TS 25.101 V5.2.0, 2002-2003).

BASIC STRUCTURE OF THE REVERSE LINK (UPLINK) OF 3G SYSTEMS

Unlike 2G systems, in 3G systems such as W-CDMA and cdma2000, the mobile station can transmit more than one channel. The different channels are used for control purposes or to send voice and/or high-speed data. For ex-