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Cover Letter and Data Collection Procedure

Proposed Data Collection Procedure (DCP) for the Low Power Mode (LPM) Roadmap and comments from Pacific Gas and Electric Company (PG&E), San Diego Gas and Electric (SDG&E), and Southern California Edison (SCE) in response to the efforts of the California Energy Commission (CEC)

Additional submitted attachment is included below.

May 14, 2021

Soheila Pasha
Appliance Office
California Energy Commission
1516 Ninth Street, MS-25 Sacramento, CA 95814

Docket Number: 17-AAEER-12

Topic: California Investor-Owned Utility Codes and Standards Enhancement Team Initial Proposal for a Data Collection Procedure for the California Energy Commission's Low Power Mode Roadmap

Dear Dr. Pasha:

This letter precedes the proposed Data Collection Procedure (DCP) for the Low Power Mode (LPM) Roadmap and comprises comments from Pacific Gas and Electric Company (PG&E), San Diego Gas and Electric (SDG&E), and Southern California Edison (SCE) in response to the efforts of the California Energy Commission (CEC).

The Codes and Standards Enhancement (CASE) initiative presents recommendations to support the CEC's efforts to update California's Appliance Efficiency Regulations (Title 20). The California Investor-Owned Utilities sponsored this effort (herein referred to as the Statewide CASE Team). The program goal is to prepare and submit proposals that will result in cost-effective enhancements to improve the energy and water efficiency of various products sold in California. The Statewide CASE Team appreciates the opportunity to provide the following comments about the DCP for the LPM Roadmap and to present an initial proposal for the DCP.

In developing a proposed DCP, the Statewide CASE Team built on the Low Power Mode Test Procedure Discussion Document published by the CEC in June 2018. Ultimately, the Statewide CASE Team sought to fulfill the goals defined by the CEC during its January 24, 2019 webinar. These goals are:

- To create a common test procedure for a wide variety of products, breaking products into groups only when absolutely needed;
- To define test setups that are repeatable and representative of the real world;
- To measure power draw in an "idle" or "inactive" state—when products are not performing their primary function;
- To capture power consumption of whatever secondary functions are present; and
- To allow stakeholders to collect and submit comparable data.

The attached files are the Statewide CASE Team's initial proposal for a DCP to serve these objectives. The Statewide CASE Team's proposal includes both a set of instructions and an Excel-based Data Reporting Tool (DRT) that would allow testers to record relevant testing information in a standardized way.

To provide additional context, the following comments summarize the Statewide CASE Team's understanding of the role of the DCP in the LPM Roadmap and the role of this initial proposal as part of an iterative, collaborative process.

1. **The Statewide CASE Team recognizes that complementary forms of data collection will be needed.**

The attached LPM DCP proposal is a means of measuring whole-product power draw and capturing relevant product attributes. The proposed DCP is designed to approximate how a wide variety of products would behave in the real world when they are not providing their active-mode energy service to a user.[1] Collecting this data can help the CEC understand how this "inactive" power draw varies across products of different types and with varying functionality.

While DCP results will be an important resource for the LPM Roadmap, the Statewide CASE Team expects that complementary data will be needed. To analyze statewide energy impacts, whole-product power data is necessary but not sufficient; data on duty cycles and installed base are also needed. Similarly, to set appropriate power targets that reflect each product's functionality, DCP data is likely to be valuable but not sufficient; data on the power requirements for secondary functions will likely also be needed.[2]

2. **The Statewide CASE Team recognizes that evolutions of the DCP are likely to be needed for later stages of the Roadmap.**

The Statewide CASE Team designed our proposed DCP to serve the next phase of the LPM Roadmap: to collect data that will inform the scope and targets for the LPM Roadmap and help illuminate the factors that impact inactive state energy usage.

The Statewide CASE Team recognizes that the DCP used in the data collection phase must be fundamentally similar to the test procedure(s) used in later phases of the Roadmap, specifically for reporting relative to voluntary (and potentially mandatory) targets. The fundamental continuity of test procedures will allow for data collected in earlier stages to maintain its relevance in later stages.

Although fundamental continuity is important, the Statewide CASE Team expects that some modifications to the DCP used for the data collection phase will be appropriate in later stages of the LPM Roadmap. Modifications could allow the CEC to incorporate lessons learned through the application of the DCP to products during the data collection phase. Moreover, modifications could allow the CEC to tailor the test procedure to the context at hand.

[1] For example, the proposed DCP is intended to capture the power draw of a toaster oven when it is not heating food or a router when it is not passing user-generated network traffic.
[2] For example, if the CEC sets power targets that include a functional adder for displays, it will be important for the CEC to have data on the power requirements for displays and the factors that affect display power draw.

One key example of how the proposed DCP is tailored to the context of data collection is that it provides instructions for testing multiple conditions. Testing multiple conditions, rather than only one as most test procedures do, will help CEC better understand which conditions impact inactive power draw, opportunities for inactive state energy savings, and how the test procedure could be strategically streamlined in future stages. During the voluntary targets phase, we expect the test procedure would be streamlined to include fewer test conditions.

The Statewide CASE Team expects that other modifications may be appropriate as the CEC transitions from the data collection phase to the voluntary targets phase. If the CEC narrows the scope of the LPM Roadmap based on results of the data collection phase, there may be opportunities to streamline the setup instructions to be more tailored to the in-scope product categories. Additionally, during the voluntary targets phase, the CEC might place a higher premium on repeatability and reproducibility, leaving less to the tester's discretion. Other refinements might be made based on lessons learned from applying the DCP to a wide scope of products during the data collection phase.

Finally, if the regulatory backstop of the LPM Roadmap is triggered, a regulation-grade test procedure would be required. Additional modifications to the test procedure used for voluntary targets may be necessary to improve test reproducibility and repeatability in the context of mandatory requirements.

3. **The Statewide CASE Team would welcome input on our proposed DCP from other stakeholders, including but not limited to input on the name of the test condition and the definition of a "primary function."**

In developing our initial proposed DCP, the Statewide CASE Team tested a variety of different product types and received reviews from a variety of stakeholders; however, the Statewide CASE Team was not able to test the full range of in-scope product types nor receive feedback from a fully representative set of stakeholders. Therefore, the Statewide CASE Team would value feedback on our proposed DCP as it applies to different in-scope products, especially in conjunction with suggestions for how to improve it while still meeting the CEC's aforementioned goals. Two particular issues that have come to our attention and are deserving of widespread feedback are the name of the test condition and the definition of a "primary function."

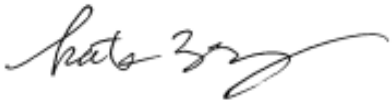
In our review process, the Statewide CASE Team has received a variety of conflicting suggestions for how to name the test condition. The Statewide CASE Team's current proposal is to refer to the test condition as the "DCP inactive state." The prefix "DCP" is intended to convey that the terminology is an operational definition specific to the LPM DCP. "Inactive" is intended to convey the focus on how much power a product draws when not performing its primary, active-mode energy service for a user. "State" is intended to convey that the test does not measure one or more prescribed low power modes, but rather it measures a certain condition: whatever the product naturally does given the DCP setup instructions. In our review process, the Statewide CASE Team has considered alternative names of the test condition such as the "DCP idle state" or "DCP inactive condition" and heard mixed feedback on such permutations. The Statewide CASE Team would welcome input on how to name the test condition.

The Statewide CASE Team is also aware that for some products the proposed test state may be ambiguous. The DCP defines the test state as an inactive state in which primary function(s) are not active and instructs testers to ensure that the primary function(s) are not triggered during the test. Although the proposed approach appears to suffice and yield reproducible test results for many products, challenges

may arise for products that have multiple primary functions[3] or for products that continuously provide their primary function.[4] The Statewide CASE Team would appreciate examples of products for which the current definition is problematic and why, especially in conjunction with suggestions for how further instructions or an alternate definition could remedy these edge cases.

In conclusion, we would like to reiterate our support of CEC's Low Power Mode Roadmap and the development of a DCP. We thank the CEC for the opportunity to be involved in this process.

Sincerely,



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[3] For example, a LED lamp that is also a network extender.
[4] For example, a standalone occupancy sensor.

Data Collection Procedure for Inactive State Power

Background

Motivation and Scope

In their low power modes (LPM) Roadmap, the California Energy Commission ("CEC") is investigating the energy savings potential of products in an "inactive" state—when not performing their active mode energy service to a user. The Roadmap is a new process developed by the CEC to address this complex and broad topic. The Roadmap consists of iterative voluntary energy efficiency improvement and participation specifications, and milestones that, if met, are expected to continue to be voluntary. It includes a mandatory regulation backstop if the CEC's voluntary energy efficiency improvement and participation goals are not met (Figure 1). The CEC has established its initial scope by excluding any product that is subject to Department of Energy or CEC Title 20 regulations that include limits on standby or inactive mode power or is being addressed by other CEC energy efficiency Roadmaps. All other products are currently in the LPM Roadmap scope.

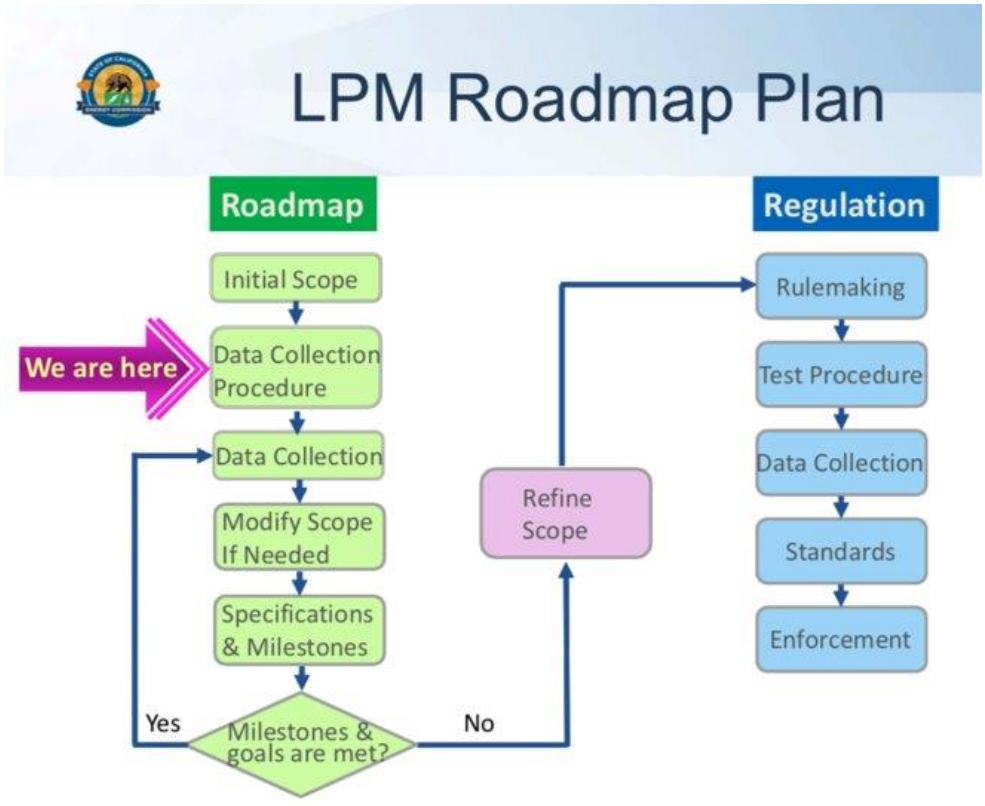

Figure 1: The CEC's LPM Roadmap plan. Source: CEC
https://efiling.energy.ca.gov/GetDocument.aspx?tn=226376&DocumentContentId=57150

Standardizing LPM Data Collection

Next, the CEC must collect data to evaluate the energy use and savings potential of products within the initial scope. One important input for this effort is standardized data on inactive whole-product power draw and relevant product attributes. To allow for any stakeholder to collect and submit such data, the CEC is developing a data collection procedure (DCP). The California investor-owned utilities' Codes and Standards Enhancement (CASE) Team has developed the DCP contained in this document (the "CASE Team DCP") for the CEC's consideration.

The CASE Team DCP is designed to test the power draw of a wide range of products in their inactive state, similar to how they would be used in the real world, but with enough test guidance that the measurements are reasonably repeatable. The CASE Team DCP includes best practice instrumentation and measurement tolerance requirements. It is intended to be a means for stakeholders to collect and submit data to the CEC that allows for discussion of the power draw of in-scope products and lay the foundation for discussing energy savings opportunities. The CASE Team anticipates that the DCP may be streamlined if the CEC narrows the scope of the LPM Roadmap based on data collected and submitted. If the LPM measure becomes a mandatory regulation, additional modifications to the DCP may be necessary to improve test repeatability.

The CASE Team DCP builds on the International Electrotechnical Commission (IEC) test procedure, IEC 62301:2011, which provides some guidance for making power measurements in low power operating modes. IEC 62301 lacks setup instructions that apply to many of the newest functions that today's electricity-using products may offer, such as network connectivity, voice activation, and environmental monitoring. In addition, IEC 62301 is designed to measure power in discrete operational modes, rather than in a general inactive state that may consist of multiple modes. The CASE Team DCP provides instructions for setting up and carrying out inactive state tests, addressing these two limitations of IEC 62301. Furthermore, it allows products to be tested in a consistent and reproducible manner under conditions that represent typical usage in the real world.

Definitions

Terms used in the CASE Team DCP are defined below and written in *italic type* in this section.

***Active mode*:** An operational mode of a *unit under test (UUT)* when it is providing one or more of its *primary function(s)*.[1]

***Automatic power down, APD*:** The capability to automatically switch a product from *active mode* to a lower power operating condition after a predetermined period of time (*APD* timing) has elapsed. *APD* timing begins when both (1) the *UUT* has ceased performance of all *primary functions*, and (2) the last user input has been received (e.g., voice command, remote control, or app command). If either a *primary function* resumes or a user input is received, the *APD* timing will reset. The intent of *APD* is that a

[1] Adapted from IEC 62301:2011, section 3.8.

product will automatically power down into a low power mode or series of modes when it is not being adjusted by the user, not sensing user activity that would trigger active mode, and not performing a *primary function*.[2]

DCP inactive state: The state of a product after performing the setup described in this procedure. Generally, the *DCP inactive state* represents the product's state after user interaction has ceased and the product need not perform its *primary function(s)*.

***Function*:** A predetermined operation undertaken by the *UUT*. Functions may be controlled by an interaction of the user, of other technical systems, of the system itself, from measurable outputs from the environment, and/or time.[3]

***Primary function*:** An intended purpose or main service that the *UUT* provides a user.

Examples:	
Product	Primary Function(s)
Speaker	Playing audio content
Multi-function device	Printing, scanning, copying, faxing
Coffee maker	Making and heating coffee
Toaster oven	Heating food
Router	Passing Internet Protocol (IP) traffic among various network interfaces

***Secondary function*:** Other functions which may enhance the *primary function(s)* or can assist with the use and operation.[4]

Examples:	
Secondary Function	***Applicable Product Type***
Network communication	Network-connected devices (see definition below)
Display	Any product except stand-alone displays
Sensors	Any product except stand-alone sensors
Voice control	Any product with vocal user interface

[2] Adapted from ENERGY STAR Program Requirements – Product Specification for Audio/Video Eligibility Criteria Version 3.0 (Rev. Dec-2014), [Link]

[3] Source: IEC 62301:2011, section 3.1.

[4] Source: Harrington and Nordman (2010). Standby Power and Low Energy Networks – issues and directions. Prepared by Energy Efficient Strategies for APP and IEA 4E Standby Annex. https://www.iea-4e.org/wp-content/uploads/publications/2010/08/Network-Standby-2010-09-final.pdf. Section 4.2.

Integrated network device: A device that possesses multiple primary functions, one of which is to pass IP traffic among various network interfaces.

> Example: An LED bulb with Wi-Fi extender has multiple primary functions: illumination and passing IP traffic among various network interfaces.

Network-connected device: A device that can pass IP traffic, but whose *primary function(s)* is(are) *function(s)* other than passing IP traffic.

> Example: A network-connected printer is a network-connected device.

Network equipment: A device whose only *primary function* is to pass IP traffic among various network interfaces.

Wide area network, WAN: A network that serves to transfer information between devices over a large geographic area, such as a city or country. The Internet connects multiple WANs.

Local area network, LAN: A network that serves to transfer information between devices within a small geographic area, such as a building or campus.

Non-network device: A device that does not have the ability to pass IP traffic.

> Example: A printer that cannot be connected to an IP network is a non-network device.

Off mode**:** A mode in which the *UUT* is connected to a power source and is not providing any *primary* or *secondary function*, with the exception of an indicator light that shows the user that the product is in the off position.[5] *Off mode* is normally entered through a hard switch, soft switch, timer expiration, display-based command on a product, or power command from a data or network link.

Unit under test, UUT: The product being tested according to this DCP.

Overview of the Data Collection Procedure

These instructions guide testers through a series of steps to prepare the UUT for and carry out DCP inactive state power measurements of a wide range of electricity-using products. The goal of the DCP is to set up the UUT in a manner similar to how a consumer would, with some simplifications and specific conditions that facilitate repeatable results. At a high level, the DCP instructs the tester to follow manufacturer instructions to prepare the UUT for use, allow the UUT to enter the DCP inactive state, and measure inactive state power (Figure 2).

[5] Adapted from IEC 62301:2011, section 3.5.

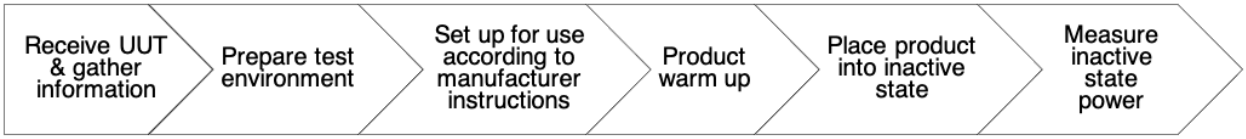

Figure 2: General steps to be carried out in the DCP.

Differences between the DCP and IEC 62301

The goal of the DCP is to measure UUT power in an inactive state, rather than specific low power *modes* as IEC 62301 does. The DCP guides testers through a process of first examining the UUT to characterize how it draws power when it is not providing its primary function(s) (warmup period analysis), and then measuring the power over a window of time in which the primary function(s) is not active. Products can show a wide range of behavior and progress through various operational modes in DCP inactive state. Some products may exhibit simple, stable power draw in their DCP inactive state. Others, especially those that utilize network connections and sensors to enhance the service provided by the product, may enter a number of modes or power states in DCP inactive state as the product activates functions to maintain expected services (Figure 3).

By measuring an inactive state, rather than individual modes, the DCP aims to characterize aggregate power draw over a period of time when the user is not benefiting from the active mode services that the UUT provides.

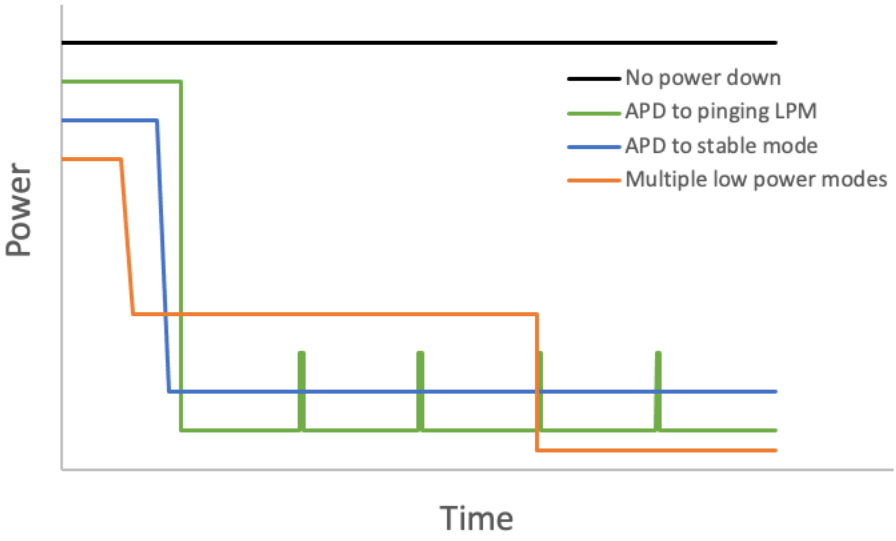

Figure 3: Illustrative examples of power behavior that might be encountered during testing.
Black line: stable, constant power draw of an always-on product.
Green line: APD to DCP inactive state "pinging' behavior at regular interval.
Blue line: APD to stable, constant power.
Orange line: APD to inactive state, which consists of two distinct low power modes.

Multiple power tests for capturing range of available secondary functions

Some UUTs will require multiple tests to measure several use cases, such as using different network technologies or different power sources. For these products, the tester will set up the UUT and carry out the tests sequentially, making the necessary changes to the UUT setup for each test.

How to use this DCP

The section below contains the CASE Team DCP. Instructions are written in outline form. Informative notes and examples are provided below the pertinent instructions. Situations that require additional test iterations are noted in boxes with borders. Information to be recorded during the setup procedure is noted in ***bold italics***. This information may be recorded in the accompanying data reporting tool (DRT), introduced in the next paragraph.

Reporting

The Statewide CASE Team developed a DRT to accompany this DCP, in spreadsheet format. The tool aids the tester to gather accurate and complete information while conducting testing according to the DCP. Minimum data reporting requirements are provided in the "Additional Guidance" Section at the end of this document for test labs that wish to use their own reporting structures. Supplemental information, for example test setup photos or graphs of test data, may be submitted as a pdf file that accompanies the test report.

Safety note

Pre-test safety planning should be performed by the tester to ensure that all hazards have been identified, evaluated, and controlled prior to start of UUT setup, warmup, and testing. The tester is responsible for conducting such pre-test safety planning and ensuring that the UUT setup is completed by qualified personnel, as specified in product instructions.

Normative References

The following standards are referenced in the DCP.

- ANSI/CTA-2049-A. Determination of Small Network Equipment Average Energy Consumption. December 2020. https://shop.cta.tech/products/determination-of-small-network-equipment-average-energy-consumption.
- IEC 62301, Edition 2.0. Household electrical appliances – Measurement of standby power. January 2011. https://webstore.iec.ch/preview/info_iec62301%7Bed2.0%7Db.pdf
- IEEE 1515-2000. IEEE recommended Practice for Electronic Power Subsystems: Parameter Definitions, Test Conditions, and Test Methods. Revised 2008. https://webstore.ansi.org/standards/ieee/ieee15152000r2008
- IEEE 802.3-2018. IEEE Standard for Ethernet. June 2018. https://ieeexplore.ieee.org/document/8457469

Data Collection Procedure

1. **Prepare test room and instrumentation.**

1.1. Power measurements will be made under the test conditions and with the instrumentation specified in IEC 62301:2011 Section 4. With the following additions and modifications:
   1.1.1. Ambient relative humidity will be maintained in the range of 10% to 80% throughout each test.
   1.1.2. Select all leads used in the test setup as specified in Table B.2— "Commonly used values for wire gauges and related voltage drops" in IEEE 1515-2000.
   1.1.3. Measurement resolution shall be:
      - 0.01 watt (W) or better for measurement values less than 10 W;
      - 0.1 W or better for measurement values from 10 W to 100 W; and
      - 1.0 W or better for measurement values greater than 100 W.

1.2. Power over Ethernet (PoE) powered UUTs: power source and meters shall have the following characteristics:
   1.2.1. UUT shall be connected to a Power Sourcing Equipment (PSE) voltage source of 53 ± 2 volts (V) during testing. The PSE voltage source must be IEEE 802.3-2018 compliant.
   1.2.2. Power meters used in PoE tests shall possess the following attributes:
      - Cable Compatibility: Capable of measuring PoE connections directly from the Category 5 enhanced (Cat 5e) or Category 6 (Cat6) cable, regardless of the PoE method or power delivery operating modes as specified by IEEE 802.3-2018.
      - Enables Ethernet link and packet traffic flow to the UUT from a link partner at all network speeds at which the UUT is capable.
      - Acts as a PSE or allows another PSE to source power to the UUT.[6]
      - Measurement Accuracy: Power measurement equipment shall have an accuracy of less than or equal to ± (2% + 0.1 W).
      - Cable Length: A one-meter CAT 5e/6 cable shall be used between the power meter and the UUT for all testing.

1.3. dc-powered UUTs:
   1.3.1. Maximum dc voltage shall not exceed +1% of the average voltage and the minimum voltage shall not be less than -1% of the average voltage. The ac ripple voltage (RMS) shall be:
      - ± 0.2V for dc voltages up to 10 V; or
      - ± 2% of the dc voltage for dc voltages over 10 V.
   1.3.2. Universal Serial Bus (USB)-powered UUTs: The ac-to-USB power supply shall be powered using a regulated ac power source that meets the requirement of IEC 62301:2011 Sections 4.3 and 4.4. The dc side of the ac-to-USB power supply shall be connected to the power meter by breaking the dc Vcc+ and wiring it though the power meter to measure the dc current drawn by the UUT. Test leads shall be connected to the dc Vcc+ and dc ground- to measure the voltage as close to the UUT as possible. See Figure 4 for reference.

[6] The first three requirements in Section 1.2.2 are adopted from Section 4.1(F) of the ENERGY STAR Final Test Method for Telephony, Rev. Nov-2013. [Link]

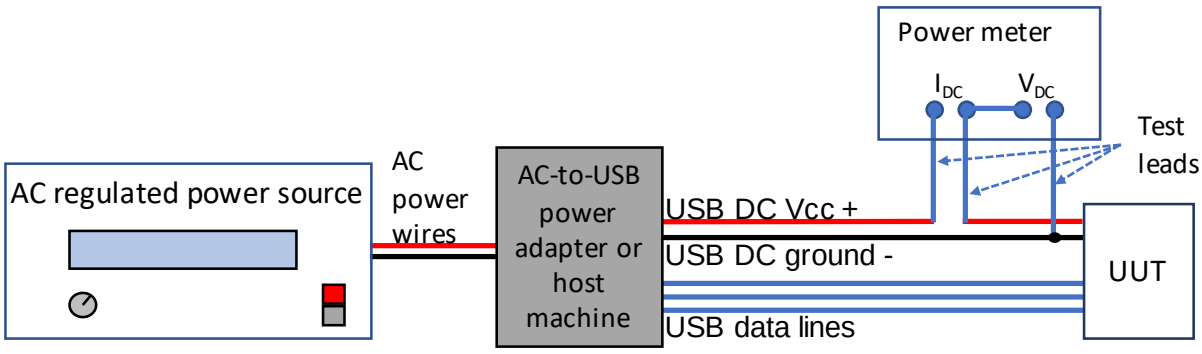

Figure 4: Power, data, and test point connections for USB-powered UUT.

1.4. Power meter calibration: Power meters shall be calibrated and in good working order. If the test laboratory does not hold ISO/IEC 17025 accreditation, power meters shall be calibrated annually or sooner.

2. Receive unit under test (UUT) and gather information.

2.1. If the UUT has been previously tested or used, perform factory reset.

2.2. Review manufacturer instructions.

2.3. ***Record product information including at minimum manufacturer, model number, and product category.***

2.4. ***Record primary and secondary functions***. Record assessment of primary function(s) as clear or ambiguous.

2.5. ***Record the functions that are available in inactive state.***

Note: the assessment may be revised as the tester examines, tests, and better understands the UUT.

2.6. ***Record whether UUT has an off mode as defined in the Definitions Section.***

3. **Set up UUT for use following manufacturer instructions.** The following guidelines include additional guidance where manufacturer instructions may be unclear or unspecified. Perform the setup in the order given in the manufacturer instructions.

Note: Some manufacturer setup instructions include a tour of product features. The tester should leave all features and functions in the as-shipped default settings. The tester need not follow instructions that do not pertain to UUT setup, such as product registration.

3.1. Connect to power. When doing so, connect UUT to a regulated power source and power meter as specified by IEC 62301.2011 Sections 4.3 and 4.4.

3.1.1. ac mains powered products: supply appropriate ac voltage (e.g. 120 V or 240 V if powered from mains) according to IEC 62301. If the UUT can accept more than one voltage, supply the lowest appropriate ac voltage (e.g., supply 120 V if product can accept either 120 V or 240 V). ***Record input voltage.***

3.1.2. dc powered and low-voltage ac powered products: supply appropriate dc or ac voltage with a power source that meets the specifications in Sections 1.1 through 1.3 as applicable. Supply the dc voltage specified by the manufacturer. If the manufacturer specifies a dc voltage range, supply the average of the given range. If the manufacturer provides a

discontinuous range, supply the average of the smallest given range (e.g., if specified dc voltage is 24-30 V or 48-55 V, supply the average of the lower range, 27 V). If the manufacturer does not specify dc voltage, use best judgement and specifications of the connection type. ***Record input voltage.***

3.1.3. If the UUT ships with an ac-dc external power supply, connect the power supply to the UUT and provide ac mains power to the power supply.

3.1.4. If the UUT can operate on either ac or dc input and ships with an ac-dc power supply, supply ac power and carry out the following procedure to measure DCP inactive state power.

Conduct an additional test for each dc power delivery technology the UUT can use, for example USB or PoE.

3.2. Connect, set up, and ***record all peripherals that ship with the UUT***. Peripherals may be wired or wirelessly connected to the UUT. If a peripheral can use either a wired or wireless connection, connect it to the UUT via the wireless connection.

Examples:

- Game console controllers
- Wireless, battery powered window and door sensors for home security systems
- Wired security cameras for home security systems

3.2.1. Peripherals may be battery powered, draw power from the UUT, or draw power from a wall outlet or other separate power source. If a peripheral draws power from a separate power source other than a disposable battery rather than the main UUT, log peripheral and main UUT power on separate channels. Average power for each peripheral will be reported separately.

3.3. Connect any additional equipment the UUT requires (but does not ship with) in order to provide the primary function(s) noted in Section 2.4. Establish the necessary wired or wireless data and/or power connection between the UUT and the additional product(s). ***Record make and model number of the additional product(s).***

3.3.1. If the additional product draws power from mains or a battery, do not measure or report its power draw. If the additional product can draw power from mains or from the UUT, power the additional product from mains and do not measure or report its power draw. If the only way to power the additional product is from the UUT, note that the UUT power measurement applies to both the UUT and the additional product.

Note: When possible, the tester shall place the additional attached products in an inactive mode for testing. In some cases, however, the additional product must be active in order to initiate the UUT test.

Examples:

- Certain network-connected lamps must be connected to a mains-powered proprietary network hub in order to turn the lamp on and off. Connect the smart lamp to the hub following manufacturer instructions and connect the hub to the network. Power the hub from mains, and do not measure or report power of the hub. During testing, the hub will be in DCP inactive state (capable of passing IP traffic, but no user traffic will be generated).
- A game console must be connected to a TV or display to graphically interact with the user. Connect game console to a mains-powered TV or display as directed by the manufacturer's instructions. Do not measure or report power of the TV or display. The TV or display must be active in order to initiate the UUT test and shall be allowed to use default APD during the test.
- A security camera stores data locally but does not ship with the micro SD card to do so. Install a micro SD card.

- An LED lighting controller must be attached to a lamp in order to draw current but does not ship with a lamp. Attach a lamp and note its make and model. Ensure that the LED lamp is compatible with the controller (if a compatibility list is available) and load requirements are met. During testing, the lamp shall be off.

3.3.2. For network-connected and non-network devices, other devices that do not ship with the UUT and are not necessary for providing the product's primary and DCP inactive state functions shall not be connected for the test. Note that network equipment UUTs will be connected to test clients to establish network connections, as described in Section 4.5.

3.4. Enroll in services, such as downloading an app, creating an account, and connecting the UUT to the app. In many cases the tester will need to use a smart phone to carry this step out, and potentially to control the UUT.

3.5. Update software or firmware, if updates are available. Record current software or firmware version or note if it is unknown.
Note: The tester may need to refer to the mobile app for the connected UUT to obtain software or firmware version information.

3.6. Where given a choice in the UUT setup, use default options for settings that potentially impact power. If the UUT does not provide a default setting, adjust the setting to the mid-point option whenever practical. Otherwise, tester is to use best judgement on which setting an average user would choose, and ***record that setting***.
Examples:

- Screen brightness
- Screen saver or background image
- Power management settings
- Video quality and bandwidth

If the product has multiple power management settings, conduct additional tests that capture the range of possible power draw. If the product has two settings, test both. If the product has three or more settings, test first with default settings, then with maximum power settings, and then with minimum power settings enabled.

3.7. Voice assistant setup.

3.7.1. If voice input is essential to operate the UUT's primary function(s), set up according to manufacturer instructions. In many of these cases, the voice assistant may require no additional setup by the tester. ***Record voice assistant type*****.**
Example: A smart speaker relies on voice control to initiate the primary function, which is to play audio.

3.7.2. If voice input is not essential to operate the UUT, decline voice assistant if possible.
Note: The intent of this instruction is to avoid implementing voice activation in products that users are unlikely to interface with by voice, or in products that work with multiple voice assistants.

3.7.3. If the UUT requires another local product to enable the voice assistant (for example, a camera that must be connected to a smart speaker in order to provide voice control), the voice assistant capability will not be enabled for the testing.

3.8. Personal information**.** With the exception of providing an email address and/or other information to set up a UUT's app, the tester should avoid providing personal information where possible during UUT setup. ***The tester will note if exclusion of personal information is expected to impact the power measurement.***
Examples:

- Voice matching, face matching or other features that allow a person to be identified for personalized calendars or settings
- Creating a password for the UUT

- Personal and business tax IDs

3.9. Product registration, licenses, and subscriptions.

3.9.1. If prompted to register the UUT, the tester should decline if possible.

3.9.2. If the UUT requires end user license agreements or terms of service/use to enable an app or service, the tester should agree to such agreements.

3.9.3. If prompted to purchase additional licenses or software keys, the tester should decline unless such items are required to complete the UUT setup process.

3.9.4. For UUTs that require a service provider subscription to provide the active function, the subscription should not be purchased unless this is required to complete the UUT setup process. The tester will note if the active function is not available because the UUT is not enrolled with a service provider. The tester will use best judgement in placing the UUT in DCP inactive state for testing (Section 7) and ***record how it was accomplished***.

Examples:

- A security system should not be registered and enrolled for additional services from the manufacturer, unless necessary to provide primary and DCP inactive state functions.
- In most cases, voice over Internet protocol (VoIP) phone must be registered with and provisioned by a service provider to provide primary function(s), dial tone and calling capability.

3.10. If the manufacturer instructions are incomplete, the tester will use best judgement in setting up UUT for use and record how it was completed.

Example: Manufacturer instructions do not give guidance to connect to network, but a network connection is required for normal use. Tester would connect the UUT to the network and record the method employed.

4. Set up network connection.

In many cases, the manufacturer's instructions will be a sufficient guide to setting up network connection(s). In some cases, the UUT may be tested multiple times to test individual network technologies, one at a time.

4.1. Determine and record which network technologies operate under normal use of the UUT.

Notes:

- Some UUTs may have multiple technologies but use only one at a time. For example, a printer may be network connected by Ethernet or Wi-Fi but uses only one at a time.
- Other UUTs, including network equipment, hubs, and mesh systems, may use multiple technologies at the same time. For example, a smart home hub connects to the WAN using Ethernet, and to end points like lamps using Zigbee. Both Ethernet and Zigbee should be connected during testing.
- Some UUTs may use Bluetooth or other low power technology to establish a network connection between a smart phone and the UUT in order set up a connection to the LAN, but the connection is not part of normal operation.

4.2. If more than one network technology or combination of network technologies can be used under normal operation, choose one for the warmup period and the first test.

Repeat the DCP inactive state test, measuring each network technology or combination of network technologies that can operate under normal use of the UUT per the instructions in Section 8.

4.3. UUTs will be connected to a live WAN and allowed to send and receive data normally.

Note: For network-connected devices, the UUT will be connected to a LAN and WAN with a

router and modem, or a gateway. See Section 4.5 for additional guidance on network equipment and integrated network devices.

4.4. The network equipment used to connect the UUT to the LAN and WAN will have the following capabilities:

4.4.1. The network equipment will support the highest and lowest data rates that the UUT can employ.

4.4.2. The network equipment will support Link Layer Discovery Protocol (LLDP) for IEEE 802.3az, or other power management functions supported by the UUT. ***Record the make and model number of any routers or other network equipment used in this setup.***

4.5. Additional steps for network equipment and integrated network device UUTs.

4.5.1. Set up UUT network connections according to Section 7.3 and 7.5 of ANSI/CTA-2049-A test procedure. ***Record the test client type(s) and model number(s) connected to the UUT.***

5. Prepare test environment.

Prepare the test environment to ensure that the UUT remains in DCP inactive state, and it is not triggered to enter an active mode unless intentionally directed by the tester. The conditions required of the test environment depend on the UUT's functionality and how active mode is triggered. If the UUT is triggered into active state by any of the following environmental conditions, perform the following measures to prevent the trigger.

5.1. Ambient light

5.1.1. Binary UUT response: If the UUT changes from active to DCP inactive state in response to a discrete light level, provide an ambient light level that keeps the UUT in DCP inactive state.

Example: A nightlight that turns on in a dark room should be tested in a bright room to prevent the light from turning on.

5.1.2. Scaled UUT response: If the UUT scales power according to room illuminance while in DCP inactive state, perform this test at 10 lux and 300 lux, and ***report power for both measurements***.

Example: A product has an information display that is illuminated in DCP inactive state and has automatic brightness control.

5.2. Ambient sound: Ensure the test environment does not have ambient sound that would activate the UUT during the warmup or test periods.

5.3. Motion: Ensure no person or moving object is in vicinity of UUT during warmup or test periods.

5.4. Voice: Ensure the trigger command is not spoken during warmup or test periods.

5.5. Gestures: Ensure no gestures are performed in front of the UUT during warmup or test periods.

5.6. Hinge or entry sensors: Ensure the sensor is not triggered during warmup or test periods.

5.7. App: Do not use the UUT's app during warmup or test periods except to place UUT in its DCP inactive state if necessary.

5.8. ***Record environmental controls employed according to this section during the warmup and test periods.***

6. UUT warmup and provisioning.

6.1. After setup, place the UUT in active mode and allow the UUT to remain powered and connected to the network (if applicable) in order to provision itself. Assuming that the UUT may power down to lower power operating states, ensure that the test environment will not trigger the UUT to re-enter active mode during the warmup period. Data collected during the warmup will help the tester determine how the UUT will be tested. The length of the warmup period shall be

determined by the greater of: (a) the amount of time needed to observe UUT power behavior in DCP inactive state, up to 24 hours, or (b) the manufacturer's recommended provisioning time. ***Record the warmup time.***

6.2. Collect timeseries power readings over the entire warmup period at equal intervals of 1 second or less.[7]

6.2.1. Use the timeseries data to determine how long the UUT takes to reach stability. Note any cyclic behavior and its period, or any other unstable behavior that could potentially be captured during a power measurement.

6.2.2. Note if the UUT power level drops during the warmup period. If power draw changes are stepwise and appear to be automatic power down (APD) events, record the time of each event relative to the start of the test.

6.2.3. ***Record environmental conditions that potentially impact inactive power and how they should be controlled during subsequent power measurements.***

6.2.4. Determine and record the amount of time power measurement test(s) should be in order to capture the UUT's inactive state behavior.

6.3. If the UUT has a rechargeable battery and the ability to indicate the state of charge to the user, for example via an indicator light or a battery icon, check that it is fully charged at the end of the warmup time.

The battery must be fully charged prior to the DCP inactive state test; continue the warmup period until battery charging is complete. If the UUT does not report state of charge information to the user, the tester should review the warmup data log for obvious signs of battery charging events and extend the warmup period as necessary to ensure the battery is fully charged prior to testing.

7. Put the UUT into DCP inactive state and collect power measurement.

7.1. After the warmup period, determine if the UUT has automatically powered down during the warmup period, and if so, estimate the time to APD (t_{APD}).

7.1.1. Note the time required for the UUT to reach its lowest power level, and whether or not that time exceeds t_{APD} + 3 hours.

7.1.2. Determine other ways the UUT can enter DCP inactive state, for example: a menu command, soft switch, or the discontinuation of content playback (for example pausing a movie).

7.2. ***Force the UUT into active mode by direct input or by using one of the triggers discussed above***. For network equipment, check that the network connection between the UUT and test client(s) is active by using the test client(s) to request data (e.g., load a web page).

7.3. If the UUT is capable of APD, allow it to enter DCP inactive state via APD (Figure 5).

[7] Minimum power reading interval adopted from IEC 62301:2011, section 5.3.2.

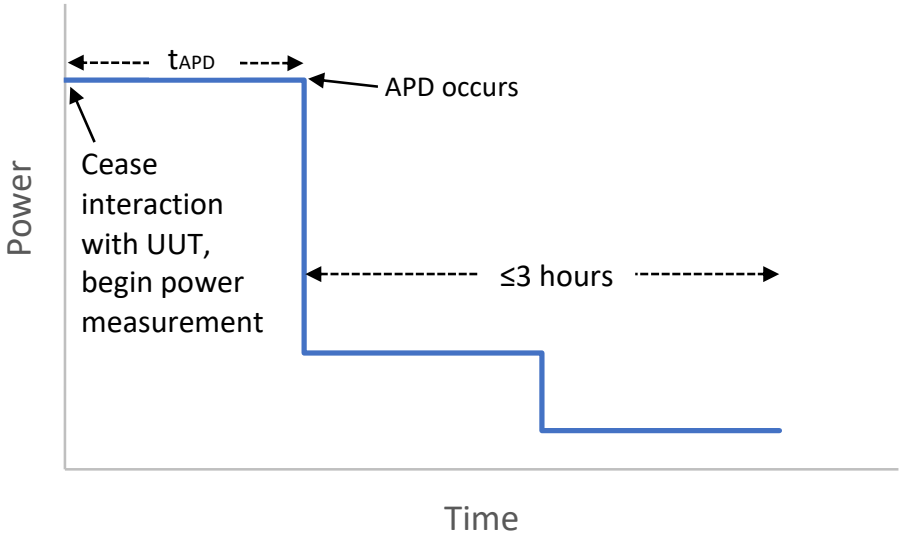

Figure 5: Example of power as a function of time if UUT is allowed to APD. The power measurement begins when the tester ceases interaction with the UUT. APD occurs at time t_{APD}. Average power is calculated over a period that characterizes UUT power in DCP inactive state, up to 3 hours following APD. In DCP inactive state, the UUT may power down to lower power operational modes or exhibit other types of variable behavior.

7.3.1. Begin power measurement upon the end of user interaction with the UUT that causes it to be in active mode, such as voice commands, playing content, triggering sensors, or using an app.

7.3.2. ***Record the APD time (t_{APD})***, which is the time from the last user interaction with the UUT to when the UUT has displayed a distinct (usually stepwise) power reduction indicating that the UUT has automatically powered down.

7.3.3. Special instructions for media players: if the UUT spends an extended period of time in active mode in response to a user interaction, the tester may halt the primary function manually. The tester will begin logging data before halting the primary function (Section 7.3.1) and measure t_{APD} as the time between halting the primary function and the first power down event (Section 7.3.2).
Example: In active mode, a DVD player plays a movie. The tester may halt the movie by pressing the stop button. The tester will begin logging data before stop button, and measure t_{APD} as the time between pressing the stop button and the first power down event.

7.3.4. Continue to measure until the datalog captures the DCP inactive state behavior of the UUT for a minimum of 15 minutes and a maximum of 3 hours after the APD event.

7.3.5. ***Calculate and record average power (P_{avg})*** of the data logged between the time of the APD event and the end of the test (maximum of 3 hours).

7.3.6. If the UUT exhibits stepwise or other power decreases over the measurement interval, additionally report the average power during the last 15 minutes (P_{last15}) of the test.
If a stepwise power decrease occurs in the last 15 minutes of a test, the test may be extended up to 15 minutes in order to capture the lowest power level observed in the P_{last15} measurement.

7.4. If the UUT is not capable of APD, manually place the UUT in DCP inactive state (Figure 6).

7.4.1. Begin power measurement as soon as the UUT has been placed in DCP inactive state.

7.4.2. Continue measurement until the datalog captures the DCP inactive state behavior of the UUT for a maximum of 3 hours of inactivity.

7.4.3. ***Calculate and record average power (P_{avg}) in inactive state.***

7.4.4. If the UUT exhibits stepwise or other power decreases over the measurement interval, additionally report the average power during the last 15 minutes (P_{last15}) of the test. If a stepwise power decrease occurs in the last 15 minutes of a test, the test may be extended up to 15 minutes in order to capture the lowest power level observed in the P_{last15} measurement.

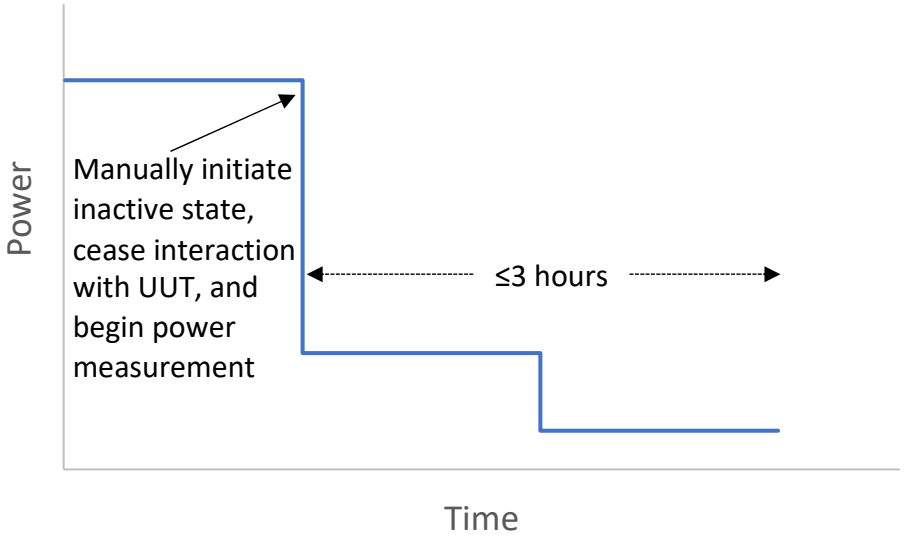

Figure 6: Example of power as a function of time if the UUT is manually forced into DCP inactive state. The power measurement begins when the tester initiates DCP inactive state and ceases interaction with the UUT. Average power is calculated over a period that characterizes UUT power in DCP inactive state, up to 3 hours following entry into DCP inactive state. In DCP inactive state, the UUT may power down to lower power operational modes or exhibit other types of variable behavior.

If the UUT is capable of both APD and manual DCP inactive state initiation, conduct a test for each initiation method.

7.5. If the UUT does not exhibit APD during the warmup period, and if it is not capable of manual DCP inactive state initiation, cease user interaction with the UUT that causes it to be in active mode (e.g., voice commands, playing content, triggering sensors, or using an app) and begin measurement (Figure 7).

7.5.1. Measure power until the datalog captures the DCP inactive state behavior of the UUT for a maximum of 3 hours.

7.5.2. ***Calculate and record average power (P_{avg}) in DCP inactive state.***

7.6. If the UUT is network equipment, allow the UUT and test clients to sit undisturbed, passing traffic as they may need to maintain connectivity and DCP inactive state functionality. Test clients may enter sleep mode, and the tester should not interact with the UUT or the test clients during the test.

7.6.1. Measure power until the datalog captures the DCP inactive state behavior of the UUT for a maximum of 3 hours.

7.6.2. ***Calculate and record average power (P_{avg}) in inactive state.***

7.6.3. If the UUT exhibits stepwise or other power decreases over the measurement interval, additionally report the average power during the last 15 minutes (P_{last15}) of the test. If a stepwise power decrease occurs in the last 15 minutes of a test, the test may be extended

up to 15 minutes in order to capture the lowest power level observed in the P_{last15} measurement.

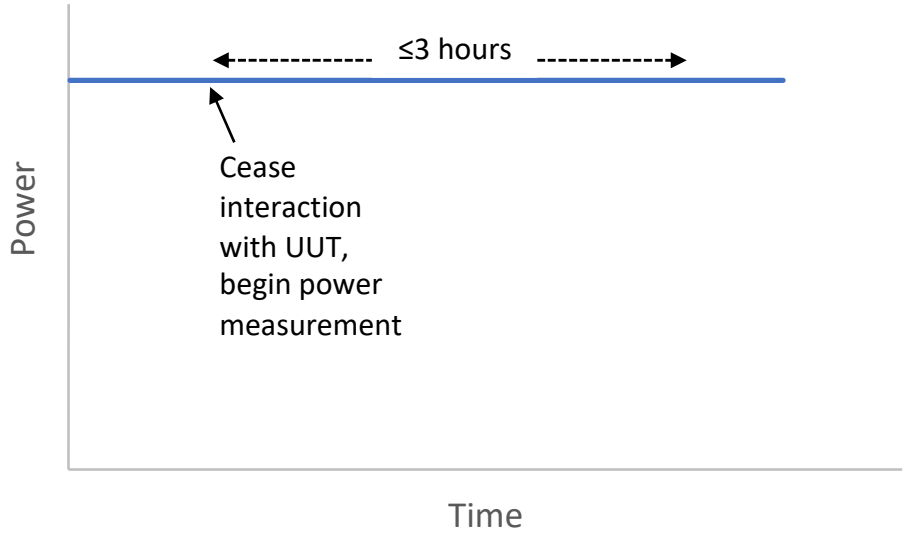

Figure 7: Example of power as a function of time if the UUT does not exhibit APD or is not capable of user initiated low power states. The power measurement begins when the tester initiates DCP inactive state and ceases interaction with the UUT. Average power is calculated over X hours after the tester has ceased interaction with the UUT.

7.7. ***For each test, to the extent practical, record the functions that are available while the UUT is being tested.*** Record, qualitatively, the power behavior exhibited by the UUT during the average power measurement (e.g., stable, varying, irregular; constant, cyclic, non-cyclic).

8. Additional tests.

As indicated in the setup instructions, a suite of tests will be performed to capture the behavior of the UUT in different setup configurations. Additional tests will be performed if the UUT:
(A) can be powered with more than one input voltage (Section 3.1),
(B) can be connected with more than one network technology or combination of technologies (Section 4),
(C) has more than one DCP inactive state initiation method (Section 7.1),
(D) has more than one power management setting (Section 3.6), and/or
(E) has an off mode as identified in Section 2.6. Off mode power will be tested according to IEC 62301-2011.
If the UUT has multiple options in more than one of the five cases above, the tester need not conduct a test for every permutation. Rather, the tester will vary setup parameters in one group while holding other setup parameters constant and according to the order of preference listed in Table 1. An illustrative example is outlined below.

Table 1: Order of Preference for Test Parameters Used in Additional Testing

Power Delivery	Network Technology	DCP Inactive State Initiation Method	Power Management Settings	UUT State
1. Mains (120 Vac) 2. Other ac voltage 3. USB 4. PoE 5. Other dc voltage	1. Highest bandwidth wireless technology 2. Highest bandwidth wired technology	1. APD 2. Manual power down 3. No power down method	1. Default settings 2. Highest power settings	1. DCP inactive state 2. Off mode

Additional tests, example A
Consider a UUT that:
(A) can be powered with 120Vac from mains or 5Vdc via USB,
(B) has Wi-Fi and Zigbee network technologies,
(C) enters DCP inactive state using APD,
(D) has no power management settings, and
(E) does not have an off mode.
The tester would conduct three tests with the following setup parameters:

Test	Power Delivery	Network Technology	DCP Inactive State Initiation Method	Power Management Settings	UUT State
A1	120 Vac	Wi-Fi	APD	Default settings	DCP inactive state
A2	5 Vdc	Wi-Fi	APD	Default settings	DCP inactive state
A3	120 Vac	Zigbee	APD	Default settings	DCP inactive state

In tests A2 through A3, properties held constant and selected from the order of preference in Table 1 are noted with gray shading.

Additional tests, example B
Consider a UUT that:
(A) can be powered with 120Vac from mains or 5Vdc via USB,
(B) can use Ethernet or Wi-Fi,
(C) can enter DCP inactive state using APD or be manually powered down,
(D) has three or more power management settings, and
(E) has an off mode.
The tester would conduct seven tests with the following setup parameters:

Test	Power Delivery	Network Technology	DCP Inactive State Initiation Method	Power Management Settings	UUT State
B1	120 Vac	Wi-Fi	APD	Default settings	DCP inactive state
B2	5 Vdc	Wi-Fi	APD	Default settings	DCP inactive state
B3	120 Vac	Ethernet	APD	Default settings	DCP inactive state
B4	120 Vac	Wi-Fi	Manual initiation	Default settings	DCP inactive state
B5	120 Vac	Wi-Fi	APD	Highest power settings	DCP inactive state
B6	120 Vac	Wi-Fi	APD	Lowest power settings	DCP inactive state
B7	120 Vac	Wi-Fi	APD	Default settings	Off mode

In tests B2 through B7, properties held constant and selected from the order of preference in Table 1 are noted with gray shading.

9. Invalid tests.

9.1. The tester may invalidate a test for a variety of reasons, including:

9.1.1. The UUT cannot be set up according to the DCP and provide its primary function(s). If the tester determines that the UUT can be placed in an inactive state, the tester will make note that active mode was not achieved and continue testing the UUT according to the DCP. If the UUT cannot be set up to provide active or secondary function, for example because a necessary app is no longer available for download, the tester will note that the UUT cannot be tested,

9.1.2. During the DCP inactive state test, the product was triggered into active mode. The tester will determine the active mode trigger and work to eliminate it from the test environment. The test will be rerun until all triggers are removed from the environment and the UUT remains in DCP inactive state for the entire test period. For multi-component UUTs, the tester shall review data collected from each mains-powered component to ensure that all components have remained in inactive state during the test.

10. Additional guidance.

Requirement: Minimum data reporting.

The minimum data reported for a valid test includes:

- UUT details: manufacturer, model, product category, primary function(s), rated voltage, and frequency.
- DCP inactive state behavior: qualitative description of UUT power behavior during warmup that is captured during the power test, time required to capture inactive state behavior as determined by warmup data.
- Test details: test number or reference, test date, state tested, power averaging interval, average power.
- Laboratory details: Laboratory name and address, test officer(s).
- Test equipment details: description, model number, calibration ID number, calibration due date.

Recommendation: Include supplemental information where useful.

If the test setup or power draw behavior is out of the ordinary, document with photos or other means in test report or attachment.

Recommendation: Deprovision UUT after testing

Once tests on a UUT are complete and the data is confirmed complete and accurate, deprovisioning the UUT is recommended to remove any information provided by the tester. This may include resetting the UUT to factory default settings and deleting or deactivating user accounts on the UUT, in an app, or on a cloud service.