MD8475B Signalling Tester Development for LTE-Advanced Commercial Terminal Evaluation

Tsuyoshi Sato, Hideya Jokawa, Hirofumi Kanno, Yasuyuki Matsuyama, Masato Sasaki, Keisuke Taniwaki, Hiroyuki Tanikage, Takuma Goto, Yuichi Negami

[Summary] Operators are accelerating deployment of the latest LTE-Advanced mobile communications technology developed in parallel with the Long Term Evolution (LTE) technology as a means to cope with the explosive increase in data traffic resulting from the popularity of mobile terminals. In addition to these new technologies, existing mobile systems (2G to 3.9G) represented by GSM and W-CDMA are still in widespread use. We developed the MD8475B Signalling Tester as an all-in-one measurement solutions supporting all the main mobile communications standards ranging from 2G to the latest LTE-Advanced. This article describes the function required for test of commercial mobiles, as well as some solutions for various test applications.

1 Introduction

Deployment of LTE-Advanced developed in parallel with its predecessor Long Term Evolution (LTE) technology by operators worldwide is accelerating to support the explosive increase in data traffic resulting from the widespread use of Internet of Things (IoT) devices. In addition, mobile devices using 2G and 3G technologies such as GSM, W-CDMA, CDMA2000, and TD-SCDMA as well 3.5G devices using HSPA and EV-DO technologies are still in widespread continued use. To support seamless communications between all these technologies ranging from 2G through to the latest LTE-Advanced with different standards, we have developed the MD8475B Signalling Tester operating as a base station simulator (Figure 1). In addition to fundamental call processing connection tests, this tester also has functions for performing data transmission tests, power consumption tests, and multi-cell tests. In addition, it supports various service test functions using Internet protocol Multimedia Subsystem (IMS) frameworks such as Voice over LTE (VoLTE). This article describes the design strategy and details of this development.

Figure 1 MD8475B Signalling Tester

2 Design Concept

LTE-Advanced is a wireless communications technology offering even faster speeds than its predecessor LTE. It features a Carrier Aggregation (CA) technology that aggregates several communications bands together. It transmission rates of better than 1 Gbps by combining Multiple-Input and Multiple-Output (MIMO) antenna technology with 256 Quadrature Amplitude Modulation (QAM) Additionally, it operates in coexistence with legacy and current mobile networks. We adopted the following design concept for the MB8475B to meet these measurement needs.

- To provide all-in-one support for 4CA 2×2 MIMO IP data transmissions, support 8 independent RF transmissions as well as a TRx bandwidth of 160 MHz in consideration of future expandability.
- Support LTE Advanced in Unlicensed Spectrum (LTE-U) and Licensed Assisted Access using LTE (LAA) covering the 5 GHz unlicensed spectrum used by LTE-U with an upper frequency limit of 6 GHz.
- To cope with the increasing complexity of test environments resulting from the increasing Component Carriers (CC) number, implement a front end combining multiple CC internally.
- Consider fundamental functions for total evaluation tests of commercial mobile terminals and assure compatibility between users' test environments and automatic test environment. As result, develop the MB8475B as a tester for 2G to LTE-advanced technologies based on the experience with MD847A applications.
- Offer an upgrade path assuring continuity with previous

MD8475A hardware and software investments.

- Design-in hardware extensibility considering future advances in LTE-Advanced technologies.

3 Hardware System Design

3.1 RF Unit

To support all 3GPP-specified frequencies and LTE-A/LAA, the RF unit is designed to support testing over a wide frequency range from 350 MHz to 6 GHz. Moreover, the TRx frequency band is extended to 160 MHz to support Intra-band contiguous CA. In addition, there are 8 downlink (DL) ports and 4 uplink (UL) ports to support 4CA 2×2 MIMO, 2CA 4×4 MIMO, and UL 2CA Mobility tests.

3.2 Front End Unit

Evaluation of high-speed communications performance using LTE-Advanced CA technology requires a tester with a function for outputting a DL signal combining multiple CCs. As a result, the MD8475B uses an internal front end to combine up to 4CCs while assuring level accuracy. Using this function supports easy user 4CA tests without the need for an external coupler.

The MD8475B Main port can output the combined signal from up to four RF units as well as accept input of up to four RF units. Each Aux port can output the combined signal from up to four RF units as well as accept input of up to two RF units (Figure 2). Using the Aux and Aux2 supports the Handover Mobility test from the UL 2CA condition without an external coupler. Moreover, the hardware configuration also supports future combination with UL MIMO.

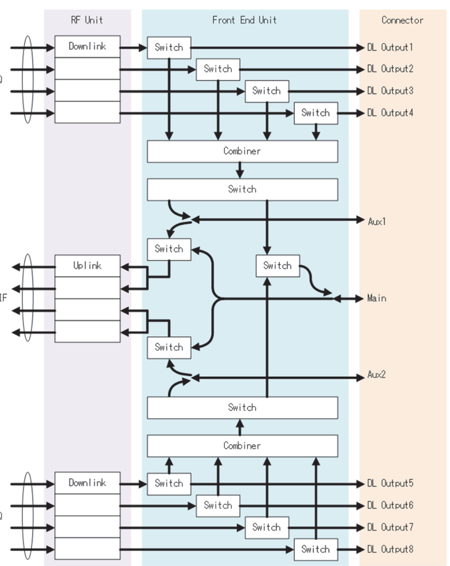

Figure 2 Transceiver Block Diagram

3.3 Tx Baseband Unit

The MD8475B Tx baseband unit uses a high-speed serial baseband signal interface that can support external output using a Fading IO option to expand the communications bandwidth. It is configured to extend the MD8475A usage targeting multi-antenna/multi-carrier fading environments, additional CC numbers, and high-order MIMO. Moreover, addition of a high-speed DA converter and strengthened FPGA resources compared to the previous design supports a 20 MHz + 20 MHz Contiguous Component Carrier test environment using one RF unit.

3.4 CPU Unit

To provide an optimum future-proof simulation environment, the MD8475B uses a high-performance Intel Core i7 host processor. The large, 12.1”, high-resolution LCD unit is the same as the predecessor MD8475A. A touch panel supports intuitive GUI operations reducing the need for hard keys. Bonding the touch panel and LCD glass not only improves screen visibility but also improves touch position accuracy from a deep viewing angle, as shown in Figure 3.

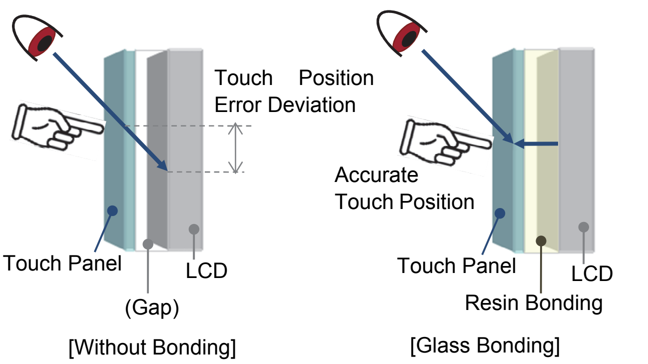

Figure 3 Glass Bonding Effect

3.5 Main Unit Hardware Design

Figure 4 shows the internal structure of the MD8475B main unit. To maintain full compatibility with the MD8475A, the configuration uses up to four printed-circuit boards, supporting an easy upgrade from the MD8475A to the MD8475B.

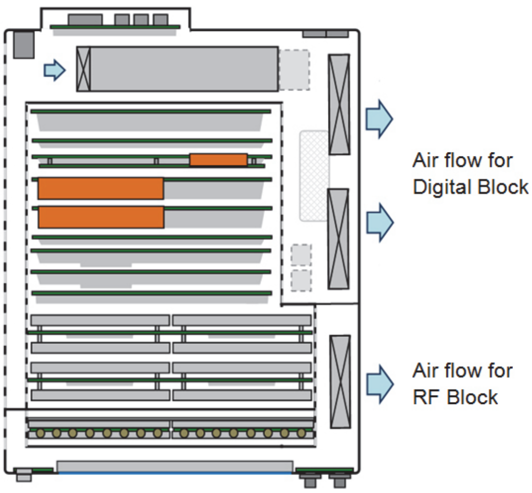

Figure 4 MD8475B Main Unit Internal Layout

To implement high-parts density with the minimum footprint, the cooling ventilation uses lateral intake and exhaust flows for both silent and effective internal cooling. Additionally, using separate fans for the RF and Digital blocks helps keep a constant temperature throughout the cabinet even when different sections under load need rapid cooling performance.

The headset for voice tests has been changed from the dedicated set used by the previous MD8475A to an easily available general-purpose headset. In consideration of user operability, the position of the headphone and microphone jacks has been moved to the front panel as shown in Figure 5.

Figure 5 Headset Connection

4 LTE-Advanced Design

4.1 LTE-Advanced Carrier Aggregation

The CA technology introduced in 3GPP Release 10 and extended in Release 11 covers specifications related to use of three or more CCs more against a background of rising traffic demand. We have added functions to the MD8475B to satisfy these 3GPP specifications for tests of 3 or more CCs.

4.1.1 LTE Simulation Software Design Concept

The MD8475B retains compatibility with its predecessor MD8475A and also supports tests of 3 or more CCs. To meet these needs, we designed the LTE simulation software built into the LTE unit based on the following design concepts.

- Use MD8475A LTE unit and maintain functional compatibility with MD8475A
- Support DL 4CCs
- Support UL 2CCs

4.1.2 LTE DL 4CCs

The DL 4CCs technology divides the LTE unit into two units each of which handles 2CCs as shown in Figure 6. Both units work cooperatively to support the Hybrid Automatic Repeat request (HARQ) function.

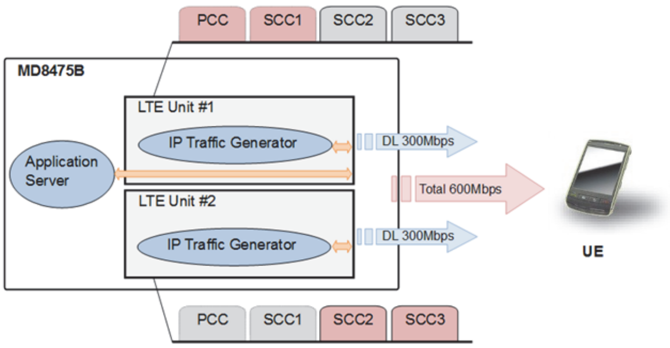

Figure 6 Dual-Unit Configuration

4.1.3 IP Throughput Test

Supporting LTE-Advanced requires a test environment for high-throughput communications. However, since the throughput test results at high throughput rates are affected by the server PC performance, test environment configuration is difficult. To facilitate easy configuration of a stable test environment, we have incorporated an IP packet generation function in the LTE unit for generating and sending IP packets.

This function supports IP data throughput evaluation using iperf. In addition, IP data throughput can also be evaluated without requiring an external server PC.

Furthermore, the two LTE units are used at the IP data throughput test. Multiple Bearers are established for the Default EPS Bearer and Dedicated EPS Bearer between the commercial terminal and network, and the path of the User Plane of the operating as the Secondary Component Carrier (SCC) operates as the Dedicated EPS Bearer to support IP data throughout tests with four CCs.

4.1.4 Future Expandability

We expect the MD8475B to support both DL 4×4 MIMO as well as SL 256 QAM introduced by 3GPP Release 12.

Combining these functions with CA will support demand for higher throughput.

4.2 Application Design

4.2.1 SmartStudio Development

Previous signalling testers required creation of a test scenario matching the test contents. As tests of commercial mobile terminals become increasingly complex, more complex scenario scripts must be created and managed, requiring many work hours to configure a simulation environment. To solve this problem, we developed the SmartStudio application software for the MD8475A/B. This software tool reproduces the various communications conditions between the base station and mobile terminal based on the concept of improving the "smartness" of difficult testing.

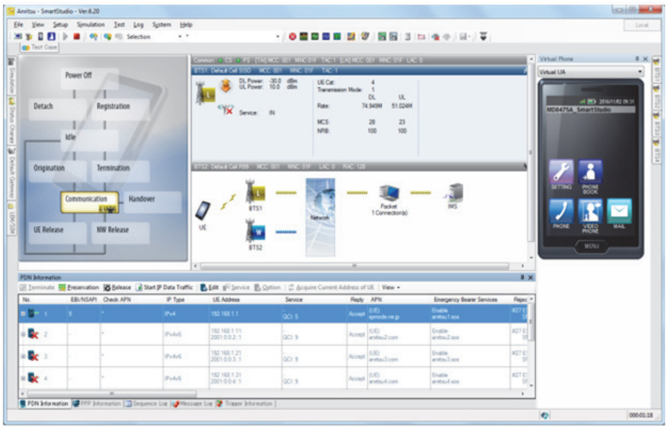

Figure 7 SmartStudio

SmartStudio simplifies base station operations for easy confirmation of fundamental connection operations such as voice calls from the DUT terminal, packet communications, SMS sending/receiving, etc. On the other hand, more efficient use of frequency resources is needed to cope with the recent spread of smartphones and the anticipated explosive future increase in smart devices, Consequently, a key issue will be future deployment of social infrastructure, as well as commercial terminals incorporating new technologies such as LTE-Advanced to support this infrastructure. With up to eight Tx and four Rx built-in RF units, the MD8475B is designed to help solve these issues by supporting simulation of various mobility tests and CA MIMIO throughput evaluations under Intra/Inter-RAT environments between multiple cells of multiple systems.

To offer functions for increasingly faster throughput rates, the MD8475B has a packet generation function described in section 4.1.3 for implementing a stable throughput test environment as well as an iperf equivalent GUI (Figure 8) for supporting network throughput measurements at DL speeds up to 600 Mbps and UL speeds up to 50 Mbps. This simplifies test systems by eliminating time-wasting preparations, such as selecting the TCP/UDP protocol and communications ports at the external server.

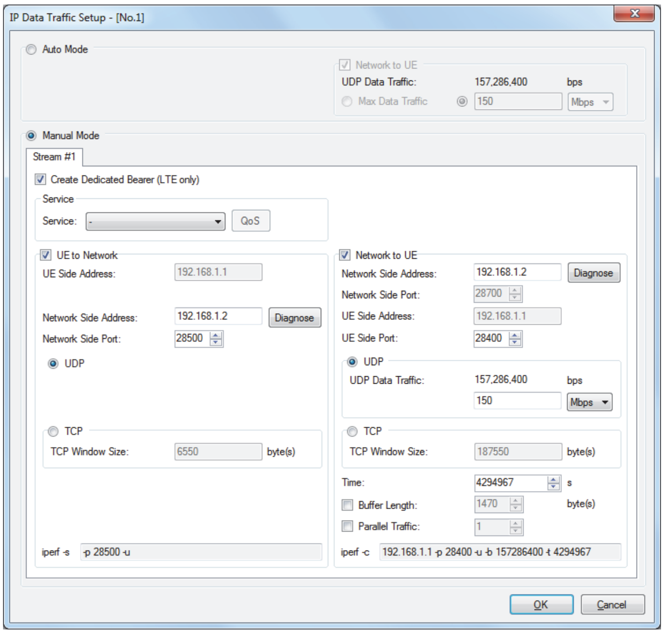

Figure 8 IP Data Traffic Function

The following describes an example of a solution combining the connection convenience of SmartStudio with the performance of the MD8475B tester.

Battery life is a critical deciding point for users choosing a new mobile. As a solution for confirming battery endurance, in addition to setting the GSMA TS.09-defined parameter Battery Consumption parameters and running a test to check the operation of terminal applications under a constant environment, the MD8475A has is a drive test function for setting information about an actual multi-cell environment at SmartStudio and monitoring changes in power consumption while driving on an expressway. This type of complex simulation environment is easily configured.

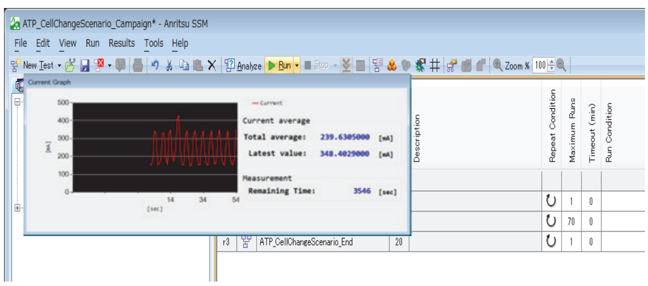

Figure 9 Power Consumption Monitor at Drive Test Simulation

In addition, as an example of a solution supporting telematics services, we have developed software (MX703330E) for simulating guidance used by European, Russian, etc., emergency vehicle assistance systems such as eCall, ERA-GLONASS, etc. A future aim is to help play a role in future public deployments of next-generation telematics smart infrastructure, etc., by supporting a valuable simulation environment.

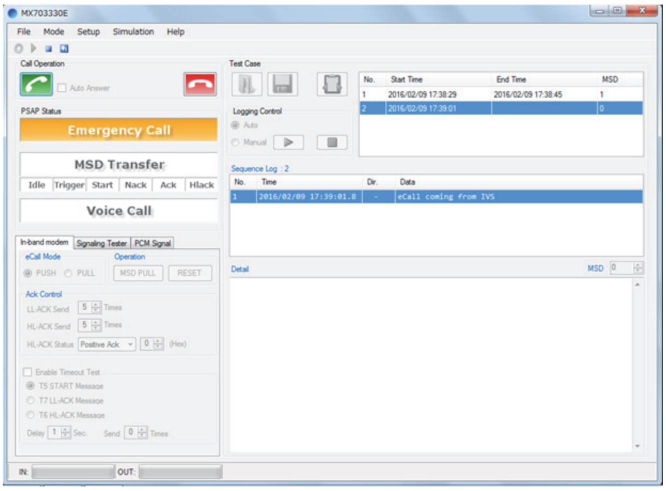

Figure 10 Automobile Emergency Information System Solution

4.2.2 Preinstalled Servers

Mobile communications networks are adopting IMS as a fundamental technology supporting All IP conversion following introduction of LTE to offer new voice services such as VoLTE and messaging services. The MD8475B incorporates a number of pre-installed servers (Table 1) to support a complete test solution focused on these IMS services.

Table 1 Pre-installed Servers

Server	Service Outline
CSCF (Call Session Control Function)	In addition to test functions for standard services such as VoLTE, and SMS over IMS, also has loopback function for audio data
DHCPv6 (Dynamic Host Configuration Protocol v6)	Allocates IPv6 address to nodes participating in network and performs DNS/SIP server address notification
DNS (Domain Name Server)	Operated as DNS cache server
NDP (Neighbor Discovery Protocol)	Provides function for sending RA (Router Advertisement) supporting RS (Router Solicitation) as well as for sending RA periodically
NTP (Network Time Protocol)	Sends time in response to NTP request and synchronizes MD8475B time clock
PSAP (Public Safety Answering Point)	Provides UA and audio data loopback functions to simulate PSAP to perform IMS Emergency tests
XCAP (XML configuration access protocol)	Perform operations such as updating, referencing and deleting XMLformat file data (XCAP documents)
BSF (Bootstrapping Server Function)	References 3GPP-defined GBA Authentication algorithm to simulate authentication procedures required when connecting to Internet via non-home networks

Offering a complete IMS network within the MD8475B main frame, supports the following test procedures simply by setting parameters at the GUI as shown in Figure 11.

- Difficult-on-live-network quasi-normal and fault tests
- Emergency call tests prohibited on live networks
- Handover test in changing wireless environment
- Mobility tests such as Single Radio Voice Call Continuity (SRVCC) required due to external factors such as other user

Additionally, the MD8475B also supports configuration of a VoLTE test environment under CA condition introduced by the latest LTE-Advanced communications technology.

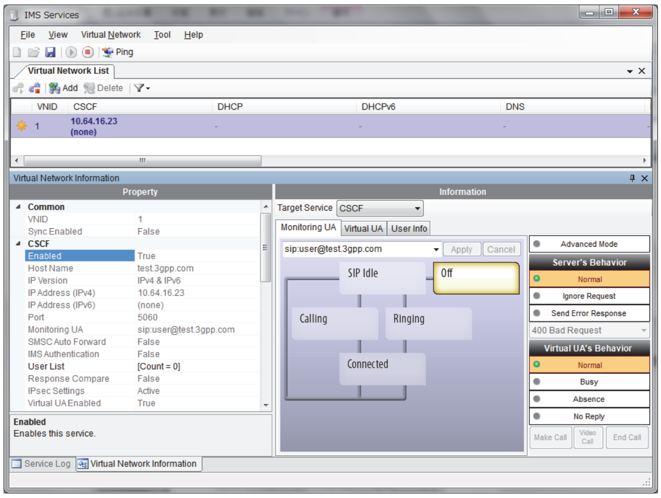

Figure 11 IMS Services

4.2.3 WLAN Offload Test

Offloading of data to WAN networks is being developed as a basic technology for solving cellular network traffic congestion problems. WLAN Calling implemented by making voice calls and sending/receiving SMS over WLAN using the telephone number registered in the SIM card in the same way as using the 3GPP network, and the testing is extremely difficult. The MD8475B can be used to configure test environments for offloading data to a WLAN, WLAN Calling, and Handover between a WLAN and LTE network during communications (Figure 12). The MD8475B has built-in functions for transferring packets between terminals and WLAN and LTE networks, and for monitoring and graphically displaying communications packets to confirm the connection status and throughput.

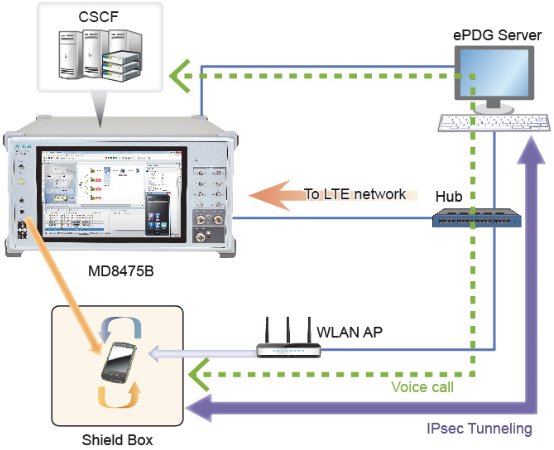

Figure 12 WLAN Calling Test Environment

4.2.4 Automatic Testing

At development of commercial terminals, it is important not to omit regression testing of existing as a result of software upgrades. Regression testing measures predetermined test items to that there are no new bugs and there are requests for continuous automated testing to improve development efficiency. We developed SmartStudio Manager (Figure 13) to help solve this problem using functions for editing test sequences as well as for executing created test sequences automatically and continuously. As shown in Figure 14, using SmartStudio Manager, items can be added to and deleted from the continuous tests and the test item sequence can also be switched easily. Automating tests improves test efficiency by enabling operator-free testing, including output of Pass/Fail evaluation reports according to the continuous test results (Figure 15).

Test Sequence Editing Screen

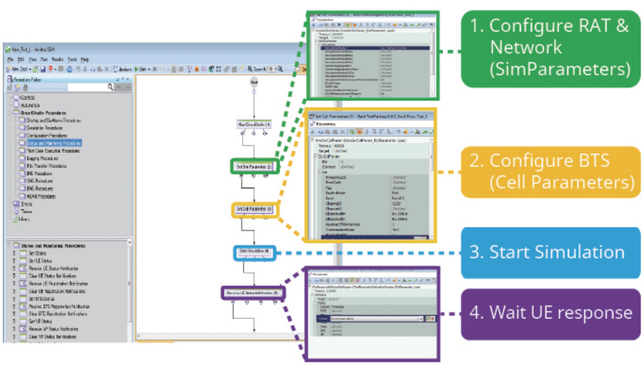

Figure 13 Automatic Test Environment—Sequence Editing

Test Sequence Continuous Execution Screen

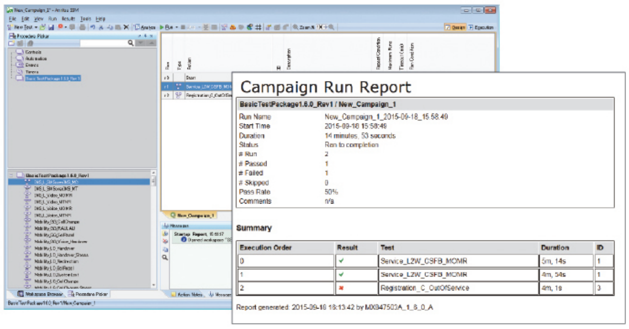

Figure 14 Automatic Test Environment—Continuous Execution

Test Sequence Continuous Execution Results Display

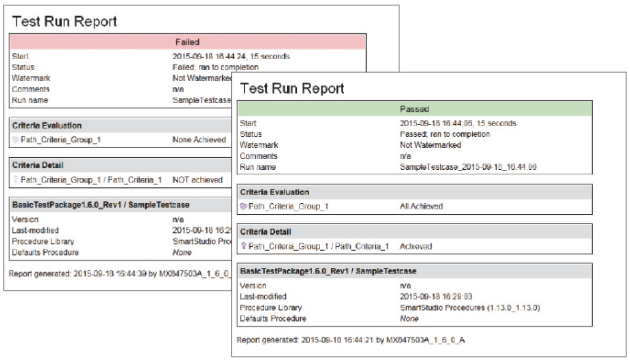

Figure 15 Automatic Test Environment—Report Output

5 Conclusion

We have developed the MD8475B to help play a role in development of commercial mobile terminals MD8475B by supporting both previous mobile communications standards ranging from 2G to 3.9G still in widespread use worldwide along with the latest LTE-Advanced mobile standard. A single MD8475B unit supports nearly all mobile communications standards, and offers data transmission tests, battery power consumption tests, and IMS-based services tests in addition to basic calling connection tests. In addition, this article introduces some examples of application solution based on these functions including automotive solutions, WLAN Calling, automated test environments, etc. Anritsu will continue to play a major role in development of mobile communications by supporting new technologies and test solutions for future 3GPP standards and evolving 5G mobile systems, etc.

References

1) GSM Association TS.09

"Battery Life Measurement and Current Consumption Technique "

Authors

Tsuyoshi Sato
3rd Product Development Dept.
R&D Division
Measurment Business Group

Hideya Jokawa
3rd Product Development Dept.
R&D Division
Measurment Business Group

Hirofumi Kanno
3rd Product Development Dept.
R&D Division
Measurment Business Group

Yasuyuki Matsuyama
3rd Product Development Dept.
R&D Division
Measurment Business Group

Masato Sasaki
3rd Product Development Dept.
R&D Division
Measurment Business Group

Keisuke Taniwaki
3rd Product Development Dept.
R&D Division
Measurment Business Group

Hiroyuki Tanikage
3rd Product Development Dept.
R&D Division
Measurment Business Group

Takuma Goto
Mobile System Dept.
1st Business Division
Anritsu Engineering Co.

Yuichi Negami
3rd Product Development Dept.
R&D Division
Measurment Business Group