VC200 SERIES OF MOBILE PHONE TESTERS FOR W-CDMA AND GSM DUAL-MODE TERMINALS

ISHIZU Tetsu [*1] *TODA Hideyuki* [*1] *CHUUMA Hidehiro* [*1] *KIMURA Tooru* [*1]

We have developed the VC200 series of mobile phone testers for both wideband-code division multiple access (W-CDMA) and global system for mobile communications (GSM) mobile phones. The VC200 series is a line of simplified testers, enabling users to test W-CDMA/GSM dual-mode terminals with just one tester, as well as test for both W-CDMA and GSM protocols at one time. Users can test mobile phones for signaling, voice calls, and radio characteristics using simple operations. The VC200 is thus suited for failure diagnoses at service shops or final inspections on production lines.

INTRODUCTION

The mobile phone has become explosively popular since entering the 21st century. One out of every three people in the world owns one (Deloitte's forecast for 2005) and in Japan, most people have one. Among mobile phone models, a W-CDMA/GSM dual-mode terminal that supports both the Global System for Mobile Communications (GSM) standard that features global-scale service areas, and the third-generation Wideband-Code Division Multiple Access (W-CDMA) standard that provides high-speed, high-quality communication service is now the focus of attention. Accordingly, there is a rapidly growing demand for mobile phone testers whereby mobile phones can be conveniently and quickly tested for compatibility with these two communications standards. These testers are mainly used at the service offices of mobile-phone service providers or manufacturers for primary fault diagnosis in response to customer complaints or in the module inspection process and/or final inspection process at mobile phone production lines. They therefore need to be compact and lightweight, as well as easy to operate without the need for any specialist knowledge.

Yokogawa released the VC100 series as a portable tester in July, 2002, and has enhanced the series this time, achieving compatibility with both the W-CDMA and GSM standards on the same platform. Figure 1 shows an external view of the VC200 series.

Figure 1 External View of the VC200 Series

*1 Communications and Measurement Business Headquarters

Table 1 Supported Frequency Bandwidths

W-CDMA Standard	Downlink	Uplink
Band I	2110 – 2170 MHz	1920 – 1980 MHz
Band II	1930 – 1990 MHz	1850 – 1910 MHz
Band III	1805 – 1880 MHz	1710 – 1785 MHz
Band IV	875 – 885 MHz	830 – 840 MHz
GSM Standard		
GSM850	869.2 – 893.8 MHz	824.2 – 848.8 MHz
P-GSM	935.2 – 959.8 MHz	890.2 – 914.8 MHz
E-GSM	925.2 – 959.8 MHz	880.2 – 914,8 MHz
R-GSM	921.2 – 959.8 MHz	876.2 – 914.8 MHz
DCS1800	1805.2 – 1879.8 MHz	1710.2 – 1784.8 MHz
PCS1900	1930.2 – 1989.8 MHz	1850.2 – 1909.8 MHz

FEATURES

(1) Compact and Lightweight
The VC200 series supports both the W-CDMA and GSM standards, while being compact and lightweight (external dimensions: 283 mm(W)×176 mm(H)×303 mm(D); weight: approximately 6.5 kg).

(2) Supports All of the W-CDMA/GSM Frequency Bandwidths (Table 1)
As a simplified tester, the VC200 series supports all of the main frequency bandwidths of W-CDMA/GSM for the first time worldwide (as of November, 2004), thanks to its wideband RF transmission/reception characteristics.

(3) Various Measurement Modes
The VC200 tester implements the Tx/Rx test mode that performs transmitter/receiver tests without establishing a call connection and a signaling test mode that performs call connection tests, voice call tests, and radio characteristics tests with the call connection established. In addition, the signaling test mode provides an automatic test mode for performing tests according to the scenario stated in the model parameter file and a manual test mode for performing desired tests freely.

(4) Setup from an External PC
All the operations practicable on the tester display can be controlled by sending communication commands from a personal computer connected to the tester via the Ethernet* or serial port. Moreover, it is possible to create new model parameter files, edit existing files, or add to the files used in the automatic signaling test mode. Thus, users can easily configure the model parameter files while confirming the test items, test conditions and evaluation criteria on a list.

(5) Easy Addition and Updating of Software
Users' firmware can easily be updated by downloading its latest version distributed via the Internet to an external storage device, such as a USB thumb drive, and clicking buttons on the tester display. In addition, using a procedure similar to the above, users can add extended software for printers as necessary.

CONFIGURATION

Hardware Configuration

Figure 2 shows the hardware configuration of the VC200 series. The tester consists primarily of three modules—a CPU module, a baseband (BB) module, and an RF module. It has two functional blocks, i.e., a downlink transmitter for generating signals to be sent to the mobile phone under test, and an uplink receiver for receiving and analyzing signals sent from the mobile phone.

- Downlink Transmitter
The transmitted information is multiplexed using a BB circuit board, subjected to digital signal processing, such as filtering,

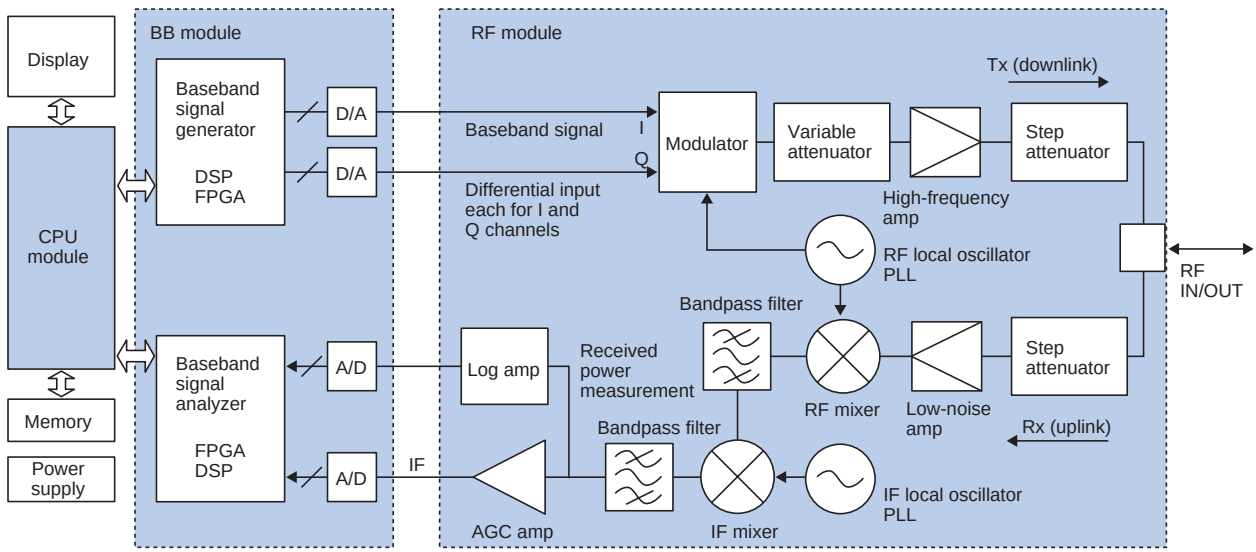

Figure 2 VC200 Hardware Configuration

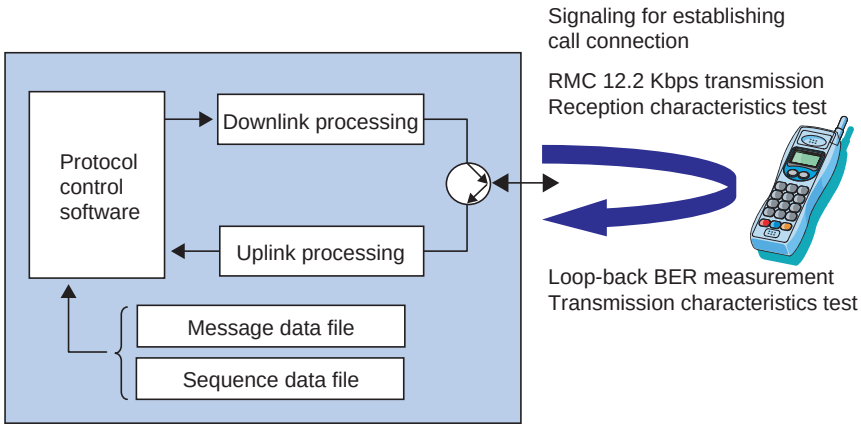

Figure 3 W-CDMA Signaling Operations

and converted into I/Q baseband signals using D/A converters. On the BB circuit board, the field programmable gate array (FPGA) and the digital signal processor (DSP) are reprogrammed so that the same hardware can be used to support both W-CDMA and GSM. The baseband signal sent to the RF module is converted with a quadrature modulator into a modulated wave with a frequency appropriate for the specified communication channel. Then, after being adjusted to the desired output level with an amplifier and an attenuator, the baseband signal is sent out to the mobile phone as a downlink signal.

- Uplink Receiver
  The signal (uplink) sent out from the mobile phone, after being adjusted to an appropriate signal level with the attenuator, is frequency-converted to an IF signal. In many cases, a duplexer is used in combination with band-specific filters since a received signal may cross-talk with a transmitted signal as the transmitter and receiver are connected to each other via the common I/O terminal. In the case of the VC200 tester however, it is possible to separate the transmitted signal from the received signal with the minimum hardware configuration by combining frequency conversion and filtering. The signal whose frequency has been converted to the intermediate frequency is adjusted to the optimum amplitude with an AGC amplifier, and digitized using the A/D converters of the BB circuit board. Then, the signal is subjected to digital signal processing for demodulation and analysis. For received power measurement that is another important measurement item, we have realized extremely wide power measurement dynamic ranges (−70 to +35 dBm for W-CDMA and −40 to +35 dBm for GSM) by analog-processing the frequency-converted, band-limited received signal with a log amplifier.

Compatibility with W-CDMA

W-CDMA is one of the international mobile telecommunications systems formulated by the 3rd Generation Partnership Project (3GPP). In the case of W-CDMA, the transmission technology for access lines including their wireless sections has been updated from that of GSM. On the other hand, W-CDMA has become increasingly compatible with GSM in terms of the core network technology. Thus, W-CDMA is a mobile telecommunications system that has been developed taking into consideration the ease with which telecommunications service providers can shift from their existing QSM systems.

Quadrature phase shift keying (QPSK) modulation, hybrid quadrature phase shift keying (HPSK) demodulation, W-CDMA physical channel mapping, error-correcting coding, Viterbi decoding, logical channel mapping, and signaling protocol processing are necessary to realize testers compatible with the W-CDMA wireless interface. Of these functions, those which require processing speeds high enough for a frame period of 10 ms are coped with using the BB module and all other functions are coped with using the CPU module. For the CPU module, the software has been built on a general-purpose operating system widely used for personal computers. As a result, it is possible to implement those functions in a short period of time.

Compatibility with GSM

GSM uses a wireless technology based on Time Division Multiple Access (TDMA) that differs significantly in the wireless access method from W-CDMA. On the other hand, it is desirable for mobile phone testers for field service use to remain compact and lightweight without the need for any additional hardware even if they are dual-mode models. We have succeeded in maintaining the volume and weight of the VC200 series same as those of the conventional VC100 series by standardizing the hardware configuration while adding GSM-compatible functions to the VC200 series.

Specifically, dual-mode mobile phone testers require Gaussian-filtered minimum-shift keying (GMSK) modulation/demodulation, TDMA framing, logical channel and GSM burst mapping, error-correcting coding, and signaling protocol processing. For the VC200 series, we have achieved compatibility with GMS by simply adding software after reconfiguring the hardware platform common to W-CDMA in a programmable manner.

MEASUREMENT FUNCTIONS

W-CDMA Measurement Functions

In order to perform the radio characteristics testing of W-CDMA terminals, we have implemented a signaling function compliant with the procedure of the Conformance Test specified by 3GPP. 3GPP stipulates in its test standards that a dedicated wireless channel (Reference Measurement Channel: RMC) be used when measuring radio characteristics. It is therefore possible

Table 2 W-CDMA Radio Characteristics Measurement Functions

Classification	Measurement Item	Details
Transmission characteristics test	Maximum transmission power	3GPP TS34.121 V5.2.0 (2003-12) Sec. 5.2
	Minimum transmission power	3GPP TS34.121 V5.2.0 (2003-12) Sec. 5.4.3
	Open-loop power	3GPP TS34.121 V5.2.0 (2003-12) Sec. 5.4.1
	Inner-loop power	3GPP TS34.121 V5.2.0 (2003-12) Sec. 5.4.2
	Modulation accuracy	3GPP TS34.121 V5.2.0 (2003-12) Sec. 5.13.1
	Frequency error	3GPP TS34.121 V5.2.0 (2003-12) Sec. 5.3
Reception characteristics test	Strong-electric-field reception	3GPP TS34.121 V5.2.0 (2003-12) Sec. 6.3
	Minimum sensitivity	3GPP TS34.121 V5.2.0 (2003-12) Sec. 6.2

Table 3 GSM Radio Characteristics Measurement Functions

Classification	Measurement Item	Details
Transmission characteristics test	Transmission power	3GPP TS11.10 Part II .3
	Phase error	3GPP TS11.10 Part II .3
	Frequency error	3GPP TS11.10 Part II .3
	Burst timing	3GPP TS11.10 Part II .3
Reception characteristics test	Reception quality	3GPP TS05.08
	Reception level	3GPP TS05.08
	FER	3GPP TS11.10 Part II .4
	RBER	3GPP TS11.10 Part II .4

to execute stable radio characteristics measurements and voice-based operation tests under the conditions of actual use by switching between the RMC and the usual voice call channel according to the test item in signaling operations based on protocol control software. On the other hand, the 3GPP standard is an international standard subject to day-to-day performance improvement and function addition. Consequently, signaling operations may be or may not be possible depending on the version of the standard supported by the mobile phone under test even if it is a W-CDMA terminal. To cope with this issue, we have made it possible for the VC200 series to support multiple versions of the standard by isolating message and sequence data that define signaling operations from the firmware and controlling the data as independent files (Figure 3).

Table 2 summarizes the W-CDMA radio characteristics measurement functions. The user can select either the automatic test mode or the manual test mode to implement these measurement items. By selectively using these two test modes, the user can, for example, switch to the manual test mode after performing a simple pass/fail test in the automatic test mode, in order to execute detailed diagnoses for those measurement items which have been judged as “fail.” Thus the user can continuously perform a series of processes, from fault-finding to cause isolation.

GSM Measurement Functions

The VC200 series is complete with signaling functions necessary for the functional and operational testing and radio characteristics measurement of GSM terminals—location registration, origination, reception, network-side disconnection, terminal-side disconnection, terminal-side looping back, network-side looping back, and frequency handover.

Table 3 summarizes the GSM. radio characteristics measurement functions. Like W-CDMA, the user can select either the automatic test mode or the manual test mode to implement these measurement items. Also for GSM-specific test items, the user can perform various examinations, from simple pass/fail judgment to detailed diagnosis, in the same manner of operation as with W-CDMA.

CONCLUSION

In this paper, we have introduced the characteristic functions of the VC200 series. The VC200 series has various measurement modes while being easy to operate, is lightweight and compact, and can therefore be used in many different places. We plan to add functions to the VC200 series so that it will be able to meet further customer needs. ◆

* Ethernet is a registered trademark of Fuji Xerox Co., Ltd.