

DOCKETED

Docket Number:	17-IEPR-07
Project Title:	Integrated Resource Planning
TN #:	221492
Document Title:	Energy Star, Energy Star Program Requirements for Electric Vehicle Supply Equipment Version 1.0, (April 7, 2017)
Description:	terms of the ENERGY STAR Partnership Agreement as it pertains to the manufacture and labeling of ENERGY STAR certified products.
Filer:	Tami Haas
Organization:	Energy Star
Submitter Role:	Public Agency
Submission Date:	10/12/2017 4:48:00 PM
Docketed Date:	10/12/2017



ENERGY STAR® Program Requirements for Electric Vehicle Supply Equipment

Partner Commitments

Following are the terms of the ENERGY STAR Partnership Agreement as it pertains to the manufacture and labeling of ENERGY STAR certified products. The ENERGY STAR Partner must adhere to the following partner commitments:

Certifying Products

1. Comply with current ENERGY STAR Eligibility Criteria, which define performance requirements and test procedures for Electric Vehicle Supply Equipment. A list of eligible products and their corresponding Eligibility Criteria can be found at www.energystar.gov/specifications.
2. Prior to associating the ENERGY STAR name or mark with any product, obtain written certification of ENERGY STAR certification from a Certification Body recognized by EPA for Electric Vehicle Supply Equipment. As part of this certification process, products must be tested in a laboratory recognized by EPA to perform Electric Vehicle Supply Equipment testing. A list of EPA-recognized laboratories and certification bodies can be found at www.energystar.gov/testingandverification.

Using the ENERGY STAR Name and Marks

3. Comply with current ENERGY STAR Identity Guidelines, which define how the ENERGY STAR name and marks may be used. Partner is responsible for adhering to these guidelines and ensuring that its authorized representatives, such as advertising agencies, dealers, and distributors, are also in compliance. The ENERGY STAR Brand Book is available at www.energystar.gov/logouse.
4. Use the ENERGY STAR name and marks only in association with certified products. Partner may not refer to itself as an ENERGY STAR Partner unless at least one product is certified and offered for sale in the U.S. and/or ENERGY STAR partner countries.
5. Provide clear and consistent labeling of ENERGY STAR certified Equipment.
 - 5.1. The ENERGY STAR mark must be clearly displayed:
 - 5.1.1. Permanently affixed to the front of the product or on/next to the machine nameplate;

Option for electronic labeling: In instances where an electronic display is present, manufacturers have the option of displaying an electronic label in place of a physical label in a corner of the display, at system start-up, between marketing segments, or at the beginning of a transaction, as long it meets the following requirements:

 - The ENERGY STAR mark in cyan, black, or white (as described in the ENERGY STAR Brand Book available at www.energystar.gov/logouse).
 - The electronic mark must display for a minimum of 5 seconds;
 - The ENERGY STAR mark must be at least 10% of the screen by area, may not be smaller than 76 pixels x 78 pixels, and must be legible.

EPA will consider alternative proposals regarding approach, duration, or size for electronic labeling on a case-by-case basis.
 - 5.1.2. In product literature (i.e., user manuals, spec sheets, etc.);
 - 5.1.3. On product packaging; and

- 5.1.4. On the manufacturer's Internet site where information about ENERGY STAR certified models is displayed.

Verifying Ongoing Product Certification

6. Participate in third-party verification testing through a Certification Body recognized by EPA for Electric Vehicle Supply Equipment, providing full cooperation and timely responses, EPA/DOE may also, at its discretion, conduct tests on products that are referred to as ENERGY STAR certified. These products may be obtained on the open market, or voluntarily supplied by Partner at the government's request.

Providing Information to EPA

7. Provide unit shipment data or other market indicators to EPA annually to assist with creation of ENERGY STAR market penetration estimates, as follows:
 - 7.1. Partner must submit the total number of ENERGY STAR certified Electric Vehicle Supply Equipment shipped in the calendar year or an equivalent measurement as agreed to in advance by EPA and Partner. Partner shall exclude shipments to organizations that rebrand and resell the shipments (unaffiliated private labelers).
 - 7.2. Partner must provide unit shipment data segmented by meaningful product characteristics (e.g., type, capacity, presence of additional functions) as prescribed by EPA.
 - 7.3. Partner must submit unit shipment data for each calendar year to EPA or an EPA-authorized third party, preferably in electronic format, no later than March 1 of the following year.Submitted unit shipment data will be used by EPA only for program evaluation purposes and will be closely controlled. If requested under the Freedom of Information Act (FOIA), EPA will argue that the data is exempt. Any information used will be masked by EPA so as to protect the confidentiality of the Partner.
8. Report to EPA any attempts by recognized laboratories or Certification Bodies (CBs) to influence testing or certification results or to engage in discriminatory practices.
9. Notify EPA of a change in the designated responsible party or contacts within 30 days using the My ENERGY STAR Account tool (MESA) available at www.energystar.gov/mesa.

Training and Consumer Education

10. Partner shall agree to complete steps to educate users about the benefits of more energy efficient products by including the following information with each EVSE (i.e., in the user manual or on a box insert):
 - 10.1. Energy saving potential;
 - 10.2. Financial saving potential;
 - 10.3. Environmental benefits;
 - 10.4. Information on ENERGY STAR and a link to www.energystar.gov; and
 - 10.5. ENERGY STAR logo (used in accordance with the ENERGY STAR Brand Book available at www.energystar.gov/logouse).
11. At the manufacturer's request, EPA will supply suggested facts and figures related to the above criteria, template elements, or a complete template suitable for use in user guides or box inserts.

Performance for Special Distinction

In order to receive additional recognition and/or support from EPA for its efforts within the Partnership, the ENERGY STAR Partner may consider the following voluntary measures, and should keep EPA informed on the progress of these efforts:

- Provide quarterly, written updates to EPA as to the efforts undertaken by Partner to increase availability of ENERGY STAR certified products, and to promote awareness of ENERGY STAR and its message.
- Consider energy efficiency improvements in company facilities and pursue benchmarking buildings through the ENERGY STAR Buildings program.
- Purchase ENERGY STAR certified products. Revise the company purchasing or procurement specifications to include ENERGY STAR. Provide procurement officials' contact information to EPA for periodic updates and coordination. Circulate general ENERGY STAR certified product information to employees for use when purchasing products for their homes.
- Feature the ENERGY STAR mark(s) on Partner website and other promotional materials. If information concerning ENERGY STAR is provided on the Partner website as specified by the ENERGY STAR Web Linking Policy (available in the Partner Resources section of the ENERGY STAR website), EPA may provide links where appropriate to the Partner website.
- Ensure the power management feature is enabled on all ENERGY STAR certified displays and computers in use in company facilities, particularly upon installation and after service is performed.
- Provide general information about the ENERGY STAR program to employees whose jobs are relevant to the development, marketing, sales, and service of current ENERGY STAR certified products.
- Provide a simple plan to EPA outlining specific measures Partner plans to undertake beyond the program requirements listed above. By doing so, EPA may be able to coordinate, and communicate Partner's activities, provide an EPA representative, or include news about the event in the ENERGY STAR newsletter, on the ENERGY STAR website, etc. The plan may be as simple as providing a list of planned activities or milestones of which Partner would like EPA to be aware. For example, activities may include: (1) increasing the availability of ENERGY STAR certified products by converting the entire product line within two years to meet ENERGY STAR guidelines; (2) demonstrating the economic and environmental benefits of energy efficiency through special in-store displays twice a year; (3) providing information to users (via the website and user's manual) about energy-saving features and operating characteristics of ENERGY STAR certified products; and (4) building awareness of the ENERGY STAR Partnership and brand identity by collaborating with EPA on one print advertorial and one live press event.
- Join EPA's SmartWay Transport Partnership to improve the environmental performance of the company's shipping operations. The SmartWay Transport Partnership works with freight carriers, shippers, and other stakeholders in the goods movement industry to reduce fuel consumption, greenhouse gases, and air pollution. For more information on SmartWay, visit www.epa.gov/smartway.
- Join EPA's Green Power Partnership. EPA's Green Power Partnership encourages organizations to buy green power as a way to reduce the environmental impacts associated with traditional fossil fuel-based electricity use. The partnership includes a diverse set of organizations including Fortune 500 companies, small and medium businesses, government institutions as well as a growing number of colleges and universities. For more information on Green Power, visit www.epa.gov/greenpower.



ENERGY STAR® Program Requirements for Electric Vehicle Supply Equipment

Eligibility Criteria Version 1.0 Rev. Apr-2017

Following is the Version 1.0 ENERGY STAR product specification for Electric Vehicle Supply Equipment. A product shall meet all of the identified criteria if it is to earn the ENERGY STAR.

1 DEFINITIONS

- A) **Electric Vehicle Supply Equipment (EVSE):** The conductors, including the ungrounded, grounded, and equipment grounding conductors, the electric vehicle connectors, attachment plugs, and all other fittings, devices, power outlets, or apparatuses installed specifically for the purpose of delivering energy from the premises wiring to the electric vehicle. Charging cords with NEMA 5-15P and NEMA 5-20P attachment plugs are considered EVSEs. Excludes conductors, connectors, and fittings that are part of the vehicle.¹
- 1) **Level 1:** A galvanically-connected EVSE with a single-phase input voltage nominally 120 volts ac and maximum output current less than or equal to 16 amperes ac.²
 - 2) **Level 2:** A galvanically-connected EVSE with a single-phase input voltage range from 208 to 240 volts ac and maximum output current less than or equal to 80 amperes ac.²
 - 3) **Fast dc:** A galvanically-connected EVSE that includes an off-board charger and provides dc current greater than or equal to 80 amperes dc.
 - 4) **Wireless / Inductive:** A non-galvanically-connected EVSE.

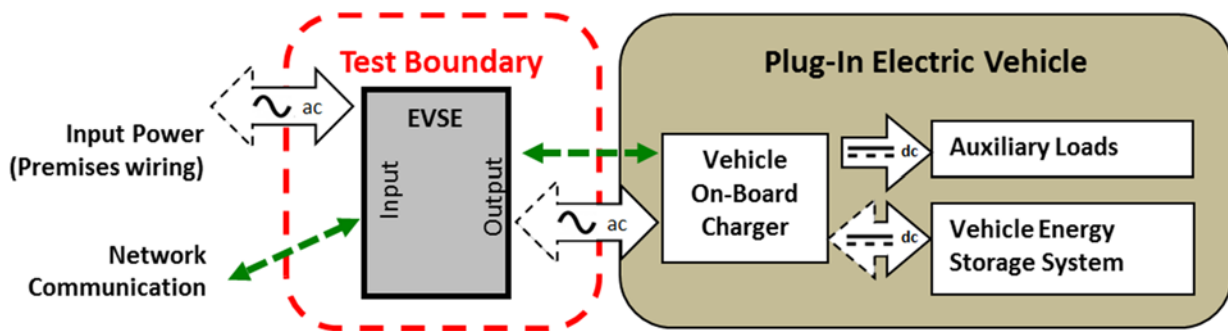


Figure 1: Schematic of Overall Plug-In Vehicle Charging System Detailing EVSE Test Boundary

- B) EVSE Functions:
- 1) **Primary Function:** Providing current to a connected load.
 - 2) **Secondary Function:** Function that enables, supplements or enhances a primary function. For EVSE, examples of Secondary Functions are:

¹ SAE J2894-1 Section 3.10.

² This definition is intended to be consistent with the requirements in SAE J1772, with some additional clarifications.

a) Automatic Brightness Control (ABC): The self-acting mechanism that controls the brightness of a display or lamp as a function of ambient light.

b) Full Network Connectivity: The ability of the EVSE to maintain network presence while in Partial On Mode.

Note: Presence of the EVSE's network services, its applications, and possibly its display is maintained even if some components of the EVSE are powered down. The EVSE can elect to change power states based on receipt of network data from remote network devices, but should otherwise stay in a low power mode absent a demand for services from a remote network device.

c) Occupancy Sensing: detection of human or object presence in front of or in the area surrounding an EVSE.

d) Communicating with the vehicle;

e) Illumination of display, indicator lights, or ambient lighting;

f) Public access control (RFID card, authorization, etc.);

g) Control Pilot Signal; and

h) Wake-up function.

3) Tertiary Function: Function other than a primary or a secondary function.

Example: An EMC filter and status indication provides their function in No Vehicle Mode, Partial On Mode, and On Mode.

C) EVSE Operational Modes and Power States:

Note: The transition period to a different mode; whether automatically initiated, or via user action; does not constitute a mode.

1) Disconnected: Condition of the equipment during which all connections to power sources supplying the equipment are removed or galvanically isolated and no functions depending on those power sources are provided. The term power source includes power sources external and internal to the equipment.

2) No Vehicle Mode: Condition during which the equipment is connected to external power and the product is physically disconnected from vehicle (mode can only be entered or exited through manual intervention). No Vehicle Mode is intended to be the lowest-power mode of the EVSE.

Note: The vehicle-EVSE interface is in State A of SAE J1772, where the vehicle is not connected.³

3) On Mode: Condition during which the equipment provides the primary function or can promptly provide the primary function.

a) Operation Mode: Condition during which the equipment is performing the primary function.

Note: The vehicle-EVSE interface is in State C, where the vehicle is connected and accepting energy.³

b) Idle Mode: Condition during which the equipment can promptly provide the primary function but is not doing so.

Note: Idle Mode is the condition within On Mode where the EVSE is connected to the vehicle or vehicle simulator but is not actively providing current. The vehicle-EVSE interface is in State C, where the vehicle is connected and ready to accept energy.³

³ This mode is intended to be associated with a vehicle/EVSE interface state (e.g., A, B, or C) as defined in SAE J1772.

- 4) **Partial On Mode:** Condition during which the equipment provides at least one secondary function but no primary function.

Note: The vehicle-EVSE interface is in State B1 or B2, where the vehicle is connected but not ready to accept energy and the EVSE is or is not ready to supply energy.³

Table 1: Operational Modes and Power States

Operational Modes	Most closely related Interface State as Defined in SAE J1772	Further Description
No Vehicle Mode	State A	No Vehicle Mode is associated with State A, or where the EVSE is not connected to the EV. The EVSE is connected to external power.
Partial On Mode	State B1 or State B2	Partial On Mode is associated with State B1 or State B2 where the vehicle is connected but is not ready to accept energy. Sub-state B1 is where the EVSE is not ready to supply energy and sub-state B2 is where the EVSE is ready to supply energy.
On Mode		
Idle Mode	State C	Idle Mode is associated with State C, where the vehicle is connected and ready to accept energy and the EVSE is capable of promptly providing current to the EV but is not doing so.
Operation Mode	State C	Operation Mode is associated with State C, where the EVSE is providing the primary function, or providing current to a connected load (i.e., the relay is closed and the vehicle is not drawing current).

- 5) **Power Management:** Automatic control mechanism that achieves the lowest power consistent with a pre-determined level of functionality.

D) Other:

- 1) **Apparent power (S):** The product of RMS voltage and RMS current, which is equal to magnitude of the complex power, and measured in volt-amperes (VA).
- 2) **Average Power (P) (also Real Power):** The power in a circuit which is transformed from electric to non-electric energy and is measured in watts (W). For a two-terminal device with instantaneous current and voltage waveforms $i(t)$ and $v(t)$ which are periodic with period T , the real or average power P is⁴:

⁴ Average power is intended to align with the definition of real power in SAE J2894.

$$P = \frac{1}{T} \int_0^T v(t)i(t)dt$$

- 3) Duty Cycle: The ratio of a given time interval of the uninterrupted duration at the high logic state to the total time.

Note: This duty cycle, lying between 0 and 1, may be expressed as a percentage.

- 4) Power Factor (PF): The ratio of the average power (P) in watts to the apparent power (S) in volt-amperes.

$$PF = \frac{P}{S}$$

- 5) Unit Under Test (UUT): The specific sample of a representative model undergoing measurement which includes the base product and any accessories packaged with it.
- 6) Illuminance: The luminous flux per unit area of light illuminating a given surface, expressed in units of lux (lx).
- 7) Luminance: The photometric measure of the luminous intensity per unit area of light travelling in a given direction, expressed in candelas per square meter (cd/m²).
- 8) High Resolution Display: A screen device that converts a video signal into a visual output and is capable of displaying a minimum of 480x234 native resolution and has a backlight (e.g., LCD panel, OLED panel).

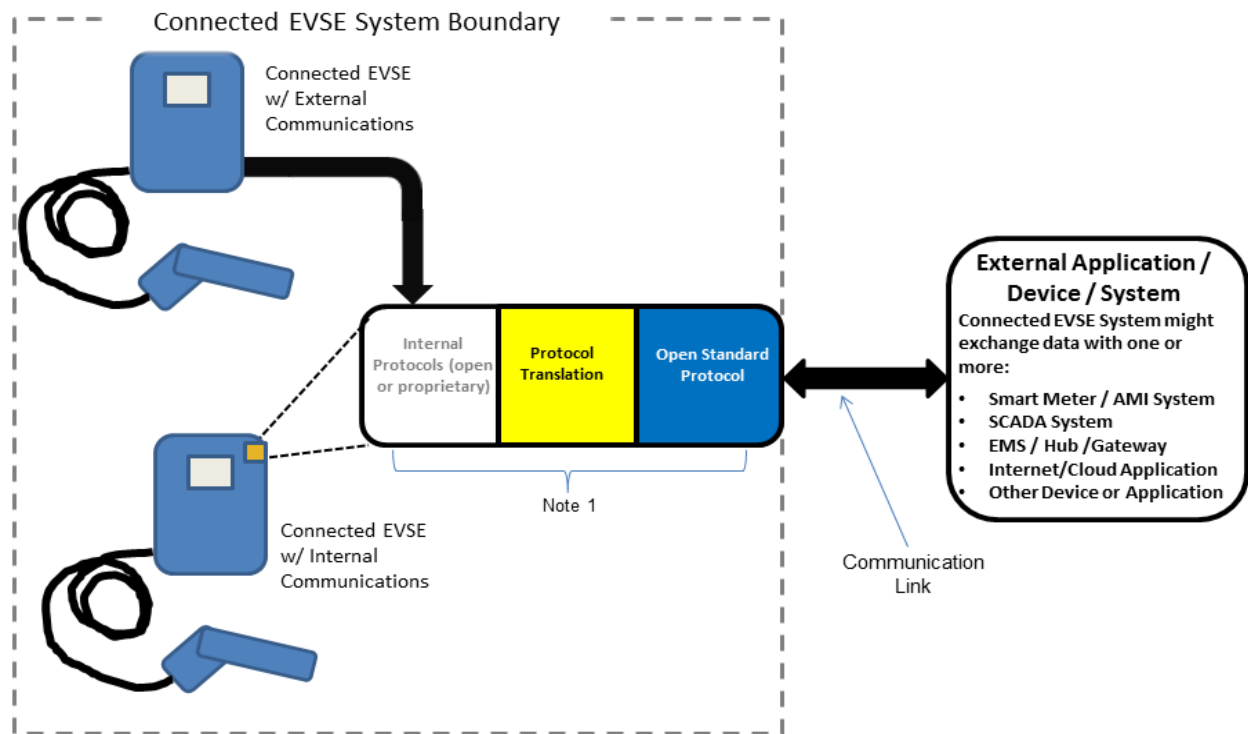
- E) Product Family: A group of product models that are (1) made by the same manufacturer, (2) subject to the same ENERGY STAR certification criteria, and (3) of a common basic design. Product models within a family differ from each other according to one or more characteristics or features that either (1) have no impact on product performance with regard to ENERGY STAR certification criteria, or (2) are specified herein as acceptable variations within a Product Family. For EVSE, acceptable variations within a Product Family include:

- 1) Color,
- 2) Output cable, and
- 3) Housing.

F) Connected Functionality Definitions

- 1) Communication Link: The mechanism for bi-directional data transfers between the EVSE and one or more external applications, devices or systems.
- 2) Demand Response (DR): Changes in electric usage by demand-side resources from their normal consumption patterns in response to changes in the price of electricity over time, or to incentive payments designed to induce lower electricity use at times of high wholesale market prices or when system reliability is jeopardized⁵.
- 3) Demand Response Management System (DRMS): The system operated by a program administrator, such as the utility or third party, which dispatches signals with DR instructions and/or price signals to the ENERGY STAR EVSE and receives messages from the EVSE.
- 4) EVSE System: As shown in Figure 2, it includes the ENERGY STAR certified EVSE, integrated or separate communications hardware, and additional hardware and software required to enable connected functionality.
- 5) Load Management Entity: DRMS, home energy management system, etc.

⁵ Federal Energy Regulatory Commission, <https://www.ferc.gov/industries/electric/indus-act/demand-response/dr-potential.asp>



Note: Communication device(s), link(s) and/or processing that enables Open Standards-based communication between the EVSE and external application / device / system(s). These elements, either individually or together, could be within the EVSE, and/or an external communication module, a hub/gateway, or in the Internet/cloud.

Figure 2: Connected EVSE System

G) Open Standards: Standards that are:

- 1) Included in the Smart Grid Interoperability Panel (SGIP) Catalog of Standards,⁶ and/or
- 2) Included in the National Institute of Standards and Technology (NIST) Smart Grid framework Tables 4.1 and 4.2,⁷ and/or
- 3) Adopted by the American National Standards Institute (ANSI) or another well-established international standards organization such as the International Organization for Standardization (ISO), International Electrotechnical Commission (IEC), International Telecommunication Union (ITU), Institute of Electrical and Electronics Engineers (IEEE), or Internet Engineering Task Force (IETF).

H) **Acronyms:**

- 1) A: Ampere
- 2) ABC: Automatic Brightness Control
- 3) ac: Alternating Current
- 4) dc: Direct Current
- 5) DOE: U.S. Department of Energy

⁶ http://collaborate.nist.gov/twiki-sggrid/bin/view/SmartGrid/PMO#Catalog_of_Standards_Processes

⁷ http://www.nist.gov/smartgrid/upload/NIST_Framework_Release_2-0_corr.pdf

- 6) DR: Demand Response
- 7) EPA: Environmental Protection Agency
- 8) EVSE: Electric Vehicle Supply Equipment
- 9) IEC: International Electrotechnical Commission
- 10) IEEE: Institute of Electrical and Electronics Engineers
- 11) NEMA: National Electrical Manufacturers Association
- 12) SAE: Society of Automotive Engineers
- 13) UUT: Unit Under Test
- 14) V: Volt
- 15) W: Watt

2 SCOPE

2.1 Included Products

- 2.1.1 Products that meet the definition for EVSE as specified herein are eligible for ENERGY STAR certification, with the exception of products listed in Section 2.2. In addition, eligible EVSE shall fall into one of the following categories:
- i. Level 1 EVSE.
 - ii. Level 2 EVSE.
 - iii. Dual Input Level 1 and Level 2 EVSE.

2.2 Excluded Products

- 2.2.1 Products that are covered under other ENERGY STAR product specifications are not eligible for certification under this specification. The list of specifications currently in effect can be found at www.energystar.gov/specifications.
- 2.2.2 The following products are not eligible for certification under this specification:
- i. Dc Output EVSE.
 - ii. Wireless/Inductive EVSE.
 - iii. Power electronic components inside the vehicle.

3 CERTIFICATION CRITERIA

3.1 Significant Digits and Rounding

- 3.1.1 All calculations shall be carried out with actual measured (unrounded) values. Only the final result of a calculation shall be rounded.
- 3.1.2 Unless otherwise specified within this specification, compliance with specification limits shall be evaluated using exact values without any benefit from rounding.

3.1.3 Directly measured or calculated values that are submitted for reporting on the ENERGY STAR website shall be rounded to the nearest significant digit as expressed in the corresponding specification limit.

3.2 General Requirements

3.2.1 Each EVSE submitted for ENERGY STAR certification shall be Listed by a Nationally Recognized Testing Laboratory (NRTL) for safety.

3.2.2 Dual Input Level 1 and Level 2 EVSE shall meet all requirements and report information in both configurations.

3.3 No Vehicle Mode Requirements

Note: These requirements refer to the SAE J1772 State A.

3.3.1 Measured No Vehicle Mode power ($P_{NO_VEHICLE}$) shall be less than or equal to the Maximum No Vehicle Mode Power Requirement ($P_{NO_VEHICLE_MAX}$), as calculated per Equation 1, subject to the following requirements.

- i. For products with ABC enabled by default, the average No Vehicle Mode power in high and low illuminance conditions shall be used in place of $P_{NO_VEHICLE}$, above.
- ii. For products capable of network connection with multiple protocols (e.g., Wi-Fi and Cellular), only the allowance for the protocol enabled during testing shall be claimed.

Equation 1: Calculation of Maximum No Vehicle Mode Power Requirement

$$P_{NO_VEHICLE_MAX} = 2.6 + P_{WAKE} + P_{DISPLAY}$$

Where:

- $P_{NO_VEHICLE_MAX}$ is the Maximum No Vehicle Mode Power Requirement;
- P_{WAKE} is the No Vehicle Mode power allowance for the network connection with wake capability enabled during testing listed in Table 2; and
- $P_{DISPLAY}$ is the No Vehicle Mode power allowance for a High Resolution Display enabled during testing listed in Table 2.

Table 2: No Vehicle Mode Power Allowances

Product Function	No Vehicle Mode Power Allowance (watts, rounded to the nearest 0.1 W for reporting)
In-use Wi-Fi or Ethernet Interface with Wake Capability (P_{WAKE})	$\frac{1.0}{n}$ <p><i>Where:</i></p> <ul style="list-style-type: none"> n is the number of outputs.
In-use Cellular with Wake Capability (P_{WAKE})	$\frac{2.0}{n}$ <p><i>Where:</i></p> <ul style="list-style-type: none"> n is the number of outputs.
Other In-use LAN (Local Area Network) Interface with Wake Capability (P_{WAKE})	$\frac{1.0}{n}$ <p><i>Where:</i></p> <ul style="list-style-type: none"> n is the number of outputs.
In-use High Resolution Display ($P_{DISPLAY}$)	$\frac{[(4.0 \times 10^{-5} \times \ell \times A) + 119 \times \tanh(0.0008 \times [A - 200.0] + 0.11) + 6.0]}{n}$ <p><i>Where:</i></p> <ul style="list-style-type: none"> A is the Screen Area in square inches; ℓ is the Maximum Measured Luminance of the Display in candelas per square meter, as measured in Section 4) C) of the ENERGY STAR Test Method for Determining Electric Vehicle Supply Equipment Energy; \tanh is the hyperbolic tangent function; and n is the number of outputs. <p>Example: For a single-output EVSE with a maximum measured luminance of 300 candelas/m² and a 5×5 inch screen, the allowance for the in-use display would be 2.7 watts.</p>

3.4 Partial On Mode Requirements

Note: These requirements refer to the SAE J1772 State B1 or State B2.

3.4.1 Measured Partial On Mode power ($P_{PARTIAL_ON}$) shall be less than or equal to the Maximum Partial On Mode Power Requirement ($P_{PARTIAL_ON_MAX}$), as calculated per Equation 2, subject to the following requirements.

- i. For products with ABC enabled by default, the average Partial On Mode power in high and low illuminance conditions shall be used in place of $P_{PARTIAL_ON}$, above.
- ii. For products capable of network connection with multiple protocols (e.g., Wi-Fi and Cellular), only the allowance for the protocol enabled during testing shall be claimed.

Equation 2: Calculation of Maximum Partial On Mode Power Requirement

$$P_{PARTIAL_ON_MAX} = 2.6 + P_{WAKE} + P_{DISPLAY}$$

Where:

- $P_{PARTIAL_ON_MAX}$ is the Maximum Partial On Mode Power Requirement;
- P_{WAKE} is the Partial On Mode power allowance for the network connection with wake capability enabled during testing listed in Table 3; and
- $P_{DISPLAY}$ is the Partial On Mode power allowance for a High Resolution Display enabled during testing listed in Table 3.

Table 3: Partial On Mode Power Allowances

Product Function	Partial On Mode Power Allowance (watts, rounded to the nearest 0.1 W for reporting)
In-use Wi-Fi or Ethernet Interface with Wake Capability (P_{WAKE})	$\frac{1.0}{n}$, Where: • n is the number of outputs.
In-use Cellular with Wake Capability (P_{WAKE})	$\frac{2.0}{n}$, Where: • n is the number of outputs.
Other In-use LAN (Local Area Network) Interface with Wake Capability (P_{WAKE})	$\frac{1.0}{n}$, Where: • n is the number of outputs.
In-use High Resolution Display ($P_{DISPLAY}$)	$[(4.0 \times 10^{-5} \times \ell \times A) + 119 \times \tanh(0.0008 \times [A - 200.0] + 0.11) + 6.0] / n$ Where: • A is the Screen Area in square inches; • ℓ is the Maximum Measured Luminance of the Display in candelas per square meter, as measured in Section 4) C) of the ENERGY STAR Test Method for Determining Electric Vehicle Supply Equipment Energy; • \tanh is the hyperbolic tangent function; and • n is the number of outputs. Example: For a single-output EVSE with a maximum measured luminance of 300 candelas/m ² and a 5×5 inch screen, the allowance for the in-use display would be 2.7 watts.

3.5 Idle Mode Requirements

Note: These requirements refer to the SAE J1772 State C.

3.5.1 Measured Idle Mode power (P_{IDLE}), shall be less than or equal to the Maximum Idle Mode Power Requirement (P_{IDLE_MAX}), as calculated per Equation 3, subject to the following requirements.

- i. For products with ABC enabled by default, the average Idle Mode power in high and low illuminance conditions shall be used in place of P_{IDLE} , above.
- ii. For products capable of network connection with multiple protocols (e.g., Wi-Fi and Cellular), only the allowance for the protocol enabled during testing shall be claimed.

Equation 3: Calculation of Maximum Idle Mode Power Requirement

$$P_{IDLE_MAX} = (0.4 \times \text{Max Current}) + 2.6 + P_{WAKE} + P_{DISPLAY}$$

Where:

- P_{IDLE_MAX} is the Maximum Idle Mode Power Requirement, in watts;
- $Max\ Current$ is the Nameplate Maximum Output Current, in amperes;
- P_{WAKE} is the Idle Mode power allowance for the network connection with wake capability enabled during testing listed in Table 4; and
- $P_{DISPLAY}$ is the Idle Mode power allowance for a High Resolution Display enabled during testing listed in Table 4.

Table 4: Idle Mode Power Allowances

Product Function	Idle Mode Power Allowance (watts, rounded to the nearest 0.1 W for reporting)
In-use Wi-Fi or Ethernet Interface with Wake Capability (P_{WAKE})	$\frac{1.0}{n}$ <i>Where:</i> • n is the number of outputs.
In-use Cellular with Wake Capability (P_{WAKE})	$\frac{2.0}{n}$ <i>Where:</i> • n is the number of outputs.
Other In-use LAN (Local Area Network) Interface with Wake Capability (P_{WAKE})	$\frac{1.0}{n}$ <i>Where:</i> • n is the number of outputs.
In-use High Resolution Display ($P_{DISPLAY}$)	$\frac{[(4.0 \times 10^{-5} \times \ell \times A) + 119 \times \tanh(0.0008 \times [A - 200.0] + 0.11) + 6.0]}{n}$ <i>Where:</i> • A is the Screen Area in square inches; • ℓ is the Maximum Measured Luminance of the Display in candelas per square meter, as measured in Section 4) C) of the ENERGY STAR Test Method for Determining Electric Vehicle Supply Equipment Energy; • \tanh is the hyperbolic tangent function; and • n is the number of outputs. Example: For a single-output EVSE with a maximum measured luminance of 300 candelas/m ² and a 5×5 inch screen, the allowance for the in-use display would be 2.7 watts.

3.6 Connected Functionality

This section includes connected criteria for ENERGY STAR certified EVSE. EVSE that meet the connected functionality criteria shall be capable of supporting Demand Response (DR) (e.g., via software updates or integration with an external service). Compliance with this section is optional. ENERGY STAR certified EVSE that comply with all connected criteria will be identified on the ENERGY STAR website as having ‘Connected’ functionality.

Note: EPA recommends that once DR capability is added, that the EVSE be capable of directly or indirectly supporting both signals-based DR as well as price response. As appropriate, EPA further encourages connected functionality that enables direct control by the Load Management Authority as well as integration with commercial EVSE management applications and/or energy management systems.

Brand owners are encouraged to engage with utilities to ensure DR capabilities align with utility needs and DR program designs.

3.6.1 Grid Communications: The product shall include a communication link that is capable of supporting DR. This link shall use open standards, as defined in this specification, for all communication layers.

- i. Products that include a communication link that uses Open Charge Point Protocol (OCPP) also comply with this criterion.

Note: Effective November 24, 2015 OCPP is being developed by OASIS as the Standard Development Organization with a goal of integrating OCPP with the International Electrotechnical Commission (IEC) framework⁸. EPA is proposing to include OCPP since it is widely used and is in the process of being established as an open standard.

3.6.2 Open Access: To enable interconnection with the product over the communication link, an interface specification, application programming interface (API) or similar documentation that is intended to enable DR functionality shall be made readily available.

Note: Products that enable direct, on-premises, open-standards based interconnection are preferred, but alternative approaches, where open-standards connectivity is enabled only with use of off-premise services, are also acceptable.

3.6.3 Consumer Override: The product shall be capable of supporting DR event override-ability by consumers.

3.6.4 Capabilities Summary: A ≤4000 character (approximately 500 words or less) summary description of the EVSE system's and/or associated Service Provider's DR capabilities/services shall be submitted.

1. In this summary, the following shall be included:
 - i. DR Support, e.g., implemented, planned for CY2017.
 - ii. For products that do not ship with DR capabilities enabled, the steps needed to enable these capabilities.
2. In this summary, EPA recommends noting the following, as applicable:
 - iii. DR services that the product has the capability to participate in such as load dispatch, ancillary services (including V2G), price notification and price response.
 - iv. Whether the EVSE can be directly addressed via the interface specification, API or similar documentation.
 - v. Support for locational DR, e.g., to ZIP code(s), feeder(s), or to EVSE endpoints specified by the Load Management Entity.
 - vi. List open communications supported by the EVSE, including applicable certifications.
 - vii. Feedback to Load Management Entity, e.g., verification/M&V, override notification.
 - viii. Response configurability/flexibility by the consumer and/or Load Management Entity.
 - ix. Measures to limit consumer impacts, if any.

4 TESTING

4.1 Test Methods

⁸ <http://www.openchargealliance.org/news/announcement/>

4.1.1 Test methods identified in Table 5 shall be used to determine certification for ENERGY STAR.

Table 5: Test Methods for ENERGY STAR Certification

Product Type	Test Method
All Electric Vehicle Supply Equipment	ENERGY STAR Electric Vehicle Supply Equipment Test Method (Rev. Apr-2017)
Electric Vehicle Supply Equipment with Display	ENERGY STAR Displays Test Method (Rev. Sep-2015)
Electric Vehicle Supply Equipment with Full Network Connectivity	Section 6.7.5.2 of Consumer Electronics Association (CEA) 2037-A, Determination of Television Set Power Consumption

4.2 Number of Units Required for Testing

4.2.1 Representative Models shall be selected for testing per the following requirements:

- i. For certification of an individual product model, the Representative Model shall be equivalent to that which is intended to be marketed and labeled as ENERGY STAR.
- ii. For certification of a Product Family, the highest energy using model within that Product Family can be tested and serve as the Representative Model. Any subsequent testing failures (e.g., as part of verification testing) of any model in the family will have implications for all models in the family.

4.2.2 A single unit of each Representative Model shall be selected for testing.

4.3 International Market Certification

4.3.1 Products shall be tested for certification at the relevant input voltage/frequency combination for each market in which they will be sold and promoted as ENERGY STAR.

5 EFFECTIVE DATE

5.1.1 Effective Date: The Version 1.0 ENERGY STAR Electric Vehicle Supply Equipment specification shall take effect December 27, 2016. To certify for ENERGY STAR, a product model shall meet the ENERGY STAR specification in effect on the model's date of manufacture. The date of manufacture is specific to each unit and is the date on which a unit is considered to be completely assembled.

5.1.2 Future Specification Revisions: EPA reserves the right to change this specification should technological and/or market changes affect its usefulness to consumers, industry, or the environment. In keeping with current policy, revisions to the specification are arrived at through stakeholder discussions. In the event of a specification revision, please note that the ENERGY STAR certification is not automatically granted for the life of a product model. Considerations for future revisions include:

- i. EPA will continue to monitor the market for dc fast, dc slow, and wireless EVSE, and evaluate the opportunity to differentiate such products based on energy performance. Should the potential for significant energy savings exist among these products, EPA will consider expanding the scope of this EVSE specification to include them in a future revision.
- ii. EPA will assess the power draw associated with different network protocols to determine if it may be necessary to test all connections in the future. In addition, EPA will consider how to appropriately encourage the powering down of certain features (e.g., network connectivity, in-use display) to a lower power state when there is no user activity.
- iii. EPA will monitor and assess if a Typical Energy Consumption approach is more appropriate for EVSE than a modal power approach in the future. In order to do so, EPA will need to gather data on the duty cycle, or common usage profile, for Level 1 and Level 2 EVSE by application.
- iv. EPA will consider amending the test method for models with ABC enabled by default to require illuminance conditions greater than 300 lux that would better represent typical outdoor conditions.



ENERGY STAR® Program Requirements for Electric Vehicle Supply Equipment

Final Test Method Rev. Apr-2017

1 OVERVIEW

The following test method shall be used for determining product compliance with requirements in the ENERGY STAR Eligibility Criteria for Electric Vehicle Supply Equipment.

2 APPLICABILITY

ENERGY STAR test requirements are dependent upon the feature set of the product under evaluation. The following guidelines shall be used to determine the applicability of each section of this document:

- The test procedures in Sections 5.1, 5.2, 5.3, and 5.4 shall be performed on all products.
- The test procedures in Section 5.5 shall be performed on products with network connectivity.

3 TEST SETUP

- A) Test Setup and Instrumentation: Test setup shall be in accordance with the diagram in Figure 1a and Figure 1b with additional requirements specified below.

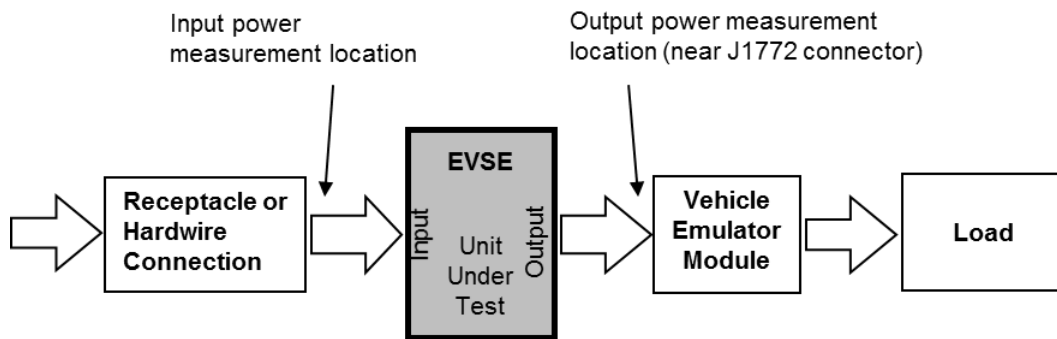


Figure 1a: Schematic of test setup connection

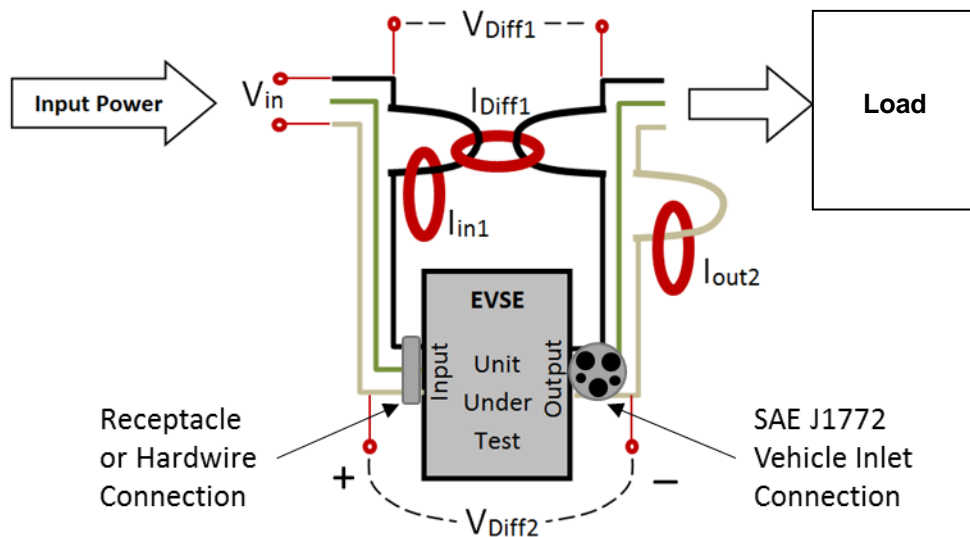


Figure 1b: Schematic of test setup connection

The test setup is to be configured to measure the following, as shown in Figure 1b:

- V_{in} : input voltage
- V_{diff1} : differential voltage measurement of Line1 across the EVSE input to the EVSE output
- V_{diff2} : differential voltage measurement of Line2 (or neutral) across the EVSE input to the EVSE output
- I_{in1} : input current measurement of Line1
- I_{diff1} : differential current measurement of Line1 across the EVSE input to the EVSE output
- I_{out2} : output current measurement of Line2 (or neutral)

- B) AC Input Power: The UUT shall be operated at the first (highest) rated voltage and rated frequency combination specified in Table 1.
- 1) UUTs that are not compatible with any of the combinations listed in Table 1 shall be connected to the highest rated voltage and frequency combination.
 - 2) UUTs that are designed to operate at multiple voltage ranges (both Level 1 and Level 2 functionality) shall be separately tested for both Level 1 and Level 2 operation. In each test configuration, the UUT shall be operated at the first (highest) rated voltage and rated frequency combination specified in Table 1.
 - 3) The voltage and frequency tolerance shall be as specified in Table 2.

Table 1: Input Supply Requirements

Voltage	Frequency
240 V AC	60 Hz
208 V AC	60 Hz
120 V AC	60 Hz

Table 2: Input Power Tolerances

Voltage Tolerance	Maximum Total Harmonic Distortion	Frequency Tolerance
+/- 4.0 %	5.0 %	+/- 1.0 %

C) Input Power Measurements:

- 1) Cables: All power cables for the test shall be the default provided by the manufacturer
- 2) For EVSE equipped with input plug(s) and cord(s), the corresponding receptacle will be used to provide power to the input plug(s) of the EVSE. If this is a multi-input EVSE, the inputs shall be connected together in parallel, requiring only one power supply and one power meter. An Input Measurement Apparatus (IMA) shall be used with EVSE that are provided with input plug(s) and cord(s). The IMA enables input current and input voltage measurements of EVSE without the need to modify the EVSE input cord(s).
 - a) Voltage Measurements shall be performed at the wiring terminals of the receptacle in the IMA providing power to the EVSE input plug.
 - b) Current Measurements shall be performed on the wiring of the IMA connected to receptacle terminals.
- 3) For EVSE intended for hardwire connection, the UUT's input power shall then be connected to AC Input Power source with cables and optional connectors that are rated for the voltage and current levels that will be encountered during testing.
 - a) Voltage Measurements shall be performed at the hardwire connection location at the input terminal of the EVSE.
 - b) Current Measurements shall be performed on the wiring to the EVSE hardwire connection.

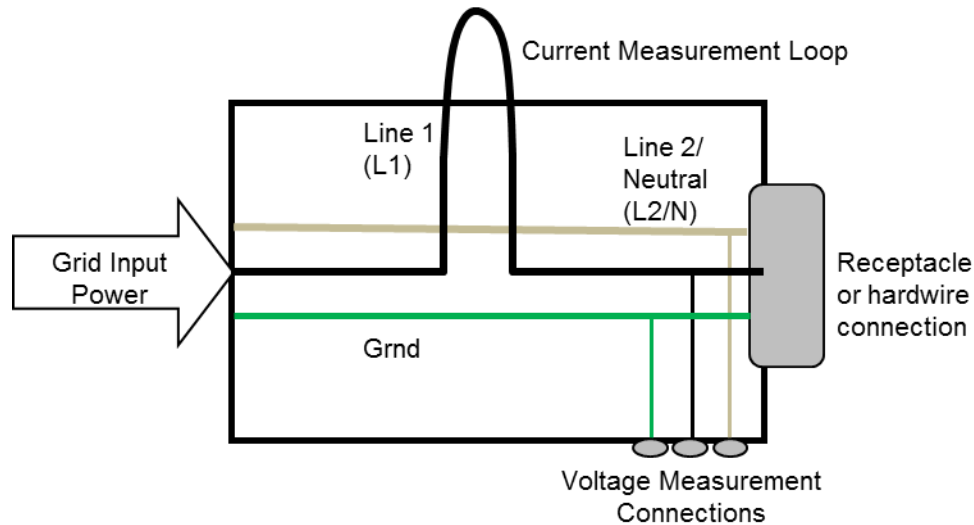


Figure 2: Schematic of Input Measurement Apparatus (IMA)¹

- D) Ambient Temperature: Ambient temperature shall remain at $25^{\circ}\text{C} \pm 5^{\circ}\text{C}$ for the duration of the test.
- E) Relative Humidity: Relative humidity shall remain between 10% and 80% for the duration of the test.
- F) Test Load: A test load shall be connected to the EVSE output in lieu of a vehicle.
 - 1) Vehicle Emulator Module (VEM): A VEM allows current and voltage measurements of the UUT output without modifying or altering the UUT output cable(s). Figure 3 shows an example schematic of the VEM.
 - a) Output Power Measurement: Insulated current conductor loops or current measurement shunts as well as voltage measurement connections shall be used to measure the UUT output current and voltage.
 - i. If there are multiple output cable options for a given model, the longest available cable shall be used for the test.
 - b) Output Coupler: The SAE J1772 interface shall be used to connect between the UUT and VEM. If the UUT does not have an SAE J1772 output coupler, an adapter shall be provided by the manufacturer.

¹ In a four-conductor system, the conductor labeled L2/N will actually be two separate conductors: L2 and N.

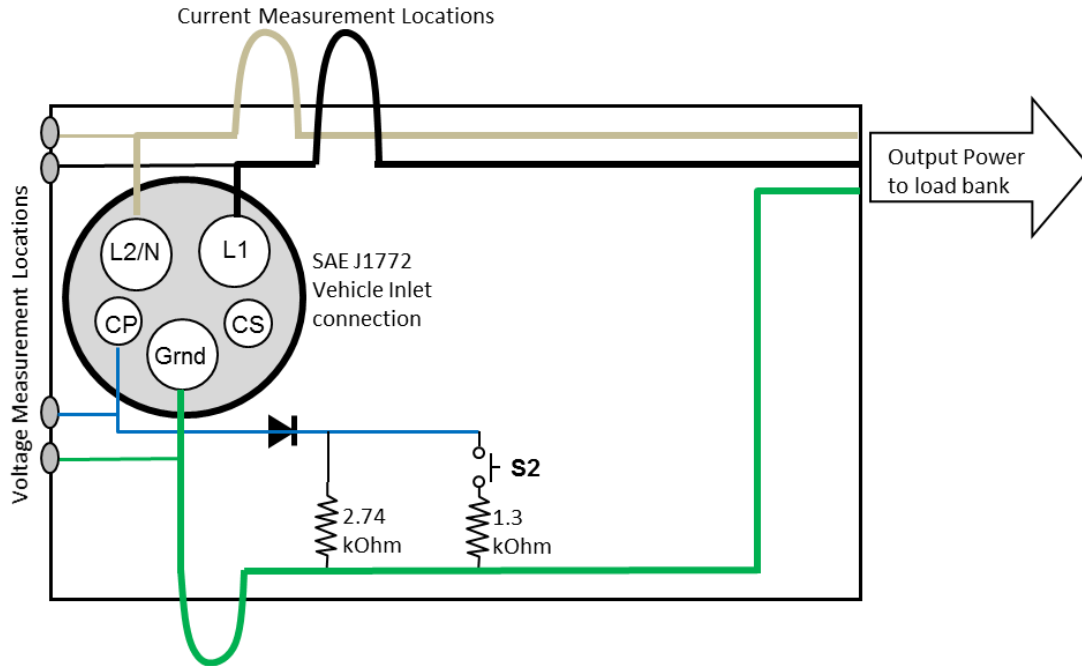


Figure 3: Schematic of Vehicle Emulator Module (VEM)²

- 2) AC Load: The AC load shall possess the following capabilities
 - a) Sink AC current up to the rated RMS current of the UUT;
 - b) Voltage range within the Level of the UUT (Level 1 or Level 2); and
 - c) Controllable RMS current levels capable of achieving current levels detailed in Table 4.
- G) Power Meter: Power meters shall possess the following attributes:
 - 1) Number of Channels:
 - a) One channel shall be set up to measure the AC power of the internal components of the UUT
 - i. Input voltage measurement (V_{in}) and the differential current measurement (I_{diff1})
 - b) One channel shall be set up to measure power loss across the EVSE on Line 1
 - ii. Differential voltage measurement of Line 1 (V_{diff1}) and the Input current measurement of Line 1 (I_{in1})
 - b) One channel shall be set up to measure power loss across the EVSE on Line 2/N
 - ii. Differential voltage measurement of Line 2/N (V_{diff2}) and the Output current measurement of Line 2/N (I_{out2})
 - 2) Crest Factor:
 - a) An available current crest factor of 3 or more at its rated range value; and
 - b) Lower bound on the current range of 10 mA or less.
 - 3) Minimum Frequency Response: 3.0 kHz

² In a four-conductor system, the conductor labeled L2/N will actually be two separate conductors: L2 and N.

- 4) Minimum Resolution:
 - a) 0.01 W for measurement values less than 10 W;
 - b) 0.1 W for measurement values from 10 W to 100 W; and
 - c) 1.0 W for measurement values greater than 100 W.
- 5) Accuracy: +/- 0.1% of reading PLUS +/- 0.1% of full scale
- 6) Measurements and Calculations:
 - a) Cable Length (ft.);
 - b) Cable Gauge (AWG);
 - c) Power Factor (PF);
 - d) Apparent Power (S);
 - e) Voltage (RMS);
 - f) Current (RMS);
 - g) Average Power (W); and
 - h) Frequency (Hz).

B) Illuminance Meter Accuracy:

- 1) All illuminance meters shall be accurate to $\pm 2\%$ (± 2 digits) of the digitally displayed value.

Note: The overall accuracy of a meter is found by taking (\pm) the absolute sum of 2% of the measurement and a 2 digit tolerance of the displayed value least significant digit. For example, if a meter displays "200.0" when measuring an illuminance of 200 lx, 2% of 200 lx is 4.0 lx. The least significant digit is 0.1 lx. "Two digits" implies 0.2 lx. Thus, the displayed value would be 200 ± 4.2 lx (4 lx + 0.2 lx). The accuracy is specific to the illuminance meter and shall not be considered as tolerance during actual light measurements. Light measurements shall be within the tolerance specified in 4.1.E)3).

4 TEST CONDUCT

4.1 Guidance for Implementation of the EVSE Test Procedure

A) As-shipped Condition: Unless specified otherwise, the model unit shall be tested in its default configuration as-shipped.

- 1) The UUT shall be mounted per the manufacturer's installation instructions. If no manufacturer instructions are provided, the UUT shall be tested on a thermally non-conductive surface (e.g., wood or rubber).

B) UUT Configuration and Control:

1) Network Connection Capabilities:

- a) Verify the UUT has network connection capabilities:
 - i. Network connections should be listed in the user manual or installation instructions.
 - ii. If no connections are specified, verify that the EVSE does not have network capabilities by checking for the absence of physical connections or the absence of network settings in the menu.

2) Peripherals and Network Connections:

- b) Any peripherals shipped with the UUT shall be connected to their respective ports per manufacturer instructions. No other devices or accessories shall be connected to any remaining open ports.
- c) If the UUT has network connection capabilities, the capabilities shall be activated using any standard or optional hardware provided by the manufacturer, and the UUT shall be connected to a live physical network (including wireless Radio Frequency (RF)).
 - a. The network shall support the highest and lowest data speeds of the UUT's network function.
 - b. An active connection is defined as a live physical connection over the physical layer of the networking protocol.
 - c. If the UUT is equipped with multiple network capabilities, only one connection shall be made in the following order of preference:
 - i. Wi-Fi (Institution of Electrical and Electronics Engineers - IEEE 802.11- 2007³);
 - ii. Ethernet (IEEE 802.3). If the UUT supports Energy Efficient Ethernet Defined in Clause 78 of IEEE 802.3 (originally specified in IEEE 802.3az)⁴, then it shall be connected to a device that also supports IEEE 802.3az;
 - iii. Cellular modem; or
 - iv. Other.
 - d) The tester shall configure the address layer of the protocol, taking note of the following:
 - i. Internet Protocol (IP) IP v6 has Neighbor Discovery and will generally configure a limited, non-routable connection automatically.
 - ii. IP can be configured manually or using Dynamic Host Configuration Protocol (DHCP) with an address in the 192.168.1.x Network Address Translation (NAT) address space if the UUT does not behave normally when autoIP is used. The network shall be configured to support the NAT address space and/or autoIP.
- e) The UUT shall maintain this live connection to the network for the duration of testing, disregarding any brief lapses (e.g., when transitioning between link speeds).
- f) Ensure there is a connection to the Wide Area Network if required in the manufacturer's instructions.
- g) If the UUT needs to install any software updates, wait until these updates have occurred; otherwise, if it will operate without updates, skip these updates.
- h) In the case of a UUT that has no data/network capabilities, the UUT shall be tested as-shipped.

³ IEEE 802 – Telecommunications and information exchange between systems – Local and metropolitan area networks – Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications

⁴ IEEE 802 – Telecommunications and information exchange between systems – Local and metropolitan area networks – Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications

- C) Luminance Testing for Products with a Display: Luminance testing shall be performed for all products at 100% of screen brightness possible as measured in Section 6.2 of the ENERGY STAR Test Method for Determining Display Energy (Rev. Sep-2015).
- 1) If the UUT cannot display the three-bar pattern specified in IEC 62087:2011, Section 11.5.5, through an external port or network connection, the UUT shall be tested using the default image that appears as-shipped.
- D) Display Brightness for Products without Automatic Brightness Control (ABC) Enabled By Default: If the UUT has a display the brightness of which is controllable by the user and does not have ABC enabled as-shipped:
- 1) The display shall be adjusted to 65% of the maximum brightness available on the display during all testing, or a setting available that is closest to 65%, to within the tolerance of the adjustments available on the EVSE (e.g., if the EVSE provides settings resulting in 50% and 75% of maximum brightness, choose the 75% setting).
 - 2) Following this initial set-up, power testing shall be conducted with the default image that appears as-shipped.
- E) Room Illuminance Conditions for Products with ABC Enabled by Default: All products with ABC enabled by default shall be tested in two illuminance conditions—light and dark—to simulate daytime and nighttime conditions:
- 1) Lamp Type:
 - a) Standard spectrum halogen flood reflector lamp. The lamp shall not meet the definition of “Modified spectrum” as defined in 10 CFR 430.2 - Definitions⁵.
 - b) Rated Brightness: 980 ± 5% lumens.
 - 2) Light Source Alignment For Testing Products with ABC Enabled By Default:
 - a) There shall be no obstructions between the lamp and the UUT’s Automatic Brightness Control (ABC) sensor (e.g., diffusing media, frosted lamp covers, etc.).
 - b) The center of the lamp shall be placed at a distance of 5 feet from the center of the ABC sensor.
 - c) The center of the lamp shall be aligned at a horizontal angle of 0° with respect to the center of the UUT’s ABC sensor.
 - d) The center of the lamp shall be aligned at a height equal to the center of the UUT’s ABC sensor with respect to the floor (i.e., the light source shall be placed at a vertical angle of 0° with respect to the center of the UUT’s ABC sensor).
 - e) No test room surface (i.e., floor, ceiling, and wall) shall be within 2 feet of the center of the UUT’s ABC Sensor.
 - f) Illuminance values shall be obtained by varying the input voltage of the lamp.
 - g) Figure 4 and Figure 5 provide more information on UUT and light source alignment.

⁵ <http://www.gpo.gov/fdsys/pkg/CFR-2011-title10-vol3/pdf/CFR-2011-title10-vol3-sec430-2.pdf>

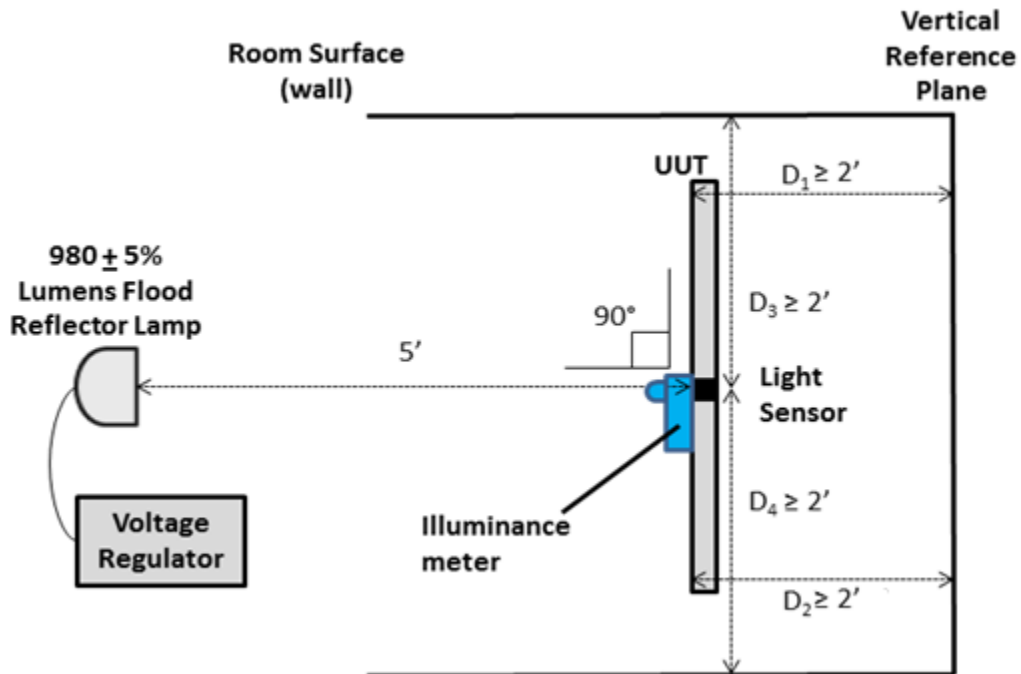


Figure 4: Test Setup - Top View

Notes:

- $D_1 = D_2$ with respect to vertical reference plane
- D_1 and D_2 indicate that the corners of the face of the UUT shall be at least 2 feet from the vertical reference plane
- D_3 and D_4 indicate that the center of the light sensor shall be at least 2 feet from the room walls

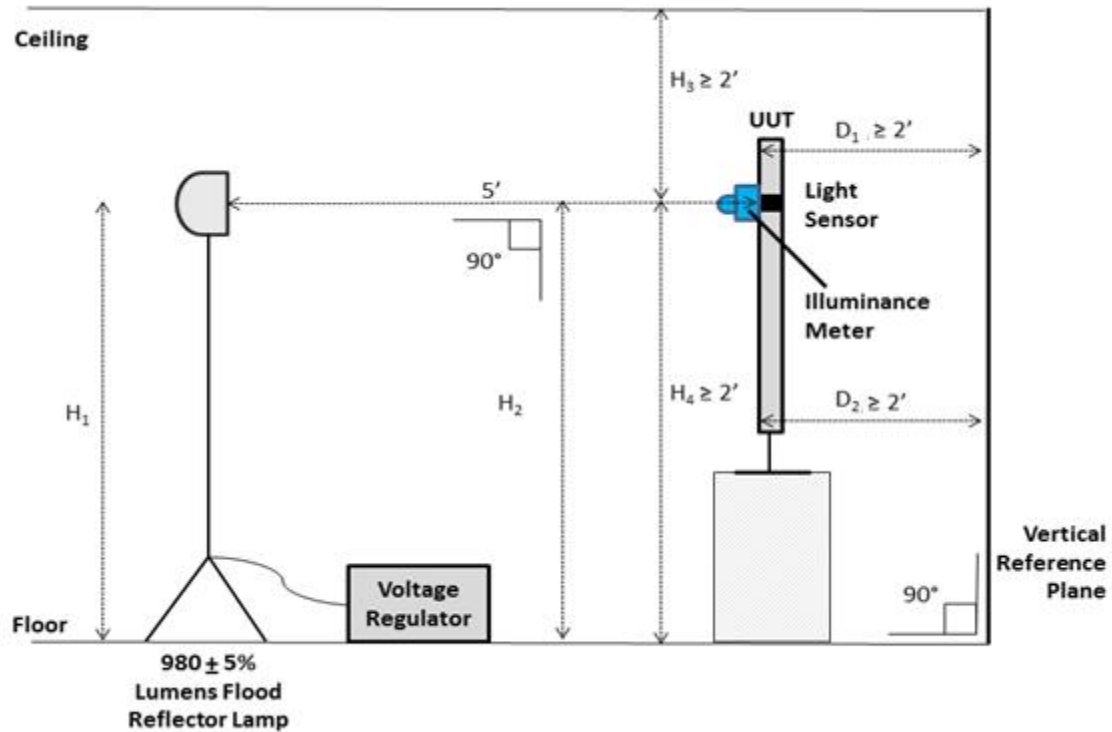


Figure 5: Test Setup - Side View

Notes:

- $D_1 = D_2$ with respect to vertical reference plane
- D_1 and D_2 indicate that the corners of the face of the UUT shall be at least 2 feet from the vertical reference plane
- $H_1 = H_2$ with respect to horizontal reference plane (e.g. floor)
- H_3 and H_4 indicate that the center of the light sensor must be at least 2 feet from the floor and 2 feet from the ceiling
- Illuminance meter shall be removed for power measurements, after target illuminance achieved

3) Setting Illuminance Conditions:

- a) Power shall be disconnected from the UUT.
- b) An illuminance meter shall be placed vertically, parallel to the UUT standing upright, such that the meter's sensor faces away from the UUT horizontally.
- c) The illuminance meter shall be placed immediately in front of the UUT's automatic brightness control (ABC) sensor.
- d) The lamp shall be adjusted such that the illuminance meter reads 300 ± 9.0 lux.
- e) The illuminance meter shall be removed after target illuminance has been achieved and all testing conducted under the specified illuminance conditions.

- f) After all testing has been completed under the high-illuminance conditions, the above steps a) through e) shall be repeated with a target illuminance equal to 10 ± 1.0 lux.

F) Test Conditions for Products with an Occupancy Sensors Enabled by Default:

- 1) Products with an Occupancy Sensors shall be positioned facing away from any testers, or have the sensor covered or otherwise disabled to be in an open position for the duration of the test.

G) Luminance Meters:

- 1) Luminance measurement shall be performed using either
 - a) A contact meter; or
 - b) A non-contact meter.
- 2) All luminance and illuminance meters shall be accurate to $\pm 2\%$ (± 2 digits) of the digitally displayed value.
- 3) Non-contact luminance meters shall have an acceptance angle of 3 degrees or less.

The overall accuracy of a meter is found by taking (\pm) the absolute sum of 2% of the measurement and a 2 digit tolerance of the displayed value least significant digit. For example, if an illuminance meter displays "200.0" when measuring a screen brightness of 200 cd/m², 2% of 200 cd/m² is 4.0 cd/m². The least significant digit is 0.1 cd/m². "Two digits" implies 0.2 cd/m². Thus, the displayed value would be 200 ± 4.2 cd/m² (4 cd/m² + 0.2 cd/m²). The accuracy is specific to the illuminance meter and shall not be considered as tolerance during actual light measurements.

H) Measurement Accuracy for All Products:

- 1) Power measurements with a value greater than or equal to 0.5 W shall be made with an uncertainty of less than or equal to 2% at the 95% confidence level.
- 2) Power measurements with a value less than 0.5 W shall be made with an uncertainty of less than or equal to 0.01 W at the 95% confidence level.
- 3) All ambient light values (measured lux) shall be measured at the location of the ABC sensor on the UUT with light entering directly into the sensor and showing the default image that appears as-shipped.
- 4) Ambient light values shall be measured within the following tolerances:
 - a) At 10 lux, ambient lighting shall be within ± 1.0 lux; and
 - b) At 300 lux, ambient lighting shall be within ± 9.0 lux.

5 TEST PROCEDURES FOR ALL PRODUCTS

5.1 UUT Preparation

- A) Prior to the start of testing, the UUT shall be initialized as follows:
- 1) Set up the UUT per the instructions in the supplied product manual.
 - 2) Verify the VEM output is connected to the AC load
 - 3) Connect the power meter to as described in Section 3.G).
 - 4) Connect an oscilloscope or other instrument to measure the duty cycle of the Control Pilot signal, the voltage at the VEM between "CP" and "Grnd" voltage measurement connections.

- 5) Connect the UUT input connection
 - a) For EVSE with an input cord, plug the EVSE input cord into the IMA receptacle.
 - b) For EVSE without an input cord, connect to the input terminals of the EVSE in accordance to Section 3.C)3).
 - c) For EVSE with multiple input cords, connect together all EVSE input cords in parallel and plug into the IMA receptacle.
- 6) Provide input power to the EVSE input connection(s).
- 7) Power on the UUT and perform initial system configuration, as applicable.
- 8) Ensure the UUT settings are in their as-shipped configuration, unless otherwise specified in this Test Method.
- 9) Report the test room ambient temperature, relative humidity, and the presence of ABC and occupancy sensors.

5.2 No Vehicle Mode (State A) Testing

- A) No Vehicle Mode testing shall be conducted for all products.
- B) Conduct the UUT preparation procedure in Section 5.1
- C) Verify the UUT output connector is unplugged from VEM.
- D) Measure and record UUT input power.

- 1) For single-output EVSE: $P = \frac{1}{T} \int_0^T v_{in}(t) \times i_{diff1}(t) dt$

- 2) For multiple-output EVSE: $P = \frac{\frac{1}{T} \int_0^T v_{in}(t) \times i_{diff1}(t) dt}{n}$, where n is the number of outputs.

- E) Power shall be measured according to IEC 62301 Ed 2.0-2011; with the additional guidance in Section 4 of this document.

5.3 Partial On Mode (State B) and Idle Mode (State C) Testing

- A) Testing shall be conducted for two operational states of the J1772 interface (State B and State C)
- B) Conduct the UUT preparation procedure in Section 5.1
- C) Ensure any demand-response functionality or timer is disabled.

- 1) If demand-response functionality or timer cannot be disabled and a demand-response or timer function occurs during a test, the results from the test shall be replaced with results from a substitute test.

- D) Conduct the following procedure to measure the UUT power consumption:

- 1) State C⁶: Plug in all UUT output connection(s) to J1772 vehicle inlet on a corresponding number of VEM(s). Switch all VEMs to State C by closing switch S2. Measure and record:

⁶ This state represents a vehicle connected and ready to accept current.

a) For single-output EVSE:

i. UUT input power; $P = \frac{1}{T} \int_0^T v_{in}(t) \times i_{diff1}(t) dt$

ii. UUT output RMS current I_{out2} (to verify zero output current).

b) For multiple-output EVSE:

i. UUT input power; $P = \frac{\frac{1}{T} \int_0^T v_{in}(t) \times i_{diff1}(t) dt}{n}$, where n is the number of outputs

ii. UUT output RMS current I_{out2} (to verify zero output current)

2) State B: Plug in the UUT output connection to J1772 vehicle inlet on the VEM. Connect all output cords to a corresponding number of VEMs. Verify S2 is open. Wait 2 minutes and then measure and record UUT input power:

a) For single-output EVSE: $P = \frac{1}{T} \int_0^T v_{in}(t) \times i_{diff1}(t) dt$

b) For multiple-output EVSE: $P = \frac{\frac{1}{T} \int_0^T v_{in}(t) \times i_{diff1}(t) dt}{n}$, where n is the number of outputs.

E) Power shall be measured according to IEC 62301 Ed 2.0-2011; with the additional guidance in Section 4 of this document.

5.4 Operation Mode (State C) Testing⁷

A) Testing shall be conducted with the VEM(s) in State C (S2 closed).

B) Ensure any demand-response functionality or timer is disabled.

1) If demand-response functionality or timer cannot be disabled and a demand-response or timer function occurs during a test, the results from the test shall be replaced with results from a substitute test.

C) Determine the UUT available current.

1) Conduct the UUT preparation procedure in Section 5.1.

2) For multiple-output EVSE, the available current shall be the maximum current that can be provided by the unit when a single output is being used (i.e., no derating/current sharing). The unit shall be configured to provide this maximum current.

3) State C: Plug in the UUT output connection to J1772 vehicle inlet on VEM. Connect all output cords to a corresponding number of VEMs. If the UUT has multiple output cords, the outputs will be switched to State C sequentially. Close S2 in the VEM; for a multiple-output EVSE, switch that VEM to State C by closing switch S2, while keeping the remainder in State B (S2 open).

4) Calculate the available current from the measured Control Pilot Duty Cycle per Table 3.

Table 3: Available Current Calculation from Control Pilot Duty Cycle (SAE J1772)

Duty Cycle (%)	Available Current (A)
$10\% \leq \text{Duty Cycle} \leq 85\%$	% Duty Cycle x 0.6

⁷ This state is similar to Charging and Maintenance Modes in SAE J2894-2; however, there may be some discrepancies due to network configuration, the lack of a connected battery, and discrete number of power values tested.

$85\% < \text{Duty Cycle} \leq 96\%$	$(\% \text{ Duty Cycle} - 64) \times 2.5$
--------------------------------------	---

D) Warm-up

- 1) Ensure the unit is kept at ambient temperature for 30 minutes prior to the test.
- 2) Engage the AC load and draw full current output for 5 minutes or more.
- 3) Only one warm-up period of 5 minutes is required for each unit under test at the beginning of the test procedure.

E) Measurement

- 1) After the 5-minute warm-up period, the technician shall monitor AC input current for a period of 5 minutes to assess the stability of the unit under test.
 - a) If the input current level does not drift by more than 1 percent from the maximum value observed over the 5-minute period, the unit under test can be considered stable and measurements can be recorded at the end of the 5-minute period.
 - b) If AC input current is not stable over a 5-minute period, the technician shall follow the guidelines established by IEC Standard 62301 for measuring average power or accumulated energy over time for both input and output.
- 2) The following measurements and calculated values shall be recorded after the 5-minute stabilization period:
 - a) RMS input current;
 - b) RMS input voltage;
 - c) Power Factor (PF)
 - d) RMS output current for each output;
 - e) EVSE internal power loss
 - i. Input voltage measurement (V_{in}) and the differential current measurement (I_{diff1})
 - f) EVSE conductive power losses on Line 1
 - i. Differential voltage measurement of Line 1 (V_{diff1}) and the input current measurement of Line 1 (I_{in1})
 - g) EVSE conductive power losses on Line 2/N
 - i. Differential voltage measurement of Line 2/N (V_{diff2}) and the output current measurement of Line 2/N (I_{out2})
 - h) For single-output EVSE, Input Power, Output Power and Total Power Loss (combinations of the power loss measurements 5.4.E)2)e), f), and g)):

$$P_{INPUT} = \frac{1}{T} \int_0^T i_{diff1}(t) \times v_{in}(t) dt$$

$$P_{OUTPUT} = \frac{1}{T} \int_0^T (i_{out2}(t) \times v_{diff2}(t) - i_{in1}(t) \times v_{diff1}(t)) dt$$

$$P_{loss} = P_{INPUT} - P_{OUTPUT}$$

- i) For multiple-output EVSE, Total Power Loss:
 - i. Measure input and output power for each EVSE output (combination of the power loss measurements 5.4.E)2)e), f), and g), where i is the number of the output under test:

$$P_{INPUT_i} = \frac{1}{T} \int_0^T i_{diff1i}(t) \times v_{in}(t) dt$$

$$P_{OUTPUT_i} = \frac{1}{T} \int_0^T (i_{out2}(t) \times v_{diff2}(t) - i_{in1}(t) \times v_{diff1}(t)) dt$$

- ii. Switch the VEM under test back to State B by opening S2.
- iii. Connect the output power meter to the next VEM. And close S2 on the VEM putting it in State C.
- iv. Repeat steps i through iii, above, until the input and output power from each output, P_{INPUT_i} and P_{OUTPUT_i} have been measured.
- v. Sum the output power results for each output and divide by the number of outputs, n .

$$P_{OUTPUT} = \frac{\sum_{i=1}^n P_{OUTPUT_i}}{n}$$
- vi. Sum the input power results for each output and divide by the number of outputs, n . Then, after conducting the Partial On test, in Section 5.3. above, multiply the measured Partial On power by $n-1$ and subtract from the input power sum, as shown below:

$$P_{INPUT} = \frac{\sum_{i=1}^n P_{INPUT_i}}{n} - (n-1) \times \frac{\frac{1}{T} \int_0^T v_{in}(t) \times i_{diff1}(t) dt}{n} \Bigg|_{\text{Partial On}}$$

$$P_{loss} = P_{INPUT} - P_{OUTPUT}$$

- 3) Repeat for all loading conditions in Table 4 that are less than or equal to the full current output capability of the UUT, in sequence from Loading Condition 2 to Loading Condition 4.
- 4) Measurements at subsequent loading conditions shall be conducted under the 5-minute stability guidelines in Section 5.4.E)1), above.

Table 4: Loading Conditions for UUT

	Test Condition Current (A)	Example for 80 A capable UUT	Example for 32 A capable UUT	Example for 16 A capable UUT
Loading Condition 1	Available Current (determined in Section 5.4.C), above) $\pm 2\%$.	80.0 A	32.0 A	16.0 A
Loading Condition 2	30.0 A ± 0.6 A	30.0 A	30.0 A	Do not test
Loading Condition 3	15.0 A ± 0.3 A	15.0 A	15.0 A	15.0 A
Loading Condition 4	4.00 A ± 0.1 A	4.0 A	4.0 A	4.0 A

5.5 Full Network Connectivity Testing

- A) For products with data/networking capabilities, the presence of Full Network Connectivity shall be determined by testing the UUT for network activity in Partial On Mode according to Section 6.7.5.2 Method 1 of Consumer Electronics Association (CEA) 2037-A, Determination of Television Set Power Consumption, with the following guidance:
- 1) The UUT shall be connected to a network per Section 4.1.B)2) of this test method prior to the test; and
 - 2) The UUT shall be placed into Partial On Mode in place of Standby-active, Low Mode.