Keysight Technologies

HV Cable Insulation Resistance Testing for Hybrid Vehicles

Application Note

KEYSIGHT TECHNOLOGIES

Introduction

Hybrid vehicle technology has grown rapidly over the last decade because of its fuel efficiency and low emissions. Today's hybrid systems are more sophisticated than conventional engines and leverage the best operating characteristics of the combustion engine and electric motor based on driving conditions. This helps to achieve superior fuel efficiency and reduce CO_2 emissions.

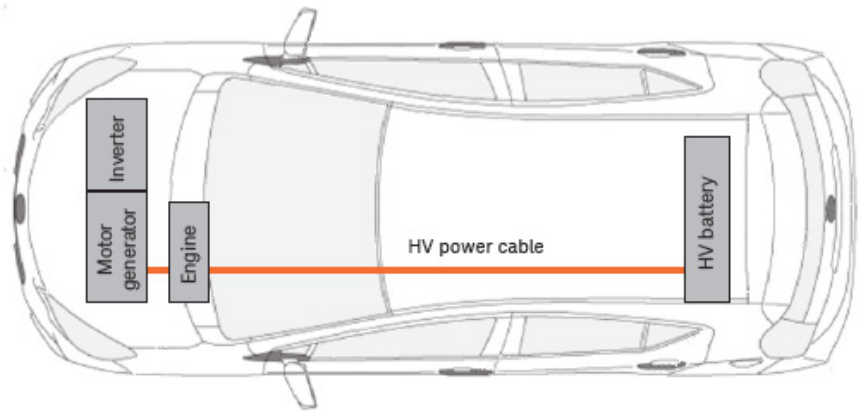
An Overview of Critical Hybrid Connections

Conventional engine vehicles operate between 12 to 14 V to activate the combustion engine. The use of hybrid technology adds a high-voltage system and expands the operating voltage to as high as 650 V to power the electric motor in the hybrid vehicle. The high-voltage (HV) system includes the HV battery, inverter assembly, and the motor generators. These elements are connected using an HV power cable, which is color-coded in orange to easily distinguish it from regular cables. An insulation resistance test is performed to check the integrity of the HV power cable between the HV battery and the inverter system, and between the inverter and motor generator.

Hybrid System Components

The hybrid system consists of the following main components:

- Gasoline engine – Powers the wheels during normal and accelerated driving
- Motor generators (MG) – Generates electrical power and recharges the HV battery
- Inverter system – Converts the high DC voltage (HV battery) to AC (MG) and vice versa
- HV batteries – Supplies electric power to the motor generator during start-off, low speed, acceleration, and uphill driving



Testing the Insulation Resistance of the HV Power Cable in a Hybrid Vehicle's HV System

Before measuring insulation resistance, it is important to ensure that the HV system is shut down. This is done by conducting a voltage test. Since exposure to any leakage in the HV system's high-voltage insulation may be harmful, technicians use personal protective gear during the testing process, such as insulating gloves, safety glasses, and safety footwear.

An insulation resistance test is conducted according the test voltage recommended by the vehicle's manufacturer. The test result is then compared with the recommended acceptance insulation resistance value. Further investigation is carried out if the insulation resistance value for the power cable is found below the defined limit. A low resistance value will be displayed if there is leakage or a puncture in the HV power cable. Sometimes contamination or moisture in the HV battery assembly or the inverter assembly can result in a low insulation resistance reading.

Keysight U1450A/U1460A Series Insulation Resistance Testers

The U1450A/U1460A Series insulation resistance tester can detect if voltage is present at the input terminal of the insulation mode before the insulation test is initiated. If external voltage is detected and is greater than the default limit, 30 V (or 50 or 75 V, depending on the voltage selection in the setup mode), the insulation test will be prohibited. This additional precautionary feature safeguards the service technician by detecting the undesired voltage present in the test connection before turning on the insulation resistance test. The insulation resistance tester auto-discharges the device under test when the test is completed. This further simplifies insulation testing and enables the service technicians to achieve higher productivity.

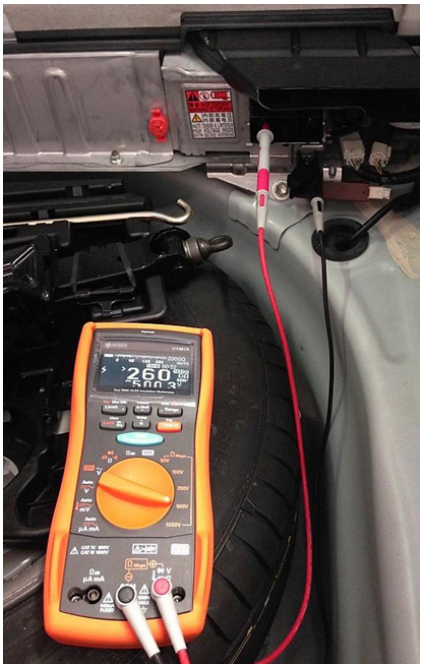


Figure 1. Testing the insulation resistance between the HV power cable and the body ground of a hybrid vehicle using the Keysight U1461A True RMS OLED insulation multimeter. The insulation resistance tester shows > 260 GΩ at 500 V test voltage, indicating the insulation is in good condition.

Summary

The hybrid vehicle uses a high-voltage system, which requires service technicians to constantly adhere to all the safety precautions and be cautious of voltage present in the HV system. The Keysight U1450A/U1460A Series insulation resistance tester now includes a built-in digital multimeter. This two-in-one functionality allows technicians to use a single device to perform the basic electrical measurement, followed by the insulation resistance test. This saves time and minimizes the pieces of equipment needed by the technician.

myKeysight

myKeysight

www.keysight.com/find/mykeysight
A personalized view into the information most relevant to you.

Three-Year Warranty

www.keysight.com/find/ThreeYearWarranty
Keysight's commitment to superior product quality and lower total cost of ownership. The only test and measurement company with three-year warranty standard on all instruments, worldwide.

Keysight Assurance Plans

www.keysight.com/find/AssurancePlans
Up to five years of protection and no budgetary surprises to ensure your instruments are operating to specification so you can rely on accurate measurements.

www.keysight.com/go/quality
Keysight Technologies, Inc.
DEKRA Certified ISO 9001:2008
Quality Management System

Keysight Channel Partners

www.keysight.com/find/channelpartners
Get the best of both worlds: Keysight's measurement expertise and product breadth, combined with channel partner convenience.

www.keysight.com/find/insulationtesters

For more information on Keysight Technologies' products, applications or services, please contact your local Keysight office. The complete list is available at:
www.keysight.com/find/contactus

Americas

Canada	(877) 894 4414
Brazil	55 11 3351 7010
Mexico	001 800 254 2440
United States	(800) 829 4444

Asia Pacific

Australia	1 800 629 485
China	800 810 0189
Hong Kong	800 938 693
India	1 800 112 929
Japan	0120 (421) 345
Korea	080 769 0800
Malaysia	1 800 888 848
Singapore	1 800 375 8100
Taiwan	0800 047 866
Other AP Countries	(65) 6375 8100

Europe & Middle East

Austria	0800 001122
Belgium	0800 58580
Finland	0800 523252
France	0805 980333
Germany	0800 6270999
Ireland	1800 832700
Israel	1 809 343051
Italy	800 599100
Luxembourg	+32 800 58580
Netherlands	0800 0233200
Russia	8800 5009286
Spain	800 000154
Sweden	0200 882255
Switzerland	0800 805353 Opt. 1 (DE) Opt. 2 (FR) Opt. 3 (IT)
United Kingdom	0800 0260637

For other unlisted countries:
www.keysight.com/find/contactus
(BP-09-23-14)

KEYSIGHT TECHNOLOGIES

Published in USA, January 9, 2015
5992-0289EN
www.keysight.com