SAE INTERNATIONAL

SURFACE VEHICLE STANDARD

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(R) Interconnection Requirements for Onboard, Grid Support Inverter Systems

RATIONALE

The California Public Utility Commission issued Rulemaking 17-07-007 in July 2017 that, in part, asked “should the Commission consider issues related to the interconnection of electric vehicles and related charging infrastructure and devices and, if so, how?” A special working group, associated with this rulemaking and Rulemaking 18-12-006, was established to consider V2G-AC interconnection issues and the use of SAE J3072. Recommendations and gaps were documented in a December 2019 report. This revision is intended to address concerns raised by this report with SAE J3072. While SAE J3072 needs to support IEEE 1547-2018 and IEEE 1547.1-2020 for four-quadrant inverters, some utilities may allow for pure bidirectional inverters to be used for V2G-AC. Therefore, SAE J3072 shall continue to optionally support IEEE 1547-2003 and IEEE 1547.1-2005. This revision will also serve as a general Five-Year Review to address other issues since the original release.

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1. SCOPE

This SAE J3072 Standard establishes requirements for a grid support inverter system function which is integrated into a plug-in electric vehicle (PEV) which connects in parallel with an electric power system (EPS) by way of conductively coupled, electric vehicle supply equipment (EVSE). This standard also defines the communication between the PEV and the EVSE required for the PEV onboard inverter function to be configured and authorized by the EVSE for discharging at a site. The requirements herein are intended to be used in conjunction with IEEE 1547 and IEEE 1547.1. This standard shall also support interactive inverters which conform to the requirements of IEEE 1547-2003 and IEEE 1547.1-2005, recognizing that many utility jurisdictions may not authorize interconnection.

1.1 Purpose

Utilities or local jurisdictions will establish procedures by which a site could be approved for the interconnection of PEVs with onboard inverters based partially on testing and certification to SAE J3072 and other required standards.

The vehicle manufacturer (VM) or their designated agents will perform the analyses, inspections, and tests to ensure that each inverter system model that is installed in one of their PEV models conforms to the requirements of SAE J3072. The VM or third party testing body will issue a certificate of conformance to SAE J3072 for each authorized inverter system model.

The EVSE manufacturer (EVSE OEM) or a Nationally Recognized Testing Laboratory (NRTL) will perform the analyses, inspections, and tests to ensure that each EVSE model to be used with a PEV with an onboard inverter system conforms to the requirements of SAE J3072 or to an EVSE standard which calls out conformance to SAE J3072, as well as other required and applicable United Laboratory (UL) standards. The EVSE OEM or NRTL will issue a certificate of conformance to SAE J3072 or other EVSE standard for each authorized EVSE model.

1.2 Background

Two approvals are needed before a photovoltaic system can be used. A building permit must be secured from the municipality and their code enforcers inspect the installation to ensure that it meets the appropriate National Electrical Code requirements. An application to interconnect to the grid must also be made with the electric utility for both business reasons (such as net metering) and grid safety (which is based on meeting IEEE 1547). If the inverter unit is listed by a NRTL as conforming to UL 1741, this generally satisfies both the local code enforcement and utility technical requirements. The application forms request the model number of the inverter unit and many states maintain a data base of listed and state approved models. Because the PV system is fixed to the site, site-specific settings (such as the reference voltage) can be directly entered into the inverter unit. For a V2G-DC application where the inverter is installed in the EVSE, the same process used with PV systems can be followed.

However, a roaming V2G-AC PEV inverter creates some unique technical and interconnection approval issues. The PEV can easily cross utility service areas and state lines and connect at locations with different site settings. For example, one EVSE could be connected to 208 VAC service and another EVSE could use 240 VAC service. For an onboard inverter that needs to meet an IEEE 1547 requirement to stop discharging if the grid voltage drops below 88% of the reference voltage, the inverter needs to know the reference voltage for the specific EVSE. It is not practicable to allow this to be an explicit inverter setting in the PEV. SAE J3072 defines requirements for these settings to be made in the EVSE and transferred to the PEV when it connects to the EVSE.

There are no established procedures in the electric power industry for handling a DER interconnection application without providing the actual inverter model to be used on the form. The inverters are always fixed to the site and exactly known. PEVs roam and there could be many different PEV models that could possibly connect to a site EVSE, particularly at public sites. Utility DER interconnection application and approval procedures will need to be modified to allow for roaming V2G-AC PEVs with onboard inverters. The utility would approve the site for interconnecting the PEVs based on the EVSE serving as the gatekeeper and only allowing PEV inverter system models that have been certified to conform to SAE J3072 to discharge.

2. REFERENCES

2.1 Applicable Documents

The following publications form a part of this specification to the extent specified herein. Unless otherwise indicated, the latest issue of publications shall apply.

2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

SAE J1766	Recommended Practice for Electric, Fuel Cell, and Hybrid Electric Vehicle Crash Integrity Testing
SAE J1772	SAE Electric Vehicle and Plug-in Hybrid Electric Vehicle Conductive Charge Coupler
SAE J2344	Guidelines for Electric Vehicle Safety
SAE J2578	Recommended Practice for General Fuel Cell Vehicle Safety
SAE J2836/3	Use Cases for Plug-in Vehicle Communication as a Distributed Energy Resource
SAE J2847/3	Communication for Plug-in Vehicles as a Distributed Energy Resource
SAE J2894/1	Power Quality Requirements for Plug-in Electric Vehicle Chargers
SAE J2894/2	Power Quality Test Procedures for Plug-in Electric Vehicle Chargers
SAE J2931/1	Digital Communications for Plug-in Electric Vehicles
SAE J2931/4	Broadband PLC Communication for Plug-in Electric Vehicles
SAE J2953/1	Plug-in Electric Vehicle (PEV) Interoperability with Electric Vehicle Supply Equipment (EVSE)
SAE J2953/2	Test Procedures for the Plug-in Electric Vehicle (PEV) Interoperability with Electric Vehicle Supply Equipment (EVSE)
SAE J3068	Electric Vehicle Power Transfer System Using a Three-Phase Capable Coupler

2.1.2 IEEE Publications

Available from IEEE Operations Center, 445 and 501 Hoes Lane, Piscataway, NJ 08854-4141, Tel: 732-981-0060, www.ieee.org.

IEEE 1547-2003	Standard for Interconnecting Distributed Resources with Electric Power Systems
IEEE 1547-2018	Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces
IEEE 1547.1-2005	Standard Conformance Test Procedures for Equipment Interconnecting Distributed Resources with Electric Power Systems
IEEE 1547.1-2020	Standard Conformance Test Procedures for Equipment Interconnecting Distributed Energy Resources with Electric Power Systems and Associated Interfaces
IEEE 2030.5-2018	IEEE Standard for Smart Energy Profile Application Protocol

2.1.3 Electric Power Research Institute (EPRI) Publications

Available from EPRI, 3420 Hillview Avenue, Palo Alto, California 94304, www.epri.com.

Common Functions for Smart Inverters, Version 4; EPRI, Palo Alto, CA; 2016. 3002008217

2.2 Related Publications

The following publications are provided for information purposes only and are not a required part of this SAE Technical Report.

2.2.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

SAE J1715 Hybrid Electric Vehicle (HEV) and Electric Vehicle (EV) Terminology

2.2.2 IEC Publications

Available from IEC Central Office, 3, rue de Varembe, P.O. Box 131, CH-1211 Geneva 20, Switzerland, Tel: +41 22 919 02 11, www.iec.ch.

IEC 61850-7-420 ED2 Communication Networks and Systems for Power Utility Automation - Part 7-420, Basic Communication Structure - Distributed Energy Resources Logical Nodes

IEC/TR 61850-90-7 Communication Networks and Systems for Power Utility Automation - Part 90-7: Object Models for Power Converters in Distributed Energy Resources (DER) Systems

2.2.3 ISO Publications

Available from International Organization for Standardization, ISO Central Secretariat, 1, ch. de la Voie-Creuse, CP 56, CH-1211 Geneva 20, Switzerland, Tel: +41 22 749 01 11, www.iso.org.

ISO 20653:2013 Road Vehicles - Degrees of Protection (IP Code) - Protection of Electrical Equipment Against Foreign Objects, Water, and Access

2.2.4 National Fire Protection Agency Publications

Available from NFPA, 1 Batterymarch Park, Quincy, MA 02169-7471, Tel: 617-770-3000, www.nfpa.org.

NFPA 70®, National Electrical Code® (NEC®)

2.2.5 UL Publications

Available from UL, 333 Pfingsten Road, Northbrook, IL 60062-2096, Tel: 847-272-8800, www.ul.com.

UL 1741 Standard for Inverters, Converters, Controllers and Interconnection System Equipment for Use with Distributed Energy Resources

UL 2202 Standard for Safety for Electric Vehicle (EV) Charging System Equipment

UL 2594 Standard for Safety for Electric Vehicle Supply Equipment

UL 9741 Outline of Investigation for Bidirectional Electric Vehicle (EV) Charging System Equipment