

Pacific Crest Labs TV Test Kit Manual

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2 Revision History

v9 – Gregg Hardy, 11/14/20	Major edits
V10 – Ben Hardy, 11/15/20	Mostly Minor Edits, Clean up section 6 Test Kit Operation
v12-Gregg Hardy, 11/16/20	Replaced equipment tables and made minor edits.
V13 – Ben Hardy, 11/18/20	Added table of contents for tables. Laptop password included. Rough additions to 6.2 Error Mitigation.
V14 – Gregg Hardy, 11/19/20	Disable local dimming during CCF. Discussion about how to confirm settings in each PPS. Added error code troubleshooting section Updated risk mitigation section.

3 Introduction

3.1 Purpose and Scope

This manual provides an overview of test kit contents, guidance on set-up, and operational instructions targeted at two emerging policy initiatives ([ENERGY STAR® v9](#) and a [potential U.S. Voluntary Agreement](#)). The manual is intended for use in first-time set-up and operation and as a reference for future use. The Appendices provide useful checklists for use in everyday testing.

The manual also provides links to the companion videos listed below. Some readers may find it helpful to watch the tutorials before reading the manual. We also provide links to the tutorials in the relevant sections of the document.

Table 1: Video Resources

Video Tutorials	Length
Set-up	01:03:05
Operation	00:24:01

Definitions for terms and acronyms used in this document can be found in draft CTA-2037-C.

Note: We continue to refine the test kit and method. The above videos and the photos throughout the manual were taken at a time when the camera distance from the TV was 1x screen diagonal and a crosshairs clip was used. We have since shifted viewing distance to 1.76-1.78 x the screen width and replaced the crosshairs clip with the Focus.mp4 clip. Furthermore, most of the photos in this manual were taken in a well-lit studio that does not represent realistic test room ambient light conditions.



We will update the manual after the test kit evaluation period.

3.2 Test System Software Overview

The PCL Test System Software is designed to simplify the testing process for the tester. When used with the PCL Test Kit it connects with the Basler camera and Wattman power meter to log 1 second power and luminance data. If also using the optional automation package, the Test System Software will provide prompts to guide the tester at each stage of the test, compile all 1 second data, and generate full reports with graphical displays of the data collected. The Test System Software is currently equipped to run tests according to current drafts of both the ENERGY STAR and Alternative (Voluntary Agreement) test methods.

3.3 Camera Technical Information

The technical details of the camera photometer testing method utilized by the PCL Test Kit are thoroughly documented in the NEEA Method for Measuring Screen-Average Dynamic Luminance with a Camera Photometer. This document explains the hardware’s technical capabilities, the image processing techniques employed, and the calibration procedures used.

4 Test Kit Equipment

4.1 Contents of test kit

The following is the list of hardware included in the PCL Test Kit.

Table 2: PCL Test Kit Contents

Equipment	Features	Photos
Camera Photometer	<ul style="list-style-type: none"> • Locked aperture • Annual calibration • Includes ND and photopic filters • Includes lens cap • Requires PoE injector (below) • Requires laptop (below) • Meets CTA-2037-C Draft v4 section 7.1.5 	
Power Meter	<ul style="list-style-type: none"> • Includes data cable • Includes USB extension cable • Includes calibration certificate • Meets CTA-2037-C Draft v4 section 7.1.2 	

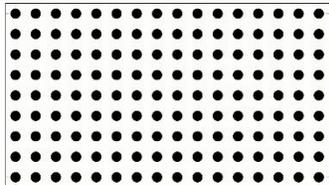


Power over Ethernet (PoE) Injector	<ul style="list-style-type: none"> • Includes 2 ethernet cables • Includes external power adapter 	
Laptop	<ul style="list-style-type: none"> • Includes PCL TV Test System Software • Includes camera calibration files • Includes external power supply • Sized to support camera performance requirements (minimum of i5 or equivalent, 8G memory, 256GB storage) • Password set to: pacificcrestlabs 	
USB Drive with Test Clips	<ul style="list-style-type: none"> • Includes video clips specified in section 4.1.1. • Meets CTA-2037-C Draft v4 section 7.1.6 	
Plug Strip	<ul style="list-style-type: none"> • Used to split power from power source to camera, TV, and ABC lamp. 	

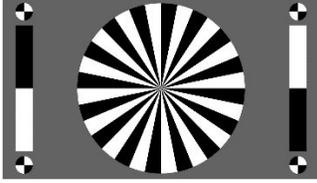
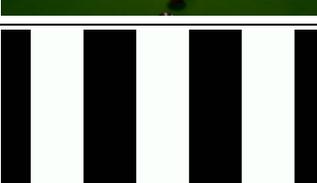
4.1.1 Video Clip List

The following is a list of clips used in test set up and execution that are included in the test kit.

Table 3: Video Clip List

Name Description	Thumbnail
<p>Dots.mp4 10 min of SDR dot pattern used to identify TV screen area and perform camera photometer geometry correction</p>	



<p>Focus.mp4 3 min of SDR focus pattern used to align and focus camera photometer</p>	
<p>Circle.mp4 10 min of SDR circle pattern used to take screen-center spot photometer readings</p>	
<p>CCF.mp4 Nine, 35-second, SDR, greyscale patterns used to measure the color correction factor (CCF) per TV</p>	
<p>Lum.mp4 90 sec of SDR 100% white pattern used for measuring each TV's luminance profile</p>	
<p>IEC_Broadcast_HD_5994p_SDR_HEVC_AAC.mp4 [Use RR_Broadcast_SDR.mp4 for round robin tests] 3 sec IEC banner, 10 sec countdown timer, 5 min test video, and 5 min 50% greyscale pattern used for measuring SDR power and luminance</p>	
<p>IEC_Broadcast_HD_5994p_HDR10_HEVC_AAC.mp4 [Use RR_Broadcast_HDR10.mp4 for round robin tests] 3 sec IEC banner, 10 sec countdown timer, 5 min test video, and 5 min 50% greyscale pattern used for measuring HDR10 power and luminance</p>	
<p>IEC_ThreeBar_HD_5994p_SDR_HEVC_AC-3.mp4 [Use RR_Threebar-HD.mp4] 10 sec of black followed by 3 min of 3-bar pattern used only to identify the brightest preset picture setting</p>	

Note:

For early stage **round robin** testing use different dynamic video clips as noted **in green** above. These will be stored in a separate folder labelled “Round Robin Test Clips” on the USB drive containing the above clip list.

For SD TVs only, use SD versions of the above test clips, provided in a separate folder on the thumb drive. [Not all of these have been created yet.]

4.2 Other Required Equipment

The following table lists the other equipment, not included in the test kit, that a lab must procure separately to conduct testing per CTA-2037-C. This table also lists the specific requirements for this equipment. Some of these requirements exceed those listed in IEC 62087:2015.

Table 4: Additional Equipment

Equipment	Spec Requirements
AC Power Source	CTA-2037-C Draft v4 section 7.1.1
Power Meter	CTA-2037-C Draft v4 section 7.1.2
Spot Photometer	CTA-2037-C Draft v4 section 7.1.3
Illuminance Photometer	CTA-2037-C Draft v4 section 7.1.4
ABC Light Source and Dimmer Switch	CTA-2037-C Draft v4 section 7.1.8
Reflective Card	CTA-2037-C Draft v4 section 7.1.9
Black Cloth Table Covering	CTA-2037-C Draft v4 section 7.1.9
Camera Stands/Tripods used for Camera Photometer, Spot Photometer and ABC Lamp	NA
Lamp Mounting Hardware	
String and Tape for positioning illuminance photometer	

For the ABC Light Source and Dimmer Switch PCL provides the following recommendations.

Table 5: Light Source Recommendations

Brand	Model	Dimmer	CCT(K)	CRI	Diameter	Beam Angle (degrees)	Nominal Rated Lumens
Philips	10PAR30L/LED/827/F40/DIM/ULW/120V	Lutron MACL-153M	2700	80	95	40	800
GE Lightin	LED12DP30RW82740	Lutron MACL-153M	2700	83	95	40	1000
Satco	S9415	Leviton DSL06-1LZ, Lutron MACL-153M	2700	82	95	40	850

5 Test Kit Set-up

The following section deals with the physical setup of lab equipment and device configuration within the PCL Test System Software. This will be split into two parts, starting with ABC set-up since it is a superset of non-ABC set-up.



5.1.2 Room Conditions

1. Ensure that the test room temperature is maintained at $23^{\circ}\text{C} \pm 5^{\circ}\text{C}$ according to IEC 62087-1:2015 section 5.1.2.
2. Maintain the ambient relative humidity between 10 and 80 percent per the Federal Test Method (10 CFR 430, Subpart B, Appendix H) Section 4.2.
3. Mitigate ambient light by covering windows, closing doors, dimming computer screens and covering any other additional sources of light. According to NEEA Test Method Input v5 section when determining On mode power and Dynamic Luminance for all televisions sets, ≤ 1 lx shall be confirmed at the surface of the ABC sensor assembly (or center of the bottom bezel for TVs without an ABC sensor) with the light sources off and the TV in the Off or Disconnected mode.
4. A dark room and/or shroud may be necessary to achieve the required ambient light conditions.
5. Set AC power source to 115V at 60Hz per the Federal Test Method¹.
6. Cover the testing table with a non-reflective black cloth.

5.1.3 TV & Power Meter Setup

1. Plug the power meter into the AC power source. Afterwards, plug the TV into the power meter and connect the power meter data cable to the laptop (Figure 3:).
2. If the TV has not been used previously (i.e. out-of-box condition) proceed through the forced menus and set-up the TV for home viewing per the Federal Test Method. If the TV is not in its out-of-box configuration, factory reset it first then configure for home viewing prior to testing.
3. Connect the TV to the internet and ensure that the TV's firmware is up to date per CTA-2037-C section 8.8.2.1.
4. When not using the TV for other steps in the setup process (i.e playing the Focus.mp4 clip), we recommend repeatedly playing the 10-minute IEC_Broadcast_HD_5994p_SDR_HEVC_AAC.mp4 dynamic video clip to warm up the UUT until the start of testing.

¹ For North America policy initiatives.



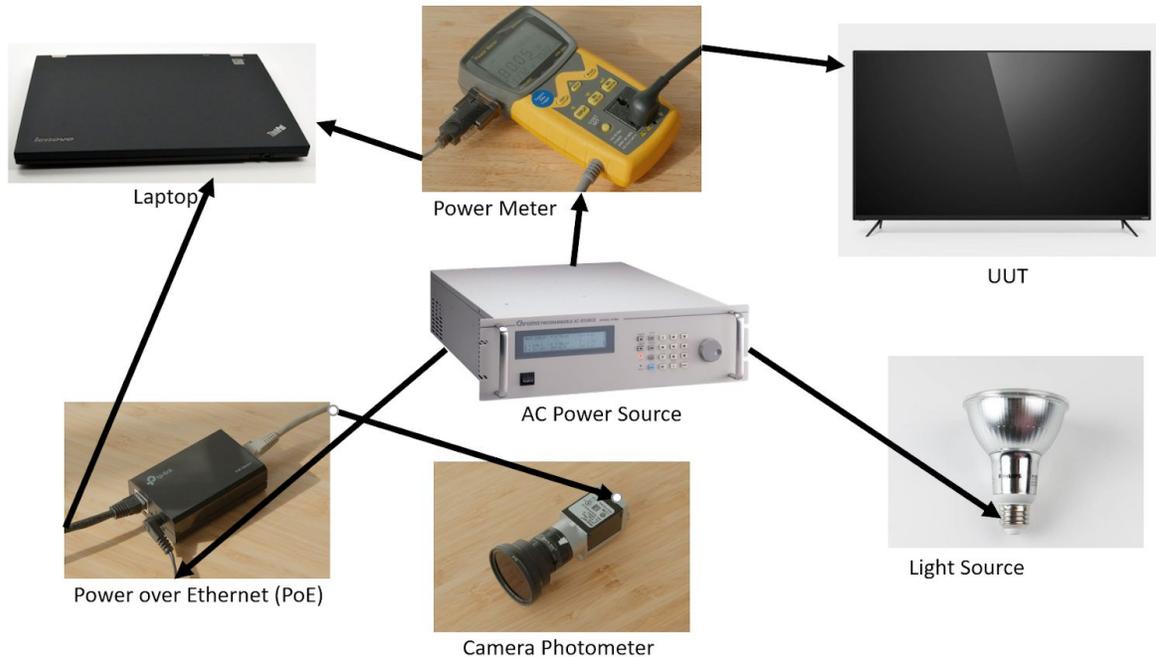


Figure 3: Equipment Connection Diagram

5.1.4 Test System Software

5.1.4.1 Pre-Test Menu

Upon opening the Test System Software², the tester will view the Pre-Test Menu. In the top left corner of the menu is the User Mode drop down field which allows the tester to switch between the two automated test modes (ENERGY STAR and Alternative/VA) and the manual mode. The manual mode enables the tester to identify the boarder of the TV screen in the camera field of view, calibrate the camera luminance, and record power and luminance at one second intervals indefinitely. It does not guide the tester through the test process or generate reports as the automated modes do. The Manual Pre-Test Menu (Figure 4) requires the tester to input the make, model, manual test sequence (see Appendix B: Basic Manual Test Sequence), and data output folders. To proceed with testing, fill in the TV Metadata and Test Configuration fields and press confirm to enter the Testing Display (Figure 5).

² TV Test System Software has a shortcut located on the desktop of the kit laptop.

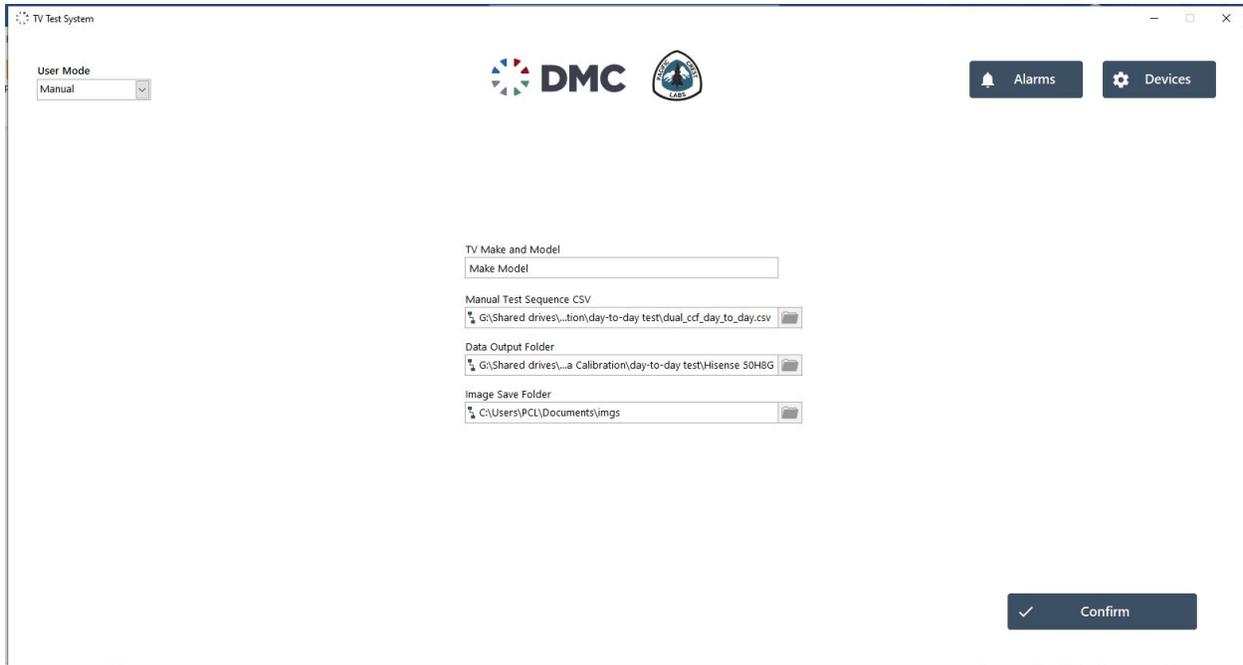


Figure 4: Manual Pre-Test Menu

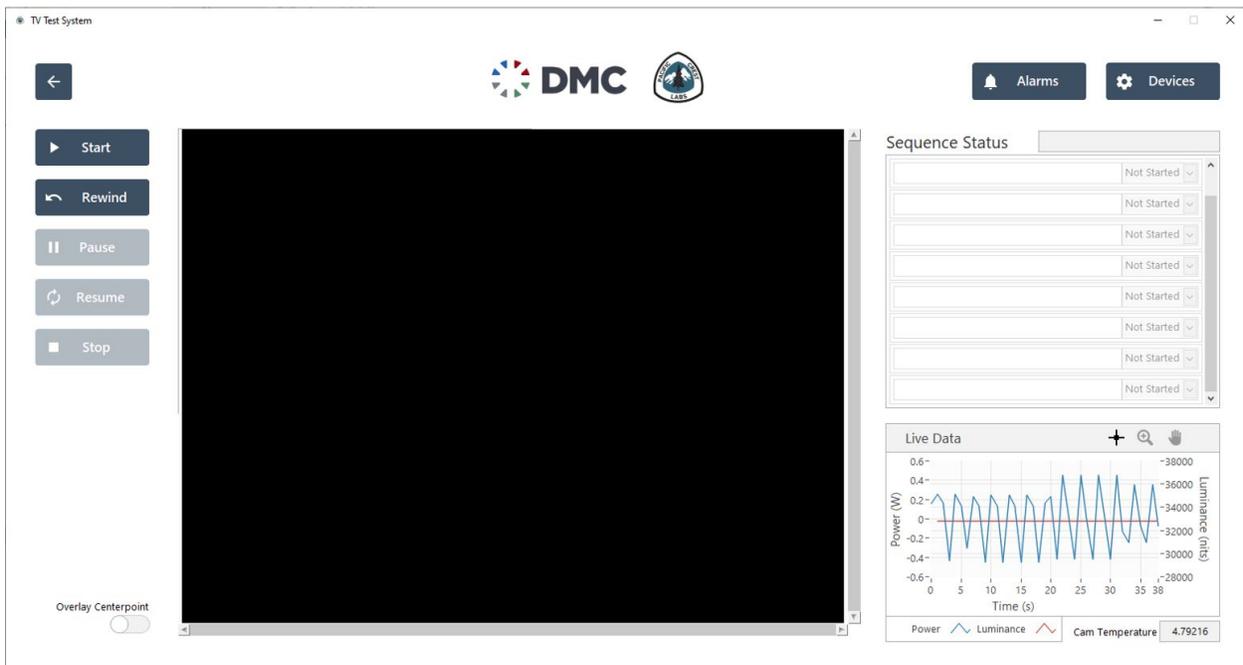


Figure 5: Testing Display

For the automated modes, the Pre-Test Menu for the ENERGY STAR (Figure 6) and Alternative/VA (Figure 7) tests provide fields for the tester to input TV Metadata (e.g. screen size, serial number, etc.) and configure the test settings (e.g. ABC, MDD). Prior to running the ENERGY STAR or Alternative/VA tests the tester must determine the default SDR and HDR PPS, brightest SDR PPS, TV waketime, and



whether the TV has a QuickStart setting enabled by default. Refer to CTA-2037-C Draft v3 sections 8.8.2.2 and 8.8.2.3 for procedures to determine the above settings.

The screenshot shows the 'TV Test System' window with the following details:

- User Mode:** ENERGY STAR
- TV Metadata:**
 - Tester Name: xxx
 - Lab Name: xxx
 - Lab Address: xxx
 - TV Make: xxx
 - TV Model: xxx
 - Model Year: 2020
 - Serial Number: xxx
 - Software Version: xxx
 - Manufacture Month: January
 - Manufacture Year: 2020
 - Screen Diagonal (in.): 55
 - Screen Area (sq. in.): 55
 - Pixel Rows: 55
 - Pixel Columns: 55
 - Technology Type: OLED
 - Humidity (%): 0
 - Temperature (°C): 26
- Test Configuration:**
 - Include HDR Testing:
 - Default SDR PPS: Standard
 - Brightest SDR PPS: Vivid
 - Default HDR PPS: Standard
 - Quickstart On by Default:
 - Wake Time (sec): 5
 - Data Output Folder: [Browse]
 - Image Save Folder: [Browse]
- Buttons:** Alarms, Devices, Confirm

Figure 6: ENERGY STAR Pre-Test Menu

The screenshot shows the 'TV Test System' window with the following details:

- User Mode:** Alternative
- TV Metadata:** (Same as Figure 6)
- Test Configuration:**
 - Include HDR Testing:
 - Include ABC Testing:
 - Default SDR PPS: Standard
 - Brightest SDR PPS: Vivid
 - Default HDR PPS: Standard
 - Quickstart On by Default:
 - Wake Time (sec): 5
 - Data Output Folder: [Browse]
 - Image Save Folder: [Browse]
- Buttons:** Alarms, Devices, Confirm

Figure 7: Alternative (VA) Pre-Test Menu



Within the Test Configuration fields, the Test System Software will come with default Data Output and Image Save folders. The default Data Output folder will be “C:\Users\PCL\Desktop\TV Test Data”, and the default Image Save folder will be “C:\Users\PCL\Desktop\TV Test Photos”. We recommend using these default locations to streamline any troubleshooting engagement with PCL.

NOTES:

HDR10 PPS Settings: It can be difficult to determine information about the default HDR10 PPS. Typically, the only way to put a TV into an HDR10 PPS is to play HDR10 content. However, on some TVs if one navigates to the settings menu from the USB clip player, it will shut down the USB clip player, presumably returning the TV to SDR settings. For cases like these, please consult the manual or manufacturer tech support to understand what features are enabled in the HDR10 PPS.

Make best attempts when testing to ensure that the TV is in fact in an HDR10 PPS. Some TVs temporarily show an HDR badge on the screen when playing HDR content. Others will indicate HDR in the PPS title. Others will indicate ST2084 as the gamma curve or EOTF in the advanced picture settings. The product manual and/or technical support may also be helpful. If one cannot confirm that the TV is in HDR10 mode when playing the HDR10 test clip, then conduct the test with the HDR10 clip anyway starting from the default SDR PPS.

Basler Photo Archiving: To ensure test stability we require that Basler photos be saved directly to the local hard drive or to a USB 3.0 thumb drive during testing. However, to maintain at least 50GB local hard drive storage space and keep an archive of test photos it is usually necessary to move locally stored photos to external storage each night after testing. This can be either cloud storage or an external hard drive array. We suggest using a RAID for backup. If using a cloud storage service, it is recommended that services with a file count limit (e.g. Google Drive) are avoided, as this file cap will be hit long before the data cap. We found other services extremely slow due to the file count.

5.1.4.2 Device Configuration within TV Test Kit Software

The device configuration can be accessed prior to or after selecting a test and entering the pre-test information via the Devices button in the top right corner of the software window (Figure 8: Left). In the Devices menu on the left-hand side you can select to configure the camera and power meter or explore the advanced settings³ (Figure 8: Right). Device Configuration settings are saved between tests runs, but it is recommended to double check them before each test.

³ This manual will not deal with the advanced settings as they are not utilized in the current version of the test kit.



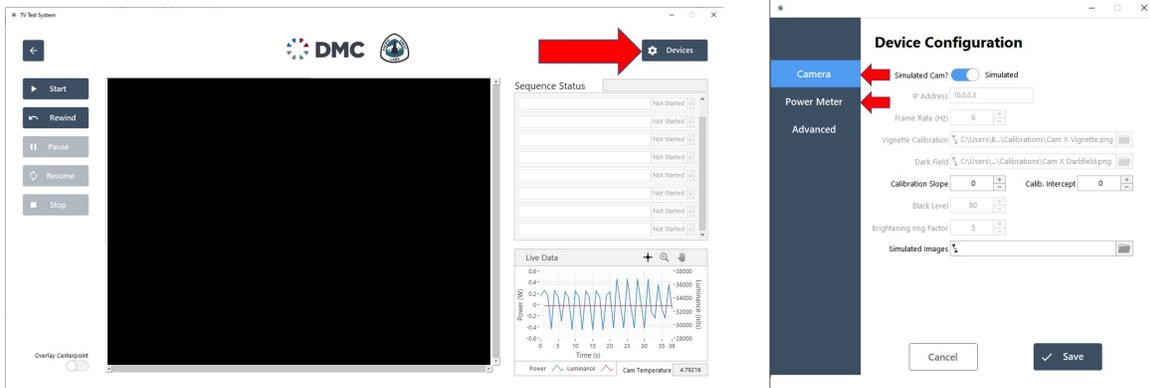


Figure 8: Devices button location (Left) Device Config Menu (Right)

Camera:

When reading the bulleted list of configuration settings below please refer to Figure 9: Camera Config Menu **Error! Reference source not found.** for clarification on the location of each field within the Camera Device Configuration screen. Fields in Figure 9 are numbered such that field 1 corresponds to step 1, field 2 to step 2, field 3 to step 3 etc..

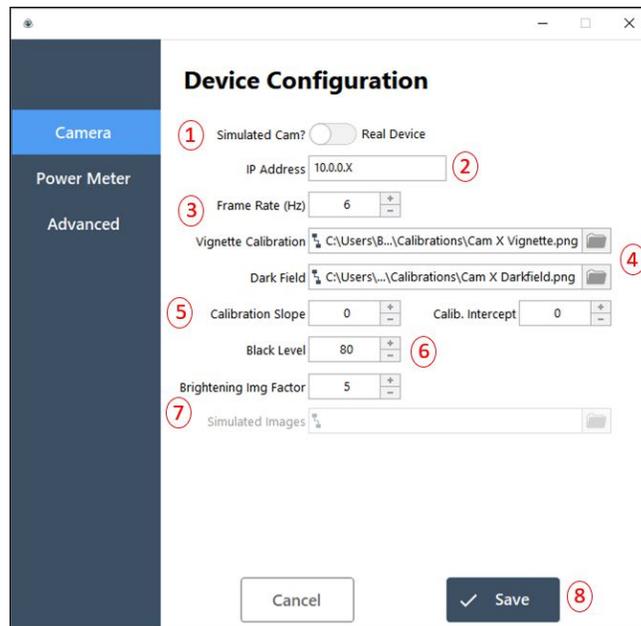


Figure 9: Camera Config Menu

1. Toggle the “Simulated Cam?” setting to “Real Device” as shown above.
2. Enter the static IP address provided with the Basler camera. This will be on the side of the camera housing in black ink.
3. Ensure the frame rate is set to 6Hz.



4. Select the vignette and darkfield calibrations associated with the camera.⁴
5. Ensure the calibration slope is set to 1 and intercept is set to 0.⁵
6. Ensure Black Level is set to 80.⁶
7. Choose a brightening image factor. This only affects the camera display visible during testing and does not affect the data collected. We recommend setting this to be within the range of 5-10, but this can be set as low or as high as the tester wants. This setting can easily be changed if you decide the camera feed is too bright or too dark. PCL recommends adjusting this setting while the camera is viewing the TV with the focus.mp4 clip playing.
8. Save the settings configuration.

Power Meter:

Similar to the camera configuration, the fields in Figure 10 are associated with each numbered step in the bulleted list below for power meter configuration.

Figure 10: Power Meter Config Menu

1. Toggle the “Simulate?” setting to “Real Device” as shown above.

⁴ These calibration files are stored by default in a new Test Kit’s laptop in a “Camera Calibrations” folder on the Desktop.

⁵ The calibration slope and intercept values are tools we have included in the system based on the potential for future use. However, within the current test method and PCL Test Kit the camera is calibrated through in-house vignette and brightness calibrations as well as the CCF portion of the test.

⁶ All internal calculations on the camera data are done assuming Black Level is set to 80, this field will be removed in a future update to the software.



2. In the Serial Com Port drop-down menu refresh the options and then select from the available com ports. There is usually only one option. If there are multiple available com ports and the selection of one triggers an error when testing, switch to another available com port.
3. Ensure calibration slope is set to 1 and intercept set to 0⁷.
4. Save the settings configuration.

Note:

The bus protocol and baud rate are set by PCL staff prior to shipment. There are no settings accessed through the Wattman itself that need to be adjusted when using a PCL Kit Wattman power meter.

5.1.5 Camera Photometer Placement

After finishing the Device Configuration within TV Test Kit Software, use the camera feed visible within the Test System Software Testing Display for the following placement procedure.



Figure 11: Labelled Camera

1. Play the Focus.mp4 clip and place the Basler camera such that the field of view (FOV) is roughly centered on the center of the TV. Measuring perpendicularly to the plane of the screen adjust the distance of the camera from the screen so that the sensor marker is at a distance of 1.76-1.78 x the width of the TV screen (Figure 12). The width of the TV screen as seen in the LabVIEW viewing window should almost fill the width of the Basler camera FOV at this distance; it is useful to check this before testing.

⁷ All Wattman power meters included in PCL Test Kits come with a valid calibration. While this calibration is valid there is no need to alter the calibration slope or intercept.



Figure 12: Setting camera distance at $1.76-1.78 \times$ the width of a 43" TV screen (reference for alignment of tape measure with sensor marker)

- Center the camera sensor on the screen by measuring the distance from the sensor marker to both the upper left and upper right corners of the TV (Figure 13). Ensure that these distances are within .25 inches of each other.



Figure 13: Centering the Camera

- Toggle on the Overlay Centerpoint setting for camera feed in the TV Test System Software (Figure 14). Center the Basler field of view using the Focus.mp4 clip through final adjustments to camera height and rotation (do not shift the camera stand left/right or front/back).
- On the camera lens there are two thumbscrews locking the focus and aperture settings. The focus is controlled by the thumbscrew and adjustable ring closest to the lens cap (Figure 11). Use the TV Test System camera feed to focus the camera on the Focus.mp4 clip. Whether it is in focus or not is up to the tester's best judgement. We recommend starting with the camera not in focus and then focusing from there.

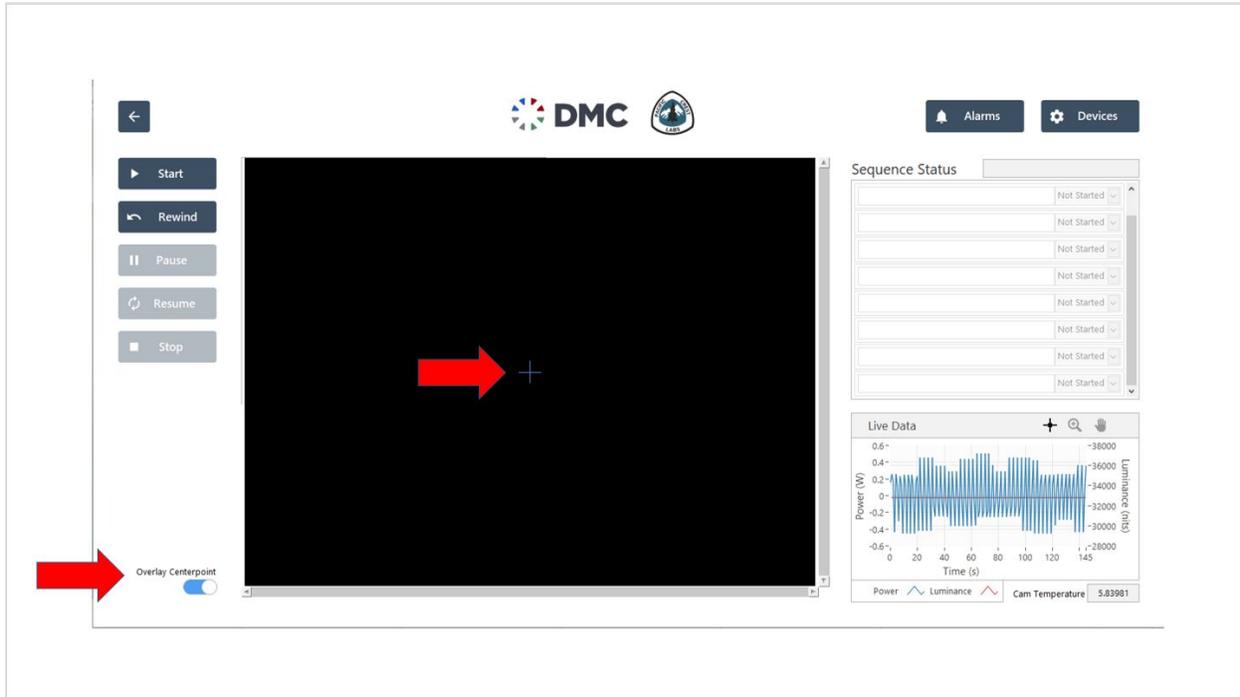


Figure 14: Testing Display with Overlay Centerpoint toggled ON (Screenshot taken prior to displaying Focus.mp4)

5.1.6 Light Source Setup

1. Place the reflective card under the TV stand and centered left/right on the ABC sensor and flush with the front of the table. In order to keep the reflective flat PCL recommends mounting the card on a thin sheet of metal to keep it flat on the table.



Figure 15: Mounting the card reflective card will reduce curling at the edges as shown with the unmounted card above.

2. Align the light source according to the ABC test diagram (Figure 1). This requires the following:
 - The lamp be centered in front of and directed at the section of the bezel closest to the ABC sensor +/- 10cm in any direction orthogonal to the light beam.
 - Placed >1.42m +/- 5cm back and above the ABC sensor with a 45° angle between the light beam and the vertical axis.

- Warm up the lamp by setting to maximum output for 10 minutes prior to the start of ABC testing.
- We recommend setting up the light source such that the dimmer switch is close enough to the illuminance photometer that the illuminance photometer display is visible when adjusting the ambient light down to 3lux

Note: ABC light Source Angle

For year one testing we propose with VA participant agreement that, within the 30°-60° ABC light source angle range specified by the NEEA Test Method, a 45° angle be used across all TVs for ABC testing.

5.1.7 Illuminance photometer Setup

The below process is the PCL suggestion for easy placement and removal of the illuminance photometer when determining lux levels during ABC testing.

1. Position the Illuminance photometer so that the center of the Illuminance photometer is flush with the plane of the TV and centered on the front of the section of the bottom bezel closest to the ABC sensor.



Figure 16: Illuminance photometer sensor centered on a centrally located ABC sensor

2. Take note of the illuminance photometer sensor location, measuring from the center of the sensor to the right and top edge of the screen providing an (x,y) coordinate relative to the top right corner of the TV. This is to allow other labs to replicate test conditions.
3. To remove and re-position the Illuminance photometer in the exact same location. PCL recommends tying a string securely to the Illuminance photometer on one end and then hanging the meter from the top bezel of TV so that the illuminance photometer sensor covers the ambient light sensor. Felt padding or other soft material on the back of the illuminance photometer reduces the risk of scratching the TV surface (Figure 17).



Figure 17: Soft covering on the illuminance photometer to protect the TV screen

4. Once the Illuminance photometer is in the desired location, use masking tape to secure the string against the back side of the TV. This allows the Illuminance photometer to be stored behind the TV when not in use, and then gently hung in front of the TV back in its original position with a high degree of accuracy. In order to rest the illuminance photometer on the table behind the TV without tearing the tape off, it may be necessary to place the pieces of tape closer to the bottom of the TV (Figure 18).



Figure 18: Tape securing string to the back of the TV

5. On the TV's top bezel place two pieces of tape, one on each side of the string, to mark a channel to return the string to (Figure 19).



Figure 19: Masking tape channel

6. Keep the illuminance photometer stored behind the TV in this manner for easy replacement when measuring ambient light during ABC testing.

5.2 Non-ABC

Figure 20 below depicts test setup for tests not including ABC. Non-ABC testing can be conducted in an ABC test set-up.

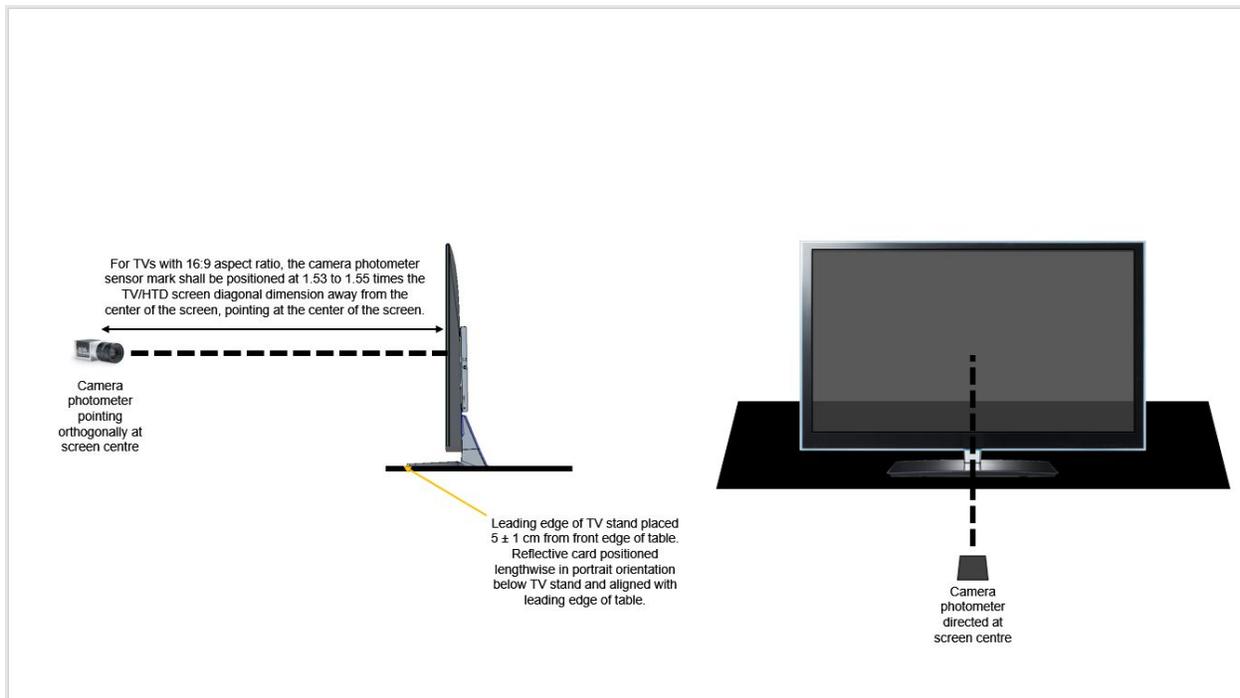


Figure 20: Non-ABC Testing Diagram

6 Test Kit Operation

The PCL TV Test System automated test option enables automatic test sequence and report generation for ENERGY STAR v9 and proposed VA test methods. It also has a manual mode described in 5.1.4.1. This section covers tester engagement with the software after completing Device Configuration within TV Test Kit Software. This includes explanations of the screen configuration, stabilization, and CCF procedures that must be completed for each TV being tested and provides a high level overview of the test steps for both automated tests.

Note: Internet Use During Testing

During testing the tester should avoid using any internet services (i.e. Zoom or any streaming service) as this can interfere with the camera photometer data transfer. Ideally the tester will disconnect from the internet for the duration of testing.

6.1 Initial Test Steps in Automated Modes

Once the tester selects a test mode, enters pre-test information, and presses the “Confirm” button (covered in Test Kit Set-up), the TV Test System will advance to the Testing Display (Figure 21).

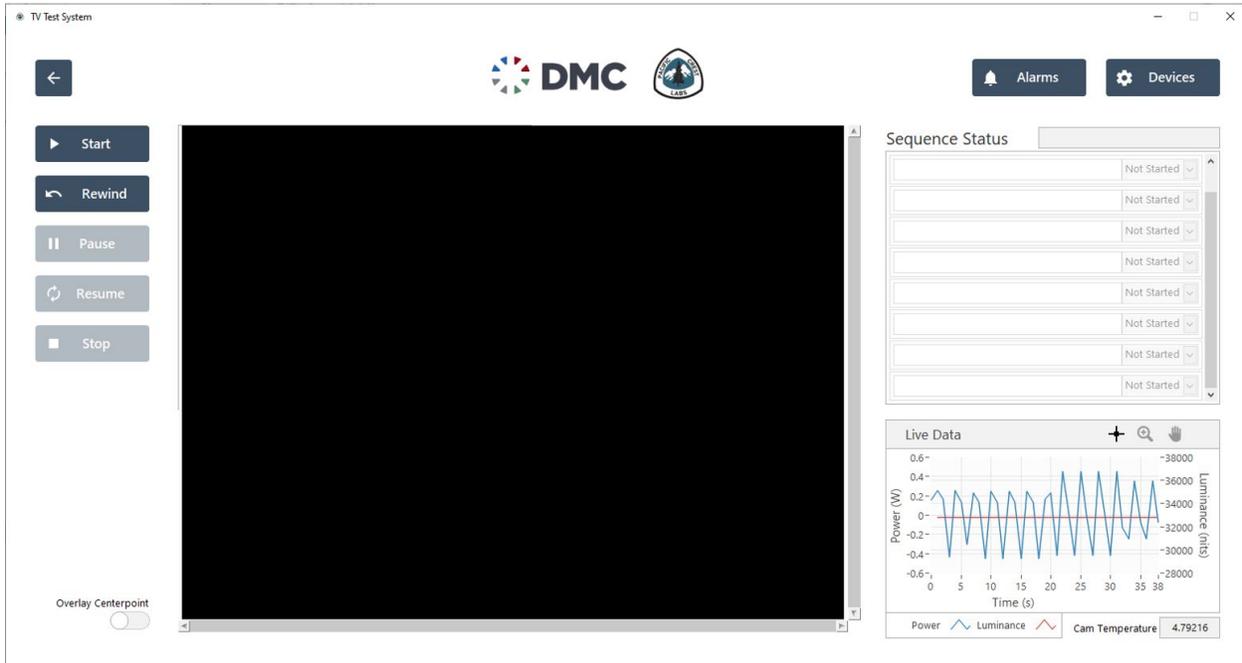


Figure 21: Testing Display

Upon pressing “Start” the testing will be met with the prompt below (Figure 22)⁸ beginning to guide the tester through the Screen Configuration, Stabilization, and CCF procedures.

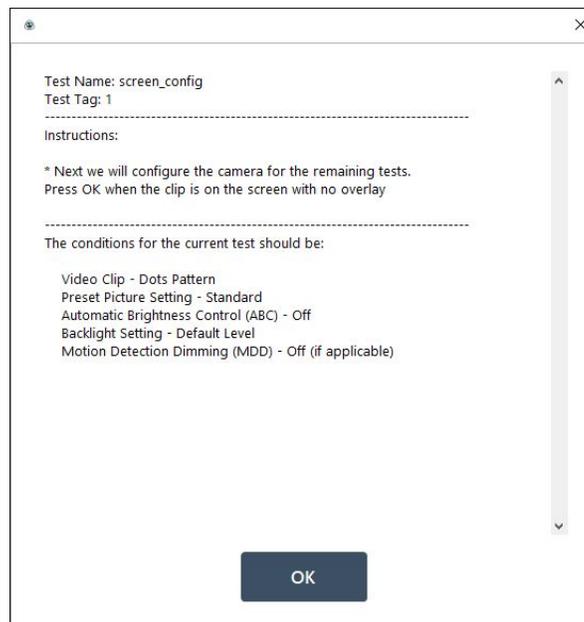


Figure 22: Screen Configuration Prompt

⁸ For a full list of ordered prompts from a VA Test run refer to Appendix C: VA Test Prompt Screenshots

6.1.1 Screen Configuration

This step involves identifying the screen border. The software asks the tester to play the Dots.mp4 file from USB stick inserted into the TV. The Test System will then identify the screen border and make necessary geometry corrections.

6.1.2 Stabilization

Second the software will stabilize the TV by asking the tester to play the first 5 minutes of the SDR dynamic test clip until the software determines that a stabilization run has an average power level that is within 2% of the previous run.

6.1.3 CCF

Third, the software will guide the tester through the process by which the Test System performs TV luminance calibration. The Test System performs a camera photometer luminance calibration before every TV test to account for variation in TV spectral power distribution (SPD). The tester does this by measuring the color correction factor (CCF) specific to the tested TV.⁹ We describe this process in detail below for the case where the tester uses a non-contact spot photometer as a reference spot photometer along with a note box for testers using a contact spot photometer.

1. Before conducting any CCF test steps, disable *local dimming* if the TV supports this capability. If uncertain, please check the manual (or check via Google search). Be sure to restore local dimming to its default state after performing CCF test steps.
2. When prompted by the Test System Software for the lum_center measurement, line up the Basler camera with the center of the Focus.mp4 clip in the Spot photometer's field of view (FOV). The Basler should completely obscure vision of the center of the pattern.



Figure 23: Spot photometer in line with camera

3. Open and pause the Circle.mp4 clip. Wait for the menu display to disappear.

⁹ See Camera Technical Write-up for more background.

4. Lean the Basler out of the FOV of the spot photometer (ideally on two of the legs of its camera stand/tripod so that it can be more easily returned to its initial location). While the screen is unobstructed by the Basler take a measurement with the spot photometer and input it as the lum_center measurement. This measurement should be taken between 15 and 60 seconds after opening and pausing the Circle.mp4 clip.



Figure 24: lum_center measurement taken with Basler shifted

5. After returning the Basler to its initial location, shift the spot photometer slightly to the right of its initial position and angle it to the left so that its FOV remains centered on the circle of the Circle.mp4 clip, but without any portion of the Basler obstructing its FOV. After shifting the spot photometer, the angle of viewing shall not exceed 5°. Take a measurement and input it as the lum_offset measurement. This measurement should be taken within a minute of lum_center.

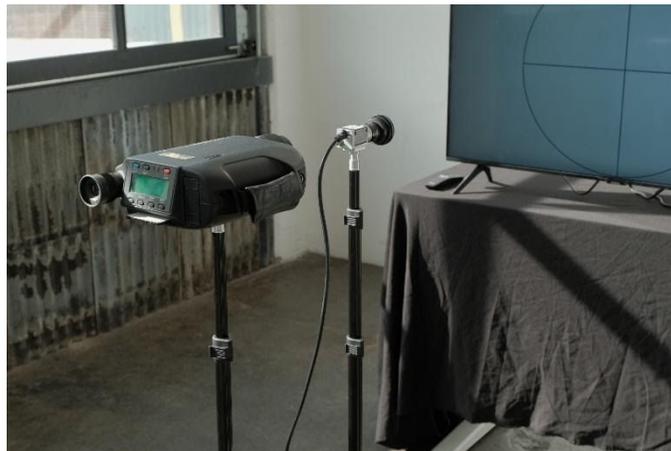


Figure 25: Spot photometer offset to left of Basler camera

6. Do not shift the spot photometer once the lum_offset data point has been taken. If the spot photometer shifts position the above process will have to be repeated. (Once the CCF portion of the test is completed the spot photometer can be moved out of the way)

7. All subsequent spot photometer readings you input during the CCF process will be automatically adjusted by the ratio of the lum_center and lum_offset measurements according to the following:

$$final\ reading = measurement * \frac{lum_center}{lum_offset}$$

8. Restore local dimming to its default setting.

NOTE: Contact Luminance Meter Procedure

If using a contact luminance meter, take the lum_center measurement by placing the contact sensor in the center of the Circle.mp4 clip circle. After taking the lum_center measurement, shift the contact probe to the point halfway between the location where the lum_center measurement was taken and the edge of the TV screen $\pm .5$ in. If the contact photometer or its stand block the Basler's view of the Circle.mp4 clips central circle, shift it farther towards the edge of the TV until the Basler's view of the circle is unobstructed. In this location take the lum_offset measurement used to calculate the $\frac{lum_center}{lum_offset}$ ratio. Leave it in this location for the duration of the CCF portion of the test.

6.2 Important Testing Considerations

This section documents key risks to test integrity and what the tester can do to mitigate them.

- Ensure that local dimming is disabled during CCF tests and restored to its default setting thereafter.
- In all tests, ensure that any menu overlay goes away before hitting the PCL Test System Software "OK" button to start a test measurement. We provide countdown timers at the start of the dynamic video clips that should be long enough for overlays to go away. However, PCL can generate clips with longer countdowns if there are TVs that require it.
- Disconnect the laptop from the internet and close all other applications prior to testing. This will reduce the possibility of dropped frames or other gaps in the data feed from the camera and power meter.
- When prompted to during testing, press OK as close to the start of the clip as possible.
- When selecting a Data Output or Image Save folder, do not enter a file name. Either click the folder and hit "select folder" or open the folder and hit "current folder". Entering a file name will throw an error.
- For some TVs, settings such as ABC and MDD are persistent (or universal) across all PPS. i.e. changing the ABC setting in the SDR Default PPS will also change it in other SDR PPSs. For other TVs this is not the case. It is recommended to always check all settings mentioned in the Test System Software prompts are correctly configured prior to beginning any test in case they were changed by the TVs persistence settings.
- Be careful with the HDR10 setting per the notes at the end of section 5.1.4.1.
- Identify the seal of clear nail polish on the camera photometers aperture. Check this prior to testing to ensure it has not broken.
- Double check that the camera photometer has been refocused after the initial setup.

6.3 Troubleshooting Common PCL Test System Error Codes

[Ben to add]



6.4 Test sequences for emerging policy initiatives

6.4.1 Alternative / Voluntary Agreement

The following is a high-level overview of the Voluntary Agreement Test Method as of 11/10/2020. Upon completion of a VA test, a report will be automatically generated from the data collected and can be found in the data output folder selected in the Pre-Test Menu. If saving to the default folders the file path to the report will be the following (with Make_Model determined by TV Meta Data inputs):

C:\Users\PCL\Desktop\TV Test Data\{Make_Model}\Alternative\alternative-report.pdf

Variables: QuickStart, Wake Time, HDR Testing, ABC

1. Screen Config (default configuration)
2. Stabilization
3. Color Correction Factor (local dimming disabled)
4. Luminance Profile (local dimming restored to default)
5. ABC off tests (default backlight for all 3 PPSs)
 - a. SDR Default PPS
 - b. SDR Brightest PPS
 - c. HDR10 Default PPS
6. ABC off tests (lowest backlight setting - for PPSs where ABC is not enabled by default)
 - a. SDR Default PPS
 - b. SDR Brightest PPS
 - c. HDR10 Default PPS
7. ABC on tests (for PPSs where ABC is enabled by default)
 - a. 100 lux \pm 5%
 - i. SDR Default PPS
 - ii. SDR Brightest PPS
 - iii. HDR10 Default PPS
 - b. 35 lux \pm 5%
 - i. SDR Default PPS
 - ii. SDR Brightest PPS
 - iii. HDR10 Default PPS
 - c. 12 lux \pm 5%
 - i. SDR Default PPS
 - ii. SDR Brightest PPS
 - iii. HDR10 Default PPS
 - d. 3 lux \pm 5%
 - i. SDR Default PPS
 - ii. SDR Brightest PPS
 - iii. HDR10 Default PPS
8. Standby
9. Waketime, QuickStart off
10. Standby with Echo connection
11. Waketime with Echo connection
12. Standby with Google connection



13. Waketime with Google connection

6.4.2 ENERGY STAR Test

The following is a high-level overview of the ENERGY STAR Test as of 11/10/2020. Upon completion of an ENERGY STAR test the automatically generated report can be found in the folder selected for data output in the Pre-Test Menu. If saving to the default folders the file path will be the following (with Make_Model determined by TV Meta Data inputs):

C:\Users\PCL\Desktop\TV Test Data\((Make_Model)\ENERGYSTAR\ENERGYSTAR-report.pdf

Variables: QuickStart, Wake Time, HDR Testing

1. Screen Config (default configuration)
2. Stabilization
3. Color Correction Factor (local dimming disabled)
4. Luminance Profile (local dimming restored to default)
5. SDR Tests with IEC_SDR Clip
 - a. Default PPS
 - i. ABC OFF
 - ii. ABC ON, Low Backlight
 - b. Brightest PPS
 - i. ABC OFF
 - ii. ABC ON, Low Backlight
6. HDR Tests with CLASP_HDR Clip and Default PPS
 - a. ABC OFF
 - b. ABC ON, Low Backlight
7. Standby
8. Waketime, QuickStart off
9. Standby with Echo connection
10. Waketime with Echo connection
11. Standby with Google connection
12. Waketime with Google connection

7 Appendix A: Testing Setup Checklist

High level checklist of steps for a full Alternative (VA) test. For ENERGY STAR testing ignore starred (*) steps which are only for ABC testing.

1. Check test room conditions.
 - a. Ambient light, temperature, and humidity
 - b. Table black cloth covering
 - c. AC power source set to 115V and 60Hz
2. Check TV
 - a. Placement
 - b. AC power source -> power meter -> TV
 - c. Firmware update
3. Collect Pre-Test Info



- a. Gather TV Metadata
- b. Gather info for Test Configuration fields
 - i. Determine SDR default, SDR brightest, and HDR default PPS
 - ii. Quick Start settings
 - iii. Waketime
- 4. Device configuration
 - a. Power meter -> laptop connection and device config
 - b. Camera -> PoE -> laptop connection and device config
 - i. Camera has been plugged in and warming up for at least 1 hour
- 5. Cam placement
 - a. Sensor mark at appropriate distance and centered
 - b. Rotation and height adjustments
- 6. ABC Setup*
 - a. Light source placement
 - i. Prior to the start of ABC testing warm up the light source at max brightness for 10 minutes
 - b. Illuminance photometer setup
 - i. String taped with illuminance photometer in desired position
 - ii. Masking tape channel on TV top bezel
 - iii. Illuminance photometer sensor location coordinates recorded
 - c. Reflective card in position centered on ABC sensor flush with front of table
- 7. CCF
 - a. Take lum_center and lum_offset measurements, and understand difference between contact and non-contact spot photometer procedure
- 8. Check each prompt provided by the TV Test System Software for the following.
 - a. What clip is played next? Important to note if SDR or HDR
 - b. Adjust PPS after opening the desired clip to ensure changing the appropriate PPS (sometimes PPS changes are not universal between SDR and HDR content)
 - i. Pause the clip immediately after starting to change PPS, then let the clip run
 - ii. Hit OK on the TV Test System prompt and start data collection at the end of the clip countdown.

8 Appendix B: Basic Manual Test Sequence

Here is an example of a Manual Test Sequence that can be copied into a CSV file and used for Manual testing. This will complete the normal screen config process where the camera photometer finds the edges of the screen, and then log data for 30 minutes. The wait time can be changed to whatever time you like. Enter the desired time in seconds.

#Config	
Macro File	
#Sequence	
tag	0



user_command	Ensure the TV has ABC off Ensure the TV is in the desired picture setting
user_command	Play the Dots SDR pattern then press OK
screen_config	screen_config
user_command	Press OK to begin your manual test.
tag	manual_test
wait	1800

9 Appendix C: Test Names and Descriptions

PCL Test System Software prompts users to walk through a series of tests based on a TV's features. The table below represents an example of a test sequence, where we have provided descriptions of each of the tests. These descriptions should enable the reader to understand the test names used in any test sequence.

Table 6: Test Names and Explanations

Test Name	Description
screen_config	Basler camera finds the outline of the screen when playing the dots pattern and makes geometry corrections.
stabilization	TV is stabilized by playing the first 5 minutes of the SDR dynamic test clip until the software determines that a stabilization run has an average power level that is within 2% of the previous run.
camera_ccf_default	Camera luminance calibration is determined by measuring the color correction factor (CCF) of the camera relative to spot photometer that is accurate when used to measure LCD and OLED TV screens.
lum_profile	The Basler camera writes pixel-level luminance data to a csv file for the purpose of making a luminance heat map.
default	Measure average power and luminance while playing the 10 minute IEC SDR dynamic test clip in the default SDR PPS with ABC off.
brightest	Measure average power and luminance while playing the 10 minute IEC SDR dynamic test clip in the brightest SDR PPS with ABC off.
hdr10	Measure average power and luminance while playing the 5 minute IEC HDR10 dynamic test clip in the default HDR10 PPS with ABC off.



brightest_low_backlight	Measure average power and luminance while playing the 10 minute IEC SDR dynamic test clip in the brightest SDR PPS with the lowest backlight setting (vs default). This test is used when ABC is disabled by default for a PPS. This data point is not used for compliance. It enables policymakers to understand how the TV performs when it dims in that PPS. This information helps set future spec lines.
default_100	Measure average power and luminance while playing the 10 minute IEC SDR dynamic test clip in the default SDR PPS with ABC on and ambient light set to 100 lx.
hdr10_100	Measure average power and luminance while playing the 5 minute IEC HDR10 dynamic test clip in the default HDR10 PPS with ABC on and ambient light set to 100 lx.
default_35	Additional ABC test ...
hdr10_35	Additional ABC test ...
default_12	Additional ABC test ...
hdr10_12	Additional ABC test ...
default_3	Additional ABC test ...
hdr10_3	Additional ABC test ...
standby_multicast	Measure standby-active, low with WAN connection, multicast traffic on LAN, and TV Remote Start feature enabled.
multicast_waketime	Measure waketime to HDMI video signal.
standby_echo	Measure standby-active, low with WAN connection, multicast traffic on LAN, and wake by voice enabled.
echo_waketime	Measure waketime to HDMI video signal.
standby_google	Measure standby-active, low with WAN connection, multicast traffic on LAN, and wake by voice enabled.
google_waketime	Measure waketime to HDMI video signal.