

MOTOR AGE
TRAINING



"State of Charge and State of Health Analysis for EV Battery Condition"

Presented by Motor Age & TST

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Sponsored by

AUTEL®

<https://autel.us/product/maxisys-ultra-s2/>

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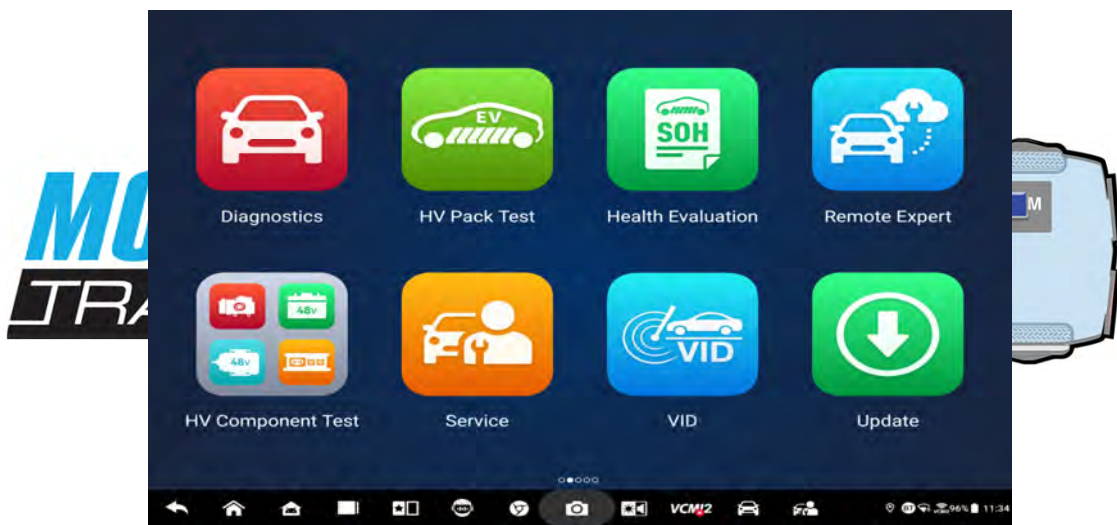
Autel Ultra S2



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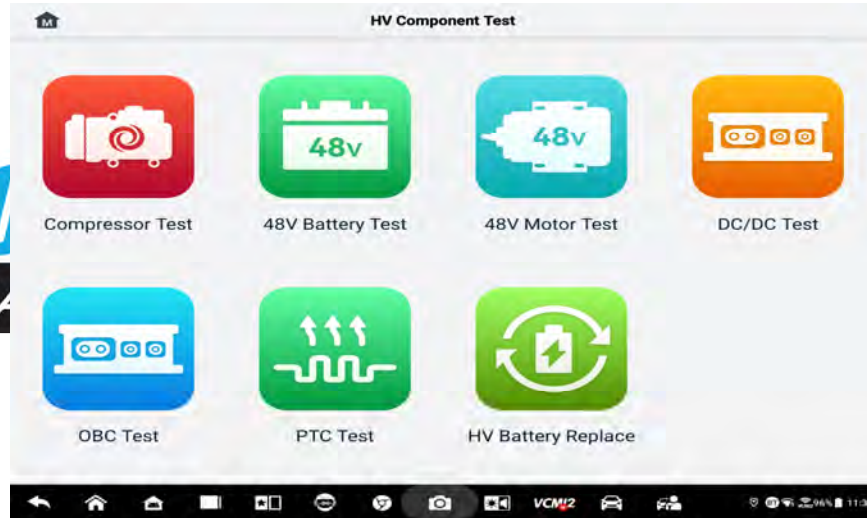
Autel HV Battery Condition



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Autel HV Battery Condition



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What To Expect From This Webinar

- **A 60 to 90+ Minute Webinar**
- **"State of Charge and State of Health Analysis for EV Battery Condition"**
- **In this webinar we will cover:**
Using the Autel Ultra S2 to dive into the HV Battery vehicle diagnostics and see how to get prepared to make money on failing Hybrid & EV batteries.
- **Have Something To Write With**
- **All Slides Are Numbered**
- **The Recording Will Be Available at [Motor Age Training Account](#) & [TSTseminars.org](#)**



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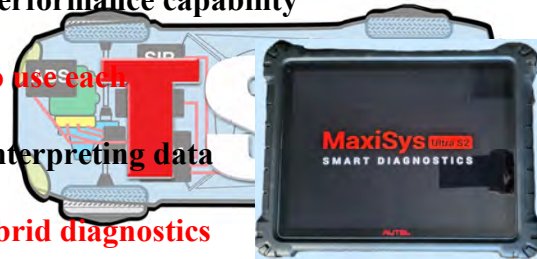
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What Will Be Covered

Using The New Autel Ultra S2

- ✓ How SOC and SOH define a battery's true performance capability
- ✓ On-board vs. direct testing - when and why to use each
- ✓ Safely measuring high voltage systems and interpreting data
- ✓ Overcoming common challenges in EV & hybrid diagnostics
- ✓ Real-world best practices to boost reliability and technician confidence path.

**MOTOR AGE
TRAINING**



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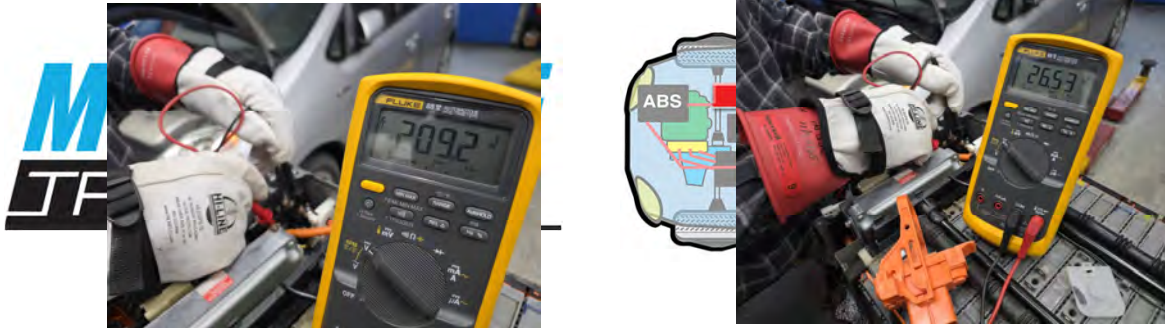
HV Battery Condition The Manual Way



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HV Battery Condition The Manual Way



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HV Battery Condition Using Autel



10

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HV Battery Condition Using Autel

Toyota V7.20
 Toyota > Automatic selection > Auto scan
 VCM2+ 13.0V
 DTCs: 7 100%

Topology List

Auto scan
 Control unit
 Live data fusion
 Hot functions
 Programming/Customization
 All advanced functions
 Vehicle profile

Legend: Not scanned (blue), Pass (green), Fault (red), No response (grey)
 V_BUS (red), BEAN (purple), SL (grey)

VIN: JTDK85026113381
 ID: Toyota/Prado
 SN: V97058V09423

DVI Remote Expert Vehicle Data Report Quick Erase Fault Scan Enter System ESC

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HV Battery Condition Using Autel

Toyota V7.20
 Toyota VCM2+

Technical Certification

Please ensure you have passed high voltage safety certification.
 Perform relevant operations according to local regulations and personal qualification: Only high voltage technicians and high voltage experts are allowed to perform high voltage related operations.

HVE High voltage experts

- Disconnection of high voltage systems (by any safe means)
- Repair of high voltage batteries

HVT High voltage technicians

- Disconnection of high voltage systems according to standard procedures
- Repair of high voltage systems disconnected from power

GMT General maintenance technicians

- General maintenance of electric vehicles not involving high voltage systems

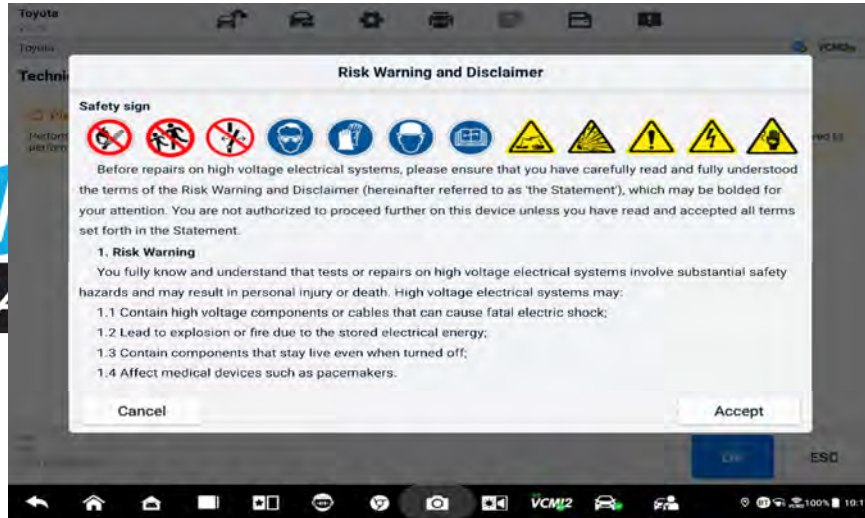
OK ESC

VIN: V97058V09423

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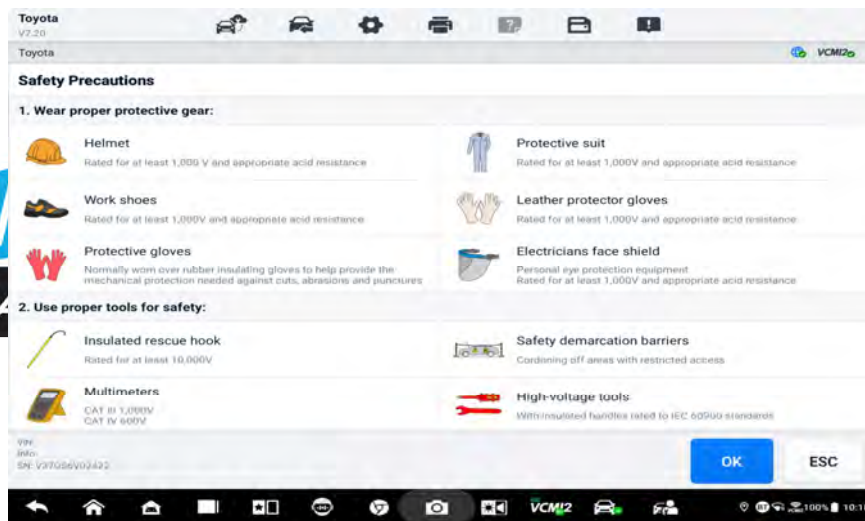
HV Battery Condition Using Autel



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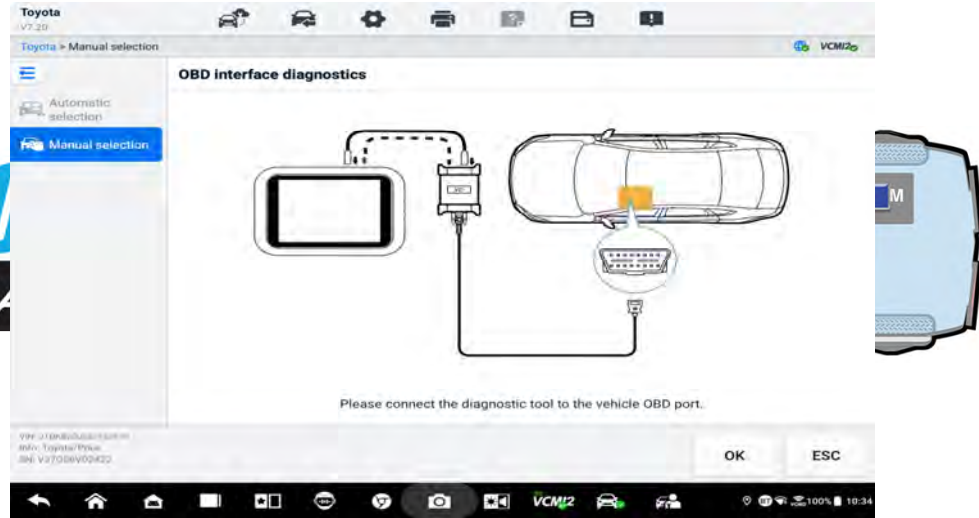
HV Battery Condition Using Autel



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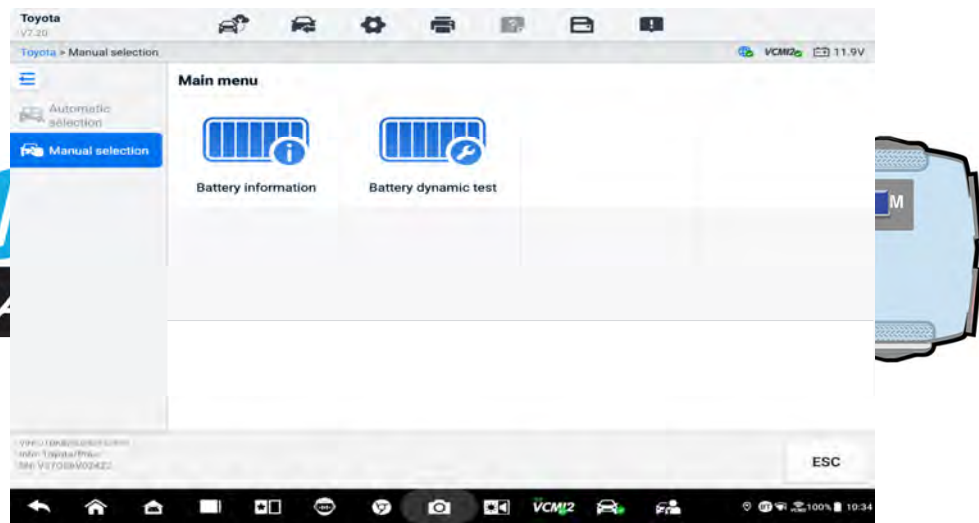
HV Battery Condition Using Autel



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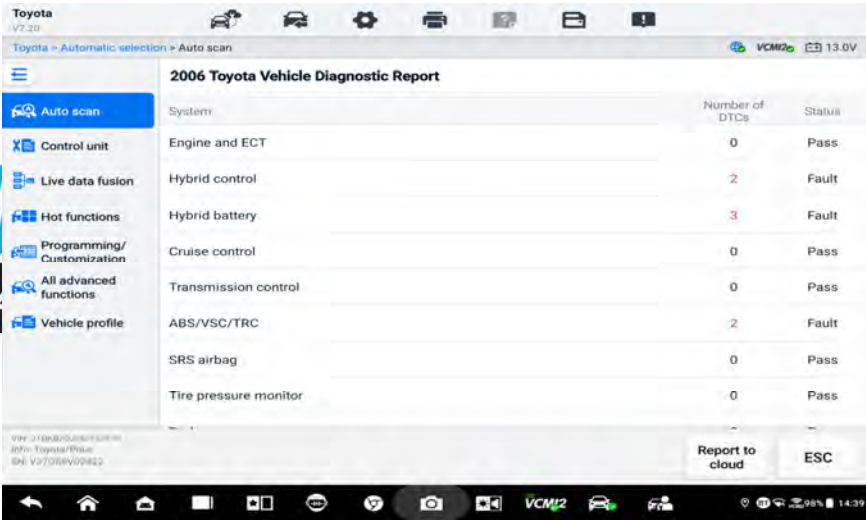
HV Battery Condition Using Autel



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HV Battery Condition Using Autel



2006 Toyota Vehicle Diagnostic Report

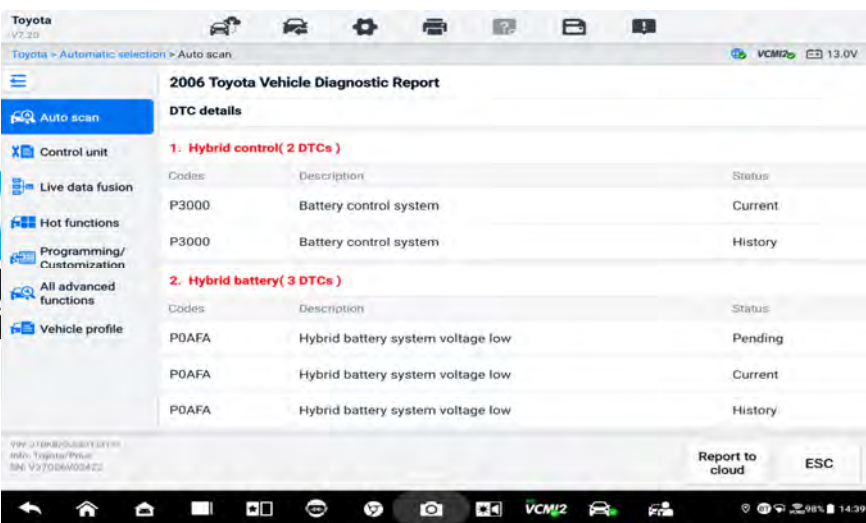
System	Number of DTCs	Status
Engine and ECT	0	Pass
Hybrid control	2	Fault
Hybrid battery	3	Fault
Cruise control	0	Pass
Transmission control	0	Pass
ABS/VSC/TRC	2	Fault
SRS airbag	0	Pass
Tire pressure monitor	0	Pass

Report to cloud ESC

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HV Battery Condition Using Autel



2006 Toyota Vehicle Diagnostic Report

DTC details

1. Hybrid control(2 DTCs)

Codes	Description	Status
P3000	Battery control system	Current
P3000	Battery control system	History

2. Hybrid battery(3 DTCs)

Codes	Description	Status
P0AFA	Hybrid battery system voltage low	Pending
P0AFA	Hybrid battery system voltage low	Current
P0AFA	Hybrid battery system voltage low	History

Report to cloud ESC

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HV Battery Condition Using Autel

Toyota
v7.29
Automatic selection > Auto scan

2006 Toyota Vehicle Diagnostic Report

2. Hybrid battery(3 DTCs)

Codes	Description	Status
P0AFA	Hybrid battery system voltage low	Pending
P0AFA	Hybrid battery system voltage low	Current
P0AFA	Hybrid battery system voltage low	History

3. ABS/VSC/TRC(2 DTCs)

Codes	Description	Status
C1259	HV system regenerative fault	Current
C1310	HV system fault	Current

I/M readiness status

Report to cloud ESC

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HV Battery Condition Using Autel

Toyota
v7.29
Automatic selection > Control unit > Hybrid battery > Live data

All parameters

Name	Value	Measured Min	Max
<input type="checkbox"/> Battery state of charge (SOC) (%)	13	13	13
<input type="checkbox"/> Battery pack current value (A)	0.07	0.04	0.09
<input type="checkbox"/> Battery block voltage - v01 (V)	0.94	0.9	0.97
<input type="checkbox"/> Battery block voltage - v02 (V)	-0.71	-0.74	-0.69
<input type="checkbox"/> Battery block voltage - v03 (V)	15.02	14.98	15.06
<input type="checkbox"/> Battery block voltage - v04 (V)	14.44	14.42	14.48
<input type="checkbox"/> Battery block voltage - v05 (V)	15.08	15.04	15.11
<input type="checkbox"/> Battery block voltage - v06 (V)	15.02	15.01	15.05
<input type="checkbox"/> Battery block voltage - v07 (V)	14.97	14.95	15

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GM Volt HV Battery Condition

Introduction to SOH Deep Test

A SOH Deep Test is a comprehensive analysis of the cell voltage, current, and temperature data of the power battery generated during the vehicle charging process using our unique HPPC (Hybrid Pulse Power Characteristic) Track battery algorithm*, providing customers with a SOH Deep Test report.

Test procedure:

1. Keep the vehicle battery SOC below 50%;
2. While vehicle is NOT charging, connect the VCI to the vehicle OBD port;
3. Execute the test according to the directions;
4. Generate an evaluation report after the test is completed.

Special note: If time permits, it is recommended to charge the vehicle SOC from below 30% to 100% (some vehicles need to adjust the SOC charging upper limit to 100%), which will significantly improve the SOH test accuracy.

***HPPC Track algorithm introduction:**
Our original HPPC (Hybrid Pulse Power Characteristic) Track algorithm (based on a large amount of real vehicle charging and maintenance data and artificial intelligence) can establish specific power battery models according to different vehicle makes, vehicle models and battery models, and automatically match and track the electrochemical characteristics of the battery through only one charging session, and comprehensively analyze data such as odometer reading, temperature, battery internal resistance, and self-ohm data to accurately estimate the health status of the battery.

OK ESC

25

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GM Volt HV Battery Condition

SOH Test

Step 1 Step 2 Step 3

Vehicle status detection

- Vehicle communication status
 - Battery management system status
 - High voltage battery status
 - SOC <= 50%

Next ESC

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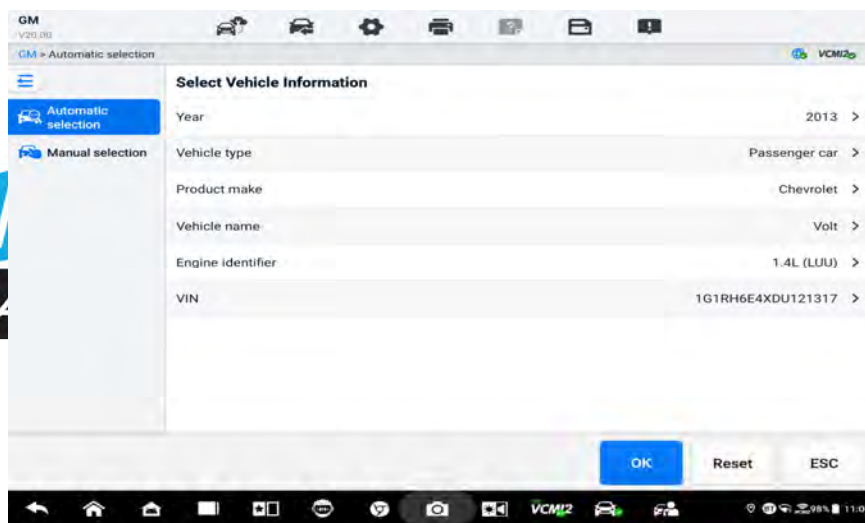
GM Volt HV Battery Condition



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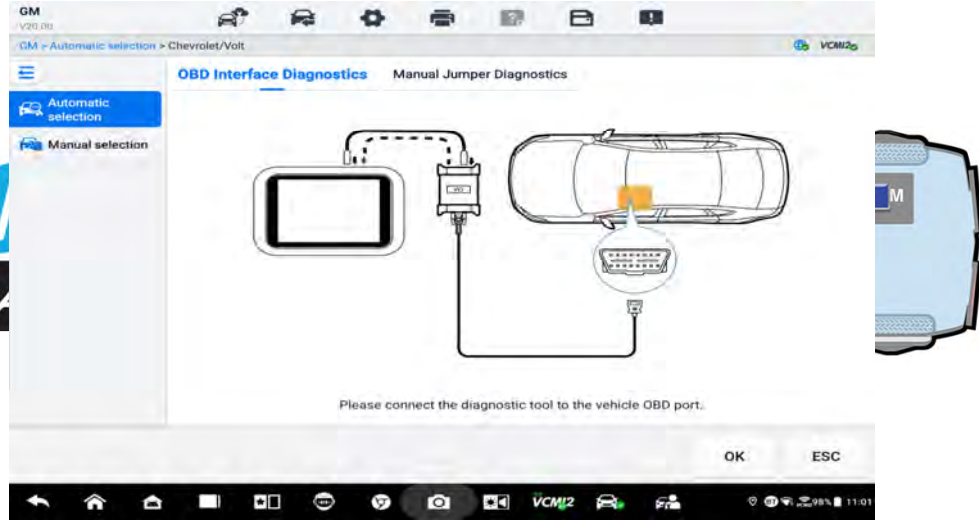
GM Volt HV Battery Condition



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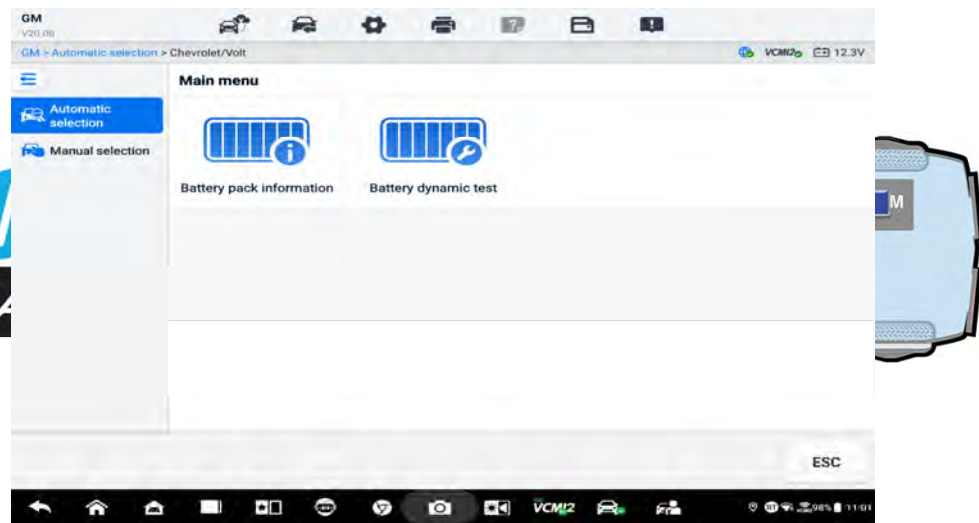
GM Volt HV Battery Condition



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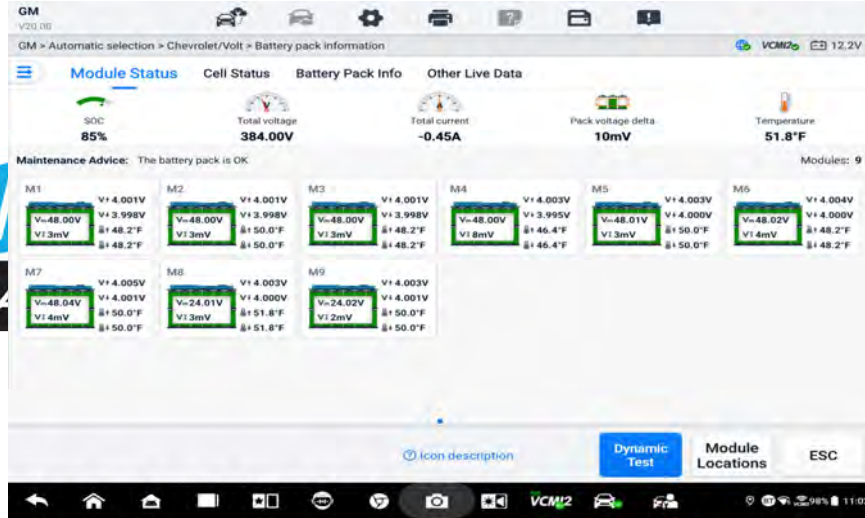
GM Volt HV Battery Condition



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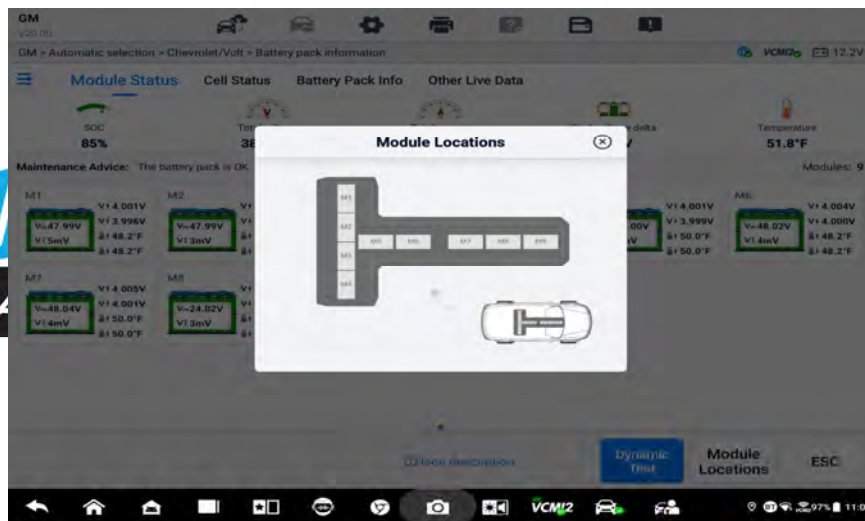
GM Volt HV Battery Condition



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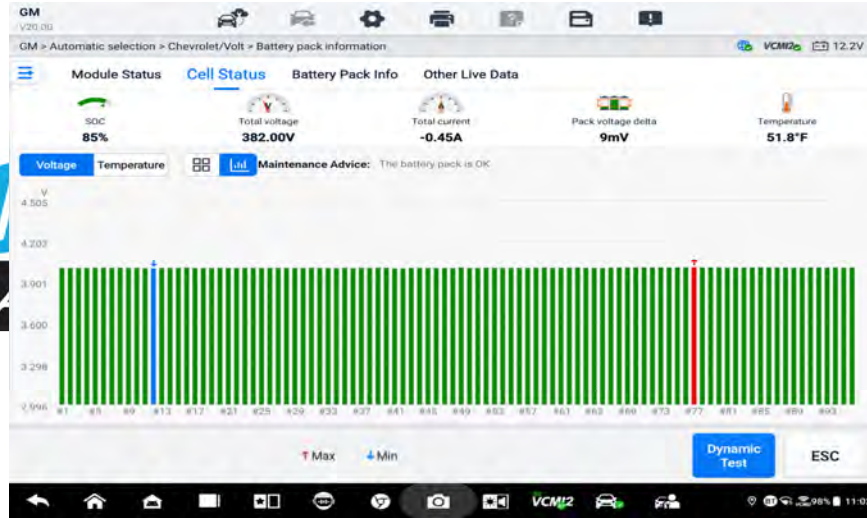
GM Volt HV Battery Condition



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GM Volt HV Battery Condition



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GM Volt HV Battery Condition

The screenshot displays the 'Battery Pack Info' tab of the GM Volt HV Battery Condition interface. It provides the following technical and version information:

Technical data	
Number of cells and series/parallel structure in battery pack	288 (3P96S)
Nominal voltage	355V
Battery capacity	46Ah
Battery pack dimension	1742mm x 1132mm x 383mm
Battery pack cooling system type	Coolant
Theoretical range	61km
Version Information	
End model part number	22911427

An 'ESC' label is visible at the bottom right of the data list.

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GM Volt HV Battery Condition

Name	Value
Average hybrid/ev battery pack temperature(°F)	50.00
Control module voltage signal(V)	11.71
5V reference 1(V)	3.02
Power mode	Operating
Hybrid/ev battery pack current(A)	0.00
Hybrid/ev batt. pack high resolution current sen.(A)	0.00
Hybrid/ev battery pack voltage(V)	383.76
Hybrid/ev battery pack terminal 2 voltage(V)	0.00
Hybrid/ev batt. pack clnt. temp. sensor 1(°F)	46.40

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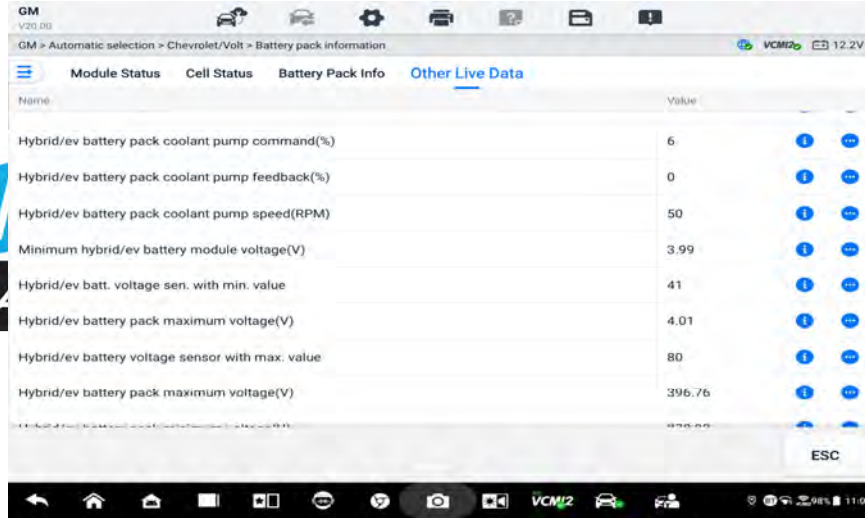
GM Volt HV Battery Condition

Name	Value
Hybrid/ev batt. pack clnt. temp. sensor 1(°F)	46.40
Hybrid/ev batt. pack clnt. temp. sensor 2(°F)	46.40
High voltage system interlock circuit	Energized
High voltage system interlock circuit status	Passed
Hybrid/ev battery pack coolant level switch(V)	3.55
Maximum hybrid/ev battery module temperature(°F)	50.00
Minimum hybrid/ev battery module temperature(°F)	48.20
Hybrid/ev batt. temp. sensor with max. value	2

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GM Volt HV Battery Condition



GM V20.00
Automatic selection > Chevrolet/Volt > Battery pack information

Module Status Cell Status Battery Pack Info Other Live Data

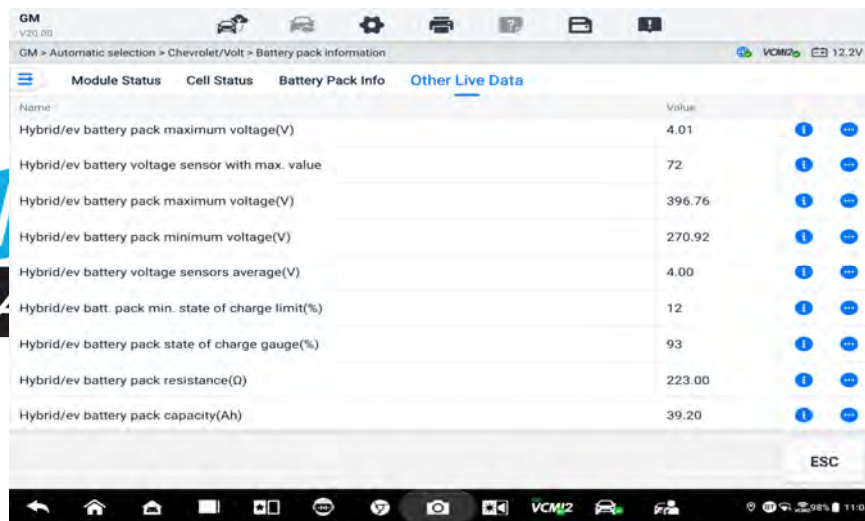
Name	Value
Hybrid/ev battery pack coolant pump command(%)	6
Hybrid/ev battery pack coolant pump feedback(%)	0
Hybrid/ev battery pack coolant pump speed(RPM)	50
Minimum hybrid/ev battery module voltage(V)	3.99
Hybrid/ev batt. voltage sen. with min. value	41
Hybrid/ev battery pack maximum voltage(V)	4.01
Hybrid/ev battery voltage sensor with max. value	80
Hybrid/ev battery pack maximum voltage(V)	396.76

ESC

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GM Volt HV Battery Condition



GM V20.00
Automatic selection > Chevrolet/Volt > Battery pack information

Module Status Cell Status Battery Pack Info Other Live Data

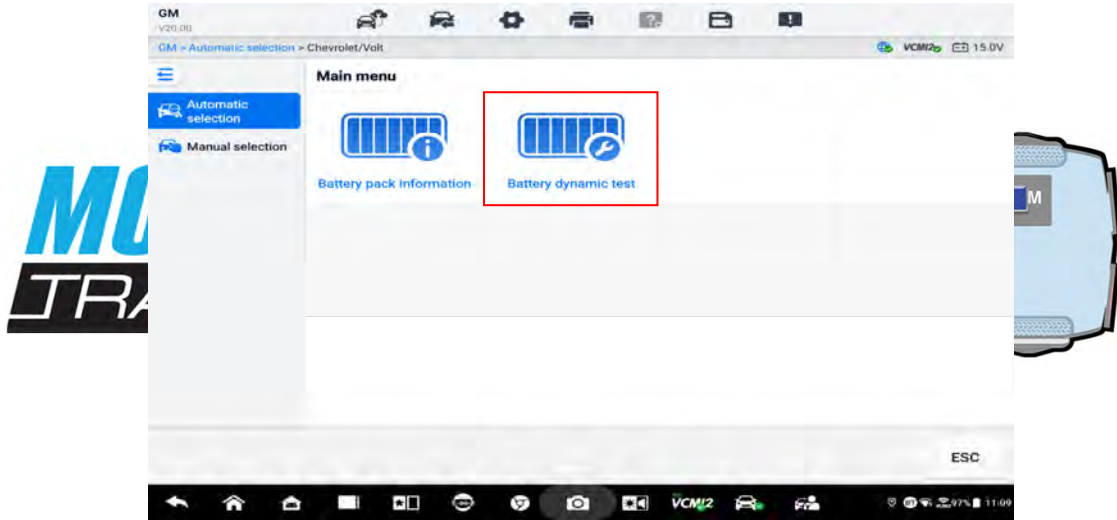
Name	Value
Hybrid/ev battery pack maximum voltage(V)	4.01
Hybrid/ev battery voltage sensor with max. value	72
Hybrid/ev battery pack maximum voltage(V)	396.76
Hybrid/ev battery pack minimum voltage(V)	270.92
Hybrid/ev battery voltage sensors average(V)	4.00
Hybrid/ev batt. pack min. state of charge limit(%)	12
Hybrid/ev battery pack state of charge gauge(%)	93
Hybrid/ev battery pack resistance(Ω)	223.00
Hybrid/ev battery pack capacity(Ah)	39.20

ESC

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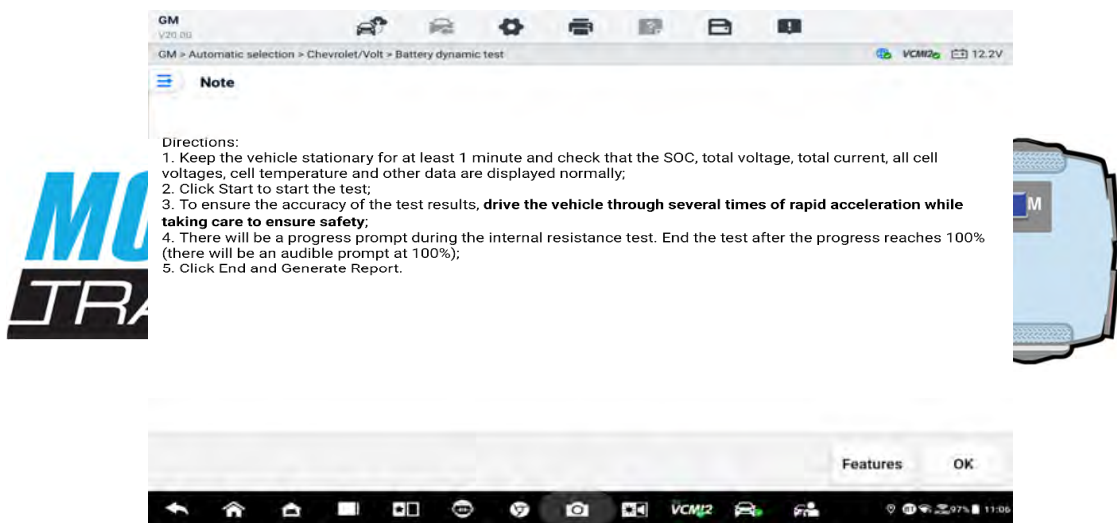
GM Volt HV Battery Condition



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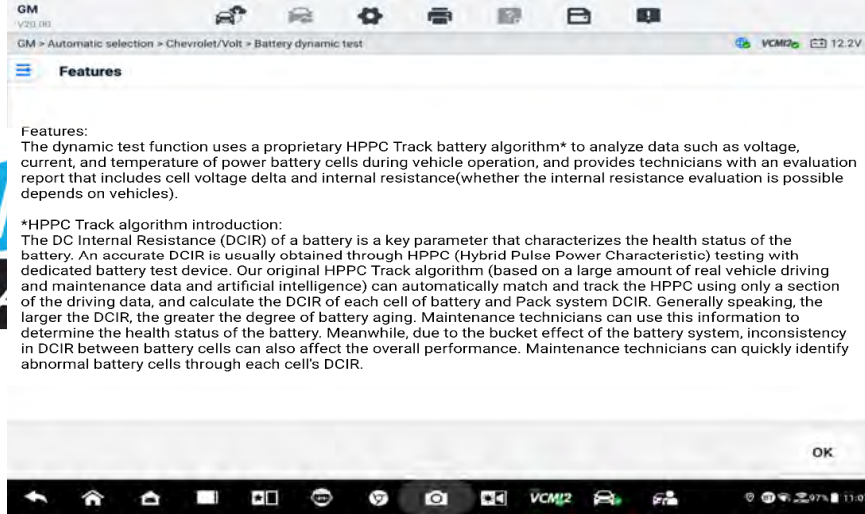
GM Volt HV Battery Condition



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GM Volt HV Battery Condition



GM
V20.00

GM > Automatic selection > Chevrolet/Volt > Battery dynamic test

Features

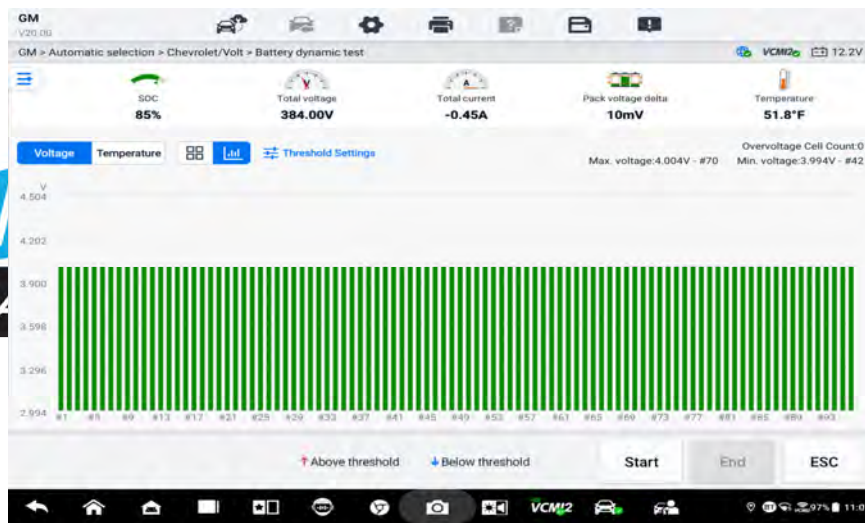
Features:
The dynamic test function uses a proprietary HPPC Track battery algorithm* to analyze data such as voltage, current, and temperature of power battery cells during vehicle operation, and provides technicians with an evaluation report that includes cell voltage delta and internal resistance (whether the internal resistance evaluation is possible depends on vehicles).

*HPPC Track algorithm introduction:
The DC Internal Resistance (DCIR) of a battery is a key parameter that characterizes the health status of the battery. An accurate DCIR is usually obtained through HPPC (Hybrid Pulse Power Characteristic) testing with dedicated battery test device. Our original HPPC Track algorithm (based on a large amount of real vehicle driving and maintenance data and artificial intelligence) can automatically match and track the HPPC using only a section of the driving data, and calculate the DCIR of each cell of battery and Pack system DCIR. Generally speaking, the larger the DCIR, the greater the degree of battery aging. Maintenance technicians can use this information to determine the health status of the battery. Meanwhile, due to the bucket effect of the battery system, inconsistency in DCIR between battery cells can also affect the overall performance. Maintenance technicians can quickly identify abnormal battery cells through each cell's DCIR.

OK



GM Volt HV Battery Condition



GM
V20.00

GM > Automatic selection > Chevrolet/Volt > Battery dynamic test

VCMI2 12.2V

SOC 85%
Total voltage 384.00V
Total current -0.45A
Pack voltage delta 10mV
Temperature 51.8°F

Voltage Temperature Threshold Settings

Max. voltage: 4.004V - #70
Min. voltage: 3.994V - #42

Overvoltage Cell Count: 0

V

4.504
4.202
3.900
3.598
3.296
2.994

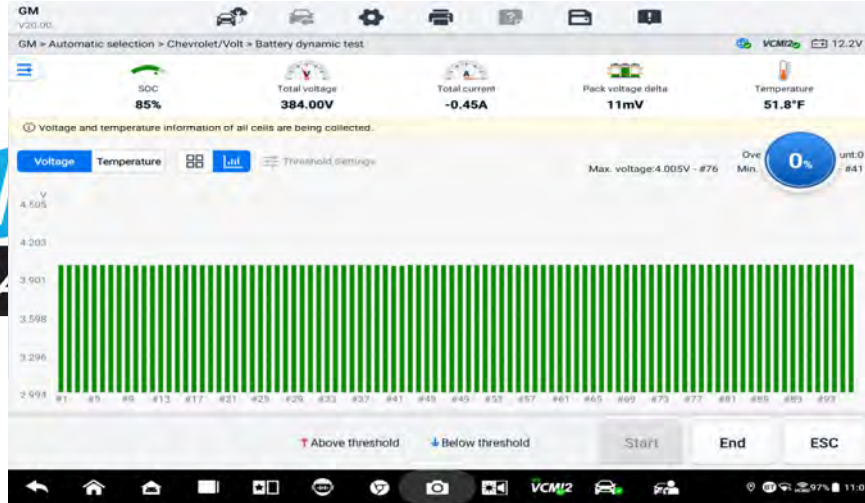
#1 #3 #5 #7 #9 #11 #13 #15 #17 #19 #21 #23 #25 #27 #29 #31 #33 #35 #37 #39 #41 #43 #45 #47 #49 #51 #53 #55 #57 #59 #61 #63 #65 #67 #69 #71 #73 #75 #77 #79 #81 #83 #85 #87 #89 #91

↑ Above threshold ↓ Below threshold

Start End ESC



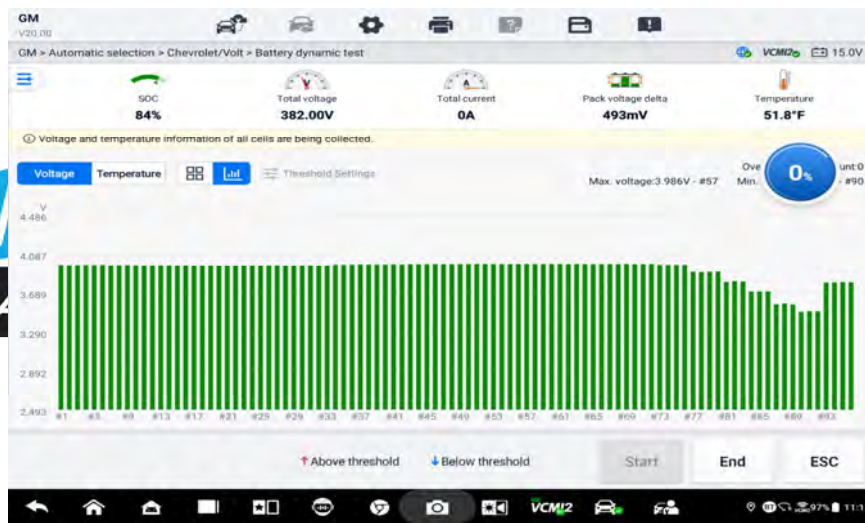
GM Volt HV Battery Condition



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GM Volt HV Battery Condition



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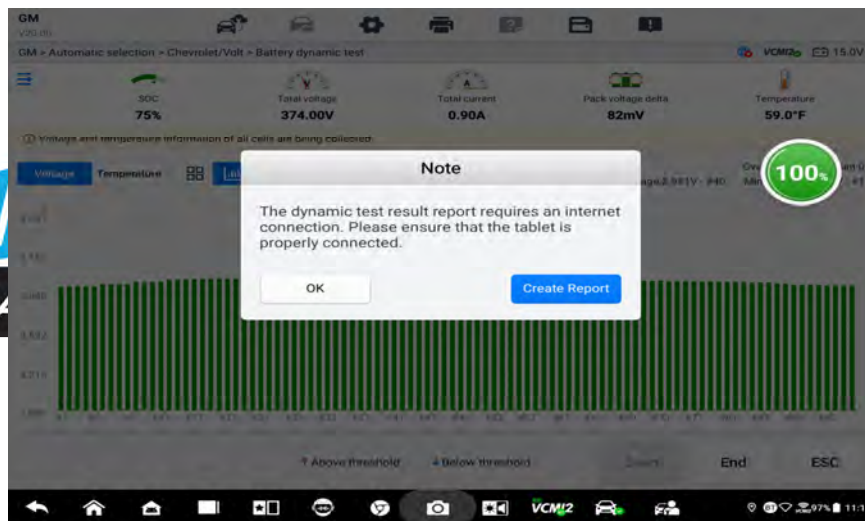
GM Volt HV Battery Condition



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GM Volt HV Battery Condition



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GM Volt HV Battery Condition



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GM Volt HV Battery Condition



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GM Volt HV Battery Condition



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GM Volt HV Battery Condition

Cell ID	Module ID	Voltage delta	Current status	Sampling time
#1	M1	529.0mV	Discharging	27s
#4	M1	846.0mV	Discharging	227s
#8	M1	181.0mV	Discharging	0s
#9	M1	607.0mV	Discharging	143s
#12	M1	170.0mV	Discharging	79s
#1	M2	464.0mV	Discharging	9s
#6	M2	636.0mV	Discharging	246s
#7	M2	180.0mV	Discharging	331s
#12	M2	870.0mV	Discharging	108s
#3	M3	561.0mV	Discharging	18s
#6	M4	132.0mV	Discharging	208s
#7	M4	869.0mV	Discharging	169s
#2	M5	189.0mV	Discharging	284s
#3	M5	577.0mV	Discharging	63s
#2	M6	952.0mV	Discharging	275s
#6	M6	684.0mV	Discharging	134s

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GM Volt HV Battery Condition

Cell ID	Module	Voltage	Status	Time
#12	M2	870.0mV	Discharging	108s
#3	M3	561.0mV	Discharging	18s
#6	M4	132.0mV	Discharging	208s
#7	M4	869.0mV	Discharging	169s
#2	M5	189.0mV	Discharging	284s
#3	M5	577.0mV	Discharging	53s
#2	M6	852.0mV	Discharging	275s
#6	M6	684.0mV	Discharging	134s
#8	M6	655.0mV	Discharging	265s
#10	M6	723.0mV	Discharging	152s
#3	M7	685.0mV	Discharging	179s
#9	M7	706.0mV	Discharging	98s
#3	M8	631.0mV	Discharging	188s
#5	M8	283.0mV	Discharging	255s
#3	M9	737.0mV	Discharging	89s
	M9	244.0mV	Discharging	217s

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GM Volt HV Battery Condition

GM
V20.00

GM > Manual selection > /Volt

Introduction to SOH Deep Test

A SOH Deep Test is a comprehensive analysis of the cell voltage, current, and temperature data of the power battery generated during the vehicle charging process using our unique HPPC (Hybrid Pulse Power Characteristic) Track battery algorithm*, providing customers with a SOH Deep Test report.

Test procedure:

1. Keep the vehicle battery SOC below 50%;
2. While vehicle is NOT charging, connect the VCI to the vehicle OBD port;
3. Execute the test according to the directions;
4. Generate an evaluation report after the test is completed.

Special note: If time permits, it is recommended to charge the vehicle SOC from below 30% to 100% (some vehicles need to adjust the SOC charging upper limit to 100%), which will significantly improve the SOH test accuracy.

***HPPC Track algorithm introduction:**
Our original HPPC (Hybrid Pulse Power Characteristic) Track algorithm (based on a large amount of real vehicle charging and maintenance data and artificial intelligence) can establish specific power battery models according to different vehicle makes, vehicle models and battery models, and automatically match and track the electrochemical characteristics of the battery through only one charging session, and comprehensively analyze data such as odometer reading, temperature, battery internal resistance, and cell voltage data to accurately evaluate the health status of the battery.

OK ESC

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GM Volt HV Battery Condition

Introduction to SOH Deep Test

2. While vehicle is NOT charging, connect the VCI to the vehicle OBD port.
3. Execute the test according to the directions.
4. Generate an evaluation report after the test is completed.

Special note: If time permits, it is recommended to charge the vehicle SOC from below 30% to 100% (some vehicles need to adjust the SOC charging upper limit to 100%), which will significantly improve the SOH test accuracy.

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Our original HPPC (Hybrid Pulse Power Characteristic) Track algorithm (based on a large amount of real vehicle charging and maintenance data and artificial intelligence) can establish specific power battery models according to different vehicle makes, vehicle models and battery models, and automatically match and track the electrochemical characteristics of the battery through only one charging session, and comprehensively analyze data such as odometer reading, temperature, battery internal resistance, and cell voltage delta to accurately evaluate the health status of the battery.

SOH (State of Health) is a key indicator that measures the degree of performance degradation of a battery relative to its initial condition.
SOH = current capacity of the fully charged vehicle/nominal capacity of the new vehicle.
Low capacity will result in a shortened vehicle range on a full charge. It is generally believed that lithium batteries with SOH below 80% are not suitable for use on vehicles.

VIN: [blurred]
SN: [blurred]
IMEI: V27088V00422

OK ESC

GM Volt HV Battery Condition

SOH Test

1 Step 1 2 Step 2 3 Step 3

Please complete the following operations.

Step 1: Park the vehicle at the charging site and do not start charging at the charger

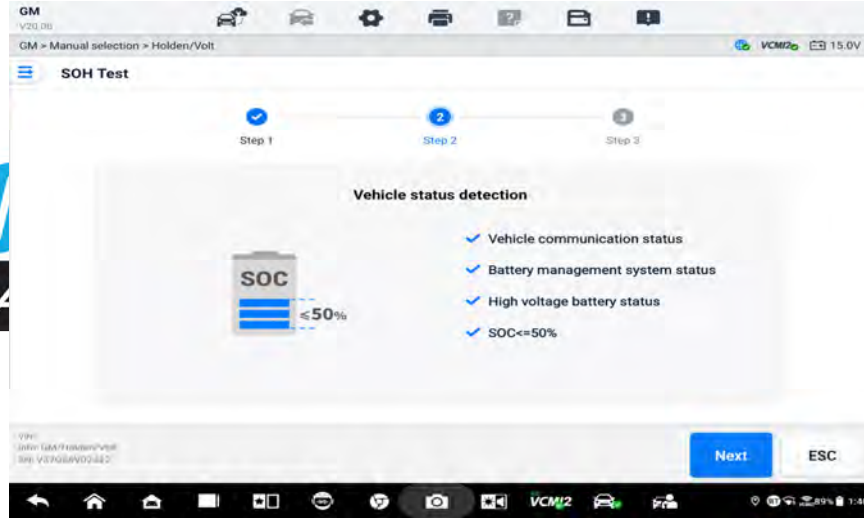
Step 2: VCI is connected to the vehicle OBD; VCI is connected to the tablet

Step 3: [blurred]

VIN: [blurred]
SN: [blurred]
IMEI: V27088V00422

Next ESC

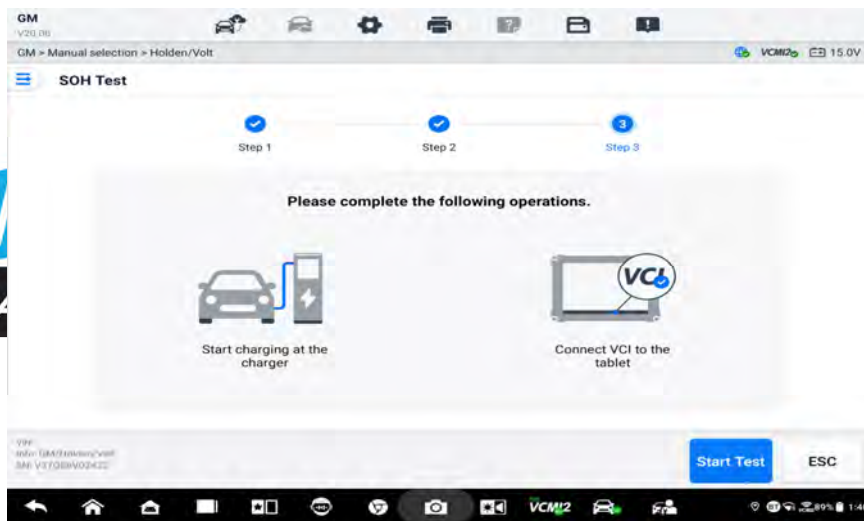
GM Volt HV Battery Condition



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GM Volt HV Battery Condition



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GM Volt HV Battery Condition

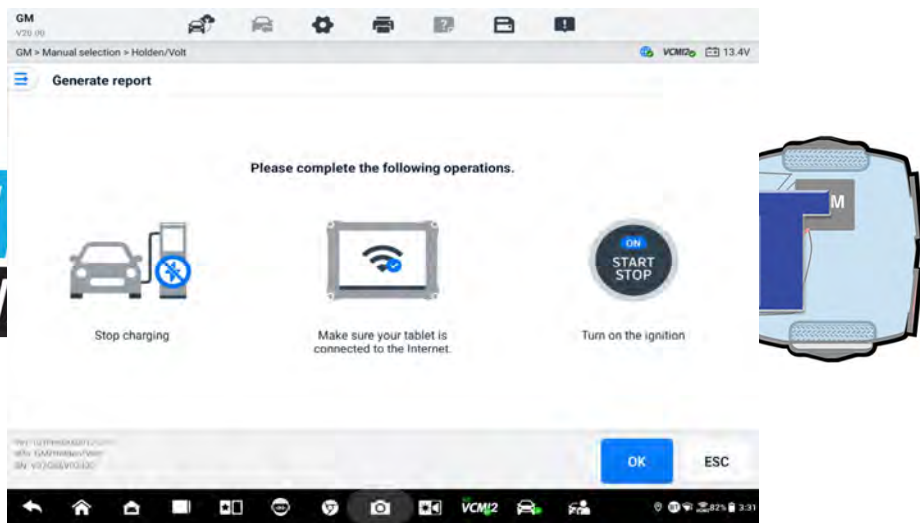


The screenshot shows the 'Under Test' screen of the GM Volt HV Battery Condition app. At the top, the status bar displays 'GM V20.00', 'GM > Manual selection > Holden/Volt', and 'VCM12 13.3V'. The main display features a large green battery icon with '44%' written above it. Below the icon, two instructions are listed: '1. An test report can be generated when the test progress reaches over 70%. To ensure the accuracy of the test results, we recommend that you charge until the charger stops charging;' and '2. Ensure that the tablet is fully charged.' At the bottom, there are fields for VIN (1G1TBE40001171717), IMC (GM1146000000), and SN (V3705AV0242), along with 'Generate Reports' and 'ESC' buttons. The bottom navigation bar shows various icons including a home button, a car icon, and a battery icon.

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GM Volt HV Battery Condition



The screenshot shows the 'Generate report' screen of the GM Volt HV Battery Condition app. At the top, the status bar displays 'GM V20.00', 'GM > Manual selection > Holden/Volt', and 'VCM12 13.4V'. The main display features the heading 'Please complete the following operations.' followed by three instructions: 'Stop charging' (with a car and charging station icon), 'Make sure your tablet is connected to the Internet.' (with a tablet and Wi-Fi icon), and 'Turn on the ignition' (with a 'ON START STOP' button icon). At the bottom, there are fields for VIN (1G1TBE40001171717), IMC (GM1146000000), and SN (V3705AV0242), along with 'OK' and 'ESC' buttons. The bottom navigation bar shows various icons including a home button, a car icon, and a battery icon.

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GM Volt HV Battery Condition

Chevrolet
V20.00
Automatic selection > HV system diagnostics

Auto scan
Control unit
HV system diagnostics
Live data fusion
Hot functions
Vehicle profile

HV system diagnostics

- High-voltage interlock fault: **NO**
- High-voltage interlock loop status: **Passed**
- Charging system high-voltage interlock loop status: **Passed**
- Battery pack active insulation brd status: **Not supported**
- Charging system insulation test status: **Passed**
- Insulation test resistance: **0.00 kWh**

Battery pack voltage: **278.76 V**

Precharge time too short: **NO**
Precharge time too long: **NO**
Precharge current too high: **NO**
Crash event detected: **NO**

Disconnect HV | Quick Erase | **Fault Scan** | Enter | ESC

VCM2 | 15.0V

999 10179HEK00012337
info: Chevrolet/Volt

12:28

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GM Volt HV Battery Condition

Chevrolet
V20.00
Automatic selection > HV system diagnostics

IV system diagnostic: DTC: 0

System List

DTC: 0 | 100%

- Battery energy control module: **Pass | No fault**
- Hybrid powertrain control module: **Pass | No fault**
- Hybrid powertrain control module 2: **Pass | No fault**
- Drive motor control module 1: **Pass | No fault**
- Drive motor control module 2: **Pass | No fault**
- Battery charger control module: **Pass | No fault**
- Electric A/C compressor control module: **Pass | No fault**
- HVAC control module: **Pass | No fault**
- Coolant heater control module: **Pass | No fault**

Disconnect HV | Quick Erase | **Fault Scan** | Enter | ESC

VCM2 | 15.0V

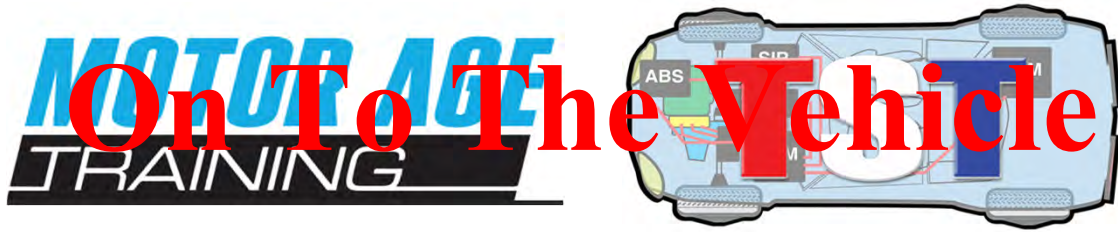
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info: Chevrolet/Volt

12:29

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MOTOR AGE
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On To The Vehicle

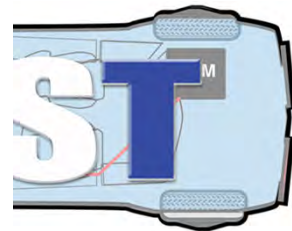
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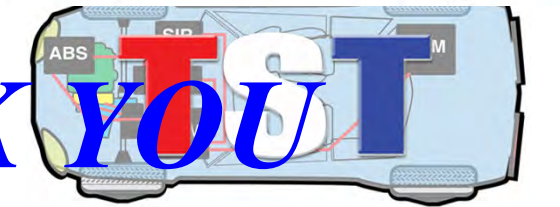
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THANK YOU



"State of Charge and State of Health Analysis for EV Battery Condition"

Presented by Motor Age & TST