

EVd-40 User Manual



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Caution:

1. EVd units cannot be used safely without a battery pack cooling box and fan.
2. EVd units should not be used without training from NuVant staff.
3. EVd users must wear safety glasses.
4. EVd users should use safety barriers (e.g. Plexiglas, poly-carbonate, shatter proof-glass, etc.) for protection during pack reconditioning.
5. EVd users should use an insulating electrical mat, safety glasses and high voltage gloves.
6. Always wear personal protective equipment when assembling battery packs, connecting the battery to EVd harness, operating the power tester, and installing the battery into enclosures. NuVant Systems is not responsible for any property damage and/or injury that occurs during use of equipment.

Failure to take the above precautions will result in injury or death.

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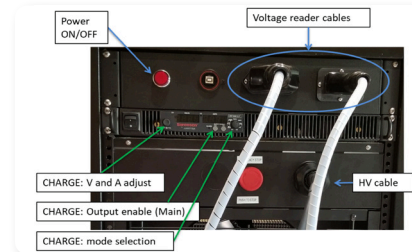
(Glossary of Terms can be found at end of document)

A	amp
Ah	amp-hour
DOD	depth of discharge
HV	high-voltage
I	current
Li-ion	lithium ion
NiCad	nickel cadmium
NiMH	nickel metal hydride
Ω	ohm
OCV	open circuit voltage
QR code	Quick Response code (found on Toyota modules)
Res	resistance
SOC	state of charge
V	voltage
Wh	watt-hour

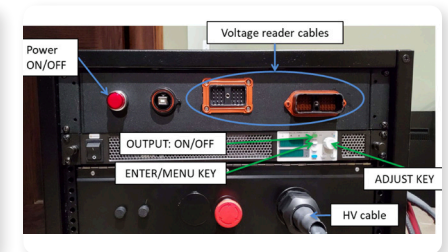
This manual is intended for EVd users, who have already completed training on the EVc Battery Reconditioner. The modules selected for power testing are post-reconditioning. Please refer to the EVc manual for more information.

1. Use Pack Builder to select balanced modules for power testing
2. Group well matched modules together as suitable pack candidates
3. Connect well matched modules to power tester, as per instructions below
4. Install tie rods and execute power cycling plan

EVd-40 Front Panel and Set-Up



Sorensen Power Supply



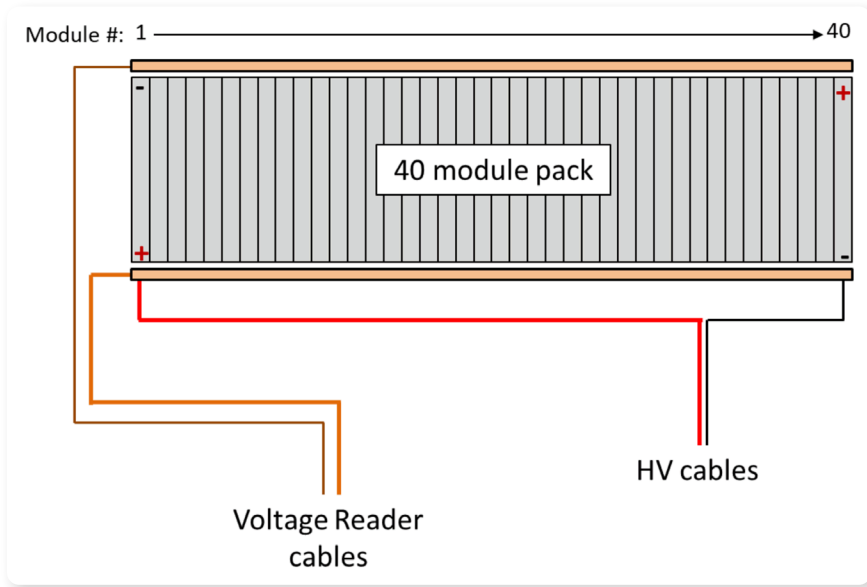
Kepco Power Supply

USE HV GLOVES (**and safety glasses**) WHEN CONNECTING HARNESS. MAKE SURE THAT HARNESS IS CONNECTED CORRECTLY AND NO SHORTS OCCUR.

WARNING: USE HV GLOVES

MAKE SURE THAT INSTRUMENT IS OFF WHEN CONNECTING/REMOVING CABLES.

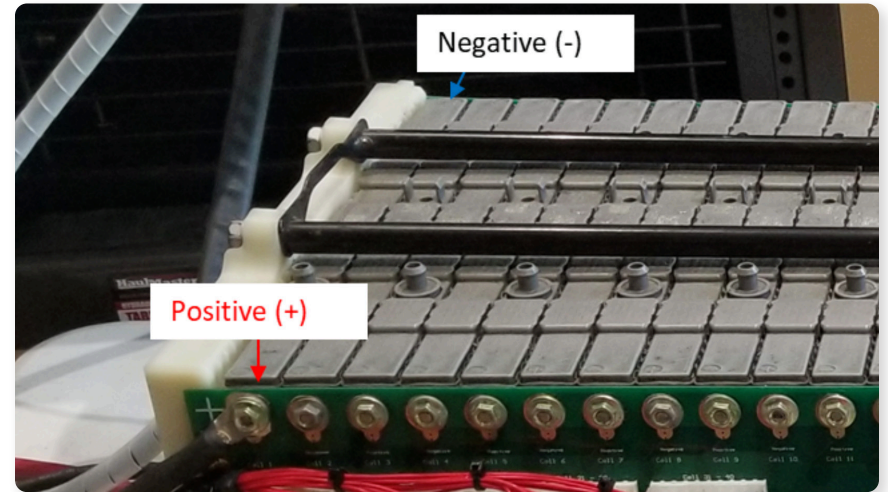
1. Connect the voltage reader harness to the suitable pack candidates (up to 40 modules). See the diagram below (and photos on following pages).
2. The voltage reader cables refers to the multi-channel cables next to the POWER button, not the HV leads (cable above the heater).
3. Connect the HV leads. Remember that BLACK is negative (-) and RED is positive (+).
4. Plug in EVd and press the white power button to turn on.
5. Connect EVd to laptop and open EVd software.
6. Select number of channels (28 for Prius, 34 for Camry, etc.)
7. Click "Connect"
8. Click "Single Read"
9. On left, check initial voltage readings of all modules
10. Module/channel numbering starts at the end with the voltage reader cables connect



EVd Connection Diagram



Full view of connected 40 modules

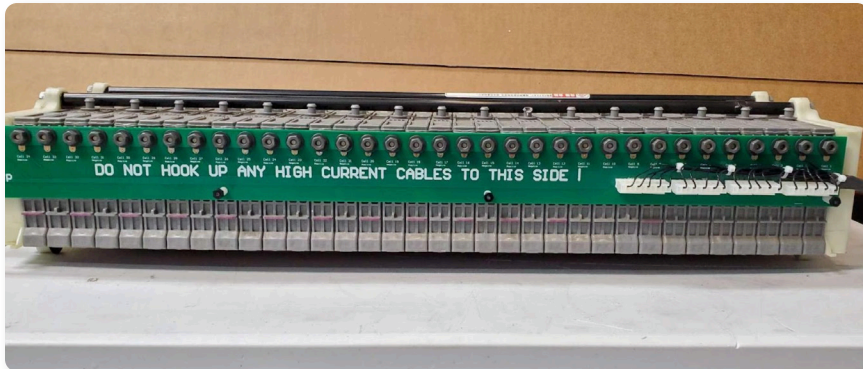
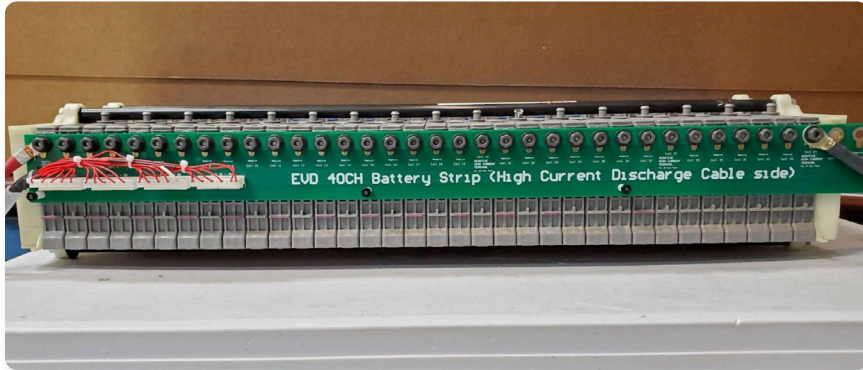


"Front" of pack



Connected Toyota Prius Pack (28 modules)

*Configuration may vary depending on vehicle year.

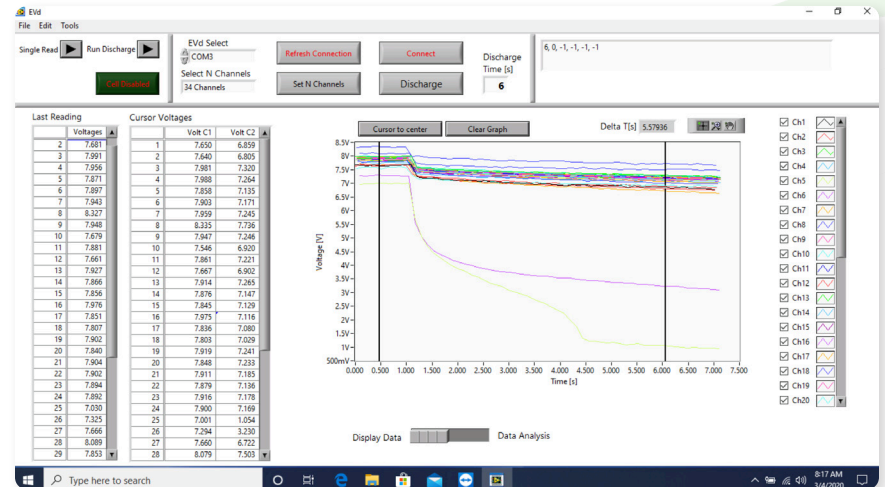


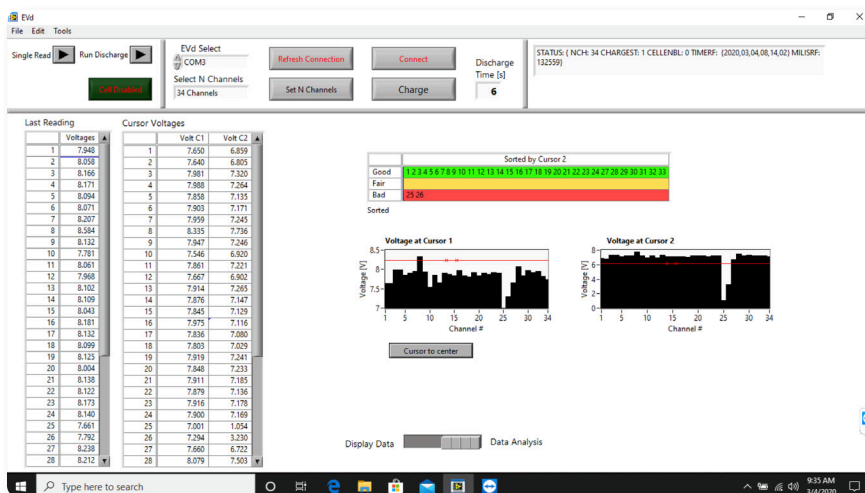
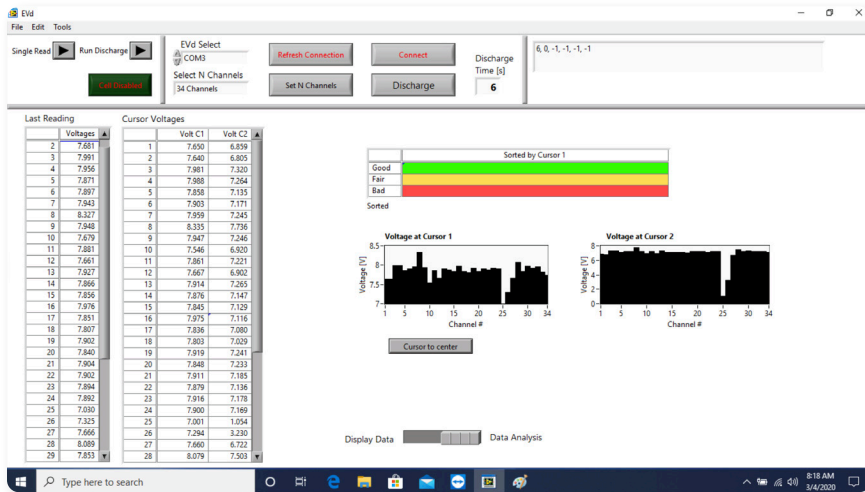
Connected Toyota Camry Pack (34 modules)

*Configuration may vary depending on vehicle year.

Power Test Discharge

1. Turn discharge cooling fan ON
2. Make sure the power supply charger is OFF
3. Input discharge time (Generally three runs of 30 seconds)
4. Click Run Discharge on software
5. POWER TEST starts
6. Once completed, the discharge data will display on screen.
7. You can choose to save the data at this point under "File"
8. To analyze data, click "Cursor to Center"
9. Drag the two cursors to the desired time points (typically one in the beginning/middle and one near the end)
10. Click "Data Analysis" to view the comparison window (shown on pg.7)
11. Identify and reject any modules that do not meet acceptance criteria
 - A. In the "Inventory" File, place rejected modules into "Failed Power Test" sheet.
12. Turn OFF discharge cooling fan



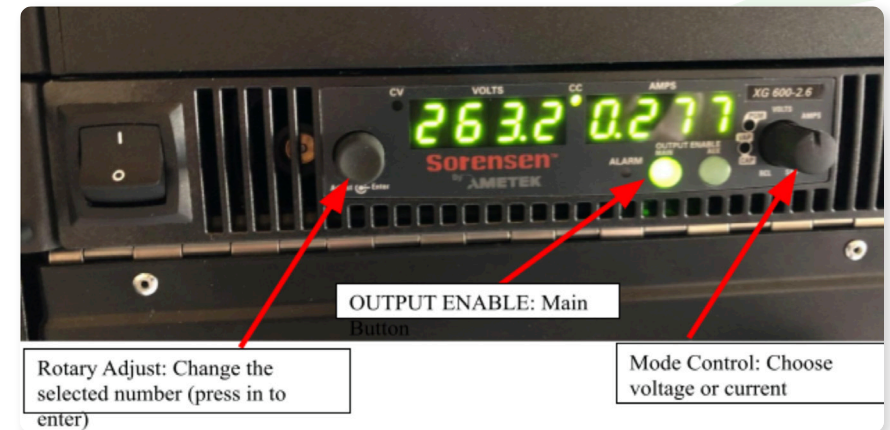


Charge Pack

1. Leave cables connected from Power Test
2. Make sure discharge cooling fan is OFF
3. In EVD software, click "DISCHARGE" to toggle to "CHARGE"
4. In EVD software, click "Cell Disabled" to change to "Cell Enabled"
5. Turn ON Power Supply Charger

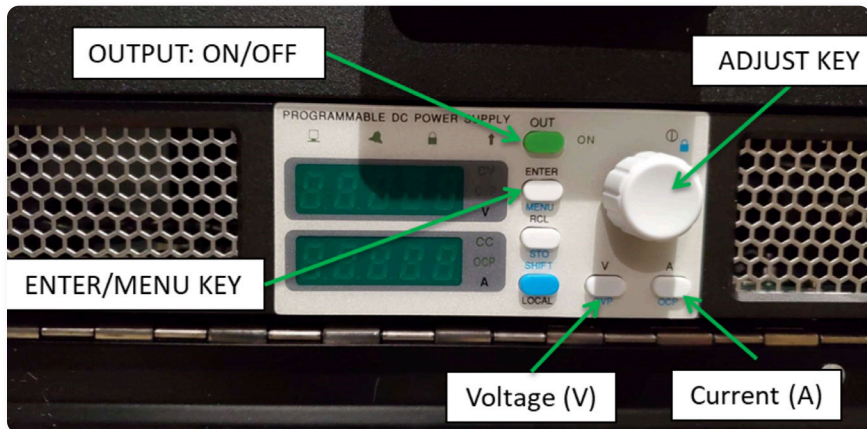
For Sorenson:

- i. Select Voltage on Mode Control (right knob)
- ii. Use left knob to choose correct Voltage (270 V for Toyota Camry Pack, 224 V for Toyota Prius Pack)
- iii. Select Current on Mode Control (right knob)
- iv. Use left knob to select desired charging current (0.5 A for slow charge)
- v. Push "OUTPUT ENABLE: Main Button"
- vi. Then pack will then start charging to the selected voltage
- vii. Once the voltage is reached the current will drop to zero
- viii. Turn off the Power Supply Charger and EVD



For KEPCO:

- i. Press Voltage key
- ii. Use Adjust key to choose correct Voltage (270 V for Toyota Camry Pack, 224 V for Toyota Prius Pack)
- iii. Press Current key
- iv. Use Adjust key to choose desired charging current (0.5 A for slow charge)
- v. Push "OUTPUT KEY" to begin charging
- vi. Then pack will then start charging to the selected voltage
- vii. Once the voltage is reached the current will drop to zero
- viii. Turn off the Power Supply Charger and EVd



1. Begin module matching for building packs.
2. Open "Inventory.xls"
3. In "Full Inventory" sheet, select all modules that failed the Power Test and transfer to the "Failed Power Test" sheet
4. Return to "Full Inventory" sheet, sort by Ah (column D)
5. Confirm formulas in Column M (28 module variance) and N (34 module variance) are correct
 - . Cell M2: $= (C2-C35)/AVERAGE(C2:C35)$
 - . Cell N2: $= (C2-C29)/AVERAGE(C2:C29)$
6. Populate those columns by clicking on the lower right-hand corner of cells M2 and N2
7. The cell values shown are the Ah variance of the module in that row and the corresponding number of modules below (for example, Cell M2 is the variance of modules in rows C2 to C35).
8. Choose a set of modules (for example, 28 for a Prius) that has an Ah variance of 1% or less.
9. Select all modules and transfer to a Prius Pack Template.
10. In the Prius Pack template sheet, sort by Voltage.
11. The blocking and sequencing order will populate on the right.
12. Assemble a complete battery pack.

Glossary Of Terms

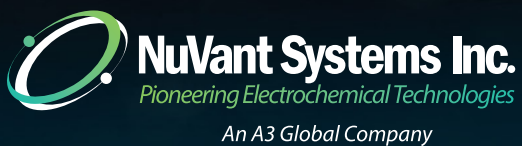
- **Amp (I)** – Unit for measurement of electric current as 1 coulomb/second.
- **Amp-hour capacity (Ah)** – Battery charge capacity. Defined as current output multiplied by time. A battery capable of outputting 2 Amp of current for 2 hours is a 4 Ah battery.
- **Anode** – The negative battery terminal during discharge. In a charged NiMH battery this is designated as MH, where M is a mixed metal and H is a hydrogen.
- **C-rate** – Discharge current is expressed as a C-rate in order to normalize against battery capacity, which varies between different batteries. A C-rate is a measure of the rate at which a battery is discharged relative to its maximum capacity. A 1C rate means that the discharge current will discharge the entire battery in 1 hour. For a 100 Ah battery, this equates to a discharge current of 100 Amps. A 5C rate for this battery is 500 Amps. C/2 is 50 Amps.
- **Cell** – The smallest form a battery can take. Comprised of a single anode/cathode pair, a separator, and an electrolyte.
- **Charge current** – The battery is charged at ~1C-rate (to roughly 70 percent SOC) before transitioning to lower C-rates (tapering eventually to $\leq C/10$)
- **Current** – Flow of electric charge measured in amps I or coulombs/second
- **Cut-off voltage** – Also called the end of discharge voltage or VEOD.
- **Cycle** – A single sequence of charge and discharge.
- **Cycle life** – An estimate of the number of cycles a battery can be subjected to before it no longer meets performance standards. Actual cycle life is dependent on factors such as temperature, DOD, cycling rate, etc.
- **Depth of discharge (% DOD)** – The percentage of battery capacity that has been discharged expressed as a percentage of maximum capacity. A discharge to at least 80 % DOD is referred to as a deep discharge.[1]
- **Electrolyte** – A chemical solution which conducts electric current by means of mobile ions. The NiMH battery electrolyte is potassium hydroxide in water (30%).
- **Energy density (Wh/L)** – Energy in the battery per unit volume. Characteristic of chemistry and packaging design. Determines battery size needed to achieve a given electric range for the vehicle.

Glossary Of Terms (Cont'd)


- **Float charge** – Constant current charging at a current low enough rate (C/10 or less) to avoid swelling due to oxygen evolution at the positive electrode.
- **Internal resistance (I)** – Resistance to flow of current within only the cell or module itself.
- **Maximum continuous discharge current** – The maximum current at which the battery can be discharged continuously. This limit is usually defined by the battery manufacturer in order to prevent excessive discharge rates that would damage the battery or reduce its capacity. Along with the maximum continuous power of the motor, this defines the top speed and acceleration of the vehicle.[1]
- **Maximum 30-sec discharge pulse current** – The maximum current at which the battery can be discharged for pulses of up to 30 seconds. This limit is usually defined by the battery manufacturer in order to prevent excessive discharge rates that would damage the battery or reduce its capacity. Along with the peak power of the electric motor, this defines the acceleration performance (0-60 mph time) of the vehicle. [1]
- **Memory effect** – An issue in NiMH and NiCd batteries observed after repetitive low DOD cycles in which the battery seems to “remember” this low DOD and behave as though it represents full discharge. This results in reversible loss of capacity due to increased resistance in the repeatedly uncycled material within the battery.
- **Module** – Several battery cells connected in series. The total voltage of the module is the sum of the individual cell voltages. The nominal module voltage for Toyota prismatic NiMH batteries is 7.2 V.
- **Nominal voltage** – The reference, or standard, voltage of the battery. The NiMH cell nominal voltage is 1.2 V.
- **Nominal energy (Wh)** – “energy capacity” or “Watt-hour capacity”. The total Watt-hours available when the battery is fully discharged at a given C-rate.[1]
- **Open-circuit voltage** – The voltage between the battery terminals with no load applied. The open-circuit voltage depends on the battery state of charge, increasing with state of charge.
- **Resistance (I)** – Material property, indicative of difficulty in passing charge through said material. Measured in ohms. Resistance is the inverse of conductance.


Glossary Of Terms (Cont'd)

- **Separator** – A material within the battery cell, between the cathode and the anode. It should allow charge to flow between the two poles of the battery, but never permit them to touch.
- **Specific Energy (Wh/kg)** – The nominal battery energy per unit mass, sometimes referred to as the gravimetric energy density. Specific energy is a characteristic of the battery chemistry and packaging. Along with the energy consumption of the vehicle, it determines the battery weight required to achieve a given electric range.[1]
- **Specific power (W/kg)** – The maximum available power per unit mass. Specific power is a characteristic of the battery chemistry and packaging. It determines the battery weight required to achieve a given performance target.
- **State of Charge (% SOC)** – An expression of the present battery capacity as a percentage of maximum capacity. SOC is generally calculated using current integration to determine the change in battery capacity over time.
- **Voltage (V)** – Electrical potential difference between two points (ex. terminals of battery). 1 volt will cause a current of 1 amp to flow through a resistance of 1 ohm



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