Battery Consumption Test

MD8475A Signalling Tester

1. User Focus on Battery Consumption

Although smartphone users are satisfied with the multifunctionality and convenience of their devices, they have some concerns about battery consumption. In a customer survey, 75% of smartphone users said they were either unsatisfied or somewhat unsatisfied with battery consumption. At a website handling smartphone rankings and user reviews with data about smartphone battery consumption, battery consumption or battery life was one of the key factors reported in the decision to purchase a smartphone.

The focus on smartphone battery consumption compared to earlier mobile phones (or feature phones) is due to the increased power consumption. Since smartphones have a large easy-to-use 4-inch liquid-crystal display (LCD) unlike earlier feature phones, users commonly spend much more time visiting websites handling large amounts of IP data. This is a key part of the smartphone user experience, and as a result of the increased usability, users naturally spend much more time using their smartphones. Furthermore, smartphones have a graphical user interface (GUI) driven by natural user interface technology (NUI) offering users a stress-free operating environment; in addition to the previously described large displays, applications using parallel processing require high-performance Dual Core and Quad Core CPUs as well as large memory. To achieve satisfactory processing performance with these types of processors and memory, smartphones require much more power than earlier feature phones (Figure 1).

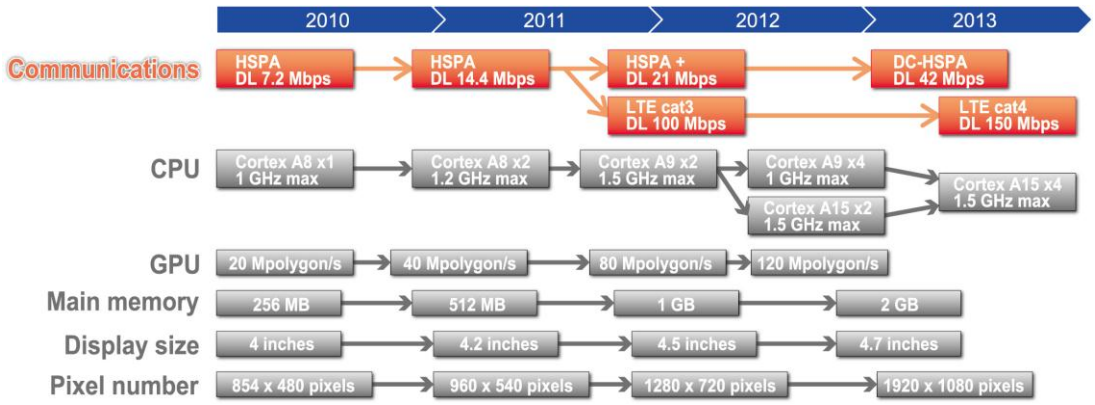

Figure 1. Evolution of smartphone technologies

Previous feature phones used a rechargeable battery with the capacity of about 800 mAh, which would last for several days with typical use on a single charge before the battery was drained. Conversely, since smartphones have a large screen and touch panel operation they have a rechargeable battery with a capacity of about 1500 mAh. However, even having a battery capacity of twice the previous amount does not fully cover the amount of power required for a typical day of smartphone usage and smartphone users are unsatisfied by the need to recharge

several times a day to get the same usage time as earlier feature phones.

We can expect a revolution in lithium-ion battery technology and while the battery capacity required by smartphones is increasing, some problems can be resolved if the energy density of the lithium-ion battery itself can be improved. It seems likely that technology trends in lithium-ion batteries will achieve a 1.3-fold increase in energy density by the early 2020s (Figure 2).

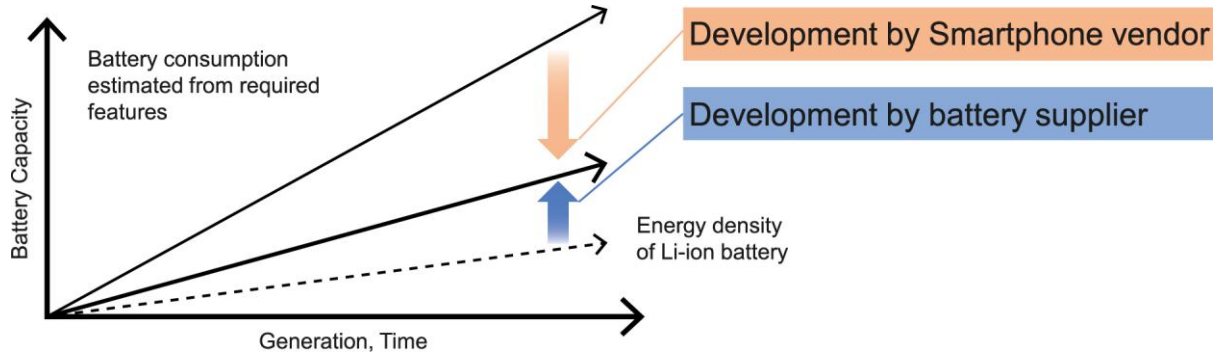

Figure 2. Gap between battery capacity required by smartphones and technical revolution in lithium battery technology

Cutting-edge cellphone technology is increasing the user experience for smartphones. Incorporation of 4G LTE technology into smartphones is increasing downlink speeds to offer maximum throughput speeds of 100 Mbps, supporting stress-free and convenient user services, such as video streaming and cloud services.

However, these types of leading-edge 4G technologies, such as LTE, are expected to require optimized processing at the chipset level with higher-level baseband processing, such as orthogonal phase modulation, than earlier 2G and 3G services, requiring much greater power consumption.

Smartphones have a variety of built-in functions, but the importance of power consumption cannot be ignored in the overall smartphone design. As technology in smartphone, designers have to do effort to reduce battery consumption in cellular technology for making customer’s satisfaction.

2. Cellular Technology Low Power Consumption Design Guidelines

Minimizing the power consumption of smartphone RF parts requires indices for quantitative measurement of power consumption. Defining these indices makes it possible to optimize baseband processing, eliminate signalling redundancy, optimize signaling speed, etc., thereby lowering power consumption.

One typical index defines the user profile. It determines the average and peak current for each usage case to quantify the average power. Use cases define the usage proportions, such as voice, SMS, MMS, streaming, etc., per unit time for users defined as "Teenage, Soccer Mom, Business User, PC User", etc., to calculate typical power consumption.

Another index references the test TS09 specification published by GSMA (www.gsm.com). This specification is the so-called "Battery Life Measurement and Current Consumption Technique" and the current draft version 7.3 published in September 2012 can be used as test methodology. In addition, the TS09 definitions are cross-referenced with the 3GPP measurement items (Table 1).

The TS09 contents define the following test specifications for each cellular standard (GSM, W-CDMA, LTE).

Table 1. TS09 Test Specification Contents

TS09 V7.3 Test Items		GSM	W-CDMA	LTE FDD
3	Standby Time Test	Defined	Defined	Defined
4	Talk Time Test	Defined	Defined	N/A
5	Packet Switched Transfer Test	Defined	Defined	Defined
6	Browsing Test	Defined (bearer setting refer to section 5)		
7	Streaming Content Test	Defined (bearer setting refer to section 5)		
8	Application Software Test	Defined, but this test spec does not depend on cellular technology.		
9	Video Telephony Test	N/A	Defined	N/A
10	*Bluetooth* Interface Usage Test	Defined, but this test spec does not depend on cellular technology.		
11	FTP Download Test	Defined	Defined	N/A
12	GPS Tracking	Defined, but this test spec does not depend on cellular technology.		

3. Outline of LTE-FDD Test Parameters

This section outlines the LTE FDD test parameters expected to have the largest impact on smartphone low-power consumption.

As described above, LTE FDD defines the Standby Time Test and Packet Switched Transfer Test. The Packet Switched Transfer Test is composed of three sections: LTE Download, LTE File Upload, and LTE FDD Parallel File Download and File Upload.

The LTE FDD Standby Time item defines recommended parameters for bearers. When testing smartphones, TS09 defines both the test results and the data including these parameters. Bearer items include DL EARFCN and Neighbor Cell settings, DRX Cycle, control channel power ratio settings. Setting these test parameters requires determining the current and power consumption when the smartphone is in the Idle status.

The LTE Download item includes the UL settings in addition to the same test items as the Standby Time Test items. Since it is necessary to run a DL download test after establishing communications, not only must the DL bandwidth and TBS index be set but also the UL EARFCN and Tx level, communications bandwidth, TBS (Transmit Block Size) index, and RB (Resource Block) settings must be set.

The LTE FDD Parallel File Download and File Upload test items are for extracting the communications-related device maximum power consumption. In comparison to the LTE Download test parameters, the RB and TBS index settings for both UL and DL are defined for performing settings required for U-Plane data communications in both directions.

4. TS09 Test Solution using SmartStudio

SmartStudio (MX847570A) is for testing multifunction smartphone functions.

It is the ideal, GUI-based, scenario-free test solution for test operators. The TS09 test coverage using SmartStudio is listed below.

Table 2. LTE FDD TS09 Test Coverage by MD8475A SmartStudio

Based on GSMA Official Document TS.09 v7.1 Dec2011

Parameter	3.8 LTE FDD Standby	5.3 LTE Download	5.4 LTE File Upload	5.5 LTE FDD Parallel File Download and File Upload	Comment
Serving Cell Downlink EARFCN	Mid range for all supported LTE bands				
Serving Cell Uplink EARFCN	-	Mid range for all supported LTE bands			
Number of neighbours declared in the neighbour cell list	16 intra-frequency, 0 inter-frequency, 0 inter-RAT, no MBSFN cells				
DRX Cycle	1.28 seconds	-			
Periodic TAU	No	-			
Reference Signal Energy Per Resource Element (RS EPRE)	-85 dBm/15kHz				
PBCH EPRE Ratio	PBCH_RA = 0 dB PBCH_RB = 0 dB				
PSS EPRE Ratio	PSS_RA = 0 dB				
SSS EPRE Ratio	SSS_RA = 0 dB				
PCFICH EPRE Ratio	PCFICH_RB = 0 dB				
PDCCH EPRE Ratio	PDCCH_RA = 0 dB PDCCH_RB = 0 dB				
PDSCH EPRE Ratio	PDSCH_RA = 0 dB PDSCH_RB = 0 dB				SmartStudio will be supported.
PHICH EPRE Ratio	PHICH_RA = 0 dB PHICH_RB = 0 dB				
RoHC	-	No			
UL Tx Power level	-	10 dBm			
DL Transmission scheme	-	2x2 closed loop spatial multiplexing (TM4)			SmartStudio will be supported.
Serving cell bandwidth	10 MHz	-			
Number of antenna ports at eNodeB	2				
Cyclic Prefix Length	Normal				
PHICH Duration	Normal				
PDCCH length	2 symbols				Currently 2 symbol fix. In future, this parameter will be flexile setting.
DCI Aggregation Level	8 CCEs	4 CCEs for DCI0 8 CCEs for all other DCI formats			SmartStudio will be supported.
DRX Configuraion	-	DRX : off			SmartStudio will be supported.
DL and UL Channel Bandwidth	-	10 MHz			
Allocated resorce blocks in DL	-	12		50	
TBS index in DL	-	19		21	
Allocated resorce blocks in UL	-	3% of the DL data rate shall be assumed for transferring TCP ACKs in UL	11	50	
TBS index in UL	-	20	20	21	
Qrxlevmin	-120 dBm	-			Need to set SIB3 user definition setting.
Sintrasearch	Not sent	-			Need to set SIB3 user definition setting.
Paging and System Information change notification on PDCCH	No	-			
System Information Reception	No	-			
OCNG	According to Table LTE_Idle_1				Under Invetstigation.

Tests can be run simply using the SmartStudio GUI without requiring the previous complex scenario scripting, compiling and loading to the test device (Figure 3).

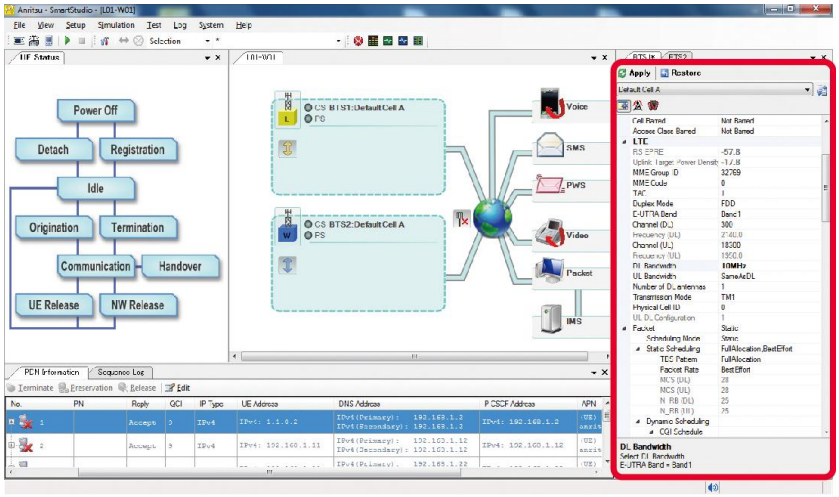

Figure 3. GUI-Based SmartStudio Main Screen for Testing

Since the power consumption test measures the target device current, the test is run multiple times under the same test conditions. In this case, it is inefficient to run tests manually from a GUI and it is more logical to use automated (operator-free) testing.

5. Summary

The need to reduce smartphone battery consumption has been explained in the context of a universal end-user requirement. Consequently, power consumption tests are a key feature during the smartphone development and verification phases. GSMA defines the test specifications for quantitative power consumption tests and SmartStudio offers a test solution matching these test specifications, providing smartphone designers with a total test environment.

Anritsu

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• **United States**
Anritsu Company
1155 East Collins Blvd., Suite 100, Richardson,
TX 75081, U.S.A.
Toll Free: 1-800-267-4878
Phone: +1-972-644-1777
Fax: +1-972-671-1877

• **Canada**
Anritsu Electronics Ltd.
700 Silver Seven Road, Suite 120, Kanata,
Ontario K2V 1C3, Canada
Phone: +1-613-591-2003
Fax: +1-613-591-1006

• **Brazil**
Anritsu Eletrônica Ltda.
Praça Amadeu Amaral, 27 - 1 Andar
01327-010 - Bela Vista - São Paulo - SP - Brazil
Phone: +55-11-3283-2511
Fax: +55-11-3288-6940

• **Mexico**
Anritsu Company, S.A. de C.V.
Av. Ejército Nacional No. 579 Piso 9, Col. Granada
11520 México, D.F., México
Phone: +52-55-1101-2370
Fax: +52-55-5254-3147

• **United Kingdom**
Anritsu EMEA Ltd.
200 Capability Green, Luton, Bedfordshire, LU1 3LU, U.K.
Phone: +44-1582-433200
Fax: +44-1582-731303

• **France**
Anritsu S.A.
12 avenue du Québec, Bâtiment Iris 1- Silic 612,
91140 VILLEBON SUR YVETTE, France
Phone: +33-1-60-92-15-50
Fax: +33-1-64-46-10-65

• **Germany**
Anritsu GmbH
Nemetschek Haus, Konrad-Zuse-Platz 1
81829 München, Germany
Phone: +49-89-442308-0
Fax: +49-89-442308-55

• **Italy**
Anritsu S.r.l.
Via Elio Vittorini 129, 00144 Roma, Italy
Phone: +39-6-509-9711
Fax: +39-6-502-2425

• **Sweden**
Anritsu AB
Borgarfjordsgatan 13A, 164 40 KISTA, Sweden
Phone: +46-8-534-707-00
Fax: +46-8-534-707-30

• **Finland**
Anritsu AB
Teknobulevardi 3-5, FI-01530 VANTAA, Finland
Phone: +358-20-741-8100
Fax: +358-20-741-8111

• **Denmark**
Anritsu A/S (Service Assurance)
Anritsu AB (Test & Measurement)
Kay Fiskers Plads 9, 2300 Copenhagen S, Denmark
Phone: +45-7211-2200
Fax: +45-7211-2210

• **Russia**
Anritsu EMEA Ltd.
Representation Office in Russia
Tverskaya str. 16/2, bld. 1, 7th floor.
Russia, 125009, Moscow
Phone: +7-495-363-1694
Fax: +7-495-935-8962

• **United Arab Emirates**
Anritsu EMEA Ltd.
Dubai Liaison Office
P O Box 500413 - Dubai Internet City
Al Thuraya Building, Tower 1, Suit 701, 7th Floor
Dubai, United Arab Emirates
Phone: +971-4-3670352
Fax: +971-4-3688460

• **India**
Anritsu India Private Limited
2nd & 3rd Floor, #837/1, Binnamangla 1st Stage,
Indiranagar, 100ft Road, Bangalore - 560038, India
Phone: +91-80-4058-1300
Fax: +91-80-4058-1301

• **Singapore**
Anritsu Pte. Ltd.
60 Alexandra Terrace, #02-08, The Comtech (Lobby A)
Singapore 118502
Phone: +65-6282-2400
Fax: +65-6282-2533

• **P.R. China (Shanghai)**
Anritsu (China) Co., Ltd.
Room 1715, Tower A CITY CENTER of Shanghai,
No.100 Zunyi Road, Chang Ning District,
Shanghai 200051, P.R. China
Phone: +86-21-6237-0898
Fax: +86-21-6237-0899

• **P.R. China (Hong Kong)**
Anritsu Company Ltd.
Unit 1006-7, 10/F., Greenfield Tower, Concordia Plaza,
No. 1 Science Museum Road, Tsim Sha Tsui East,
Kowloon, Hong Kong, P.R. China
Phone: +852-2301-4980
Fax: +852-2301-3545

• **Japan**
Anritsu Corporation
8-5, Tamura-cho, Atsugi-shi, Kanagawa, 243-0016 Japan
Phone: +81-46-296-1221
Fax: +81-46-296-1238

• **Korea**
Anritsu Corporation, Ltd.
502, 5FL H-Square N B/D, 681
Sampyeong-dong, Bundang-gu, Seongnam-si,
Gyeonggi-do, 463-400 Korea
Phone: +82-31-696-7750
Fax: +82-31-696-7751

• **Australia**
Anritsu Pty. Ltd.
Unit 21/270 Ferntree Gully Road, Notting Hill,
Victoria 3168, Australia
Phone: +61-3-9558-8177
Fax: +61-3-9558-8255

• **Taiwan**
Anritsu Company Inc.
7F, No. 316, Sec. 1, NeiHu Rd., Taipei 114, Taiwan
Phone: +886-2-8751-1816
Fax: +886-2-8751-1817

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