

USER MANUAL

AVL DITEST HV SAFETY 2000



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FUTURE SOLUTIONS FOR TODAY

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IMPORTANT SAFETY INSTRUCTIONS

Read all instructions – SAVE THESE INSTRUCTIONS

Read all instructions.

Do not operate equipment with a damaged cord or if the equipment has been dropped or damaged – until it has been examined by a qualified service person.

Do not let the supply lead and the measuring leads hang over the edge of the table, bench, or counter or come in contact with hot manifolds or moving fan blades.

Always unplug equipment from electrical outlet when not in use. Never use the cord to pull the plug from the outlet. Grasp plug and pull to disconnect.

Let equipment cool completely before putting away. Loop cord loosely around equipment when storing.

To reduce the risk of fire, do not operate equipment in the vicinity of open containers of flammable liquids (gasoline).

Adequate ventilation should be provided when working on internal combustion engines.

Keep hair, loose clothing, fingers, and all parts of body away from moving parts.

To reduce the risk of electric shock, do not use on wet surface or expose to rain.

Use only as described in this manual. Use only manufacturers recommended attachments.

ALWAYS WEAR SAFETY GLASSES.

Everyday eyeglasses only have impact resistant lenses, they are not safety glasses.

Warning and safety instructions

This equipment manual contains important **warnings and safety information** which must be observed by the user.

The product is only intended for a very specific application described in the equipment manual. Furthermore, the most important prerequisites and safety measures required for the use and operation of the product are explained to ensure smooth operation.

We do not accept any warranty and liability for applications other than the application described and without observing the required preconditions and safety measures.

The product may only be used and operated by personnel that due to its professional qualification is able to observe the required safety measures when using and operating the equipment. It may only be operated with the accessories and consumables supplied by DITEST or approved by DITEST. Since with this product the measuring results not only depend on proper functioning of the product, but also on a number of further conditions, it is necessary to have the results generated by the product checked (e.g. plausibility check) by an expert prior to implementing further measures based on the generated measured value.

Adjustments and maintenance of live, opened devices may only be carried out by qualified personnel trained for that purpose and that is aware of the risks involved.

The product may only be repaired at the supplying factory or by the qualified personnel trained for that purpose.

When using the product, a specialist must ensure that neither the test object nor the test facility can operate in such a manner that it might damage property or put personnel at risk.

Summarised safety notes



DANGER



Danger of death from electrical voltage in vehicles with high-voltage systems

The HV battery and the parts connected to it operate at a potentially lethal high voltage. Make sure that nobody touches the terminals of the HV battery, the connection cables of the HV battery and other parts under high voltage.



WARNING



Danger of electric shock on the ignition system

The ignition system is under life-threatening high voltage!
Do not touch the ignition system while engine is running!



WARNING



Danger of electric shock on vehicles with xenon headlight

The lighting system with xenon headlight is under life-threatening high voltage!
Do not touch any component while the xenon light is switched on!



WARNING

Danger due to harmful or irritating substances

Tests with engine running in closed rooms (workshops, test halls, etc.), the exhaust emission has to be vented to the outside and the space should be adequately ventilated!



WARNING

Risk of burns due to hot components

Perform measurements at normal engine operating temperature or follow the respective test specification!
Do not touch any hot components such as engine, engine mountings and the entire exhaust system!
If necessary, use cooling fans!

**WARNING****Risk of injury due to rotating parts**

Perform any work in the engine compartment while engine and ignition are turned off!
Do not touch any rotating parts, such as, assemblies of electric generator, radiator fan and their drives (e.g. V belt)!
With running engine ensure a safe installation of the measuring cables!

**WARNING****Risk of injury due to unsecured vehicle**

Apply the hand brake or place the selector lever to P (automatic transmission)!
Secure vehicle adequately against rolling!

**WARNING****Explosion hazard due to pyrotechnic installation and restraint system**

Test and installation work should only be carried out by trained personnel!
Under no circumstances should the igniter be tested with the multimeter!
System verification only with approved testing device!
Disconnect the battery when working on the airbag system!
When disconnecting the battery the ignition has to be switched off and there should be nobody in the passenger compartment!
Always store dismantled airbag unit with discharge area up or according to the storage instructions!
Airbag unit should never be left unattended!
Protect airbag unit against flying sparks, open fire and temperatures above 100°C!
Do not transport airbag unit in the passenger compartment!
Do not bring airbag unit in contact with oil, grease and cleaning agents!
Airbag unit that dropped more than 0.5m has to be replaced!
Dispose of untriggered airbag units!
Do not open or repair airbag unit!

NOTICE

Observe the applicable manufacturer's specifications when holding the cutoff speed of diesel engines!

NOTICE

Always switch off the ignition first before connecting and disconnecting the OBD plugs or the different AVL vehicle adapters!

Safety notes



DANGER



Danger of death from electrical voltage

The AVL DiTEST HV Safety 2000 is not suitable for measurements on the mains!

The AVL DiTEST HV Safety 2000 is only suitable for measuring DC voltages!

Any outlets installed in the vehicle must not be measured!

Measurements with the AVL DiTEST HV Safety 2000 on electric vehicles may only be carried out if no charging cable is connected to the vehicle!



DANGER



Danger of death from electrical voltage in vehicles with high-voltage systems

Please note that only trained and authorised staff is allowed to carry out work, in particular dismantling work, on high voltage vehicles.



DANGER



Danger of death from electrical voltage in vehicles with high-voltage systems

Life-threatening high voltage is applied to the HV energy store (HV battery) and the connected parts. Make sure that no one gets in contact with hybrid battery terminals, the connecting cables of the HV battery and other live parts.



DANGER



Danger of death from electrical voltage in vehicles with high-voltage systems

Special safety and training conditions apply for work under voltage! Make sure to observe these safety conditions in every situation!



DANGER



Danger of death from electrical voltage in vehicles with high-voltage systems

Please make sure that all required safety precautions are taken before you start measuring!



DANGER



Danger of death from electrical voltage in vehicles with high-voltage systems

Please note, that only measurement equipment, which was delivered from AVL DiTEST, will be used!

When using general measuring adapters (probe tips, test clips ...) please note that these are suitable and approved for measuring- and test voltage until 1000V and correspond to the norm EN 61010-31!

**DANGER****Danger of death from electrical voltage in vehicles with high-voltage systems**

During measurements in high-voltage environment, the AVL DiTEST HV Safety 2000 may only be used, if the voltage source is non-grounded!

**DANGER****Danger of death from electrical voltage in vehicles with high-voltage systems**

During high voltage insulation measurement, you must make sure not to touch test adapter tips which are not insulated! During measurement, a test high voltage (250V, 500V to 1000V) is generated with a test current of up to 2mA flowing through the connected test object. If you touch not insulated test adapter tips, you can feel the electric shock considerably. However, the electric current which is limited to 2mA is not life-threatening. After high voltage insulation measurement, the high voltage at the test tips is automatically reduced due to the measuring module.

**DANGER****Danger of death from electrical voltage in vehicles with high-voltage systems**

During the high-voltage insulation measurement, the measured object must be de-energized! Before measuring, disconnect the HV energy store (HV battery) from the HV vehicle electrical system. Secure the measured object against switching back on! After disconnecting the HV energy store, you must wait at least 2 minutes for all capacitors (e.g.: link circuit capacitors) to discharge. Before every high-voltage insulation measurement, do a voltage measurement to make sure no voltage is applied to the measured object! (Measurement, as close to the work location as possible) Make sure neighboring live parts are covered and secured!

SAVE THESE INSTRUCTIONS

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1 General

1.1 General description

The AVL DiTEST HV Safety 2000 is used in conjunction with AVL DSS to conduct measurements on modern vehicles equipped with a high-voltage system.

Functions:

- Initialisation/self-test
- DC voltage measurement (absence of voltage)
- Insulation resistance measurement
(calculation of insulation resistance by current and voltage measurement)
- Insulation resistance measurement to SAE J1766
(measurement under load with parallel resistance)
- Full measurement
(combines the DC voltage, HV insulation resistance and SAE J1766 measurements into one user-guided procedure)
- Equipotential bonding check
- Resistance measurement
- Diode test
- Capacity measurement
- Insulation monitor check

Features:

- Parameterisation by configurable test voltage: 250 to 1,000 volts, nominal test current: 1 mA
- Generation of high voltage, enablement only at press of a button, automatic discharge of transient current and voltage after the high-voltage insulation resistance measurement
- High-voltage safety circuit (automatic switch-off)
- Function indicator with 2 LEDs
- Compatibility between AVL DiTEST HV Safety 2000 and AVL DSS
- Power supply by USB interface, 5 V / 500 mA (500 mA: maximum value)
- Interface: USB 2.0
- Galvanic isolation from USB interface

1.2 Safety instructions

This documentation contains important warnings and safety instructions which have to be observed by the user. Only through compliance with these requirements and safety measures it is possible to ensure correct and safe operation.

Please note the safety instructions on the screen.

1.3 Typographical conventions

Safety instructions:



DANGER

Indicates an **extremely dangerous** risk which - if not prevented - leads to death.



WARNING

Indicates an imminent danger - if not prevented - can result in death or serious injury.



CAUTION

Indicate a danger that may lead to moderate or light injuries.

Additional danger signal:



Danger due to electrical current.

Notes:

NOTICE

This text draws attention to situations or operating error that can lead to property damage or loss of data.

Information

This text indicates important information or instructions. Failure to comply with these instructions prevents or significantly hampers a successful finalization of the operations described in this documentation.

Standard text formats:

bold	Important text/text passages, parameter
<i>italic</i>	On screen dialogs and messages
CAPITAL LETTERS	Device designation and operating conditions
Menu Menu item	Selection of menu command through tapping on buttons

List formats:

1. 2.	Step-by-step instructions in a specified sequence
•	Instructions, consisting of only one step
▪	Listings without a specific order
-	

1.4 Operation of PC programs

This manual assumes basic knowledge of Microsoft Windows.

Please turn to your Windows manual for details.

If necessary, contact your PC support/system administrator.

1.5 Design

1.5.1 Overview

The AVL DiTEST HV Safety 2000 comprises the following components

- (1) AVL DiTEST HV Safety test module
- (2) LEDs, blue and red/green
- (3) Black protective cap to cover the black probe tip
- (4) Black probe tip to connect to the black test adapter
- (5) Red protective cap to cover the red probe tip
- (6) Red probe tip to connect to the red test adapter
- (7) Protection against accidental contact for red test adapter
- (8) Button on red test adapter
- (9) Red test adapter
- (10) Protection against accidental contact for black test adapter
- (11) Black test adapter
- (12) USB connector

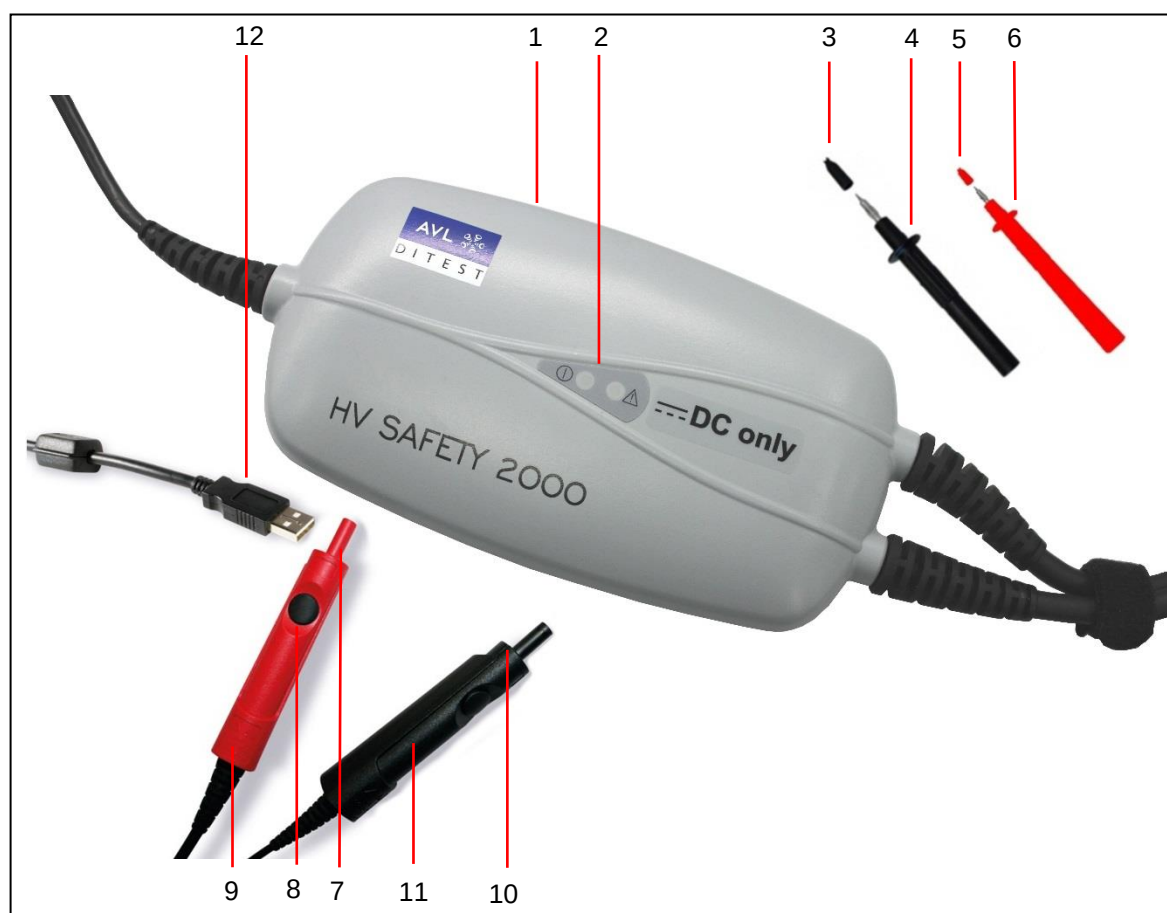


Fig. 1-1

1.5.2 Top side

There are two LEDs (1) and (2) on the top:

LED	LED colour	LED state	Meaning
(1) ①	Blue	Lit	Operation normal
		Slow flashing	Error during normal operation
		Fast flashing	Error, e.g. no firmware in device.
(2) ⚠	Green	Lit	Normal operating condition
		Slow flashing	Self-test in progress
		Fast flashing	Waiting for press of button to start self-test
	Red/green	Off	Firmware update with bootloader in progress
	Red Green Blue	Lit Off Lit	Voltage > 10 V present at probe tips. (test voltage or high voltage generated by the AVL DiTEST HV Safety 2000)

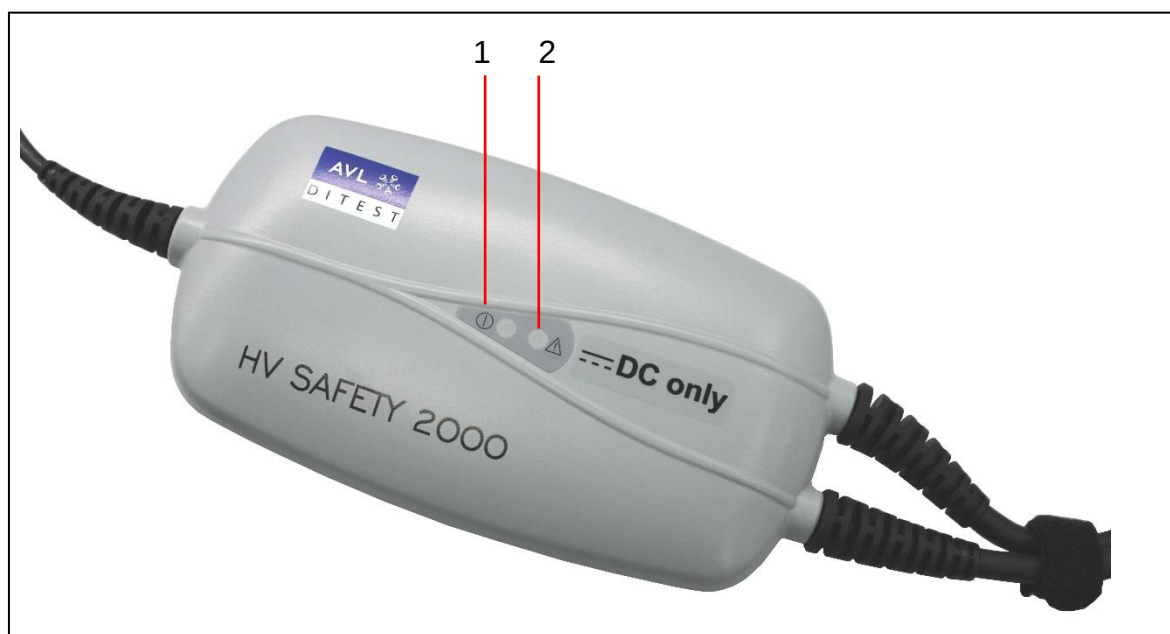


Fig. 1-2

1.5.3 Test adapters



DANGER



Danger of death from electrical voltage

Overvoltage categories CAT-II 600V / CAT-III 300V

The AVL DiTEST HV Safety 2000 fulfils impulse voltage values as per the overvoltage category CAT-II 600V / CAT-III 300V.

Measurements in electric circuits that are connected directly to the mains are not permitted!

For this reason use the AVL DiTEST HV Safety 2000 only for measurements on the vehicle.

The 3 m test cables are permanently connected to the test adapters and the AVL DiTEST HV Safety 2000.

The red test adapter has a button that is used to start various actions.

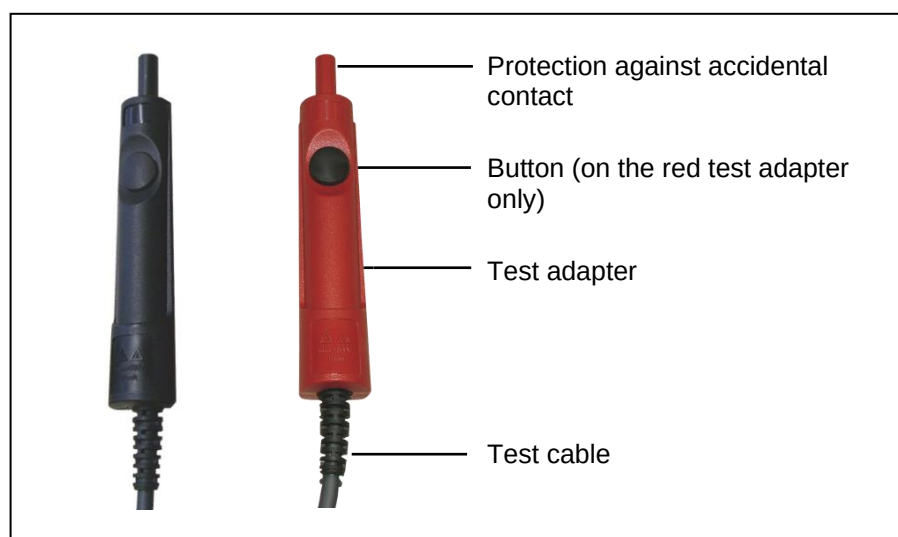


Fig. 1-3

1.5.4 Probe tips

Probe tips with removable protective caps can be attached to the test adapters.



DANGER

Danger of death from electrical voltage

Overvoltage categories CAT-II 600V / CAT-III 300V

The AVL DiTEST HV Safety 2000 fulfils impulse voltage values as per the overvoltage category CAT-II 600 V / CAT-III 300 V.

Measurements in electric circuits that are connected directly to the mains are not permitted!

For this reason use the AVL DiTEST HV Safety 2000 only for measurements on the vehicle.



DANGER

Danger of death from electrical voltage

Please note, that only measurement equipment, which was delivered from AVL DiTEST, will be used!

When using general measuring adapters (probe tips, test clips ...) please note that these are suitable and approved for measuring- and test voltage until 1000 V and correspond to the norm EN 61010-31!

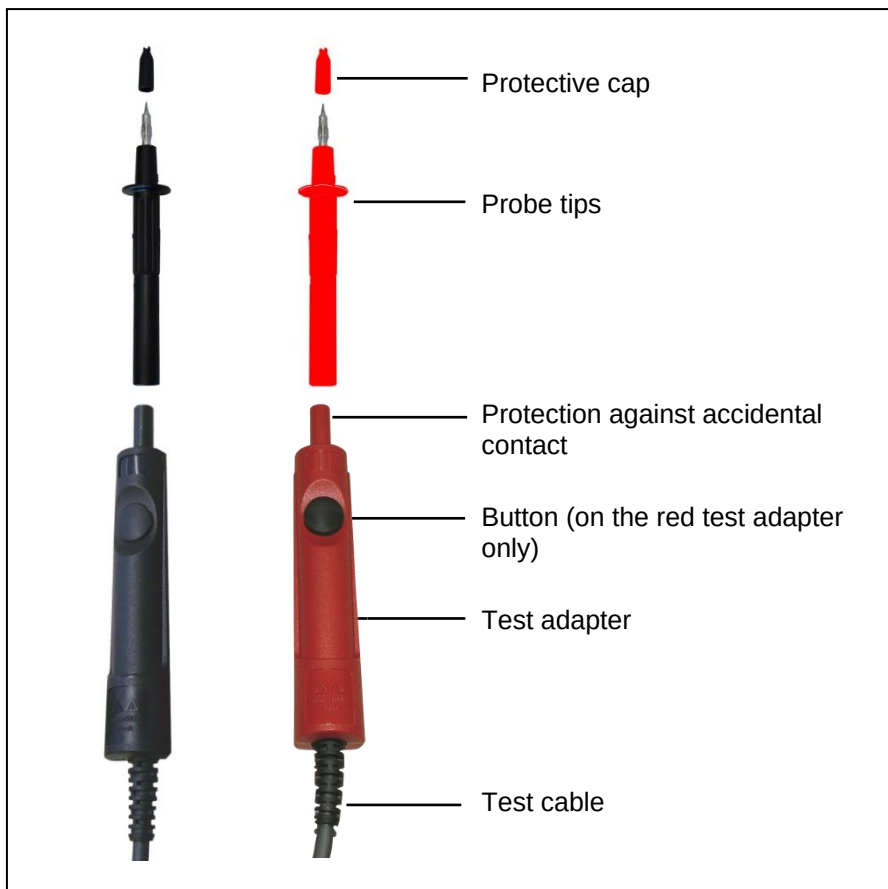


Fig. 1-4

2 Commissioning

Please also refer to the AVL DSS user manual and the AVL DSS quick-reference guide.

2.1 Hardware

1. Connect a USB cable between the USB socket on the AVL DiTEST HV Safety 2000 and a spare USB socket on the AVL DSS PC, see Fig. 2-1.

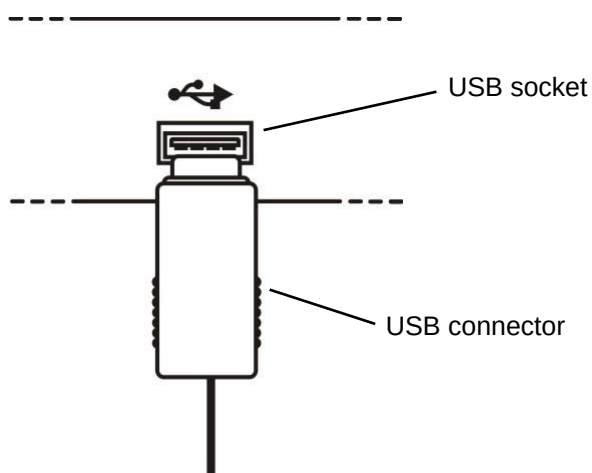


Fig. 2-1

2. **With use of an AVL MDS trolley:**
Place the AVL DiTEST HV Safety 2000 somewhere suitable on the tray of the AVL MDS trolley.

2.2 Software

NOTICE

Please note that the AVL DiTEST HV Safety 2000 works only in conjunction with AVL DSS version 2.3.2700.0 or higher.

To be able to use the AVL DiTEST HV Safety 2000, you must:

1. Install AVL DSS 2.3.2700.0 (if no version of AVL DSS is installed on your PC).
Proceed as described in section 1 “AVL DSS installation”, of the AVL DSS brief instruction.
2. Update AVL DSS to version 2.3.2700.0 (if an older version is installed on your PC).
Proceed as described in section 2 “AVL DSS update” of the AVL DSS brief instruction.
3. Copy the licence file to the dongle.
Proceed as described in section 3 “Import of licence file to dongle” of the AVL DSS brief instruction.

The AVL DSS brief instruction (ID no.: AT7260) comes with the AVL DSS DVD.

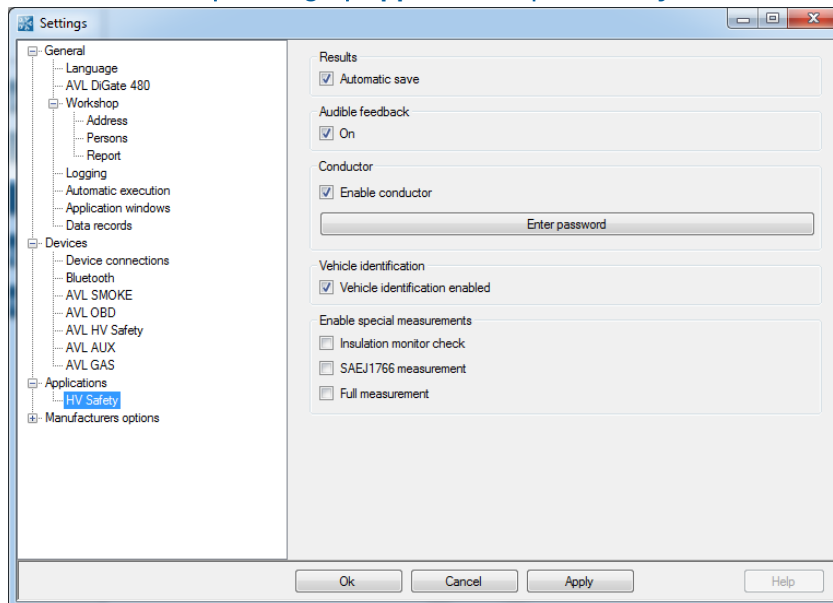
2.2.1 Data entry and settings

Please refer to section 3.1.2.1 “*Settings*” of the AVL DSS user manual.

Please also refer to section 3.1.2.2 “*Log file*”. This section provides a detailed description of how to manage the logged settings and operating steps.

2.2.1.1 Settings for HV Safety

Click on [Extras](#) | [Settings](#) | [Applications](#) | [HV Safety](#)



Results

By enabling "Automatic save", the measurement results are saved automatically.

Audible feedback

By enabling "On" an acoustic feedback operates during measuring.

Conductor

If the "Enable conductor" option is enabled with the AVL DiTEST HV Safety, it is necessary to enter the conductor's name at the start of the measurement procedure. The conductor is entered under the item [Settings](#) | [Workshop](#) | [Persons](#)

By clicking on [Enter password](#) the conductor can enter his/her name and set a password.

Vehicle identification

If "Vehicle identification enabled" is enabled the vehicle identification (dialog box) appears, at the beginning of each measurement, to enter the vehicle information.

Activation of special measurements

By activating the current records, the special measurement functions (insulation monitor check, SAEJ1766 measurement and overall measurement) will appear in the measurement function selection on the home screen of the HV Safety application (see Figure 3-1).

3 Performing a measurement

1. Start AVL DSS by double-clicking on  .
Click on **Diagnostic | HV Safety**, (see Fig. 3-1).

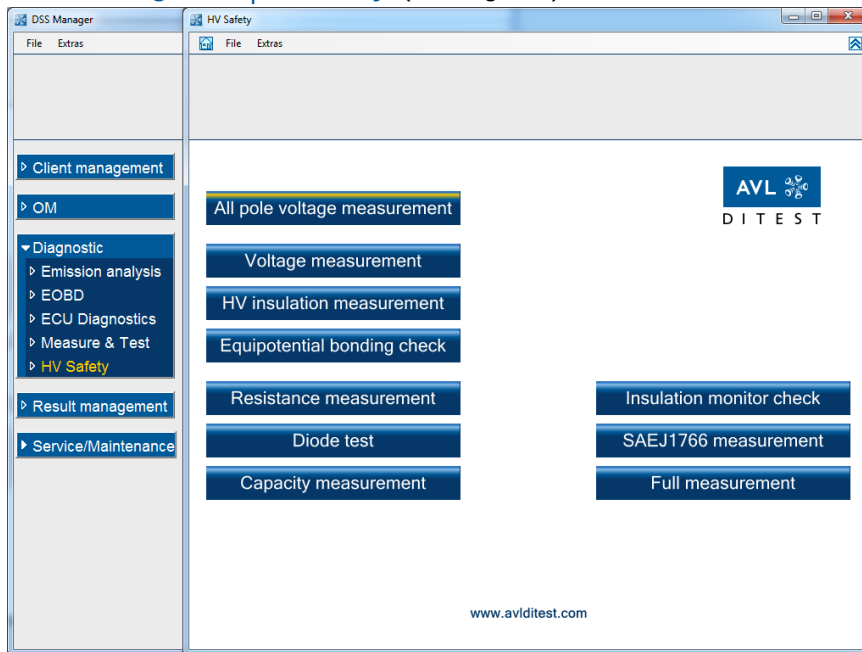


Fig. 3-1

2. Click on the desired operating mode:
 - All pole DC voltage measurement, see section 3.2,
 - DC voltage measurement, see section 3.3,
 - HV insulation measurement, see section 3.4,
 - Equipotential bonding check, see section 3.5,
 - Resistance measurement, see section 3.6,
 - Diode test, see section 3.7,
 - Capacity measurement, see section 3.8,
 - Insulation monitor check, see section 3.9,
 - SAE J1766 measurement, see section 3.103.5,
 - Full measurement, see section 3.113.11
3. Clicking on  in the "HV Safety" window closes AVL DiTEST HV Safety 2000.
4. Clicking on  in the "DSS Manager" window closes AVL DSS.



DANGER



Danger of death from electrical voltage

Make sure that no other devices with an earth connection are connected to the test object at any time during a measurement.



DANGER



Danger of death from electrical voltage

During measurements in high-voltage environment, the AVL DiTEST HV Safety 2000 may only be used, if the voltage source is non-grounded!

3.1 Results protocols

After each measurement a detailed results protocol can be generated. You can edit, print and save these protocols. By activating "Results – Automatic save" (see 2.2.1.1) a result protocol is generated and saved automatically after each measurement.

3.1.1 Editing and printing results protocol

After a measurement click **F6 Report** to display the results protocol.

Report

Result protocol
Full HV safety measurement

28.11.2012 19:41

DITEST Entwicklung
Alte Poststr. 152
8020 Graz
Phone: 0316 787 0
Fax:

Licence number: HV SAFETY
Mileage: 2000
VIN: 12345
Registration date: 01.01.2012
Manufacturer: I-Car
Vehicle type: Hybrid
Engine code:
Engine type: Petrol engine TWC

Software
Test software: HV Safety
Version: 2.3.2679.0

Device information
Device designation: AVL HV Safety 2000
Serial number: 117
Firmware version: 4.14
Production date: 07.11.2012
Calibration date: 07.11.2012
Calibration by: 5143
Calibration device: VAS5143A, SWB, Keithley2000
Equipment safety check accomplished: 28.11.2012 19:49:41

Navigation bar: F1 (Cancel), F2 (Identification), F3 (Print), F4 (Edit), F5 (Save), F6 (Next), F7 (Next)

F3 Identification

"Vehicle identification" will appear.

F4 Print

Prints the result protocol.

F5 Edit

This is where you can edit the results protocol (enter comments and display workshop and vehicle data: yes/no).

F5 Apply Quits results protocol editing.

F6 Save

Saves the results protocol in the internal database.

F8 Next

Back to measurement screen.

3.2 All-pole DC voltage measurement

In the "All-pole DC voltage measurement" mode the absence of a voltage is verified. This is performed by a menu-driven measurement of the three relevant voltages:

- Voltage measurement HV+ against HV-
- Voltage measurement HV+ against the chassis
- Voltage measurement HV- against the chassis

1. When you click on the **All pole DC voltage measurement** mode (see Fig. 3-1), a screen of safety instructions will appear. **You must read and observe these safety instructions.**
2. Click on **F8 Next**.
3. The AVL DiTEST HV Safety 2000 **safety test** is carried out:
 - Connect the probe tips briefly
 - Press and hold the test button on the red test adapter until the safety test has completed
 - The result of the safety test is displayed
4. Place the probe tips on the test object.
5. Press and hold the test button on the red test adapter until a stable measured value is displayed.
6. The result of the measurement is displayed, see Fig. 3-2.

(If the test button is not kept pressed for long enough, the following message will appear: "Measurement invalid: Test button released too early".

If this happens, start a new measurement.

Press and hold the test button on the red test adapter until a stable measured value is displayed.

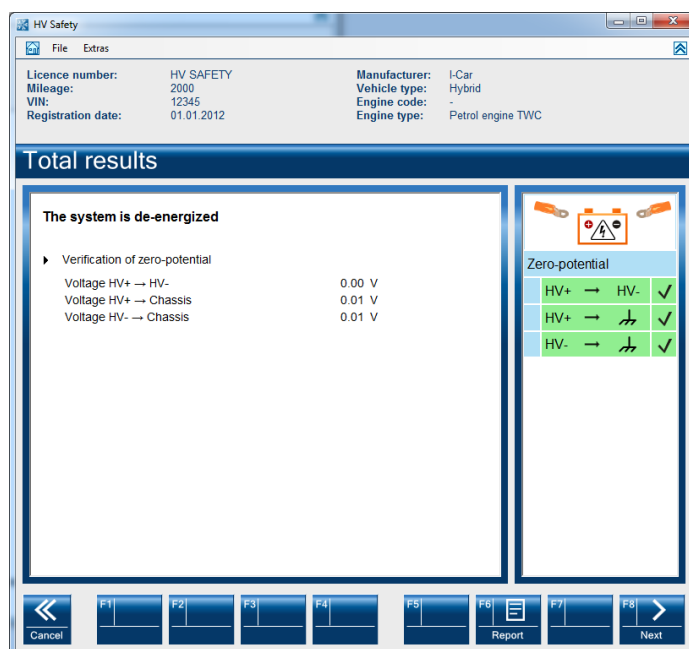


Fig. 3-2

7. Clicking on **F6 Report** creates a report of the measurement results (see chapter 3.1)
8. Clicking on **F8 Next** repeats the all pole voltage measurement.
9. Clicking on **<< Cancel** cancels the all pole voltage measurement.

3.3 DC voltage measurement

The “DC voltage measurement” mode is used to measure voltage.

1. When you click on the **DC voltage measurement** mode (see Fig. 3-1), a screen of safety instructions will appear. **You must read and observe these safety instructions.**
2. Click on **F8 Next**.
3. The AVL DiTEST HV Safety 2000 **safety test** is carried out:
 - Connect the probe tips briefly
 - Press and hold the test button on the red test adapter until the safety test has completed
 - The result of the safety test is displayed
4. Place the probe tips on the test object.
5. Press and hold the test button on the red test adapter until a stable measured value is displayed.
6. The result of the measurement is displayed, see Fig. 3-3 .

(If the test button is not kept pressed for long enough, the following message will appear: “Measurement invalid: Test button released too early”.

If this happens, start a new measurement.

Press and hold the test button on the red test adapter until a stable measured value is displayed.

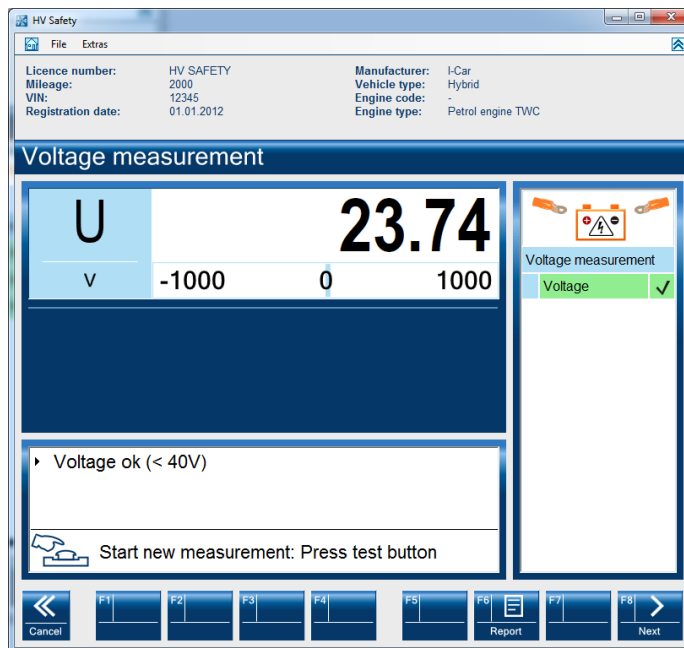


Fig. 3-3

7. To start a new DC voltage measurement, click on **F8 Next** or press and hold the test button on the red test adapter.
8. Clicking on **F6 Report** creates a report of the measurement results (see chapter 3.1).
9. Clicking on **<< Cancel** cancels the voltage measurement.

NOTICE

If no stable measured value is displayed:

- Start a new measurement
- Press and hold the test button on the red test adapter until a stable measured value is displayed
- If necessary, restart AVL DiTEST HV Safety 2000 or AVL DSS

3.4 HV insulation measurement

The “*HV insulation measurement*” mode is used to test for insulation resistance by applying a high voltage.

1. When you click on the **HV insulation measurement** mode (see Fig. 3-1), a screen of safety instructions will appear. **You must read and observe these safety instructions.**
 2. Click on **F8 Next**.
 3. The AVL DiTEST HV Safety 2000 **safety test** is carried out:
 - Connect the probe tips briefly
 - Press and hold the test button on the red test adapter until the safety test has completed
 - The result of the safety test is displayed
 4. Select the HV measuring range.
- Observe the nominal HV on-board voltage of the vehicle under test.
5. Observe the safety instructions that appear on the screen.
 6. Click on **F8 Next**.
 7. Place the probe tips on the test object.
 8. Press and hold the test button on the red test adapter until a stable measured value is displayed.
 9. The result of the measurement is displayed, see Fig. 3-4

(If the test button is not kept pressed for long enough, the following message will appear: “*Measurement invalid: Test button released too early*”. If this happens, start a new measurement.

Press and hold the test button on the red test adapter until a stable measured value is displayed.

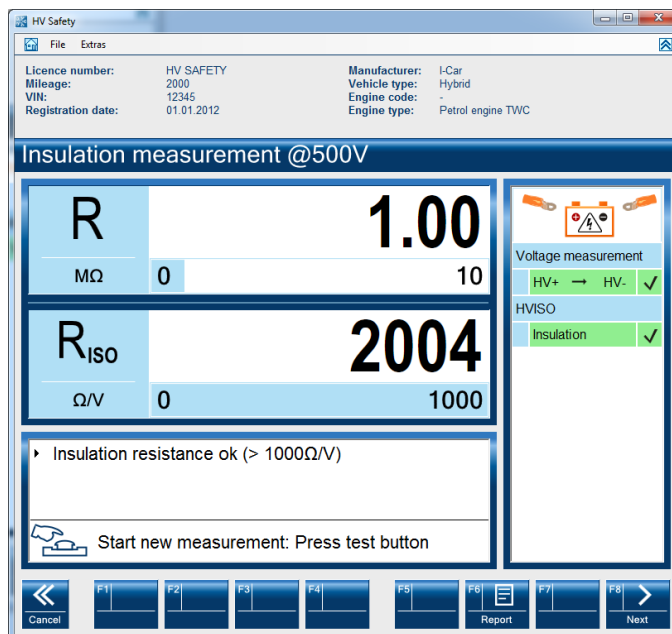


Fig. 3-4

10. To start a new HV insulation measurement, click on **F8 Next** or press and hold the test button on the red test adapter.
11. Clicking on **F6 Report** creates a report of the measurement results (see chapter 3.1).
12. Clicking on **<< Cancel** cancels the HV insulation measurement.

NOTICE

If no stable measured value is displayed:

- Start a new measurement
- Press and hold the test button on the red test adapter until a stable measured value is displayed
- If necessary, restart AVL DiTEST HV Safety 2000 or AVL DSS

3.5 Equipotential bonding check

In the "equipotential bonding check" mode the resistance of an equipotential bonding conductor is measured.

In the bonding conductor measurement the meter generates a test current of up to 1A. This high test current loads the bonding conductor accordingly so that conductor faults can be detected. The test voltage generated for this is respectively low so that the measurement does not create a hazard.

1. When you click on the **Equipotential bonding check** mode (see Fig. 3-1), a screen of safety instructions will appear. **You must read and observe these safety instructions.**
2. Click on **F8 Next**.
3. Select the test current. For this you should take account of:
 - the specifications of the vehicle manufacturer
 - specifications according to ECE Regulation R 100
4. The AVL DiTEST HV Safety 2000 **zero adjustment** is carried out:
 - Place the tips of the probe at the 0-ohm zero point marker aid (blue cable clip)
 - Press and hold the test button on the red test adapter until the zero adjustment has completed
 - The result of the zero adjustment is displayed

If Kelvin terminals are used, there is no need for zero adjustment. Please press **F5 Skip**.

5. Place the probe tips on the test object.
6. Press and hold the test button on the red test adapter until a stable measured value is displayed.
7. The result of the measurement is displayed, see Fig. 3-5
(If the test button is not kept pressed for long enough, the following message will appear: "Measurement invalid: Test button released too early". If this happens, start a new measurement.
Press and hold the test button on the red test adapter until a stable measured value is displayed.

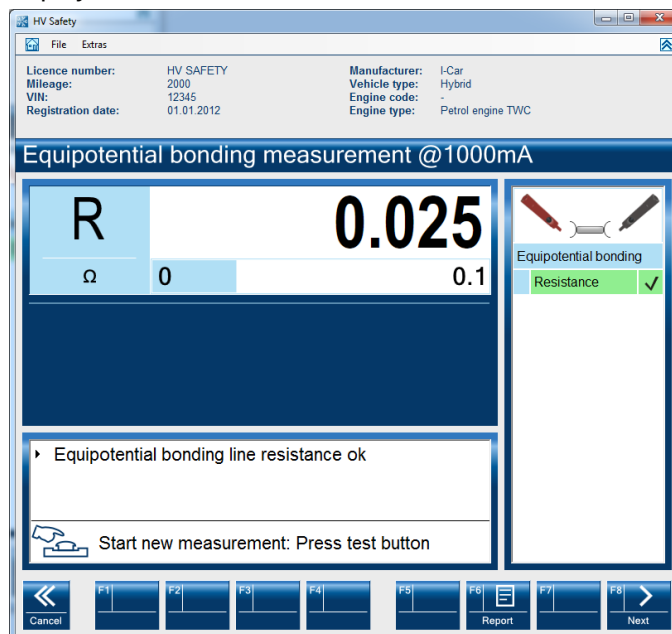


Fig. 3-5

8. To start a new measurement, click on **F8 Next** or press and hold the test button on the red test adapter.
9. Clicking on **F6 Report** creates a report of the measurement results (see chapter 3.1).
10. Clicking on **<< Cancel** cancels the measurement.

NOTICE

If no stable measured value is displayed:

- Start a new measurement
- Press and hold the test button on the red test adapter until a stable measured value is displayed
- If necessary, restart AVL DiTEST HV Safety 2000 or AVL DSS

3.6 Resistance measurement

In the "resistance measurement" mode resistors in the range of 1 mΩ to 10 MΩ can be measured.



DANGER

Please note that the component which is to be assessed must be disconnected and that all cable connections which might affect the measurement must be removed prior to each resistance measurement.

1. When you click on the **Resistance measurement** mode (see Fig. 3-1), a screen of safety instructions will appear. **You must read and observe these safety instructions.**
2. Click on **F8 Next**.
3. The AVL DiTEST HV Safety 2000 **zero adjustment** is carried out:
 - Place the tips of the probe at the 0-ohm zero point marker aid (blue cable clip)
 - Press and hold the test button on the red test adapter until the zero adjustment has completed
 - The result of the zero adjustment is displayed
4. Place the probe tips on the test object.
5. Press and hold the test button on the red test adapter until a stable measured value is displayed.
6. The result of the measurement is displayed, see Fig. 3-6.

(If the test button is not kept pressed for long enough, the following message will appear: "Measurement invalid: Test button released too early". If this happens, start a new measurement.

Press and hold the test button on the red test adapter until a stable measured value is displayed.

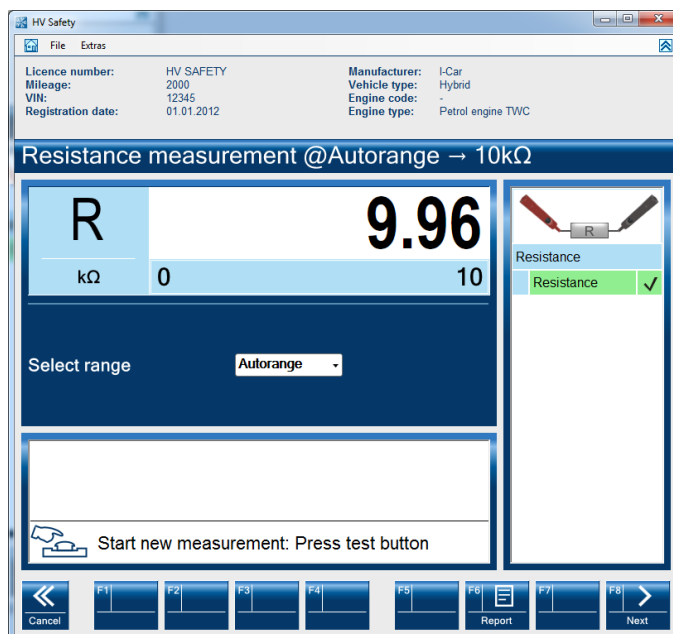


Fig. 3-6

7. To start a new measurement, click on **F8 Next** or press and hold the test button on the red test adapter.
8. Clicking on **F6 Report** creates a report of the measurement results (see chapter 3.1).
9. From the list under **Select range** selection the measurement range can be set for the next measurement.
10. Clicking on **<< Cancel** cancels the measurement.

NOTICE

If no stable measured value is displayed:

- Start a new measurement
- Press and hold the test button on the red test adapter until a stable measured value is displayed
- If necessary, restart AVL DiTEST HV Safety 2000 or AVL DSS

3.7 Diode test

In the "diode test" mode diodes can be tested. The forward direction, reverse direction, open and short circuit states are determined and displayed.



DANGER

Please note that the component which is to be assessed must be disconnected and that all cable connections which might affect the measurement must be removed prior to each diode measurement.

1. When you click on the **Diode test** mode (see Fig. 3-1), a screen of safety instructions will appear. **You must read and observe these safety instructions.**
2. Click on **F8 Next**.
3. The AVL DiTEST HV Safety 2000 **safety test** is carried out:
 - Connect the probe tips briefly
 - Press and hold the test button on the red test adapter until the safety test has completed
 - The result of the safety test is displayed
4. Place the probe tips on the test object.
5. Press and hold the test button on the red test adapter until a stable measured value is displayed.
6. The result of the measurement is displayed, see Fig. 3-4.

(If the test button is not kept pressed for long enough, the following message will appear: "Measurement invalid: Test button released too early". If this happens, start a new measurement.

Press and hold the test button on the red test adapter until a stable measured value is displayed.

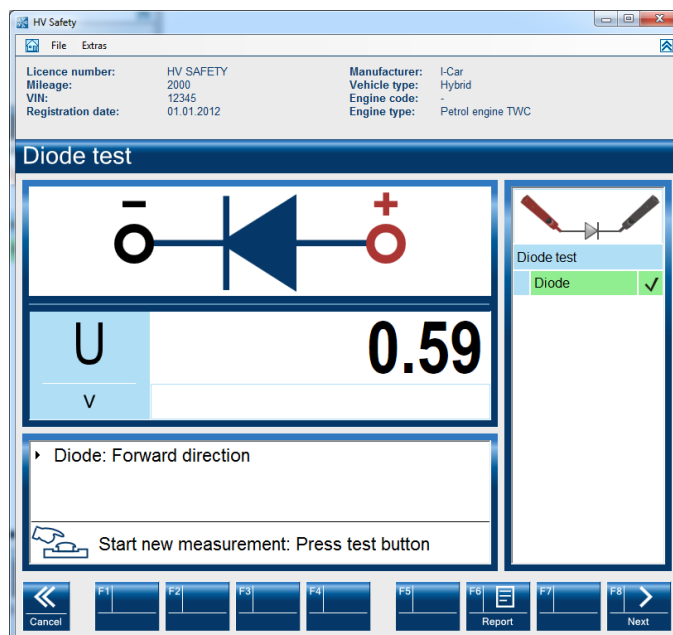


Fig. 3-7

7. To start a new measurement, click on **F8 Next** or press and hold the test button on the red test adapter.
8. Clicking on **F6 Report** creates a report of the measurement results (see chapter 3.1).
9. Clicking on **<< Cancel** cancels the measurement.

NOTICE

If no stable measured value is displayed:

- Start a new measurement
- Press and hold the test button on the red test adapter until a stable measured value is displayed
- If necessary, restart AVL DiTEST HV Safety 2000 or AVL DSS

3.8 Capacity measurement

In the "Capacity measurement" mode capacitors can be measured in the range 1 nF to 300 μ F.



DANGER

Please note that the component which is to be assessed must be disconnected and that all cable connections which might affect the measurement must be removed prior to each capacity measurement.

1. When you click on the **Capacity measurement** mode (see Fig. 3-1), a screen of safety instructions will appear. **You must read and observe these safety instructions.**
2. Click on **F8 Next**.
3. The AVL DiTEST HV Safety 2000 **safety test** is carried out:
 - Connect the probe tips briefly
 - Press and hold the test button on the red test adapter until the safety test has completed
 - The result of the safety test is displayed
4. Place the probe tips on the test object.
5. Press and hold the test button on the red test adapter until a stable measured value is displayed.
6. The result of the measurement is displayed, see Fig. 3-8

(If the test button is not kept pressed for long enough, the following message will appear: "Measurement invalid: Test button released too early". If this happens, start a new measurement.

Press and hold the test button on the red test adapter until a stable measured value is displayed.

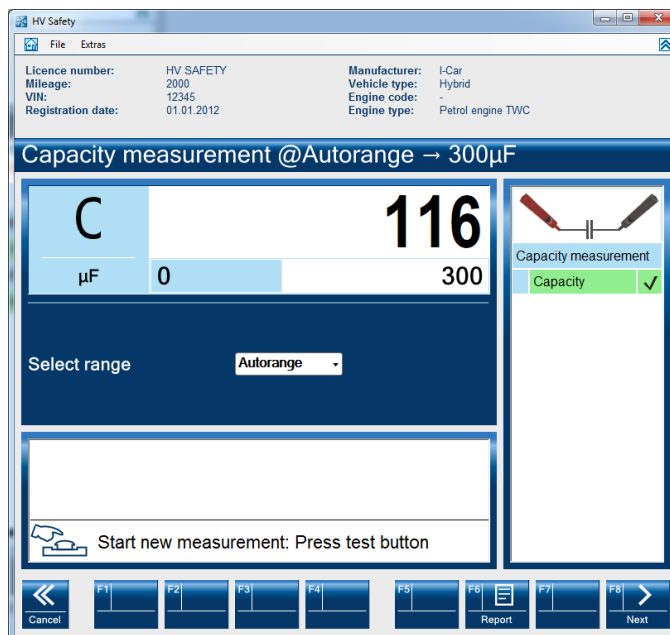


Fig. 3-8

7. To start a new measurement, click on **F8 Next** or press and hold the test button on the red test adapter.
8. Clicking on **F6 Report** creates a report of the measurement results (see chapter 3.1).
9. From the list under **Select range** selection the measurement range can be set for the next measurement.
10. Clicking on **<< Cancel** cancels the measurement.

NOTICE

If no stable measured value is displayed:

- Start a new measurement
- Press and hold the test button on the red test adapter until a stable measured value is displayed
- If necessary, restart AVL DiTEST HV Safety 2000 or AVL DSS

3.9 Insulation monitor check

In the "Insulation monitor check" mode the function of the insulation monitor in a HV vehicle is tested and the trigger threshold determined. For this purpose, a series of voltage measurements between HV + and the chassis are performed, whereby at each voltage measurement the internal resistance of the HV Safety 2000 is gradually decreased by steps.

1. When you click on the **Insulation monitor check** mode (see Fig. 3-1), a screen of safety instructions will appear. **You must read and observe these safety instructions.**
2. Click on **F8 Next**.
3. The AVL DiTEST HV Safety 2000 **safety test** is carried out:
 - Connect the probe tips briefly
 - Press and hold the test button on the red test adapter until the safety test has completed
 - The result of the safety test is displayed
4. Attach the test leads to HV + and the chassis, as shown on the screen.
5. Repeat DC voltage measurements with varying internal resistance:
 - a. Press the test button to start the DC voltage measurement for each internal resistance for the device (as indicated on the screen).
 - b. If the insulation monitor has tripped, press **<< Cancel**. This will take you to the end result → Point 6.
The triggering of the insulation monitor will be recognized when the measured DC voltage has reached a very low level (<1V) and a steadily decreasing voltage value (intermediate circuit capacitor effect) will be displayed.
 - c. If the insulation monitor is not triggered, proceed with the next DC voltage measurement → point 5a
6. The result of the measurement is displayed, see Fig. 3-9.
(If the test button is not kept pressed for long enough, the following message will appear: "Measurement invalid: Test button released too early". If this happens, start a new measurement.
Press and hold the test button on the red test adapter until a stable measured value is displayed.

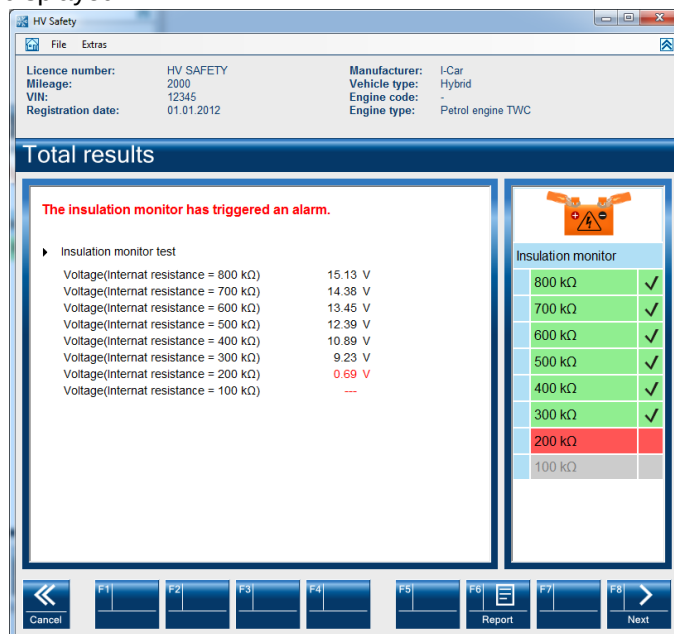


Fig. 3-9

7. Clicking on **F6 Report** creates a report of the measurement results (see chapter 3.1).
8. Clicking on **F8 Next** cancels the measurement.
9. Clicking on **<< Cancel** cancels the measurement.

NOTICE

If no stable measured value is displayed:

- Start a new measurement
- Press and hold the test button on the red test adapter until a stable measured value is displayed
- If necessary, restart AVL DiTEST HV Safety 2000 or AVL DSS

3.10 SAE J1766 measurement

The “SAE J1766 measurement” mode is used to measure insulation resistance in accordance with the recommendation of SAE J1766 (SAE: Society of Automotive Engineers, J1766 “Recommended Practice for Electric and Hybrid Electric Vehicle Battery Systems Crash Integrity Testing”).

1. When you click on the **SAE J1766 measurement** mode (see Fig. 3-1), a screen of safety instructions will appear. **You must read and observe these safety instructions.**
2. Click on **F8 Next**.
3. The AVL DiTEST HV Safety 2000 **safety test** is carried out:
 - Connect the probe tips briefly
 - Press and hold the test button on the red test adapter until the safety test has completed
 - The result of the safety test is displayed
4. Connect the HV battery to the system and click on **F8 Next**.
5. A screen with a description of the SAE J1766 measurement appears:
 1. Battery voltage measurement HV+ against HV-
 2. Insulation measurement HV+ against Chassis
 3. Insulation measurement HV- against ChassisObserve this information and proceed as described below.
6. Click on **F8 Next**.
7. Battery voltage measurement:

Place the probe tips on HV+ and HV- as described on the screen.
8. Press and hold the test button on the red test adapter until a stable measured value is displayed.
9. The result of the measurement is displayed.

(If the test button is not kept pressed for long enough, the following message will appear: “Measurement invalid: Test button released too early”. If this happens, start a new measurement.
Press and hold the test button on the red test adapter until a stable measured value is displayed.
10. Select internal resistance
Select the internal resistance of the meter to be used for measurement. As a rule of thumb 500 times the battery voltage should be used. The unit calculates a standard value from the previously measured HV battery voltage and suggests the next higher internal resistance. This value can be changed manually if needed.
11. Click on **F8 Next**.
12. Insulation measurement HV+ against Chassis:

Place the probe tips on HV+ and on the chassis as described on the screen.
13. Press and hold the test button on the red test adapter until a stable measured value is displayed.
14. The result of the measurement is displayed,

(If the test button is not kept pressed for long enough, the following message will appear: “Measurement invalid: Test button released too early”. If this happens, start a new measurement.
Press and hold the test button on the red test adapter until a stable measured value is displayed.
15. After the waiting time of 3 seconds has elapsed, pressing the test button on the red test adapter takes you to “Insulation measurement HV- against Chassis”.
Proceed as instructed on the screen.
16. The result of the SAE J1766 measurement is displayed after the waiting time of 3 seconds has elapsed, see

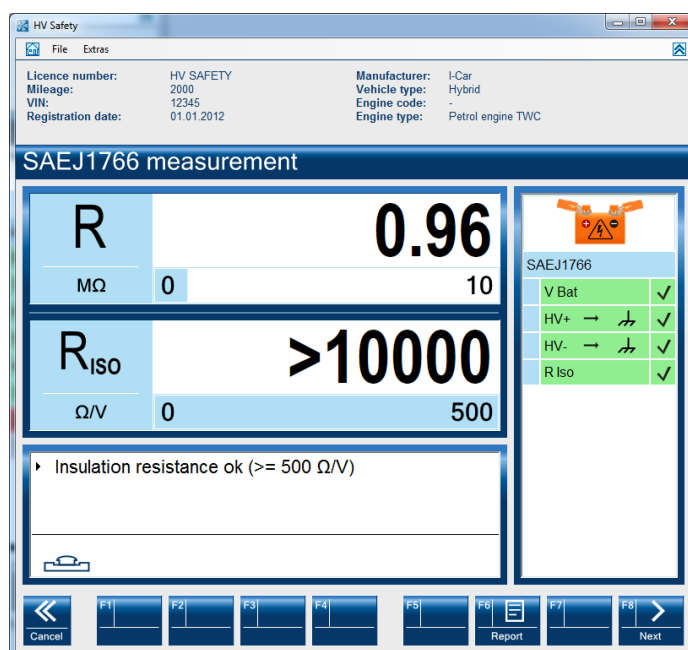


Fig. 3-10

17. Clicking on **F6 Report** creates a report of the measurement results (see chapter 3.1).
18. Click on **F8 Next** or press and hold the test button on the red test adapter to return to item 11, "Insulation measurement HV+ against Chassis".
19. **<< Cancel** cancels the SAE J1766 measurement mode.

NOTICE

If no stable measured value is displayed:

- Start a new measurement
- Press and hold the test button on the red test adapter until a stable measured value is displayed
- If necessary, restart AVL DiTEST HV Safety 2000 or AVL DSS

3.11 Full measurement

“The *Full measurement*” mode combines the following measurements into one user-guided procedure:

1. **Prepare vehicle for the measurement**
2. **Verification of zero-potential**
 - 2.1 HV+ measurement against HV-
 - 2.2 HV+ measurement against Chassis
 - 2.3 HV- measurement against Chassis
3. **HV Insulation measurement at the zero-potential system**
 - 3.1 HV+ measurement against Chassis
 - 3.2 HV- measurement against Chassis
4. **SAE J1766 measurement on the live system**
 - 4.1 Battery voltage measurement HV+ against HV-
 - 4.2 Insulation measurement HV+ against Chassis
 - 4.3 Insulation measurement HV- against Chassis

1. When you click on the **Full measurement** mode (see Fig. 3-1), a screen of safety instructions will appear. **You must read and observe these safety instructions.**
2. The AVL DiTEST HV Safety 2000 **safety test** is carried out:
 - Connect the probe tips briefly
 - Press and hold the test button on the red test adapter until the safety test has completed
 - The result of the safety test is displayed
3. Proceed as instructed on the screen.
As the procedure is menu-driven, a detailed description is not provided here.
Please refer to the description for the “*Voltage measurement*”, “*HV insulation measurement*” and “*SAE J1766 measurement*” modes in sections 3.1, 3.4 and 3.5.
4. At the end of “*Full measurement*” mode, the combined result of all measurements is displayed.
5. Clicking on **F6 Report** creates a report of the measurement results (see chapter 3.1).
6. To repeat the “*Full measurement*”, click on **F8 Next** or press and hold the test button on the red test adapter.
7. **<< Cancel** cancels the “*Full measurement*”.

NOTICE

If no stable measured value is displayed:

- Start a new measurement
- Press and hold the test button on the red test adapter until a stable measured value is displayed
- If necessary, restart AVL DiTEST HV Safety 2000 or AVL DSS

4 Troubleshooting

4.1 Introduction

Please try to determine the nature of the malfunction and localise it as accurately as possible. Follow the problem-solving strategies below and attempt to carry out all suggested measures. If an error cannot be rectified, please contact your AVL DiTEST branch office or AVL DiTEST sales partner in your country, see section 6 “*Warranty*”.

4.2 Error messages

The error messages that you may encounter are listed below together with possible solutions.

- Make sure that the AVL DiTEST HV Safety 2000 is correctly connected to the USB connection on the AVL MDS-PC.
- If necessary, disconnect the AVL DiTEST HV Safety 2000 from the USB connection on the AVL MDS-PC, wait a few seconds and then reconnect it.

Error message	Solution / description
A timeout occurred	Repeat the measurement
Firmware not running (run mode)	Quit the current measurement function and restart
A transient current occurred	Repeat the measurement
A transient voltage occurred	Repeat the measurement
Error during self-test	Repeat the self-test If the error persists, please contact AVL DiTEST customer service
Error during discharge	Repeat the measurement
High voltage could not be generated	Repeat the measurement
Safety test failed	Repeat the safety test If the repeat safety test fails, check the equipment hardware
Test button released too early	Repeat the measurement
Measurement aborted	
No stable measured value achieved	
Out of measuring range (too high)	
Out of measuring range (too low)	

4.3 Function test

4.3.1 DC voltage measurement

To test the DC voltage measurement function of the AVL DiTEST HV Safety 2000, proceed as follows:

- Measure a known DC voltage.
- Please refer to section 3 *“Performing a measurement”*.

4.3.2 HV insulation measurement

To test the HV insulation measurement function of the AVL DiTEST HV Safety 2000, proceed as follows:

- Test the AVL DiTEST HV Safety 2000 by performing an HV insulation measurement on a vehicle known to be in good working order.
- Please refer to section 3 *“Performing a measurement”*.

4.3.3 SAE J1766 measurement

To test the SAE J1766 measurement function of the AVL DiTEST HV Safety 2000, proceed as follows:

- Test the AVL DiTEST HV Safety 2000 by performing an SAE J1766 measurement on a vehicle known to be in good working order.
- Please refer to section 3 *“Performing a measurement”*.

4.3.4 Full measurement

To test the full measurement function of the AVL DiTEST HV Safety 2000, proceed as follows:

- Test the AVL DiTEST HV Safety 2000 by performing a full measurement on a vehicle known to be in good working order.
- Please refer to section 3 *“Performing a measurement”*.

4.3.5 Resistance measurement

A functional test of the resistance measurement of the AVL DiTEST HV Safety 2000 can be carried out as follows:

- Measure a known resistance.
- Please refer to section 3 *“Performing a measurement”*.

4.3.6 Diode test

A functional test of the diode measurement of AVL DiTEST HV Safety 2000 can be carried out as follows:

- Measure a known diode.
- Please refer to section 3 *“Performing a measurement”*.

4.3.7 Equipotential bonding check

A functional test of the equipotential bonding check of the AVL DiTEST HV Safety 2000 can be carried out as follows:

- Measure a known resistance <100 mΩ.
- Please refer to section 3 *“Performing a measurement”*.

4.3.8 Capacity measurement

A test of the capacity measurement of the AVL DiTEST HV Safety 2000 can be carried out as follows:

- Measure a known capacitance.
- Please refer to section 3 *“Performing a measurement”*.

4.4 Service screen

Click on [Service/Maintenance | HV SAFETY | Service screen](#).

The service screen shows:

- Communication status
 - Firmware version
 - Firmware checksum
- Device status
 - Serial number
 - The COM port in use

If an error has occurred, a message relating to the error is displayed.

Clicking on [F5 Self-test](#) starts a self-test and the result can be printed out by clicking on [F4 Print](#).

5 Maintenance and care

5.1 Visual check

Visually check the AVL DiTEST HV Safety 2000, USB cable and test cables with test adapters at regular intervals.

Check for damage and contamination.



DANGER



Danger of death from electrical voltage

If the AVL DiTEST HV Safety 2000, USB cable or test cables with probe tips are damaged, these must not be used until approval is given by a qualified expert.

5.2 Cleaning the product



DANGER



Danger of death from electrical voltage

Always disconnect the test cables and USB cable before you clean the AVL DiTEST HV Safety 2000.

Clean the AVL DiTEST HV Safety 2000 using a dry cloth **only**.

Do **not** use a cleaning agent or solvent.

6 Warranty

6.1 New devices

New devices have a 12-month warranty period.

The batteries have a six-month warranty period.

The agreements with your supplier apply.

Principally wear parts and accessories are excluded from the warranty.

For the execution the date of the shipping note to the final customer does apply.

The warranty expires due to:

- Mechanical damage (e.g. fall, etc.)
- Penetration of moisture (e.g. water, oil, acids, etc.)
- External intervention (e.g. repairs carried out by non-authorized people)
- Improper operation (e.g. control of touch screen with sharp or pointed object, cleaning with compressed air)
- Improper storage, care and maintenance (e.g. cleaning the device with solvent-based cleaners)

6.2 Exchange or loaned devices

The agreements with your supplier apply.

For the execution the date of the shipping note to the final customer does apply.

6.3 Event of damage or loss

In the event of damage or loss, please contact the respective AVL DiTEST office / the respective AVL DiTEST partner in your country.

7 Technical data

7.1 CAT overvoltage categories

Measurement Categories AVL DiTEST HV Safety 2000

CAT I / Equipment without a rated measurement category up to 1000 V:

Means that the test equipment can measure voltages of up to 1000 V in electric vehicles. The appliance is not suitable for direct connection to a supply mains!

CAT II / 600V:

Means that the test equipment can withstand transient overvoltages of up to 4000 V.

CAT III / 300V:

Means that the test equipment can withstand transient overvoltages of up to 4000 V.



DANGER

Danger of death from electrical voltage

The AVL DiTEST HV Safety 2000 is not suitable for measurements in a supply mains!

The AVL DiTEST HV Safety 2000 is only suitable for measurement of DC voltages.

Any outlets installed in the vehicle must not be measured!

Measurements with the AVL DiTEST HV Safety 2000 on electric vehicles may only be carried out if no charging cable is connected to the vehicle!



DANGER

Danger of death from electrical voltage

Overvoltage categories CAT-II 600V / CAT-III 300V

The AVL DiTEST HV Safety 2000 fulfils impulse voltage values as per the overvoltage category CAT-II 600V / CAT-III 300V.

Measurements in electric circuits that are connected directly to the mains are not permitted!

For this reason use the AVL DiTEST HV Safety 2000 only for measurements on the vehicle.

The AVL DiTEST HV Safety 2000 High Voltage Measurement Module is only suitable for Measuring of DC-Voltages!

The AVL DiTEST HV Safety 2000 has no AC-Measuring Ranges!

Doing measurements on E-cars with connected battery charging station is only allowed, when the battery charger is provided with electrical separation to the supply mains!

**DANGER****Danger of death from electrical voltage**

Please note, that only measurement equipment, which was delivered from AVL DiTEST, will be used!

When using general measuring adapters (probe tips, test clips ...) please note that these are suitable and approved for measuring- and test voltage until 1000 V and correspond to the norm EN 61010-31!

**DANGER****Danger of death from electrical voltage in vehicles with high-voltage systems**

During measurements in high-voltage environment, the AVL DiTEST HV Safety 2000 may only be used, if the voltage source is non-grounded!

7.2 Operating data

Dimensions (w x l x h)	95 x 220 x 45 mm
Weight	approx. 0.5 kg
Ambient conditions	
Operation	Ambient temperature 0 to +40 °C Relative humidity at max. +25 °C 10 to 80 % No condensation Max. height above mean sea level 4,000 m
Transport and storage	-20 to +55 °C Ambient temperature at max. +20 °C Relative humidity 10 to 80 %, No condensation
Electrical protection	Certified according the following regulations: - DIN EN 61010-1 - IEC 1010-1 - VDE 0411-1 - UL 201 GARAGE EQUIPMENT - CAN/CSA-22.2 Nr. 61010-1-04 - Protection class II - Index of protection: IP 44 (housing) - Pollution degree II - Overvoltage category - CAT-I 1000V - CAT-II 600V - CAT-III 300V
Supply from USB interface	
Nominal voltage	5 V ⁼⁼
Current consumption	max. 500 mA
Protection	The input is protected against polarity reversal.
External interfaces	
USB interface	1 x USB standard 2.0
2 x test cables	

7.3 Metrology specifications

7.3.1 Voltage measurement



DANGER



Danger of death from electrical voltage

Overvoltage categories CAT-II 600V / CAT-III 300V

The AVL DiTEST HV Safety 2000 fulfils impulse voltage values as per the overvoltage category CAT-II 600V / CAT-III 300V.

Measurements in electric circuits that are connected directly to the mains are not permitted!

For this reason use the AVL DiTEST HV Safety 2000 only for measurements on the vehicle.

DC voltage ($R_i \geq 1 \text{ M}\Omega$)	Range:	Resolution:	Tolerances:
	-20 to +20 V $\approx$	0.01 V	$\pm 0.5 \% \text{ v. M.}^1 \pm 5 \text{ digits}$
	-100 to +100 V $\approx$	0.1 V	$\pm 1.0 \% \text{ v. M.}^1 \pm 5 \text{ digits}$
	-1,000 to +1,000 V $\approx$	0.5 V	$\pm 1.5 \% \text{ v. M.}^1 \pm 5 \text{ digits}$

1. of the measured value

7.3.2 SAE J1766 insulation measurement



DANGER



Danger of death from electrical voltage

Overvoltage categories CAT-II 600V / CAT-III 300V

The AVL DiTEST HV Safety 2000 fulfils impulse voltage values as per the overvoltage category CAT-II 600V / CAT-III 300V.

Measurements in electric circuits that are connected directly to the mains are not permitted!

For this reason use the AVL DiTEST HV Safety 2000 only for measurements on the vehicle.

Insulation measurement to SAE J1766	Range:	Resolution:	Tolerances:
	0 to 1,000 meg ohms	10 kilo ohms	$\pm 5 \% \text{ v. M.}^1$

1. of the measured value

7.3.3 High-voltage insulation measurement



DANGER



Danger of death from electrical voltage

Overvoltage categories CAT-II 600V / CAT-III 300V

The AVL DiTEST HV Safety 2000 fulfils impulse voltage values as per the overvoltage category CAT-II 600V / CAT-III 300V.

Measurements in electric circuits that are connected directly to the mains are not permitted!
For this reason use the AVL DiTEST HV Safety 2000 only for measurements on the vehicle.

High-voltage measurement	insulation	Range:	Resolution:	Tolerances:
		1 - 10MΩ	10 kΩ	± 1,5 % v. M. ¹
		10 - 100MΩ	10 kΩ	± 1,5 % v. M.. ¹
		0,1 - 0,5 GΩ	10 kΩ	± 3 % v. M.. ¹
		0,5 - 1 GΩ	10 kΩ	± 5 % v. M.. ¹
		Test voltage:		
		250 V □ to 1,000 V □ adjustable in 16 increments		
		Nominal test current:		
		1 mA		

1. of the measured value

7.3.4 Equipotential bonding check



DANGER



Danger of death from electrical voltage

Overvoltage categories CAT-II 600V / CAT-III 300V

The AVL DiTEST HV Safety 2000 fulfils impulse voltage values as per the overvoltage category CAT-II 600V / CAT-III 300V.

Measurements in electric circuits that are connected directly to the mains are not permitted!
For this reason use the AVL DiTEST HV Safety 2000 only for measurements on the vehicle.

Equipotential bonding check	Range:	Resolution:	Tolerances:
		1 mΩ	± 3,5 % v. M. ¹
	Measuring currents 100 ... 1000 mA		

1. of the measured value

7.3.5 Resistance measurement



DANGER



Danger of death from electrical voltage

Overvoltage categories CAT-II 600V / CAT-III 300V

The AVL DiTEST HV Safety 2000 fulfils impulse voltage values as per the overvoltage category CAT-II 600V / CAT-III 300V.

Measurements in electric circuits that are connected directly to the mains are not permitted!

For this reason use the AVL DiTEST HV Safety 2000 only for measurements on the vehicle.

Resistance measurement	The measuring current depends on the measurement range and is 5mA maximum.		
	Range	Resolution	Tolerances
	0 Ω to 10 Ω	10 m Ω	$\pm 1\%$ v. M. ± 5 m Ω ²⁾
	0 Ω to 100 Ω	0,1 Ω	$\pm 1\%$ v. M. ± 50 m Ω
	0 Ω to 1 k Ω	1 Ω	$\pm 1\%$ v. M. ± 1 Ω
	0 Ω to 10 k Ω	10 Ω	$\pm 1\%$ v. M. ± 10 Ω
	0 Ω to 100 k Ω	100 Ω	$\pm 1,5\%$ v. M. ± 100 Ω
	0 Ω to 1 M Ω	1 k Ω	$\pm 2\%$ v. M. ± 1 k Ω
	0 Ω to 10 M Ω	10 k Ω	$\pm 2\%$ v. M. ± 10 k Ω
	²⁾ The accuracy in the measurement range of 10 Ω is only valid after a zero adjustment		

7.3.6 Diode test



DANGER



Danger of death from electrical voltage

Overvoltage categories CAT-II 600V / CAT-III 300V

The AVL DiTEST HV Safety 2000 fulfils impulse voltage values as per the overvoltage category CAT-II 600V / CAT-III 300V.

Measurements in electric circuits that are connected directly to the mains are not permitted!

For this reason use the AVL DiTEST HV Safety 2000 only for measurements on the vehicle.

Diode test	Measuring current: 1 mA
	Measuring voltage: 5 Volt $\rightleftharpoons$ max.
	The direction of the flow is indicated by a diode symbol. The reversion of polarity is done automatically during the test

7.3.7 Capacity measurement



DANGER



Danger of death from electrical voltage

Overvoltage categories CAT-II 600V / CAT-III 300V

The AVL DiTEST HV Safety 2000 fulfils impulse voltage values as per the overvoltage category CAT-II 600V / CAT-III 300V.

Measurements in electric circuits that are connected directly to the mains are not permitted!

For this reason use the AVL DiTEST HV Safety 2000 only for measurements on the vehicle.

Capacity measurement	Range:	Resolution:	Tolerances
	300nF	1nF	$\pm 4,5\% \text{ v. M.}^1 \pm 1\text{nF}$
	3 μF	10nF	$\pm 4,5\% \text{ v. M.}^1 \pm 10\text{nF}$
	30 μF	100nF	$\pm 4,5\% \text{ v. M.}^1 \pm 0,1\mu\text{F}$
	300 μF	1 μF	$\pm 4,5\% \text{ v. M.}^1 \pm 1\mu\text{F}$

1. of the measured value

7.4 Disposal

Disposal:



This product by AVL DiTEST is a high-quality electrical and electronic device that must not be disposed of with household waste.

For disposal, it is essential to comply with local legal obligations!

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