Introduction

This document describes the test protocol for evaluating HD (High Definition) and UHD (Ultra High Definition, 4K and 8K) televisions at Consumers Reports (CR). The test process is designed to reveal the performance strengths and weaknesses for each television under test and to make a final assessment of the product’s overall performance.

Summary:

CR’s TV testing covers most brands that are currently available on the market. This includes many model series within the brand and many screen sizes within the series. Each television follows the same test procedure which allows all TVs to be scored and rated on the same scale. The television’s controls are optimized so that they may perform to the best of their ability. Both picture and sound are adjusted via the basic user controls for best performance.

A description of our test categories can be summarized as follows:

- Inventory of features
- Optimizing picture settings
- Motion Blur
- Viewing Angle
- HD, UHD, HDR performance
- Subjective viewing test
- Sound Quality
- Power Consumption
- Data Security and Data Privacy

Inventory of features:

Product specifications are collected, which include: TV connections, features, display capabilities and internet features, among others. These are gathered by inspecting the TV’s on-screen menus, physical cabinet, the user manual, and online data.

Optimizing picture settings:

Using specialized test patterns and videos the TV’s picture settings are fine tuned to optimize image quality for HD and UHD content, including HDR. One or more professionally calibrated televisions are in the test room to provide a picture quality reference for comparison. Picture enhancement modes, noise reduction or other image-related processing are inspected for any negative impact on picture quality and are typically turned off. Optimized picture settings include contrast, black level, color, tint, sharpness, gamma, backlight, motion, and local dimming. This calibration process utilizes the basic user picture
settings and does not include the adjustment of the separate color RGB sub-controls used in a professional calibration. Adjustments are performed separately for both SDR and HDR modes (on TVs that support HDR). On HDR-capable TVs that do not provide independent picture settings for HDR content, the basic HD settings remain the default.

**Motion blur:**

A special test pattern still image is put into horizontal motion. The display is inspected for the degree of blur introduced to various elements within the image, with particular emphasis on the clarity of moving text. If the TV includes a blur reduction feature that is found to be effective, it will be turned on unless this feature also introduces a motion “smoothing effect,” in which case it is left off. Additionally, any blur reduction feature that limits image brightness or introduces flicker will also be turned off. The degree blur is determined by comparing the moving image on the test display to itself while paused vs. in motion, as well as by comparing performance to a reference TV in the test lab.

**Viewing angle:**

The viewing angle test is an assessment of image quality degradation as the viewer moves between the front, head-on view, and to the sides of the display at approximately 45 degrees. Quality is also assessed in the vertical direction, looking up from below the display. During this process a viewing panel observes and scores the visual changes of several picture attributes including: color saturation, depth of black level, contrast, and dimming. This series of evaluations are done twice: with a bright still image, and a dark still image.

**HD, UHD, HDR performance tests**

HD and UHD picture quality is tested using native HD and 4K video content, photos, and test patterns to confirm the display is able to deliver performance to the respective format's full potential. We check the TV's ability to reproduce 4K image detail as well as its ability to deliver high dynamic range (HDR) effectively. Image quality is tested using a 4K Bluray player connected to the TV's HDMI input, as well as from files stored on flash drive plugged into the TV's USB port. We also check how well the TV can upscale HD movies to the display's higher UHD resolution while keeping artifacts such as “jaggies” along the edges of content to a minimum. The best UHD TVs, and HDTVs, present high fidelity images that reveal the full quality of the best source content without degradation.

**CR's picture quality test expectations:**

- The display device shall present images with maximum fidelity and transparency to the source input video signal and reproduce the full image detail supported by its native resolution.

- When set to its optimized settings, the TV shall neither diminish nor enhance an image characteristic with added image processing (i.e. over-sharpening, noise reduction, etc.) Any processing that degrades
fidelity is minimized or turned off.

- The display shall reproduce a gray scale that reveals levels from black to white, with no clipping or compression of near-black or near-white levels, and with no false contouring (banding) effects.

- The black level reproduced by the display shall be at true black (i.e. at a luminance level comparable with the current state-of-the-art such as OLED), and will not change with a varying average picture level. Any LCD-related local dimming side-effects such as halos and uneven illumination are noted.

- Colors are adjusted to proper saturation and hue consistent with CIE standards (adjusted to match our lab reference televisions), and have sufficient bit resolution to avoid quantization effects.

- Color temperature shall be set as close to D65 as possible.

- For HDR content, the display shall deliver the high peak brightness required by our test HDR content, while maintaining sufficient brightness on mid and lower-tones. The display should deliver wide color and support 10 bit processing. The TV should support an alternate set of picture settings in HDR mode that allow for the independent optimization of HDR content.

**Subjective viewing tests:**

Following the technical test pattern-based tests and meter measurements, UHD and HD picture quality is evaluated using “real world” high quality videos from a Blu-ray disc. The group of test video sequences include a bright scene, a mid-tone scene, and a dark scene, each revealing particular aspects of the display’s performance capabilities. The picture attributes inspected include: image detail, black level, color accuracy, contrast, and any image degradation due to image processing that can’t be turned off. A viewing panel will assess the performance of the display for each of the test images and assign an overall picture score.

**Sound quality:**

Each TV is evaluated for sound quality through its built-in speakers. A pink noise audio signal is played through the speakers as readings are taken from a sound meter that’s positioned in front of the TV at a fixed distance. The audio equalizer controls found in the TV’s menu (if available) are optimized for a flat frequency response and a nominal listening level of 70dbSPL. Special sound or dialog enhancement modes are avoided or turned off in favor of basic stereo reproduction. Specially selected sound clips from music and movie soundtracks are used to reveal attributes such as clarity of dialog, depth of bass, treble extension, and openness. Other tested attributes include volume range, audible distortion at high volume, and cabinet resonance. Sound quality is compared to that of several reference TVs of varying quality that are present in the lab, and each attribute is given a subjective score. The listening panel then assigns an overall sound score.
Power consumption:

With the TV adjusted to its final picture settings, power consumption is measured in both standby and power ‘on’ modes. In each case the power is averaged over a period of 10 minutes. In the ON power test, the TV is displaying video from a DVD (IEC 62087 International Standard DVD).

Data Security and Data Privacy:

Data security is a measure of how well the device and its service provider protects your data with respect to authentication, encryption, software updates, resistance to known exploits, etc., based on inspection of device features and analysis of network traffic, penetration testing, and publicly-available documentation.

Data privacy is a measure of how the device and its service provider collects, shares, and uses your data, and the user’s ability to control the flow of their data. Analysis is based on (but not limited to) an evaluation of user interfaces and publicly-available material.

Predicted reliability and Owner satisfaction:

These data are provided by the CR Survey Research Department, at the brand-level, updated typically once per year, and following robust surveying and analysis methods.

Predicted brand reliability scores are based on estimated problem rates for newly purchased TVs, not under service contract, within the first five years of ownership.

Owner satisfaction scores are based on the proportion of members who are extremely likely to recommend their TV brand to their friends and family.

About CR’s test infrastructure

The TV test environment at CR consists of three test laboratories. Each lab includes a 4K/HDR-capable HDMI video distribution system that supports the simultaneous viewing of multiple displays. The video signal paths are periodically checked to ensure that each TV receives the highest quality video. Source video includes custom test patterns, online streaming, consumer hardware (i.e. HD/UHD Blu-ray), and programming from cable and terrestrial broadcasts. At least one fully calibrated Ultra HD TV is present in each of the test labs during testing and serves as the reference for various aspects of image quality. For HDR testing, the source video player is connected directly to the TV under test.