THE IMPLEMENTATION OF RTU AND RSU TRANSCEIVER FOR WLL SYSTEM

Young-Jun Chong, Sang-Gee Kang, Il-Kyoo Lee, Bong-Kyum Kim, Heon-Jin Hong

Radio Technology Section, Mobile Telecommunication Division, ETRI
161 Kajong-Dong, Yusong-Gu, Taejon, Korea

ABSTRACT: The implementation of RTU and RSU transceiver for Korean WLL system based on W-CDMA is presented in this paper. RTU transceiver consists of three boards; receiver, transmitter and RF controller. RSU transceiver is divided into three parts; receiver, transmitter and IF board. At the RTU receiver, the experimental measurement shows 2.86dB of NF and 60dB above of dynamic range in AGC locking. At the RTU transmitter, the -49.34dBc of ACPR is attained when the output power of the transmitter is 34.3dBm. At the RSU receiver, the measured of the NF shows 5.65dB. The measured ACPR of the RSU transmitter is -49.33dBc when the transmitter operates in normal state. These results are good enough to meet standard performance specifications.

I. INTRODUCTION

Recently the access-loop paradigm is shifting radically from the traditional wireline to a wireless model. WLL networks are different from mobile cellular systems in many aspects. Due to infrequent communications channel shifting and no hand-off function, the WLL system has a feasibility of construction and can give good qualities of various services such as low cost and high-speed data transmission. In fixed WLL systems, CDMA is much simpler due to the relaxed power-control constraints and the reduced fading rates. While the first implementation of WLL is targeting voice services, business customers will soon demand higher-data-rate services and broadband services. Residential subscribers will need Internet access and multimedia services. Referring to the "Proposed Wireless Local Loop Standard" as shown [1], we estimated the performance test using EEsof S/W. We also implemented RTU(Radio Transceiver Unit) and RSU(Radio Subscriber Unit) RF transceiver according to the simulation results and then described the test results in this paper.

II. PRINCIPLES OF OPERATION

A.RTU transceiver

A simplified block diagram of reverse link receiver and forward link transmitter chain is designed in Fig.1.

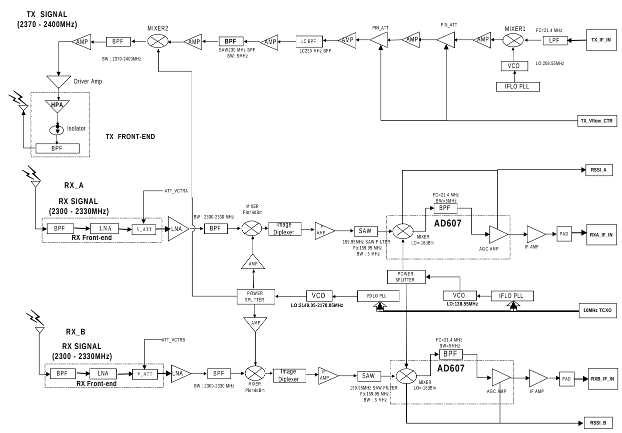

Fig.1 Block diagram of the RTU transceiver

The RTU receiver consists of receiver front-end and downconverter. It has three main functions: One is frequency down conversion from UHF(2300~2330MHz) to an IF of 21.4MHz, another is RSSI (Received Signal Strength Indicator), and the other is noise balancing through the controllable NF degradation.

The RTU transmitter consists of upconverter, frequency synthesizer and transmitter front-end. It provides four main functions: first is frequency up conversion from an IF to UHF(2370~2400MHz), second is filtering the signal to reduce spurious energy and noise power, third is adjusting gain control for the entire forward link, fourth determines frequency up/down converting and IF frequency and assign transceiver channel by the constant step[2].

B. RSU transceiver

A block diagram of forward link receiver and reverse

0-7803-4471-5/98/$10.00 (c) 1998 IEEE

link transmitter is designed in Fig.2.

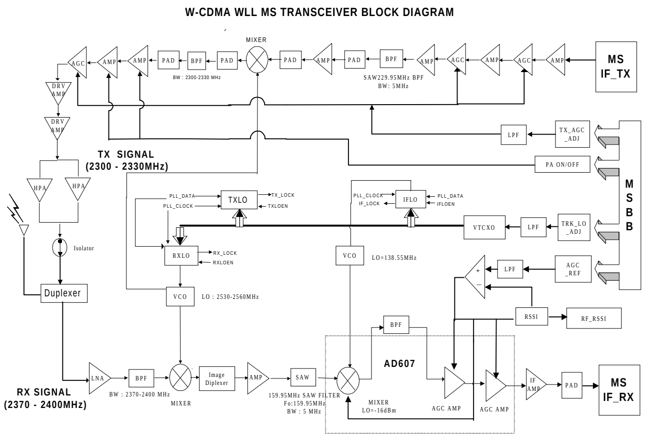

Fig. 2 Block diagram of the RSU transceiver

The RSU receiver provides frequency down conversion from UHF to an IF and control signal to the ADCs to maintain full-scale quantization, and to prevent overload through the AGC_REF.

The RSU transmitter provides frequency up conversion from an IF of 229.95MHz to UHF, and on/off function of the PA, and power control through the TX_AGC_ADJ signal, and frequency error compensation through the TRK_LO_ADJ signal[3].

III. DESIGN SPECIFICATIONS

A. RTU and RSU receiver design

The RTU and RSU receiver specifications are summarized in Table 1.

Table 1. RTU and RSU receiver specifications

Receiver parameter	Receiver requirements
Operating band	2300 ~ 2330MHz(RTU) 2370 ~ 2400MHz(RSU)
Noise figure	<5dB(RTU) <8dB(RSU)
IF Output power	-10 ± 5dBm @AGC lock(RTU) -20 ± 5dBm @AGC lock(RSU)

A. RTU and RSU transmitter design

The allocations of specifications for the transmitter are shown in Table 2.

Table 2. RTU and RSU transmitter specifications

Transmitter parameter	Transmitter requirements
Total spurious emission(ACPR; Adjacent Channel Power Rejection)	<-45dBc(RTU) <-42dBc(RSU) @greater than 2.5MHz from the CDMA channel center frequency
Re-radiation	-13dBm(max.) @RBW=30kHz
Output power	2W Max.(RTU) 200mW Max.(RSU)

IV. EXPEREMENT RESULTS

Fig. 5 shows the RTU up/down converter and frequency synthesizer, respectively. And Fig. 6 shows the RSU RF transceiver.

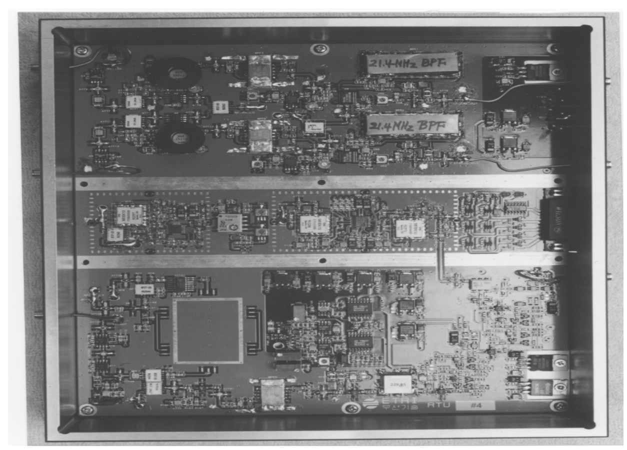

Fig. 5 The implemented of the RTU up/down converter and frequency synthesizer.

A. RTU and RSU receiver characteristics

When the input power of -99dBm is applied to receiver for the estimation of NF at the receiver, the measured CNR(Carrier-to-Noise Ratio) is –22.14dBc at the output port, as shown in Fig. 7. NF can be expressed in terms of CNR as follows.

$$NF \cong RF\ Pin + 174(dBm/Hz) - 10Log(RBW/Hz) + CNR \quad (1)$$

The experimental measurement of NF using Eq.(1) showed 2.86dB.

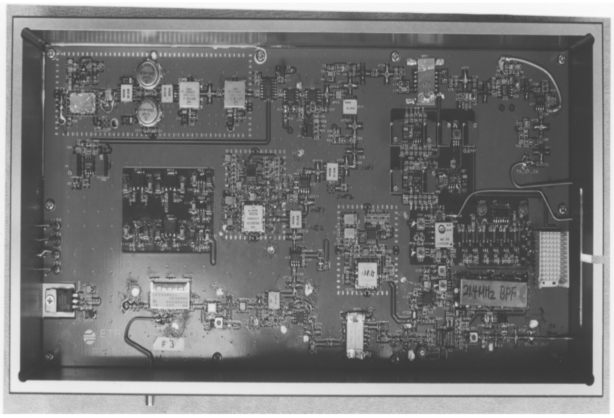

Fig. 6 The implemented of the RSU RF transceiver

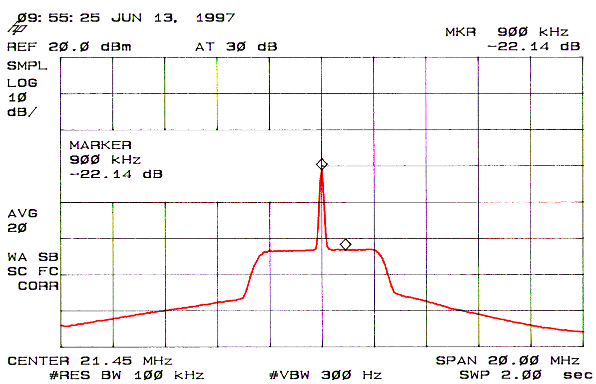

Fig. 7 The measured CNR of the RTU receiver

When AGC circuit was in operation, the control voltage value changed amplification of mixer and AGC amplifiers so that AGC circuit could sustain constant output power level versus the change of applied input power level. The measured RSSI of the RTU receiver(Fig. 8) showed dynamic range of 60dB above in AGC locking.

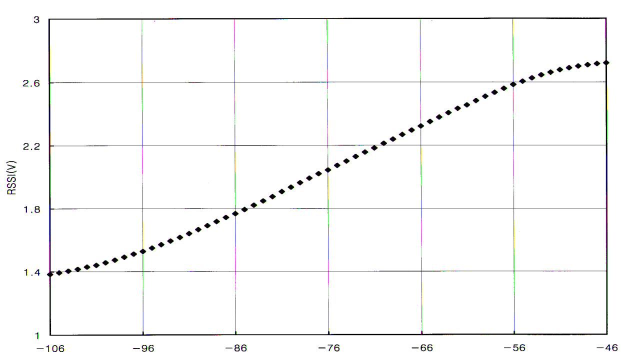

Fig. 8 The measured RSSI of the RTU receiver.

The transmitted W-CDMA signal of the RSU is applied to RTU receiver for reverse link test of the total system. When the input power of -70dBm is applied to RTU receiver, the measured result is shown in Fig. 9.

When the input power of -91dBm is applied to the RSU receiver, the measured CNR is –27.35dBc, as shown in Fig. 10. The experimental measurement of NF using Eq.(1) showed 5.65dB

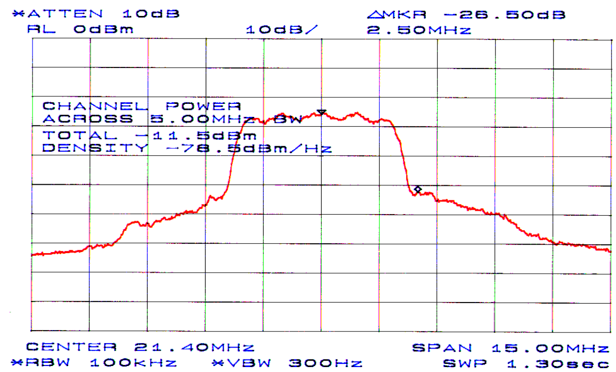

Fig. 9 The measured result of the reverse link (RTU receiver output)

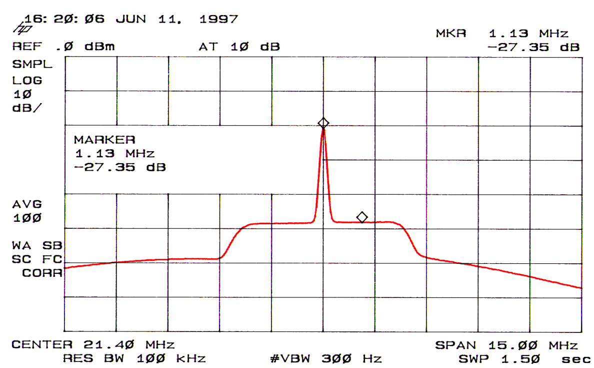

Fig. 10 The measured CNR of the RSU receiver

B. RTU and RSU transmitter characteristics

By applying the W-CDMA signal generated from the RTU IF to the RF transmitter, the ACPR is measured. The measured ACPR characteristics are –38.33dBc at the upconverter and –33.34dBc at the transmitter. The calculated ACPR using Eq.(2) are –54.33dBc and –49.34dBc, respectively. The spurious emission(or ACPR) can be expressed as

$$\text{Spurious emissions} = -P_{out}/P_{spur}(\text{dBc}) - 10\text{Log}(BW/RBW) \quad (2)$$

The measured result W-CDMA signal of the transmitter at the input port is shown in Fig.11. The measured ACPR characteristic of the upconverter and the transmitter are shown in Fig. 12 and Fig.13, respectively.

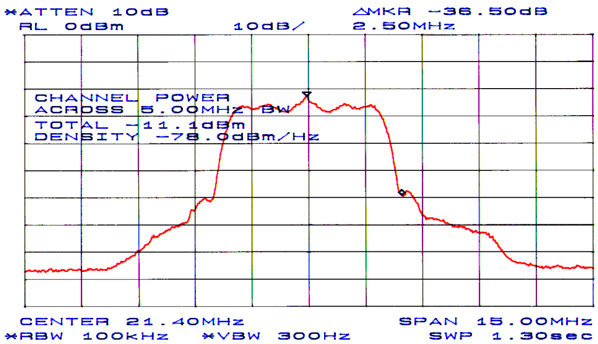

Fig. 11 The measured W-CDMA signal of the RTU transmitter at the input port.

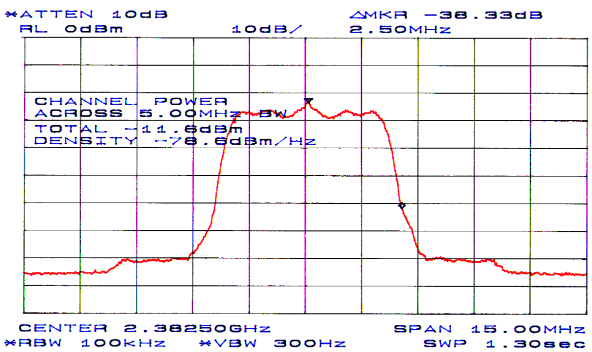

Fig. 12 The ACPR characteristic of the upconverter

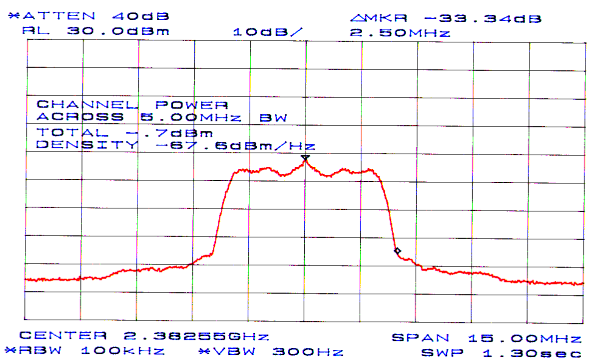

Fig. 13 The ACPR characteristic of the RTU transmitter

The W-CDMA signal generated from the RSU IF ia applied to the RSU RF transmitter. And then the ACPR characteristic is measured. The measured and calculated ACPR characteristic are –33.33dBc and –49.33dBc at the transmitter, respectively. The measured result W-CDMA signal of RSU IF at the output port is shown in Fig. 14. The measured ACPR characteristics of the RSU transmitter is shown in Fig. 15.

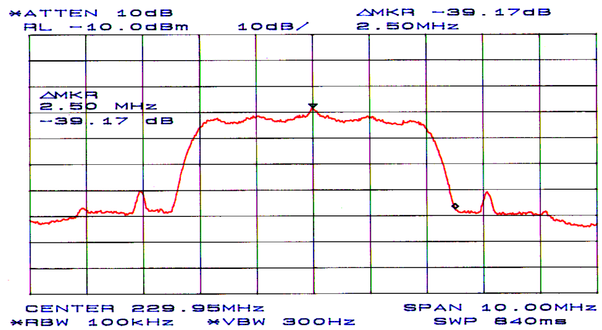

Fig. 14 The measured result of the W-CDMA output signal at the RSU IF.

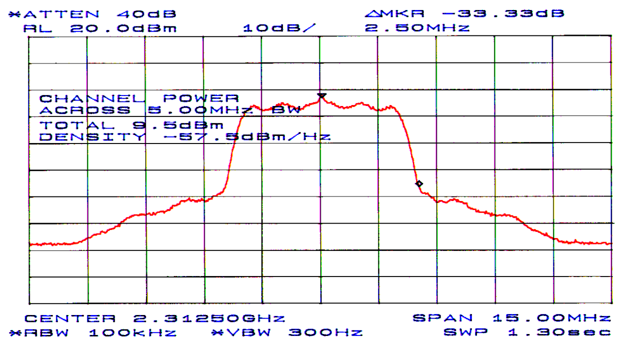

Fig. 15 The ACPR characteristics of the RSU transmitter (@normal operation state).

IV. CONCLUSIONS

We have developed RTU and RSU RF transceiver for WLL system based on W-CDMA to verify the proposed Korean WLL standard. The implemented RTU and RSU transceiver was tested and verified using test jig and analysis tool. Test results have shown the implemented RTU and RSU transceiver meets the requirements of the operating performance.

REFERENCES

[1] ETRI, *Proposed Wireless Local Loop Standard ver1.5*, Mar.1997.

[2] Y.J.Chong, et al, “A Design and Implementation of a Base Station Transceiver for WLL System”, 2nd CIC, pp464-468, Seoul, Korea, Oct.1997.

[3] QUALCOMM, *CDMA Mobile Station Modem2*, 1995.7.

[4] P.Washkewicz, “Standardized IS-95 CDMA system simulation aids advanced designs”, RF Design, pp47-54, Oct.1996.

[5] S.W. Chen, et al, “Effects of nonlinear distortion on CDMA communication systems”, IEEE MTT-S Digest, pp775-778, Sanfranscisco, USA, Jun. 1996.