THE RF MODULE DESIGN FOR W-CDMA /GSM DUAL BAND AND DUAL MODE HANDSET*

Xiaowei Zhu, Wei Hong, Liu Jin, Ling Tian and Jianyi Zhou
State Key Laboratory of Millimeter Waves, Department of Radio Engineering
Southeast University, Nanjing (210096), P. R. China
Email: xwzhu@seu.edu.cn

ABSTRACT

In this paper, novel RF front-ends for GSM/W-CDMA dual band and dual mode mobile terminal are described. The zero IF direct modulation transmitter and duel-superheterodyne receiver have been realized in the RF module development. The power down functions of IC chip used to switch the RF module turn on W-CDMA mode or GSM. The testing results are shown both for the W-CDMA and GSM modes finally.

I. INTRODUCTION

The 3rd generation (3G) wireless systems can not only offer high-speed, high-quality multimedia services, but also be compatible with 2G systems, such as the GSM and CDMA IS-95. Multi-mode and multi-band communication networks have emerged as a step towards true 3G systems[1].

The W-CDMA system is considered to be one of most challenge of 3G communication systems in China. The core network of W-CDMA system is based on the GMS-MAP, so it can be run on the core network of ANSI-41 by using network extension approach. Meanwhile, the flexible wireless protocol can support to serve user with voice and multi-media data in one carrier simultaneously. Therefore, W-CDMA ensures a fluent evolution from present GSM systems towards 3G systems and networks.

GSM system is worldwide acceptance 2nd generation wireless systems. The subscribers of GSM network will reach 70million before the end of 2000 in China. Multi-mode/band mobile terminals (especially W-CDMA/GSM, or W-CDMA/GSM/DCS, due to its worldwide operation) built around generic platforms will be an essential requirement for 3G mobile communication systems development. Such terminals will have to cope with different radio interface standards, operate in multiple environments. A multi-mode/band handset must incorporate multiple RF front-ends into the same space now allocated for a single front-end

This paper presents the RF front-end development for GSM/W-CDMA dual-band/mode mobile terminal. The direct modulation transmitter output the signal at W-CDMA and GSM Tx frequency band, and the dual LNA/mixer are used to down-convert received signal of W-CDMA and GSM to IF and then demodulate to I/Q information fed to base band. The mode switch is realized by using the power down function, in which there is no SPDT switcher required. The PLL generates four different frequencies to the down-convertor and de/modulator, in which the 2-prescaler is used to divide the LO frequency for the modulator in GSM mode. The transmitter and receiver of RF front-end are assembled up and down sides of 6 layers PCB board respectively. Finally, the measured results are shown.

II. THE DESIGN OF DUAL BAND/MODE RF FRONT-END

In W-CDMA mode, the Tx channel frequency

range is 1920~1980MHz and Rx channel frequency range is 2110~2170MHz. The frequency interval of Tx and Rx channel assigned to one mobile user is just 190MHz[2]. So it is available to design the direct modulation transmitter with only same one local oscillator for modulator and down-converter at 1920-1980MHz[3]. The IF frequency of receiver is chosen at 190MHz. In the GSM mode, GMSK base band signal is modulated at Tx frequency from 890-915MHz, and the IF frequency of receiver is chosen at 200MHz[4]. Therefore, the RF design eliminates the IF SAW filter and image rejection in transmission. This scheme reduces greatly system design and cut down the cost of W-CDMA/GSM dual band/mode RF front-end.

The diagram is shown in Fig. 1. There are common broadband I/Q modulator and VGA, as well as each P.A and channel filter for GSM and W-CDMA in transmitter. The I/Q two ways signals that are coded with GSM or WCDMA mode are fed to RF module respectively. The Los of modulator are generated by multi-frequency PLL module. One SPDT switcher is employed to selected what local oscillation frequency at 1920~1980MHz or 890~915MHz is injected directly to modulator, according to operation mode W-CDMA and GSM.

Regarding the receiver, there are common I/Q demodulator/VGA, as well as each LNA/mixer and SAW filter for GSM and W-CDMA. The received signal is converted to I/Q signals after being mixed and demodulated, and then output to the base band where they are retrieved to information bits of W-CDMA mode or GSM mode by correlation. The Los of mixer are at 1920~1980MHz for W-CDMA and 735~760MHz for GSM respectively, and Lo of demodulator is generated at frequency 380MHz for W-CDMA or 400MHz for GSM which is the double of IF signal frequency. The control signals from the base band to the RF front-end module include Rx/Tx AGC, AFC, APC, and digital BUS used to transfer proper data to the frequency synthesizers in PLL.

The mode controller will switch the SPDT, P.A and LNA/mixer power down on/off, as well as LO's on/ff based on that W-CDMA or GSM mode is operation.

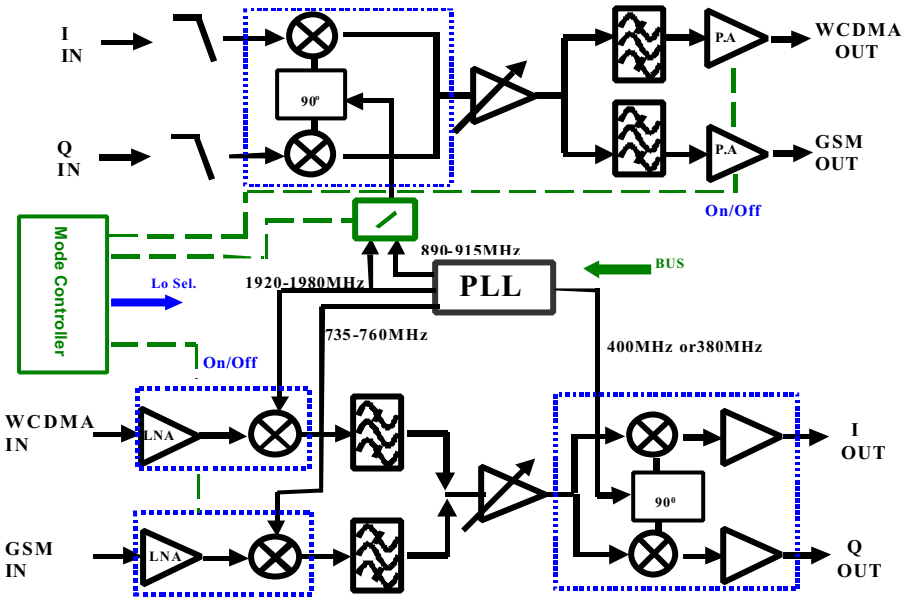

Fig.1 Diagram block of dual band/mode RF module for W-CDMA/GSM

There are four LOs generated in the PLL module as shown in Fig.2, which are generated from two integrated dual-loop synthesizer chips. Lo1 is for mixer of GSM at frequency 735~760MHz, Lo2 is for demodulator at output frequency 380MHz for W-CDMA or 400MHz for GSM mode, Lo3 is for direct RF modulator of GSM mode at 890~915MHz, Lo4 is for direct RF modulator and mixer of W-CDMA at 1920~1980MHz. In W-CDMA mode, the Lo2 and Lo4 are turned on; meanwhile the Lo1 and Lo3 are turned off. In the GSM mode, the Lo1, Lo2 and Lo3 are turned on; meanwhile Lo4 is turned off.

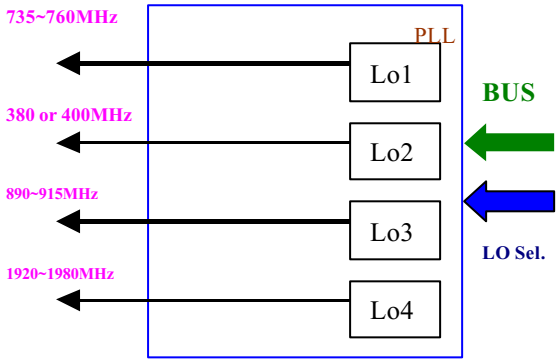

Fig. 2 The diagram of PLL

III. EXPERIMENT

In experiment, the RF front-end was tested for W-CDMA and GSM mode by using Agilent ESG-D E4433B signal generator, E4403B Spectrum analyzer. The performance is listed in Table1. Output spectrum for GSM mode is shown in Fig.3 The ACPR was from –35~-40dBc with different output power for W-CDMA mode as shown in Fig.4. The eye diagram and constellation of output signal is shown in Fig.5. The quadrature performance of I/Q demodulator was measured with single-tone signal input to receiver and monitored on oscilloscope as shown in Fig. 6. The time domain signal waveform of W-CDMA, which is demodulated and output to base band, was monitored by using an oscilloscope as shown in Fig. 7. The Prototype of W-CDMA and GSM dual band/mode RF front-end is shown in Fig.8.

Table1 Performance of tested

Mode	W-CDMA	GSM
Tx band	1920~1980MHz	890~915MHz
Sensitivity	-110dBm	-106dBm
Rx band	2110~2170MHz	935~960MHz
Output Power Modulation	21dBm QPSK	30dBm GMSK
Channel Space	200KHz	200KHz
Bit Rate	384 or 144KHz	13 or 22.8KHz
Transmit Efficient	35%	45%

CONCLUTION

The RF front-end for GSM/W-CDMA dual-band/mode mobile terminal has been developed in this paper. The prototype was tested with the W-CDMA mode and GSM mode signal.

**This paper is sponsored by Hua Yin Culture and Education Funs*

REFERENCE

[1] Mike Bailey, Panu Hagstrom, "An integrated front-end for multi-mode handsets", IEEE MTT-S Digest, pp1269-1272, 2000

[2] 3GPP TS 25. 103, RF Parameters in Support of Radio Resource Management.

[3] Jin Liu, Jianyi Zhou, Xiaowei Zhu, Jixin Chen and Wei Hong, "W-CDMA RF Module Design With Direct Modulation", APMC2000 Digest.

[4] GSM 02. 07: "European digital cellular telecommunication system (phase 2); Mobile Station features"

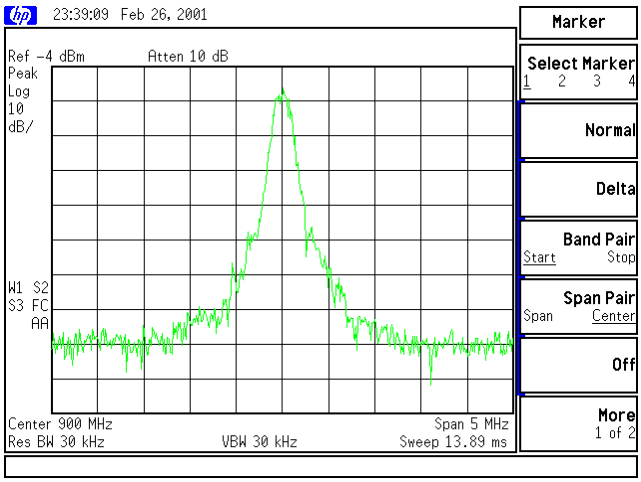

Fig.3 Output spectrum for GSM mode

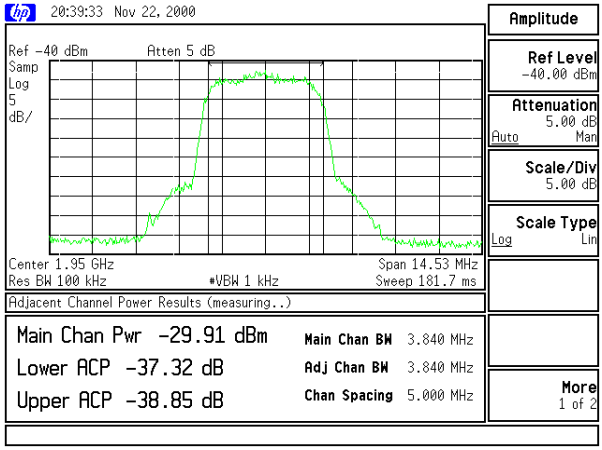

Fig.4 ACPR test for W-CDMA mode

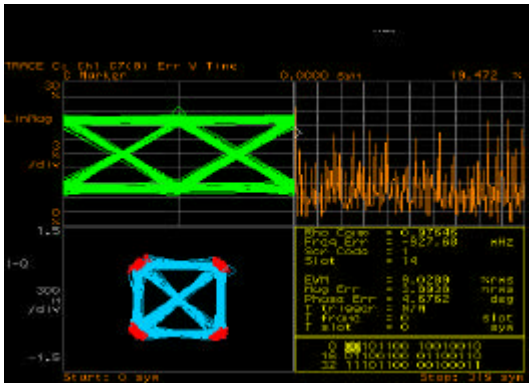

Fig.5 The eye diagram and constellation of output signal

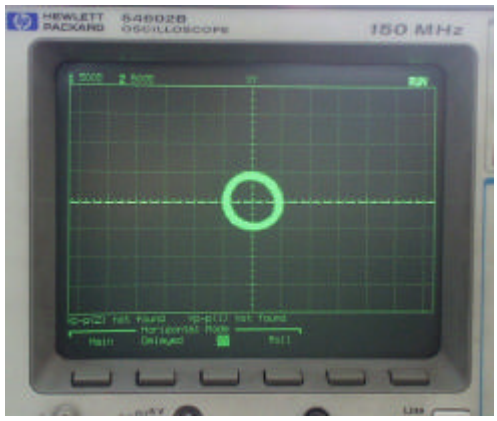

Fig.6 quadrature performance testing

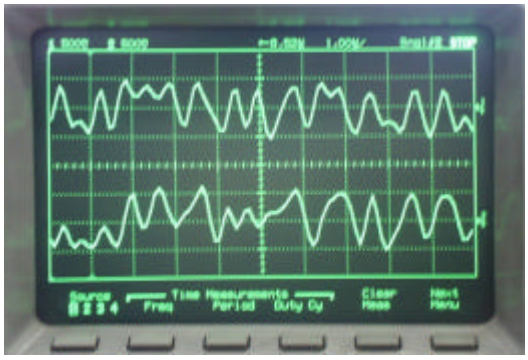

Fig.7 The time domain I/Q signal waveform of W-CDMA

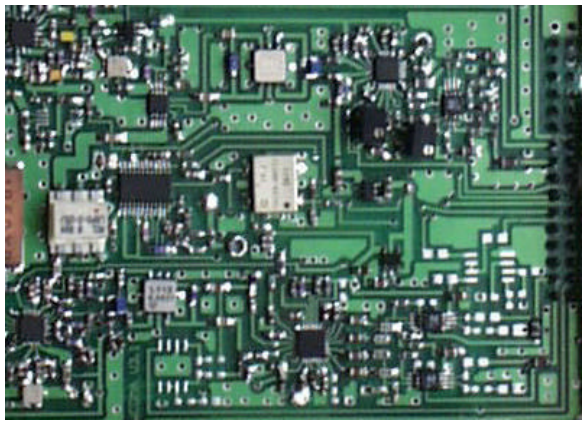

Fig. 8 The PCB photo of W-CDMA/GSM dual band/mode RF front-end