1. Introduction

1.1 Motivation

Wireless communications is going under explosive growth. Today, there are approximately 100 million mobile subscribers. The number of mobile users is expected to reach 1 billion by 2010 [1]. In Japan, this enormous growth of the mobile users is especially prominent. Currently, subscribers are increasing at a monthly rate of 0.8-1 million. The total number of mobile users was approximately 31.5 million at the end of March 1998 [2]. Because of the high growth rate, Japan has an aggressive plan for developing 3rd-generation mobile systems to solve the spectrum shortage of the current 2nd-gerneration communications systems - Personal Handyphone System (PHS) and Personal Digital Cellular (PDC).

The main goal of the 3rd-generation cellular system is to offer seamless wideband services across a variety of environments, including 2 Mbps in an indoor environment, 384 kbps in a pedestrian environment and 144 kbps in a mobile environment [2]. The Japanese 3rd generation system employs wideband code division multiple access (W-CDMA) technology. The International Telecommunications Union (ITU) is also considering W-CDMA technology for a global standard - IMT-2000. The ITU is an international standards body of the United Nations. The system approach is leading to a revolutionary solution instead of an evolutionary solution from the current IS-95 CDMA system. IS-95 was designed based on the needs of voice communications and limited data capabilities, but the 3rd-generation requirements include wideband services such as high-speed Internet access, high-quality image transmission and video conferencing [3]. The current IS-95 CDMA standard specifies 1.25MHz channel bandwidth and 1.2288Mchip/s chip rate. The relatively narrow bandwidth and low chip rate makes it impossible for IS-95 to meet the data rate requirement of the 3rd-generation. While the cdma2000 system, which supports CDMA over wider bandwidths for capacity improvement and higher data rates, will maintain backward compatibility with existing IS-95 CDMA systems, the W-CDMA system will use dual-mode terminals to retain the backward compatibility.

NTT DoCoMo, Japan's biggest cellular operator, intends to introduce the 3rd-generation mobile system based on W-CDMA [4]. According to NTT DoCoMo's schedule, a system trial took in place in Tokyo by the end of 1997. The first indoor tests were scheduled to begin in April 1998, with outdoor tests commencing in October 1998 [4]. Texas Instruments is one of the participants in the experiments with this revolutionary technology. Texas Instruments approached CWT to participate in the experiments and to develop the W-CDMA radio.

1.2 Objective

Once the system is commercialized at the beginning of 2001 [2], the demand of mobile terminal equipment is expected to be huge. Mobile communications has become a demand-led industry. Short time-to-market is very critical to the success of a terminal product. A systematic design procedure of the radio portion of terminal equipment is important to shorten the product design cycle. In order to formulate a design procedure for this revolutionary system, a clear understanding of the system and signal characteristics is necessary to parameterize the radio design.

The primary goal of the research work is to build a radio transceiver that fully complies with the radio specifications of the W-CDMA system and to establish a systematic design procedure. The focus of this work is on the radio portion, while the baseband portion is handled by the sponsor, Texas Instruments. Appendix A is a summary of the radio specifications. Analysis and simulations have been performed to explain some of the requirements of the radio design.

1.3 Outline of Thesis

The presentation of this thesis is organized from the system level down to the circuit level. The outline is as follows: Chapter 2 gives an overview of the system. Chapter 3 discusses the design detail of the radio. Chapter 3 comprises three main sections. Each section presents a major sub-system of the radio. They are the transmitter, the receiver

and the synthesizer. The block diagram of the sub-system is given at the beginning of the section. Following is a summary of the technical specification. The design approach and analysis are discussed next. Finally, the discussion is down to the circuit level of describing the part selection and circuit topologies. Chapter 4 presents the performance of the radio. Chapter 5 concludes the thesis and gives a recommendation for extending this work.