Electronics

External Audience Protocol (EAP) - Smartphones

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Introduction

The following document presents the protocol for testing and evaluating Smartphones at Consumer Reports. The purpose of this test process is to expose the performance strengths and weaknesses for Smartphones, and to make a final assessment of its overall performance.

A high level description of our test process can be summarized by the following list of attributes:

1. Camera
   i) Rear image quality
   ii) Rear video quality
   iii) Selfie image quality

2. Battery and Charging
3. Performance
4. Durability
5. Display
6. Sound
7. Ease of use
8. Calling
9. Versatility

Description of Test Process

The general information is taken from the delivered or downloaded manuals.

All devices are coded and their IMEI numbers, EAN codes and the following relevant operating system information are recorded:

Operating system name
OS version after initial setup
OS version at the end of testing period
Build number after initial setup
Build number at the end of testing period
Automatic OS updates enabled by default or requested during initial setup
Automatic app updates enabled by default or requested during initial setup
Security Patch date
Security patch data at the end of testing period
1.0 Photo functions and picture quality tests

All evaluations of the picture quality are performed after transferring the photos to a computer. For all tests, the cameras are set to their standard focal length (most of the time wide angle) and to full-automatic mode, including auto exposure, auto white balance and autofocus mode with maximum resolution and image quality setting in JPEG, except where otherwise stated. The test charts are adjusted to fill the full viewfinder of the camera, except for the zoom picture. A tripod is used, if not stated otherwise. The visual evaluation is performed on a high-end computer with a calibrated 24" TFT display.

Sharpness, contrast and color balance (daylight) - TE42 V2 test chart

The picture quality of the cameras is determined by taking a picture of the evaluation test chart. The main measurements are performed by using IQ Analyzer software. The test chart is illuminated by 2 light sources with around 6000 K, the illumination level is about 1500 lux. The measurements deliver information about different parameters such as sharpness, color, luminance, chrominance, hue, shading and distortions.

1.1 Subjective rating - visual appraisal

Additional subjective visual tests with trained testers are done by means of this test chart. The subjective impression of the picture quality for the test chart is rated by 3 trained lab experts. For the visual inspection, all fields of the test chart are evaluated including luminance, contrast, color saturation and definition.

Picture quality (daylight) – Still life (Studio) and Portrait (outdoor)

An indoor set of 6 light sources at 6000K is set up as well as a moving element. Two pictures (HDR turned on and off) are then taken. The distance of the target depends on the focal length and is adjusted to fill the screen with the targets.

Portrait (outdoor light simulation) for normal and Bokeh effect portraits

An outdoor light simulation is set up. These lights illuminate a female natural mannequin, designed for real life scenes in museum settings. If applicable, the face detection mode or HDR (High Dynamic Range) mode is tested. The pictures are taken in front of plants and a background which shows a street scene with chairs and tables in a small alley. To investigate the quality of sharpness functions like Portrait mode, Bokeh mode or Aperture mode an additional test picture with the artificial head and structured background is taken. If possible, the portrait mode is activated and a zoom type is chosen.
External Audience Protocol (EAP) - Smartphones

UTT Test picture (daylight illumination and 4 x zoom)

In another test setup the zoom quality is recorded and evaluated. A picture of the test chart is taken from a distance of 1.5 m between the camera and test chart.

Wide angle quality and suitability for camera and camcorder

The ability and the suitability for the wide-angle lens is tested by using the selfie test setup with its background of a small village for the front camera. The smartphones are adjusted to the widest field of view (wide angle lens if possible). Besides the field of view aspect of the photo sensor, also the maximum range of the digital zoom and the overall quality are evaluated in this setup.

Picture quality in low light conditions without and with flash, if available

The light sensitivity, resolution, noise and sharpness are evaluated by subjective ratings with trained testers. The same still life setup as in the artificial studio light investigations is used, with the lighting set to 10 Lux. The focusing aspects like speed, ringing, stability and sharpness in the monitor and viewfinder are rated by two trained lab experts.

Front camera “Selfie” picture quality – bright and low light

A selfie picture with the front camera is taken. The illumination is 1000 lux with daylight color temperature. We test the capabilities of the front camera in low light conditions with a setting of approximately 10 Lux. A second picture is taken without flash and a third picture is taken with – if available – additional illumination by flash or display.

Measurement of the shutter delay, picture sequence speed, AF speed and start up time

The delay between triggering the shutter and when the picture is measured. The camera is set to automatic mode with an object set at a distance. The shutter of the camera is triggered via a button or touchscreen. In addition, a picture sequence speed measurement in manual single shot mode is made. The minimum time span between two shots in automatic (smart) mode without picture review is measured and given in ms.

Video function

All camera phones with camcorder functionality are tested as video phones.

Video/Camcorder capabilities

The following video/camcorder capabilities are recorded:
Video quality (daylight)

The phone is placed on a tripod and a video scene in studio light conditions is recorded. A dummy torso is permanently turning slowly and the plants move slightly from 2 ventilators. The phone is panning slowly from right to left.

In maximum three recordings are made, if possible:

- Full HD (1080p) with default frame per second rate,
- Full HD with 60 fps
- UHD with best frame rate

The Zoom quality while filming and the selfie camera video recording quality in portrait mode are also assessed.

Test of the image stabilizer for Camera and Camcorder

“Image stabilizers” are quite important for smartphones and help to improve video recordings as well as still pictures.

We check for and test the following:

- Checking the zoom behavior of the EIS
  - Main Camera Video Recording – image stabilizing test with test rig and a mixed tremor signal
  - Selfie front Camera Video Recording - image stabilizing test with test rig and mixed tremor signal with the smartphone’s camcorder mode with IS adjustment(s).
  - Taking Pictures - image stabilizing test with test rig and mixed tremor signal. We take 10 pictures in low light conditions of 10 lux with all IS systems switched on.

Sound quality rating (for video recording)

Classical music, speech and pop music is played back from a high-quality stereo speaker setup in a semi anechoic room while the smartphone records a video at a defined distance.

2.1 Battery

The battery running time is tested with a robot arm. A “typical user day” is defined. The battery is drained with the help of this test cycle until it is completely discharged. The phone is then
fully charged. The test consists of stand-by, internet use, camera use, navigation use, and making a phone call.

Every device is tested with a display brightness setting of 300 nits.

**Charging times**

The charging times are measured in real charging scenarios. The phone is fully discharged then connected to the charger included in the phone’s package. If no charger is provided, we use a 5W charger. The charging indicators (LEDs or battery symbols) are checked every 15 minutes until the device displays that its battery is completely charged. In addition, a short 15 minutes quick charging test is also done using the included charger or 5W charger if none is provided. The charging capacity in percent after 15 min charging time is determined. We then use that percent and the battery rundown time to calculate how much time a 15 minute charge equates to.

**3 Performance**

We run benchmarks to give indications for the processing speed of the phone

A rating for the processing speed for all current operating systems is provided.

**4 Durability**

The durability test consists of three different investigations.

**4.1 Scratch resistance test**

The scratch resistance of the phones’ displays is examined via a hardness test pencil. This pencil is equipped with a spiral spring and a carbide ball tip of 1 mm diameter. The test load of the spring can be adjusted ranging from 0 to 20 N. First, an attempt is made to scratch the display of the phones with five different loads. Afterwards, a rating for the display is generated depending on the maximum load that does not lead to permanent scratches on the device under test. Secondly, the scratch sensitivity of the camera glass is assessed with the same procedure.

**4.2 Shock resistance – Tumble test**

The durability against mechanical shocks (e.g. dropping) is tested with a tumbling barrel with a fall height of 80 cm and a stone surface. The phones are switched on and put into a tumbling drum for 50 rotations, which means 100 drops from 80 cm. They are checked and rated by trained testers for damage after 25 and 50 rotations (equivalent to 50 and 100 drops).

**4.3 Water resistance – Rain test & dunk test (when applicable)**

The mobile phones are switched on and connected to a network. A rain appliance is used to give an even distribution of the rain. The phones lie horizontally on a rotary table and are
irrigated for 5 minutes. The functionality is assessed immediately, after one day, after 2 days and after 3 days. Devices that claim to be waterproof (IPx7-IPx8) are submerged in water to the stated depth and for the stated time (e.g. 1.5 m water tube for 30 minutes) to verify the water resistance. The functionality is assessed immediately, after one day, after 2 days and after 3 days.

5 Display

The display quality is investigated by several measurements and subjective checks:

Display in general

Evaluation of the general display quality under consideration of the following items:

Resolution: Dot trio pitch of the display (dots per inch; 1 inch = 25.4mm)

The dot trio pitch is recorded from the manufacturers’ claims and is checked via a binocular microscope.

Display size

This display size is recorded from the manufacturer’s claims and is checked by measurements. The bigger the display, the more information is visible with the same character size.

Brightness (max value in cd/m²)

This measurement is done with a luminance meter in low light conditions. It quantifies the ability of the display to operate in bright light conditions. For these measurements all display auto-brightness settings are switched off, the manual brightness is set to maximum and the measurement is taken at a distance of 0.6mm, if possible. The phone displays an image with a 100% white picture.

Contrast (ratio of the luminance between the white and the black part of a test picture)

This measurement is done with a luminance meter in low light conditions to find the maximum difference between white and black parts of the display. We use a computer generated test picture with both a 100% white area and 100% black area. The measurement with the luminance meter outputs a maximum and a minimum brightness.

Readability from sides

The readability from the sides is evaluated by trained lab experts with regular display brightness in the camera mode. The same content is evaluated at different angles and positions.

Readability indoors in low light conditions
External Audience Protocol (EAP) - Smartphones

This aspect is evaluated by trained lab experts with regular display brightness.

Readability outdoors with bright sunlight

This aspect is evaluated by trained lab experts with maximum display brightness in sunlit outdoor conditions. There are two other factors evaluated for this score besides readability from the sides. We also look at maximum brightness achievable from the phone and sensitivity for fingerprints.

6 Sound - Sound quality of the music player

The test is conducted using reference high-quality headphones. This test serves as a check for the electrical output (no distortions etc.) and thus is only performed by one lab expert.

Rated sound quality with built-in speakers

The quality of the built-in speakers is determined by measurement. A rating for the quality of the built-in speakers is provided.

Loudness measurement of the speakerphone:

The maximum undistorted loudness in Sone is measured at a distance of 1m in an anechoic room acoustic chamber.

7.0 Ease of Use - User manual

Printed full manual

Manual on CD/DVD

Manual on device (e.g. pdf)

Printed quick start guide

Accordance with the device

Manual only for this device

Manual for more than one device

Number of pages in main language

Table of contents
7.1 Registration process

The setup assistant and any additional registration processes or software installations (e.g. if a special e-mail account has to be set up) are rated by trained lab experts.

7.2 Operation

The handling of the phone is investigated by trained lab experts. Comments on the ratings are noted.

7.3 Menu / Configuration

The ease of changing the ringtone, ring volume, language, and advanced settings like network settings or resetting the device to factory settings are assessed.

7.4 Deactivate data download, WLAN, GPS, roaming

We assess how easy it is to activate flight mode.

7.5 Keyboard, keypad, touch screen

The touch screen is evaluated by trained lab experts considering the design, shape, usability with small and big fingers, blind operation, pressure point and feedback (acoustical or other) of the keyboard. If capable, we assess multi-touch gestures (zoom with 2 fingers), kinetic scrolling, swipe writing, copy and paste functions and using the supplied pen.

7.6 Convenience of Camera and Camcorder and transfer to PC

We use 3 trained lab experts to evaluate adjusting camera settings, taking photos and videos, quickness of auto focus, zooming behavior and if the phone can be used as a barcode scanner.

8 Calling

We evaluate the send and receive sound quality of the phone using the POLQA
standard. We use a base station emulator and a telecom artificial head for these tests. These tests are repeated with and without background noise.

9 Navigation Versatility

It is recorded if the phones support the following satellite systems:

- GPS
- GLONASS
- Galileo
- Beidou

Accuracy of positioning

With each phone the trained lab engineers drive the same test track in order to record the GNSS signals. These signals are afterwards transmitted and evaluated. The evaluated parameters are the accuracy of the recorded tracks, the time behavior (exact position versus displayed position) and the smoothness of the signals especially in areas with tunnels and weak satellite signals. Some phones use additional information from sensors like gyroscopes and compasses to interpolate weak GNSS reception. This is useful for example when driving through tunnels. Without the supporting information the GNSS signal may be recovered too late.

- In the case of Android Maverick and GPS Status are used.

- In case of iOS (Apple) the track analysis of “sports tracker” is used.