ETA-HTP10

Revision 0

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Measurement and Evaluation of Hybrid Electric Vehicle RESS Charger Performance

Prepared by

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1. Objective

This procedure provides methods for the evaluation of Rechargeable Energy Storage System (RESS) charger performance for vehicles capable of grid connection and participating in HEV America.

Purpose

The purpose of this procedure is to provide a quantitative methods for determination of key RESS charger performance parameters, including the chargers ability to return the RESS to 100% SOC from any depth of discharge in less than 12 hours. This testing and data acquisition meets the requirements specified in the HEV America Vehicle Specification.

3. Documentation

Documentation addressed by this procedure shall be consistent, easy to understand, easy to read, and readily reproducible. This documentation shall contain enough information to "stand alone"; that is, be self-contained to the extent that all individuals qualified to review it could be reasonably expected to reach a common conclusion, without the need to review additional documentation. Review and approval of test documentation shall be in accordance with ETA-HAC04, "Review of Test Results." Storage and retention of records during and following testing activities shall be completed as described in Procedure ETA-HAC01, "Control, Close-out and Storage of Documentation."

4. Prerequisites

4.1 Personnel conducting testing under this procedure shall be familiar with the requirements of this procedure as evidenced by Certification by the Program Manager or Test Manager, any applicable SAE Test Instructions, and the Administrative Control Procedures, prior to commencing any testing activities.

4.2 Overall error in recording or indicating instruments shall not exceed ±2% of the maximum value of the variable being measured, unless otherwise excepted. Periodic calibration shall be performed and documented to ensure compliance with this requirement. [This error value does not apply to instrumentation permanently installed by the Supplier that is required by the RFP.]

4.3 A list of all instrumentation used in the test shall be identified on Appendix A, and attached to the test results. It shall include the following information:

4.3.1 Manufacturer

4.3.2 Model Number

4.3.3 Serial Number

4.3.4 Last Calibration date

4.3.5 Next Calibration date

4.4 Any deviation from the test procedure and the reason for the deviation shall be approved in advance by the Program Manager or Test Manager in accordance with ETA-HAC02, "Control of Test Conduct," and so noted on the appropriate data sheet(s).

4.5 Necessary recording equipment shall be installed in a manner that does not hinder vehicle operation or alter the operating characteristics of the vehicle.

5. Measurement of RESS Charger Parameters

The Rechargeable Energy Storage System (RESS) chargers shall be evaluated for their ability to recharge the RESS in less than twelve hours, their power factor, their effect on supply line power quality, and the Total Harmonic Distortion (THD) introduced by the charger. Several of these evaluations are completed concurrently, and are described in the following sections.

5.1 Parameter Identification

5.1.1 AC input voltage

5.1.2 AC input current

5.1.3 RESS voltage

5.1.4 DC current.

5.2 Measurement System Components

5.2.1 Sensors, including potential transformers and AC and DC current transformers.

5.2.2 Signal conditioners, including isolation amplifier and attenuator.

5.2.3 Data acquisition system (LabVIEW)

5.3 Measurement Of AC Input Parameters

The input AC parameters shall be measured using a potential transformer and current transformer. The potential transformer (PT) shall have a ratio of 4:1 to reduce the line-to-neutral voltage. The voltage signal shall be further reduced using attenuation through an isolation amplifier. The output of the amplifier shall then be fed to the acquisition system. The AC line current shall be measured using a

clamp-on current transformer (CT), with a ratio of 1000:1 and a frequency response of DC to 400Hz. On the secondary side of the CT, a resistor with a value of 10Ω, a 100Ω, or 1000Ω shall be connected, in order to obtain a measurable voltage drop. This voltage will be proportional to the line current and will be fed to the data acquisition system.

5.4 Measurement Of DC Output Parameters

5.4.1 The DC voltage of the RESS shall be measured using the proper attenuation in the isolation amplifier. The DC current shall be measured using an AC/DC CT. The CT shall have a ±2V analog output which will be directly fed to the acquisition system, with a frequency response of 0 to 2 kHz. The signals are first passed through a signal conditioning and amplifier unit which provides the necessary signal levels for compatibility with the A/D converter. The program shall sample at a frequency of at least 21.6 kHz, acquiring at least 720 points per channel, and covering at least two cycles of the 60 Hz waveform. This sampling frequency will ensure adequate resolution for the power quality measurements.

5.4.1 Using the collected samples, the required parameters shall be calculated every 30 seconds and stored in a data file. The following parameters shall be calculated:

5.4.1.1 V_{rms} of the AC input voltage

5.4.1.2 I_{rms} of the AC input voltage

5.4.1.3 THD of the AC input voltage

5.4.1.4 THD of the AC input current

5.4.1.5 AC active power

5.4.1.6 Harmonic power

5.4.1.7 Total apparent power

5.4.1.8 Harmonic apparent power

5.4.1.9 True power factor

5.4.1.10 Displacement power factor

5.4.1.11 RESS voltage

5.4.1.12 DC value of the charging current

5.4.1.13 Ripple factor of the charging current

5.4.1.14 Ampere-hours

5.4.1.15 Watt-hours

5.4.1.16 Charger efficiency (DC power out / AC power in)

NOTE

These data shall be saved in columns along with the time stamp, to be used to plot the required waveforms as a function of time. Power quality calculations use the fundamental components of the voltage and current. These fundamental components shall be calculated using the Fourier series expansion. Through operator control, the acquired data shall also be saved in a separate file to allow plotting of the input voltage and current waveforms. This function should be performed at various times in the charging cycle, including the beginning, mid-point and end.

5.5 Determination of the End of Charge Point for Vehicle RESS.

The HEV America Vehicle Specification requires that the RESS charger automatically terminate charge when the RESS has reached 100% SOC. This automatic termination point shall be used to determine when the RESS has reached 100% SOC.

6. RESS Charger Evaluation

To perform evaluation of the RESS charger capability, conduct the following:

6.1. Discharge the RESS to the minimum SOC allowed by the Supplier by driving vehicle per HTP04, Electric Vehicle Constant Speed Range Tests, Section 5.1 or as directed by the vehicle operating manual.

6.2 Within two hours of completing Step 6.1, place the vehicle on charge in accordance with procedure ETA-HTP08, "RESS Charging." Record the time the charger is connected per ETA-HTP08, "RESS Charging."

6.3 Monitor the AC and DC parameters during the entire charge period.

6.4 Determine the end of charge per Section 5.6 of this procedure and note the time.

6.5 Note the time the vehicle indication of full charge (if this time is different from the method specified in Section 5.6) shows the RESS fully charged.

6.6 Charge for 13 hours or until section 6.4 and 6.3 are complete

6.7 Verify the time to full charge is less than 12 hours by reviewing the stored data.

6.8 Verify the maximum AC current was less than 40 Amps at all times.

6.9 Plot the parameters listed in Section 5.5.1 of this procedure.

7. Glossary

7.1 Effective Date - The date, after which the procedure has been reviewed and approved, that the procedure can be utilized in the field for official testing.

7.2 HEV America – Hybrid Electric Vehicle America Performance Test Program, the DOE sponsored test program for independently assessing the performance of vehicles submitted for testing.

7.3 Program Manager - As used in this procedure, the individual within Electric Transportation Applications responsible for oversight of the HEV America Performance Test Program. [Subcontract organizations may have similarly titled individuals, but they are not addressed by this procedure.]

7.4 Rechargeable Energy Storage System (RESS)_– A component or system of components that stores energy and for which its supply of energy is rechargeable by an electric motor-generator system, an off-vehicle energy source, or both. Examples of RESS's for HEVs include batteries, capacitors and electromechanical flywheels

7.5 Shall - Items which require adherence without deviation. Shall statements identify binding requirements. A go, no-go criterion.

7.6 Should - Items which require adherence if at all possible. Should statements identify preferred conditions.

7.7 Snapshot - A term given to the time frame that normally accompanies a single event or a number of concurrent events. Usually indicates a repetitive series of events is occurring or is meant to occur.

7.8 State of Charge (SOC) - For vehicles operable in "RESS only mode," the SOC of the RESS is defined as the present capacity, (amperes-hours or watt-hours or miles), expressed as a percentage of the total available. The 100% SOC basis (available ampere-hours, kilowatt hours or miles) is determined by the actual discharge capability of the RESS when discharged to the requirements of the 45 mph Constant Speed Range Test portion of procedure ETA-HTP04.

7.9 Test Director - The individual within Electric Transportation Applications responsible for all testing activities associated with HEV America.

7.10 Test Director's Log - A daily diary kept by the Test Director, Program Manager, Test Manager or Test Engineer to document major activities and decisions that occur during the conduct of a Performance Test Evaluation Program. This log is normally a running commentary, utilizing timed and dated entries to document the days activities. This log is edited to develop the Daily Test Log published with the final report for each vehicle.

7.11 Test Engineer - The individual(s) assigned responsibility for the conduct of any given test. [Each contractor/subcontractor should have at least one individual filling this position. If so, they shall be responsible for adhering to the requirements of this procedure.]

7.12 Test Manager - The individual within Electric Transportation Applications responsible for the implementation of the test program for any given vehicle(s) being evaluated to the requirements of HEV America. [Subcontract organizations may have similarly titled individuals, but they are not addressed by this procedure.]

7.13 Time Stamp - The arbitrary time zero (t_o) denoting the beginning of an event.

8. References

8.1 HEV America Vehicle Specification

8.2 IEEE-450 1987, "Recommended Practices for Stationary Lead Acid Storage Batteries"

8.3 ETA-HAC01 - "Control, Close-out and Storage of Documentation"

8.4 ETA-HAC02 - "Control of Test Conduct"

8.5 ETA-HAC04 - "Review of Test Results"

8.6 ETA-HAC05 - "Training and Certification Requirements for Personnel Utilizing ETA Procedures"

8.7 ETA-HAC06 - "Receipt Inspection"

8.8 ETA-HTP04 - "Electric Vehicle Constant Speed Range Test"

8.9 ETA-HTP11 - "Vehicle Verification"

APPENDIX-A
Vehicle Metrology
Setup Sheets
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VIN Number: _____-_

Instrument/Device:	Calibration Due Date:	Initials / Date:
Current Clamp S/N:		
Voltmeter S/N:		
DAS S/N:		
DAS Set-up Sheet S/N		
kWh Meter S/N:		
Shunt S/N:		
Misc:		
Misc:		
Misc:		
Misc:		
Misc:		

Comments (initials/date):

Completed By:

(Printed Name) (Signature) (Date)

Reviewed By (QA):

(Printed Name) (Signature) (Date)