ENERGY STAR® Program Requirements
Product Specification for
Electric Vehicle Supply Equipment

Draft 1 Test Method
Rev. June-2015

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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 7.1–7.4 shall be performed on all products.
- The test procedures in Section 7.5 shall be performed on products with network connectivity.
- The test procedures in Section 7.6 shall be performed on products with utility grid communication.

3 DEFINITIONS

Unless otherwise specified, all terms used in this document are consistent with the definitions in the ENERGY STAR Eligibility Criteria for Electric Vehicle Supply Equipment, Version 1.0.

Note: The below section lists the definitions that EPA is considering using throughout the EVSE program. This section will eventually be moved to the specification/Eligibility Criteria document, but is included temporarily in this draft test method for ease of reference and to ensure that all aspects of the test method are defined appropriately.

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.[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 greater than 16 amperes AC and less than 80 amperes AC.2

[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.

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.

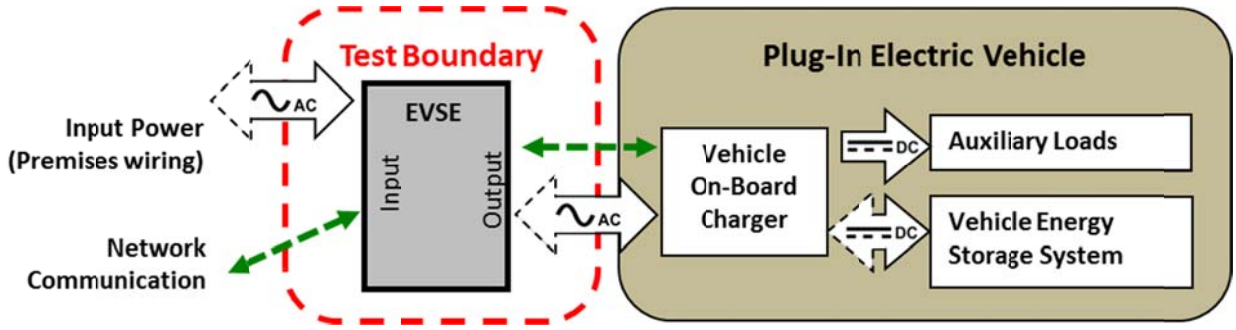
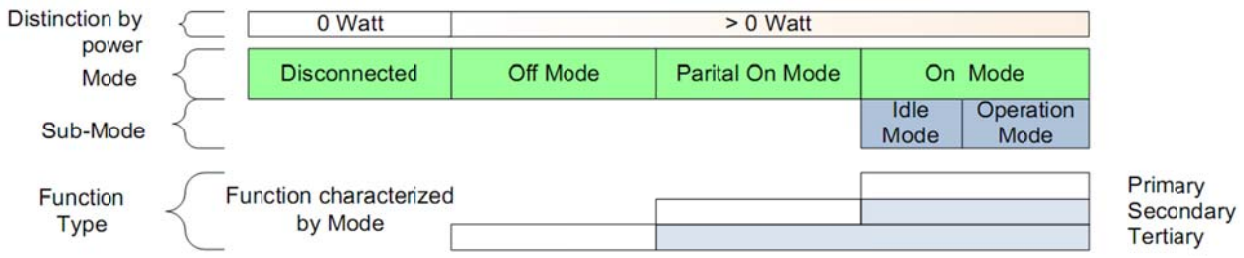


Figure 1: Schematic of Overall Plug-In Vehicle Charging System detailing EVSE Test Boundary

Note: The Test Boundary above reflects the EVSE products that that EPA is considering including within the scope of the EVSE program (see Section 4). The dotted lines reflect anticipated future testing of reverse power flows. The EVSE may have DC power outputs for use by devices other than the vehicle; if present, these are not tested.

Note: The below definitions incorporate standard operational mode names, based on IEC 62542 – Environmental Standardization for Electrical and Electronic Products and Systems. This standard establishes mode "classes" that can be applied to a specific product by defining functions as Primary, Secondary, and Tertiary. Using the same mode names (On, Partial On, Off, and Disconnected) across all products reduces ambiguity and allows for cross-comparisons. The modes and the functions available in each are illustrated in the Figure below:



EPA proposes to use these more generic mode terms rather than the terms in SAE J2894/2 as SAE J2894/2 primarily tests a complete EVSE-charger-battery system, such that the tests are different and using the same terms could lead to more confusion rather than less. EPA welcomes feedback on this approach.

A) Functions:

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

2) Full Network Connectivity: The ability of the display to maintain network presence while in Partial On mode. 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.

Note: Full Network Connectivity is not limited to a specific set of protocols. Also referred to as "network proxy" functionality and described in the Ecma-393 standard.

3) Occupancy Sensor: a device used to detect human presence in front of or in the area surrounding an EVSE.

4) Primary Function: Function providing the intended purpose. For EVSE, Primary Functions are:

   a) Charging.

5) Secondary Function: Function that enables, supplements or enhances a primary function. For EVSE, Secondary Functions are:

   a) Communicating with the vehicle;

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

   c) Network communication;

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

   e) Use of ABC;

   f) Use of Occupancy Sensor;

   g) Wake-up function.

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

Example: An EMC filter, status indication, and area lighting if present, provides their function in off mode, partial on mode and on mode.

B) Operating Modes:

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.

Note: The term power source includes power sources external and internal to the equipment.

2) Mode: Distinct condition

Note: Any transition of equipment from or towards a neighboring mode, either through user intervention or automatically initiated, should not be considered to form part of either mode.

Off Mode: Condition during which the equipment only provides tertiary function(s).

Note: Off Mode is intended to be the lowest-power mode of the EVSE that can only be entered or exited through a manual switch. Not all devices will have an Off Mode.

3) On Mode: Condition during which the equipment provides at least one primary function or can promptly provide a primary function

a) Operation Mode or State C[3]: Condition during which the equipment is performing at least one primary function.

b) Idle Mode or State B2 or C[3]: Condition during which the equipment can promptly provide a 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 charging.

4) Partial On Mode or States A or B1[3]: Condition during which the equipment provides at least one secondary function but no primary function.

Note: The term Sleep Mode and No Battery Mode also describe the Partial On mode.

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

C) 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 is:

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

3) Power factor (PF): The ratio of the average power (P) consumed in watts to the apparent power (S), drawn in volt-amperes.

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

4) Unit Under Test (UUT): The specific sample of a representative model undergoing measurement which includes the base product and any accessories packaged with it.

D) Acronyms:

1) °C: Degree Centigrade

2) A: Ampere

3) AC: Alternating Current

4) DC: Direct Current

5) DOE: U.S. Department of Energy

6) EPA: Environmental Protection Agency

7) EPS: External Power Supply

8) EVSE: Electric Vehicle Supply Equipment

9) Hz: Hertz

[3] This mode is intended is typically associated with a vehicle/EVSE interface state (A, B, or C) as defined in SAE J1772, however, it may not always align as these modes refer to the entire EVSE (including networking and other functions), while the SAE J1772 states apply only to the interface..

10) IEC: International Electrotechnical Commission
11) IEEE: Institute of Electrical and Electronics Engineers
12) IPMA: Input Power Measurement Apparatus
13) NEMA: National Electrical Manufacturers Association
14) SAE: Society of Automotive Engineers
15) UPS: Uninterruptible Power Supply
16) USB: Universal Serial Bus
17) UUT: Unit Under Test
18) V: Voltage
19) VEM: Vehicle Emulator Module
20) W: Watts

4 SCOPE

Note: The below section lists the types of products that EPA is considering including within the scope of the EVSE program. This section will eventually be moved to the specification/Eligibility Criteria document, but is included temporarily in this draft test method for ease of reference and to ensure that all the requirements of the test method apply to these specific products.

4.1 Included Products

4.1.1 Level 1 and Level 2 EVSE that (1) have a rated current less than or equal to 80 amperes; (2) have an SAE J1772 coupler intended for electric vehicle charging; and (3) are outside the vehicle.

4.2 Excluded Products

4.2.1 Products that are covered under other ENERGY STAR product specifications are currently not eligible for qualification under this specification. The list of specifications currently in effect can be found at www.energystar.gov/specifications.

4.2.2 Fast DC EVSE.

4.2.3 Wireless/Inductive EVSE.

4.2.4 Power electronic components inside the vehicle.

Note: EPA is beginning the development of the ENERGY STAR test method and specification for EVSE with Level 1 and Level 2 EVSE, due to their prevalence in the market. However, as the market for Fast DC and Wireless/Inductive EVSE grows, EPA will consider include these product types in a future program revision.

5 TEST SETUP

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

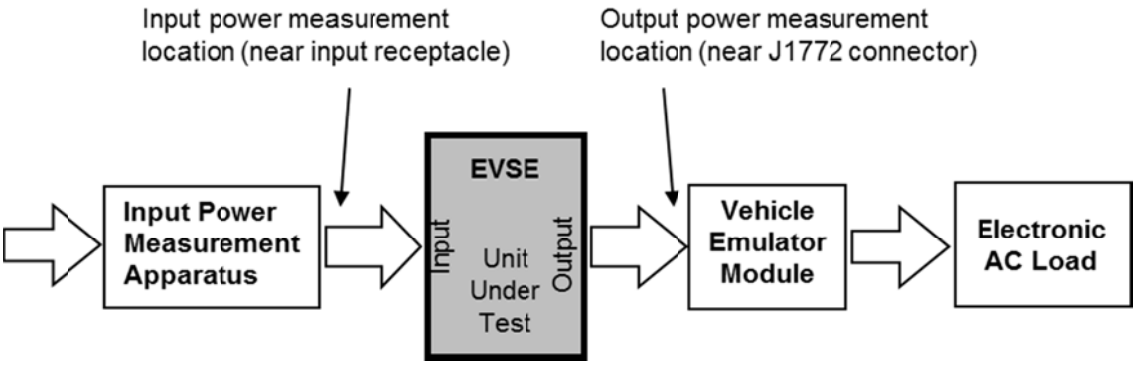


Figure 2: Schematic of test setup connection

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 Measurement Apparatus (IPMA): To enable safe and repeatable measurements of the EVSE input power, an IPMA will be used. This device contains a NEMA receptacle (such as 6-50R or 5-20R) for connection to the UUT as well as means for safe voltage and current measurements by the power meter without the need to modify or alter the input cable to the UUT. This apparatus supplies power to the UUT input connection. This apparatus input is to be connected to the grid electrical supply as appropriate for the current and voltage rating of the UUT. Additionally, any electrical conductors and connections within the input power measurement apparatus must be of the same or larger voltage and current rating as the UUT. A schematic example of the IPMA is shown in Figure 3.

1) Voltage Measurement Example: fused "finger safe" connectors for voltage measurement connection to power meter

2) Current Measurement Examples:

a) Insulated conductor loop external to apparatus (entire UUT current through the measurement conductor) for the purpose of current measurement by clamp-on current transformer or other means.

b) Current shunt with connection to external power meter (entire UUT current through the measurement conductor)

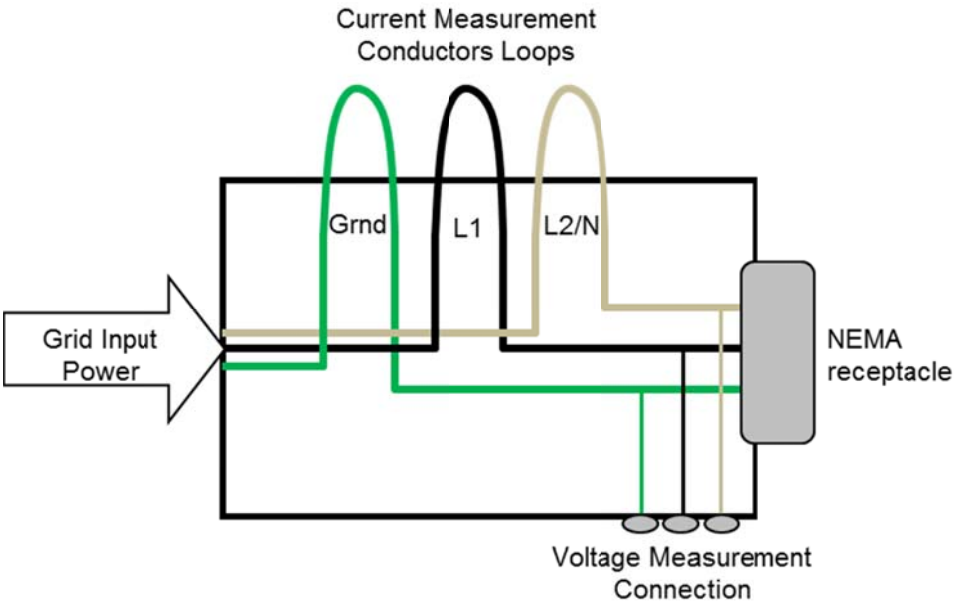


Figure 3: Schematic of Input Power Measurement Apparatus[4]

D) Ambient Temperature: Ambient temperature shall remain at 25°C ± 5°C for the duration of the test.

E) Relative Humidity: Relative humidity shall be between 10% and 80%.

F) Cables: All power cables for the test shall be the default provided by the manufacturer

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

1) If no default EVSE input cable is provided, a 0.5 m cable shall be used sized according to the maximum current rating of the UUT, per Table 310-15(B)(16) of the NFPA 70® 2014 National Electrical Code.

2) If no default EVSE input cable is provided, the UUT cable shall be connected to the IPMA output receptacle using a NEMA plug sized appropriately for the local electrical service and the maximum current rating of the EVSE (example: use 50 A plug for UUT with 32 A max. rating) .

3) The IPMA shall then be connected to the premises wiring with cables and optional connectors that are rated for the voltage and current levels that will be encountered during testing.

Note: EPA welcomes feedback on the prevalence of EVSEs that are intended to be hard-wired and may therefore ship without an input power cable, as well as what is the typical cable run that should be measured, while trying to balance testing burden, representativeness, and comparability between models.

G) Test Load: A test load consisting of a SAE J1772 vehicle control pilot emulator and an AC load bank shall be connected to the EVSE output in lieu of a vehicle. This enables full functionality of the EVSE as well as a means to draw current through the EVSE for the purposes of efficiency and power consumption evaluation.

1) Vehicle Emulator Module (VEM): To enable UUT functionality, a vehicle emulation module will be used to emulate the SAE J1772 control pilot resistances associated with the operational states. Additionally, this VEM allows current and voltage measurements of the UUT output without modifying or altering the UUT output cable. Figure 4 shows an example schematic of the VEM.

a) SAE J1772 Control Pilot emulation: Specific resistances are connected between the control pilot and ground to create a voltage that correlates to the operational state. Switch S1 is used for State C and switch S2 is used for State D. The resistors should be sized for a 12V source (i.e. up to 0.5 W). The diode forward current requirement is up to 10 mA.

b) Output Power measurement: Insulated current conductor loops or current measurement shunts as well as voltage measurement connections are used for the purpose of measurement of the UUT output current and voltage.

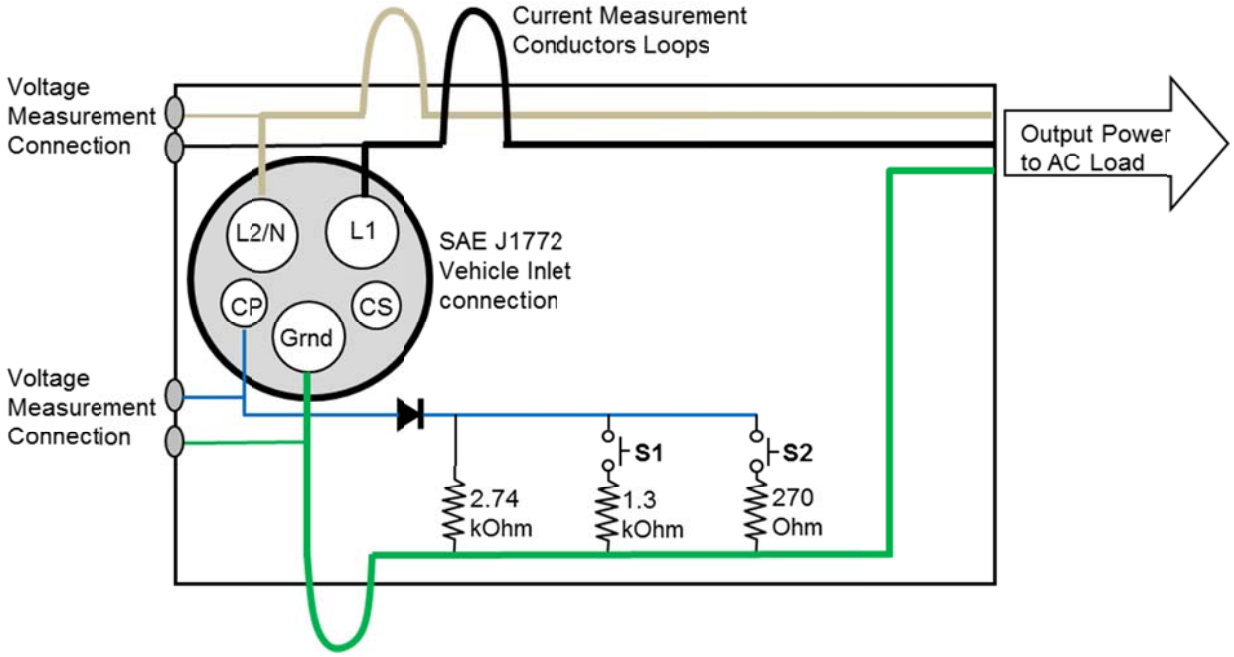


Figure 4: Schematic of Vehicle Emulator Module[5]

2) AC Load: The AC load bank 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 executing current levels detailed in Table 4.

H) Power Meter: Power meters shall possess the following attributes:

1) Number of Channels:

a) One channel shall be set up to measure AC power into the UUT;

b) One channel shall be set up to measure ground current at the input connection to the UUT;

c) One channel shall be set up to measure AC power output of the UUT; and

d) One channel shall be set up to measure the Control Pilot characteristics:

1. Peak dc voltage of the control pilot signal at the output of the UUT;
2. Frequency of the Control Pilot; and
3. Percent Duty Cycle of the Control Pilot.

2) Crest Factor:

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

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

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) Voltage (RMS);

b) Current (RMS);

c) Voltage total harmonic distortion (THD);

d) Average Power (W);

e) Apparent Power (VA);

f) Power Factor; and

g) Frequency (Hz).

6 TEST CONDUCT

6.1 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 will be mounted to a vertical surface or structure per the manufacturer's installation instructions

Note: variation from the above mounting per manufacturer's instructions is allowed only if the UUT has no cooling system including vents, opening, slits, etc. to allow convective air flow (completely sealed).

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:

Note: The requirements below have been adapted from the ENERGY STAR test method for Displays and Televisions and are intended to set-up the UUT's network connection for realistic testing. EPA welcomes comment on the applicability of these requirements to EVSE.

a) 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.

b) 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- 2007[6]);

        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)[7], then it shall be connected to a device that also supports IEEE 802.3az;

        iii. Cellular modem; or

        iv. Other.

c) 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.

d) 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).

e) Ensure there is a connection to the Wide Area Network if required in the manufacturer's instructions.

f) 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.

g) In the case of a UUT that has no data/network capabilities, the UUT shall be tested as-shipped.

C) <u>Room Illuminance Conditions for Products with Displays or Indicator Lamps with Automatic Brightness Control (ABC) Enabled by Default:</u>

[6] 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

[7] 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

Note: The requirements below have been adapted from the ENERGY STAR test method for both Displays and Televisions and are intended to highlight energy savings due to ABC. In the Displays and Televisions test methods, UUTs are tested at multiple illuminance conditions representative of typical use and the results of the tests are averaged to result in a representative power consumption.

Here, EPA is proposing a simplified test that will recognize the advantages of ABC without multiple tests. By testing in one (dark) condition, products with ABC will be able to reduce indicator lamp and/or display brightness, thereby saving power. The tradeoff is that the resultant power value may not be as representative. EPA welcomes feedback on this proposal.

Note: EPA also welcomes comment on the prevalence of Advertisement and Area lighting, intended to call attention to an EVSE or illuminate it or the surrounding area. Is this functionality typically included with an EVSE and can it be controlled either through ABC, user settings, or timers to reduce power consumption when not needed?

1) All products with ABC enabled by default shall be tested in a darkened room or enclosure to simulate nighttime conditions:

   a) Powered 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) No test room surface (i.e., floor, ceiling, and wall) shall be within 0.6 m of the center of the UUT's ABC Sensor.

   e) The ambient light shall be adjusted such that the illuminance meter reads less than 11 lux.

Note: EPA proposes setting the ambient light conditions at less than 11 lux to capture any savings from dimming illuminated displays or indicator lamps. In developing this proposal, EPA observed nighttime ambient lighting conditions around EVSE at 0 or 1 foot candles, which corresponds to a range of 0 to 10 lux. EPA is intentionally keeping the lighting condition flexible, but still within a very low light range, to permit testing without an adjustable light source, thereby reducing test burden.

   f) The illuminance meter shall be removed for power measurements, after target illuminance has been achieved.

   g) Figure provides more information on UUT and illuminance meter alignment.

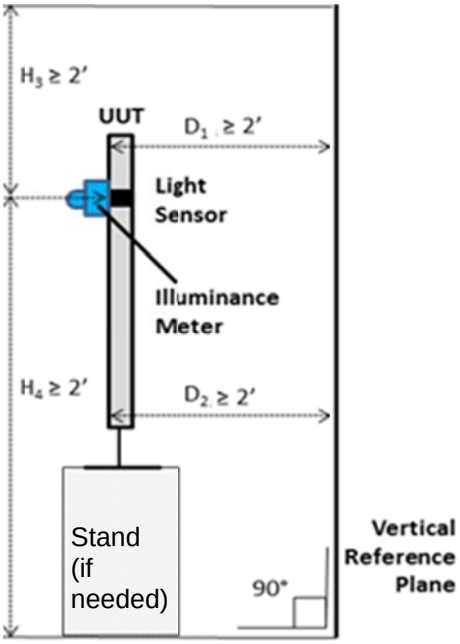


Figure 5: Illuminance Test Setup - Side View

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 0.6 m from the vertical reference plane
- H_3 and H_4 indicate that the center of the light sensor must be at least 0.6 m from the floor and 0.6 m from the ceiling
- Illuminance meter removed for power measurements, after target illuminance achieved

2) Alternatively, the ABC sensor shall be covered with an opaque material to block all light entering the sensor.

D) 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 for the duration of the test.

Note: EPA welcomes input into the presence of ABC or occupancy sensing in today's equipment and how best to highlight low-power modes of operation (nighttime or with no customer nearby), including sensor design and location that might impact EVSE testing.

E) Measurement Accuracy:

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 throughout the duration of the test.

7 TEST PROCEDURES FOR ALL PRODUCTS

7.1 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 the following connections

a) Input Power Measurements:

1. AC input current at the Input Power Measurement Apparatus “L1” current measurement location

2. AC input voltage at the Input Power Measurement Apparatus between “L1” and “L2/N” voltage measurement connections

b) Ground current leakage measurement:

1. AC current at the Input Power Measurement Apparatus “Grnd” current measurement location.

c) Output Power Measurements:

1. AC output current at the Vehicle Emulator Module “L1” current measurement location

2. AC output voltage at the Vehicle Emulator Module between “L1” and “L2/N” voltage measurement connections

3. For UUTs with multiple output connectors, measure output power at only one output connector, leaving the remaining output connector(s) in a docked position.

d) Control Pilot Signal:

1. Voltage at Vehicle Emulator Module between “CP” and “Grnd” voltage measurement connections

4) Power on the power meter and ensure the meter is zeroed (degaussed) and adjusted per applicable meter operational procedures. Ensure that the meter is powered on for the minimum required time prior to measurements per the manufacturer’s instructions.

5) Connect the UUT input connection to the Input Power Measurement Apparatus.

6) Connect grid input power to the Input Power Measurement Apparatus for the appropriate Level for the UUT (Level 1 or Level 2)

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 AC input voltage and frequency.

10) Report the test room ambient temperature, relative humidity, and the presence of ABC and occupancy sensor.

7.2 Off Mode Testing

A) Off Mode testing shall be conducted only for products that have a manual off switch that disables secondary functions.

B) Conduct the UUT preparation procedure in section 7.1

C) Place the UUT in off mode using the manual switch.

1) Measure and record:

a) UUT input power; and

b) UUT input ground current.

D) Power shall be measured according to IEC 62301 Ed 2.0-2011; with the additional guidance in Section 6 of this document.

7.3 Partial On Mode and Idle Mode Testing

A) Testing shall be conducted for three operational states of the UUT (State A through State C)

B) Conduct the UUT preparation procedure in section 7.1

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

D) Set the power meter current and voltage measurement ranges to the highest resolution possible (lowest current and voltage setting) as applicable for the following measurements taking into consideration the requirements of sections 5.H.5, 6.E.1 and 6.E.2.

E) Conduct the following procedure to measure the UUT power consumption and operational characteristics during the States of operation.

1) State A: Verify the UUT output connector is unplugged from VEM. Measure and record:

a) UUT input power; and

b) UUT input ground current.

2) State B[8]: Plug in the UUT output connection to J1772 vehicle inlet on the VEM and verify S1 is open. Measure and record:

a) UUT input power;

b) UUT input ground current; and

c) Control Pilot peak dc voltage, frequency, and % duty cycle.

3) State C[9]: Plug in the UUT output connection to J1772 vehicle inlet on VEM. Connect S1 in the VEM. Measure and record:

[8] This state represents a vehicle connected but not ready to accept current.

a) UUT input power;

b) UUT input ground current;

c) Control Pilot peak dc voltage, frequency, and % duty cycle; and

d) UUT Output RMS voltage and output power (to verify zero output power).

Note: EPA has omitted testing of State D to shorten the test method. State D (activated by closing S2 in the VEM) communicates that the vehicle battery requires ventilation, which is not typical of today's battery technologies.

F) Power shall be measured according to IEC 62301 Ed 2.0-2011; with the additional guidance in Section 6 of this document.

7.4 Operation Mode Testing[10]

A) The unit under test shall operate at full current output for the applicable intended Level of operation (i.e. Level 1 or Level 2) for at least 30 minutes immediately before conducting efficiency measurements.

B) Testing shall be conducted with the VEM in State C (S1 connected). On Mode Testing will be repeated with the VEM in State D (S2 connected) only for EVSE that operate a ventilation fan as required by a vehicle in State D. If the UUT does not operate a ventilation fan, testing with the VEM in State D is not required.

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

Note: EPA is aware of some EVSE products that will permit only low-current operation at certain times (as set by a timer), and this would also occur during demand-response events. During such times, the EVSE could only power auxiliary circuits in the connected vehicle and not perform any charging. Such limits should be disabled for the duration of this test to permit operation across the range of input conditions; however, a low-current condition is also included as Loading Condition 4 in Table 4.

EPA welcomes comment on how well Loading Condition 4 (2 A) represents low-current maintenance modes as well as the number of hours per day an EVSE would be limited to low-current operation, and the number of hours that it would actually operate in such a mode.

D) Determine the UUT full current output capability.

1) Conduct the UUT preparation procedure in section 7.1.

2) State C: Plug in the UUT output connection to J1772 vehicle inlet on VEM. Connect S1 in the VEM.

3) Measure the Control Pilot Duty Cycle percentage.

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[9] This state represents a vehicle connected and ready to accept current.

[10] 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.

4) Determine the full current output, defined as the lesser of the two:

a) Nameplate output current; and

b) The calculated available current from the measured Control Pilot Duty Cycle percentage. The calculation for the available current is as shown in table 3:

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

Duty Cycle (%)	Available Current (A)
10% ≤ Duty Cycle ≤ 85%	% Duty Cycle x 0.6
85% < Duty Cycle ≤ 96%	(% Duty Cycle – 64) x 2.5

5) If the calculated available current from the measured Duty Cycle is less than 90% of the nameplate output current, verify the UUT setup. Correct any operational issues or contact the UUT manufacturer to verify the full current output capability. Additionally, verify that there is not an active demand response / current curtailment request, which would cause a reduction in available current from the Control Pilot Duty Cycle. Do not continue with testing until available current as measured from Control Pilot Duty Cycle percentage is greater than 90% of nameplate output current or UUT manufacturer confirms the full current output for the remaining tests.

E) For each Loading condition, set the power meter current and voltage measurement ranges to the highest resolution possible (lowest current and voltage setting) as applicable for the following measurements taking into consideration the accuracy requirements of sections 5.H.5, 6.E.1 and 6.E.2.

F) The UUT shall be tested at the loading conditions listed in Table 4.

Table 4: Loading Conditions for UUT

	Test Condition Current (A)	Example for 32 A Nameplate UUT	Example for 16 A Nameplate UUT
Loading Condition 1	100% of Full Current Output Current ±2%.	32.0 A	16.0 A
Loading Condition 2	30.0 A ±0.6 A	30.0 A	Do not test
Loading Condition 3	15.0 A ±0.3 A	15.0 A	15.0 A
Loading Condition 4	2.00 A ±0.1A	2.0 A	2.0 A

1) Testing shall be conducted in sequence from Loading Condition 1 to Loading Condition 4, as indicated in Table 4.

2) Warm-up Procedure

a) Ensure the UUT preparation procedure is complete (section 7.1)

b) State C: Plug in the UUT output connection to J1772 vehicle inlet on VEM. Connect S1 in the VEM.

c) Engage the AC load and draw full current output for 30 minutes or more.

3) After this 30 minute warm-up period, the technician shall monitor AC input power for a period of 5 minutes to assess the stability of the unit under test. If the input power 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.

4) The following measurements and calculated values to be recorded after the 5-minute stabilization period:

a) RMS input current;

b) RMS input voltage;

c) Instantaneous input power;

d) Input power factor;

e) RMS input ground leakage current;

f) RMS output current;

g) RMS output voltage;

h) Instantaneous output power; and

i) Calculated efficiency (instantaneous output power / instantaneous input power).

5) Measurements at subsequent loading conditions, listed in Table 4, shall then be conducted under the same 5-minute stability guidelines. Repeat for all loading conditions that are less than or equal to the full current output capability of the UUT.

6) Only one warm-up period of 30 minutes is required for each unit under test at the beginning of the test procedure.

7) If AC input power 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.

7.5 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 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 6.1B)2) prior to the test; and

2) The UUT shall be placed into Partial On Mode in place of Standby-active, Low Mode.

Note: EPA is proposing to adapt a test of Full Network Connectivity from the CEA-2037-A Television Test Procedure in order to distinguish EVSE models that maintain an active network connection. However, given that the purpose of network connections in EVSE is often identification or payment processing, EPA welcomes feedback on whether EVSE would accept an external signal from the network (potentially blocked for security reasons) as required by the test.

7.6 Connected Functionality Verification Testing

TBD.

Note: Smart Grid thought leaders have long advocated a transactive Smart Grid in which residential, commercial, and industrial consumers alike can benefit. In such a model, Demand Response and other direct load control programs give way to dynamic pricing programs, including real-time pricing that is reflective of actual, time-dependent cost of delivering energy to the building. In order to benefit under dynamic pricing, consumers need to shift consumption away from peak periods to periods with reduced grid stress and lower pricing. Consumer efforts to shift their consumption will both reduce consumer energy expenses as well as provide broad societal benefits, such as:

- Lower peak period consumption, potentially reducing the need for new power plants, and
- Increase penetration of clean renewable energy

In a dynamic pricing environment, products that are capable of adjusting their consumption in accordance with consumer price preferences will help consumers remain in control while saving money. As such, in lieu of Demand Response, EPA proposes encouraging the adoption of a transactive Smart Grid within EVSE in order to enable price responsiveness and energy management in the following manner:

- ENERGY STAR EVSE would be capable of receiving price signals and adjusting charging in accordance with consumer preferences, and
- ENERGY STAR EVSE would be capable of transmitting EVSE meter data to consumer authorized devices, apps and services in order to help ensure consumers understand their EV "fuel" costs and to encourage reduced consumption.

Based on information gleaned from stakeholder discussions, EPA understands that the Smart Energy Profile 2.x protocol includes function sets that support these broad goals. EPA encourages stakeholders to provide specific feedback on this proposed approach, including identification of other relevant open standards, test methods, and/or certification programs. In addition, EPA encourages stakeholders to provide specific input on leveraging existing product certification programs as well as identification of specific certification requirements that will limit stakeholder burden while ensuring EPA goals for connected EVSE are achieved.

8 OTHER CONSIDERATIONS

8.1 Role of EVSE

Note: EPA recognizes that activity related to vehicle electrification, energy storage and accessing power from photovoltaics (PVs) is rapidly evolving. As EVSEs play a role in emerging interactions between products and the grid, and have the potential to evolve into a hub for collecting and distributing DC power in a building, EPA is interested in incorporating and addressing emerging features of EVSEs in the first and subsequent versions of the specification that will give users expanded benefits and capabilities for more efficient power distribution. These EVSE features include the ability to:

- Receive DC power, such as from PV panels or local storage;
- Provide DC power to other devices in a building, possibly via USB, Ethernet, or other power transmission medium;
- Supply AC power to a building or specific appliances, whether or not the utility grid is operational;
- Coordinate power distribution with other entities in the building;
- Include electricity storage internal to the EVSE; or
- Receive power from a vehicle.

Such features may affect the EVSE scope, test method, and specifications. EPA seeks to better understand the energy efficiency implications of the presence or absence of these features and invites stakeholders to comment on the feasibility of including these features in this and future test methods and specifications for EVSE.

8.2 User Interface

Note: EPA considers that consumers may operate products, including, EVSEs more efficiently if they can easily understand the status of the devices and how to operate them. Where feasible, EPA seeks opportunities to promote and encourage adoption of best practices for communicating information to the consumer that may impact the product's energy consumption. Ideally, no user manual should be needed to recognize or obtain the most energy-saving settings. EPA requests manufacturers to submit information or provide feedback on EVSE user interface elements—words, symbols, colors, and dynamic operation—to better understand their "user-friendliness". Most user manuals cover this information, so forwarding electronic copies of user manuals covers this request. EPA will then review submissions to better understand the most important concepts being communicated in user interfaces, and the degree of their commonality in representation within and between manufacturers.