CTIA Battery Life Test Plan

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Table of Contents

List of Figures

List of Tables

Section 1   Introduction

1.1   Purpose

The purpose of this test plan is to define the CTIA Certification Program requirements for testing and determining the expected battery life of smartphones.

1.2   Scope

This document makes use of the GSM Association document TS.09: *Battery Life Measurement and Current Consumption Technique.* Additional considerations and requirements are outlined in this test plan.

The document is applicable to smartphones supporting WCDMA and LTE RATs. All tests are conducted in LTE, except voice calls which are conducted in WCDMA.

1.3   Applicable Documents

The following documents are referenced in this test plan:

Battery Life Program Management Document, Latest Revision, CTIA

TS.09: *Battery Life Measurement and Current Consumption Technique*, Version 8.0, GSM Association

TS 36.521-1: *Technical Specification Group Radio Access Network; Evolved Universal Terrestrial Radio Access (E-UTRA); User Equipment (UE) conformance specification Radio transmission and reception; Part 1: Conformance Testing*, Latest Revision, 3GPP

TS 44.014: *Technical Specification Group GSM/EDGE Radio Access Network; Individual equipment type requirements and interworking; Special conformance testing functions*, Latest Revision, 3GPP

TS 34.109: *Technical Specification Group Radio Access Network; Terminal logical test interface; Special conformance testing functions*, Latest Revision, 3GPP

TS 36.509: *Technical Specification Group Radio Access Network; Evolved Universal Terrestrial Radio Access (E-UTRA) and Evolved Packet Core (EPC); Special conformance testing functions for User Equipment (UE),* Latest Revision, 3GPP

TS 36.508*: Technical Specification Group Radio Access Network; Evolved Universal Terrestrial Radio Access (E-UTRA) and Evolved Packet Core (EPC); Common test environments for User Equipment (UE) conformance testing*, Latest Revision, 3GPP

1.4   Test Process

All testing shall be conducted at a CTIA Authorized Testing Laboratory (CATL). A current list of CATLs can be found at www.ctia.org/certification. Devices shall be submitted for testing in accordance with the instructions detailed in the *CTIA Battery Life Program Management Document.*

1.5 Acronyms and Definitions

ABC	Automatic Brightness Control
AP	Access Point
APN	Access Point Name
Battery/Battery Pack	An assembly of any number of Li-Ion or Li-Ion Polymer cell(s), associated electronics, battery packaging and connector(s).
Camped	DUT has registered with the network and is in idle mode, waiting to be paged
CATL	CTIA Authorized Testing Laboratory
Cell	Basic manufactured Li-Ion or Li-Ion Polymer unit providing a source of electrical energy by direct conversion of chemical energy that consists of electrodes, separators, electrolyte, container and terminals, and that is designed to be charged electrically.
CS	Circuit Switched
DUT	Device Under Test
E-UTRA	Evolved Universal Terrestrial Radio Access
Forget/delete AP	The registration from an AP is deleted resulting in the DUT returning to state 'Wi-Fi on, no AP'
GSM	Global System for Mobile Communications
IMS	IP Multimedia Subsystem
Iteration	A measurement of average current drain of the activity defined by the test case
LTE	Long Term Evolution
MCS	Modulation Coding Scheme
LUX	A figure used to represent illuminance and luminous emittance expressed in lumen per square meter
NITS	A figure used to represent luminance expressed in candela per square meter
RAT	Radio Access Technology
RRC	Radio Resource Control
RS EPRE	Reference Symbol Energy Per Resource Element
RTSP	Real Time Streaming Protocol
SDP	Standard Discharge Profile

SG-SMS	SMS over SGs
Smartphone	A mobile phone built on a mobile operating system that includes, among other capabilities, Internet access, applications, email and camera.
SMS	Short Message Service
TAE	Total Available Energy
TBS	Transport Block Size
VLC	VideoLAN Client
VoLTE	Voice over LTE
WCDMA	Wideband Code Division Multiple Access
Wi-Fi disabled	The Wi-Fi radio is turned off
Wi-Fi enabled, device connected to AP	Wi-Fi is on, connected and registered to an AP. Access to the Public Internet is available
Wi-Fi enabled, no AP	Wi-Fi is on. DUT is searching for an AP. No connection to the Public Internet is available

Section 2   Test Conditions and Generic Setup

2.1   Ambient Test Conditions

Testing shall be performed at ambient temperature: 23 ± 5 °C.

The display of the DUT shall be configured per this section.

The ambient conditions, including the display configuration, shall be followed for all tests. In the DUT Details document, the Smartphone manufacturer shall define the NITS level and brightness setting of the DUT's display.

The CATL shall measure and record the NITS level and brightness setting provided by the manufacturer in the test report.

The CATL shall perform two checks of the display brightness settings:

1)   The manufacturer shall provide the DUT brightness configuration and a figure of candelas per meter squared (NITS) (based on the DUT's response in ambient light conditions of 300 LUX) to the CATL.

   The automatic brightness control setting shall be disabled during this part of the display brightness testing.

   Using a light meter, the CATL shall verify the measured figure is within 10% of the manufacturer-declared NITS figure.

2)   The automatic brightness control shall be ENABLED during this part of the display brightness testing. The CATL shall independently measure the DUT and document the NITS figure in an ambient light condition of 300 LUX in its test lab. Using a light meter, the CATL shall verify their measurement is within 10% of the manufacturer declared value from (1) above.

If the CATL is not able to confirm the information provided by the manufacturer, the manufacturer shall work with the CATL to resolve the issue or submit another set of brightness setting values. If the manufacturer does not resolve these issues with the CATL then the DUT will be rejected by the CATL.

In order to confirm the brightness settings, the CATL shall use a standardized picture. The picture shall be such that surface-area-wise it covers 70% of the display in black color and 30% of the display in white color. The interior section shall be white while the exterior section shall be black. The measurement shall be made in the white area only. The CATL test operator shall target the center of the white area during this test step.

The preferred picture to use for the brightness testing is shown in Figure 2.1-1. The intent of the standardized picture is that it represents a white color of 255, 255, 255 and black color of 0, 0, 0 [RGB].

The picture in Figure 2.1-1 is for devices with a 16:9 aspect ratio. For displays with different aspect ratios, another picture may be used but it must fulfill the 70% black and 30% white criteria.

FIGURE 2.1-1 PREFERRED PICTURE TO USE FOR THE BRIGHTNESS TESTING
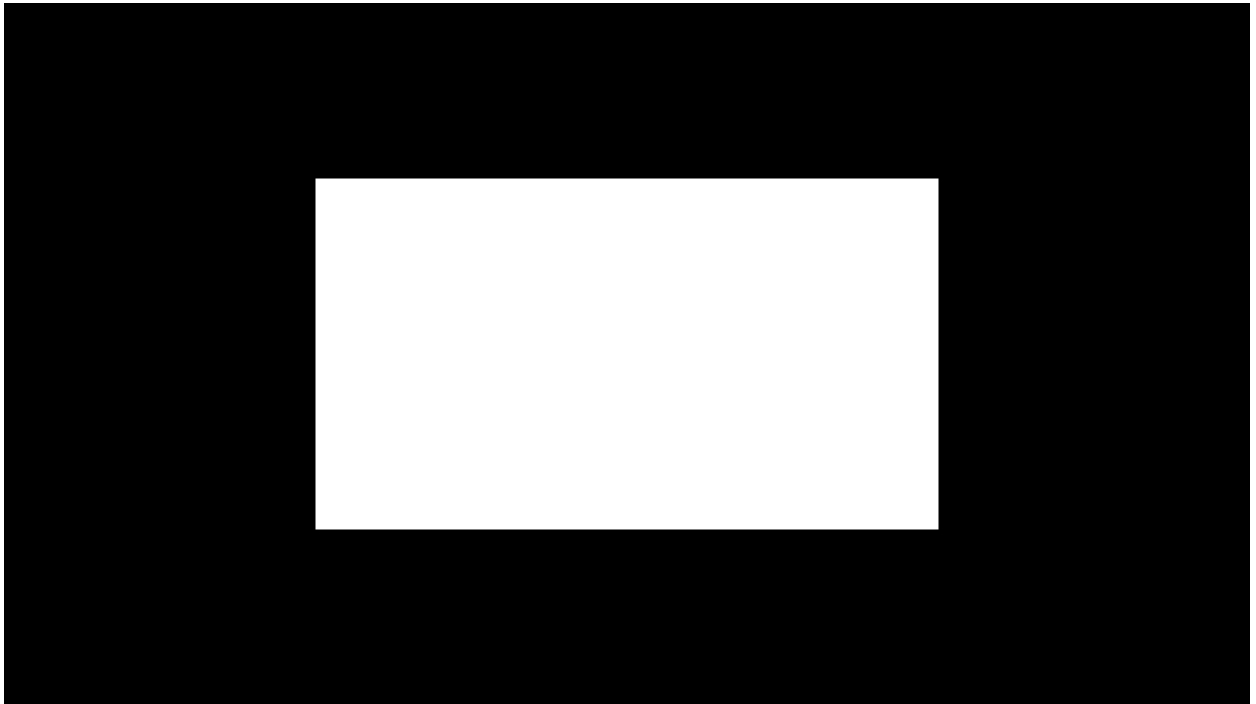
2.2   Test Case Procedures

Unless otherwise specified in this document, the test case procedures are specified in GSMA TS.09.

2.3   RF Parameters

Except where specified in this section, the RF parameters shall be as defined in GSMA TS.09 for WCDMA and LTE devices.

For LTE test cases, the parameters found in GSMA TS.09 for E-UTRA standby shall be used. Additionally, RS EPRE level of -85dBm/15kHz shall be used, in alignment with 3GPP TS 36.521-1. Per Table 20 for download use case in GSMA TS.09, for 10MHz BW allocation, web browsing, video streaming, audio streaming, and email test cases shall use 1 uplink resource block and 12 downlink resource blocks. The TBS shall be set to 19 on the downlink and 20 on the uplink. (MCS: 21 for downlink and 22 uplink).

The RRC inactivity timer shall be set to 10 seconds.

For LTE transmit power, the profile defined in Table 2.3-1 shall be used.

TABLE 2.3-1 LTE TRANSMIT POWER DISTRIBUTION PROFILE

+24dBm	+18dBm	+8dBm	+2dBm	-20dBm
24.66%	35.75%	27.66%	4.98%	6.95%

During the LTE test cases, the transmit power profile will be distributed over the test time to meet the distribution percentages defined in Table 2.3-1. This defines the % of test time that the DUT transmits at a particular output power level. Additionally, the transmit power profile will start at the lowest power level defined, and increase towards the maximum defined transmit power in order to mitigate any heating concerns. For WCDMA, only the power profile measurements are required, but not the fixed Tx RF power level).

For test cases where the test time is 5 minutes or less (per test iteration), a fixed power level of +10dBm shall be used instead of the LTE transmit power profile.

Table 2.3-2 defines the preferred frequency bands for testing the DUT.

TABLE 2.3-2 PREFERRED FREQUENCY BANDS FOR TESTING

Operator	LTE	WCDMA
AT&T	12 / 17	2
Sprint	25	N/A
T-Mobile	4	2
Verizon	13	N/A

2.4   Sampling Rate

The physical sampling frequency for current drain measurement for all test cases shall be a minimum of 50k samples per second.

2.5   DUT Configuration Prior to Testing

When possible, the DUT shall be factory reset prior to the start of testing. Instructions on how to set up the DUT prior to testing shall be found in the DUT Details document, completed by the manufacturer. This includes whether the DUT needs access to a Wi-Fi connection in order to download any updates. If Wi-Fi is used to download game, application, VLC, music file or other, then the Wi-Fi AP connection is to be forgotten/deleted prior to execution of any test. The Wi-Fi shall then be enabled or disabled, depending on how the DUT is to be configured by default. All GPS /location based services shall be disabled on the DUT.

After the DUT has been factory reset and setup, the DUT shall be powered on and allowed to settle for a duration which is specified by the manufacturer.

Unless explicitly specified:

- The default audio settings shall be used for all tests.

- The DUT's orientation shall be Portrait.

- The Headset should not be used.

All notification settings shall be set to the default state.

The APN on the SIM card supplied by the operator shall be used. If the SIM card does not contain an APN, then the Operator should supply the details required to enter in the DUT.

The CATL shall indicate in the DUT Details document the DUT configuration used. The DUT configuration prior to testing is described in Table 2.5-1.

TABLE 2.5-1 DUT CONFIGURATION PRIOR TO TESTING

Test Case	Comments
Audio Streaming	Install the VLC player application by copying it to the DUT hard drive or downloading it from the online store. VLC version for Android devices shall be 1.7.5.
Music Playback	Install the VLC player application by copying it to the DUT hard drive or downloading it from the online store. VLC version for Android devices shall be 1.7.5. Copy the music source file to the DUT. These may be copied to the DUT hard drive if you have OEM-provided USB drivers. Per the GSMA TS.09, download the reference music file from the GSMA website and store it onto the DUT.
Video Streaming	Install the VLC player application by copying it to the DUT hard drive or downloading it from the online store. VLC version for Android devices shall be 1.7.5.
Compose, Send, Receive, Read Email Message	Set up the test email account using the default email application. If the default email application does not support push, then an alternative email application may be used. The application and version information must be documented in the test reports.
Gaming	Install Angry Birds® game.
Compose, Send, Receive, Read SMS Message	Create one unique contact in the default messaging client.

2.6 DUT Wait Time Before Testing

For all tests, the CATL test operator shall wait a minimum of 5 minutes after activation for DUT boot processes to be completed. If the DUT was not rebooted, the 5 minutes wait time can be skipped.

2.7 DUT Configuration During Testing

See Appendix A for the DUT configuration to be used during testing.

2.8   Power Supply and Analyser

Table 2.8-1 and Table 2.8-2 merge settings specified within GSMA TS.09 and provide the additional requirements for stability and accuracy.

It should be noted that the current validated Power Analyser meets these requirements.

TABLE 2.8-1 POWER SUPPLY

Parameter	Requirement	Comments
Range	Nominal Voltage of device	Additional headroom to compensate for any cabling losses
Resolution	<= 10mV	
Deviation	<= 10mV	
Temporary Voltage Drop	60mV	Transient Voltage drop as a result of transient loads
Recovery/Settling Time	50uS	Time to recover to within 30 mV of the final voltage value following a load current transient
Current Source	The DC source should have sufficient output current capability, both continuous and peak, to adequately supply the MS during all measurements.	Current limiting of the power supply shall not function during a measurement
Sense Lines	Remote sensing to allow the effects of resistance of the supply cables to be compensated for, and to allow maintenance of the nominal voltage at the MS battery terminals	Should be connected as close as possible to the device under test

TABLE 2.8-2 ANALYSER

Parameter	Requirement	Comments
Measurement Resistance	<= 0.1 Ohms	
Sampling Frequency	>= 50ksps	Measurement shall be continuous
Voltage Measurement Range	4.5V to 2.5V	
Voltage Resolution	1mV	
Voltage Deviation	0.3%	Of measured value across Voltage Measurement Range
Current Resolution	<=0.1mA Idle Mode <= 0.5mA Dedicated Mode	
Current Deviation	2%	Of measured value across full operating range of the device under test
Noise floor	Less than the lowest ADC step	

Section 3   Total Available Energy

3.1   Test Setup and Definition of Standard Discharge Profile (SDP)

A battery will be used for the determination of Total Available Energy (TAE). In order to determine the TAE, simultaneous measurements of voltage and current are performed until the DUT switches off.

The SDP procedures require the capability to measure both instantaneous current and voltage. Using a sense resistor circuit is not an acceptable solution for this process because that requires the measurement of two voltage signals.

See Figure 3.1-1 for the test setup.

On completion of the test, average current, voltage and energy will be calculated (per the procedure described in Section 3.6) and the test time will be made available. The TAE shall be recorded in the test report, along with the average current and average voltage.

The average voltage measured in this section of the test plan will be used as the fixed voltage setting in Section 4.

FIGURE 3.1-1 SDP TEST SETUP
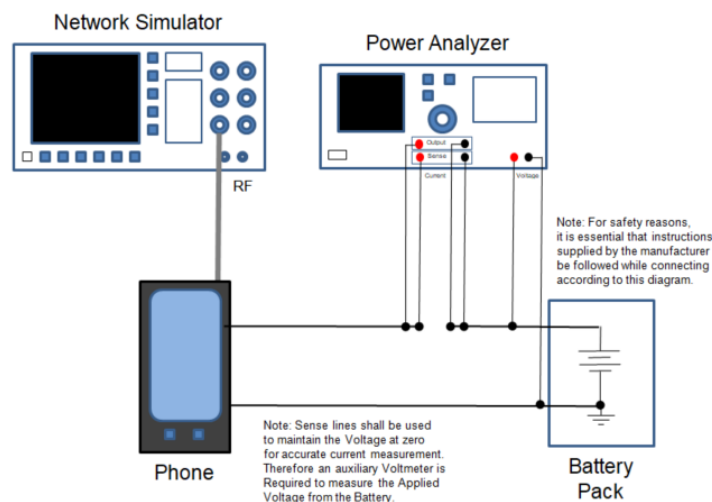
3.2   Process to Charge the DUT

The process to charge the DUT shall be defined by the manufacturer in the DUT Details document.

3.3   Determination of When the DUT Turns Off

The process to determine when the DUT has turned off shall be defined by the manufacturer in the DUT Details document.

3.4   Determination of Total Available Energy - Measurement Procedure

Fully Charge the battery using the DUT and following the manufacturer charging instructions stated in the DUT Details document, using the manufacturer-specified charger.

Connect the fully charged battery with the analyzer so that both instantaneous current and instantaneous voltage measurements can be performed.

Activate the network simulator in the desired RAT. All testing will be performed using the highest RAT supported by the DUT.

Switch the DUT on and start the instantaneous voltage and instantaneous current measurements.

Wait for the DUT to register with the simulator.

Place the DUT in the appropriate Connected Test Mode State.

Continue performing the measurements until the DUT has powered off per the DUT Details document.

Stop the measurement and record the time, average voltage, current and calculate the usable battery capacity and the TAE (per the process defined in Section 3.6).

Throughout the measurement, the Uplink DUT Power shall be continuously changed according to the Power Distribution Profile specified for the used RAT as defined in Section 2.3. The Power Distribution Profile shall be repeated in 10-minute cycles for the SDP portion of the testing.

3.5   Connected Test Mode

Test Modes are defined in the core specifications to allow for testing data connections with no requirement for any U-Plane connection (i.e. no Application Layers). These Test Modes are defined for WCDMA (3GPP 34.109) and LTE (3GPP 36.509, 36.508).

3.6   Procedure to Calculate TAE

The current drain figures from Section 3.4 shall be multiplied by the voltage figures for every measurement sample to calculate the instantaneous power. That instantaneous power shall be integrated over the entire data set by using the integration time period in order to calculate the TAE from the battery and the DUT. The figure that is derived is the TAE and this figure shall be recorded in the test report in mWh.

3.7   Procedure to handle multiple cell vendors or battery packs

In the instance where the DUT manufacturer submits more than 1 battery pack vendor or there is more than 1 cell vendor, then the TAE for all of the different cell and pack vendor combinations shall be measured for TAE and average voltage. All of the TAE figures shall be reported by the CATL. The lowest TAE measured AND the associated measured average voltage from the different cells and pack combinations shall be used in the customer profile calculation spreadsheet to determine the estimated hours of operation.
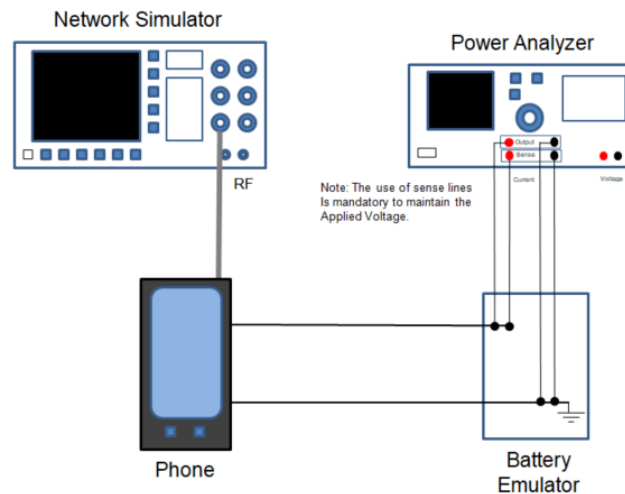
Section 4   Energy Use per Activity

4.1   Test Setup and Test Cases

Testing shall be performed per GSMA TS.09 for all test cases where test procedures are defined, as noted in Table 4.2-1. Test cases and procedures not defined in the GSMA TS.09 document are specified here.

The average voltage figure which was recorded in Section 3 will be used as the fixed voltage setting in this section of the test plan. It is required that the dummy battery shall have sense line connections. The standby time test case shall be preceded by rebooting the DUT and waiting for the required settling time prior to performing that test.

See Figure 4.1-1 for the test setup.

FIGURE 4.1-1   ENERGY USE PER ACTIVITY TEST SETUP

4.2   Determination of Energy Use per Activity

In order to determine the energy use per activity, current drain measurements shall be performed. A dummy battery shall be used for all energy use per activity items. The current drain shall be used, along with the voltage, to determine overall power consumed by these activities.

The current drain (I) and the voltage (V) figures shall be recorded in the test report for each test case. The power consumed per activity shall be calculated using the formula $P = V * I$. The power consumed by each activity shall be recorded in the test report and shall be used in Section 5.1.

If possible, prior to testing, the CATL test operator shall confirm that there is no current drain due to the dummy battery being connected to the power supply while the DUT is not connected. Current drain measurements shall be performed on the following list of activities. The power consumed for each activity shall be determined based on the current drain measurements for each individual activity. Then, the power consumed shall be converted to a figure of energy. The energy used for the different activities shall be subtracted from the TAE figure from Section 3.6.

TABLE 4.2-1 TEST CASE PROCEDURE REFERENCE

Test Case	Refer to GSMA TS.09 for Test Procedures	Refer to this Document for Test Procedures
Gaming		X
Compose, Send, Receive, Read SMS Message		X
Compose, Send, Receive, Read Email Message		X
Home Screen Display On		X
Audio Streaming	X	
Music Playback	X	
Video Streaming	X	
Voice Call	X	
Web Browsing	X	
Standby	X	

4.2.1 Gaming

The purpose of this test is to measure the power consumed while performing gaming activities.

Test Setup:

• No Internet connection shall be available for this test case.

DUT Configuration:

• For the gaming test case, the DUT shall be set to Airplane/Flight mode.

• Connect manufacturer-provided headset to the DUT's audio headset socket and set Headset Volume to DUT default setting.

• Download and install the latest version of the Angry Birds Mobile App.

• The version of the Angry Birds application shall be recorded in the test report.

• Open Angry Birds. Note: if the game does not run, then it will be necessary to connect the Application to the Server to progress to the menus. To achieve this, change the Wi-Fi state to *Wi-Fi enabled, device connected to AP* and relaunch the game. Once the game has launched then forget/delete the AP and set the Wi-Fi to the default state as per Annex A.

- Display shall be ON and in landscape mode during the entire duration of this test.

Test Procedure:

- Open Angry Birds, go to the "Play" sign, select "Poached Eggs", select the First Level, and fast forward the preview screen to get to the game ready mode.

- The CATL test operator shall manage the time properly during the measurement of game play.

- Play the game by launching each of the 3 birds at the 5, 10 and 15 second time mark of every 20 second interval of gameplay. Launch the birds to the opposite side (Left Side) of the target so it DOES NOT hit the target pigs. After the game is failed, select "Replay" to repeat the same level with the same procedure. Play the same level 6 times. Pace yourself to use approximately 20 seconds for each round of the game.

- Begin the current drain measurement and immediately begin game play, following the previously given guidelines.

- If during gameplay the CATL test operator is offered an upgrade, assistance, pop-up box or other similar disruption, the message/upgrade shall be acknowledged/dismissed, that data shall be thrown out, and that iteration shall be run again.

- The test equipment will stop the current drain measurement after 2 minutes. This represents one iteration of the data.

- Record the average current drain measurement for the test.

- Run this test for a total of 5 iterations and average the results.

- Calculate the average power consumed for this activity.

4.2.2   Compose, Send, Receive, Read SMS Message

Options:

Primary: If DUT supports SG-SMS, then SG-SMS shall be used.

Secondary: All DUTs shall support SMS over CS. This is the last option which is to be used and only if no other options are supported by the DUT.

Future: Until this document specifies the configuration which is required to send SMS over IMS for each network operator, SMS over CS and SG-SMS shall be used.

4.2.2.1   Compose SMS Message

The purpose of this test is to measure the power consumed to compose a single SMS message 60 bytes in length.

Test Setup:

- Mobile data shall be turned off.

- DUT shall be camped to the highest RAT with the display ON.

- DUTs support a variety of different text messaging applications. The default messaging application shall be used for this test.

- The default SMS application shall be set up to add 1 recipient prior to testing. The default SMS application shall be opened with recipient information filled out and cursor positioned for message-body text entry.

- The CATL test operator shall not use the text auto correction feature, or the text auto completion feature, on the DUT, if possible.

Test Procedure:

- Begin measuring current drain (do not let display timeout before starting measurement).

- Type 60 characters at a rate of 2 characters per second for 30 seconds until the test stops. Any two alternating characters may be used for this test. The test equipment will stop the current drain measurement 30 seconds after the measurement started. This represents one iteration of the data.

- Record the average current drain measurement for the test.

- Run this test for a total 5 of iterations and average the results.

- Calculate the average power consumed for this activity.

4.2.2.2   Send SMS Message

The purpose of this test is to measure the power consumed to send a single SMS message 60 bytes in length.

Test Setup:

- DUT shall be camped to the highest RAT with the display ON.

- DUTs support a variety of different text messaging applications. The default messaging application shall be used for this test.

- The default SMS application shall be set up to add 1 recipient prior to testing. The default SMS application shall be opened with recipient information filled out and cursor positioned for message-body text entry.

- Enter 60 characters of text: "Are you going to the party tonight? I will be there at eight" in the message body.

- Mobile data shall be turned off.

Test Procedure:

- Begin measuring current drain (do not let display timeout before starting measurement).

- Press the send icon to send the text: "Are you going to the party tonight? I will be there at eight" in the message body.)

- Send the text to whatever number is required by the network simulator/test script.

- The test equipment will stop the current drain measurement 15 seconds after the measurement started. This represents one iteration of the data.

- Record the average current drain measurement for the test.

- Run this test for a total of 5 iterations and average the results.

- Calculate the average power consumed for this activity.

4.2.2.3 Receive SMS Message

The purpose of this test is to measure the power consumed to receive a single SMS message 60 bytes in length.

Test Setup:

- DUT shall be camped to the highest RAT with the display off.

- DUTs support a variety of different text messaging applications. The default messaging application shall be used for this test.

- On a network simulator, open a test message application and fill out the recipient information for sending a message to the DUT. Enter 60 characters of text: "Are you going to the party tonight? I will be there at eight" in the message body but do not yet send the text.

- Mobile data shall be turned off.

Test Procedure:

- Begin measuring current drain.

- Send text from the network simulator to the DUT.

- DO NOT touch/wake the DUT.

- The test equipment will stop the current drain measurement 30 seconds after the measurement started. The CATL test operator shall confirm that the text is in the inbox of the DUT AFTER the measurement has stopped. This represents one iteration of the data.

- Record the average current drain measurement for the test.

- Run this test for a total of 5 iterations and average the results.

- Calculate the average power consumed for this activity.

4.2.2.4 Read SMS Message

The purpose of this test is to measure the power consumed to read a single SMS message 60 bytes in length.

Test Setup:

- DUT shall be camped to the highest RAT with the display ON.

- DUTs support a variety of different text messaging applications. The default messaging application shall be used for this test.

- On a network simulator, open a test message application and fill out the recipient information for sending a message to the DUT. Enter 60 characters of text: "Are you going to the party tonight? I will be there at eight" in the message body but do not yet send the text.

- Send 5 texts to the DUT such that the default text application has 5 or more text threads. This means that there are 5 different senders sending text messages to the DUT.

- Mobile data shall be turned off.

- The default SMS application shall be opened.

Test Procedure:

- Begin measuring current drain.

- Read a new text from the application list view at the 10, 20, 30, 40, 50 second time mark for the entire measurement time.

- The test equipment will stop the current drain measurement 60 seconds after measurement was started. This represents one iteration of the data.

- Record the average current drain measurement for the test.

- Run this test for a total of 5 iterations and average the results.

- Calculate the average power consumed for this activity.

4.2.3   Compose, Send, Receive, Read Email Message

4.2.3.1   Compose Email Message

The purpose of this test is to measure the power consumed to compose a single email message 60 bytes in length.

Test Setup:

- DUT device shall be camped to the highest RAT with the display ON.

- Mobile data shall be turned off.

- The default email application shall be set up to add 1 recipient prior to testing.

- The default email application shall be opened with recipient information filled out and cursor positioned for message-body text entry.

- Configure the DUT's native email client with an email service account (e.g., Gmail, Yahoo, Exchange). Do not use the over-the-top applications of these email services.

- The CATL test operator shall not use the text auto-correction feature, or the text auto-completion feature, on the DUT, if possible.

Test Procedure:

- Begin measuring current drain (do not let display timeout before starting measurement).

- Type 60 characters at a rate of 2 characters per second for 30 seconds until the test stops. Any two alternating characters may be used for this test.

- The test equipment will stop the current drain measurement 30 seconds after measurement started. This represents one iteration of the data.

- Record the average current drain measurement for the test.

- Run this test for a total of 5 iterations and average the results.

- Calculate the average power consumed for this activity.

4.2.3.2 Send Email Message

The purpose of this test is to measure the power consumed to send a single email message 60 bytes in length.

Test Setup:

- DUT device shall be camped to the highest RAT with the display ON.

- The default email application shall be set up to add 1 recipient prior to testing.

- The default email application shall be opened with recipient information filled out and cursor positioned for message-body text entry.

- Enter 60 characters of text: "Are you going to the party tonight? I will be there at eight" in the message body.

Test Procedure:

- Begin measuring current drain (do not let display timeout before starting measurement).

- Press the send icon to send the email message.

- Send the email to whatever email address is required by the network simulator/test script.

- The test equipment will stop the current drain measurement 15 seconds after the measurement started. This represents one iteration of the data.

- Record the average current drain measurement for the test.

- Run this test for a total of 5 iterations and average the results.

- Calculate the average power consumed for this activity.

4.2.3.3 Receive Email Message

The purpose of this test is to measure the power consumed to receive a single email message 60 bytes in length.

Test Setup:

- *Note: Due to the short measurement time of this test, it is required that only the measurement of the email activity should be recorded so there is no significant impact on the overall measurement. If, during the test, another application receives an update or performs an activity in the background, then the result should be discarded and the test repeated.*

- DUT shall be camped to the highest RAT with the display off.

- DUTs support a variety of different email messaging applications. The default email messaging application shall be used for this test.

- The DUT should start this test case in idle mode.

- The test shall be executed in such a way that the DUT push settings (synch schedule) shall be configured such that the DUT will immediately fetch the email once it receives a notification.

- If the DUT does not support push email or does not fetch the email, then this test case must be performed such that the CATL test operator manually fetches the email per the manufacturer provided instructions. The current drain will be recorded using this alternate method.

- On a network simulator, open a test email message application and fill out the recipient information for sending an email message to the DUT. Enter 60 characters of text: "Are you going to the party tonight? I will be there at eight" in the message body but do not yet send the email message.

Test Procedure:

- Email application will be killed (force stop or clear all applications for example) before testing.

- RRC idle state should be the initial condition.

- The CATL test operator shall push home screen icon (e.g. house, circle) one time in order to set the DUT to the home screen.

- Begin measuring current drain.

- Send email message from the network simulator the DUT.

- Wait a total of 30 seconds for the email to be received but DO NOT touch/wake the DUT.

- The test equipment will stop the current drain measurement 30 seconds after measurement was started. This represents one iteration of the data.

- The CATL test operator shall confirm receipt of the email message by verifying that the email is in the DUT inbox AFTER the measurement has stopped.

- Record the average current drain measurement for the test.

- Run this test for a total of 5 iterations and average the results.

- Calculate the average power consumed for this activity.

4.2.3.4 Read Email Message

The purpose of this test is to measure the power consumed to read a single email message 60 bytes in length.

Test Setup:

- DUT shall be camped to the highest RAT with the display ON.

- On a network simulator, open a test email message application and fill out the recipient information for sending an email message to the DUT. Enter 60 characters of text: "Are you going to the party tonight? I will be there at eight" in the message body but do not yet send the email.

- Send 5 email messages to the DUT.

- Mobile data shall be turned off.

- The default email application shall be opened.

Test Procedure:

- Begin measuring current drain (do not let display timeout before starting measurement).

- Read a new email from the application list view at the 10, 20, 30, 40, 50 second time mark for the entire measurement time.

- The test equipment will stop the current drain measurement 60 seconds after measurement was started. This represents on iteration of the data.

- Record the average current drain measurement for the test.

- Run this test for a total of 5 iterations and average the results.

- Calculate the average power consumed for this activity.

4.2.4   Home Screen Display On

The purpose of this test is to measure the power consumed while the display is on and the DUT is idle on the home screen.

Test Setup:

- Mobile data shall be turned off for this test case. The call box shall allow the DUT to go to an RRC idle state after the initial attach.

- DUT shall be camped to the highest RAT with the display ON.

- The CATL test operator shall disable screen timeout and screen setting options in the DUT software menu. The DUT shall not dim nor blank the display during this test.

- Test case begins and ends with DUT on the home screen. The CATL test operator shall push the home screen icon (e.g., house, circle) one time in order to set the DUT to the home screen. After that, the CATL test operator shall not touch the DUT.

Test Procedure:

- Make sure that the DUT is on the home screen and that the display is ON.

- Begin measuring current drain.

- The test equipment will stop the current drain measurement 5 minutes after measurement was started. This represents one iteration of the data.

- Record the average current drain measurement for the test.

- Run this test for a total of 3 iterations and average the results.

- Calculate the average power consumed for this activity.

Post Test Procedure:

- The CATL test operator shall restore the DUT backlight and display timeout settings to the default settings after completion of the home screen display on test.

4.2.5 Audio Streaming/Music Playback

Use the GSMA TS.09 test procedures.

4.2.5.1 Audio Streaming

- When performing the audio streaming test case, the audio shall be played using the manufacturer-provided headset, as opposed to that which is detailed in the GSMA test plan, which is defined in the DUT Details document.

- The volume shall be set to the default setting, in accordance with the DUT Details document.

- The preferred media player to be used is the VLC player. If there are issues which do not allow the VLC player to be used, then an alternative solution for measuring the current drain for audio streaming may be used, but it is necessary to use a RTSP which may be verified through monitoring the IP traffic.

- The LTE power profile shall be applied for this test case, with the distribution spread evenly for the total test time.

- Run test 3 times and average the results.

4.2.5.2 Music Playback

- The media may be played using the hard drive of the DUT and does not have to be played from an external SD card/media source.

- Navigate to the media file and click on it to open it. Select the option to open the media file using the preferred media player/VLC player.

- For music play back, launch VLC player, select the song to be played, and start listening to the audio media clip.

- Mobile data shall be turned off for music playback.

- Run test 3 times and average the results.

4.2.6 Video Streaming

Use the GSMA TS.09 test procedures.

- When performing the video streaming test case, the audio shall be played using the manufacturer-provided headset, which is defined in the DUT Details document.

- The volume shall be set to the default setting, in accordance with the DUT Details document.

- Display shall be ON and in landscape mode during the entire duration of this test.

- The preferred media player to be used is the VLC player. If there are issues which do not allow the VLC player to be used, then an alternative solution for measuring the current drain for video streaming may be used, but it is necessary to use a RTSP which may be verified through monitoring the IP traffic.

- The LTE power profile shall be applied, with the distribution spread evenly for the total test time.

- The CATL test operator shall start playing the video on the DUT and then begin the measurement.

- This test shall be executed for a 10-minute duration in alignment with GSMA TS.09 section 7.1.

- The approved 720p video source file will be provided by the authorized test system vendors. If the DUT does not support 720p, then the 480p file will be provided by the authorized test system vendor.

- Run this test 3 times and average the results.

4.2.7 Voice Call

Use the GSMA TS.09 test procedures.

- The CATL test operator shall turn off the DUT display after starting the talk time voice call, before starting the current drain measurement.

- Current drain measurement shall begin once the DUT display is off.

- If the highest RAT supported for voice is VoLTE, test shall be executed by using CS voice test case from Section 4.2 of the GSMA TS.09 test document.

- Specifications for VoLTE test case will be defined in version 2.0 of this document.

- The audio shall be routed through the normal audio path, not the speakerphone and no headset is to be connected to the DUT.

- Run this test 3 times and average the results.

4.2.8 Web Browsing

Use the GSMA TS.09 test procedures.

- Run this test 3 times and average the results.

- Swiping/scrolling guidelines:

  At the 20 second mark, using one continuous touching movement, scroll down to the bottom of the page by swiping the finger up from the bottom to the top of the screen.

  At the 40 second mark, using one continuous touching movement, scroll up to the top of the page by swiping the finger down from the top to the bottom of the screen.

4.2.9   Standby

Use the GSMA TS.09 test procedures.

- During the idle mode measurement per GSMA TS.09, mobile data shall be switched off.

- Run this test 3 times and average the results.

Section 5   User Profiles

5.1   Definition of User Profiles

Power consumption figures for individual activities from Section 4 shall be used, in conjunction with the user profile weighting factors (# of times per day and duration of activities), to calculate the user profile result(s).

The list of activities for current drain measurement from Section 4 shall each be assigned a weighting factor. The weighted activities which drain the smartphone battery shall be processed mathematically in order to arrive at a figure of expected hours of operation for the device.

The energy consumed will be subtracted from the overall TAE as determined in Sections 3.4 and 3.6.

Section 6   **Battery Life Rating**

6.1   Calculation of Battery Life Rating

Once the user profiles are processed, a figure of estimated hours of operation shall be reported as the final result.

Appendix A DUT Configuration During Testing (for both TAE and Energy Use Per Activity)

Test Case	Title	Comments
ALL TEST CASES	Brightness Setting	For ABC-enabled devices the DUT brightness level shall be set to "X", corresponding to a 300 LUX condition. The automatic brightness control shall be disabled. For DUT which do not support ABC, or ABC is off by default, the brightness level shall be set to the manufacturer default level as defined in the DUT Details document.
ALL TEST CASES	Mobile Data	Mobile data shall be turned on unless otherwise specified in the test case.
ALL TEST CASES	Volume Setting	Shall be the default as defined in the DUT Details document and recorded in the Test Report.
ALL TEST CASES	Backlight Off After X sec	Shall be set as defined in the DUT Details document and recorded in the Test Report as off after X sec.
ALL TEST CASES	Wi-Fi Status	Shall be the default as defined in the DUT Details document and recorded in the Test Report.
ALL TEST CASES	Bluetooth Status	Shall be the default as defined in the DUT Details document and recorded in the Test Report (on/off).
ALL TEST CASES	GPS Status	Shall be OFF. The default as defined in the DUT Details document shall be recorded in the Test Report (on/off).
ALL TEST CASES	GPS Location Mode Status	Shall be OFF. The default as defined in the DUT Details document shall be recorded in the Test Report (on/off). (Also may be battery saving, high accuracy, or device only mode settings)
ALL TEST CASES	NFC Status	Shall be the default as defined in the DUT Details document and recorded in the Test Report (on/off).
ALL TEST CASES	Email Push/Synch Settings	Manufacturer shall detail how the DUT will fetch emails and how the CATL shall execute the 'receive email' test procedures
ALL TEST CASES	Battery Saver Settings	For all DUT, the CATL is to set the battery saver setting to off by default
ALL TEST CASES	Data Saver Settings	For all DUT, the CATL is to set the data saver setting to off by default
ALL TEST CASES	Doze Mode Setting	For all DUT, the CATL is to set the doze mode setting to on by default
ALL TEST CASES	Low power mode setting	For all DUT, the CATL is to set the low power mode setting to off by default
ALL TEST CASES	Background application refresh setting	For all DUT, the CATL is to set the background application refresh setting to on by default
Home Screen On	Backlight Off Disabled	Disable Backlight Off (e.g., screen timeout).
Voice Call	Backlight Setting	Confirm that the backlight is OFF before measurement for the voice call test case
Audio Streaming	Backlight Setting	Confirm that the backlight is OFF for audio streaming test case
Music Playback	Backlight Setting	Confirm that the backlight is OFF for music playback test case
Video Streaming	Backlight Setting	Confirm that the backlight is ON for video streaming test case
Compose SMS	Backlight Setting	Confirm that the backlight is ON for the compose SMS test case. No Internet connection shall be available for this test case.
Send SMS	Backlight Setting	Confirm that the backlight is ON for the send SMS test case and that the display does not timeout before starting the measurement. No Internet connection shall be available for this test case.
Read SMS	Backlight Setting	Confirm that the backlight is ON for the read SMS test case and that the display does not timeout before starting the measurement. No Internet connection shall be available for this test case.
Receive SMS	Backlight Setting	Confirm that the backlight is OFF as the initial condition for the Receive SMS test case. No Internet connection shall be available for this test case.
Compose Email	Backlight Setting	Confirm that the backlight is ON for the compose email test case. No Internet connection shall be available for this test case.
Send Email	Backlight Setting	Confirm that the backlight is ON for the send email test case and that the display does not timeout before starting the measurement. No Internet connection shall be available for this test case.
Read Email	Backlight Setting	Confirm that the backlight is ON for the read email test case and that the display does not timeout before starting the measurement. No Internet connection shall be available for this test case.
Receive Email	Backlight Setting	Confirm that the backlight is OFF as the initial condition for the Receive Email test case. No Internet connection shall be available for this test case.

Appendix B Change History

Date	Revision	Description
April 2016	1.0	• Initial release

February 2017	1.1	• Section 1.2: WCDMA added. Removed references to GSM and cdma2000.
		• Section 0: Added additional definitions.
		   • Section 2.3: Updated text to remove reference to CDMA test plan 3GPP2 c.R1013_0.
		   • Table 2.5-1: Updated DUT configuration for compose, send, receive, read email message test cases.
		• Section 2.8: Created a new section for power supply and analyser settings.
		• Section 4.2.2.1, 4.2.2.2, 4.2.2.3: Added additional instruction to Test Setup.
		• Section 4.2.3.3: Added additional instruction to Test Setup and Test Procedure.
		• Section 4.2.5, 4.2.7: Added additional instruction.
		• Section 4.2.6: Modified the location of the video source files.
		• Section 4.2.8: Modified swiping/scrolling guidelines.

July 2017	1.1.1	• Section 2.1: Revised RGB numbers for white color and black color. • Section 4.2.2.1, 4.2.2.2, 4.2.2.3, 4.2.2.4, 4.2.3.1, 4.2.3.2, 4.2.3.3, 4.2.3.4, 4.2.4: Removed "No Internet connection shall be available for this test case" • Section 4.2.6: Changed GSMA TS.09 section to 7.1. • Appendix A: Added "No Internet connection shall be available for this test case" to some test cases.
April 2018	1.2	• Section 1.3 and 1.4: Removed 'Certification' • Section 1.5: Added additional acronyms and definitions • Section 2.1: Clarified light measurements and specified handling in case of non-resolution • Section 2.5: Updated the APN that should be used during testing • Section 3.6: Specified units as mWh. • Sections 4.2.1, 4.2.2, 4.2.3, and 4.2.4: clarified recording average current only • Section 4.2.3: Editorial correction • Section 4.2.5, 4.2.6 and 4.2.7: Editorial corrections and updated the number of iterations for different test cases • Section 4.2.5 split into 2 subsections. • Section 4.2.5.1: Clarification of headset use in relation to GSMA TS.09 • Defined the orientation of the screen for each test case • Defined the test cases where a headset is required for testing • Defined the settings for notifications for all tests • Updated diagrams for TAE and energy use per activity

| July 2018 | 1.3 | • Section 1.1 – Added smartwatch.
• Section 1.2 – indicate VoLTE preferred option.
• Section 1.3 – GSMA TS.09 version 10.1 referenced.
• Section 1.5
  – Added acronyms DRX and cDRX.
  – New definitions added.
• Section 2.1 – Added smartwatch.
• Section 2.3
  – Indicate Dynamic Uplink Scheduling preferred option.
  – Reference GSMA TS.09 Table 21.
• Section 2.5 – Clarification of wi-fi setting.
• Section 2.9 – Creation of wearables section.
• Table 4.2-1 – Modification for applicability.
• Section 4.2.7
  – Indicate voice call uses VoLTE test from GSMA TS.09 version 10.1.
  – Clarification of the modification to the headset required for the TS.09 specified VoLTE test.
• Section 5.1 – Addition of smartwatch result handling.
• Appendix A – Clarification of wi-fi setting. |
| December 2018 | 1.2.1 | • Clarification of GPS and Location Services Settings in Appendix A.
• Clarification of Wi-Fi terminology in Section 1.5 and 2.5.
• Clarification of 4.2.3.3 Receive email.
• Details to progress the Angry Birds when the Application will not run. |