Confirming safety of electric and hybrid vehicles

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Confirm the safety of Electric and Hybrid vehicles

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HV vehicle in PTI:
  - What does HV mean?
  - Where are you faced with HV?
  - When to check in PTI

Possible Measurement:
  - All pole voltage measurement
  - HV insulation measurement
  - SAE J1766 measurement
  - Insolation monitor check
  - Equipotential bonding check

Conclusion
WHAT DOES HV MEAN?

- ALL voltage > 60V DC and >25V AC are defined as „HIGH VOLTAGE“ (HV)

- hazardous HV components
  - electric motor
  - HV battery
  - HV electronics
  - A/C compressor / heating…

- specific marking
  - HV symbol
  - orange cables

HV:  >60V DC  >25V AC
OVERVIEW HIGH VOLTAGE VEHICLES

Hybrid Vehicle
Combustion Engine + Electric Motor

MICRO
Start/Stop Automatic

MICRO-MILD
electr. Break Energy Regeneration

MILD
electr. Acceleration Boost

FULL
electrical Driving

Pure Electro Vehicle
Source: Mitsubishi

CAUTION „HIGH VOLTAGE“

below HV limit

SERIAL
pure electric driving and Range Extender

PARALLEL
Drive by Electric Motor and / or Combustion Engine
OUTLOOK: ELECTRIFIED POWERTRAINS

- Market shares (Western Europe 2015)
  - ICE: 25%
  - Micro-Hybrid: 55%
  - Micro-Mild-Hybrid: 15%
  - Mild-Hybrid: 3%
  - Full-Hybrid: 1.7%
  - Electric vehicles: 0.3%

Increase in electric energy on board
WHEN TO CHECK IN PTI?

- In every days use the correct function of the safety system is checked via on board diagnosis system
- Correct function of system is checked via on board diagnosis system
- Complete control of the HV system is complex as it only can be performed by specially trained personal as system need to be voltage free
- Therefore complete check @ each PTI might be to high effort

- Additional measurement necessary in case of
  - Visible wear
  - crashed cars
  - modified cars
  - after a certain age/km run

Impact on HV safety
RECOMMENDED MEASUREMENTS

- All pole voltage measurement
- Voltage measurement
- HV insulation measurement
- SAE J1766 measurement
- Insulation monitor check
- Equipotential bonding check

AVL DiTEST HV SAFETY 2000
Necessary for all further steps to prove safety during PTI measurements

- Reliable confirm that vehicle under test is voltage free
- Clear documentation that process was performed
Method to determine the insulation resistance strength

HV insulation measurement

Check the status of the insulation of the HV system

The tool is generating the appropriate test voltage. According to the possible current flow through the measurement, the insulation resistance strength is determined.
Method to determine the insulation resistance strength

HV insulation measurement

The measurement result shows the resistance in Ohm per 1V (applied test voltage)

--- > min. 1000 Ω / Volt
Method to determine the insulation resistance strength

**SAEJ1766 measurement**

Insulation strength test according SAE J1766 standard

**Measurement on an ENERGIZED system!**

Basically it is a voltage drop measurement
First step with a high internal resistance of the tool $\geq 1\,\text{M}\Omega$,
Second step with an internal load resistor 500 x of the nominal HV battery voltage (400V $\Rightarrow$ 200k $\Omega$)
Result: min. 500 $\Omega$ / Volt

1. Measurement of HV battery voltage
2. Measurement of HV - to chassis with and without load resistor
3. Measurement of HV + to chassis with and without load resistor

**AVL DiTEST HV SAFETY 2000**
The insulation monitor check is a Measurement on an energized system!

Via the variable adjustable load resistor in the tool (500k Ω - ʡ) the Insulation value is detected at which the on-board insulation monitor show alerts @ min. 500 Ω / Volt
The on-board insulation monitor permanently checks (cyclic) the condition of the insulation between the HV terminals and chassis ground.

- Supported and controlled by the 14V on-board power supply
- Fault code set if insulation is faulty - Warning lamp alerts the driver
- HV solenoids get open if insulation problems occur → vehicle is stopped

CAUTION „HIGH VOLTAGE“

AVL DiTEST HV SAFETY 2000
Every HV-component housing is connected via a massive conductive cable with each other and to chassis

- Conduct compensating current in the case of an error
- Equalize potential differences amongst HV-components in the case of an insulation error

→ Prevent an electro shock by touching the chassis and/or the defective HV-component

CAUTION „HIGH VOLTAGE“
HIGH VOLTAGE Components

- When insulation failures at HV-modules occur
- Equipotential bonding conducts compensating current
- Potentially lethal when equipotential line is missing or defective in case of HV insulation problems
- Equipotential bonding test with a test current of min. 200mA resp. 1A (ECE R100)

Continuity check with high current
Method to evaluate the condition of the equipotential bonding

Equipotential bonding check

The equipotential bonding check is comparable to a continuity test using a very high test current.

The equipotential bonding is stressed by the test current to reveal faults with the bonding.

max. $\leq 100 \, \text{m}\Omega$ @ 200mA resp. 1A test current (ECE R100)

Manufacturer specific limits $\leq 10 \, \text{m}\Omega$

→ four-wire technology required

AVL DiTEST HV SAFETY 2000
AVL DiTEST HV SAFETY 2000

USB connection suitable for every PC
Power supplied solely via USB

Funktion & Status LEDs

3m measuring leads using four-wire technology

Probes with control button useable with safety gloves
Probes using four-wire technology