# Smartphone Performance Test Case Guideline

**Version 7.0**

**16 December 2021**

*This is a Non-binding Permanent Reference Document of the GSMA*

## Security Classification: Non-confidential

Access to and distribution of this document is restricted to the persons permitted by the security classification. This document is subject to copyright protection. This document is to be used only for the purposes for which it has been supplied and information contained in it must not be disclosed or in any other way made available, in whole or in part, to persons other than those permitted under the security classification without the prior written approval of the Association.



## Disclaimer

The GSM Association ("Association") makes no representation, warranty or undertaking (express or implied) with respect to and does not accept any responsibility for, and hereby disclaims liability for the accuracy or completeness or timeliness of the information contained in this document. The information contained in this document may be subject to change without prior notice.

## Compliance Notice

The information contain herein is in full compliance with the GSM Association's antitrust compliance policy.

This Permanent Reference Document is classified by GSMA as an Industry Specification, as such it has been developed and is maintained by GSMA in accordance with the provisions set out in GSMA AA.35 - Procedures for Industry Specifications.

# Table of Contents

# 1 Introduction

## 1.1 Overview

This document is applicable to 3GPP system capable terminals. It defines user experience performance test methods for mobile equipment (ME). This document covers the performance test cases for browser, the system response, system stability, camera image quality performance test cases, the AI speech recognition performance and device biometric AI recognition performance test cases.

## 1.2 Scope

This document lists test cases to help developers optimize the complete system user experience. For example, avoiding long waiting time or response latency for users, maintain a stable operation system while the device has been running for a long period or present photos with better image quality.

These test cases outline the rationale, initial configuration, test procedure and expected result are non-binding and non-exclusive. Operators, terminal manufacturers and test houses can perform additional or alternative tests.

These tests provide only the methodology but not a minimum required performance value. The performance results produced from these tests are intended to provide benchmarks for Mobile Network Operators to use when comparing terminals. The desired results should be provided by individual operators.

## 1.3 Definition of Terms

| Term | Description |
|---|---|
| AI | Artificial Intelligence |
| AP | Access Point |
| APK | Android Package Kit |
| APP | Application |
| ASR | Automatic Speech Recognition. |
| Bpm | Beats per minute |
| DUT | Device Under Test |
| E-UTRA | Evolved Universal Terrestrial Access |
| Fps | Frames per second |
| FAR (False Accept Rate) | Defined by ISO/IEC 19795-1: Proportion of verification transactions with wrongful claims of identity that are incorrectly confirmed. |
| FRR (False Reject Rate) | Defined by ISO/IEC 19795-1: Proportion of verification transactions with truthful claims of identity that are incorrectly denied. |
| GPRS | General Packet Radio Service |

| | |
|---|---|
| GSM | Global System for Mobile Communications |
| HTTP | Hypertext Transfer Protocol |
| LBS | Location Based Service |
| MMS | Multimedia Messaging Service |
| MO | Mobile Originated |
| MT | Mobile Terminated |
| NLU | Natural Language Understanding. |
| PC | Personal Computer |
| PDCCH | Physical Downlink Control Channel |
| RAT | Radio Access Technology |
| RCS | Rich Communication Services |
| RSRP | Reference Signal Receiving Power |
| RSSI | Received signal strength indication |
| SAR (Spoof Accept Rate) | Proportion of verification transactions that accepts fake biometric input incorrectly as real biometric input. |
| SINR | Signal to Interference plus Noise Ratio |
| SMS | Short Message Service. |
| TAR (True Accept Rate) | Proportion of verification transactions with truthful claims of identity that are confirmed correctly. |
| The model | The real people or the real tester used as subject of identification |
| TTS | Text to Speech. |
| UEX | User Experience |
| UI | User Interface |
| URL | Uniform Resource Locator |
| VoLTE | Voice over Long-Term Evolution |
| WCDMA | Wideband Code Division Multiple Access |
| Wi-Fi | Wireless Fidelity |
| WLAN | Wireless Local Area Network |

## 1.4 Document Cross-References

| Ref | Document Number | Title |
|---|---|---|
| 1 | TS.09 | GSMA PRD Battery Life Measurement and Current Consumption Technique |
| 2 | ETSI EG 202 396-1 | Speech Processing, Transmission and Quality Aspects (STQ); Speech quality performance in the presence of background noise; Part 1: Background noise simulation technique and background noise database |
| 3 | ISO/IEC 19795-1 | Information technology — Biometric performance testing and reporting |

# 2 Browser UEX performance Test

## 2.1 Test Environment and configuration

### 2.1.1 Test Scenarios Preparation

- A high-speed camera capable of shooting at a frame rate of⩾200 fps is recommended to be used to record the screen refresh process during testing. The camera lens must be filled with mobile screen during testing, which means the camera will be using macro settings.
- An intranet HTTP server PC which would host "static" IP pages that could contain representative web pages that would be downloaded by the Smartphone. This server will be used for browser performance testing.
- A WLAN or a WLAN simulator, so that the tester can compare Smartphone performance under different network conditions. These can provide a repeatable test environment. The simulator will be used for browser performance testing.
- A computer with video player software to analyze the recorded operation process. The video player software should be able to playback the video frame by frame (e.g. QuickTime player, KMPlayer).
- A Metronome can be used to provide standard operation speed.

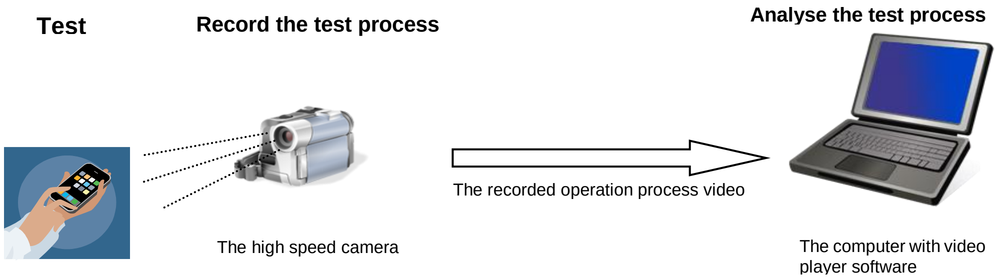



**Figure 1 The test scenario**

### 2.1.2 Device Configuration

- The device display contrast / brightness shall be set to the default values as delivered from the factory.
- The device uses battery power or is connected to a power supply.
- The terminal screen is unlocked.
- No APPs are running in the background except for the application that will be tested. This would include push notifications for all applications which have been disabled.
- Test environment lighting:

  - Avoid strong or flickering light.
  - The light in the test lab should make the captured image clear enough to be analysed on the computer

- A wide range of input methodology is used for the tests. For example, terminals may have touch sensitive screens, scroll bars, external sliders, physical buttons, a stylus or speech recognition. Within the tests, the term “press to use” means to convey an input methodology.
- For browser performance testing:

  - The browser to be tested is the Smartphone’s original browser as supplied with the devices when sold.
  - The terminal WLAN function is enabled.
  - 20 specified bookmarks are stored in the browser already. The stored bookmark should be the most popular websites, which are commonly visited by the public.
  - No APPs are running in the background except for the browser APP or the “AT&T Network Attenuator” APP. This would include push notifications for all applications which have been disabled.

### 2.1.3 Test network configuration

Smartphones perform differently under good and poor network condition. The devices should be tested under different network conditions and compared with other devices.

To provide a simple test network for a terminal, it is recommended to use a WLAN. To compare the Smartphone performance under different network conditions (e.g. WLAN transmit/receive power), two approaches are recommended:

One approach is to install the “AT&T Network Attenuator” APP on Smartphone. The “AT&T Network Attenuator” is an example application. The “Network Attenuator” application could control various network speed and congestion levels on the device which would help with analysing the devices performance under the good/bad network conditions.

An example network attenuator application instruction and installation package can be found on the following link: https://developer.att.com/blog/at-amp-t-network-attenuator.

Another approach is to use a WLAN signal simulator to provide a repeatable test environment. The test environment, which is detailed in the GSMA TS.09 BLM PRD [1] enables the tester to control many aspects of the base station simulator or WLAN signal simulator and allows the user to configure the test environment for different transmission powers.

The WLAN network configurations are provided in this version. (The GSM/GPRS/WCDMA/E-UTRA network configuration will be provided in future versions). The WLAN parameters of the test bed AP are given as below: (Refer to the GSMA TS.09BLM PRD [1], Section 3.8). The Wi-Fi RSSI parameter can be configured for different network conditions.

| Parameter | Mandatory Value | Comment |
| --- | --- | --- |
| WLAN standards | IEEE 802.11b/g/a/n or Wi-Fi CERITIFED 11a, 11g and 11n depending on whether Wi-Fi CERTIFIED devices are going to be mandated in the tests. | |
| WLAN frequency (2.4 GHz) | Channels 1,6,11 | |
| WLAN frequency (5 GHz) | Channel 36 (using a 20 MHz bandwidth) | Devices that support the 2.4 GHz and 5 GHz bands may be tested in each band |
| Authentication / Ciphering | WPA2 | Assumption is that this is WPA2-Personal as WPA2-Enterprise would require an authentication (AAA) server |
| BEACON INTERVAL | 100MS | |

**Table 1: WLAN parameters of the test Access Point (AP)**

### 2.1.4 Test web page

Five test webpages have been created together with their associated files. Before testing, download the files onto a local web server that is accessible to the terminal.

It is recommended to place the files in five different folders of the server so the page and its contents are reloaded instead of taken from the cache of the mobile device during the test

The test webpages can be found in the links below:

- jiage.vicp.io:7500/test_webpage_1.html
- jiage.vicp.io:7500/test_webpage_2.html
- jiage.vicp.io:7500/test_webpage_3.html
- jiage.vicp.io:7500/test_webpage_4.html
- jiage.vicp.io:7500/test_webpage_5.html

The webpage open resource codes can be found in Github:

https://github.com/GSMATerminals/Smartphone-Performance-Test-Case-Guideline-Public/tree/master/TS.29%20chapter%202-Webpage%20browser%20performance%20testing(test%20case%202.1.4)

Test pages are designed so that there is a clear visual indication on a terminal's UI when that web page has completely loaded.

## 2.2 Browser application set up time

### 2.2.1 Default Starting Page is a Blank Page Test

**Description**

To measure the average time taken between user activation of the browser and the browser reaching an active state: the untitled blank page is presented.

**Reason for test**

The time taken for the browser to start has an impact on user experience: a long start-up time is worse than a short start-up time. This test case evaluates the overall browser start-up time (without any content loading or rendering) to ensure users do not have to wait long for browser applications to start.

**Initial Condition**

The initial configuration is the same as defined in section 2.1.2. In addition, the default starting page for browser is set to be the untitled blank page. The cache for the browser and browsing history are cleared. No applications and services are to be running in the background.

**Test Procedure**

1. The user interface of the Smartphone is opened.
2. Use the high speed camera to capture the operation process.
3. Press the web browser icon or launch button to start up the browser.
4. Playback the testing process captured by high speed camera and analyse frame by frame. Record the time it takes from FINISHING pressing the browser icon or launch button, to when the untitled blank webpage is displayed completely.
5. Close the webpage, clear the browser cache and close the browser application in the Smartphone background.
6. Repeat test steps 2 through to 4 ten times, with a short break of ten seconds, to obtain an average application set up time.

**Expected Result**

The times required are decided by individuals, however the shorter the time the better the user experience.

**Additional Notes**

In this test case, the blank default starting page means the untitled webpage interface where the user could search or type a URL. Different Smartphone UIs display varied blank starting pages. For example, Chrome shows some popular links on the start-up webpage; Safari shows the white blank page.

### 2.2.2 Default starting page is the last page visited test

**Description**

To measure the average time taken between user activation of the browser and the browser reaching an active state and the most recently visited webpage is presented.

**Reason for test**

The time taken for the browser to start has an impact on the user experience. A long start-up time is less acceptable than a short start-up time. This test case evaluates the overall browser start-up time (with content loading or rendering) to ensure users do not have to wait too long for the browser application to start.

**Initial Condition**

- The initial configuration is the same as defined in section 2.1.2. In addition, the default starting page of the browser is set to be the page that is most recently visited. No applications are running in the background.

**Test Procedure**

1. The user interface of the Smartphone is opened.
2. Press the web browser icon or launch button to start up the browser.
3. Enter the URL in the address bar to open the test web page.
4. Close the webpage and exit the browser application.
5. Use the high speed camera to capture the operation process.
6. Press the web browser icon or the launch button to start up the browser.
7. Playback the testing process captured by the high speed camera and analyse frame by frame. Record the time it takes from FINISHING pressing the browser icon or launch button, to when the webpage has completed loading.
8. Close the webpage, clear the cache and exit the browser application.
9. Repeat the test steps 5 through to 8 ten times, with a short break of ten seconds, to obtain an average application set up time.

**Expected Result**

The times required are decided by individuals, however the shorter the time the better the user experience.

## 2.3 Web page zoom speed performance

The following test cases are designed for different mechanisms of a zooming UI action. The test case 3.4.1, 3.4.2 and 3.4.3 are alternatives and should be used depending on the support by the terminal browser.

### 2.3.1 Zoom mechanism: 2-finger press test

**Description**

Testing the terminal’s overall response speed, when the user zooms in/out on one opened web page.

**Reason for test**

To ensure the users do not have to wait too long when zooming in/out on a webpage.

**Initial condition**

The initial configuration is the same as defined in section 2.1.2.

**Test Procedure**

1. The user interface of the Smartphone is opened.
2. Open the browser application and load the test web page completely.
3. Use a high speed camera to capture the process.
4. Press the Smartphone screen and zoom in on the webpage. The content on screen becomes stable indicating that the webpage has finished zooming in.
5. Playback the testing process captured by the high speed camera and analyse frame by frame. Record the time point as T1 when the fingers finish sliding out. Record the time point as T2 when the webpage finishes zooming in.
6. Obtain the webpage zoom in speed by calculating the time difference between T1 and T2.
7. Press the Smartphone screen and zoom out from the webpage. The content on screen becomes stable indicating that the webpage has finished zooming out.
8. Playback the testing process captured by high speed camera and analyse frame by frame. Record the time point as T3 when the fingers finish sliding out. Record the time point as T4 when the webpage finishes zooming out.
9. Obtain the webpage zoom out speed by calculating the time difference between T3 and T4.
10. Repeat the tests step 3 through to 9 ten times, with a short break of ten seconds, to obtain an average webpage zoom in/out speed.

**Expected Result**

The times required are decided by individuals, however the shorter the time the better the user experience.

**Additional Notes**

Define a standard input sliding speed to reduce the impact from user habit. The metronome could provide testers with a standard speed. 90 bpm (beats per minute) is suggested as a recommendation for zoom in/out speed. Another approach is to use an automated mechanism to operate the Smartphone.

The following is an example recommendation for the finger moving range during zooming in on the webpage;

Start from the middle of the screen, the sliding distance for each finger is approximately 50% of the screen width, and the movement should be at approximately 45degrees, to avoid either finger reaching the screen edge. It is recommended to use an automated mechanism to operate the Smartphone. The procedure for zooming out is vice-versa.

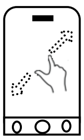


**Figure 2 Zoom in illustration**

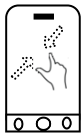


**Figure 3 Zoom out illustration**

### 2.3.2 Zoom mechanism: application zoom button test

**Description**

Testing the terminal response speed, when the user zooms in/out on an opened web page. The zoom mechanism is a one press zoom button.

**Reason for test**

To ensure users do not have to wait too long when zooming in/out on a webpage.

**Initial condition**

The initial configuration is the same as defined in section 2.1.2.

**Test Procedure**

1. The user interface of the Smartphone is opened.
2. Open the browser application and load the test web page completely.
3. Use a high speed camera to capture the process.
4. Press the application zoom button on the webpage to zoom in the webpage. It indicates the webpage has finished zooming in when the content on screen becomes stable.
5. Playback the testing process captured by high speed camera and analyse frame by frame. Record the time as $T_1$ when the finger finishes pressing the zoom button. Record the time point as $T_2$ when the webpage has finished zooming in.
6. Obtain the webpage zoom in speed by calculating the time difference between $T_1$ and $T_2$.
7. Press the application zoom button on the webpage to zoom out the webpage. It indicates the webpage has finished zooming out when the content on the screen becomes stable.
8. Playback the testing process captured by a high speed camera and analyse frame by frame. Record the time as $T_3$ when the finger finishes pressing the zoom button. Record the time point as $T_4$ when the webpage finishes zooming out.
9. Obtain the webpage zoom out speed by calculating the time difference between $T_3$ and $T_4$.
10. Repeat the test steps 4 through to 9ten times, with a short break of ten seconds, to obtain an average webpage zoom in/out speed.

**Expected Result**

The times required are decided by individuals, however the shorter the time the better the user experience.

### 2.3.3 Zoom mechanism: double-click the screen test

**Description**

Testing the terminal response speed when the user zooms in/out of an opened web page. The zoom mechanism is: double-click on the screen.

**Reason for test**

To ensure users do not have to wait long when zooming in/out webpage.

**Initial Condition**

The initial configuration is the same as defined in section 2.1.2.

**Test Procedure**

1. The user interface of the Smartphone is opened.
2. Open the browser application and load the test webpage completely.
3. Use a high speed camera to capture the process.
4. Double-click the Smartphone screen with an input device to zoom in the webpage. The webpage has finished zooming in when the content on the screen becomes stable.
5. Playback the testing process captured by a high speed camera and analyse frame by frame. Record the time as $T_1$when the input device finishes. Record the time point as $T_2$when the webpage finishes zooming in.
6. Obtain the webpage zoom in speed by calculating the time difference between $T_1$ and $T_2$.
7. Double-click the Smartphone screen with an input device to zoom out of the webpage. It indicates the webpage has finished zooming out when the content on screen becomes stable. Record the time as $T_3$ when the input device finishes.
8. Playback the testing process captured by a high speed camera and analyse frame by frame. Record the time as $T_3$ when the finger finishes pressing the screen. Record the time point as $T_4$ when the webpage finishes zooming out.
9. Obtain the webpage zoom out speed by calculating the time difference between $T_3$ and $T_4$.
10. Repeat the test steps 4 through to 9 ten times, with a short break of ten seconds, to obtain an average webpage zoom speed.

**Expected Result**

The times required are decided by individuals, however the shorter the time the better the user experience.

## 2.4 Web page zoom frame rate performance

The following test cases are designed for different mechanism of zooming action. The test case 2.4.1, 2.4.2 and 2.4.3 are alternatives, depending on which is supported by the device browser.

### 2.4.1 Zoom performance: 2-finger press test

**Description**

Testing the terminal overall response performance (frame rate) when the user zooms in/out of an opened webpage with a 2-finger press.

**Reason for test**

To ensure the Smartphone provides a user with a smooth zoom in/out performance. The Smartphone screen refreshes at 60 fps uniformly in theory during zoom in/out. If the zoom in/out process is not fluent or blocked, the screen refresh rate will be less than the theoretical value.

**Initial Condition**

The initial configuration is the same as defined in section 2.1.2.

**Test Procedure**

1. The user interface of the Smartphone is opened.
2. Open the browser application and load the test webpage completely.
3. Set a high speed camera to capture the zoom in/out procedure.
4. Press Smartphone screen with two fingers then slide out the fingers to zoom in the webpage.
5. The content on screen becomes stable indicates the webpage finished zooming in.
6. Press the outer area of the Smartphone screen with two fingers then slide in the fingers to zoom out the webpage.
7. The content on screen becomes stable indicates the webpage has finished zooming out.
8. Calculate the actual frame rate (fps) during the captured zoom in/out procedure.

Frame rate *("a" fps)* measurement recommendation:

- Playback the high speed camera captured test process frame by frame (Frame Rate of camera is assumed to be "Y" fps).
- Watch the video to find the point when the display starts zooming and record the frame number as $F_1$. Find the point when the display finishes zooming and record the frame number as $F_2$.
- Calculate the duration of zoom as: t = $(F_2-F_1)/Y$ seconds.
- The screen refresh process: The captured video shows one clear image when the screen starts to refresh, a few blurred images will be shown until the screen refreshes next time. When the next clear image appears on the captured video, the screen starts to refresh again. Within this interval "t", pick out the frames that show the screen has completely refreshed. Count the number of refresh frames (assumed to be A).
- Then the average actual frame rate during zooming can be calculated by the equation: Actual Frame Rate a= A/t.

9. Repeat the test steps 4 to 8 ten times, with a short break of ten seconds, to obtain an average webpage zoom in and zoom out frame rate.

**Expected Result**

The times required are decided by individuals, however the shorter the time the better the user experience

**Additional Notes**

Define standard finger sliding speed to reduce the impact from the user habit. The metronome could provide testers with a standard speed, 90 bpm is suggested as a recommendation for finger zoom in/out speed. Another approach is to use an automated mechanism operating the Smartphone.

The following is an example recommendation for the finger moving range:

Start from the middle of the screen. The slide distance for each finger is approximately 50% of the screen width, and the movement should be at approximately 45degrees, to avoid either finger reaching the screen edge. It is recommended to use an automated mechanism to operate the Smartphone. The procedure for zooming out is vice versa.

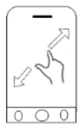


**Figure 4 Zoom in illustration**

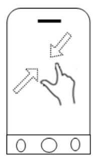


**Figure 5 Zoom out illustration**

### 2.4.2 Zoom performance: application zoom button test

**Description**

Testing the terminal performance (frame rate) when a user zooms in/out of an open web page.

**Reason for test**

To ensure the Smartphone provides the user with a smooth zoom in/out performance. In theory, the Smartphone screen refreshes 60 fps uniformly during zooming in/out. If the zoom in/out process is not fluent or blocked, the screen refresh rate will be less than the theoretical value.

**Initial Condition**

The initial configuration is the same as defined in section 2.1.2.

**Test Procedure**

1. The user interface of the Smartphone is opened.
2. Open the browser application and load the test web page completely.
3. Set a high speed camera to capture the zoom in/out procedure.
4. Press the application zoom button on the webpage to zoom in the webpage.
5. The content on the screen becomes stable indicating the webpage has finished zooming in.
6. Press the application zoom button on the webpage to zoom out of the webpage.
7. The content on the screen becomes stable indicating the webpage has finished zooming out.
8. Calculate the actual frame rate (frames per second) during the captured zoom in/out procedure.

Frame rate *("a" fps)* measurement recommendation:

- Playback the high speed camera captured test process frame by frame (Frame Rate of camera is assumed to be "Y" fps).
- Watch the video to find the point when the display starts zooming and record the frame number as $F_1$. Find the point when the display finishes zooming and record the frame number as $F_2$.
- Calculate the duration of zoom as:
  $t = (F_2-F_1)/Y$ seconds
- The screen refreshing process: The captured video shows one clear image when the screen starts to refresh. A few blurred images will be shown until the screen refreshes the next time. When the next clear image appears on the captured video, the screen has started to refresh again. Within this interval "t", pick out the frames that show the screen is refreshed. Count the number of refresh frames (assumed to be A).
- The average actual frame rate during zooming can be calculated by the equation: Actual Frame Rate a= A/t.

9. Repeat the test steps 4 through to 8 ten times, with a short break of ten seconds, to obtain an average webpage zoom in and zoom out frame rate.

**Expected Result**

The times required are decided by individuals, however the shorter the time the better the user experience.

### 2.4.3 Zoom performance: double-click the screen test

**Description**

Testing the terminal performance (frame rate) when the user zooms in/out of an open webpage with a double click mechanism.

**Reason for test**

To ensure the Smartphone provides the user with a smooth zoom in/out performance. In theory, the Smartphone screen refreshes 60 fps uniformly during zoom in/out. If the zoom in/out process is not fluent or blocked, the screen refresh rate will be less than the theoretical value.

**Initial Condition**

The initial configuration is the same as defined in section 2.1.2.

**Test Procedure**

1. The user interface of the Smartphone is opened.
2. Open the browser application and load the test webpage completely.
3. Set a high speed camera to capture the zoom in/out procedure.
4. Double-click the Smartphone screen with an input device to zoom in the webpage.
5. The content on screen becomes stable indicating the webpage has finished zooming in.
6. Double-click the Smartphone screen with an input device to zoom out the webpage.
7. When the content on the screen becomes stable, the webpage has finished zooming out.
8. Calculate the actual frame rate (frames per seconds) during the captured zoom in/out procedure.

Frame rate *("a" fps)* measurement recommendation:

- Playback the high speed camera captured test process frame by frame (Frame Rate of camera is assumed to be "Y" fps).
- Watch the video to find the point when the display starts zooming and record the frame number as $F_1$. Find the point when the display finishes zooming and record the frame number as $F_2$.
- Calculate the duration of zoom as:
  $t = (F_2-F_1)/Y$ seconds
- The screens refresh process: The captured video shows one clear image when the screen starts to refresh. A few blurred images will be shown until the screen refreshes next time. The next clear image appears on the captured video when the screen has to be refreshed again. Within this interval "t", pick out the frames that show the screen refreshed. Count the number of refresh frames (assumed to be A).
- The average actual frame rate during zooming can then be calculated by the equation: Actual Frame Rate a= A/t.

9. Repeat the test steps 4 through to 8 ten times, with a short break of ten seconds, to obtain an average webpage zoom in and zoom out frame rate.

**Expected Result**

The times required are decided by individuals, however the shorter the time the better the user experience.

## 2.5 Web page rotation speed performance

The following test case is designed for terminals which support web page rotation.

### 2.5.1 Rotation speed performance test

**Description**

Opening and fully loading one specified web page, testing the web page rotation response speed when the screen is switched from a horizontal position to a vertical position.

**Reason for test**

To ensure the Smartphone provides the user with a smooth rotational performance when using the browser.

**Initial Condition**

- The initial configuration is the same as defined in section 2.1.2.
- In addition, the screen is set to be able to rotate. The terminal is placed vertical (90 degrees) to the local ground.

**Test Procedure**

1. The user interface of the Smartphone is opened.
2. Open the browser application and load the test web page completely.
3. Set a high speed camera to capture the rotation procedure.
4. Rotate the terminal from a vertical to horizontal orientation in a clockwise direction. The content on the screen becomes stable indicating the webpage has finished its rotation.
5. Playback the testing process captured by a high speed camera and analyse frame by frame. Record the time point as $T_1$ when the device completes position switch. Record the time point as $T_2$ when the webpage finishes rotation.
6. Obtain the webpage rotation speed by calculating the time difference between$T_1$ and$T_2$.
7. Apply the same method to obtain the rotation speed when the webpage is rotated from horizontal to vertical orientation in a clockwise direction.
8. Apply the same method for the test steps 3 through to 6 again when the terminal is rotated in an anticlockwise direction.
9. Repeat the test steps 4 through to 8 ten times, with a short break of ten seconds, to obtain an average webpage rotation speed.

**Expected Result**

The times required are decided by individuals, however the shorter the time the better the user experience.

**Additional Notes**

The illustrations for terminal vertical/horizontal rotation are shown in figures 6 and 7. Define a standard device rotation speed to reduce the impact from the user. The metronome could provide testers with a standard speed. 90 bpm is suggested as a recommendation for device rotation speed. Another approach is to use an automated mechanism to operate the Smartphone.

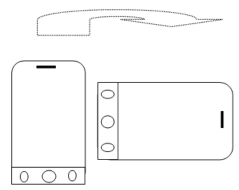


**Figure 6 Vertical to horizontal rotation in a clockwise direction**

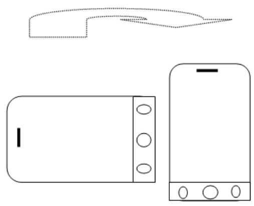


**Figure 7 Horizontal to vertical rotation in a clockwise direction**

## 2.6 Web page scrolling performance

The following test case is designed for terminals which support web page scrolling.

### 2.6.1 Web page scrolling performance test

**Description**

Testing the performance when the user scrolls up/down with an opened webpage.

**Reason for test**

To ensure the Smartphone provides the user with a smooth scroll up/down performance. In theory the Smartphone screen refreshes 60 fps uniformly during zooming in/out and the frame interval variance will be zero. If the zoom in/out process is not fluent or blocked, the screen refresh rate will be less than the theoretical value and the refresh frame interval variance will be greater than zero.

**Initial Condition**

The initial configuration is the same as defined in section 2.1.2.

**Test Procedure**

1. The user interface of the Smartphone is opened.
2. Open the browser application and load the test webpage completely.
3. Set a high speed camera to capture the scroll procedure.
4. Slide the webpage on the Smartphone screen with an input device.
5. Calculate the average frame rate *("a" fps)* according to the captured webpage scroll procedure.

Frame rate *("a" fps)* measurement recommendation:

- Playback the high speed camera captured test process frame by frame (Frame Rate of camera is assumed to be "Y" fps).
- View the video to find the point when the input device starts sliding the screen and record the frame number as $F_1$. Find the point when the display finishes scrolling and record the frame number as $F_2$.
- Calculate the duration of scroll as:
  $t = (F_2-F_1)/Y$ seconds
- The screen refreshing process: The captured video shows one clear image when the screen starts to refresh. A few blurred images will be shown until the screen has refreshed. The next clear image appears on the captured video is when the screen starts to refresh. Within this interval "t", pick out the frames that show the screen has refreshed. Count the number of refresh frames (assumed to be A).
- The average actual frame rate during scrolling can be calculated by the equation:
  Actual Frame Rate a= A/t.

6. Calculate the frame interval variance *( $\delta^2$)* according to the captured webpage scroll procedure video.

Frame interval variance *( $\delta^2$)* measurement recommendation:

- Playback the high speed camera captured test process frame by frame.
- Watch the video to pick out the refreshing frames. Calculate the time interval ($\triangle T_1$, $\triangle T_2$, $\triangle T_3$,……) between these refreshing frames.
- If the theory frame rate is 60, then the theory average frame interval ($\triangle T$) is 14.3ms, which can be considered as the variance centre.
- The frame interval variance during scrolling can be explained by the equation:
  $\delta^2 = \sum(\triangle T - \triangle T_{(1,2,3.....)})^2$

7. Repeat the test steps 4 through to 6 ten times, with a short break of ten seconds, to obtain an average webpage scroll performance.

**Expected Result**

For the frame rate, the higher the better. For the frame interval variance, the lower the better. The value requirement is decided by individuals.

**Additional Notes**

Define standard scroll speed to reduce the impact from the user. The metronome could provide testers with a standard speed - 90 bpm is recommended as a scroll speed for fingers. Another approach is to use an automated mechanism to operate the Smartphone.

The following is an example recommendation for the input device moving range:

Start point: 25% screen length to the bottom, end point: 25% screen length to the top. The user should not release the input device from the screen. If the user releases the screen, touch events will cease sending and the "scroll animator" may coast. This will change the frame rate. It is recommended to use an automated mechanism to operate the Smartphone. The procedure for scrolling down is vice-versa.

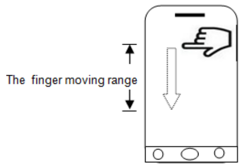



**Figure 8 Scroll down illustration**

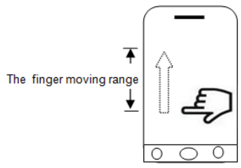



**Figure 9 Scroll up illustration**

## 2.7 Webpage loading times

### 2.7.1 Page loading time test

**Description**

The testing time between the start of opening a test webpage and displaying the entire page.

**Reason for test**

To ensure users do not have to wait too long when opening one webpage.

**Initial Condition**

The initial configuration is the same as defined in section 2.1.2. In addition, ensure the cache of the browser is empty.

**Test Procedure**

1. The user interface of the Smartphone is opened.
2. Use the high speed camera to capture the process.
3. Press the web browser icon or launch button to start up the browser.
4. Enter the URL of the test webpage at the address bar and then press the open button to load the webpage.
5. Playback the testing process captured by the high speed camera and analyse frame by frame. Record the time it takes from FINISHING pressing the browser icon or launch button to when the whole webpage has completed loading.
6. Close the webpage and exit the browser application in the Smartphone background.
7. Clear the browsing history and cache of the browser.
8. Repeat the test steps 2 through to 7ten times, with a short break of ten seconds, to obtain an average webpage loading time.

**Expected Result**

The times required are decided by individuals, however the shorter the time the better the user experience.

## 2.8 Backing up one history page test

### 2.8.1 Backing up History page test

**Description**

Testing the time between backing-up/forwarding one history page and displaying the page.

**Reason for test**

To ensure users do not have to wait too long when opening a formerly visited website.

**Initial Condition**

The initial configuration is the same as defined in section 2.1.2.

**Test Procedure**

1. The user interface of the Smartphone is opened.
2. Use the high speed camera to capture the process.
3. Press the web browser icon or launch button to start up the browser.
4. Enter URL of the testing webpage 1 at the address bar to open the webpage.
5. Press the back button to reload the testing webpage 1.
6. After the testing webpage is loaded completely, enter the URL of another testing webpage 2 at the address bar to open a second webpage.
7. Playback the testing process captured by a high speed camera and analyse frame by frame. Record the time it takes from finishing pressing the back button to when the testing webpage 1 completes there loading.
8. Close the webpage, clear the cache and exit the browser application in the Smartphone background.
9. Clear the browser history and cache.
10. Repeat the test steps 2 through to 9 ten times, with a short break of ten seconds, to obtain an average history webpage loading time.

**Expected Result**

The times required are decided by individuals, however the shorter the time the better the user experience.

## 2.9 Multiple web-page switching speed

The following test case is designed for browsers on terminals which support multiple open web pages at the same time.

### 2.9.1 Web-Page switching speed test

**Description**

Open several web pages by one browser and switch between different browser tabs to measure the switching speed.

**Reason for test**

The multi-page switching performance is related to the Smartphone browser cache read performance. To ensure users do not have to wait too long when switching between websites.

**Initial Condition**

The initial configuration is the same as defined in section 2.1.2. In addition, the browser is able to open several webpage (tabs) at the same time.

**Test Procedure**

1. The user interface of the Smartphone is opened.
2. Press the web browser icon or launch button to start up the browser.
3. Enter the URL of the testing webpage 1 at the address bar to open the webpage.
4. Add a new tab in the browser when the testing webpage 1 is loaded completely.
5. On the newly opened tab, enter the URL of the testing webpage 2 in the address bar to open the webpage.
6. Repeat test steps 4 and 5 to open five different webpage.
7. Press the browser tab switcher icon in order to scroll through five tabs.
8. Choose one of those five webpage then click to switch to that webpage.
9. Record the time point as $T_1$ when the input device finishes clicking the screen for webpage switching.
10. Record the time point as$T_2$ when the chosen page is loaded completely.
11. Calculate the multi-page switching time by taking the time difference between $T_1$ and $T_2$. The high speed camera is recommended to capture the process.
12. Choose different webpage from these five tabs and then repeat the test steps 7 through to 11 ten times, with a short break of ten seconds, to obtain an average multi-page switching time.

**Expected Result**

The times required are decided by individuals, however the shorter the time the better the user experience.

## 2.10 Web-page multimedia play performance

The following test case is designed for browsers on terminals which support multimedia applications (e.g. video).

- Note: Different terminals buffer an initial frame of a video sequence in different ways. Some mechanisms load the initial frame quickly to introduce a video, by displaying that initial frame, and then load the rest of the other frames whilst other mechanisms display a blank screen, loading many of the frames before starting. This is a trade-off between displaying the first frame and buffering the rest. This difference in operation can distort the results of the following test between differing terminals and is not necessarily representative of the video loading time.

### 2.10.1 Video loading time test

**Description**

Using the browser, open one specified webpage containing different formats of video stream links. Playback the video and then measure the time to show the first frame of the video.

**Reason for test**

The time taken for the browser to play the video has an impact on the user experience, a shorter waiting time is preferred. This test case evaluates the browser video first frame play time to ensure users do not have to wait too long.

**Initial Condition**

The initial configuration is the same as defined in section 2.1.2. In addition, the video player to be tested is built-in inside the browser. The testing webpage is loaded onto a local server to avoid the influence of network instability.

**Test Procedure**

1. The user interface of the Smartphone is opened.
2. Press the web browser icon or launch button to start up the browser.
3. Clear the browser cache and browsing history.
4. Enter the URL of the testing webpage 1 at the address bar to open the webpage.
5. Click the video playback button.
6. Record the time it takes from finishing pressing the playback button, to when the video shows the first frame. The high speed camera should be used to capture the process.
7. Stop playing the video.
8. Repeat test steps 3 through to 7 ten times, with a short break of ten seconds, to obtain the average video loading time.

**Expected Result**

The times required are decided by individuals, however the shorter the time the better the user experience.

### 2.10.2 Video playback performance test

**Description**

Using the browser to open one specified webpage, which contains different video formats in video streaming links. Playback the video and then measure the average frame rate of the video.

**Reason for test**

To ensure the Smartphone browser provides users with a smooth video playback performance.

**Initial Condition**

The initial configuration is the same as defined in section 2.1.2. In addition, the video player to be tested is embedded inside the browser. The testing webpage is loaded onto a local server to avoid the influence of network instability.

**Test Procedure**

1. The user interface of the Smartphone is opened.
2. Press the web browser icon or launch button to start up the browser.
3. Clear the browser cache and browsing history.
4. Enter the URL of the testing webpage at the address bar to open the webpage.
5. Click the video playback button.
6. Set a high speed camera to capture the procedure.
7. Calculate the average frame rate according to the captured video.

Frame rate *("a" fps)* measurement recommendation:

- Playback the high speed camera captured test process frame by frame.
- Assume the video playback time is "t".
- The screen refreshing process: The captured display shows one clear image when the screen starts to refresh. A few blurred images will be shown until the screen refreshes. When the next clear image appears on the captured display, the screen has started to refresh again. Within this interval "t", pick out the frames that show the screen refreshing. Count the number of refresh frames (assumed to be "A").
- The average video playback frame rate can be explained by the equation: $a=A/t$.

8. Calculate the frame interval variance ($\delta^2$) according to the captured video procedure.

Frame interval variance ($\delta^2$) measurement recommendation:

- Playback the high speed camera captured test process frame by frame.
- Watch the video to pick out the refreshing frames. Calculate the time interval ($\triangle T_1$, $\triangle T_2$, $\triangle T_3$, ……) between these refreshing frames.
- The theoretical frame rate is "*V*", the average frame interval ($\triangle T$) is *1/V* s, which can be considered as the variance centre.
- The frame interval variance duringmultimedia play can be explained by the equation: $\delta^2 = \Sigma(\triangle T - \triangle T_{(1,2,3\ldots\ldots)})^2$

9. Repeat the test steps 3 through to 8 ten times, with a short break of ten seconds, to obtain the webpage video playback performance.

**Expected Result**

For the frame rate, the higher the better. For the frame interval variance, the lower the better. The value requirement is decided by individuals.

# 3 System response performance testing

## 3.1 Test Environment and configuration

### 3.1.1 Device configuration

For system response performance testing, the following are required:

- 800 contacts shall be created as follows:
  - Contact Name. Example – *Fred Blogs*
  - Contact Phone Number. Example - *+66 6781 001 001*
  - Contact Email address. Example –*fblogs@google.com*
  - Contact Address - *No.26 telecom road, Human city, Thailand*
- 1000 SMS messages shall be created. These shall be between 10 and 20 word long.
- 60 emails shall be created as follows.
  - 30 emails with a pdf, MS Word, MS Power Point or MS Excel document attachment, the size shall be less than 1Mb. It is suggested to use this TS.29 document as the attachment.
  - 30 emails with a 3Mb photo attached. The photo could be downloaded from the photo material link below.
  - Example email text.
    - Dear Sir,
      This is the specified email text for UEX testing. This is the specified email text for UEX testing. This is the specified email text for UEX testing.
      This is the specified email text for UEX testing. This is the specified email text for UEX testing. This is the specified email text for UEX testing. This is the specified email text for UEX testing. This is the specified email text for UEX testing. This is the specified email text for UEX testing.

      Best regards, Mr Blogs 31st February 2000
- 200 photos shall be created using the following example photos https://github.com/GSMATerminals/Smartphone-Performance-Test-Case-Guideline-Public/tree/master/TS.29%20chapter%203-System%20response%20performance%20testing(test%20case%203.1.1)/TS.29_specified%20materials-UEX-picture-examples
- 30 video files shall be created using the following example video files https://github.com/GSMATerminals/Smartphone-Performance-Test-Case-Guideline-Public/tree/master/TS.29%20chapter%203-

System%20response%20performance%20testing(test%20case%203.1.1)/TS.29_specified%20materials-UEX-vedio-examples

- 50 audio files shall be created using the following example audio files https://github.com/GSMATerminals/Smartphone-Performance-Test-Case-Guideline-Public/tree/master/TS.29%20chapter%203-System%20response%20performance%20testing(test%20case%203.1.1)/TS.29_specified%20materials-UEX-audio-example

### 3.1.2 Test network configuration

It is suggested to use a signal simulator to provide a repeatable test environment. The LTE network configuration, provided below, enables the tester to control many aspects of the base station simulator or signal simulator. (Refer to the GSMA TS.09 BLM PRD [1], Section 3.7). The GSM/GPRS/WCDMA network configuration method, which also takes reference to the TS.09, will be updated in future versions.

| Parameter | Recommended Value | | Comment |
|---|---|---|---|
| | FDD | TDD | |
| Serving Cell Downlink EARFCN | Mid-range for all supported E-UTRA bands | | All bands supported by the handset must be measured.<br>Results must indicate which band(s) have been measured, and individual results for each band |
| Number of neighbours declared in the neighbour cell list | 16 intra-frequency,<br>0 inter-frequency,<br>0 inter-RAT,<br>no MBSFN cells | | Although the mobile is required to monitor these neighbour cells, the test equipment does not in fact provide signals. |
| DRX Cycle | 1.28 seconds | 1.28 seconds | Results must indicate the used DRX Cycle. |
| Periodic TAU | No | | T3412 = 111xxxxx |
| Reference Signal Energy Per Resource Element (RS ) | -85 dBm/15kHz | -85 dBm/15kHz | Refer to 3GPP TS 36.521-1,,C.0<br>Default value used for 3GPP performance test setup and signalling tests. |
| $N_{oc}$ | -98dBm/15kHz | | |
| Uplink downlink configuration | NA | 1 | Refer to 3GPP TS36.521-1,,C.2 |
| Special sub frame configuration | NA | 4 | |

| Parameter | Recommended Value | | Comment |
|---|---|---|---|
| | FDD | TDD | |
| PBCH EPRE Ratio | PBCH_RA = 0 dB<br>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<br>PDCCH_RB = 0 dB | | |
| PDSCH EPRE Ratio | PDSCH_RA = 0 dB<br>PDSCH_RB = 0 dB | | |
| PHICH EPRE Ratio | PHICH_RA = 0 dB<br>PHICH_RB = 0 dB | | |
| Serving cell bandwidth | 10 MHz | | |
| Number of antenna ports at eNodeB | 2 | | |
| Cyclic Prefix Length | Normal | | No extended cyclic prefix |
| PHICH Duration | Normal | | 1 symbol only, no extended PHICH |
| PDCCH length | 2 symbols | | Refer to 3GPP TS 36.521-1, C.1 |
| DCI Aggregation Level | 8 CCEs | | Refer to 3GPP TS 36.521-1,,C.3.1<br>Note that there is no UL in this test so DCI 0 is not relevant |
| $Q_{rxlevmin}$ | -120 dBm | | Lower than the expected RSRP to ensure that the UE camps on the target cell |
| $Q_{qualmin}$ | -20 Db | | Lower than the expected RSRQ to ensure that the UE camps on the target cell. |
| $S_{intraSearchP}$ | 0 dB | | |

| Parameter | Recommended Value | | Comment |
|---|---|---|---|
| | FDD | TDD | |
| $S_{intraSearchQ}$ | 0 dB | | I.e. UE may choose not to perform intra-frequency measurements.<br>Note: In Rel-8 only $S_{IntraSearch}$ is sent. In case Rel-8 is used this shall have the same value as $S_{IntraSearchP}$ in the table. |
| Paging and System Information change notification on PDCCH | No | | No P-RNTI on PDCCH |
| System Information Reception | No | | System information will be transmitted, but not received by the UE during the test. |
| OCNG | According to Table E-UTRA_FDD Idle_1 | According to Table E-UTRA TDD_Idle_1 | 3GPP TS 36.521, A.5.1.2 |

Smartphones perform differently under good and poor network conditions. It is suggested to test the devices under different network conditions and then compare the performance with other devices. The strong/ normal/ weak signal environment configuration is given as below. Testers may set up the strong/ normal/ weak network configuration for the network related test cases.

| Parameter | Recommended Value | | | Comment |
|---|---|---|---|---|
| | Weak signal environment | Normal signal environment | Strong signal environment | |
| SINR | -3~0dB | 5~10dB | 15~20dB | |
| RSRP | -120~-110dBm | -100~90dBm | -90~-80dBm | |

## 3.2 Communication function response performance

### 3.2.1 The "Contacts" start up speed

**Description**

To measure the average time taken between user activation of the “Contacts” APP and the address book reaching an active state until the contact list interface is presented completely.

**Reason for test**

The time taken for the “Contacts” APP to start has an impact on a user experience. A shorter start-up time is a better result than a longer start-up time. This test case evaluates the overall “Contacts” APP start-up time to ensure users do not have to wait long for the “Contacts” APP to start.

**Initial condition**

The initial configuration is the same as defined in section 2.1.2. In addition, 800 contacts are already stored in the “Contacts”.

**Test Procedure**

1. The user interface of the DUT is opened.
2. Set the high speed camera to capture the operation process.
3. Touch the “Contacts” icon or launch button.
4. Use the computer player to playback the testing process captured by the high speed camera and analyse frame by frame. Record the time it takes from finishing touching the Contacts icon or launch button to when the contact list interface is displayed completely.
5. Close the “Contacts” APP in the Smartphone background.
6. Repeat the test steps 2 through to 5 ten times to obtain an average “Contacts” start-up time.

**Expected Result**

The times required are decided by individuals, however the shorter the time the better the user experience.

### 3.2.2 The contact search speed

**Description**

Enter the contact name in the search bar of the contact list. Measure the time difference between finishing entering the characters and displaying of the related contact.

**Reason for test**

To ensure users do not have to wait long when searching for contacts.

**Initial condition**

The initial configuration is the same as defined in section 2.1.2. In addition, 800 contacts are already stored in the “Contacts”. 10 specified contacts are defined among these 800 contacts. They were provided in section 3.1.1 in the contact source examples.

**Test Procedure**

1. The user interface of the DUT is opened.
2. Set the high speed camera to capture the operation process.
3. Open the contact list interface with the contact search bar.
4. Use copy-paste function to paste one of the specified names e.g. “aejpz” directly into the address bar.

5. Playback the testing process captured by the high speed camera and analyse frame by frame. Record the time it takes from finishing pasting the name until the related contact is completely displayed.
6. Close the “Contacts” APP in the Smartphone background.
7. Repeat the test steps 2 through to 6 to search the other nine specified names and obtain an average contact search speed.

**Expected Result**

The times required are decided by individuals, however the shorter the time the better the user experience.

**Additional Notes**

In order to check the terminal search ability, the search range is suggested to cover the whole alphabet and the 10 contact names e.g. “aejpz” “bmkfw” “cwhay” “dbxioa” are specified since the letters cover the whole alphabet range from a-z.

### 3.2.3 The Contacts list scrolling fluency

**Description**

Measure the fluency (frame rate) when user scroll up/down the contacts list.

**Reason for test**

To ensure the Smartphone provides the user with a smooth scroll up/down performance. In theory, the Smartphone screen refreshes 60 fps uniformly and the frame interval variance will be zero. If the scroll process is not fluent or blocked, the screen refresh rate will be less than the theoretical value and the refresh frame interval variance will be greater than zero.

**Initial condition**

The initial configuration is the same as defined in section 2.1.2. In addition, 800 contacts are already stored in the “Contacts”. They were provided in section 3.1.1 in contact source examples.

**Test Procedure**

1. The user interface of the Smartphone is opened.
2. Open the contact list interface.
3. Set a high speed camera to capture the scroll procedure.
4. Slide up /down the contact list on the Smartphone screen with an input device.
5. Calculate the average frame rate *(“a” fps)* according to the captured contacts list scroll procedure.

Frame rate *(“a” fps)* measurement recommendation:

- Playback the high speed camera captured test process frame by frame (Frame Rate of camera is assumed to be “Y” fps).

- View the video to find the point when the input device starts sliding the contact list on screen and record the frame number as $F_1$. Find the point when the display finishes scrolling and record the frame number as $F_2$.
- Calculate the duration of scroll as:
  $t = (F_2-F_1)/Y$ seconds
- The screens refresh process: The captured video shows one clear image when the screen starts to refresh. A few blurred images will be shown until the screen has refreshed. The next clear image appears on the captured video is when the screen starts to refresh. Within this interval “t”, pick out the frames that show the screen has refreshed. Count the number of refresh frames (assumed to be A).
- The average actual frame rate during scrolling can be calculated by the equation:
  Actual Frame Rate a= A/t.

6. Calculate the frame interval variance ( $\delta^2$) according to the captured contact list scroll procedure video.

Frame interval variance ( $\delta^2$) measurement recommendation:

- Playback the high speed camera captured test process frame by frame.
- Watch the video to pick out the refreshing frames. Calculate the time interval ($\triangle T_1$, $\triangle T_2$, $\triangle T_3$ …) between these refreshing frames.
- If the theory frame rate is 60, then the theory average frame interval ($\triangle T$) is 14.3ms, which can be considered as the variance centre.
- The frame interval variance during scrolling can be explained by the Equation:
  $\delta^2 = \sum(\triangle T-\triangle T_{(1,2,3\ldots..)})^2$

7. Repeat the test steps 1 to 6 ten times and obtain an average contact list scroll performance.

**Expected Result**

The times required are decided by individuals, however for the frame rate, higher is better; for the frame interval variance, lower is better.

**Additional Notes**

Define a standard scroll speed to reduce the impact from the user. The metronome could provide testers with a standard speed - 60 bpm is recommended as a scroll speed for fingers. Another approach is to use an automated mechanism to operate the Smartphone.

The following is an example recommended for the input device moving range:

Start point for scrolling up: Bottom of the contact list area, end point: Top of the contact list area. The user should not release the input device from the screen. If the user releases the screen, touch events will cease sending and the "scroll animator" may coast. This will change the frame rate. It is recommended to use an automated mechanism to operate the Smartphone. The procedure for scrolling down is vice-versa.

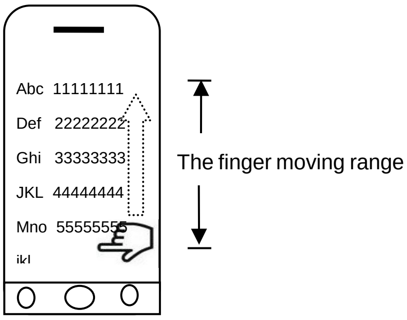



**Figure 10 Scroll up illustration**

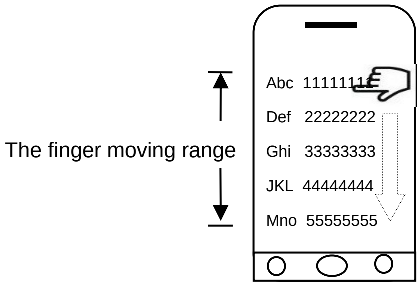



**Figure 11 Scroll down illustration**

### 3.2.4 "Phone Call" start up speed

**Description**

To measure the average time taken between user activation of the “Phone call” APP and the “Phone call” APP reaching an active state: the keypad interface is presented completely.

**Reason for test**

The time taken for the “Phone Call” APP to start has an impact on user experience: A shorter start-up time is a better result than a longer start-up time. This test case evaluates the overall “Phone Call” APP start-up time to ensure users do not have to wait long for “Phone Call” to be initiated.

**Initial condition**

The initial configuration is the same as defined in section 2.1.2. In addition, 800 contacts are already stored. They were provided in section 3.1.1 source examples. 20 calls are dialled and the call history shall display these 20 calls.

**Test Procedure**

1. The user interface of the Smartphone is opened.
2. Use the high speed camera to capture the operation process.
3. Touch the “Phone Call” icon or launch button.
4. Use the computer player to playback the testing process captured by the high speed camera and analyse frame by frame. Record the time it takes from finishing touching the “Phone Call” icon or launch button to when the keypad interface is displayed completely.

5. Close the “Phone Call” APP in the Smartphone background.
6. Repeat the test step 2 – 5 for ten times to obtain an average “Phone Call” start-up time.

**Expected Result**

The times required are decided by individuals, however the shorter the time the better the user experience.

### 3.2.5 "Messages" start up speed

**Description**

Measure the average time taken between user activation of the “Message” APP and the “Message” APP reaching an active state - the message list is presented completely.

**Reason for test**

The test case evaluates the "Message" response time to ensure users do not have to wait long.

**Initial condition**

The initial configuration is the same as defined in section 2.1.2. In addition, 1000 short messages are already stored in the “Messages” APP. The messages examples are specified in section 3.1.1 source examples.

**Test Procedure**

1. The user interface of the Smartphone is opened.
2. Use the high speed camera to capture the operation process.
3. Touch the “Messages” icon or launch button.
4. Use the computer player to playback the testing process captured by the high speed camera and analyse frame by frame. Record the time it takes from finishing touching the “Messages” icon or launch button to when the message list is displayed completely.
5. Close the “Messages” APP in the Smartphone background.
6. Repeat the test steps 2 to 5 ten times to obtain an average “Message” start-up time.

**Expected Result**

The times required are decided by individuals, however the shorter the time the better the user experience.

### 3.2.6 Message search speed

**Description**

Measure the time needed to search one contact within all of the short messages.

**Reason for test**

The test case evaluates the "Messages" response time to ensure users do not have to wait long when searching for one particular message.

**Initial condition**

The initial configuration is the same as defined in section 2.1.2. In addition, 1000 short messages are already stored in the “Messages” APP. The messages examples are specified in section 3.1.1 source examples.

**Test Procedure**

1. The user interface of the Smartphone is opened.
2. Set the high speed camera to capture the operation process.
3. Open the message list interface including the message search bar.
4. Enter one character, like “B” in the search bar.
5. Playback the testing process captured by the high speed camera and analyse frame by frame. Record the time it takes from finishing entering the characters to when the related contact is completely displayed.
6. Close the “Messages” APP in the Smartphone background.
7. Repeat the test steps 2 to 6 nine more times to search the other nine characters and obtain an average message search speed.

**Expected Result**

The times required are decided by individuals, however the shorter the time the better the user experience.

**Additional Notes**

In order to check the terminal search ability, the search range is suggested to cover the whole alphabet.

### 3.2.7 "Email" start up speed

**Description**

To measure the average time taken between user activation of the “Email” APP and reaching an active state until the mail list is presented completely.

**Reason for test**

The test case evaluates the “Email” response time to ensure users do not have to wait long.

**Initial condition**

The initial configuration is the same as defined in the section 2.1.2. In addition, 60 mails are already stored in the “Email-Inbox”. The mails are specified in section 3.1.1 source examples.

**Test Procedure**

1. The user interface of the Smartphone is opened.

2. Use the high speed camera to capture the operation process.
3. Touch the “Email” icon or launch button.
4. Use the computer player to playback the testing process captured by the high speed camera and analyse frame by frame. Record the time it takes from finishing touching the “Email” icon or launch button to until when the mail list finished updating completely.
5. Close the “Email” APP in the Smartphone background.
6. Repeat the test steps 2 to 5 ten times to get an average “Email” start-up time.

**Expected Result**

The times required are decided by individuals, however the shorter the time the better the user experience.

**Additional Notes**

Please note that no emails should be sent to the test email account, that way the email starting speed won’t be affected by the email loading speed.

### 3.2.8 Email loading speed

**Description**

To measure the time difference between starting loading one email and displaying of the entire email.

**Reason for test**

To ensure users do not have to wait too long when loading one email.

**Initial condition**

- The initial configuration is the same as defined in the section 2.1.2. In addition, 60 emails are already stored in the “Email-Inbox”.
- One unread new email with one 3MB picture has been sent to the email account. The email with the attachment is specified in section 3.1.1 source examples.
- When sending the “new” email, the attached photo size should be configured to be the actual size not the reduced size.

**Test Procedure**

1. Use the high speed camera to capture the process.
2. Press the “Email” icon or launch button to start up the testing email APP.
3. Send one new email to the testing email account by another device or computer. One picture is attached in this email and the size of the picture is 3MB.
4. Update and check for new emails. Select the unread new email to load the entire email.
5. Playback the testing process captured by the high speed camera and analyse frame by frame. Record the time it takes from finishing pressing the new email to when the whole email including the picture has completed loading.
6. Close the email application in the Smartphone background.

7. Repeat the test steps 2 to 6 ten times, with a short break of five seconds, to obtain an average email loading time.

**Expected Result**

The times required are decided by individuals, however the shorter the time the better the user experience.

**Additional Notes**

The content of the email should be specified and standardised to ensure the test result is repeatable and comparable for different terminals.

## 3.3 Local multimedia function response performance

### 3.3.1 The "Camera" start-up speed

**Description**

To measure the average time taken between user activation of the "Camera" APP and the camera reaching an active state until the photo taking interface is presented completely.

**Reason for test**

The time taken for the "Camera" APP to start has an impact on user experience: A shorter start-up time is a better result than a longer start-up time. This test case evaluates the overall "Camera" APP start-up time to ensure users do not have to wait long for the "Camera" APP to start.

**Initial condition**

The initial configuration is the same as defined in section 2.1.2. In addition, 200 photos are already stored in the "Photos". The photos are specified in section 3.1.1 source examples.

**Test Procedure**

1. The user interface of the Smartphone is opened.
2. Set the high speed camera to capture the operation process.
3. Touch the "Camera" icon or launch button.
4. Use the computer player to playback the testing process captured by the high speed camera and analyse frame by frame. Record the time it takes from finishing touching the Camera icon or launch button to until when the photo taking interface with a clear viewfinder is displayed completely.
5. Close the "Camera" APP in the Smartphone background.
6. Repeat the test steps 2 to 5 ten times to obtain an average "Camera" start-up time.

**Expected Result**

The times required are decided by individuals, however the shorter the time the better the user experience.

### 3.3.2 The "Photo" APP (Gallery) start-up speed

**Description**

To measure the average time taken between user activation of the “Photos” APP and the “Photos” reaching an active state until the album is presented completely.

**Reason for test**

The time taken for the “Photo” APP to start has an impact on user experience: A shorter start-up time is a better result than a longer start-up time. This test case evaluates the overall “Photos” APP start-up time to ensure users do not have to wait long to view the photo album.

**Initial condition**

The initial configuration is the same as defined in section 2.1.2. In addition, 200 photos are already stored in the “Photos”. The photos are specified in section 3.1.1 source examples.

**Test Procedure**

1. The user interface of the Smartphone is opened.
2. Set the high speed camera to capture the operation process.
3. Touch the “Photos” icon or launch button.
4. Use the computer player to playback the testing process captured by the high speed camera and analyse frame by frame. Record the time it takes from finishing touching the “Photos” icon or launch button to until when the album is displayed completely.
5. Close the “Photos” APP in the Smartphone background.
6. Repeat the test steps 2 to 5 ten times to obtain an average “Photos” start-up time.

**Expected Result**

The times required are decided by individuals, however the shorter the time the better the user experience.

### 3.3.3 Picture loading speed

**Description**

To measure the time difference between starting to load one picture and displaying the entire image. The size of the picture is 2Mb or above.

**Reason for test**

To ensure users do not have to wait too long when downloading one photo.

**Initial condition**

The initial configuration is the same as defined in section 2.1.2. In addition, 200 photos are already stored in the “Photos”. The photos are specified in section 3.1.1 source examples.

**Test Procedure**

1. Set the high speed camera to capture the operation process.
2. Touch the “Photos” icon or launch button to show the album list.
3. Select one picture.
4. Use the computer player to playback the testing process captured by the high speed camera and analyse frame by frame. Record the time it takes from finishing touching the picture to until when the whole picture is displayed completely.
5. Close the “Photos” APP in the Smartphone background.
6. Repeat the test steps 2 to 5 ten times to obtain an average picture loading time.

**Expected Result**

The times required are decided by individuals, however the shorter the time the better the user experience.

### 3.3.4 Picture sliding performance

**Description**

Measure the sliding fluency (frame rate) when the user slides the screen to switch photos.

**Reason for test**

To ensure the Smartphone provides the user with a smooth photo sliding performance. In theory, the Smartphone screen refreshes 60 fps uniformly and the frame interval variance will be zero. If the sliding process is not fluent or blocked, the screen refresh rate will be less than the theoretical value and the refresh frame interval variance will be greater than zero.

**Initial condition**

The initial configuration is the same as defined in section 2.1.2. In addition, 200 pictures are already stored in the “Photos”. The photos are specified in section 3.1.1 source examples.

**Test Procedure**

1. The user interface of the Smartphone is opened.
2. Open the “Photos” album.
3. Set a high speed camera to capture the sliding procedure.
4. Slide the picture on the Smartphone screen from right to the left with an input device.
5. Calculate the average frame rate *(“a” fps)* according to the captured picture sliding procedure.

Frame rate *(“a” fps)* measurement recommendation:

- Playback the high speed camera captured test process frame by frame (Frame Rate of camera is assumed to be “Y” fps).
- View the video to find the point when the input device starts sliding one picture on screen and record the frame number as $F_1$. Find the point when the display finishes sliding and record the frame number as $F_2$.
- Calculate the duration of sliding as:
  $t = (F_2-F_1)/Y$ seconds

- The screen refreshes process: The captured video shows one clear image when the screen starts to refresh. A few blurred images will be shown until the screen has refreshed. The next clear image appears on the captured video when the screen starts to refresh. Within this interval “t”, pick out the frames that show the screen has refreshed. Count the number of refresh frames (assumed to be A).
- The average actual frame rate during sliding can be calculated by the equation: Actual Frame Rate a= A/t.

6. Calculate the frame interval variance *($\delta^2$)* according to the captured picture sliding procedure video.

Frame interval variance *($\delta^2$)* measurement recommendation:

- Playback the high speed camera captured test process frame by frame.
- Watch the video to pick out the refreshing frames. Calculate the time interval ($\triangle T_1$, $\triangle T_2$, $\triangle T_3$,……) between the refreshing frames.
- If the theory frame rate is 60, then the theory average frame interval ($\triangle T$) is 14.3ms, which can be considered as the variance centre.
- The frame interval variance during sliding can be explained by the
- equation: $\delta^2 = \sum(\triangle T - \triangle T_{(1,2,3.....)})^2$

7. Repeat the test steps 4 - 6 ten times and obtain an average picture slide performance.

**Expected Result**

The times required are decided by individuals, however for the frame rate, higher is better. For the frame interval variance, lower is better.

**Additional Notes**

Define a standard slide speed to reduce the impact from the user. The metronome could provide testers with a standard speed - 60 bpm is recommended as a slide speed for fingers. Another approach is to use an automated mechanism to operate the Smartphone.

The following is an example recommendation for the input device moving range:

Start point for sliding: 25% screen length to the left side of screen, end point: 25% screen length to the right side of screen. The user should not release the input device from the screen. If the user releases the screen, touch events will cease sending and the "scroll animator” may coast. This will change the frame rate. It is recommended to use an automated mechanism to operate the Smartphone.

The finger moving range from 25%
screen length left to right

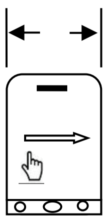


**Figure 12 Screen slide illustration**

### 3.3.5 Photograph taking speed

**Description**

To measure the average time used to take one photo: from touching the photo shooting key to when the photo preview is presented completely.

**Reason for test**

To ensure users do not have to wait too long when taking one photo.

**Initial condition**

- The initial configuration is the same as defined in section 2.1.2. In addition, 200 pictures are already stored in the “Photos”. The photos are specified in section 3.1.1 source examples.
- There are many factors that may influence the photo shooting speed e.g. the image quality, background light, background colour. It is necessary to define a standard scenario for the photo taking background.
- The camera settings are given as below:

| Smartphone Camera settings | Statues |
|---|---|
| Pixels | The original pixel of the Photo sensor |
| The format of photo | JPEG |
| The photo effects or special edition | OFF |
| Photo colour | Factory default setting |
| Flash light | OFF |
| White Balance | Auto |
| ISO Sensitivity | Auto |
| Autofocus | ON |
| Camera with time delay | OFF |

- The environment light source condition is the same as defined in section 2.1: The light in the test lab should make the captured image clear enough to be analysed on the computer. Avoid strong or flickering light. Additionally, some light temper is suggested here:

| Light type | Light temper |
|---|---|
| D65 | 6500K |
| D50 | 5000K |

| | |
|---|---|
| TL84 | 4000K |
| A light | 2856K |

- The picture that will be shot is the standard colour test chart. E.g. X-rite Colour Checker Chart with 24 colours.

**Test Procedure**

1. Set the high speed camera to capture the operation process.
2. Touch the “Camera” icon and enter the photo taking interface.
3. Click the photo taking icon/button.
4. Use the computer player to playback the testing process captured by the high speed camera and analyse frame by frame. Record the time it takes from finishing touching the photo taking button to when the whole photo preview is displayed completely.
5. Close the “Camera” APP in the Smartphone background.
6. Repeat the test steps 2 to 5 ten times to obtain an average photo taking time.

**Expected Result**

The times required are decided by individuals, however the shorter the time the better the user experience.

**Additional Notes**

In this test case the complete display of photo preview means the image becomes stable and not blurry.

### 3.3.6 Video shooting /photograph switching speed

**Description**

To measure the time used to switch from the camera mode to video shooting mode or video mode to camera mode.

**Reason for test**

To ensure users do not have to wait long when switching between camera and video shooting mode.

**Initial condition**

The initial configuration is the same as defined in section 2.1.2. In addition, 200 pictures are already stored in the “Photos”. The photos are specified in section 3.1.1 source examples.

**Test Procedure**

1. Set the high speed camera to capture the operation process.
2. Touch the “Camera” icon and enter the photo taking interface.
3. Click the camera/video mode switch icon.

4. Use the computer player to playback the testing process captured by the high speed camera and analyse frame by frame. Record the time it takes from finishing touching the camera/video mode switch icon to when the video shooting interface is displayed completely.
5. Apply the same method to record the video mode to camera mode switch speed.
6. Close the “Camera” APP in the Smartphone background.
7. Repeat the test steps 2 to 6 ten times to obtain an average video/camera mode switching speed.

**Expected Result**

The times required are decided by individuals, however the shorter the time the better the user experience.

**Additional Notes**

In this test case, the complete display of photo preview means the image becomes stable and not blurry.

### 3.3.7 Local audio loading speed

**Description**

Playback an audio file stored on the phones internal memory and measures the latency to hear the audio or when the pause key appears.

**Reason for test**

To evaluate the local multimedia applications response time and ensure users do not have to wait long when loading one audio.

**Initial condition**

The initial configuration is the same as defined in the section 2.1.2. In addition, 50 audios are already stored in the “Music” or “Recording”-APP. The audios are specified in section 3.1.1 source examples.

**Test Procedure**

1. Set the high speed camera to capture the operation process.
2. Touch the “Music” or “Recording” icon and enter the audio playlist interface.
3. Select one audio file and play it.
4. Use the computer player to playback the testing process captured by the high speed camera and analyse frame by frame. Record the time it takes from finishing touching the audio play key to when the audio starts to play (the pause key appears).
5. Close the “Music” or “Recording” APP in the Smartphone background.
6. Repeat the test steps 2 to 5 ten times to obtain an average audio loading speed.

**Expected Result**

The times required are decided by individuals, however the shorter the time the better the user experience.

### 3.3.8 Local video loading speed

**Description**

Playbacks a video file stored on the phones internal memory and measures the time to show the first frame of the video.

**Reason for test**

To evaluate the local multimedia applications response time and ensure users do not have to wait long when loading one video.

**Initial condition**

The initial configuration is the same as defined in section 2.1.2. In addition, 30 video files are already stored in the “video file” APP.

**Test Procedure**

1. Set the high speed camera to capture the operation process.
2. Touch the “video file” icon and enter the video playlist interface.
3. Select one video file and play it.
4. Use the computer player to playback the testing process captured by the high speed camera and analyse frame by frame. Record the time it takes from finishing touching the video play icon to when the video starts to play (the pause key appears).
5. Close the “video file” APP in the Smartphone background.
6. Repeat the test steps 2 to 5 ten times to obtain an average video loading speed.

**Expected Result**

The times required are decided by individuals, however the shorter the time the better the user experience.

## 3.4 Network registration response performance

### 3.4.1 LBS service locating speed

**Description**

Measure the speed that the "Location based Service" APP needs to provide the user with the accurate location. (The location based service APP is the Smartphone’s original APP as supplied with the devices when sold).

**Reason for test**

To ensure the Smartphone provides the user with a quick and accurate location service.

**Initial condition**

The initial configuration is the same as defined in section 2.1.2. The AGPS function on the Smartphone is switched on.

**Test Procedure**

1. Set the high speed camera to capture the operation process.
2. Open the location service APP in place A then switch on the airplane mode.
3. Go to another place B. The horizontal distance between A and B is at least 20 meters.
4. Switch off the airplane mode, open the location service APP at place B and get the current location again.
5. Use the computer player to playback the testing process captured by high speed camera and analyse frame by frame. Record the time it takes from finishing touching the current location icon at place B to when the accurate location is shown on the map.
6. Close the “map APP” in the Smartphone background.
7. Repeat the test steps 2 to 6 ten times to obtain an average LBS service locating speed.

**Expected Result**

The times required are decided by individuals, however the shorter the time the better the user experience.

### 3.4.2 System power on speed

**Description**

To measure the system power-on speed.

**Reason for test**

To ensure the Smartphone provides the user with a quick network registration.

**Initial condition**

The initial configuration is the same as defined in section 2.1.2.

**Test Procedure**

1. Set the high speed camera to capture the operation process.
2. The Smartphone is in shut down state. Long press the power on/off button.
3. Use the computer player to playback the testing process captured by high speed camera and analyse frame by frame. Record the time point as T1 when the screen starts to become bright. Record the time point as T2 when the network signal appears.
4. Obtain the system power on speed by calculating the time difference between T1 and T2.
5. Power off the Smartphone.
6. Repeat the test steps 2 to 5 ten times to obtain an average power on speed.

**Expected Result**

The times required are decided by individuals, however the shorter the time the better the user experience.

### 3.4.3 Airplane mode switching speed

**Description**

Measure the time used to switch from airplane mode to idle mode.

**Reason for test**

To ensure the Smartphone provides the user with a quick network registration.

**Initial condition**

The initial configuration is the same as defined in section 2.1.2.

**Test Procedure**

1. Set the high speed camera to capture the operation process.
2. Set the Smartphone status into airplane mode status, with a short break of ten seconds. Turn off the airplane mode icon and change the Smartphone state into idle status.
3. Use the computer player to playback the testing process captured by high speed camera and analyse frame by frame. Record the time point as T1 when the airplane mode icon is turned off. Record the time point as T2 when the network signal appears in idle status.
4. Obtain the airplane mode switching speed by calculating the time difference between T1 and T2.
5. Repeat the test steps 2 to 4 ten times to obtain the average airplane mode switching speed.

**Expected Result**

The times required are decided by individuals, however the shorter the time the better the user experience.

## 3.5 Screen response performance

### 3.5.1 Home screen sliding speed in horizontal direction

**Description**

Slide on the screen in horizontal direction. Measure the time difference from the moment when the user finishes the screen sliding gesture to the moment when the home screen starts sliding.

**Reason for test**

To ensure the Smartphone provides users with a quick and smooth sliding performance.

**Initial condition**

The initial configuration is the same as defined in section 2.1.2. In order to slide the home screen leftwards or rightwards, there are at least 2 home pages on the screen and each home screen has one leftmost APP icon and one rightmost APP icon.

**Test Procedure**

1. Set the high speed camera to capture the operation process.
2. Slide on the home screen from left to right in horizontal direction.
3. Choose the leftmost APP icon as reference. Playback the testing process captured by the high speed camera and analyse frame by frame. Record the time point as T1 when the finger starts to slide the home screen. Record the time point as T2 when the reference APP icon starts to move to the right.
4. Obtain the sliding speed of home screen from left to right by calculating the time difference between T1 and T2.
5. Apply the same method to obtain the sliding speed of home screen from right to left.
6. Repeat the test steps 2 to 5 ten times and obtain the average home screen sliding speed in horizontal direction.

**Expected Result**

The times required are decided by individuals, however the shorter the time the better the user experience.

**Additional Notes**

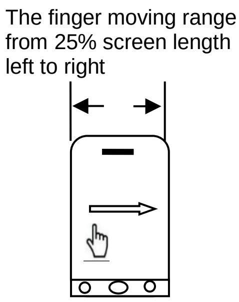



**Figure 13 Screen slide illustration**

### 3.5.2 Screen sliding speed in vertical direction

**Description**

Slide on the Smartphone screen in vertical direction. Measure the time difference from the moment when the user finishes the screen sliding gesture to the moment when the screen starts sliding.

**Reason for test**

To ensure the Smartphone provides user with a quick and smooth sliding performance.

**Initial condition**

The initial configuration is the same as defined in section 2.1.2. In order to slide the screen upwards or downwards, there are at least 2 pages on the contact list screen.

**Test Procedure**

1. Open the contact list. Set the high speed camera to capture the operation process.

2. Slide on the contact list from the bottom of the contact list to the top of the contact list. The finger moving range is given in the additional notes.
3. Choose the bottom contact as reference. Playback the testing process captured by the high speed camera and analyse frame by frame. Record the time point as T1 when the finger starts to slide the contact list upwards. Record the time point as T2 when the reference contact starts to move upwards.
4. Obtain the screen sliding speed from bottom to top by calculating the time difference between T1 and T2.
5. Apply the same method to obtain the screen sliding speed from top to bottom.
6. Repeat the test steps 2 to 5 ten times and obtain the average screen sliding speed in vertical direction.

**Expected Result**

The times required are decided by individuals, however the shorter the time the better the user experience.

**Additional Notes**

Starting point for sliding upwards: Bottom of the contact list area. End point: Top of the contact list area. The user should not release the input device from the screen. If the user releases the screen, touch events will cease sending and the "scroll animator" may coast. This will change the frame rate. It is recommended to use an automated mechanism to operate the Smartphone. The procedure for sliding downwards is vice-versa.

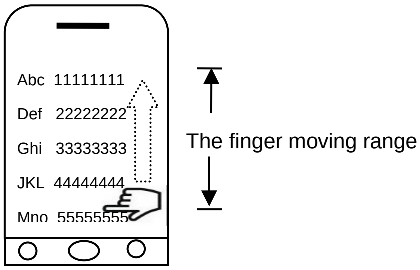



**Figure 14 Sliding upwards illustration**

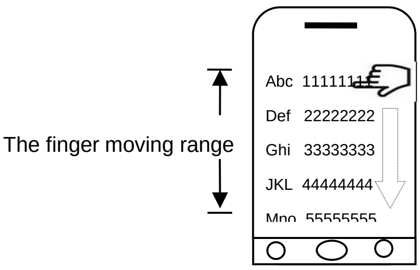



**Figure 15 Sliding downwards illustration**

### 3.5.3 Home screen slide fluency

**Description**

Slide on the home screen. Measure the fluency (frame rate and frame interval variance) when the home screen starts sliding.

**Reason for test**

To ensure the Smartphone provides user with a quick and smooth sliding performance.

**Initial condition**

The initial configuration is the same as defined in section 2.1.2. In order to slide the home screen leftwards or rightwards, there are at least 2 home pages on the screen.

**Test Procedure**

1. The home screen of the Smartphone is opened. Set a high speed camera to capture the sliding procedure.
2. Slide from left to right on the Smartphone home screen page with the input device.
3. Calculate the average frame rate ("a" fps) according to the captured sliding procedure.

Frame rate *("a" fps)* measurement recommendation:

- Playback the high speed camera captured test process frame by frame (Frame Rate of camera is assumed to be "Y" fps).
- View the video to find the point when the input device starts sliding the home screen and record the frame number as $F_1$. Find the point when the display finishes sliding and record the frame number as $F_2$.
- Calculate the duration of sliding as:
  $t = (F_2-F_1)/Y$ seconds
- The screens refresh process: The captured video shows one clear image when the screen starts to refresh. A few blurred images will be shown until the screen has refreshed. The next clear image appears on the captured video is when the screen starts to refresh. Within this interval "t", pick out the frames that show the screen has refreshed. Count the number of refresh frames (assumed to be A).
- The average actual frame rate during sliding can be calculated by the equation:
  Actual Frame Rate a=A/t.

4. Calculate the frame interval variance ( $\delta 2$) according to the captured sliding procedure video.

Frame interval variance *( $\delta^2$)* measurement recommendation:

- Playback the high speed camera captured test process frame by frame.
- Watch the video to pick out the refreshing frames. Calculate the time interval ($\triangle T_1$, $\triangle T_2$, $\triangle T_3$,……) between these refreshing frames.
- If the theory frame rate is 60, then the theory average frame interval ($\triangle T$) is 14.3ms, which can be considered as the variance centre.
- The frame interval variance during home screen sliding can be explained by the equation: $\delta^2 = \sum(\triangle T-\triangle T_{(1,2,3.....)})^2$

5. Apply the same method to obtain the sliding fluency when the home screen is slide from right to left.
6. Repeat the test step 2 –5 for ten times and obtain an average home page sliding fluency.

**Expected Result**

The times required are decided by individuals, however for the frame rate, higher is better; for the frame interval variance, lower is better.

**Additional Notes**

Define a standard sliding speed to reduce the impact from the user. The metronome could provide testers with a standard speed - 60 bpm is recommended as a scroll speed for fingers. Another approach is to use an automated mechanism to operate the Smartphone.

The recommendation for the sliding range: From 25% screen length left to right as shown in figure 13.

### 3.5.4 Drag and drop latency

**Description**

Long press an application icon on the left side of the home screen. Drag and drop icon from left to right. Record the delay until when the image shadow of the icon appears.

**Reason for test**

To ensure the Smartphone provides user with a quick and smooth dragging performance

**Initial condition**

The initial configuration is the same as defined in section 2.1.2.

**Test Procedure**

1. Set the high speed camera to capture the operation process.
2. Long press an application icon on the left side of the home screen. Drag and drop icon from far left to far right.
3. Playback the testing process captured by the high speed camera and analyse frame by frame. Record the time point as T1 when the finger starts to drag the icon from left to right. Record the time point as T2 when the icon starts to move.
4. Obtain the drag and drop latency by calculating the time difference between T1 and T2.
5. Apply the same method to obtain the drag and drop latency when the APP icon is dragged from far right to far left on the screen.
6. Repeat the test steps 2 to 5 ten times and obtain an average drag and drop latency.

**Expected Result**

The times required are decided by individuals, however the shorter the time the better the user experience.

### 3.5.5 Drag and drop fluency

**Description**

Test the system overall response fluency (measure the frame rate or Frame interval variance), when the user drag and drop one APP icon on the screen.

**Reason for test**

To ensure the Smartphone provides user with a quick and smooth dragging performance

**Initial condition**

The initial configuration is same as defined in the section 2.1.2.

**Test Procedure**

1. Set a high speed camera to capture the drag and drop procedure.
2. Long press an application icon on the left side of the home screen. Drag and drop the icon from left to right.
3. Calculate the average frame rate ("a" fps) according to the captured procedure.

Frame rate *("a" fps)* measurement recommendation:

- Playback the high speed camera captured test process frame by frame (Frame Rate of camera is assumed to be "Y" fps).
- View the video to find the point when the input device or finger starts dragging the APP icon and record the frame number as $F_1$. Find the point when the image of the icon starts moving and record the frame number as $F_2$.
- Calculate the duration of drag and drop as:
  $t = (F_2-F_1)/Y$ seconds
- The screen refreshes process: The captured video shows one clear image when the screen starts to refresh. A few blurred images will be shown until the screen has refreshed. The next clear image appears on the captured video is when the screen starts to refresh. Within this interval "t", pick out the frames that show the screen has refreshed. Count the number of refresh frames (assumed to be A).
- The average actual frame rate during drag and drop can be calculated by the equation: Actual Frame Rate a= A/t.

4. Calculate the frame interval variance ( $\delta 2$) according to the captured drag and drop procedure video.

Frame interval variance *( $\delta^2$)* measurement recommendation:

- Playback the high speed camera captured test process frame by frame.
- Watch the video to pick out the refreshing frames. Calculate the time interval ($\triangle T_1$, $\triangle T_2$, $\triangle T_3$ …) between these refreshing frames.
- If the theory frame rate is 60, then the theory average frame interval ($\triangle T$) is 14.3ms, which can be considered as the variance centre.
- The frame interval variance during drag and drop can be explained by the equation: $\delta^2 = \sum(\triangle T-\triangle T_{(1,2,3.....)})^2$

5. Apply the same method to obtain the drag and drop fluency when the APP icon is dragged from right to left on the screen.
6. Repeat the test step 2 – 5 for ten times and obtain an average screen drag and drop fluency.

**Expected Result**

The times required are decided by individuals, however for the frame rate, higher is better; for the frame interval variance, lower is better.

### 3.5.6 Screen rotation speed

**Description**

Test the screen rotation response speed when the screen is switched from a horizontal position to a vertical position.

**Reason for test**

To ensure the Smartphone provides the user with a smooth rotational performance.

**Initial condition**

The initial configuration is the same as defined in section 2.1.2.

**Test Procedure**

1. Open one photo from the gallery.
2. Set a high speed camera to capture the rotation procedure.
3. Rotate the terminal from a vertical to horizontal orientation in clockwise direction. The photo on the screen becomes stable indicating the photo has finished its rotation.
4. Playback the testing process captured by a high speed camera and analyse frame by frame. Record the time point as T1 when the device completes position switch. Record the time point as T2 when the photo finishes rotation.
5. Obtain the screen rotation speed by calculating the time difference between T1 and T2.
6. Apply the same method to obtain the rotation speed when the home screen is rotated from horizontal to vertical orientation in clockwise direction.
7. Apply the same method for the test steps 3 to 6 again when the terminal is rotated in anticlockwise direction.
8. Repeat the test steps 3 to 7 ten times to obtain an average screen rotation speed.

**Expected Result**

The times required are decided by individuals, however the shorter the time the better the user experience

**Additional Notes**

The illustrations for terminal vertical/horizontal rotation in clockwise direction are shown in figures 16 and 17. The anticlockwise rotation is vice-versa. Define a standard device rotation speed to reduce the impact from the user. The metronome could provide testers with a standard speed. 90 bpm is suggested as a recommendation for device rotation speed. Another approach is to use an automated mechanism to operate the Smartphone.

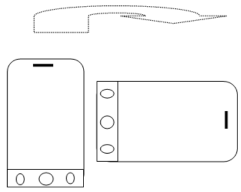


**Figure 16 Vertical to horizontal rotation in clockwise direction**

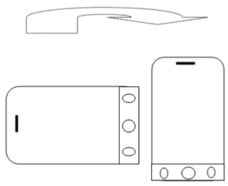


**Figure 17 Horizontal to vertical rotation in clockwise direction**

### 3.5.7 Screen unlock speed

**Description**

Test the time used to unlock the screen after user finishes the unlock gesture.

**Reason for test**

To ensure the user do not have to wait long when unlocking the Smartphone screen.

**Initial condition**

The initial configuration is the same as defined in section 2.1.2. The Smartphone has set the screen unlock password or fingerprint or graphic unlock already.

**Test Procedure**

1. Set a high speed camera to capture the unlock procedure.
2. Unlock the screen. The different mechanisms could be input password or fingerprint verification or graphic unlock.
3. Playback the testing process captured by a high speed camera and analyse frame by frame. Record the time point as T1 when the unlock mechanism is completed. Record the time point as T2 when the homepage is displayed completely.
4. Obtain the screen unlock speed by calculating the time difference between T1 and T2.
5. Repeat the test steps 2 to 4 ten times to obtain an average screen unlock speed.

**Expected Result**

The times required are decided by individuals, however the shorter the time the better the user experience.

### 3.5.8 Screen Click sensitivity

**Description**

Test whether the touch screen is too sensitive and causes false touch action.

**Reason for test**

To ensure the Smartphone screen provide user with an accurate click response.

**Initial condition**

The initial configuration is the same as defined in section 2.1.2. The screen is set to be unlocked.

**Test Procedure**

1. Open the keypad of the phone.
2. Place one capacitive finger above keypad on the screen. The distance between the capacitive finger and the screen is about 1mm and the capacitive finger cannot touch the screen.
3. Confirm the number buttons won't be tapped and screen won't react.
4. Repeat the test steps 1 to 3 ten times.

**Expected Result**

The number buttons won't be tapped and screen won't react when the capacitive finger is placed about 1mm away from the keypad on the screen.

# 4 System Stability Testing

## 4.1 Test Environment and configuration

### 4.1.1 Test Scenarios

If devices operate for extended period without shutdown, the Device memory will increase and cause system defects or slow running. So the system stability test is to operate the Device for a long period of time to evaluate the stability performance.

The following test topics 1-11 will be executed repeatedly for 5*8 hours. Record the total number of defects. The defects will be divided into different levels: critical, major, normal, and minor.

**Test topics scope:**

1. Phone call stability test
2. Message stability test
3. Mail stability test
4. RCS stability test

5. Browser stability test
6. APP downloads and uninstall stability test
7. Personal information management stability test
8. Multimedia function stability test
9. Multi-task stability test
10. Menu stability test
11. Wi-Fi connection stability test

### 4.1.2 Device Configuration:

- The initial configuration is the same as defined in section 2.1.2.
- Switch on the Device one week before starting the test and configure everything. The device stays switched on during the whole testing (5*24 hours).
- Device will be connected to a power supply.
- The DUT has already stored compiled Emails, SMS, MMS, audio files and 100 contacts. These standard contacts, Email, audio files sources could take reference to section 3.1.1.
- The android phone APP is avalible here：https://github.com/GSMATerminals/Smartphone-Performance-Test-Case-Guideline-Public

### 4.1.3 Test environment preparation:

It is suggested to use a signal simulator to provide a repeatable test environment. The GSM/GPRS/WCDMA/LTE network configuration refers to the GSMA TS.09 BLM document chapter 3.

### 4.1.4 Defects definition

1. Reboot: Phone shuts down and restarts automatically.
2. Freeze: Screen stops working without any response.
3. Automatic shutdown: Phone shuts down automatically.
4. Slow running: The phone responses slowly when carrying out any operation.
5. Network connection defects: When the network signal condition is good, the phone shows no service or phone calls cannot be received and dialled. The defects cannot be automatically restored within limited hours only when the Device is restarted manually.
6. APP/APK not responding: There is no response when opening, running, or closing an APP.
7. Error box appearance: Pop-up error box when opening, running, or shutting down the APP.
8. APP exits automatically: The APP exits automatically when it is opened or running.
9. APP functional failures: Functional failure happens when running the APP.
10. Interface error: Some error displayed on the interface of screen.
11. Other defects.

The defects level:

| Critical/Major defects | Defects |
|---|---|
| • Reboot | • Error box appearance |

| | |
|---|---|
| • Automatic shutdown<br>• Network connection defects<br>• Freeze<br>• APP/APK not responding | • APP exits automatically<br>• APP functional failures<br>• Interface errors<br>• Slow Running |

## 4.2 Phone call stability test:

### 4.2.1 MO/MT voice call service when the Device is registered in 2G network

**Description**

Dial voice calls from the address book and from the recent contacts list respectively.

Answer voice calls.

**Initial condition**

- The initial configuration is the same as defined in section 4.1.2.
- The DUT is registered in 2G network.

**Test Procedure**

1. Open the contact list of DUT.
2. Choose one contact and make a voice call.
3. Keep on line for 5 seconds
4. End the call.
5. Repeat step 1, 2, 3, 4 and redial for 30 times.
6. Open the recent contacts list.
7. Choose one recent call record and make a voice call.
8. Keep on line for 5 seconds.
9. End the call.
10. Repeat step 6, 7, 8, 9 and redial for 30 times.
11. Reference1 makes a voice call to DUT.
12. DUT answers the voice call.
13. Keep on line for 5 seconds.
14. End the voice call.
15. Repeat step 11, 12, 13, 14 and redial for 30 times.

**Expected Result**

1. For step 2, 7 and 12 the call can be connected.
2. For step 3, 8 and 13 the call can be maintained.
3. For step 4, 9 and 14 the call can be ended.
4. For step 5, 10 and 15 the loop can be processed successfully.

### 4.2.2 MO/MT voice call service when the Device is registered in 3G network

Repeat the test case 4.2.1 when the DUT is registered in 3G network.

### 4.2.3 MO/MT voice call service when the Device is registered in 4G network

Repeat the test case 4.2.1 when the DUT is registered in 4G networks and the VoLTE function of DUT is turned off.

### 4.2.4 MO/MT VoLTE voice call service

**Description**

Dial a VoLTE voice call from the address book and from the recent contacts list respectively.

Answer VoLTE calls.

**Initial condition**

- The initial configuration is the same as defined in section 4.1.2.
- The DUT is registered in 4G network.
- The VoLTE function of DUT is turned on.

**Test Procedure**

1. Open the contact list of DUT.
2. Choose one contact and make a VoLTE voice call.
3. Keep on line for 5 seconds
4. End the call.
5. Repeat step 1, 2, 3, 4 and redial for 30 times.
6. Open the recent contacts list.
7. Choose one recent call record and make a VoLTE voice call.
8. Keep on line for 5 seconds.
9. End the call.
10. Repeat step 6, 7, 8, 9 and redial for 30 times.
11. Reference 1 makes a voice call to DUT.
12. DUT answers the voice call.
13. Keep on line for 5 seconds.
14. End the voice call.
15. Repeat step 11, 12, 13, 14 and redial for 30 times.

**Expected Result**

1. For step 2, 7 and 12 the call can be connected.
2. For step 3, 8 and 13 the call can be maintained.
3. For step 4, 9 and 14 the call can be ended.
4. For step 5, 10 and 15 the loop can be processed successfully.

### 4.2.5 MO/MT VoLTE video call service

**Description**

Dial and answer VoLTE video calls.

**Initial condition**

- The initial configuration is the same as defined in section 4.1.2.

- The DUT is registered in 4G network.
- The VoLTE function is turned on.

**Test Procedure**

1. Open the contact list of DUT.
2. Choose one contact and make a VoLTE video call.
3. Keep on line for 5 seconds after the video call has been established.
4. End the video call.
5. Repeat step 1, 2, 3, 4 and redial for 10 times.
6. Reference 1 makes a VoLTE video call to DUT.
7. DUT answers the video call.
8. Keep on line for 5 seconds after the video call has been established.
9. End the video call.
10. Repeat step 6, 7, 8, & 9 and redial for 10 times.

**Expected Result**

1. For step 2 and 7 the video call can be connected.
2. For step 3 and 8 the video call can be maintained.
3. For step 4 and 9 the videocall can be ended.
4. For step 5 and 10 the loop can be processed successfully.

## 4.3 Message stability test

### 4.3.1 Send text messages (SMS)

**Description**

DUT sends text messages.

**Initial condition**

- The initial configuration is the same as defined in section 4.1.2.
- The network is set to the highest available RAT technology (4G>3G>2G).
- One contact number has been stored in the phone contact list.
- One text message has been stored in the message box, which contains numbers, symbols and characters. The SMS shall be between 10 and 20 word long.

**Test Procedure**

1. Enter the message box.
2. Copy the stored text message and enter SMS forward interface.
3. Add a receiver from the phone contact list.
4. Forward SMS to the receiver contact.
5. Wait for ten seconds.
6. Repeat step 1, 2, 3, 4 & 5 for 30 times.

**Expected Result**

1. For step 3, the contact can be added as receiver successfully.
2. For step 4, the message can be forwarded successfully.

3. For step 5, the receiver can receive the message with correct content.

### 4.3.2 Receive text message (SMS)

**Description**

DUT receives text messages.

**Initial condition**

- The initial configuration is the same as defined in section 4.1.2.
- The network is set to the highest available RAT technology (4G>3G>2G).
- The content of the received text message contains numbers, symbols and characters. The SMS shall be between 10 and 20 word long.

**Test Procedure**

1. The DUT is in idle mode.
2. Reference 1 sends messages to DUT.
3. Wait for ten seconds.
4. Repeat step 1, 2 and 3 for 30 times.

**Expected Result**

1. For step 3 & 4, the DUT can receive the message and the content is displayed correctly.

### 4.3.3 Send multimedia messages (MMS)

**Description**

DUT sends multimedia messages.

**Initial condition**

- The initial configuration is the same as defined in section 4.1.2.
- The network is set to the highest available RAT technology (4G>3G>2G).
- One contact number has been stored in the phone contact list.
- One multimedia message has been stored in the message box of DUT, the size is 300kb or the maximum size that the DUT can support.

**Test Procedure**

1. Enter the message box.
2. Copy the stored multimedia message and enter MMS forward interface.
3. Add a receiver from the phone contact list.
4. Forward MMS to the receiver.
5. Wait for ten seconds.
6. Repeat step 1, 2, 3, 4 & 5 for 10 times.

**Expected Result**

1. For step 3, the contact can be added as receiver successfully.
2. For step 4, the message can be forwarded successfully.

3. For step 5, the receiver can receive the message with correct content.

### 4.3.4 Receive multimedia message (MMS)

**Description**

DUT receives multimedia messages.

**Initial condition**

- The initial configuration is the same as defined in section 4.1.2.
- The network is set to the highest available RAT technology (4G>3G>2G).
- The size of the received multimedia message is 300kb or the maximum size that the DUT can support.

**Test Procedure**

1. The DUT is in idle mode.
2. Reference 1 sends multimedia messages to DUT.
3. Wait for ten seconds.
4. Repeat step 1, 2 & 3 for 10 times.

**Expected Result**

1. For step 3 & 4, the DUT can receive the message and the content is displayed correctly.

## 4.4 E-Mail stability test

### 4.4.1 E-mail service when the device is registered in 3G network

**Description**

DUT sends and receives e-mails without attachment when the network registration is in 3G.

**Initial condition**

- The initial configuration is the same as defined in section 4.1.2.
- The DUT is registered in 3G network.
- Each of DUT and Reference 1hasone email without attachment stored in the email inbox. The mails are specified in section 3.1.1source examples.

**Test Procedure**

1. Enter the inbox of DUT.
2. Select the stored email and enter the mail forwarding interface.
3. Edit recipient address and forward the email.
4. Wait for ten seconds.
5. Repeat step 1, 2 & 3 for 30 times.
6. The DUT is in idle mode.
7. Reference 1 sends the stored e-mail to DUT.
8. Wait for ten seconds.
9. Repeat step 7 & 8 for 30 times.

**Expected Result**

1. For step 3, the email can be forwarded successfully.
2. For step 4, the receiver can receive the email with correct content.
3. For step 8, the DUT can receive the email with correct content.

### 4.4.2 E-mail service when the device is registered in 4G network

Repeat the test case 4.4.1 when the DUT is registered in 4G network.

### 4.4.3 E-mail service with attachment added

**Description**

DUT sends and receives e-mails with attachment when the network registration is set to the highest available RAT technology.

**Initial condition**

- The initial configuration is the same as defined in section 4.1.2.
- The network is set to the highest available RAT technology (4G>3G>2G).
- Each of DUT and Reference 1 has one email with attachment stored in the inbox. The mails are specified in section 3.1.1 source examples.
- For the attachment use a file of size 1Mb.

**Test Procedure**

1. Enter the inbox of DUT.
2. Select the stored email and enter the mail forwarding interface.
3. Edit recipient address and forward the email.
4. Wait for ten seconds.
5. Repeat step 1, 2 & 3 for 30 times.
6. The DUT is in idle mode.
7. Reference 1 sends the stored e-mail to DUT.
8. Wait for ten seconds.
9. Repeat step 7 & 8 for 30 times.

**Expected Result**

1. For step 3, the email can be forwarded successfully.
2. For step 4, the receiver can receive the email with correct attachment.
3. For step 8, the DUT can receive the email with correct attachment.

## 4.5 RCS stability test

### 4.5.1 Sending and Receiving RCS messages in 3G network

**Description**

DUT sends and receives RCS messages when the network registration is in 3G.

**Initial condition**

- The initial configuration is the same as defined in section 4.1.2.

- The DUT is registered in 3G network.
- DUT, Reference 1 and 2 are registered RCS users.

**Test Procedure**

1. DUT sends a RCS message in a 1-to-1 chat to Reference 1.
2. Reference 1 sends a RCS message in a 1-to-1 chat to DUT.
3. DUT sends a RCS message in a Group chat to Reference 1 and 2.
4. Reference 1 sends a RCS message in a Group chat to DUT and Reference 2.
5. Wait for ten seconds.
6. Repeat step 1, 2, 3 & 4 for 30 times.

**Expected Result**

1. For step 1, the RCS message is send successfully.
2. For step 2, the RCS message is received successfully.
3. For step 3, the RCS message is send successfully.
4. For step 4, the RCS message is received successfully.

### 4.5.2 Sending and Receiving RCS messages in 4G network

Repeat the test case 4.5.1 when the DUT is registered in 4G network.

### 4.5.3 Receive Simultaneous RCS File Transfer

**Description**

DUT receives simultaneous RCS file transfers.

**Initial condition**

- The initial configuration is the same as defined in section 4.1.2.
- The DUT is set to the highest available RAT technology (4G>3G>2G).
- DUT and Reference 1, 2, 3, 4, 5, 6, 7, 8, 9 and 10 are registered RCS users and RCS File Transfer enabled.
- DUT is in ten 1-to-1 chats, each with one Reference device.

**Test Procedure**

1. Reference 1 – 10 sends DUT a file with RCS file transfer in a 1-to-1 chat timely as close as possible.
2. DUT accepts all file transfers as fast as possible.
3. Wait for all file transfers to complete.
4. Repeat step 1, 2 & 3 for 5 times.

**Expected Result**

1. For step 2, all files are received.

## 4.6 Browser stability test

### 4.6.1 Open the browser homepage when the network registration is in 3G mode

**Description**

Open the homepage of the browser when the network registration is in 3G mode.

**Initial condition**

- The initial configuration is the same as defined in section 4.1.2.
- The network is set to be 3G mode.
- The homepage of the browser is already defined and should not be the Google Homepage or some kind of locally stored start-page.

**Test Procedure**

1. Open the browser of DUT.
2. Open the defined homepage of the browser.
3. Wait for ten seconds, access another page, clear the cache and then close the browser.
4. Repeat step 1, 2 & 3 for 30 times.

**Expected Result**

1. For step 1, the browser can be started up successfully.
2. For step 2, the homepage can be opened.
3. For step 4, the loop can be processed successfully.

### 4.6.2 Open the browser homepage when the network registration is in 4G mode

Repeat the test case 4.6.1 when the DUT is registered in 4G network.

### 4.6.3 Open multiple pages simultaneously on the browser

**Description**

Open multiple pages simultaneously on the browser when the network registration is in set to the highest available RAT technology.

**Initial condition**

- The initial configuration is the same as defined in section 4.1.2.
- The network is set to the highest available RAT technology (4G>3G>2G).
- Bookmarks for ten different webpages are already stored in the browser.

**Test Procedure**

1. Open the browser of DUT.
2. Access the ten different bookmarks, each in a single parallel window in the browser.

3. Wait for ten seconds, close all but one window and access another page, clear the cache and then close the browser.
4. Repeat step 1, 2 & 3 for 30 times.

**Expected Result**

1. For step 1, the browser can be started up successfully.
2. For step 2, the webpages can be opened.
3. For step 4, the loop can be processed successfully.

## 4.7 APP/APK install and uninstall stability test

### 4.7.1 Install and operate and remove one APP/APK

**Description**

Install one APP/APK from platform and then uninstall it.

**Initial condition**

- The initial configuration is the same as defined in section 4.1.2.
- The network of DUT is set to be the highest available RAT technology (4G>3G>2G).
- Tester can choose the top famous APP/APKs in market based on local user habit. Besides, one test script was developed and uploaded on GitHub website. The test script can automatically execute specific APK installation, operation and uninstall in loop. The instructions for the test scripts are in the Annex B of this document. Tester could also self-define the APKs to be tested and the number of automatic test cycles. Test script modifications are also welcomed. https://github.com/GSMATerminals/Smartphone-Performance-Test-Case-Guideline-Public

**Test Procedure**

1. Open the APP/APK download platform.
2. Download the APP/APK and DUT install it automatically.
3. When the APP/APK finishes installing then wait for 10 seconds.
4. Open the APP/APK.
5. Operate the APP/APK.
6. Exit the APP/APK then wait for 10 seconds.
7. Uninstall and remove the APP/APK that was downloaded.
8. Repeat step 1 to 7 for 10 times.

**Expected Result**

1. For step 2, the APP/APK can be downloaded and installed successfully.
2. For step 4, the APP/APK can be opened successfully.
3. For step 5, the APP/APK can be operated successfully.
4. For step 6, the APP/APK can be exited successfully.
5. For step 7, the APP/APK can be removed successfully.

## 4.8 Personal information management stability test

### 4.8.1 Add and cancel the alarm

**Description**

Add and cancel the alarm.

**Initial condition**

- The initial configuration is the same as defined in section 4.1.2.
- The network of DUT is set to be the highest available RAT technology (4G>3G>2G).

**Test Procedure**

1. Open the alarm of DUT.
2. Set one alarm that sounds 1 minute later.
3. Wait until the alarm sounds.
4. Stop the alarm and cancel the alarm.
5. Exit the alarm.
6. Repeat step 1, 2, 3 & 4 for 30 times.

**Expected Result**

1. For step 2, the alarm can be set successfully.
2. For step 3, the alarm sounds.
3. For step 4, the alarm can be cancelled successfully.

### 4.8.2 Add, edit and delete a phone contact.

**Description**

Add, edit and delete the phone contact.

**Initial condition**

- The initial configuration is the same as defined in section 4.1.2.
- The network of DUT is set to be the highest available RAT technology (4G>3G>2G).

**Test Procedure**

1. Add one contact with phone numbers, email and address and save the newly added contact.
2. Exit the contacts list user interface.
3. Re-enter the contact list interface, edit the contact mobile number and save the newly edited contact.
4. Exit the contacts list user interface.
5. Re-enter the contact list and delete the added contact.
6. Repeat step 1, 2, 3, 4 & 5 for 30 times.

**Expected Result**

1. For step 1, the contact can be added successfully.

2. For step 3, the contact can be edited successfully.
3. For step 5, the contact can be deleted successfully.

## 4.9 Multimedia function stability test

### 4.9.1 Take and delete photos with front facing camera

**Description**

Take and delete photos with front facing camera.

**Initial condition**

- The initial configuration is the same as defined in section 4.1.2.
- The network of DUT is set to be the highest available RAT technology (4G>3G>2G).

**Test Procedure**

1. Open the front facing camera interface.
2. Take one photo.
3. Enter the gallery and delete the photo.
4. Repeat step 1, 2 & 3 for 30 times.

**Expected Result**

1. For step 2, the photo can be taken successfully.
2. For step 3, the photo can be deleted successfully.

### 4.9.2 Take and delete multiple photos with front facing camera

**Description**

Take and delete multiple photos with front facing camera.

**Initial condition**

- The initial configuration is the same as defined in section 4.1.2.
- The network of DUT is set to be the highest available RAT technology (4G>3G>2G).

**Test Procedure**

1. Open the front facing camera interface.
2. Take one hundred photos in quick succession.
3. Enter the gallery and delete all the photos.
4. Repeat step 1, 2 & 3 for 5 times.

**Expected Result**

1. For step 2, the photos can be taken successfully.
2. For step 3, the photos can be deleted successfully.

### 4.9.3 Record, play and delete local videos with front facing camera

**Description**

Record, play and delete local videos with front facing camera interface.

**Initial condition**

- The initial configuration is the same as defined in section 4.1.2.
- The network of DUT is set to be the highest available RAT technology (4G>3G>2G).

**Test Procedure**

1. Open the front facing camera interface and switch to video shooting mode.
2. Record one video for 30 seconds and save the video.
3. Play the recorded video for 10 seconds.
4. Enter the gallery and delete the recorded video.
5. Repeat step 1, 2, 3 & 4 for 30 times.

**Expected Result**

1. For step 2, the video can be taken successfully.
2. For step 3, the video can be played successfully.
3. For step 4, the photo can be deleted successfully.

### 4.9.4 Take and delete photos with rear facing camera

Repeat the test case 4.9.1 with rear facing camera.

### 4.9.5 Take and delete multiple photos with rear facing camera

Repeat the test case 4.9.2 with rear facing camera.

### 4.9.6 Record, play and delete local videos with rear facing camera

Repeat the test case 4.9.3 with rear facing camera.

### 4.9.7 Play sound files by using the default music player

**Description**

Play sound files by using the default music player.

**Initial condition**

- The configuration is the same as defined in section 4.1.2.
- The network of DUT is set to be the highest available RAT technology (4G>3G>2G).
- Five sound files have already been stored in the DUT. The audio files sources are referenced in section 3.1.1.

**Test Procedure**

1. Open the music player of the DUT.
2. Choose and play the stored sound files for 10 seconds.
3. Play the next four sound files for 10 second.

4. Repeat step 1, 2, 3 for 30 times.

**Expected Result**

1. For step 2 & 3, the sound files can be played successfully.

## 4.10 Menu stability test

### 4.10.1 Settings menu stability test

**Description**

DUT opens the menus in settings.

**Initial condition**

- The configuration is the same as defined in section 4.1.2.
- The network of DUT is set to be the highest available RAT technology (4G>3G>2G).

**Test Procedure**

1. DUT opens the interface of settings.
2. Open the main functions in settings: cellular network selection, Wi-Fi, Bluetooth, personal hotspot, sounds, wallpaper, display, general, account and security setting.
3. Close “Settings” menu.
4. Repeat step 1, 2 & 3 for 30 times.

**Expected Result**

1. For step 1, the interface of settings can be opened successfully.
2. For step 2, the UI interface of each settings menu can be presented correctly.

### 4.10.2 Phone call menu stability test

**Description**

DUT opens the menus of phone call.

**Initial condition**

- The configuration is the same as defined in section 4.1.2.
- The network of DUT is set to be the highest available RAT technology (4G>3G>2G).
- Ten recent calls are stored in the call history.

**Test Procedure**

1. DUT opens the UI interface of phone call.
2. Open the menus of phone call respectively: call history, missed calls, contacts, and keypad.
3. Exit the phone call interface and repeat step 1, 2 for 30 times.

**Expected Result**

1. For step 1, the phone call interface can be opened successfully.

2. For step 2, the UI interface of each phone call menu can be presented correctly.

### 4.10.3 Messages (SMS) menu stability test

**Description**

DUT opens the menus of message.

**Initial condition**

- The configuration is the same as defined in section 4.1.2.
- The network of DUT is set to be the highest available RAT technology (4G>3G>2G).
- Ten messages are stored already.

**Test Procedure**

1. DUT opens the UI interface of message.
2. Open the menus of message respectively: unread message, message list, add new message and delete message.
3. Exit the message interface and repeat step 1, 2 for 30 times.

**Expected Result**

1. For step 1, the message interface can be opened successfully.
2. For step 2, the UI interface of each message menu can be presented correctly.

### 4.10.4 Email menu stability test

**Description**

DUT opens the menus of mail.

**Initial condition**

- The configuration is the same as defined in section 4.1.2.
- The network of DUT is set to be the highest available RAT technology (4G>3G>2G).
- Ten e-mails are stored already.

**Test Procedure**

1. DUT opens the UI interface of email box.
2. Open the menus of email respectively: drafts, trash, inbox and outbox.
3. Exit the email interface and repeat step 1 & 2 for 30 times.

**Expected Result**

1. For step 1, the email interface can be opened successfully.
2. For step 2, the UI interface of each email menu can be presented correctly.

## 4.11 Wi-Fi connection stability test

### 4.11.1 Wi-Fi service start up stability test

**Description**

DUT turns on and turns off the Wi-Fi service.

**Initial condition**

- The configuration is the same as defined in section 4.1.2.
- The DUT has been connected to the Wi-Fi access point.
- Wi-Fi service of DUT is shutdown.

**Test Procedure**

1. Turn on the Wi-Fi service of DUT and wait for 10 seconds.
2. Close the Wi-Fi access point network and wait for 10 seconds.
3. Turn off the Wi-Fi service of DUT.
4. Repeat step 1, 2 & 3 for 30 times.

**Expected Result**

1. For step 1, the Wi-Fi of DUT can be started successfully and connected automatically.
2. For step 2, the Wi-Fi of DUT is disconnected.
3. For step 3, the Wi-Fi service is turned off.

### 4.11.2 Open one website when the Wi-Fi connection is active

**Description**

Open one website when the Wi-Fi connection is active.

**Initial condition**

- The configuration is the same as defined in section 4.1.2.
- The DUT has been connected to the Wi-Fi access point.
- Wi-Fi service of DUT is turned off.

**Test Procedure**

1. Turn on the Wi-Fi service of DUT.
2. When the Wi-Fi of DUT is connected, open the home webpage in the browser.
3. Open another Web page and clear the cache.
4. Exit the browser and turn off the Wi-Fi
5. Repeat step 1 to 4 for 30 times.

**Expected Result**

1. For step 1, the Wi-Fi of DUT can be connected.
2. For step 2, webpage can be loaded.
3. For step 4, the Wi-Fi can be closed.

# 5 Smartphone Camera Image Quality Test

## 5.1 Test environment and configuration

### 5.1.1 Overview

This section will test the Smartphones photographic capability and performance, based on different use cases. The evaluation will be carried out looking at different key features which the device supports.

### 5.1.2 The test environment preparation:

The tests are taken in different scenarios for example: photographing a portrait at night, photograph the sun rise scene, photograph indoor objects. Here we give the general suggestions and photo examples for different scenarios. There are no restrictions on the place or the period that the photos should be taken.

- **The device configuration:** The Focus distance, Aperture, ISO sensitivity, exposure compensation, white balance values are set to default values when device is sold.
- The screen auto-brightness feature is turned on.
- Use the default camera: the photo format is set to JPG, the image size is set to maximum, the compression and colour modes are set to “default”.
- Automatic photometry (autofocus, automatic white balance, automatic exposure)

### 5.1.3 Test result evaluation:

The picture quality will be judged by looking at the following elements: Exposure, Contrast, Focus, Colour rendering and Noise distortion. Each element will be rated between 1 and 3 depending on its quality. One being the lowest score.

| Scores | Exposure Control | Tone Control | Colour Restoration | Imaging Analysis | Noise containment |
|---|---|---|---|---|---|
| Excellent | 3 | 3 | 3 | 3 | 3 |
| Moderate | 2 | 2 | 2 | 2 | 2 |
| Poor | 1 | 1 | 1 | 1 | 1 |

Some photo examples and score evaluations are given in the link below:

https://github.com/GSMATerminals/Smartphone-Performance-Test-Case-Guideline-Public

## 5.2 City scenery at dusk

**Description**

Use the rear camera to take a photo of a large scene with sky and ground lights. The street and house lighting should be on but the sky should be in twilight. Ideally just after sunset with little to no cloud (like the example above).

| | General display | Detailed display |
|---|---|---|
| **Device A** |  |   |
| **Device B** |  |   |

**Test Procedure**

1. Use the rear camera to take a photo of a large scene with sky and ground lights. The flash is turned off. If the camera has the built-in “night view” and “long exposure mode”, these can be selected.
2. Take 5 photos continuously.
3. Use the computer screen to play back the photos in the test lab.
4. View the photo under full size view and evaluate the exposure, tone and colour control of the photo.
5. View the photo under detail view and evaluate the imaging clarity, resolution and image noise containment.
6. Repeat step 4 & 5 for the 5 photos and record the average score.

**Expected Result**

1. Exposure control: The exposure is accurate and close to the brightness distribution of the real scene; some optimization enhancement can be made by the DUT.
2. Tone control: For the bright areas, the image should show the details and level of the night scene. For the dark areas, the image should show less deep darkness as little as possible. Even for the night scenes, the whole image should maintain a clear tone and be in line with people's expectations for the night scenes view.
3. Colour restoration: The colour of the screen can be optimized without colour distortion. The cold tone of the sky and the warm tone of the ground should be in line with people’s aesthetic expectation for the night scene. The colours of the lights are displayed correctly. Certain colour rendering can be optimized to make the lights in line with people’s aesthetic expectation.
4. Image analysis: The focus area of the image should be clear enough, and the depth of field should be large enough. The image detail should be real and delicate, no excessive sharpening, no obvious digital pixel compression and processing trace. For detailed display evaluation, the lights in the image should be clearly displayed without too much extra shine. The shining logos or Banners/Letters should be displayed clearly without too much blurring.

5. Noise containment: The light sensitivity is generally high. For the bright area the noise distortion should be as little as possible. For the transition area the noise distortion should be as little as possible. The image should keep the original details of the night scenes while containing the noise.
6. According to the requirements of the above five sub-items, each photo is evaluated at three different levels: excellent, moderate and poor. Give the corresponding scores for each photo and then obtain the average score.

## 5.3 Sun rise

### Description

Use the rear camera to take a photo of a sunrise scene and place the sun in a non-central part. The photograph time is morning when sun rises.

| | General display | Detailed display |
|---|---|---|
| **Device A** |  |  |
| **Device B** |  |  |

### Test Procedure

1. Use the rear camera to take a photo of sunrise scene and place the sun in a non-central part. The flash is turned off. If the camera has the built-in “sunrise nature” mode, this can be selected.
2. Take 5 photos continuously.
3. Use the computer screen to play back the photos in the test lab.
4. View the photo under full size view and evaluate the exposure, tone and colour control of the photo.
5. View the photo under detail view and evaluate the imaging clarity, resolution and image noise containment.
6. Repeat step 4 & 5 for the 5 photos and record the average score.

**Expected Result**

1. Exposure control: The exposure is accurate and close to the brightness distribution of the real scene.
2. Tone control: The sky is not over exposed, the sun/clouds retain the real colour levels. The ground is not completely dark. The image can clearly display the details and edges of the buildings. The overall contrast of light and shade is clear and suitable.
3. Colour restoration: The whole picture needs to present an early morning tone atmosphere, which is in line with people's aesthetic expectation for the early morning scenery.
4. Image analysis: The focused area of the image should be clear enough, and the depth of field should be large enough. The image detail should be real and delicate, no excessive sharpening, no obvious digital pixel compression and processing trace.
5. Noise containment: There is no noise distortion in the real scene content, so any noise distortion generated in the image is bad. The image should contain the noise distortion and also maintain the original details, layers of authenticity.
6. According to the requirements of the above five sub-items, each photo is evaluated at three different levels: excellent, moderate and poor. Give the corresponding scores for each photo and then obtain the average score.

## 5.4 Sun set

Use the rear camera to take a photo of the sun set and place the sun in a non-central part. The photograph time is dawn when sun sets.

| | **General display** | **Detailed display** |
|---|---|---|
| **Device A** |  |  |
| **Device B** |  |  |

**Test Procedure**

1. Use the rear camera to take a photo of the sun set and place the sun in a non-central part. The flash is turned off. If the camera has the built-in “sun set mode”, this can be selected.
2. Take 5 photos continuously.
3. Use the computer screen to play back the photos in the test lab.
4. View the photo under full size view and evaluate the exposure, tone and colour control of the photo.
5. View the photo under detail view and evaluate the imaging clarity, resolution and image noise containment.
6. Repeat step 4 & 5 for the 5 photos and record the average score.

**Expected Result**

1. Exposure control: The exposure is accurate and close to the brightness distribution of the real scene; some optimization enhancement can be made by the DUT.
2. Tone control: For the bright areas, the image should show the details of the dawn scene. For the dark areas, the image should show less deep darkness at best as little as possible. The whole image should maintain a clear tone and be in line with people's expectations for the sun set scenes view.
3. Colour restoration: The colour of the image can be optimized without colour distortion and should be in line with people’s aesthetics and expectation for the sun set scene.
4. Image analysis: The focus area of the image should be clear enough, and the depth of field should be large enough. The image detail should be real and delicate, no excessive sharpening, no obvious digital pixel compression and processing trace.
5. Noise containment: There should be no noise distortion in the bright region. For the transition area the noise distortion should be as small as possible. The image should keep the original details of the sun set scenes while containing the noise distortion.
6. According to the requirements of the above five sub-items, each photo is evaluated at three different levels: excellent, moderate and poor. Give the corresponding scores for each photo and then obtain the average score.

## 5.5 Object at a micro distance

**Description**

Use the rear camera to take a photo with the object occupying the main position of the picture. The photograph environment is indoor or outdoor with sufficient lighting

| | General display | Detailed display |
|---|---|---|
| **Device A** |  |  |
| **Device B** |  |  |

**Test Procedure**

1. Use the rear camera to take a photo with the object occupying the main position of the picture. Flash is turned off.
2. Take 5 photos continuously.
3. Use the computer screen to play back the photos in the test lab.
4. View the photo under full size view and evaluate the exposure, tone and colour control of the photo.
5. View the photo under detail view and evaluate the imaging clarity, resolution and image noise containment.
6. Repeat step 4 & 5 for the 5 photos and record the average score.

**Expected Result**

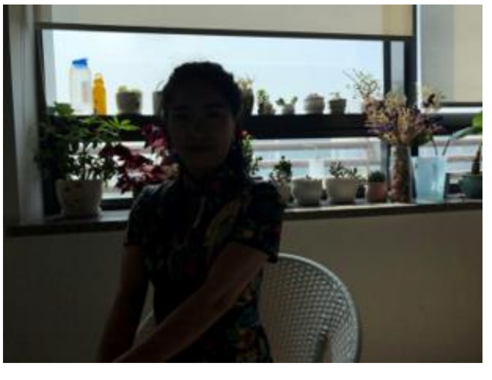
1. Exposure control: The exposure of the object should be accurate and close to the brightness distribution of the real scene.
2. Tone control: There is no complete darkness or white on the image. The tone level of the object is rich and real. The transition from bright area to dark area should be natural.
3. Colour restoration: The colour of the image needs to represent the original colour of the object. Some enhancement can be made to highlight the image colour.
4. Image analysis: The focused area of the image should be clear enough. The image detail should be real and delicate, no excessive sharpening, no obvious digital pixel compression and processing trace.

5. Noise containment: The noise distortion of the object is almost invisible. For the area that's out of focus and for the transition area, the noise distortion should be as small as possible. The image should keep the original details of the object while containing the noise distortion.
6. According to the requirements of the above five sub-items, each photo is evaluated at three different levels: excellent, moderate and poor. Give the corresponding scores for each photo and then obtain the average score.

## 5.6 Portrait with backlight for rear camera

### Description

The photograph direction is backlight. Use the rear camera to take a photo of a person from the waist up as portrait.

| | General display | Detailed display |
|---|---|---|
| **Device A** |  |  |
| **Device B** |  |  |

### Test Procedure

1. Use the rear camera to take a photo of a person from the waist up as portrait. If the camera has the built-in portrait at backlight exposure mode, this can be selected. The flash mode is automatic.
2. Take 5 photos continuously.
3. Use the computer screen to play back the photos in the test lab.
4. View the photo under full size view and evaluate the exposure, tone and colour control of the photo.

5. View the photo under detail view and evaluate the portrait exposure, tone and skin colour control.
6. Repeat step 4 & 5 for the 5 photos and record the average score.

**Expected Result**

1. Exposure control: The exposure of portrait should be accurate and close to the brightness distribution of the real scene. The background sky can show certain details without serious exposure.
2. Tone control: The image should show the details and level of the portrait. The background scene of the image should show less deep darkness and less white.
3. Colour restoration: Certain optimization can be made on the portrait skin and the background colour. The tone of the image should be in line with the aesthetic expectation for the portrait at backlight scene.
4. Image analysis: The portrait face should be clearly focused. The scene could have some certain blur effect outside of the focused area. The image details should be real and delicate with moderate sharpening. No obvious digital pixel compression and processing trace.
5. Noise containment: The portrait skin is smooth with less noise distortion. For the transition area, the noise distortion should be as small as possible. For the area that's out of focus, the noise containment should keep the original details and levels of the scene.
6. According to the requirements of the above five sub-items, each photo is evaluated at three different levels: excellent, moderate and poor. Give the corresponding scores for each photo and then obtain the average score.

## 5.7 Portrait at night

**Description**

The photograph is taken at night or in a dark area with lights on. Use the rear camera to take a photo of a person from the waist up as portrait. Set the portrait face as the focused area.

| | **General display** | **Detailed display** |
|---|---|---|
| **Device A** |  |  |

| | | |
|---|---|---|
| **Device B** |  |  |

**Test Procedure**

1. Use the rear camera to take a photo of a person from the waist up as portrait. If the camera has the built-in “portrait at night” mode, this can be selected. Flash mode is automatic and no extra light.
2. Take 5 photos continuously.
3. Use the computer screen to play back the photos in the test lab.
4. View the photo under full size view and evaluate the exposure, tone and colour control of the photo.
5. View the photo under detail view and evaluate the portrait exposure, tone and skin colour control.
6. Repeat step 4 & 5 for the 5 photos and record the average score.

**Expected Result**

1. Exposure control: The exposure of portrait should be accurate. The background light is not over exposed. The luminance of the flash light is sufficient and the brightness distribution of the whole image is uniform.
2. Tone control: The image should show the details and level of the portrait. The dark area of the image should show less deep darkness. The overall contract between bright area and dark area should be moderate.
3. Colour restoration: The portrait skin doesn’t show the colour deviation because of the flash light.
4. Image analysis: The portrait face should be clearly focused. The scene could have some certain blur effect outside of the focused area. The image details should be real and delicate with moderated sharpening. No obvious digital pixel compression and processing trace.
5. Noise containment: The light sensitivity is generally high. The portrait skin is smooth with less noise distortion. For the transition area, the noise distortion should be as small as possible. For the area that’s out of focus, the noise containment should keep the original details and levels of the scene.
6. According to the requirements of the above five sub-items, each photo is evaluated at three different levels: excellent, moderate and poor. Give the corresponding scores for each photo and then obtain the average score.

## 5.8 Portrait at daylight

**Description**

The photograph is taken outdoor in day time. Use the rear camera to take a photo of a person from the waist up as portrait. Avoid intense sunshine expose on face. Set the portrait face as the focused area. Flash mode is turned off.

| | General display |
|---|---|
| Device A |  |
| Device B |  |

**Test Procedure**

1. Use the rear camera to take a photo of a person from the waist up as portrait. If the camera has the built-in “portrait” mode, this can be selected.
2. Take 5 photos continuously.
3. Use the computer screen to play back the photos in the test lab.
4. View the photo under full size view and evaluate the exposure, tone and colour control of the photo.
5. View the photo under detail view and evaluate the portrait exposure, tone and skin colour control.
6. Repeat step 4 & 5 for the 5 photos and record the average score.

**Expected Result**

1. Exposure control: The exposure of the portrait should be accurate.
2. Tone control: The background scene of the image should show less deep darkness and less white.
3. Colour restoration: It is better to have some colour rendering for the background. For detailed display, Portrait beauty can be made to optimize the skin colour and lip colour.

4. Image analysis: The portrait face should be clearly focused. The scene could have some certain blur effect outside of the focused area. It is acceptable to have some beauty retouching on portrait face. E.g. skin smooth, wrinkle and spot elimination, pouches and black circles elimination.
5. Noise containment: The portrait skin is smooth with less noise distortion. For the transition area, the noise distortion should be as small as possible. For the area that’s out of focus, the noise containment should keep the original details and levels of the scene.
6. According to the requirements of the above five sub-items, each photo is evaluated at three different levels: excellent, moderate and poor. Give the corresponding scores for each photo and then obtain the average score.

## 5.9 City scenery at daylight

**Description**

The photograph time is in daytime. The photograph environment is the outdoor with enough lighting. Use the rear camera to take a photo of the city scenery.

| | **General display** | **Detailed display** |
|---|---|---|
| **Device A** | h  |  |
| **Device B** |  |  |

**Test Procedure**

1. Use the rear camera to take a photo of the city scenery. The picture should include the sky, ground and one reference object or architecture that can be used for detailed display evaluation.
2. Take 5 photos continuously.
3. Use the computer screen to play back the photos in the test lab.
4. View the photo under full size view and evaluate the exposure, tone and colour control of the photo.

5. View the photo under detail view and evaluate the imaging clarity, resolution and image noise containment.
6. Repeat step 4 & 5 for the 5 photos and record the average score.

**Expected Result**

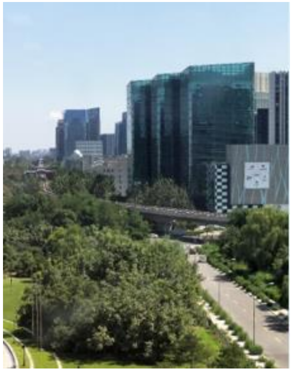
1. Exposure control: The exposure of the scenery should be accurate and close to the brightness distribution of the real scene.
2. Tone control: The sky is not too white and the ground is not too dark. The tone level of the whole image is rich and real. The transition from the bright area to the dark area should be natural.
3. Colour restoration: The colour of the image needs to represent the original colour of the scene. The sky shouldn't be too white due to over exposure.
4. Image analysis: For detailed display, the referenced object or architecture in the image should be displayed clearly without excessive sharpening.
5. Noise containment: The noise distortion of the sky and the ground architecture is almost invisible. For the area that's out of focus and for the transition area, the noise distortion should be as small as possible.
6. According to the requirements of the above five sub-items, each photo is evaluated at three different levels: excellent, moderate and poor. Give the corresponding scores for each photo and then obtain the average score.

## 5.10 Lens zoom

### Description

The photograph time is in daytime. The photograph environment should be with enough lighting. Use the rear camera to take a photo of an outdoor long-distance scenery with 3 X lens zoom.

| | General display | Detailed display |
|---|---|---|
| **Device A** |  |  |

| | | |
|---|---|---|
| **Device B** |  |  |

**Test Procedure**

1. Use the rear camera to take a photo of an outdoor long-distance scenery with 3 X lens zoom. Set one referenced object or architecture as the focused area. The picture should also include the sky, and surroundings that can be used for detailed display evaluation.
2. Take 5 photos continuously.
3. Use the computer screen to play back the photos in the test lab.
4. View the photo under full size view and evaluate the exposure, tone and colour control of the photo.
5. View the photo under detail view and evaluate the image clarity, resolution and image noise containment.
6. Repeat step 4 & 5 for the 5 photos and record the average score.

**Expected Result**

1. Exposure control: The exposure of the image should be accurate and close to the brightness distribution of the real scene. The sky and light colour object shouldn’t be too white due to over exposure.
2. Tone control: The light colour object is not too white and the deep colour object is not too dark. The tone level of the whole image is rich and real. The transition from bright area to dark area should be natural.
3. Colour restoration: The colour of the image needs to represent the original colour of the scene.
4. Image analysis: For detailed display, the referenced object or architecture details and the surrounding details should be displayed clearly without excessive sharpening.
5. Noise containment: The noise distortion of the sky and the ground architecture is almost invisible.
6. According to the requirements of the above five sub-items, each photo is evaluated at three different levels: excellent, moderate and poor. Give the corresponding scores for each photo and then obtain the average score.

## 5.11 Portrait with flash for rear camera

**Description**

The photograph is taken in a dark area with a dark coloured background. Use the rear camera to take a portrait photo with flash light turned on.

| | General display |
|---|---|
| **Device A** |  |
| **Device B** |  |

**Test Procedure**

1. Use the rear camera to take a portrait photo. If the camera has the portrait mode, this can be use directly. Set the portrait face as the focused area. Flash mode is turned on.
2. Take 5 photos continuously.
3. Use the computer screen to play back the photos in the test lab.
4. View the photo under full size view and evaluate the exposure, tone and colour control of the photo.
5. View the photo under detail view and evaluate the portrait exposure, tone and skin colour control.
6. Repeat step 4 & 5 for the 5 photos and record the average score.

**Expected Result**

1. Exposure control: The luminance on the portrait face is sufficient and the brightness distribution of the whole image is uniform.
2. Tone control: The skin of portrait is not too black.

3. Colour restoration: Portrait beauty can be made to optimize the skin colour and lip colour.
4. Image analysis: The portrait face should be clearly focused. The details of the cloth in the scene should be displayed correctly. The scene could have some certain blur effect outside of the focused area.
5. Noise containment: For the portrait skin, the noise distortion should be as small as possible.
6. According to the requirements of the above five sub-items, each photo is evaluated at three different levels: excellent, moderate and poor. Give the corresponding scores for each photo and then obtain the average score.

## 5.12 Dynamic mode

**Description**

The photograph time is in daytime with sufficient light. Use the rear camera to take a photo of people while jogging.

| | General display |
|---|---|
| **Device A** |  |
| **Device B** |  |

**Test Procedure**

1. Use the rear camera to take a photo of people while jogging.
2. Take 5 photos continuously.
3. Use the computer screen to play back the photos in the test lab.
4. View the photo under full size view and evaluate the exposure, tone and colour control of the photo.
5. View the photo under detail view and evaluate the imaging clarity, resolution and image noise containment.

6. Repeat step 4 & 5 for the 5 photos and record the average score.

**Expected Result**

1. Exposure control: The exposure of the whole image should be accurate and close to the brightness distribution of the real scene.
2. Tone control: The tone level of the whole image is rich and real.
3. Colour restoration: The colour of the image needs to represent the real colour of the scene. Some enhancement can be made to highlight the image colour.
4. Image analysis: The colour and details of the moving shoes or moving arms should be displayed clearly.
5. Noise containment: To capture dynamic characters, shutter delays are short, so small amount of noise distortion is allowed and should be as small as possible.
6. According to the requirements of the above five sub-items, each photo is evaluated at three different levels: excellent, moderate and poor. Give the corresponding scores for each photo and then obtain the average score.

## 5.13 Portrait for background blur effect

**Description**

The photograph is taken in daylight with background. The distance from the background to the portrait should be 5 meters away. Use the rear camera to photograph a person from the chest up as portrait.

| | General display |
|---|---|
| **Device A** |  |
| **Device B** |  |

#### Test Procedure

1. Use the rear camera to photograph a person from the chest up as portrait. Select the portrait mode or background blur effect mode. Set the portrait face as the focused area.
2. Take 5 photos continuously.
3. Use the computer screen to play back the photos in the test lab.
4. View the photo under full size view and evaluate the exposure, tone and colour control of the photo.
5. View the photo under detail view and evaluate the portrait exposure, tone and skin colour control.
6. Repeat step 4 & 5 for the 5 photos and record the average score.
7. Repeat steps 1-6 with the rear camera.

#### Expected Result

1. Exposure control: The exposure and brightness distribution of the whole image should be accurate.
2. Tone control: The image should show the details and tone levels of the portrait and background.
3. Colour restoration: For detailed display, Portrait beauty can be made to optimize the skin colour and lip colour.
4. Image analysis: It is acceptable to have some beauty retouching on portrait face. For detailed display, the blurred background details should be displayed correctly and distributed uniformly. The hair edge should be displayed smoothly.
5. Noise containment: The portrait skin is smooth with less noise distortion.
6. According to the requirements of the above five sub-items, each photo is evaluated at three different levels: excellent, moderate and poor. Give the corresponding scores for each photo and then obtain the average score.

### 5.14 Portrait with daylight for front camera

#### Description

The photograph is taken indoor or outdoor in day time. Avoid intense sunshine expose on the face. Use the front camera to photograph a person from the chest up as portrait.

| | General display |
|---|---|
| **Device A** |  |
| **Device B** |  |

**Test Procedure**

1. Use the front camera to photograph a person from the chest up as portrait. Set the portrait face as the focused area. If the camera has the built-in "portrait" mode, this can be selected.
2. Take 5 photos continuously.
3. Use the computer screen to play back the photos in the test lab.
4. View the photo under full size view and evaluate the exposure, tone and colour control of the photo.
5. View the photo under detail view and evaluate the portrait exposure, tone and skin colour control.
6. Repeat step 4 & 5 for the 5 photos and record the average score.

**Expected Result**

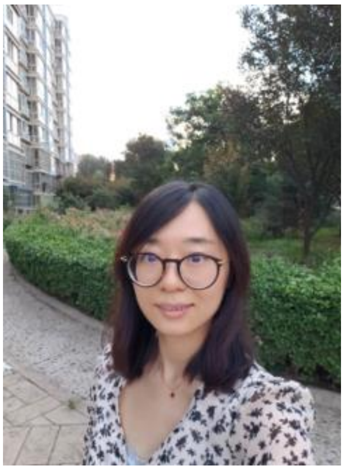
1. Exposure control: The exposure of portrait and the background scene should be accurate and close to the brightness distribution of the real scene.
2. Tone control: The image should show the details and tone levels of the portrait. The transition from bright area to dark area should be natural.

3. Colour restoration: It is better to have some colour rendering for the background. For detailed display, Portrait beauty can be made to optimize the skin colour and lip colour.
4. Image analysis: The portrait face should be clearly focused. The scene could have some certain blur effect outside of the focused area. For detailed display, it is acceptable to have some beauty retouching on portrait face. E.g. skin smooth, wrinkle and spot elimination, pouches and black circles elimination.
5. Noise containment: The portrait skin is smooth with less noise distortion. For the transition area, the noise distortion should be as small as possible. For the area that’s out of focus, the noise containment should keep the original details and levels of the scene.
6. According to the requirements of the above five sub-items, each photo is evaluated at three different levels: excellent, moderate and poor. Give the corresponding scores for each photo and then obtain the average score.

## 5.15 Portrait at backlight for front camera

### Description

Use the front camera to photograph a person from the chest up as portrait. The flash light is turned on.

| | **General display** |
|---|---|
| **Device A** |  |

| | |
|---|---|
| **Device B** |  |

**Test Procedure**

1. Use the front camera to photograph a person from the chest up as portrait. The photograph is taken outdoor. The photograph direction is into the backlight. If the camera has the built-in portrait at backlight exposure mode, this can be selected.
2. Take 5 photos continuously.
3. Use the computer screen to play back the photos in the test lab.
4. View the photo under full size view and evaluate the exposure, tone and colour control of the photo.
5. View the photo under detail view and evaluate the portrait exposure, tone and skin colour control.
6. Repeat step 4 & 5 for the 5 photos and record the average score.

**Expected Result**

1. Exposure control: The exposure of portrait should be accurate and close to the brightness distribution of the real scene. The background scene should show certain details without serious exposure.
2. Tone control: The image should show the details and level of the portrait. From the background highlight area to the portrait backlight area, the image should keep the details and tone levels as much as possible.
3. Colour restoration: Certain optimization can be made on the portrait skin and the background colour. The tone of the image should be in line with the aesthetic expectation for the portrait at backlight scene.
4. Image analysis: The portrait face should be clearly focused. The scene could have some certain blur effect outside of the focused area. For detailed display, it is acceptable to have some beauty retouching on portrait face. E.g. skin smooth, wrinkle and spot elimination, pouches and black circles elimination.
5. Noise containment: The portrait skin is smooth with less noise distortion. For the transition area, the noise distortion should be as small as possible. For the area that's out of focus, the noise containment should keep the original details and levels of the scene.

6. According to the requirements of the above five sub-items, each photo is evaluated at three different levels: excellent, moderate and poor. Give the corresponding scores for each photo and then obtain the average score.

## 5.16 Portrait with flash for front camera

### Description

The photograph is taken in a dark area with background lights on. Use the front camera to photograph a person from the chest up as portrait.

| | **General display** |
|---|---|
| **Device A** |  |
| **Device B** |  |

### Test Procedure

1. Use the front camera to photograph a person from the chest up as portrait. Set the portrait face as the focused area. Flash mode is turned on and no extra light. If the camera has the built-in portrait mode, this can be selected.
2. Take 5 photos continuously.
3. Use the computer screen to play back the photos in the test lab.
4. View the photo under full size view and evaluate the exposure, tone and colour control of the photo.
5. View the photo under detail view and evaluate the portrait exposure, tone and skin colour control.
6. Repeat step 4 & 5 for the 5 photos and record the average score.

### Expected Result

1. Exposure control: The luminance on portrait face is sufficient and not over exposed. The background light is not over exposed. The light distribution of the whole image is uniform.
2. Tone control: The portrait and the background are not too black. The overall contrast between bright area and dark area should be moderate. The tone and the atmosphere of the whole image should be in line with the expectation of the background.
3. Colour restoration: The portrait skin doesn’t show the colour deviation because of the flash light. Portrait beauty can be made to optimize the skin colour and lip colour.
4. Image analysis: The portrait face should be clearly focused. For detailed display, it is acceptable to have some beauty retouching on portrait face. E.g. skin smooth, wrinkle and spot elimination, pouches and black circles elimination.
5. Noise containment: The light sensitivity is generally high. The portrait skin is smooth with less noise distortion.

According to the requirements of the above five sub-items, each photo is evaluated at three different levels: excellent, moderate and poor. Give the corresponding scores for each photo and then obtain the average score.

# 6 Smartphone AI Speech Recognition Performance Test

## 6.1 Test environment and configuration

### 6.1.1 Overview

AI speech recognition technical frame:

The AI speech recognition technology can transform speech into text through the recognition and understanding process. Speech recognition technology mainly includes feature extraction, pattern matching criterion and model training technology.

The AI speech recognition system includes the voice front-end interactive system, which is composed of microphone array, speech recognition module and speaker. The AI speech assistant processing system is composed of Automatic Speech Recognition (ASR), Text to Speech (TTS), Natural Language Understanding (NLU) and business logic processing modules.

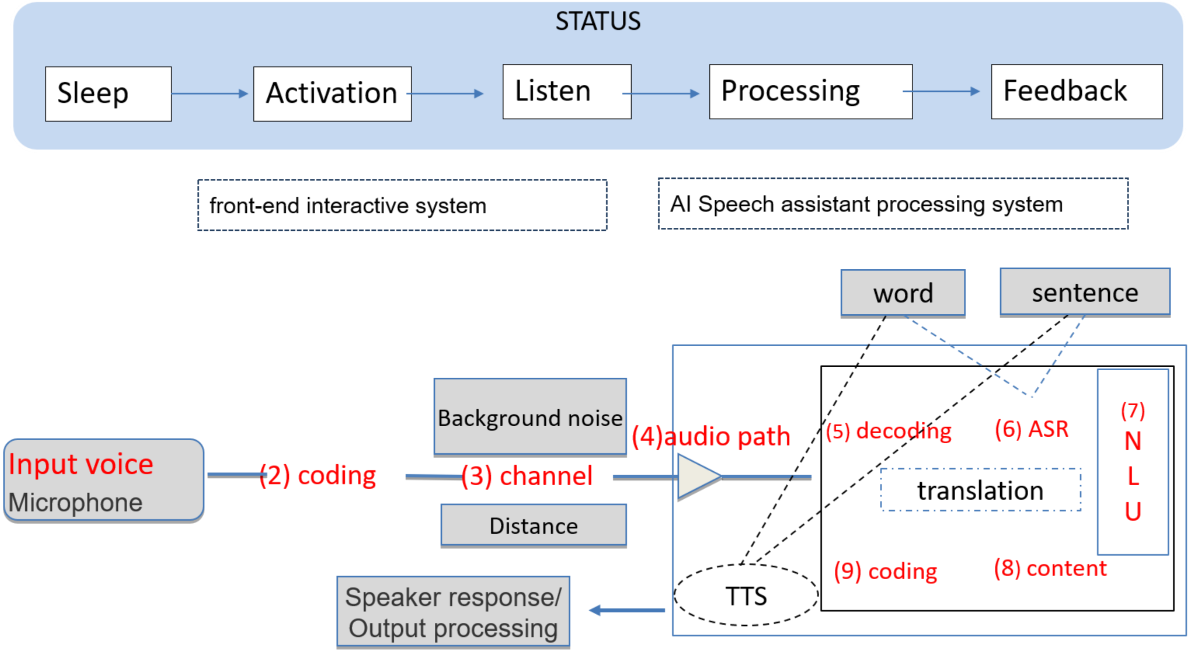



**Figure 18 The AI speech recognition system**

### 6.1.2 The test environment preparation

It is recommended to carry out tests in the reverberation chamber.

- The chamber reverberation time should be between 0.4 second and 0.7 seconds.
- The chamber frequency should be between 100Hz and 8kHz.
- The background noise scenarios have been defined in section 6.1.2.1 - 6.1.2.3.
- Other specifications for the reverberation chamber can take reference from ETSI EG 202 396-1 (part 6).

It is acceptable to replace the reverberation chamber and the head model by a normal test lab and a real tester. However, the repeatability of the test will not be as good and it may be difficult to compare results across multiple devices.

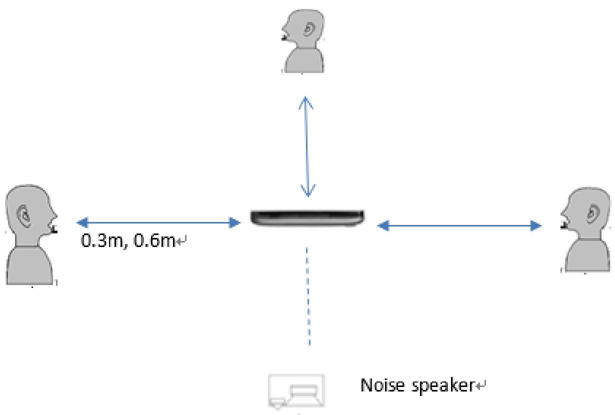



**Figure 19 the AI speech recognition system**

The background noise definition:

| Noise Scenario No. | Noise Scenario | Distance between noise source & DUT | Noise source level | Proportion |
|---|---|---|---|---|
| 6.1.2.1 | Background with low noise | 1.5m | Less than 40dB | 20% |
| 6.1.2.2 | Background with medium noise | 1.5m | 40-60dB | 40% |
| 6.1.2.3 | Background with high noise | 1.5m | 60-70dB | 40% |

1. The background noise source should come from a TV show, a spoken conversation, music and a radio broadcast.
2. The noise source is to be in the native language.
3. The noise should be:

   3 minutes TV show

   3 minutes human spoken conversation

   3 minutes music (CD or mp3 file)

   3 minutes radio broadcast (anything)

   The background noise can be looped as required

The Target voice source distance:

| Scenario No. | Distance from the voice source to the DUT | Voice source height | Angle between the voice source and the DUT | Proportion |
|---|---|---|---|---|
| 6.1.2.4 | 0.3m | Standing posture:<br>1.7m from the ground.<br>Sitting posture:<br>0.8m from the ground.<br>Lying posture：<br>0.4m from the ground. | 0°、90°、180° | 50% |
| 6.1.2.5 | 0.6m | | | 50% |

The voice source speed/frequency/tone:

| Scenario No. | Gender distribution | Age of the tester | Proportion | Number of People |
|---|---|---|---|---|
| 6.1.2.6 | Female 50%<br>Male 50% | Below 7 | 20% | For manual testing: More than 20 people.<br>For tool testing: 50-100 people. |
| 6.1.2.7 | | 7-18 | 20% | |
| 6.1.2.8 | | 19-50 | 40% | |
| 6.1.2.9 | | Beyond 50 | 20% | |

### 6.1.3 The conversation scenarios

When defining the audio sources, testers may speak the local language with poor pronunciation or with an accent to test the AI recognition ability of DUT.

#### 6.1.3.1 Conversation scenarios for wake-up scenarios

- This conversation scenario contains the defined wake-up word of the device speech recognition assistant.
- The language of the voice source is the native language.
- The target voice volume should be more than 70dB.
- The number of the recorded wake-up words should be repeated for 20 times.
- The gender and age distribution of the conversation is the same as in section 6.1.2.6 -6.1.2.9.

#### 6.1.3.2 Conversation scenarios false wake-up scenarios

- This conversation scenario contains some words that may cause a device speech recognition assistant to wake-up incorrectly. The voice source may come from the TV show, conversation, music or any other background noise.
- The language of the voice source is the native language.
- Within each ten minutes, the TV show occupies 3 minutes, the random conversation occupies 4 minutes and the music occupies 3 minutes to check if the phone doesn't react.
- The gender and age distribution of the conversation is the same as in section 6.1.2.6-6.1.2.9.

#### 6.1.3.3 Conversation scenarios for single subject with multiple round of dialogs

- The conversation scenario covers all areas that are supported by the DUT, including the following category but not limited to:

| Category | Dialogs examples |
|---|---|
| Send messages: | "Open the message"<br>"Read the latest message"<br>"Reply to this number"<br>"Attach one photo in this message"<br>"Send this message". |
| Operate browser | "Open browser and search where is the capital of France"<br>"Open browser and search how many kinds of cats are there"<br>"Open browser and search what is nuclear"<br>"Open browser and search what are the main types of roses"<br>"Open browser and search why is the sky blue" |
| Call for location service | "Find the nearest restaurant"<br>"Make a phone call to this restaurant"<br>"How to get there?" |

#### 6.1.3.4 Conversation scenarios for multiple subjects that cross different categories

- The AI speech assistant is triggered by a voice trigger firstly. For example: Hi Siri, Bixby, and Alexa.
- The conversation scenario covers all areas that are supported by the DUT, including the following categories but not limited to:

| Category | Examples1 | Examples 2 |
|---|---|---|
| Business & finance | What is the stock market for GOOG? | Is there any new E-mail? |
| Food & drink | I want to eat beef steaks | How to cook king's crab |
| Games & fun | I want to listen to music | Tell me a joke |
| Health & fitness | What is the benefit of drinking hot tea? | Where is the closest fitness centre? |
| Smart Home control | Switch on the lamp for me | Turn up the heating |
| Children & family | Where is the tallest building in the world? | Tell the Cinderella fairy tale for my daughter |
| Local service | How do I get to the nearest patrol station? | I want to take a taxi to the city museum |
| Movies, Music, photos | Open the photo that was taken in Beijing last month | I want to watch movies |
| News & books | Display the news for yesterday | Display the BBC. |
| Productivity | Is there any arrangement on 19th of March? | Raise the volume of the phone |
| Shopping | What is the price for iPhone X on Amazon? | Search my order number on eBay. |
| Social & Communications | Check my tweets on twitter | Send one message to Jack and tell him "hello my cat" |
| Sports | What is the UK premier league football match for tonight | Did the Los Angeles Lakers win? |
| Travel & transportation | List some hotels in Dubai | Book two airplane tickets from Munich to Barcelona. |
| Weather | Will it rain tomorrow? | The temperature for Paris |
| Knowledge & encyclopaedia | Give me an introduction to the Law of Gravity | What is the main production area of sugarcane? |
| Random Chat | I am not happy; the time moves so slowly | I am busy, how about you? |

#### 6.1.3.5 Conversation scenarios for local tasks on DUT

The conversation scenario covers all areas that are supported by the DUT, including the following category but not limited to:

| Category examples | |
|---|---|
| Set the volume of the phone | Calculate mathematics |
| Play local music | Turn on the flashlight |
| Set alarms on the phone | Launch Applications |
| Open the Gallery | Add memos |

### 6.1.4 Configuration for devices

- The DUT is connected to the internet and the speech assistant function is turned on.
- The background noise scenarios as defined in sections 6.1.2.1 - 6.1.2.3.
- The target voice source distance scenarios as defined in sections 6.1.2.4 and 6.1.2.5.
- When analysing the acoustic waveforms, we need to ensure the acoustic wave of the human voice command won't be significantly disturbed by noises: The distance between the artificial mouth and the DUT microphone is closer than the distance between the artificial mouth and the high-speed camera's microphone.

## 6.2 AI speech assistant wake-up latency

**Description**

To test the AI speech assistant APP start-up speed after speaking the wake-up key words.

Definition for voice Wake-up:

When the device is on standby, the device AI speech assistant detects the wake-up word and makes correct response.

Definition for voice Wake-up Word:

The key word used for a device AI speech assistant wake-up, usually a phrase or a user-defined sentence.

**Initial configuration**

The initial configuration is the same as defined in section 6.1.4.

**Test Procedure**

1. Set the wake-up word for the speech recognition assistant on DUT.
2. One tester or an artificial mouth on head model speaks the wake-up key word. The end time of the voice input is $T_1$.
3. Detect the moment when the speech assistant responses and record the time as $T_2$.
4. The high-speed camera will produce two files: the audio file and video file. Play back the audio file with a professional audio editor and observe the audio waveform to get the $T_1$ and $T_2$. Calculate the wake-up speed as $t=T_2-T_1$. If $T_2$ is less than $T_1$, it means the speech assistant wake-up was falsely. The test result should be abandoned and repeated.
5. Repeat the steps 1 to 4 for 20 times.
6. Repeat the test steps 1 to 5 using the voice source frequency scenarios 6.1.2.8 and get an average wake-up latency.

**Expected Result**

1. The requirement for wake-up speed is decided by individuals, however the shorter the time the better the user experience.

## 6.3 AI speech assistant wake-up rate

### 6.3.1 Scenario 1: The DUT is in idle mode

**Description**

To test the wake-up key words recognition accuracy when the DUT is in idle mode.

**Initial configuration**

The initial configuration is the same as defined in section 6.1.4.

The definition for idle mode: Turn off the screen of DUT for 10 minutes.

**Test Procedure**

1. One tester or an artificial mouth on head model speaks the wake-up key word.
2. Check the response of the DUT and determine whether the speech assistant wake-up is successful (such as displaying the text or giving the voice prompt).
3. Repeat the test step 1 and 2 for 20 times.
4. If the speech assistant woke up successfully for X times, the wake-up successful rate will be X/20*100%.
5. Repeat the test steps 1 to 4 using the voice source frequency scenarios 6.1.2.8 and get an average wake-up rate.

**Expected Result**

1. The requirement for a successful wake-up rate is decided by individuals, however the higher the rate, the better the user experience.

### 6.3.2 Scenario 2: When other applications are operated on the DUT

**Description**

To test the wake-up key words recognition accuracy when other applications are operated on the DUT.

**Initial configuration**

The initial configuration is the same as defined in section 6.1.4.

**Test Procedure**

1. Start one application which does not include any audio.
2. Keep the application running on the screen, the tester or an artificial mouth speaks the wake-up key word.
3. Check the response of the DUT and determine whether the speech assistant wake-up is successful (such as displaying the text or giving the voice prompt).
4. Repeat the test step 1 to 3 for 20 times.
5. If the speech assistant woke up successfully for X times, the wake-up successful rate will be X/20*100%.
6. Repeat the test steps 1 to 5 using the voice source frequency scenarios 6.1.2.8 and get an average wake-up rate.

**Expected Result**

1. The requirement for a successful wake-up rate is decided by individuals, however the higher the rate, the better the user experience.

#### 6.3.3 Scenario 3: The data service is turned off on DUT

**Description**

To test if the speech assistant can perform base functions when the data service is turned off on DUT.

**Initial configuration**

The initial configuration is the same as defined in section 6.1.4.

The data service of the DUT is turned off.

**The test procedure and expected result:**

Take reference to test case 6.3.1.

### 6.4 AI speech assistant false wake-up rate

Definition for false Wake-up:

Situation 1: When the device is on standby, the device AI speech assistant wakes-up incorrectly by detecting the defined wake-up word that is not spoken by the identified user.

Situation 2: When the device is on standby, the device AI speech assistant wakes-up incorrectly by detecting an undefined word rather than the defined wake-up word.

#### 6.4.1 Scenario 1: Triggered by the wake-up word that is not spoken by the identified tester.

**Description**

The device speech assistant is triggered by detecting the wake-up word that is not spoken by the identified tester. This test case only applies to devices that support the user voiceprint recognition.

**Initial configuration**

The initial configuration is the same as defined in section 6.1.4.

The artificial mouth A and artificial mouth B pronounce voices with different frequency and tone.

The target voice volume should be more than 70dB.

**Test Procedure**

1. Tester B or artificial mouth B speaks the wake-up word.
2. Check the response of the DUT and determine whether the speech assistant woke-up (such as displaying the text or giving the voice prompt).
3. Record the speech assistant wake-up times as $X_2$.

4. Repeat the test step 1-3 for 20 times.
5. The false wake-up rate: $X_2$/20*100%.
6. Repeat the test steps 1 to 5 using the voice source frequency scenarios 6.1.2.8 and get an average false wake-up rate for scenario 2.

**Expected Result**

1. The requirement for false wake-up rate is decided by individuals, however the lower the rate, the better the user experience.

### 6.4.2 Scenario 2: Triggered by random noise

**Description**

In a random noise environment, the speech assistant is triggered due to the faulty of the device itself.

**Initial configuration**

The initial configuration is the same as defined in section 6.1.4.

**Test Procedure**

1. Broadcast some TV show, music and conversation that was defined in section 6.1.2 for 24 hours.
2. Check the response of the DUT and determine whether the speech assistant woke-up (such as displaying the text or give the voice prompt).
3. Record the speech assistant wake-up times as $X_3$.
4. The average false wake-up rate for scenario 3: $X_3$/20*100%.

**Expected Result**

1. The requirement for false wake-up rate is decided by individuals, however the lower the rate, the better the user experience.

## 6.5 AI speech assistant wake-up sensitivity

**Description**

To test the speech assistant can recognize the low voice volume.

**Initial configuration**

The initial configuration is the same as defined in section 6.1.4.

**Test Procedure**

1. One tester or an artificial mouth on head model speaks the wake-up key word. For noise scenario 6.1.2.1, the target voice volume is suggested to be 40dB. For noise scenario 6.1.2.2, the target voice volume is suggested to be 50dB. For noise scenario 6.1.2.3, the target voice volume is suggested to be 60dB.
2. Check the response of the DUT and determine whether the speech assistant wake-up is successful (such as displaying the text or giving the voice prompt).
3. Repeat the test step 1-2 for 20 times.

4. Repeat the test steps 1 to 5 using the voice source frequency scenarios 6.1.2.8 respectively.
5. Record the times that the speech assistant woke-up successfully.

**Expected Result**

1. The requirement for the wake-up times are decided by individuals, however the more the better.

## 6.6 AI speech assistant text display speed

**Description**

To test speech assistant text display speed when detecting the voice.

**Initial configuration**

The initial configuration is the same as defined in section 6.1.4.

**Test Procedure**

1. The speech assistant is activated.
2. Speak one sentence based on the conversation scenario defined in section 6.1.3.4. The speech assistant will record that sentence and display the sentence on screen.
3. Record the moment as $T_1$ when the tester or artificial mouth finishes speaking. Record the moment as $T_2$ when the text is displayed completely. The high-speed camera will produce two files: the audio file and video file. Based on the sentence that the speech assistant recognized, playback the audio file with a professional audio editor and observe the acoustic waveform to get the $T_1$. Playback the video file and observe the DUT screen status frame by frame to get the $T_2$.
   To ensure the accuracy, the time slot of the audio file and video file captured by the high-speed camera needs to be synchronized: Add one synchronization symbol on the DUT and use the high-speed camera to capture the DUT screen. One easy approach is to display something on the DUT that also makes sound at the same time (e.g. video). If the time clock between the video image and the video sound are out of synchronization, the time difference needs to be calculated for synchronization.
4. Calculate the text display speed as $t=T_2-T_1$.
5. Repeat the test step 1-3 for 20 times. The sentence should be different with each other within these 20 times.
6. Repeat the test steps 1 to 5 using the voice source frequency scenarios 6.1.2.8 respectively and calculate the average text display speed.

**Expected Result**

1. The requirement for the text display speed is decided by individuals, however the quicker the display speed, the better the user experience.

## 6.7 AI speech assistant text display accuracy

**Description**

To ensure the voice assistant displays the text correctly when detecting the voice.

**Test configuration**

The initial configuration is the same as defined in section 6.1.4

**Test Procedure**

1. The speech assistant is activated.
2. Speak one sentence based on the conversation scenario defined in section 6.1.3.4. The speech assistant should display the sentence on screen.
3. Check if the text is displayed correctly on screen. When checking the results, it is suggested to check whether the core content is correct from the perspective of end user, and if the information is correct and no information is missing.
4. Repeat the test steps 1 to 3 for 20 times. The sentence should be different from each other within these 20 times.
5. Record the number of correct displays as M.
6. The text display accuracy rate: M/20*100%.
7. Repeat the test steps 1 to 5 using the voice source frequency scenarios 6.1.2.8 respectively and get the average display accuracy value.

**Expected Result**

1. The requirement for the text display accuracy rate is decided by individuals, however the higher the accuracy rate, the better the user experience.

## 6.8 User intention recognition accuracy rate

### 6.8.1 Scenario 1: Conversation for single subject

**Description**

Make conversation with the speech assistant. The conversation contains multiple rounds of dialogs on one topic.

**Test configuration**

The initial configuration is the same as defined in section 6.1.4.

**Test Procedure**

1. The speech assistant is activated.
2. Make conversation with the speech assistant. The conversation scenarios have been defined in section 6.1.3.3.
3. Check if the response of DUT is matched with the expectation.
4. No need to exit speech assistant just continue to repeat the test steps 1-3 for 20 times. The conversation contains multiple rounds of dialogs on one subject.
5. Record the number of correct responses as M.
6. The User intention recognition accuracy rate: M/20*100%.
7. Repeat the test steps 1 to 6 using the voice source frequency scenarios 6.1.2.8 respectively and get the average accuracy rate value.

**Expected Result**

1. The requirement for accuracy rate is decided by individuals. The higher the accuracy rate, the better the user experience.

### 6.8.2 Scenario 2: Conversation for multiple categories

**Description**

Make conversation with the speech assistant. The conversation subjects will switch between different categories.

**Test configuration**

The initial configuration is the same as defined in section 6.1.4.

**Test Procedure**

1. The speech assistant is activated.
2. Make conversation with the speech assistant. The conversation scenarios have been defined in section 6.1.3.4.
3. Check if the response of DUT is matched with the expectation.
4. No need to exit speech assistant just continue to repeat the test steps 1-3 for 20 times. The conversation subjects should be switched between different categories.
5. Record the number of correct responses as M.
6. The User intention recognition accuracy rate: M/20*100%.
7. Repeat the test steps 1 to 6 using the voice source frequency scenarios 6.1.2.8 respectively and get the average accuracy rate value.

**Expected Result**

1. The requirement for accuracy rate is decided by individuals. The higher the accuracy rate, the better the user experience.

### 6.8.3 Scenario 3: Local task response

**Description**

Use the speech assistant to operate local functions on the DUT and test if the task is carried out successfully.

**Test configuration**

The initial configuration is the same as defined in section 6.1.4.

**Test Procedure**

1. The speech assistant is activated.
2. Use the speech assistant to operate the DUT. The conversation scenarios have been defined in 6.1.3.5.
3. Check if the response of the DUT is correct.
4. No need to exit speech assistant just continue to repeat the test steps 1-3 for 20 times. The operation task should be different with each other within these 20 times.
5. Record the number of correct responses as M.
6. The User intention recognition accuracy rate: M/20*100%.

7. Repeat the test steps 1 to 6 using the voice source frequency scenarios 6.1.2.8 respectively and get the average accuracy rate value.

**Expected Result**

1. The requirement for accuracy rate is decided by individuals. The higher the accuracy rate, the better the user experience.

### 6.8.4 Scenario 4: Local task response when the DUT is in flight mode

**Description**

The data service is turned off on the DUT. Use the speech assistant to operate local functions on the DUT and test if the task is carried out successfully.

**Test configuration**

The initial configuration is the same as defined in section 6.1.4.

Turn on the flight mode (There is no network connection).

**The Test procedure and expected result**

Take reference to test case 6.8.3.

### 6.8.5 Scenario 5: Compatibility with 3rd Party APP

**Description**

Make conversation with the speech assistant. The conversation subjects may be important for 3rd party APPs like Facebook, Uber or Amazon. Since the 3rd Party APPs are not the factory default functions on DUT, they are optional.

**Test configuration**

The initial configuration is the same as defined in section 6.1.4.

**Test Procedure**

1. The speech assistant is activated.
2. Make conversation with the speech assistant: “Call a taxi to the airport at 7:30am” or “I want to check Bob’s new message on Facebook” or “I want to buy a red wool coat”.
3. Check if the response of DUT is matched with the expectation: The category accuracy, intention accuracy and key information accuracy need to be checked respectively.
4. No need to exit speech assistant just continue to repeat test steps 1-3 for 20 times. The conversation subjects should be switched between different categories.
5. Record the number of correct responses as M.
6. The User intention recognition accuracy rate: M/20*100%.
7. Repeat the test steps 1 to 6 using the voice source frequency scenarios 6.1.2.8 respectively and get the average accuracy rate value.

**Expected Result**

| Conversation Analysis | | | | Expected Response | Test Result | | |
|---|---|---|---|---|---|---|---|
| Conversation Example 1 | Category | Intention | Key information | | Category recognition | Intention recognition | Key information recognition |
| Call a taxi to the airport at 7:30am | Taxi APP | Call a taxi | 7:30 airport | Doesn't open taxi APP | Fail | - | - |
| | | | | Opens taxi APP interface | Pass | Fail | - |
| | | | | Set the destination | Pass | Pass | Fail |
| | | | | Reserved a taxi, the destination is airport, reservation time is set to 7:30 | Pass | Pass | Pass |

| Conversation Analysis | | | | Expected Response | Test Result | | |
|---|---|---|---|---|---|---|---|
| Conversation Example 2 | Category | Intention | Key information | | Category recognition | Intention recognition | Key information recognition |
| I want to check Bob's new message on Facebook | Facebook | Check the message | Bob | Doesn't open Facebook | Fail | - | - |
| | | | | Opens Facebook interface | Pass | Fail | - |
| | | | | View the messages | Pass | Pass | Fail |
| | | | | View the messages of Bob | Pass | Pass | Pass |

## 6.9 User intention recognition response speed

### 6.9.1 Scenario 1: Conversation for single subject

**Description**

Make conversation with the speech assistant. The conversation contains multiple rounds of dialogs on one subject. This test case is to check the task response speed.

**Test configuration**

The initial configuration is the same as defined in section 6.1.4.

**Test Procedure**

1. The speech assistant is activated.
2. Make conversation with the speech assistant. The conversation scenarios have been defined in section 6.1.3.3.
3. Check if the response of DUT is matched with the expectation. If the response on DUT is not matched with the expectation, then step 1 and step 2 need to be repeated.
4. Record the moment as $T_1$ when the tester or artificial mouth finishes speaking. Record the moment as $T_2$ when the expected response is displayed completely. The high-speed camera will produce two files: the audio file and video file. Playback the audio file with a professional audio editor and observe the acoustic waveform to get $T_1$. Playback the video file and observe the DUT screen status frame by frame to get $T_2$.
   To ensure the accuracy, the time slot of the audio file and video file captured by the high-speed camera needs to be synchronized: Add one synchronization symbol on the DUT and use the high-speed camera to capture the DUT screen. One easy approach is to display something on the DUT that also makes sound at the same time (e.g. video). If the time clock between the video image and the sound is out of synchronization, the time difference needs to be calculated for synchronization.
5. Calculate the task response speed as $t=T_2-T_1$.
6. No need to exit speech assistant but continue to repeat the test steps 1-5 for 20 times. The conversation contains multiple rounds of dialogs on one subject. The dialogs should be different with each other within these 20 times.
7. Repeat the test steps 1 to 6 using the voice source frequency scenarios 6.1.2.8 respectively.
8. Calculate the average User intention recognition speed.

**Expected Result**

1. The requirement for User intention recognition is decided by individuals. The shorter the time, the better the user experience.

### 6.9.2 Scenario 2: Conversation for multiple categories

**Description**

Make conversation with the speech assistant. The conversation subjects will switch between different categories. To check the task response speed.

**Test configuration**

The initial configuration is the same as defined in section 6.1.4.

**Test Procedure**

The test procedure can take reference to test case 6.9.1. The conversation scenarios should take reference to section 6.1.3.4.

**Expected Result**

The expected result can take reference to test case 6.9.1.

### 6.9.3 Scenario 3: Local Task response

**Description**

Use the speech assistant to operate local functions on the DUT and test the task response speed.

**Test configuration**

The initial configuration is the same as defined in section 6.1.4.

**Test Procedure**

The test procedure can take reference to test case 6.9.1. The conversation scenarios should take reference to section 6.1.3.5.

**Expected Result**

The expected result can take reference to test case 6.9.1.

### 6.9.4 Scenario 4: Local task response when DUT is in flight mode

**Description**

The data service is turned off on the DUT. Use the speech assistant to operate local functions on the DUT and test the task response speed.

**Test configuration**

The initial configuration is the same as defined in section 6.1.4.

Turn on the flight mode (There is no network connection).

**Test Procedure**

The test procedure can take reference to test case 6.9.1. The conversation scenarios should take reference to section 6.1.3.5.

**Expected Result**

The expected result can take reference to test case 6.9.1.

## 6.10 AI speech assistant stability performance

**Description**

Operate the speech assistant for a long period of time to evaluate the stability performance.

**Test configuration**

The initial configuration is the same as defined in section 6.1.4.

**Test Procedure**

1. Run the test cases 6.8 repeatedly. The total duration is suggested to be 1 hour.

2. Detect if any defects happened during this 1 hour. The defects include: voice broadcasting stutter and other scenarios that were defined in section 4.1.4 (system stability testing chapter).
3. Record the number of times those defects happen.

**Expected Result**

1. The requirement for defect numbers are decided by individuals. The fewer defects happen, the better the user experience.

## 6.11 AI speech assistant data throughput monitoring

**Description**

Evaluate the speech assistant data traffic usage when inactive.

**Test configuration**

The initial configuration is the same as defined in section 6.1.4.

**Test Procedure**

1. Turn off all applications except for the speech assistant. Make sure the other applications won't generate data traffic.
2. The speech assistant is inactive.
3. Place the DUT in the environment with noise background for 20 minutes. The background noise scenario has been defined in scenario 6.1.2.1.
4. Use the default traffic detection tool on the DUT to monitor data traffic.
5. Repeat the test steps 1-3 for 10 times and get the average data traffic.
6. Repeat the test steps 1-5 to get the data traffic for background noise scenarios 6.1.2.2 and 6.1.2.3.

**Expected Result**

1. The requirement for the data traffic is decided by individuals, however the lower the data traffic the better the user experience.
2. The Data traffic for a quite environment (background noise scenario 6.1.2.1) should be significantly less than the noisy environment (background noise scenario 6.1.2.2 and 6.1.2.3).

## 6.12 TTS broadcast accuracy

**Description**

Evaluate the speech assistant text broadcast accuracy.

**Test configuration**

The initial configuration is the same as defined in section 6.1.4.

**Test Procedure**

1. One message or e-mail has been sent to the DUT. The message / e-mail content should contain numbers, letters and symbols.

2. The speech assistant is activated.
3. Get the speech assistant to broadcast the received message / e-mail (“Please broadcast the received new message / e-mail”).
4. Check if the content is broadcasted correctly.
5. Repeat the test steps 1 to 4 for 20 times. The content should be different with each other within these 20 times.
6. Record the number of correct broadcasts as M.
7. The TTS broadcast accuracy rate: M/20*100%.
8. Repeat the steps 1 to 7 based on the voice source frequency scenarios: 6.1.2.6-6.1.2.9 respectively and get the average rate value.

**Expected Result**

1. The requirement for the TTS broadcast accuracy rate is decided by individuals, however the higher the accuracy rate, the better the user experience.

## 6.13 Switching fluently between voice broadcasting and task response

**Description**

Interrupt the voice broadcasting and trigger other tasks to evaluate the switching fluency between voice broadcasting and task response.

**Test configuration**

The initial configuration is the same as defined in section 6.1.4.

**Test Procedure**

1. One message or e-mail has been sent to the DUT. The message / e-mail content should contain numbers, letters and symbols.
2. The speech assistant is activated.
3. Ask the speech assistant to broadcast the received message / e-mail. (“Please broadcast the received new message / e-mail”).
4. During the broadcasting, interrupt it and speak one sentence based on the conversation scenario defined in section 6.1.3.5.
5. Check if the response of the DUT is correct: The DUT stops reading the email and carries on the second command.
6. Repeat the test steps 1 to 5 for 20 times. The message / e-mail content and task should be different from each other within these 20 times.
7. Record the number of correct responses as M.
8. The switching fluency: M/20*100%.
9. Repeat the steps 1 to 8 based on the voice source frequency scenarios: 6.1.2.6-6.1.2.9 respectively and get the average value.

**Expected Result**

The requirement for the switching fluency is decided by individuals, however the higher the better the user experience.

# 7 Smartphone Biometric AI Recognition Performance Test

## 7.1 Overview

This chapter defines the test method for smartphone biometric recognition. The scope includes facial identification, fingerprint recognition, voiceprint identification and iris identification.

## 7.2 Facial Identification

### 7.2.1 The technical frame of facial identification

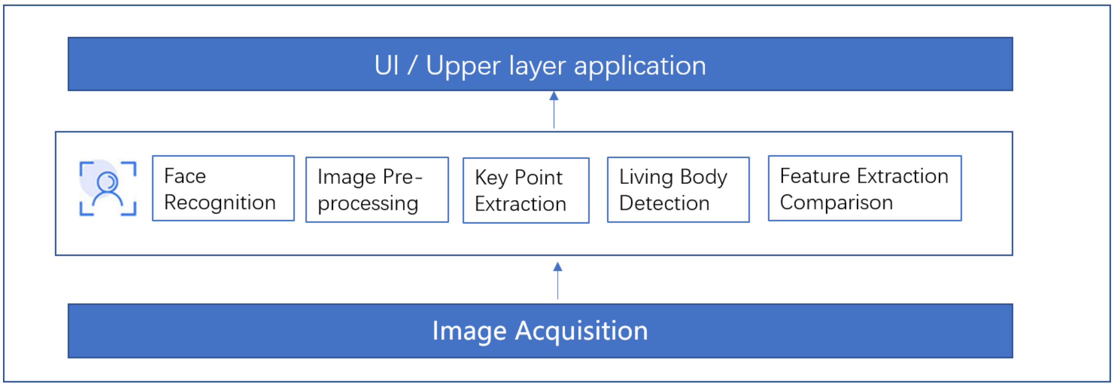



Figure 20

Face recognition is an AI biometric technology based on human face feature information. By using the camera to collect the image or video stream, the device automatically detects and tracks the face in the image, and then carries out feature recognition of the detected face. Generally, the face recognition technical frame includes these main blocks:

**Image Acquisition:**

Device performs optical signal acquisition of the user face and converts it into digital image information.

**Face recognition:**

Device searches the collected image to determine whether it contains a face. If so, return the position, size and pose of the face.

**Image preprocessing:**

Based on the face detection result, the device carries out image compensation, gray level transformation, filtering and sharpening etc.

**Key point Extraction:**

Device extracts the geometric characteristics of the Eye, mouth, nose and other key points, then builds the template based on the face characteristics.

**Living body detection:**

By blinking, opening the mouth, shaking the head, nodding and so on, the device applies the key point location and face tracking technology to verify whether the user is a real living person.

**Feature Extraction Comparison:**

Device compares the extracted feature data of the face image with the feature template stored in the database, then determines the similarity and judges the identification result.

### 7.2.2 The test environment preparation

#### 7.2.2.1 The Background of the portrait:

| | |
|---|---|
| 7.2.2.1.1 | Single colour background without other patterns. |
| 7.2.2.1.2 | Background including natural scenery or objects, the objects can be dynamic or static. |
| 7.2.2.1.3 | Background including multiple faces, the faces can be dynamic or static. |

#### 7.2.2.2 The illumination of the background:

| | The direction between light and portrait | The intensity of the light |
|---|---|---|
| 7.2.2.2.1 | Front light | Normal light:10000lux<br>Dark light:5 lux<br>Strong light:100000lux (Sunshine in the summer noon) |
| 7.2.2.2.2 | Backlight | |
| 7.2.2.2.3 | 90-degree sidelight | |

#### 7.2.2.3 The population samples:

| Gender Distribution | Age | Number of People |
|---|---|---|
| Female 50%<br>Male 50% | 18~30 50% | Manual Testing: More than 20 people. |
| | 31~50 50% | |

The nationality and race are not defined in this document. Testers in different region can choose the local population for testing.

#### 7.2.2.4 The distance between the camera and the face:

| | Category | Distance |
|---|---|---|
| 7.2.2.4.1 | Near | 15cm |
| 7.2.2.4.2 | Normal | 50cm |
| 7.2.2.4.3 | Far | 1.5m |

#### 7.2.2.5 The angle and direction between the camera and the face:

The face keeps relatively static. Building a three-dimensional coordinate with DUT as the origin. These three axes keep orthogonal to each other. Y axis is vertical to the ground and X/Z axes are horizontal to the ground.

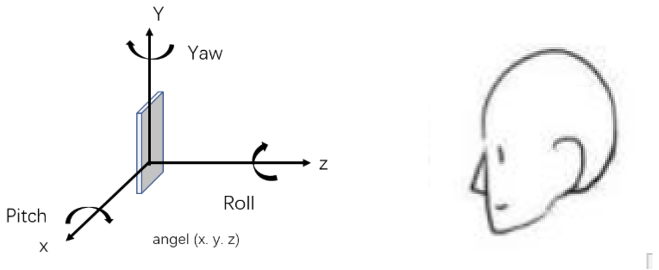



Figure 21

Rotating the DUT along the Y axis is used to describe the scenarios when the head turns left and right or rotate the DUT in left and right direction.
Rotating the DUT along the X axis is used to describe the scenarios when the head raises up and lowers down or lays the DUT on the table.
Rotating the DUT along the Z axis is used to describe the scenarios when the head crooks or the DUT screen is rotated from vertical to horizontal.

### 7.2.3 The device configuration

The face ID function is turned on. Set the DUT to be unlocked through facial identification.

The front camera can acquire images.

The test case is applicable to the terminal device that needs to press the unlock key or power key to perform facial recognition. Not applicable to devices that can recognize faces when the screen is turned off.

### 7.2.4 The test cases

#### 7.2.4.1 Face Recognition Latency for vertical screen

**Description**
Applying the face ID to unlock the screen and test the screen unlocking speed.

**Initial configuration**
1. The DUT configuration is the same as defined in section 7.2.3.
2. The posture of the model is sitting or standing.
3. The DUT remains relatively static with the model.
4. The camera of the DUT is in front of the face.
5. Use a high-speed camera to capture the DUT screen.

**Test Procedure**
1. Turn on the screen by pressing the unlocking key or power key on the screen or on the side of DUT.
2. Use the face to unlock the screen.
3. Check the response of the screen. If the face recognition is failed then restart this test case from the beginning.
4. Playback the testing process captured by a high-speed camera and analyze frame by frame. Record the moment as *T1* when the finger finishes pressing the unlocking key or power key. Record the moment as *T2* when the screen finishes unlocking.
5. Calculate the face recognition speed as $t=T2-T1$.
6. Lock the screen and repeat the test step 1-5 for 5 times and calculate the average recognition speed.
7. Repeat the test step 1-6 using the scenarios 7.2.2.1-7.2.2.4 respectively.

**Expected Result**
The requirement for recognition latency is decided by individuals. The lower the latency, the better the user experience.

#### 7.2.4.2 Face Recognition latency for landscape screen

**Description**

To test the DUT can recognize the face smoothly when the DUT screen is in landscape mode.

**Initial configuration**

As per section 7.2.4.1.

Place the DUT screen to horizontal direction.

**Test Procedure**

As per section to 7.2.4.1.

**Expected Result**

As per section 7.2.4.1.

#### 7.2.4.3 Face Recognition latency for screen upside down scenario

**Description**

To test the DUT can recognize the face smoothly when the DUT screen is upside down.

**Initial configuration**

As per section to 7.2.4.1.

Place the DUT screen upside down.

**Test Procedure**

As per section to 7.2.4.1.

**Expected Result**

As per section to 7.2.4.1.

#### 7.2.4.4 Face recognition distance sensitivity- Far distance scenario

**Description**

To test the farthest distance that the DUT can recognize the face.

**Initial configuration**

1. The DUT configuration is the same as defined in section 7.2.3.
2. The posture of the model is sitting or standing.
3. The DUT remains relatively static with the model.
4. Use a high-speed camera to capture the DUT screen.

**Test Procedure**

1. Place the DUT 30 cm away from the model.
2. Turn on the screen by pressing the unlocking key or power key on the screen or on the side of DUT. Use the face to unlock the screen.
3. Check if the screen is unlocked.
   3a. If it is unlocked, go to the step 4.
   3b. If it is not unlocked, increase the DUT start position to 40 cm away from the model and increase the distance by 10cm until it is unlocked. When the screen is unlocked, go to step 4.
4. Lock the screen and increase the distance for 10cm each time until the screen fails to unlock. Record the last distance value that the screen is unlocked as *N* cm.
5. Lock the screen and place the DUT *N* cm away from the model. Use the face to unlock the screen for 5 times and record the number of successful instances as *M*.
6. Repeat the test step 1-5 using the scenarios 7.2.2.1-7.2.2.3 respectively and get the value for *M* of each scenario.

7. Check that the value of *M* for each scenario should be more than 3. If any *M* is less than 3 then record the previous distance value as the far distance sensitivity. For example, when the distance is increased to 160 cm and *M* is more than 3 but when the distance is increased to 170 cm and *M* is less than 3. Record 160 cm as the far distance sensitivity.

**Expected Result**

The requirement for recognition distance sensitivity is decided by individuals. The further distance the DUT can recognize, the better the user experience.

#### 7.2.4.5 Face recognition distance sensitivity- Near distance scenario

**Description**

To test the nearest distance that the DUT can recognize a face.

**Initial configuration**

1. The DUT configuration is the same as defined in section 7.2.3.
2. The posture of the model is sitting or standing.
3. The DUT remains relatively static with the model.
4. The camera of the DUT is in front of the face.
5. Use a high-speed camera to capture the DUT screen.

**Test Procedure**

1. Place the DUT at the distance that the screen is unlocked in test case 7.2.4.4 step 3.a or 3.b (Note: the device is off at this stage).
2. Turn on the screen by pressing the unlocking key or power key on the screen or on the side of DUT. Use the face to unlock the screen.
3. Check if the screen is unlocked.
4. Lock the screen and decrease the distance for 3 cm each time until the screen fails to unlock. Record the last distance value that the screen is unlocked as *N* cm.
5. Lock the screen and place the DUT *N* cm away from the model. Use the face to unlock the screen for 5 times and record the number of successful instances as *M*.
6. Repeat the test step 1-5 using the scenarios 7.2.2.1-7.2.2.3 respectively and get the value for *M* of each scenario.
7. Check that the value of *M* for each scenario should be more than 3. If any *M* is less than 3 then record the previous distance value as the near distance sensitivity. For example, when the distance is decreased to 21cm and *M* is more than 3 but when the distance is decreased to 18cm and *M* is less than 3. Record 21cm as the near distance sensitivity.

**Expected Result**

The requirement for recognition distance sensitivity is decided by individuals. The nearer distance the DUT can recognize, the better the user experience.

#### 7.2.4.6 Face Recognition yaw angle sensitivity

**Description**

When there is a yaw angle deviation between the camera on DUT and the model, the DUT can recognize the face smoothly.

**Initial configuration**

1. The DUT configuration is the same as defined in section 7.2.3. The attention detection of face ID is turned off.

2. The posture of the model is sitting or standing.
3. The DUT remains relatively static with the model.
4. The camera of the DUT is in front of the face. The direction between the DUT and the facial is shown in the figure below.
5. Use a high-speed camera to capture the DUT screen.
6. The distance between DUT and the model is normal distance as defined in 7.2.2.4.

**Test Procedure**

1. Place the DUT in front of the model.
2. Turn on the screen by pressing the unlocking key or power key on the screen or on the side of DUT. Use the face to unlock the screen. Check if the screen is unlocked.
3. Lock the screen and rotate the DUT along the Y axis 10 degrees in the right direction (As shown in the figure below). Repeat step 2. Continue to rotate the DUT by further 10 degrees until it fails to unlock. Record the last angel that the DUT is unlocked.
4. Repeat the test step 1-3 using the scenarios 7.2.2.1-7.2.2.3 respectively and get the average angle value.
5. Rotate the DUT along the Y axis 10 degrees in the left direction and repeat the test step 1-4.

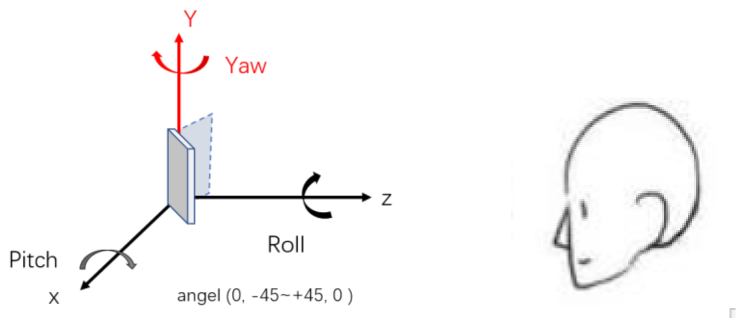



Figure 22

**Expected Result**

The requirement for recognition yaw angle sensitivity is decided by individuals. The bigger yaw angles the DUT can recognize, the better the user experience.

#### 7.2.4.7 Face Recognition pitch angle sensitivity

**Description**

When there is a pitch angle deviation between the camera on DUT and the model, the DUT can recognize the face smoothly.

**Initial configuration**

1. As per section to test case 7.2.4.6.
2. The direction between the DUT and the facial is shown in the figure below.

**Test Procedure**

1. As per section to test case 7.2.4.6. Besides, the rotating direction of DUT is along the x axis.

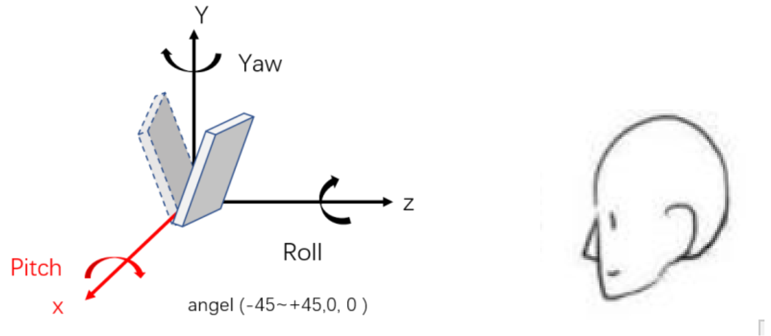



Figure 23

**Expected Result**

As per section to test case 7.2.4.6.

### 7.2.4.8 Face Recognition roll angle sensitivity

**Description**

When there is a roll angle deviation between the camera on DUT and the model, the DUT can recognize the face smoothly.

**Initial configuration**

1. As per section to test case 7.2.4.6.
2. The direction between the DUT and the facial is shown in the figure below.

**Test Procedure**

1. As per section to test case 7.2.4.6. Besides, the rotating direction of DUT is along the z axis.

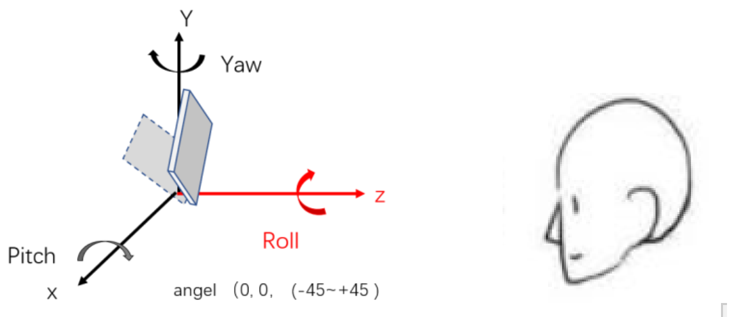



Figure 24

**Expected Result**

As per section to test case 7.2.4.6.

### 7.2.4.9 Face Recognition accuracy rate for extreme dynamic scenarios - the recognition distance range is changing

**Description**

To test if the DUT can recognize the face successfully while changing the distance between DUT and model.

**Initial configuration**

1. The DUT configuration is the same as defined in section 7.2.3.
2. The posture of the model is sitting or standing.

3. The camera of the DUT is in front of the face and no angle deviation as shown in figure 21.
4. Use a high-speed camera to capture the DUT screen.

**Test Procedure**

1. Place the DUT 10 cm further away than the furthest recognition distance in test case 7.2.4.4 from the model. Turn on the screen by pressing the unlocking key or power key on the screen or on the side of DUT. Use the face to unlock the screen.
2. Turn on the screen again by pressing the unlocking key or power key. Moving the DUT closer to the model at the same instance. The moving speed is 100 cm per second. The moving direction is horizontal. The moving end point is 40 cm away from the model.
3. Check whether the DUT screen can be unlocked during this dynamic procedure.
4. Lock the screen and repeat the test step 1-3 for 5 times. Record the number of successful instances as *M*.
5. Repeat the test step 1-4 using the scenarios 7.2.2.1-7.2.2.3 respectively and get the average value for *M*.

**Expected Result**

The requirement is decided by individuals. The higher the accuracy rate and the wider the distance range, the better the user experience.

#### 7.2.4.10 Face Recognition accuracy rate for extreme dynamic scenarios - the recognition angle deviation is changing

**Description**

To test if the DUT can recognize the face successfully while changing the angle.

**Initial configuration**

1. The DUT configuration is the same as defined in section 7.2.3.
2. The posture of the model is sitting or standing.
3. The distance between DUT and model is defined in section 7.2.2.4.2.
4. The camera of the DUT is in front of the face. Use a high-speed camera to capture the DUT screen.

**Test Procedure**

1. Place the DUT at a position that is 45-degree rotating along the Y axis, as shown in figure 22. Turn on the screen by pressing the unlocking key or power key on the screen or on the side of DUT. Use the face to unlock the screen. Check if the DUT screen cannot be unlocked. If the screen is unlocked then the angle should be larger.
2. Turn on the screen again by pressing the unlocking key or power key. At the same instant, turn the DUT along the Y axis for 45 degree until the front camera faces the model directly. The moving speed is 90 degrees per second.
3. Check whether the DUT screen can be unlocked during this dynamic procedure.
4. Lock the screen and repeat the test step 1-3 for 5 times. Record the number of successful instances as *M*.
5. Rotate the DUT along X axis and Z axis to repeat the test step 1-4.
6. Repeat the test step 1-5 using the scenarios 7.2.2.1-7.2.2.3 respectively and get the average value for *M*.

**Expected Result**

The requirement is decided by individuals. The higher the accuracy rate and the wider the angle deviation, the better the user experience.

#### 7.2.4.11 Face Recognition accuracy rate for extreme dynamic scenarios - the background brightness is changing

**Description**

To test if the DUT can recognize the face successfully while the environment illumination is changing.

**Initial configuration**

1. The DUT configuration is the same as defined in section 7.2.3.
2. The posture of the model is sitting or standing.
3. The distance between DUT and model is defined in section 7.2.2.4.2. No angle deviation as shown in figure 21.
4. The camera of the DUT is in front of the face. Use a high-speed camera to capture the DUT screen.

**Test Procedure**

1. The environment light is set to be strong as defined in 7.2.2.2. Turn on the screen by pressing the unlocking key or power key on the screen or on the side of DUT. Use the face to unlock the screen. Check if the DUT screen cannot be unlocked. If the screen is unlocked then the brightness of the background light should be brighter.
2. Turn on the screen again by pressing the unlocking key or power key. Use the face to unlock the screen. At the same instant, lower the brightness of light to a normal stage as defined in 7.2.2.2.
3. Check whether the DUT screen can be unlocked during this dynamic procedure.
4. Lock the screen and repeat the test step 1-3 for 5 times. Record the number of successful instances as *M*.
5. Repeat the test steps 1-4 using the scenarios 7.2.2.1 and 7.2.2.3 respectively and get the average value for *M*.

**Expected Result**

The requirement is decided by individuals. The higher the accuracy rate and the wider the variation of intensity of brightness, the better the user experience.

#### 7.2.4.12 Face Recognition accuracy rate for extreme dynamic scenarios - the facial expression is changing

**Description**

To test if the DUT can recognize the face successfully during changing the facial expression.

**Initial configuration**

1. The DUT configuration is the same as defined in section 7.2.3.
2. The posture of the model is sitting or standing.
3. The distance between DUT and model is defined in section 7.2.2.4.2. No angle deviation as shown in figure 21.
4. The camera of the DUT is in front of the face. Use a high-speed camera to capture the DUT screen.

**Test Procedure**

1. Make some expression that cannot be recognized by the DUT. For example, laugh with the mouth open heavily, pout, close the eyes, or eyeballs up. Check if the screen cannot be unlocked. If the screen is unlocked then make the expression more exaggerated.
2. Turn on the screen again by pressing the unlocking key or power key. Use the face to unlock the screen and at the same instance the model's face recover to a stage without special expression.
3. Check whether the DUT screen can be unlocked during this dynamic procedure.
4. Lock the screen and repeat the test step 1-3 for 5 times. Record the number of successful instances as *M*.
5. Repeat the test steps 1-4 using the scenarios 7.2.2.1 to 7.2.2.3 respectively and get the average value for *M*.

**Expected Result**

The requirement is decided by individuals. The higher the accuracy rate and the higher number of different facial expressions, the better the user experience.

#### 7.2.4.13 Face Recognition accuracy rate for static scenarios - heavy make-up or hair covered one eye

**Description**

To test the face recognition TAR when the model puts on heavy make-up or the hair covers one eye or half of the cheek is blocked.

**Initial configuration**

1. The DUT configuration is the same as defined in section 7.2.3.
2. The posture of the model is sitting or standing.
3. The distance between DUT and model is defined in section 7.2.2.4.2. No angle deviation as shown in figure 21.
4. The camera of the DUT is in front of the face. Use a high-speed camera to capture the DUT screen.

**Test Procedure**

1. The model puts on heavy make-up. Turn on the screen by pressing the unlocking key or power key. Use the face to unlock the screen.
2. Lock the screen and repeat the test step 1 for 5 times. Record the number of successful instances as *M*. The TAR=*M*/5*100%
3. Repeat the test steps 1-2 using the scenarios 7.2.2.1 to 7.2.2.3 respectively and get the average value for TAR.
4. Similarly, apply these test steps and check the scenarios when hair covers one eye or half of the cheek is blocked.

**Expected Result**

The requirement is decided by individuals. The higher the TAR, the better the user experience.

#### 7.2.4.14 Face Recognition accuracy rate for static scenarios - lying down posture or bowing posture

**Description**

To test the face recognition TAR when the model is lying or bowing down.

**Initial configuration**

1. The DUT configuration is the same as defined in section 7.2.3.
2. Use a high-speed camera to capture the DUT screen.

**Test Procedure**

1. The model is lying flat as shown in figure 25.
2. The distance between DUT and the model is 50cm (as defined in 7.2.2.4.2) and no angle deviation.
3. Turn on the screen by pressing the unlocking key or power key on the screen or on the side of DUT. Use the face to unlock the screen.
4. Lock the screen and repeat the test step 3 for 5 times. Record the number of successful instances as *M*. The TAR=*M*/5*100%.
5. Repeat the test steps 1-4 using the scenarios 7.2.2.1 to 7.2.2.3 respectively and get the average value for TAR.
6. Similarly, apply these test steps and check the scenario when the model is lying sideways, check the scenario when the DUT is placed on a table and model bows the head (as shown in figure 26).

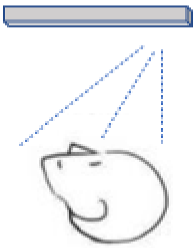


Figure 25

Figure 26

**Expected Result**

The requirement is decided by individuals. The higher the TAR, the better the user experience.

#### 7.2.4.15 Face Recognition anti-spoof ability - glasses with tricked eye

**Description**

To test the face recognition SAR when the model is wearing a special glass. The glasses are pasted with black tape and white dots in the middle of the lenses to imitate the eyes. Since some DUT doesn't extract 3D information from the eye frame area when wearing glasses this can check the device anti-spoof ability.


Figure 27

**Initial configuration**

1. The DUT configuration is the same as defined in section 7.2.3.
2. The posture of the model is sitting or standing.
3. The distance between DUT and model is defined in section 7.2.2.4.2. No angle deviation as shown in figure 21.

4. The camera of the DUT is in front of the face. Use a high-speed camera to capture the DUT screen.

**Test Procedure**

1. The model puts on the glasses that shown on the figure 27 above.
2. Turn on the screen by pressing the unlocking key or power key on the screen or on the side of DUT. Use the face to unlock the screen. Check if the screen can be unlocked.
3. Repeat the test step 1 for 5 times and record the number of successful instances as *M*. The SAR=*M*/5*100%
4. Repeat the test steps 1-3 using the scenarios 7.2.2.1 to 7.2.2.3 respectively and get the average value for SAR.

**Expected Result**

The requirement is decided by individuals. The lower the SAR, the better the user experience.

#### 7.2.4.16 Face Recognition anti-spoof ability - fake face model (3D printing, high resolution photo, videos)

**Description**

To test the face recognition SAR when applying 3D printing, high resolution photo or videos instead of model.

**Initial configuration**

1. The DUT configuration is the same as defined in section 7.2.3.
2. The posture of the model is sitting or standing.
3. The distance between DUT and model is defined in section 7.2.2.4.2.
4. The camera of the DUT is in front of the face. Use a high-speed camera to capture the DUT screen.

**Test Procedure**

1. The DUT is in front of the face. Unlock the screen by applying the fake face models and check if the screen can be unlocked.
2. Repeat the test step 1 for 5 times and record the number of successful instances as *M*. The SAR=*M*/5*100%
3. Repeat the test steps 1-2 using the scenarios 7.2.2.1 to 7.2.2.3 respectively and get the average value for SAR.
4. Turn the DUT along x, y, z axis for 30 degree and repeat the test steps again.

| **Faked Face Models** |
|---|
| 2D photos: apply inkjet or laser printer to print the high-resolution photo. |
| Photo on mobile: Mobile device display of face photo. |
| Video: Video display of the registered face. Video resolution should be no less than 1080p. |
| 3D face masks: the material can be paper, silicon, plastic or other types; production accuracy is less than 5 mm. |

**Expected Result**

The requirement is decided by individuals. The expected SAR should be zero for 2D photos and videos. For 3D face masks the lower the SAR, the better the user experience.

#### 7.2.4.17 Face Recognition- FAR and FRR

**Description**

To test the face recognition FAR and FRR when DUT is in idle mode.

**Initial configuration**

1. The DUT configuration is same as defined in section 7.2.3.
2. The posture of the model is sitting or standing.
3. The DUT remains relatively static with the face.
4. The camera of the DUT is in front of the face and no angle deviation as shown in figure 21.
5. The background of the face is as defined in 7.2.2.1.2.
6. The illumination of the background is normal light as defined in 7.2.2.2.
7. The distance between DUT and the model is normal distance as defined in 7.2.2.4.
8. The population sample is labelled as *v(i)*, where *i* belongs to {1 ~ *n*}, where *n* is the total number of the population samples.

**Test Procedure**

1. Switch on DUT and lock the screen.
2. For each *v(i)*, use its face to unlock the screen for *m* times.
3. Check the response of the screen and record the number of unsuccessful instances as *X(i)*.
4. Calculate the FRR as $\sum_{i=1}^{n} X(i)/mn$.
5. Lock the screen. For each *v(i)*, use the rest *n*-1 population sample's face to unlock the screen. (Note: the rest population is supposed to be rejected during recognition)
6. Check the response of the screen and record the number of successful instances as *X1*.
7. Repeat step 6 for 2 times, record the number of successful instances as *X2* and *X3*.
8. Calculate the FAR as (*X1*+*X2*+*X3*)/(*n**3*(*n*-1)).

**Expected Result**

The requirement for FAR and FRR is decided by individuals. The lower the FAR and FRR simultaneously, the better the user experience and security.

## 7.3 Fingerprint Identification

### 7.3.1 The technical frame of fingerprint identification

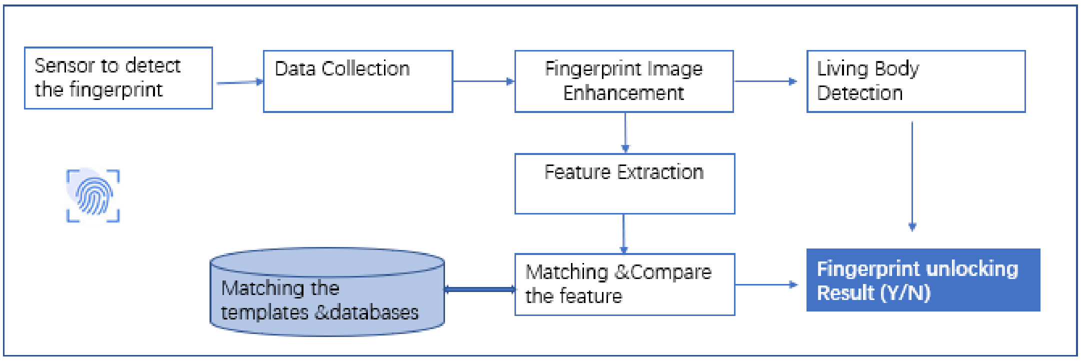



Figure 28

Generally, the technical frame includes these main blocks:

**Data Collection:**
The fingerprint sensor obtains the fingerprint image. The fingerprint sensors on commercial terminals can be divided into three categories: Capacitive sensors, optical sensors and ultrasonic sensors. The fingerprint sensor can be integrated on the front side of the DUT (above or below the touch screen), the rear side of the DUT and the side of the DUT. Since the sensor technology, screen light transmittance and AI algorithms are completely different on different terminals, this guideline will evaluate the fingerprint identification performance from the perspective of user experience.
**Fingerprint Image Enhancement:**
Preprocess the original image including image segmentation, image enhancement and refinement.
**Feature Extraction:**
Find the details from the image including the end point of the fingerprint, divergence point, intersection point, direction information so as to extract the feature data.
**Living Body Detection:**
Apply AI machine learning algorithm to compare the true and false fingerprint images.
**Match and Compare:**
Compare the extracted feature data with the feature template stored in the database, then determine the similarity and judge the identification result.

### 7.3.2 Test Environment

#### 7.3.2.1 The illumination of the test environment: (The performance of fingerprint optical sensors will be affected by the environment illumination).

1. Strong light environment: 100000lux (Sunshine in the summer noon)
2. Normal light environment: 10000lux

#### 7.3.2.2 The relative humidity of the test environment: (The performance of fingerprint optical sensors and ultrasonic sensors will be affected by the environment humidity).

1. Dry and cold environment: temperature is -10 °C and relative humidity is 10% RH
2. Dry and hot environment: temperature is 35 °C and relative humidity is 10% RH
3. Normal humidity environment: temperature is 20 °C and relative humidity is 50% RH

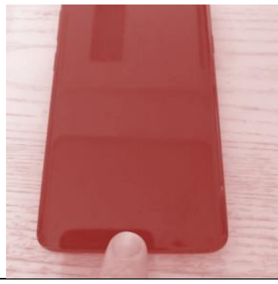
#### 7.3.2.3 The temperature of the test environment: (The performance of fingerprint optical sensors and ultrasonic sensors will be affected by the environment temperature especially for the cold scenarios).

1. Extremely Cold environment: temperature is -15 °C and relative humidity is 40%
2. Cold environment: temperature is -5 °C and relative humidity is 40%
3. Normal temperature environment: temperature is 20 °C and relative humidity is 40% RH

#### 7.3.2.4 The population samples:

| Gender distribution | Age | Number of People |
|---|---|---|
| Female 50% | 18~30 50% | Manual Testing: More than 20 people. |
| Male 50% | 31~50 50% | |

#### 7.3.2.5 The finger sample direction:

| **Finger Sample Direction**<br>The angle between the finger and the touch screen: | **Example** |
|---|---|
| 0 degree (the whole finger presses on the screen unlocking key or power key) |  |
| 0 degree (half of the finger presses on the screen unlocking key or power key) |  |
| 45 degree (right side) |  |
| 45 degree (left side) |  |
| 45 degree (upside) |  |

### 7.3.3 The device configuration:

The fingerprint identification function is turned on. Set the DUT to be unlocked through fingerprint identification.
Use a high-speed camera to capture the process.

### 7.3.4 The Test Case:

#### 7.3.4.1 The Fingerprint Recognition Latency - The Screen is Turned on

**Description**

Apply the fingerprint to unlock the screen and test the screen unlocking speed. The status of the touch screen is on. This test case is suitable for devices that don't support fingerprint identification under dark screen.

**Initial configuration**

1. The DUT configuration is the same as defined in section 7.3.3.
2. The illumination of the test environment is normal light environment.
3. The humidity of the test environment is normal.
4. The temperature of the test environment is normal.

**Test Procedure**

1. Turn on the touch screen and ensure the status of the screen is turned on and locked.
2. Unlock the screen by pressing the fingerprint unlock key on the touch screen side of DUT, or on the side of the DUT, or on the rear side of DUT.
3. Check the response of the screen. If the fingerprint recognition is failed then restart this test case from the beginning.
4. Playback the testing process captured by a high-speed camera and analyze frame by frame. Record the moment as *T1* when the finger finishes pressing the fingerprint unlock key. Record the moment as *T2* when the screen finishes unlocking. (If the fingerprint unlock key is located on the rear side of the DUT, the mirror can be used to reflect the finger movement and help the high-speed camera capture the action.)
5. Calculate the fingerprint recognition speed as $t=T2-T1$.
6. Lock and turn off the screen and repeat the test step 1-5 for 5 times and calculate the average recognition speed.
7. Repeat the test step 1-6 using the scenarios that were defined in 7.3.2.4 respectively.

**Expected Result**

The requirement for recognition latency is decided by individuals. The lower the latency, the better the user experience.

#### 7.3.4.2 The Fingerprint Recognition Latency - The Screen is Turned off

**Description**

Applying the fingerprint to unlock the screen and test the screen unlocking speed. The status of the touch screen is turned off. This scenario is suitable for the devices that support fingerprint identification under dark screen. (For example: devices with capacitive sensors and ultrasonic sensors).

**Initial configuration**

1. The DUT configuration is the same as defined in section 7.3.3.

2. The illumination of the test environment is normal light environment.
3. The humidity of the test environment is normal.
4. The temperature of the test environment is normal.

**Test Procedure**

1. Ensure the DUT screen is turned off.
2. Unlock the screen by pressing the fingerprint unlock key on the touch screen side of DUT, or on the side of the DUT, or on the rear side of DUT.
3. Other procedures please take reference to test case 7.3.4.1.

**Expected Result**

As per section to test case 7.3.4.1.

#### 7.3.4.3 Fingerprint Recognition Latency- Payment Application Scenario

**Description**

Applying the fingerprint to verify the payment on DUT and test the verification speed. The payment application could be Samsung Pay, Huawei Pay, PayPal or Alipay or other applications.

**Initial configuration**

1. The DUT configuration is the same as defined in section 7.3.3.
2. The illumination of the test environment is normal light environment.
3. The humidity of the test environment is normal.
4. The payment verification on DUT is set to be fingerprint verification.
5. The temperature of the test environment is normal.

**Test Procedure**

1. Turn on the DUT payment application and start the payment action.
2. Apply the fingerprint for the payment verification.
3. Check the response of the screen. If the fingerprint verification is failed then restart this test case from the beginning.
4. Playback the testing process captured by a high-speed camera and analyze frame by frame. Record the moment as *T1* when the finger finishes pressing the payment fingerprint verification key. Record the moment as *T2* when the payment verification finishes (Note: not the payment transaction time point).
5. Calculate the fingerprint recognition speed as *t=T2-T1*.
6. Lock and turn off the screen and repeat the test step 1-5 for 5 times and calculate the average recognition speed.
7. Repeat the test step 1-6 using the scenarios defined in 7.3.2.4 respectively.

**Expected Result**

The requirement is decided by individuals. The lower the latency, the better the user experience.

#### 7.3.4.4 Fingerprint Recognition Latency- Application Login Scenario

**Description**

Applying the fingerprint to login the application on DUT and test the application login speed. The application could be a local application like Message or third-party application like WeChat, Taobao, etc.

**Initial configuration**

As per test case 7.3.4.3

**Test Procedure**

As per test case 7.3.4.3

**Expected Result**

As per test case 7.3.4.3

#### 7.3.4.5 Fingerprint Recognition Accuracy Rate for Extreme Environment-Strong light Scenario

**Description**

To test the fingerprint recognition TAR when unlocking the screen under strong light environment. This test case is applicable for DUT that use optical fingerprint sensors.

**Initial configuration**

1. The DUT configuration is the same as defined in section 7.3.3.
2. The illumination of the test environment is strong light environment as defined in 7.3.2.1.

**Test Procedure**

1. Unlock the screen by pressing the fingerprint unlock key on the touch screen side of DUT, or on the side of the DUT, or on the rear side of DUT.
2. Lock the screen and repeat the test step 1 for 5 times.
3. Record the number of successful instances as *M*. The TAR=*M*/5*100%.
4. Repeat the test steps 1-3 using the scenarios as defined in 7.3.2.4 respectively and get the average TAR value.

**Expected Result**

The requirement is decided by individuals. The higher the TAR, the better the user experience.

#### 7.3.4.6 Fingerprint Recognition Accuracy Rate for Extreme Environment - Dry Humidity Scenario

**Description**

To test the fingerprint recognition TAR when unlocking the screen under dry humidity environment. This test case is applicable for devices with capacitive fingerprint recognition sensors and optical fingerprint recognition sensors.

**Initial configuration**

1. The DUT configuration is the same as defined in section 7.3.3.
2. The humidity of the test environment is dry environment as defined in 7.3.2.2.

**Test Procedure**

As per section to test case 7.3.4.5.

**Expected Result**

As per section to test case 7.3.4.5.

#### 7.3.4.7 Fingerprint Recognition Accuracy Rate for Extreme Environment - Cold Scenario

**Description**

To test the fingerprint recognition TAR when unlocking the screen under cold environment. This test case is applicable for devices with all types of fingerprint sensor.

**Initial configuration**

1. The DUT configuration is the same as defined in section 7.3.3.
2. The humidity of the test environment is cold environment as defined in 7.3.2.3.

**Test Procedure**

As per section to test case 7.3.4.5.

**Expected Result**

As per section to test case 7.3.4.5.

#### 7.3.4.8 Fingerprint Recognition Accuracy Rate when Water and Oil are stuck on Finger

**Description**

To test the fingerprint recognition TAR when unlocking the screen. The finger is stained with water or oil or dust. This test case is applicable for devices with all types of fingerprint sensor.

**Initial configuration**

1. The DUT configuration is the same as defined in section 7.3.3.
2. The illumination of the test environment is normal light environment.
3. The humidity and temperature of the test environment is normal.
4. The finger is stained with water or oil or dust. The amount of water or oil or dust is 1ml. To ensure the interference objects can be distributed uniformly on the finger, a dropper can be used to drop the interference objects evenly on fingers.

**Test Procedure**

As per section to test case 7.3.4.5.

**Expected Result**

As per section to test case 7.3.4.5.

#### 7.3.4.9 Fingerprint Recognition Accuracy Rate for Extreme Environment - Insulation Scenario

**Description**

This test case is applicable for devices using capacitive fingerprint identification sensors, since the user's conductivity will affect the performance of DUT fingerprint identification. It is necessary to test the fingerprint recognition TAR when the tester is standing or lying on a chair or bed that is made of insulated material.

**Initial configuration**

1. The DUT configuration is the same as defined in section 7.3.3.
2. The illumination of the test environment is normal light environment.
3. The humidity and temperature of the test environment is normal.
4. The tester standing or lying on a wood/plastic chair or bed.

**Test Procedure**

As per section to test case 7.3.4.5.

**Expected Result**

As per section to test case 7.3.4.5.

#### 7.3.4.10 Fingerprint Recognition anti-spoof ability- 3D fake finger model

**Description**
To test the fingerprint recognition SAR when applying a 3D fake model instead of a real finger.

**Initial configuration**
1. The DUT configuration is the same as defined in section 7.3.3.
2. The illumination of the test environment is normal light environment.
3. The humidity and temperature of the test environment is normal.

**Test Procedure**
1. Unlock the screen when applying the 3D fake model finger and check if the screen can be unlocked.
2. Repeat the test step 1 for 5 times and record the number of successful instances as *M*. The SAR=*M*/5*100%
3. Repeat the test steps 1-2 using the scenarios 7.3.2.4 respectively and get the average value for SAR.

**Expected Result**
The requirement is decided by individuals. The lower the SAR, the better the user experience.

## 7.4 Voiceprint Identification

### 7.4.1 The Technical Frame of Voiceprint Identification

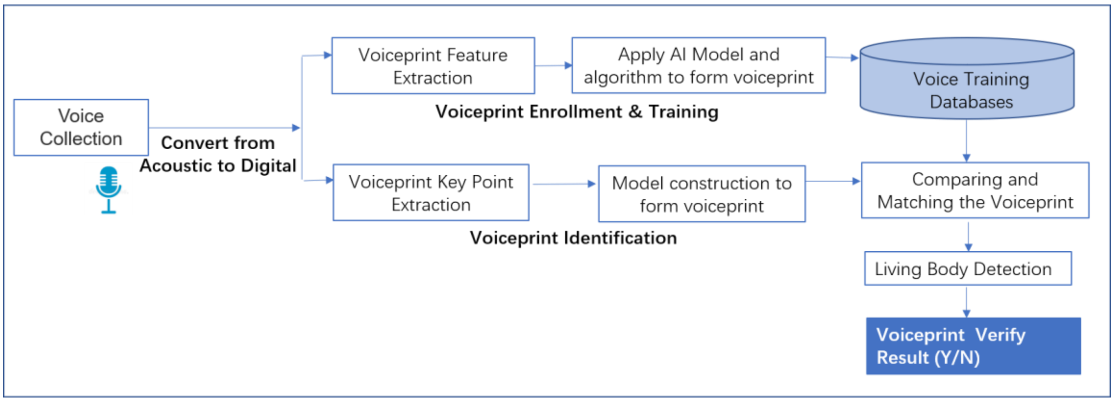



Figure 29

The voice spectrum, voice rhythm and tone characteristics are varied from people to people. Devices can identify user by applying and analyzing the voiceprint information. The voiceprint recognition process is divided into Voiceprint Enrollment & Training process and Voiceprint Identification.

**Voiceprint enrollment and training process:**
The device prompts the user to read specific text and records user's voice information. The device converts the acoustic signal into digital signal. Then the voiceprint feature information is extracted. The AI model and algorithm are applied and trained to form a unique voiceprint as the user’s identity. Finally, the trained model and voiceprint are stored in the voiceprint database.

**Voiceprint Identification process:**

The user speaks the specific text for identity verification. The device detects the voice and then converts the acoustic signal into digital signal. Next, the voiceprint key point feature information is extracted. The AI model is applied to form the voiceprint, and then the voiceprint is compared and matched according to the stored voice training databases. If necessary, the living body detection is applied to avoid cracking identity authentication using the recorded voice. Finally, device will show the result of identification.

### 7.4.2 The test Environment

The test environment preparation, for example the background noise, the target voice source distance, the voice source speed/frequency/tone should take reference to section 6.1.2.

### 7.4.3 The Device Configuration

The microphone function is allowed on DUT.
The voiceprint identification function is turned on. Set the DUT to be unlocked through voiceprint identification.

### 7.4.4 The Test Cases

#### 7.4.4.1 The Voiceprint Recognition Latency - Various background noise Scenarios

**Description**

Applying the voiceprint to unlock the application and test the unlocking speed.

**Initial configuration**

1. The DUT configuration is the same as defined in section 7.4.3.
2. The background noise scenarios are defined in sections 6.1.2.1 - 6.1.2.3.
3. The target voice source distance scenarios are defined in sections 6.1.2.4 and 6.1.2.5.
4. The voice source age group is defined in 6.1.2.8.

**Test Procedure**

1. Unlock a certain application by saying the specific text that is used for identity verification.
2. Check the response of the screen. If the voiceprint recognition is failed then restart this test case from the beginning.
3. Record the moment as *T1* when the tester or artificial mouth finishes speaking. Record the moment as *T2* when the application is displayed completely. The high-speed camera will produce two files: the audio file and video file. Based on the sentence that the device recognized, playback the audio file with a professional audio editor and observe the acoustic waveform to get the *T1*. Playback the video file and observe the DUT screen status frame by frame to get the *T2*.
4. Calculate the voiceprint recognition speed as $t=T2-T1$.
5. Close the application and start the application again by repeating the test step 1-4 for 5 times and calculate the average recognition speed.
6. Repeat the test step 1-5 using the scenarios defined in section 6.1.2.1 - 6.1.2.3 and 6.1.2.4 - 6.1.2.5 respectively to fulfil different background noise.

Note: Apply the voiceprint to unlock the DUT screen can use the similar test process.

**Expected Result**

The requirement for recognition latency is decided by individuals. The lower the latency, the better the user experience.

#### 7.4.4.2 The Voiceprint Recognition Accuracy Rate - Fast Speaking Speed

**Description**

To test the voiceprint recognition TAR when unlocking the application with fast speaking speed.

**Initial configuration**

1. The DUT configuration is the same as defined in section 7.4.3.
2. The background noise scenarios are defined in sections 6.1.2.1.
3. The target voice source distance scenarios are defined in sections 6.1.2.4.
4. The voice source group is defined in 6.1.2.8.

**Test Procedure**

1. Unlock a certain application by saying the specific text that is used for identity verification. The speed should be faster than normal speed. (E.g., 240 words per minutes).
2. Close the application and repeat the test step 1 for 5 times.
3. Record the number of successful instances as *M*. The TAR=*M*/5*100%.

Note: Apply the voiceprint to unlock the DUT screen can use the similar test process.

**Expected Result**

The requirement is decided by individuals. The higher the TAR, the better the user experience.

#### 7.4.4.3 The Voiceprint Recognition Accuracy Rate - Speaker Changes the Tone during Speaking

**Description**

To test the voiceprint recognition TAR when the speaker changes the tone during speech.

**Initial configuration**

As per section to test case 7.4.4.2.

**Test Procedure**

1. Unlock the application by saying the specific text that is used for identity verification. During speaking, the speaker should change the tone. For a real person tester, the tester can change the mood from normal to roar, sob, laugh. For an artificial head, change the pronunciation frequency from normal to high pitch or low pitch.
2. Close the application and repeat the test step 1 for 5 times.
3. Record the number of successful instances as *M*. The TAR=*M*/5*100%.

Note: Apply the voiceprint to unlock the DUT screen can use the similar test process.

**Expected Result**

The requirement is decided by individuals. The higher the TAR, the better the user experience.

#### 7.4.4.4 The Voiceprint Recognition Accuracy Rate - Apply external microphone as the acoustic channel

**Description**

To test the voiceprint recognition TAR when applying external microphone to collect the voice. For example, the microphone equipped with the earphone. It is recommended to use the original external microphone sold together with the DUT or supplied by the same manufactory.

**Initial configuration**

As per section to test case 7.4.4.2.

**Test Procedure**

1. Unlock the application by saying the specific text that is used for identity verification.
2. Close the application and repeat the test step 1 for 5 times.
3. Record the number of successful instances as *M*. The TAR=*M*/5*100%.

Note: Apply the voiceprint to unlock the DUT screen can use the similar test process.

**Expected Result**

The requirement is decided by individuals. The higher the TAR, the better the user experience.

#### 7.4.4.5 The Voiceprint Recognition Anti-Spoof Ability- Recorded Fake Voice

**Description**

To test the voiceprint recognition SAR when applying recorded fake voice instead of a real speaker.

**Initial configuration**

As per section to test case 7.4.4.2.

**Test Procedure**

1. Unlock a certain application when applying the recording fake voice and check if the application can be unlocked.
2. Repeat the test step 1 for 5 times and record the number of successful instances as *M*. The SAR=*M*/5*100%.

Note: Apply the voiceprint to unlock the DUT screen can use a similar test process.

**Expected Result**

The requirement is decided by individuals. The lower the SAR, the better the user experience.

## 7.5 Iris Identification

### 7.5.1 The Technical Frame of Iris Identification

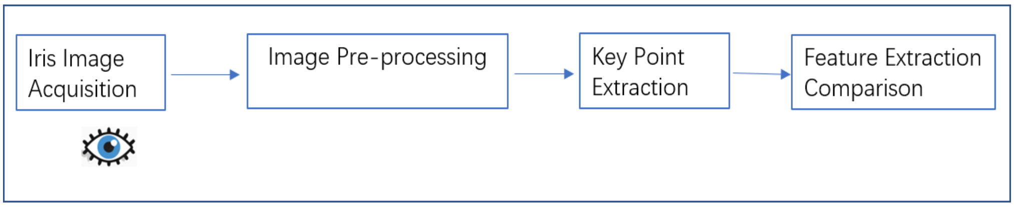



Figure 30

The uniqueness, stability and unchangeable characteristics of human iris can be used as a good basis of identity identification. A Mobile phone extracts the iris feature and applies AI algorithm to compare the identity for users. The process contains these main blocks:

**The iris image acquisition:**

The camera captures the human eyes image and then transmits the data to the image preprocessing part.

**Image preprocessing:**

Iris registration is used to locate the inner ring and outer ring of the iris to the iris region accurately. Adjust the image size, brightness, contrast and smoothness to enhance the iris feature information.

**Key point Extraction:**

AI algorithms are used to extract the iris feature information required for identity recognition.

**Feature Extraction Comparison:** The extracted iris feature is compared with the stored templates in the database, then it determines the similarity and judges the identification result. In the iris recognition scene currently counterfeiting is difficult and costly, so the security of iris identification is very good. However, there are few smartphones supporting this function at present, because the user experience of iris recognition is not as good as the above three kinds of identification. The reason is the iris identification scheme requires that the distance and shooting angle between the mobile phone and the eye should be kept within the specified range (25-30cm, and the camera should be parallel to the eye), when the angle and distance of the user holding the mobile phone deviate from the regulations, the smoothness and delay will affect the user experience. Besides, strong light directly into the eyes or wearing glasses will also affect the iris identification FRR.

### 7.5.2 The Test Environment

The illumination of the background: take reference to 7.2.2.2.
The population samples: take reference to 7.2.2.3.

### 7.5.3 The Device Configuration

The camera function is allowed on DUT. The camera of the DUT is in front of the face.
The iris identification function is turned on. Set the DUT to be unlocked through iris identification.
The distance between DUT and the model is within the required iris recognition distance of DUT.
The test cases are applicable to the terminal device that needs to press the unlock key or power key to perform facial recognition. Not applicable to devices that can recognize iris when the screen is turned off.

### 7.5.4 The Test Cases

#### 7.5.4.1 The Iris Recognition Latency

**Description**

Applying the iris feature to unlock the screen and test the screen unlocking speed.

**Initial configuration**

1. The DUT configuration is the same as defined in section 7.5.3.
2. The camera of the DUT is in front of the face.

**Test Procedure**

1. The DUT screen is placed in the front of the face. Turn on the screen by pressing the unlocking key or power key on DUT. Apply iris recognition to unlock the screen.
2. Check the response of the screen. If the iris recognition is failed then restart this test case from the beginning.
3. Playback the testing process captured by a high-speed camera and analyze frame by frame. Record the moment as *T1* when the finger finishes pressing the unlocking key or power key. Record the moment as *T2* when the screen finishes unlocking.
4. Calculate the voiceprint recognition speed as *t=T2-T1*.
5. Lock and turn off the screen and repeat the test step 1-4 for 5 times and calculate the average recognition speed.

6. Repeat the test step 1-5 using the scenarios 7.2.2.2 and 7.2.2.3 respectively to fulfil different environment scenarios.
7. Similarly, apply these test steps and check the scenario when the model is lying sideways, check the scenario when the DUT is placed on table and model bows the head (as shown in figure 25 and 26).

**Expected Result**

The requirement for recognition latency is decided by individuals. The lower the latency, the better the user experience.

#### 7.5.4.2 Iris Recognition yaw angle sensitivity

**Description**

When there is a yaw angle deviation between the camera on DUT and the model, the DUT can verify the user identity of the iris smoothly.

**Initial configuration**

1. The DUT configuration is the same as defined in section 7.5.3.
2. The direction between the DUT and the facial is shown in the figure 22.

**Test Procedure**

1. Place the DUT in front of the model.
2. Turn on the screen by pressing the unlocking key or power key on the screen or on the side of DUT. Use the iris to unlock the screen. Check if the screen is unlocked.
3. Lock the screen and rotate the DUT along the Y axis 10 degrees in the right direction (As shown in the figure 22). Repeat step 2. Continue to rotate the DUT by further 10 degrees until it fails to unlock. Record the last angel that the DUT is unlocked.
4. Repeat the test step 1-3 using the scenarios 7.2.2.1-7.2.2.3 respectively and get the average angle value.
5. Rotate the DUT along the Y axis 10 degrees in the left direction and repeat the test step 1-4.

**Expected Result**

The requirement for iris recognition yaw angle sensitivity is decided by individuals. The bigger yaw angles the DUT can recognize, the better the user experience.

#### 7.5.4.3 Iris Recognition pitch angle sensitivity

**Description**

When there is a pitch angle deviation between the camera on DUT and the model, the DUT can recognize the iris smoothly.

**Initial configuration**

1. The DUT configuration is the same as defined in section 7.5.3.
2. The direction between the DUT and the facial is shown in the figure 23.

**Test Procedure**

As per section to test case 7.5.4.2. Besides, the rotating direction of DUT is along the x axis.

**Expected Result**

As per section to test case 7.5.4.2.

#### 7.5.4.4 Iris Recognition roll angle sensitivity

**Description**

When there is a roll angle deviation between the camera on DUT and the model, the DUT can recognize the iris smoothly.

**Initial configuration**

1. The DUT configuration is the same as defined in section 7.5.3.
2. The direction between the DUT and the facial is shown in figure 24.

**Test Procedure**

As per section to test case 7.5.4.2. Besides, the rotating direction of DUT is along the z axis.

**Expected Result**

As per section to test case 7.5.4.2.

#### 7.5.4.5 The Iris Recognition FRR – extreme scenarios

**Description**

Applying the iris feature to unlock the screen when users are wearing glasses, sunglasses and test the false rejection rate.

**Initial configuration**

1. The DUT configuration is the same as defined in section 7.5.3.
2. The camera of the DUT is in front of the face.

**Test Procedure**

1. The model is wearing a pair of glasses. The DUT screen is placed in the front of the face. Turn on the screen by pressing the unlocking key or power key on DUT. Apply iris recognition to unlock the screen.
2. Lock the screen and repeat the test step for 5 times. Record the unsuccessful time as *X*. The FRR=*X*/5*100%.
3. Repeat the test steps 1-2 using the scenarios 7.2.2.2 and 7.2.2.3 respectively and get the average value for FRR.
4. Similarly, check if the DUT can recognize the iris successfully when the model is wearing the sunglasses.

**Expected Result**

The requirement for recognition latency is decided by individuals. The lower the FRR, the better the user experience.

# Annex A Additional Considerations for browser performance testing

This document provides test cases to support measuring the performance of web browsers and the user experience of web applications. However, it should be noted that there are numerous limitations affecting the measurement that are beyond the control of the tester.

Those limitations include, but are not limited to:

- Hardware Design Considerations: the hardware platform always plays a key role in improving the browser performance and related user experience, such as processor, memory, GPU, display, etc. Those are variables leading to reasonable variations in the performance and the user experience. It is necessary to understand and assess those variables so that the measurement of performance and the user experience are comparable.
- Web Apps Design: Although a consistent set of webpages and assets are used in the performance and user experience testing, specific design variations such as static vs. responsive page design or combinations of web content (e.g. fixed layout or CSS-driven layout) should be used in designing the tests. Some other factors also affect the performance and measurement, such as:
    - Duplicate Content and Caching Strategy: eliminating duplicate content can effectively improve performance measurement and perceived user experience, thus affect the actual test measurement.
    - Cache Expiration and Cache Control: implementing a full caching mechanism can eliminate unnecessary transactions, reduce the response time and improve the performance and perceived user experience, and thus affect the actual test measurement.
    - Content Pre-fetching: when used properly, pre-fetching the content that the user wants can effectively improve the perceived user experience, and thus affect the actual test measurement.
    - Periodic Transfers and Keep Alive: eliminating unnecessary periodic transfers, and/or using other techniques such as push notifications, HTTP bundling, TCP piggybacking etc. will significantly improve the performance measurement and the user experience, and thus affect the actual test measurement.
    - Multiple, simultaneous TCP connections: opening and closing TCP connection in an efficient way and keeping a persistent TCP connection for multiple usages will improve the performance and perceived user experience, and thus affect the actual test measurement.
- Network and Server Performance: Tests should be executed with ample network bandwidth and server capacity, e.g. by default over WLAN and to servers for which server load and stored are not a test factor.
- OS and Software Platform: multithreading and background workers will impact the performance of the foreground applications and therefore, the OS and platform resources should be dedicated to the test programs and there should no other threads run in parallel except for the browser and the network attenuator tool.

# Annex B The introduction for the APP/APK automatic test scripts

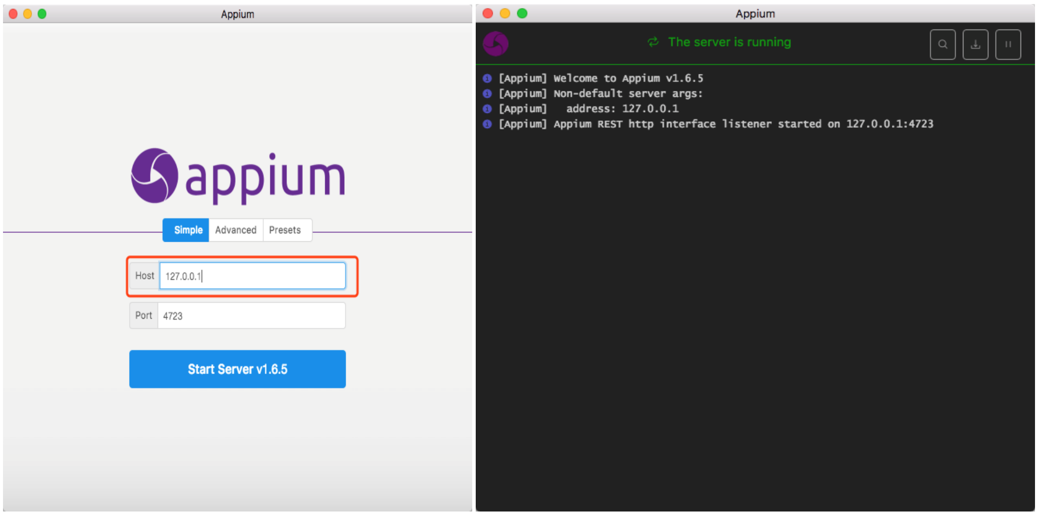
The test script can automatically execute specific APK installation, operation and uninstall in loop. *QQ* and *wechat* are chosen as the APK examples. Tester could also self-define the APKs to be tested and the number of automatic test cycles in the test scripts. Test script modifications are also welcomed. The link: https://github.com/GSMATerminals/Smartphone-Performance-Test-Case-Guideline-Public

- In order to run the automatic tests, “Appium” and “Eclipse” need to be installed on a server.
- Eclipse: Free IDE. It is an open source development platform based on Java. http://www.eclipse.org
- Appium: It is an open source test automation tool to drive iOS, Android, and Windows apps that run automatically on the device. https://github.com/appium/appium

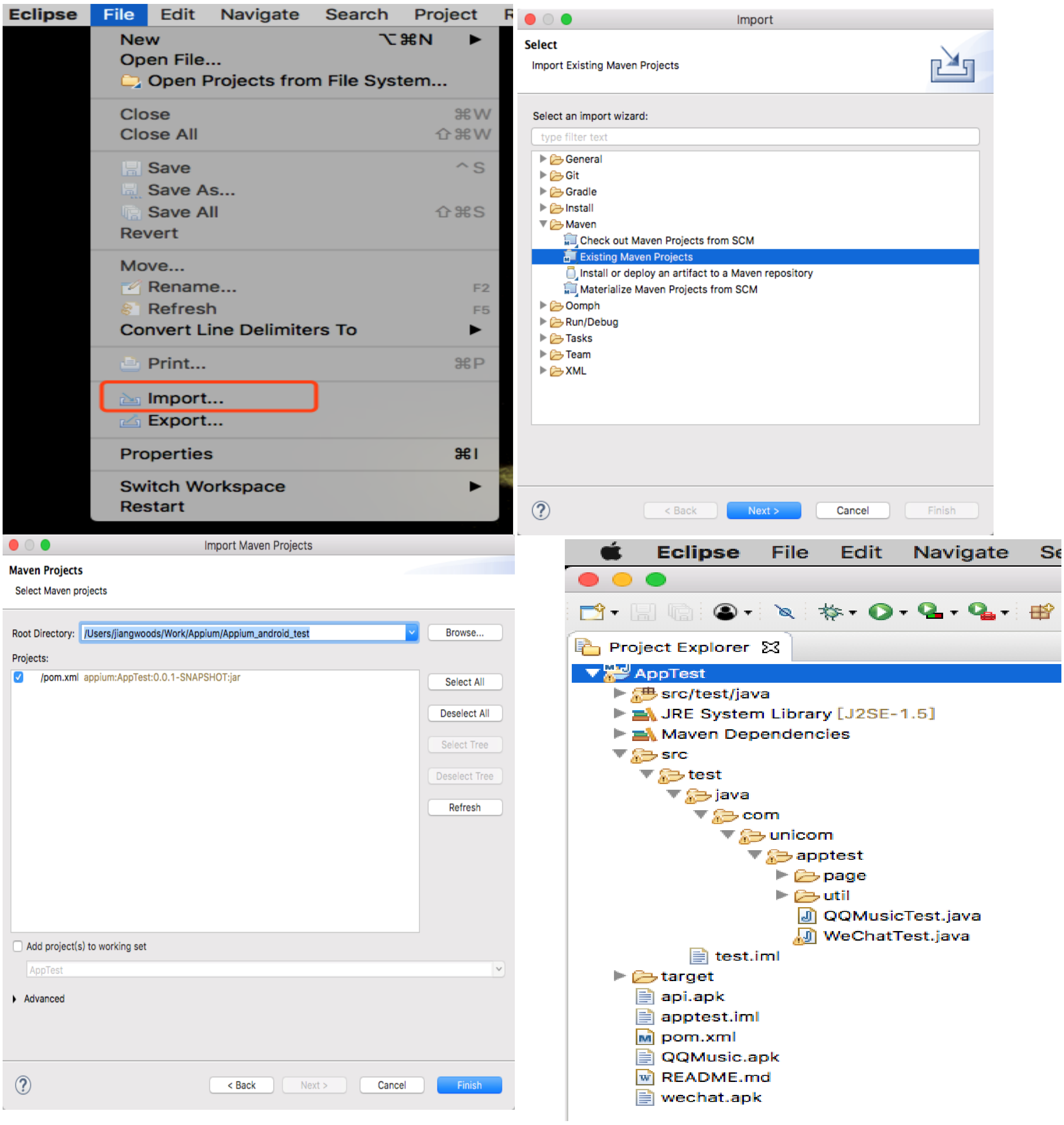
1. Run the automatic test script:

- Start up Appium.

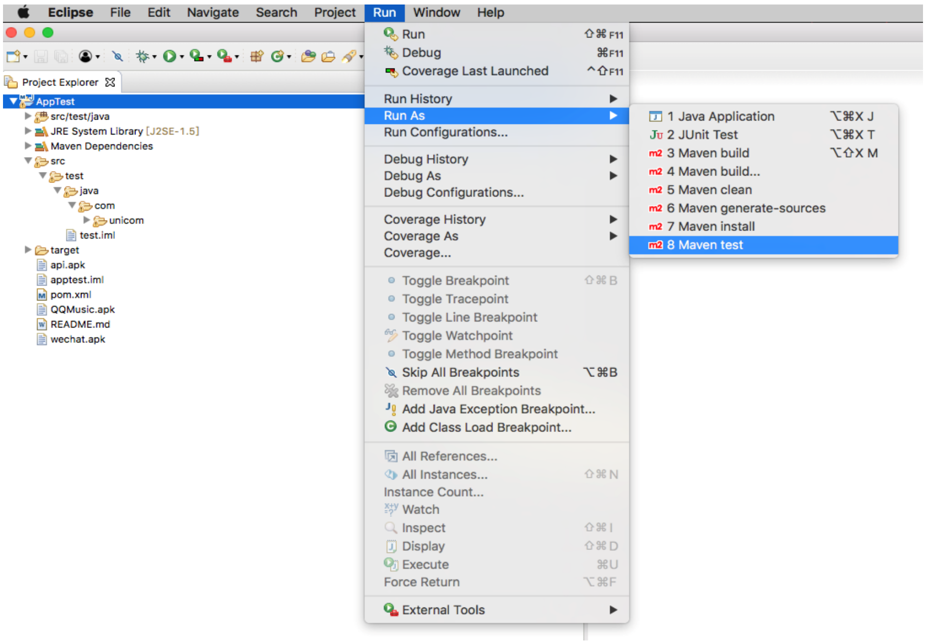
Configure server IP address and port, start the Server and connect server to android DUT. (The DUT needs to open the debug port)




- Start Eclipse, go to File then Import and select the Existing Maven Projects, which is the developed automatic test script.




- Compile and run the Eclipse automatic test scrip. As an example: The DUT will be controlled by the server to automatically install, open and uninstall two specified APKs: QQ and Wechat. Tester could self-define the APKs to be tested and the number of automatic test cycles.




- The device will be controlled to carry out the automatic test; on the server we can check the test log:

# Annex C System stability and system response speed test scripts

Automatic test scripts were proposed to help executing some test cases in the system stability testing and system response speed testing.

The link: https://github.com/GSMATerminals/Smartphone-Performance-Test-Case-Guideline-Public

The “System stability testing” test script can generate an APP that can be installed on android smartphones. The APP can drive the smartphone to automatically start up and exit specified applications and loop execution for 10 times. The APP can also record the times that defects happen during applications start up and exit execution. Email, Browser, Map, Phone are chosen as the application examples. Tester could also self-define the applications to be tested and the number of automatic test loops. The operation guide is in the file “BaseAccessibilityService.java”. The number of loops can be modified in the file “MainActivity.java”.

The “System response testing-single” test script can generate an APP that can be installed on android smartphones. The APP can drive the smartphone to automatically start up and exit specified applications. The applications start up response speed will be recorded. Phone, Message, Camera and Gallery are chosen as the application examples. Tester could also self-define the applications to be executed. The operation guide is in the file “BaseAccessibilityService.java”.

The “System response testing-loop” test script can generate an APP that can be installed on android smartphones. The APP can drive the smartphone to automatically start up and exit specified applications and loop execution for 10 times. The application average starts up response speed will be recorded. Phone, Message, Camera and Gallery are chosen as the application examples. Tester could also self-define the applications to be executed. The operation guide is in the file “BaseAccessibilityService.java”. The number of loops can be modified in the file “MainActivity.java”.

# Annex D Document Management

## D.1 Document History

| Version | Date | Brief Description of Change | Approval Authority | Editor / Company |
|---|---|---|---|---|
| 1.0 | December 2014 | The first version of TS.29 when published, mainly focus on the browser UEX performance test cases. | TSG/PSMC | Xin Wang, China Unicom<br>Bin Hu, AT&T<br>Stephen McCann Blackberry |
| 2.0 | August 2016 | System Response Performance Test Cases added | TSG | Xin Wang, China Unicom<br>Kay Fritz, Vodafone |
| 3.0 | December 2017 | System Stability Test cases added | TSG | Xin Wang, China Unicom<br>Kay Fritz, Vodafone |
| 4.0 | November 2018 | Updated with changes approved in TS.29 CR1005<br>Camera Image Quality Test added | TSG | Xin Wang, China Unicom<br>Kay Fritz, Vodafone |
| 5.0 | July 2019 | Updated with changes approved in TS.29 CR1006<br>Webpage links updated | TSG | Xin Wang, China Unicom<br>Kay Fritz, Vodafone |
| 6.0 | October 2019 | Updated with changes approved in TS.29 CR1007<br>AI speech recognition performance test added | TSG | Xin Wang, China Unicom<br>Kay Fritz, Vodafone<br>Pang Gao Kun Hua Wei |
| 7.0 | December 2021 | Updated with changes approved in TS.29 CR1008<br>AI biometric recognition tests added | TSG#46<br>ISAG#11 | Xin Wang, China Unicom<br>Kay Fritz, Vodafone<br>Di Zhang, China Telecom |

## D.2 Other Information

| Type | Description |
|---|---|
| Document Owner | TSG Working Group |
| Editor/Company | Xin Wang, China Unicom |
| Editor/Company | Bin Hu, ATT |
| Editor/Company | Stephen McCann, Blackberry |
| Editor/Company | Kay Fritz, Vodafone |
| Editor/Company | Pang Gao Kun, Huawei |
| Editor/Company | Di Zhang, China Telecom |

It is our intention to provide a quality product for your use. If you find any errors or omissions, please contact us with your comments. You may notify us at prd@gsma.com

Your comments or suggestions & questions are always welcome.