
Vehicle Electrification System Standards

V. Phase Drive Motors and Generators

V.f Electric Machine Testing, Analysis, and Diagnostics – On and Off Vehicle

Description:

Testing, analysis, and diagnostics of 3-Phase electric machines, whether onboard or offboard the vehicle, are essential knowledges and skills that all electrified vehicle technicians need to acquire. Understanding how and when to use various testers and testing methods/techniques is fundamental to ensure thorough and complete testing of any electric powertrain system, whether HEV, PHEV, BEV or, FCEV. The education and training of technicians is not complete unless they are adept at IM or PM electric machine testing.

Outcome (Goal):

Students will be able to utilize all of the testers/equipment provided to them for performing testing, analysis, and diagnostics on 3-Phase HEV, PHEV, BEV or, FCEV electric powertrain systems.

Objective:

Students shall be able to:

1. Perform a HV Disable procedure to ensure the system is de-energized so test equipment can be safely connected
2. Connect, and properly setup, a DSO and AC Current clamps, to acquire 3-Phase electric machine waveforms while the vehicle is being driven on a test drive or on a dyne
3. Analyze and provide a diagnostic on acquired DSO waveforms



4. Measure the phase resistances of a 3-phase electric machine and determine if the phases are balanced and within specifications provided by the IEEE
 5. Utilize an MCA tester and determine the SOH of a 3-phase electric machine, and provide a final diagnostic
 6. Use a Scan Tool to acquire electric machine data and compare it to OEM testing values to determine if it is operating within the OEM stated operating metrics.
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Task:

Students will utilize OEM service information, component supplier information, engineering data, IEEE standards, and vetted industry information (DOE, EASA, INL, etc.) to perform testing and analysis on electric machines. Students will test, analyze, and evaluate live vehicles, transmissions, or drive units. Students will be provided lab sheets with procedures and processes to measure each of the specified electric powertrain systems. As part of testing and analysis, Students will use proper technical terminology, acronyms, and definitions.

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Name	Acronym	Definition
Digital Storage Oscilloscope (Differential)	DSO	A laptop compatible oscilloscope with a minimum of 4-channels, preferable with differential inputs, to assist in filtering electrical noise provided by AC current clamps. E.g. Pico 4444 or equivalent.
Current Clamps (Fluke i400s)		Three AC current clamps with a minimum of 400-600 amps are necessary to acquire light duty electric machine (drive motor or generator) waveforms so 3-Phase electric machines can be tested and analyzed for a diagnostic.
MilliOhmmeter (Kelvin)		To complete proper IEEE resistance testing of and electric machine, a miliohmmeter, with a Kelvin connection system, must be used to accurately measure low resistances of the electric machine phases to ensure proper electrical current balance.
Insulation Resistance Tester (Fluke 1507)	IR	Insulation testing is the primary IEEE test metric that is performed on an electric machine as part of testing, analysis, and diagnostics to measure the internal insulation integrity of magnet wire coating and slot liner.
Motor Circuit Analysis (AT33EV)	MCA	MCA testing provides the highest number of metrics utilized for thorough and accurate testing, analyzing, and diagnosing a 3-Phase electric machine. MCA testing will test the electrical and magnetic balance of the stator and rotor. MCA testing will test for the following properties of an IM or PM electric machine: DC resistance, inductance, impedance, phase angle, current to Hz ratio, dissipation factor (i.e. winding or slot liner contamination), and insulation resistance. MCA testing can be utilized to determine electric SOH or acquire empirical testing data.
Serial Data (Scan) Tool		Scan Tool PID and Special Function testing may provide additional diagnostic value when testing and analyzing an electric machine for proposing a final diagnostic. Scan Tools provide interrogation of vehicle controllers via the CAN/LIN bus to provide basic electric machine diagnostics but, will not provide SOH (precision) data.