MAINTENANCE & SERVICE MANUAL

1996/7 SOLECTRIA FORCE NiMH

Electric 4-Door Sedan With Nickel Metal Hydride Batteries

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FORWARD

This manual has been prepared as a supplement to the service information contained in the Geo® Service Manual. Information contained in this manual is based on the latest product information available at the time of publication. The right is reserved to make changes at any time without notice.

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If additional service information is needed or to order replacement parts, please call 978-658-2231 or Toll-free 888-FIX-EV97 (888-349-3897), or fax 978-658-3224, Monday-Friday, 9 AM to 5 PM Eastern Time.

INTRODUCTION

This manual is written specifically for the 1996/7 Solectria Force NiMH electric vehicle. This section contains a description of the Solectria Force NiMH vehicle and general service guidelines. Please read **Standard Practices For Working On or Near High Voltage Systems** before servicing any vehicle. For operating information, refer to the Solectria Force NiMH Owner's Manual.

General Overview Of Solectria Force NiMH

The Solectria Force NiMH is very similar to Solectria's standard lead acid battery powered electric sedan ("The Solectria Force"), except it is equipped with a much larger energy storage system and additional battery monitoring equipment.

WEIGHT

The Solectria Force NiMH curb weight is about 2300 lb., slightly less than a lead acid battery powered Solectria Force at about 2500 lb.. The Solectria Force has a GVWR of 3200 lb. so, depending on options selected, the Solectria Force NiMH has a maximum payload or carrying capacity of approximately 900 pounds.

RANGE

If driven conservatively (i.e., using about 1 Amp-Hour of energy per mile) and with no use of accessories, the Solectria Force NiMH has a range of approximately 85 miles in mixed city/highway driving, and it will consume 85 Amp-Hours to travel the 85 miles. Range can be reduced by 25 to 30% if the car is driven hard.

During testing conducted by the EV America program in 1996, a Solectria Force NiMH traveled 105 miles at a constant 45 MPH; 85 miles in a combination of city & highway driving; and 71 miles at a constant 60 MPH.

BATTERY PACK

The energy storage device in a 1996/7 Solectria Force NiMH is a Nickel Metal Hydride battery pack consisting of 14 or 15 modules, providing a total nominal system voltage of either 180V, 185V, or 198V, depending on the specific battery in your vehicle.

Depending on the nominal voltage of your vehicle, different operating system voltage ranges will be observed, as follows:

For vehicles with a nominal voltage of **180V** DC, charging the batteries will bring the battery pack voltage up to approximately 219V DC. Discharging this same pack will drop the voltage down to about 150V DC. Applies to some model year 1997 vehicles.

For vehicles with a nominal voltage of **185V** DC, charging the batteries will bring the battery pack voltage up to approximately 230V DC. Discharging this same pack will drop the voltage down to about 154V DC. Applies to model year 1996 vehicles.

For vehicles with a nominal voltage of **198V** DC, charging the batteries will bring the battery pack voltage up to approximately 240V DC. Discharging this same pack will drop the voltage down to about 165V DC. Applies to some model year 1997 vehicles.

Note: Only Solectria authorized service personnel are permitted to service the NiMH batteries.

Vehicle Layout

The Solectria Force NiMH operates at a nominal battery voltage between 180V to 198V DC depending on the model year and specific battery type. The exact voltage level of the battery in any Force NiMH depends on the vehicle's state-of-charge. The battery modules are split between a front and a rear battery box, located under the hood in the motor compartment and in the trunk.

A high-amperage fuse is located in both front and rear battery boxes. The high voltage system is completely isolated from the vehicle chassis. The chassis is not electrically connected to the positive or negative side of the battery. The chassis is grounded to the AC ground whenever the vehicle is plugged in to be charged. In spite of these safety features, there is a remote possibility that a closed circuit could be formed as a result of a short circuit to the vehicle chassis.

Therefore, extreme care must be taken when handling any high voltage cables so as not to form a short circuit to the vehicle chassis or other potentially live wires.

The Solectria electric drive system includes a 3-phase AC induction drive motor that is coupled to an automatic transmission. An associated motor controller receives electric power from the self-contained battery pack. The motor controller is located in the motor compartment on top of the front battery box. The controller converts direct current (DC) electric energy to 3 phases of alternating current (AC) electric energy to operate the motor. The motor compartment also contains the air conditioning system (if provided) and the DC/DC converter which supplies 13.2V DC to the vehicle's accessories.

The battery pack is recharged from any 208-240V AC 60 Hz outlet with the BC3300 battery charger. The charger(s) is located in the trunk on the driver's side of the vehicle. Using the "Emergency Charging Adaptor" your Force NiMH can be charged with 110V AC in an emergency. It is very important that this option is used only for emergencies and not on a routine basis. If this option is used frequently, the life span of the battery pack will decrease. **All major components are electrically connected to the battery pack and have high voltage labels. Use due caution when servicing.**

High Voltage DC Systems (nominal voltage ranges from 180V to 198 V DC depending on specific battery in vehicle)

- 14 (or 15) NiMH Module Battery Pack
- DAQ Battery Management System
- High Voltage Fuse Box
- Amp-Hr Shunt
- AH100 Amp-Hr Meter Control Box
- UMOC 440 48kW motor controller
- AC GUXXX drive motor
- DC-DC Converter 750W, 13.2 V
- Heater/Defogger (front only)
- Heater Relay
- DC 30-250V BRS1 A/C Compressor Motor Controller
- A/C Compressor Motor
- BC3300 Charger
- High voltage wiring and connectors
    - 2-pin gray Deutsch connector
    - 3-pin gray Deutsch connector
    - 4-pin gray Deutsch connector
    - 2-pin red small Anderson connector
    - 2-pin gray large Anderson connector
    - 2-pin white Molex
    - 4-pin white Mini-Molex connector
    - 6-pin white International Molex connector

Low Voltage DC Systems (13.2 V DC)

- Low Voltage Fuse Box (OEM)
- Vacuum Pump
- Vacuum Switch
- IB Ignition Box
- Amp-Hr Meter Display
- Regenerative Braking Wiring
- Reverse Light Wiring
- Reverse Beeper (optional)
- DAQ Alarm Beeper and LED's
- Drive Motor Cooling Fan
- Drive Motor Temperature Sensor
- Front Battery Box Cooling Fans
- Rear Battery Box Cooling Fans
- Low Voltage Connectors
    - 1-pin black Packard
    - 2-pin black Packard connector
    - 3-pin black Packard connector
    - 4-pin black straight Packard connector
    - 4-pin black square Packard connector
    - slide terminal connector

High Voltage AC Systems (240 VAC) (These AC systems are "live" only when the vehicle is plugged in.)

- Charging Outlet
- BC3300 (input side)
- Preheat computer (optional)

Mechanical Systems

- Motor Speed Sensor
- Gearbox
- Speedometer Cable
- Drive Shafts
- A/C Compressor
- A/C Condenser
- A/C Accumulator
- A/C Pressure Switches
- A/C Thermostatic Switch

Component Layout

Each of the three major electronic components on the car—the UMOC, the BC3300 charger, and the DAQ battery management system—has a 9-pin serial port for electronic communication with a standard Personal Computer. By connecting to these components with a laptop computer, diagnostic information can be obtained and certain functional parameters of the units can be adjusted. (These procedures are performed by Authorized Solectria Service Personnel only.)

Wiring Conventions

The wiring follows certain conventions. In all DC circuit wiring, the red wire is always positive. If neither wire is red, the lighter colored wire is positive. In AC circuitry, the black wire is hot, and ground is green.

Connectors

Packard and small gray Anderson connectors are low voltage (12-V DC); Deutsch, red Anderson and large gray Anderson connectors are high voltage. Molex connectors can have both low and high voltage. Familiarize yourself with these connectors and their uses, as shown in the Figures in the Appendix.

Battery Type

This vehicle is equipped with either 14 or 15 Nickel Medal Hydride batteries. The nominal voltage of this vehicle is between 180V and 198V DC, depending on specific battery quantity and type. As a requirement of the battery warranty, both battery boxes have been sealed. Breaking these seals will void the warranty. These boxes should not be opened unless written consent is provided by Solectria Corporation. All battery maintenance and service must be performed by Solectria Corporation personnel or with the direct prior written authorization of Solectria Corporation.

Disabling the Vehicle

The Solectria Force NiMH is completely silent when it is not moving. The absence of noise or motors "running" does not indicate that the vehicle is disabled.

To secure the vehicle, the parking brake must be set by lifting the standard hand-operated brake lever between the front seats. Turn the Tri-power switch to the *Off* position. (This switch is located on the floor console.) This provides additional security by setting the motor controller to neutral. Turn the key *Off*, as you would in a conventional vehicle. Turning the key *Off* shuts the motor controller off, thereby disconnecting the motor, and disables most vehicle accessories. (Note: When the key is turned off and removed, the steering wheel will lock. To unlock the steering wheel, the key must be inserted and turned to the first *accessory* position).

The batteries in the Solectria Force NiMH are completely isolated from the vehicle chassis to prevent the possibility of electrical shock or current leakage to the vehicle. Unless two separate and isolated locations of the high voltage system at different electrical potential are touched simultaneously, there is no shock hazard. Nevertheless, exposed electrical cables should be treated with caution, and assumed to carry high voltage regardless of the gauge of wire.

To disconnect all high voltage electricity from all auxiliary systems (such as air conditioning, heat, and the 13.2 volt DC-DC converter) disconnect the single pole, red Anderson accessory connector located between the large gray Anderson connector to controller and the high voltage fuse box on the passenger side, front strut tower. With this connector unplugged and the motor controller turned off (using the ignition switch), the electrical power of the vehicle is isolated to the battery boxes, the controller, the DAQ, the charger, and the connectors. All high voltage and low voltage power to the vehicle is thus disabled and no systems or accessories on the vehicle will operate except the charger. (Note: The DAQ will still have high voltage inputs into it, but will not operate.) The charger can be disabled by disconnecting the single pole black Anderson connector under the fuse box. **Be aware that the onboard battery data acquisition system (DAQ) will be disabled if this red Anderson connector is unplugged. Do not charge the vehicle with the connector undone as the battery cooling fans will not operate.**

Although turning the key to the *Off* position will disable the motor controller, the controller can also be disconnected manually, if necessary, by disconnecting the large gray 2-pin connector located on the upper transmission support beam. Note that each Solectria component under the hood and in the trunk may store electricity in capacitors for some time even after being disconnected from the battery. Therefore, exposed conductors should always be treated with caution.

Battery boxes should not be opened and electrical cables should never be cut in order to make the vehicle "safe". Following the procedure above for disabling the vehicle should make the vehicle "safe" in virtually all circumstances. If there are indications that a battery module is smoldering or heating up after an accident or fire, cutting the interconnecting battery cable may eliminate the problem. However, cutting cables presents additional safety problems, and is not recommended by Solectria.

Vehicle fires should be sprayed with dry chemical or carbon dioxide foam (BC extinguishers).

Failure to follow these guidelines could lead to injuries.

COMPARISON OF A SOLECTRIA FORCE NiMH TO A SOLECTRIA FORCE POWERED BY LEAD ACID BATTERIES

If you are familiar with the layout and wiring of a Solectria Force, you will notice several differences when compared to the Solectria Force NiMH model.

The Solectria Force NiMH contains more wires, mostly to support the onboard battery thermal management system (cooling) and the DAQ (data acquisition) system.

The battery thermal management consists of cooling fans in both front and rear battery boxes. The fans are turned on and off by the DAQ system as necessary.

A battery heating system is not required in this vehicle as the battery performance is not adversely affected much by cold temperatures (particularly when compared to lead acid batteries, which exhibit a marked decrease in performance when cold).

In very cold weather, the car may be a little sluggish at first (similar to the performance in the ECONOMY setting) until the batteries warm up from driving. Range is not affected.

All power wires are run in separate harnesses away from cables carrying signals.

The nominal voltage of the Solectria Force NiMH is higher than the nominal voltage of a lead acid battery powered Solectria Force. The Solectria Force NiMH has a nominal system voltage of either 180V, 185V, or 198V, depending on the model year and specific battery in your vehicle.

The vehicle is equipped with a UMOC ("Universal MOtor Controller"). This type of controller will gradually limit the vehicle speed to 45 MPH when the motor is overheated. To avoid motor overheating, the "POWER" setting should be used only when needed.

The DC-DC converter provides 750 Watts, tuned to 13.2V DC output. (The DAQ and the battery cooling fans operate on the low DC voltage system.)

The drive system of a fully charged Solectria Force NiMH produces 40kW of power at the drive train (compared to 38kW for the Solectria Force).

Unlike the operation of the standard Solectria Force, activation of the cabin pre-heat system in the Solectria Force NiMH will restart the battery charger (in the lead acid cars, the cabin pre-heat system operates off float).

ADDITIONAL SERVICE INFORMATION

The Geo Metro Service Manual GMP/96-M and GPP/97 (not included with this manual but available through a local GEO dealership) should be consulted for service information on all parts of the Solectria Force NiMH, except for the following parts:

- Electric Drive Motor
- Solectria Automatic Transmission
- Batteries
- Solectria Electronic Components
- Heating and A/C System
- Solectria-installed wiring

GUIDELINES

1. The diagnostic connector for the Geo Metro is inoperative on the Solectria Force NiMH.

2. Replacement rear coil springs must be ordered from Solectria Corporation. They are not interchangeable with the standard springs.

3. For safety, always remove the ignition key from the steering column before performing service work on the car. Unplug the vehicle from the wall outlet when changing out electronic components. **Solectria electronic components are not user serviceable. Any attempt to service components will void all warrantees.**

4. Disconnect all Solectria components which are connected to the batteries if you attempt any fast charging of the batteries or if using a non-Solectria battery charger unless installed by Solectria. FAILURE TO DO SO WILL VOID ALL WARRANTIES.

5. **Lifting vehicle**: If using a lift, use factory recommended lifting points (i.e. reinforced sections of rocker panel). If using a floor jack, position jack under center of reinforced section of sub-frame just forward of front battery box. **Do not position jack directly under battery box, or attempt to lift vehicle from any point on the battery box.** Using a floor jack at the rear, position floor jack under center reinforced section of sub-frame between lower control arms. Position jack stands safely under vehicle and apply emergency brake, or chock wheels

6. **Towing**: Solectria recommends towing the vehicle with the front wheels on a dolly or carrying it on a flat bed truck. If you must tow with the front wheels on the ground, never leave the key in the ON position and the regen disable switch in the DRY position. **Regenerative breaking is enabled with the key ON and could cause the batteries to be severely overcharged**. Move the Regen switch to the SLIPPERY position.

7. **Washing**: Solectria does not recommend washing the vehicle in an automatic car wash.

STANDARD PRACTICES FOR WORKING ON OR NEAR HIGH VOLTAGE SYSTEMS

General Practices

1. Always use safety glasses. Remove all jewelry, such as watches, rings, bracelets, and necklaces.
2. No tools with exposed metal over 2" long are allowed in work area. Heat shrink metal tools over 2" long.
3. Keep all tools away from or below high voltage areas. Keep tools in a tool caddie, toolbox, pants pocket, or floor, not on vehicle surfaces.
4. Use a fender protector pad whenever working on the car.
5. Use only your right hand when working with high voltage. Put your left hand in your pocket. Never use jumper clips or touch anything to live plugs/batteries except when using a voltmeter.
6. Use a voltmeter to check voltages and polarity before making any connection of components. (Make sure voltmeter is not set to measure current, and leads are connected to correct positive and negative jacks on meter.)
7. Unplug the red, 1-pin Anderson accessory connector before removing a live device. (Leave a note on the amp-hr counter with the reading before disconnecting it, and check the meter display for power after disconnecting it.) Always unplug vehicle from wall outlet.
8. Do not use fuses to connect or disconnect accessories. If you are installing an air conditioner controller or fuse, for example, follow these steps:
   o check the amp-hr counter
   o disconnect 220 VAC charging cord (gas cap) or other charger
   o put a post-it note on the meter with the reading
   o disconnect the red 1-pin Anderson accessory connector
   o verify that the amp-hr counter has no power (no display)
   o install the controller or fuse
   o reattach the red connector
9. When servicing batteries, always isolate the battery pack from other components (including the DAQ) before removing any battery interconnects. Always work on only one battery terminal at a time. Never allow another person to touch any other part of the battery pack while you are working on it. **ONE PERSON ONLY!!**
10. Do not use any piece of test equipment unless you have been trained and you fully understand and accept its operation. UNDER NO CIRCUMSTANCES SHOULD TESTING RIGS OR USE OF THEM DISOBEY ANY OF THE ABOVE RULES!

BATTERY PACK DESCRIPTION/LOCATION

PHYSICAL

The battery pack consists of 14 or 15 battery modules wired in series. About 40% of the batteries are located in the front battery box, and the balance are in the rear battery box. The nominal voltage of the battery pack is either 180V, 185V, or 198V, depending on model year and the specific battery in your vehicle. ***Only Solectria authorized service personnel are allowed to open the battery boxes.***

SELF-DISCHARGE AND VEHICLE STORAGE

NiMH batteries tend to self discharge, and this effect is more pronounced in warm weather. The vehicle can go unplugged for up to 4 weeks without need of outside service (i.e., the car's battery charger will properly recharge the battery pack once the car is plugged in). If the car is unplugged for longer than 4 weeks, a Solectria authorized service technician must tune the batteries individually.

ENERGY CONSUMPTION

At a constant 45 MPH, energy usage is about 137 Watt-Hours *per mile* (per EV America).

The total *instantaneous* energy draw can be found as follows:

$$137 \frac{\text{Watt-hr}}{\text{mile}} \times 45 \frac{\text{mile}}{\text{hr}} = 6165 \text{ Watts}$$

Therefore, the car uses 6165 Watts to maintain a constant speed of 45 MPH.

OPERATING TEMPERATURE

Preferred operating temperature for the battery pack is from 25 to 30 degrees C (77 to 86 degrees F). NiMH batteries generally perform better in cooler weather (Solectria Force NiMH sedans in Michigan and Vermont operate successfully in -20 Degrees F weather).

While charging, the batteries give off heat so the thermal management (battery cooling) system should be more active especially towards end of charge cycle (i.e., fans will run more)

MECHANICAL VS. CHEMICAL REACTION

NiMH batteries exhibit a mechanical or columbic* reaction vs. a chemical reaction. No gassing occurs; just steam and a little white powder (potassium hydroxide) is produced if a problem occurs. (With the sophisticated support systems built into the battery charger and motor controller, battery charging or discharging will be terminated before this stage is reached.)

*Columbic describes the actual movement of electrons across the plates of the battery.

Data Acquisition System (DAQ)

The Battery Monitoring and Data Acquisition System is the Solectria DAQ. DAQ is located in the rear of the vehicle, mounted on the center top of the trunk just behind the rear seat. DAQ has no user serviceable parts, and has high voltage circuitry which can store energy even when the unit is unplugged. Do not attempt to open or repair this unit. Doing so will void the warranty and could lead to shock.

DAQ monitors module voltages and temperatures and controls the thermal management fans for each battery box. DAQ can also disable the charging or driving of the car if the battery is too hot or if the modules are thermally or electrically unbalanced. DAQ can also be used to collect and monitor battery performance data.

Whenever DAQ senses a critical battery condition, it issues an alarm. After 10 continuous seconds of the critical condition, the DAQ yellow *WARNING* light on the dash turns on and an intermittent beep sounds. If the critical condition persists for 20 continuous seconds, the yellow *WARNING* light stays on and the alarm sounds continuously. After 30 continuous seconds of a critical battery condition, DAQ turns on the red *DISABLE* light and disables the controller and the charger for as long as the critical condition remains. The *DISABLE* light will remain lit and a beep will sound every 30 seconds until the critical condition goes away.

The battery cooling fans are controlled by the DAQ system. They will go on and off automatically, first to equalize the temperatures in the two separate battery compartments, then to cool them simultaneously. Ambient temperature is also being monitored. Users should not be alarmed if they hear fans at any time--when the vehicle is being driven, is charging, or is idle, and regardless of whether it is plugged into an electrical outlet.

The BC3300 battery charger has its own temperature sensors. In the front battery box, the sensor is attached to battery #5; in the rear, it is at battery #8.

The DAQ monitors voltage at each individual module (there is an in-line 1/8 Amp fuse at each module). The DAQ also monitors the current through the Amp-Hour meter.

The second alarm is indicated by the same yellow LED and a continuous beeping for 10 seconds. If the user demands the same or more power from the battery pack, DAQ will disable the motor controller so that the vehicle cannot be driven.

Note: If the vehicle is disabled, it will not charge until the DAQ re-enables it. Leave the vehicle plugged in and eventually it will begin to charge as the module voltages and/or temperatures become more balanced.

TROUBLE SHOOTING WITH DAQ

What To Do If Problems Arise With The Battery Pack

If alarms are heard early in a discharge cycle, data should be collected and sent to Solectria for analysis and any maintenance deemed necessary. Contact Solectria to obtain the software that will permit you to log data from the vehicle. To collect data from the onboard DAQ, follow the steps outlined below.

1. Obtain a 13.2V DC - 110VAC inverter to power a laptop. (The inverter can be plugged into the cigarette lighter or contact Solectria for an adaptor that will plug into the DAQ unit.)

2. Connect the female end of a 9-pin cable (RS232 male/female) to "COM 1" in the laptop computer and connect the male end of the cable to the 9-pin serial port on the DAQ.

3. Turn on the computer. The Solectria Menu will be displayed.

4. Choose option #1 "A: Communicate with DAQ"

5. You should see rows of data scrolling up the screen. However, if the vehicle is idle or charging, a row of data could take as much as 5 minutes to appear on the screen. To ensure that the computer is receiving data from DAQ, run some vehicle accessories like the heat and air conditioning. This will cause DAQ to go into "discharge mode," in which data is stored at two-second intervals. With data scrolling every two seconds, you should be able to verify that data is being received.

6. The next step requires naming a file. To name a file that will contain the data about to be logged, press **ALT-L** (i.e., press the ALT key first and, while holding it down, press the "L" key.), then type the file name and its location. An example illustrating the file naming procedure follows.

File Naming Example
If a file is named for a vehicle own by American Electric Power on December 16 at 2 o'clock in the afternoon, the filed would be named

C:\AEP\ae16de14.daq

The meaning of each character is as follows.

C:- denotes the drive where the file is being saved;

\AEP- denotes the directory in which the file will be saved;

ae- are the two characters assigned to each vehicle;

de- are the first two characters of the month in which the file is created. For months that have the same second character as a previous month, the third character is used as shown in the following list of month abbreviations:

January	ja	July	jl
February	fe	August	au
March	ma	September	se
April	ap	October	oc
May	my	November	no
June	ju	December	de

14- denotes in military time, the hour in which the file was created. The hour should be approximated to the nearest 15 minutes.

.daq is the extension for the file. This is just used to indicate the type of file.

7. Press ENTER to complete the file naming procedure.

8. To close the file, press ALTXL and choose "yes". This will bring you back to the original menu (Solectria menu).

9. To send these data to Solectria, choose OPTION C and follow directions. You will need a formatted 1.44MB, 3.5" diskette.

Logging Period

The logging period should always cover a charge period, a drive cycle and a second charge period. A charge period is defined as the time from which the vehicle is plugged in until the "Charge Complete" light is illuminated. A driving period is defined as the time it takes to drive the vehicle until a second alarm warning occurs.

DRIVE MOTOR TRANSMISSION ASSEMBLY

MOTOR AND TRANSMISSION

The drive motor is a 3-phase AC induction motor, located in the rear of the motor compartment behind the battery box, and coupled to the transmission. The motor and transmission are removed from the vehicle as a unit. There are no user serviceable parts in the motor; however the bearings should be checked every 50,000 miles. Please notify Solectria when this mileage is reached.

The automatic transmission is a single-speed, gear reduction drive with an integral differential. Check the transmission oil level at every periodic maintenance.

Checking Transmission Oil Level

1. Turn ignition key off and set emergency brake. To check oil level look at the sight glass located on the driver's side of the transmission forward of the half shaft. The oil level should be visible in the glass. The vehicle must be level to get an accurate reading.

2. If the sight glass is not half full, it is necessary to add transmission oil. To add transmission oil, remove filler plug. Filler plug is located at the top of the transmission just below the vent.

3. Using a **clean** funnel add oil until fluid level fills half the sight glass. Use Dextron III ATF oil. Reinstall filler plug.

Changing Transmission Oil

After the first 6,000 miles of operation and every two years or 12,000 miles thereafter, replace the transmission oil.

It is preferable to drive the vehicle first to warm the gearbox. Raise the vehicle following the lifting instructions under **Additional Service Information**.

1. Turn ignition key off and set emergency brake. The belly pan must be removed in order to access the transmission drain plug. Remove the two 5/16 bolts at the belly pan bracket. Snip the two tie-wraps at each forward corner. Remove the Phillips screw at the center bottom bracket on the front bumper. Slide the belly pan backward and out while pulling down on the lower bumper lip.

2. Put a drain pan under the transmission, then remove the drain plug located on the bottom of the transmission to drain the oil.

3. Clean drain plug. Solectria recommends using LOCKTITE Pneumatic Hydraulic Seal 545 then re-install the drain plug. Torque to 15 ft. lb.. DO NOT OVERTIGHTEN. Allow sealer to set approximately 15 minutes before adding oil.

4. To add transmission oil, remove filler plug. Filler plug is located at the top of the transmission just below the vent. Using a clean funnel add approximately 1 quart of Dextron III ATF.

NOTE

Disregard the instructions in the owner's manual regarding use of any other type of oil in the transmission.

6. Reinstall filler plug and check for leaks. Reinstall belly pan with new tie-wraps.

Replacement of Drive Motor Transmission Assembly

1. Turn ignition key off and apply emergency brake.

2. Loosen the axle nuts at the front wheels. Raise the front of vehicle and support on stands so that the front suspension hangs free.

3. Remove the belly pan.

4. Drain the transmission oil. **See Changing Transmission Oil.**

5. Remove ball joint pinch bolts.

6. Loosen sway bar link retaining nuts from lower control arms.

7. Pull lower ball joints from steering knuckles.

8. Pry drive axles out of transmission using a large screw driver taking care to avoid damaging the seals.

9. Pull steering knuckles away from axles, and remove the axles from the vehicle.

10. Pull back the boot from the speedometer cable end where it enters the transmission: it is above the lower support beam at the bottom of the firewall. Remove the clip and pull the cable straight out.

11. Remove the vent tube from the hole in the frame rail under the master cylinder.

12. Remove the controller from the vehicle as outlined in the motor controller removal procedure.

13. Remove the gray motor speed sensor cable from the firewall by detaching the harness clamps located along firewall. Coil the wire harness and lay it on top of motor to keep it out of the way- it will be removed with the motor. A tie-wrap or rubber band can help make this procedure easier.

14. Unplug the two 13.2V wire harness connectors at the firewall from the motor cooling fan and the motor temperature sensor.

16. To remove the upper support beam, remove the two 1/4 - 20 bolts holding the remaining half of the large gray Anderson connector. Remove the center through bolt at the rubber motor mount. Remove two 3/8 bolts from each end of the beam. Remove the beam and the motor mount as a unit. The motor/transmission can lean on the front battery box.

17. Remove the two Phillips screws attaching the motor cooling fan housing to the motor and carefully tilt it up and off the motor. (The drive train may not clear the fuse box with the fan on.)

18. Re-insert the through bolt at the upper motor mount bracket and attach a suitable lifting device to it. Put slight tension on it. (Lifting fixture may be made or purchased from Solectria).

19. Underneath, remove the two 1/2 x 3 3/4 bolts connecting the lower support beam to the transmission "bat wings". Now carefully lift the drive train out of the vehicle.

Motor/Transmission Installation

Installation is the reverse of removal. The spacers on each lower through bolt are 3/4 inch thick. These spacers may be a stack of 6 washers or 3/4 inch round aluminum spacers.

Be sure to clean, seal and tighten the transmission drain plug before adding fluid (1 quart capacity).

When inserting the speedometer cable, align the tab on the speedometer cable end with slot in the speedometer drive gear. Push the speedometer cable in and insert the securing clip in the slot of the cable end. Do not secure the clip over the edge of the cable end. If this occurs it will bind and break the cable.

ELECTRONIC COMPONENTS

MOTOR CONTROLLER

The motor controller is located in the motor compartment on top of the front battery box. There are no user serviceable parts in the motor controller. The motor controller is air cooled therefore the cooling fans should be kept free of debris. ***See Appendix B for diagram.***

Removing Motor Controller

1. Turn ignition key off and apply emergency brake.

2. Disconnect the high voltage input to motor controller (large gray Anderson connector).

3. Disconnect regenerative braking signal connector (4-pin, 2-wire black Packard connector).

4. Snip the two tie-wraps on metal mesh over motor power connector (red, white and blue) and unzip mesh. Remove the tie-wraps at the Tri-power output connector to motor and disconnect multi-colored connectors.

5. Snip the tie-wraps at the harness junctions near the driver's side strut tower and disconnect the 25-pin (ignition box) and 9-pin (motor speed sensor) connectors. The tie-wrap fixed to the side of the strut tower is reusable. Undo the black 2-pin Packard connector (13.2V input).

6. Remove the 1/4 - 20 nuts and washers that secure controller to rubber mounts and lift it off the mounts.

Installing Motor Controller

Installation is the reverse of removal. Be sure to replace any tie-wraps that were cut off. **Be sure the ignition key is still off and park brake is set.**

DC-DC CONVERTER

The DC-DC converter converts 180V to 198V DC to 13.2V DC for the vehicle's 13.2V accessories (horn, radio, wipers, etc.). It is located in the motor compartment on the driver's side behind the headlight assembly. Other than the external fuse there are no user serviceable parts.

Never charge the vehicle with the DC-DC converter unplugged as the battery cooling fans will not operate.

DC-DC Converter Removal

1. Turn ignition key off, set emergency brake, and make certain vehicle is unplugged from the wall charging outlet.

2. Disconnect 2-pin gray Anderson connector (13.2 volt).

3. Disconnect 3-pin, 2-wire gray Deutsch connector from the high voltage DC input.

4. Remove the 3/8" nut holding the end attached to the top cross member and the 6 mm bolt attaching the bracket to the front hood panel.

5. Remove component from vehicle.

DC-DC Converter Installation

Installation is the reverse of removal. Be sure replacement unit is correct voltage for vehicle.

Note: To avoid spark, connect high voltage Deutsch connector before the 13.2V gray Anderson connector. Be sure headlights and other 13.2V accessories are turned *Off*, and ignition key is *Off*.

AMP-HOUR COUNTER

The Amp-hour counter measures and integrates the current across the shunt in the high voltage fuse box when discharging and charging the battery pack. It consists of two modules connected by a 20-pin cable. The Amp-hour display is integral with the instrument cluster/speedometer assembly. The Amp-hour control box is located just left of the steering column over the lower dash panel. The control box and display may be removed from the vehicle individually. The Amp-hour control box and display are not user serviceable.

IMPORTANT WARNING!

Disconnect the red one-pin Anderson accessory connector which is located [redacted] between the fuse box and the large grey Anderson connector to the controller before unplugging the amp-hr counter or the harness. This will cause the Amp-Hour counter to go blank. Doing so will also protect the Amp-Hour counter from a power surge when the Amp-Hour counter is plugged back in. Make a note of the Amp-Hour counter reading before disconnecting so that when counter is re-connected the vehicle operator will know the battery state of charge (i.e., meter will reset

to 0.00, so without a note, the operator has no way of knowing the true battery state of charge - see below for more details). All electrical components will not operate now except for the battery charger. (220V AC charging connection should be disconnected from the vehicle.)

Upon reconnecting the 1-pin red Anderson accessory connector, the Amp-hour counter will reset to zero. Please note that this does not indicate the actual state-of-charge. When charging vehicle, the Amp-Hour counter may read negative numbers in excess of actual overcharge. The Amp-Hour counter will reset itself as soon as it senses a current draw after charging.

If the Amp-hr counter reads 100.00 or 99.99 (instead of 00.00) after re-connecting the 1-pin red Anderson accessory connector, disconnect and wait at least 10 seconds before reconnecting.

<u>Amp-Hour display removal</u>

1. Turn the ignition key off and unplug the vehicle from the wall.
2. Disconnect the red one-pin Anderson Service Disconnect under the hood. **See "IMPORTANT WARNING!" immediately above.**
3. Remove three Phillips screws from the driver's side lower dash panel. Pull out on the upper left corner of the panel only, then slide it left to clear the small tab on the right.
4. Pull the white foam absorber straight out from the knee bolster plate (there are two push clips holding it). Undo the four Phillips screws and remove the plate. The Amp-Hour control box is now visible to the left of the steering column (the ignition box is on the right).
5. Working from underneath the dashboard, disconnect the flat ribbon 20-pin connector from the Amp-Hour box. Also disconnect the 6-pin international Molex "Y" connectors from the vehicle harness and the Amp-Hour box.
6. Remove the (2) Torx T-40 bolts holding up the steering column. Allow the steering column to hang free but do not force it down. Remove the small left and right lower instrument panel covers, just on either side of the steering column (one screw each). Remove the 4 medium length screws holding the instrument cluster trim panel.
7. Remove the 4 screws securing the instrument cluster assembly. (The (2) top shorter screws are holding the white tabs on each side.) Reach behind and squeeze the tab holding the speedometer cable to the speedometer head. Pull it straight off. Remove the 3 multi-pin electrical connections also in back of the instrument cluster.
8. Pull the instrument cluster out of the vehicle complete with wires to the Amp-Hour Meter display and Ammeter/voltmeter, carefully feeding both harnesses through the instrument cluster opening.
9. Squeeze the 7 black tabs holding the cover on to the cluster assembly and pull the cover straight off. Undo the (2) small and (2) large Phillips screws holding the speedometer head assembly at the back of the cluster. Transfer the speedometer head and the ammeter/voltmeter assembly to the new cluster assembly.

10. Installation is the reverse of removal. Please take extreme care not to pull on the voltmeter/ammeter and Amp-Hour harness. Be sure the red-Anderson connector under the hood is still unplugged, the key is off, and the vehicle is unplugged from the wall.

Amp-Hour box removal

1. Turn the ignition key off and set emergency brake. Unplug vehicle from the wall. **Unplug the single pole red Anderson accessory connector**. ***See Important Warning above.***
2. Remove three Phillips screws from the driver's side lower dash panel. Pull out on the upper left corner of the panel only, then slide it left to clear the small tab on the right.
3. Pull the white foam absorber straight out from the knee bolster plate (there are two push clips holding it). Undo the four Phillips screws and remove the plate. The Amp-hour control box is now visible to the left of the steering column (the ignition box is on the right).
4. Release the Amp-Hour box from its position (it is attached with Velcro) and pull it out just enough to carefully unplug the 20-pin connector which goes to the Amp-hour display, the 6-pin Molex connector which goes to the fuse box, and the 4-pin connector to the DAQ.

Installation of Amp-Hour Counter

Installation is the reverse of removal. Be sure the red Anderson accessory connector under the hood is still unplugged, the key is off, and the vehicle is unplugged from the wall. **It is very important that the single pole red Anderson Connector is connected last.**

BATTERY CHARGER

The vehicle is equipped with one 3.3 kW battery charger. The battery charger is located in the rear left corner of the truck.

IMPORTANT WARNING!

Disconnect all Solectria components which are connected to the batteries if you attempt any fast charging of the batteries. FAILURE TO DO SO WILL VOID ALL WARRANTIES. Contact Solectria if you are unsure which components may be affected.

3.3 kW Battery Charger Removal

1. Turn ignition key off and set emergency brake. Unplug vehicle from the wall outlet.
2. Pull back of rear seat forward.
3. Pull driver's side carpet aside and remove foam from trunk floor.
4. Unscrew the 18-pin cable that goes to the LED box.

5. Remove four 1/4 - 20 nuts at each corner of the charger, lift charger off of its rubber mounts and place it on the battery box cover. Locate and disconnect the remaining two electrical connections tucked behind the side-wall carpet:
- AC input: large black 3 prong plug.
- DC output: large red Anderson connector.
6. Remove charger. Leave interface box as is inside vehicle.

Installation of 3.3 kW Battery Charger

Installation is the reverse of removal. Be sure the vehicle is unplugged from the wall.

MOTOR SPEED SENSOR

The motor speed sensor is located on the rear of the motor under the motor end plate. It provides the motor controller feedback on the direction and speed of the motor. To access the sensor, the motor cooling fan and shroud must be removed.

Testing Motor Sensor

1. Turn the key off and set the emergency brake.
2. Jack front of the vehicle and place it on jack stands.
3. Turn vehicle on, select the normal driving setting, and accelerate slowly up to maximum speed. Listen for motor vibrations or shudders: if a motor sensor is malfunctioning, it will shudder sharply at a particular speed (usually a high speed). DO NOT TO CONFUSE THIS WITH OUT OF BALANCE TIRES.
4. If the sensor is functioning properly, turn off the key, lower the vehicle, and test drive for the same symptoms. If adjustment or replacement is required proceed as follows:

Motor Speed Sensor Adjustment/Replacement

1. Turn the ignition key off and set the emergency brake.
2. Disconnect the 9-pin connector between the controller and speed sensor . It is located near the driver's side strut tower.
3. Disconnect the DC input to controller (large gray Anderson Connector). Loosen the remaining half to the connector from the upper cross beam and place out of the way.
4. To remove the upper cross beam, remove the through bolt at the upper mount, then undo 2 bolts from each end of the beam and remove it from the vehicle. You will not need to support the motor, it can lean on the battery box.
5. Remove the 2 nuts holding the fuse box to the passenger side upper beam bracket and pull the fuse box down and forward out of the way. Separate the motor cooling fan harness from the motor temperature sensor harness at the firewall.
6. Remove the 2 Philips machine screws (SAE) securing the fan housing to the motor and remove the fan and housing by tilting it up as you slide and lift it off the motor. (The shield on the motor fans does not need to be removed.)
7. Remove the 3 small M4 (metric) screws from the motor cover plate. Carefully cut the seal between the plate and the motor with a razor blade while gently prying the plate

with a small slotted screwdriver. Be extra careful near the sensor cable exit point from motor.

8. Inspect encoder wheel for dirt and sensor wear marks. Replace if damaged.
9. **To adjust:** Carefully remove silicone from inner slotted screw-head at circuit board and adjust as outlined later in this procedure.
10. **To replace:** Cut the small zip tie securing the gray harness to the holder and remove the small Phillips screw (metric) securing the holder and ground wire to the motor.
11. Remove the silicone from the slotted screws at the circuit board. Loosen the outer screw almost all the way- there is a spacer between the board and the motor under this screw. Loosen the inner screw(metric) all the way while reaching behind the board to catch the small spring. Now, remove the outer screw all the way being careful to catch the spacer/ washer behind it. Please do not lose any hardware.
12. Snip the two black temperature sensor wires close to the board (1/8 - 1/4 inch), then undo the harness clamps at the firewall and remove the sensor from the vehicle.

Motor Speed Sensor Installation

1. Install a lock washer and a flat washer on outer shorter screw (metric) and insert through circuit board and 0.025 spacer/washer under board. Hold spacer on back of board while starting screw into motor two turns. Place spring behind board and hold it while inserting inner longer screw (metric) and flat washer through board and spring and into motor. Tighten down outer shorter screw all the way.
2. **To adjust**: Line up the speed sensor plate retaining screws parallel to the inner edge of the circuit board by turning the drive wheels slightly. Using a plastic non-abrasive feeler gauge to avoid damaging the sensor wheel, adjust inner screw so that the gap between the center inner edge of the board itself and the sensor plate is 0.130 inches. Insert gauge only 1/8 inch from edge of board. Do not lift board with gauge.
3. Put a 1/8 inch dab of silicone sealant on each screw head and along outer edge of board to prevent movement.
4. Re-solder the temperature sensor wires if they were cut upon removal (they are not polarized). Be careful not to overheat the terminals or they may unsolder from the board. Install small harness holder and ground wire against the motor and tie-wrap harness to holder.
5. Apply a narrow bead of silicone sealant around the motor cover plate rim and install the cover plate. Be sure harness is seated in its notch.
6. The rest of the procedure is the reverse of removal. Be sure to install 2 tie-wraps at the red, white and blue connector before reinstalling metal "zip-on" mesh. Run the test procedure and road test the vehicle to verify that the repair is complete.

AIR CONDITIONING CONTROLLER

The Air Conditioner (A/C) Controller is both a switching device and a voltage converter for the A/C compressor motor. It is located on the passenger side of the motor compartment near the fuse box. Other than the external fuse, there are no user serviceable parts. Before checking the fuse, disconnect red one-pin Anderson connector

near high voltage fuse box and unplug the vehicle from the wall if charging. Write down amp-hour counter number before disconnecting. When finished checking or replacing fuse, plug in the single pole red connector.

A/C Controller removal

1. Turn ignition key off and set emergency brake. Disconnect the red single pole Anderson accessory connector between the fuse box and large gray Anderson connector to the motor controller. Make a note of the Amp-hour meter reading before disconnecting (the amp-hour meter will go blank).
2. Disconnect the high voltage input wires (3-pin grey connector labeled A/C), the output wire, the signal wire (red wire with single-pin black connector), and black ground wire with eyelet.
3. Remove the two Phillips machine screws which hold the controller to the passenger side upper beam bracket and remove it from the vehicle.

A/C Controller installation

Installation is the reverse of removal. Re-connect the red single pole Anderson connector. If amp-hour counter reads 99 or 100, disconnect the red Anderson connector, wait 10 seconds and try again.

IGNITION BOX

The ignition box is an electronic device which turns the controller on with the key and provides other safety interlocks. It is located just right of the steering column over the lower dash panel.

Ignition Box removal

1. Turn ignition key off and set emergency brake. Unplug vehicle from the wall. Be sure parking brake is set.
2. Remove three Phillips screws from the driver's side lower dash panel. Pull out on the upper left corner of the panel only, then slide it left to clear the small tab on the right top corner.
3. Pull the white foam absorber straight out from the knee bolster plate (there are two push clips holding it). Undo the four Phillips screws and remove the plate. The ignition box is now visible to the right of the steering column (the Amp-Hour box is on the left).
4. Release the ignition box from its position (it's attached with Velcro) and pull it out just enough to unplug the following connections:

No particular order required

a) Regenerative Brake Disable: 2-pin female Amp connector-2 yellow wires.
b) Charge Interlock: 4-pin female Molex connectors- 2 wires, white and blue.
c) Power Saver signal: 3-pin female Amp connector to Tri-power switch, 3 wire-red, green and black in gray jacket.

d) Forward Reverse signal to Tri-power switch: 3-pin male international Molex-3 wire red, green and black in gray jacket.
e) Neutral Interlock signal to Tri-power switch: 2-pin female international Molex - orange and purple wires.
f) 13.2V ignition supply: round single-pin male connector- white wire.
g) Ground wire: male spade connector, gray wire.
h) Controller cable: 25-pin male D-sub connector.
i) Pot box: 10-pin male header connector.

Ignition Box Installation
Installation is the reverse of removal.

VACUUM PUMP AND RESERVOIR

Because there is no vacuum created by the electric motor, a 13.2V vacuum pump is utilized to supply vacuum to the brake booster. It is located beside the driver's side headlight. A vacuum reservoir is also used in the system. It is located under the hood at the passenger side inner fender.

Vacuum Pump Removal
The vacuum pump is removed complete with the bracket. To remove the vacuum pump assembly, separate the 1/4 - 20 bolt attached to the headlight housing and the 6 mm nut on the top of the assembly. Unplug the 13.2V wires and the vacuum hose, and slide it out over the front bumper.

Vacuum Pump Installation
Installation is the reverse of removal.

TRI-POWER SWITCH

The Tri-power switch replaced the gear-shift lever. It is located on the center console.

Tri-Power Switch Removal
1. Turn key off and set emergency brake.
2. Unscrew the 6 screws securing the console. Lift out the console.
3. Remove the four 1/4" nuts holding the Tri-power switch bracket to the floor and move it out in order to give yourself space to disconnect the following:

- 2-pin male mini-Molex (black wires) to Regen. relay (reverse lights)
- 3-pin female international Molex (red, black, and white with red stripe wires) to ignition box (forward/reverse signal)
- 2-wire, 3-pin male Amp connector (black and red wires) to ignition box (power saver signal)

- 2-pin male international Molex (purple wires) to ignition box (neutral interlock)

4. Unplug the 2-wire connector from the regen disable switch (yellow wires).
5. Follow the wires from the heat switch and disconnect:

- orange wire to heater relay
- gray ground eyelet under Torx screw at front of console plate
- red wire to heater fan "T" tap behind glove box

6. Remove unit from vehicle.

Tri-Power Switch Installation

Installation is the reverse of removal. Be sure the key is off. Also be sure to include all the wires that were under the same ground screw as the heater switch.

ACCESSORIES

CABIN PREHEATING SYSTEM

The Cabin Preheat system is programmed to heat the cabin before the driver starts a trip. The Cabin Preheat system uses power from the battery pack, however it only works when the charger(s) are plugged into wall outlet. The charger is typically able to replenish or supply enough energy used by the preheat system. ***See Solectria Force NiMH Owner's Manual for operation and programming***.

Cabin Preheat removal

1. Turn ignition key off and set emergency brake. Unplug vehicle from wall outlet. Remove three Phillips screws from the driver's side lower dash panel. Pull out on the upper left corner of the panel only, then slide it left to clear the small tab on the right.
2. Pull the white foam absorber straight out from the knee bolster plate (there are two push clips holding it). Undo the four Phillips screws and remove the plate.
3. Reach up and unscrew the 2 plastic thumb screws from the back of the cabin pre-heat computer.
4. Pull out the computer just enough to unplug the two connectors:

- 220VAC supply: 2-pin male international Molex (black and white wires).
- Signal to heater relay: 2-pin male amp connector (purple and red/white wires).

Cabin Preheat installation

Installation is the reverse of removal.

APPENDIX A - INSTRUCTIONS FOR MONITORING A SOLECTRIA BC3300

These instructions assume that you have the monitoring program (mon.exe) installed in a directory called BC3300 in the c drive of a your computer.

Make sure that the charger is plugged in. If the any of the five lights located in the charger interface box are not lit check that the plug has voltage in the range of 200 to 240 VAC. If none of the lights turn on after checking for the input voltage, the charger has to be sent to Solectria to be diagnosed; the monitoring program will not work in this case.

To run the monitoring program follow these steps:

1. With the charger plugged in, connect a 9 pin cable from COM 1 in the computer to the 9 pin connector on the charger.
2. Turn the computer on, it should display the c prompt (c:\)
3. Type cd bc3300 *enter*. This will change the directory to the BC 3300 directory.
4. Type mon *enter*. This will run the program. At this point you should see a screen like this one:

```
+-------------------------------------------------------------------------------------+
| NLG  - monitor program on COM1:  Version 1.61, Solectria Corp.  (C) 1996            |
+-------------------------------------------------------------------------------------+
|status NLG4: |     0      |Um_pk[V]: 299.4 |Tpstg[°C]: 35.71 |power [%]: 100.00      |
|             |            |                |                 |                       |
|Imains[Amp]:   0.000      |Umeff[V]: 206.13 |Tbat1[°C]: 26.61 |Pprim [W]:     0       |
|                          |                 |Tbat2[°C]: 26.25 |F_out[Hz]:     0       |
|Ibatt [Amp]:   0.000      |Ubatt[V]: 219.26 |Tbatt[°C]: 26.61 |Psec  [W]:     0       |
+-------------------------------------------------------------------------------------+
| section: 5|  sect.1   |sect.2   | sect.3   | sect.4 | sect.5 | sum 1-5|  total  |  calc._ |
+-----------+-----------+---------+----------+--------+--------+--------+---------+---------+
|time  [min] |  235.7  |  30.0   |  60.0    |  65.8  |  20.0  | 411.5  |  504.5|  0.0    |
+-----------+-------+-------------+----------+--------+--------+--------+---------+---------+
|charge [Ah ]|  44.7   |  5.0    |  5.0     |  5.5   |  0.0   | 60.2   |  85.0   |  0.0    |
+-----------+-----------+---------+----------+--------+--------+--------+---------+---------+
|energy [Wh]|  10640  |  1219   |  1212    |  1335  |   0    | 14406  |  19191  |         |
+-----------+-----------+---------+----------+--------+--------+--------+---------+---------+
|UB min. [V]| 198.82  |  221.17 | 220.60   | 221.10 | 219.24 | 198.82 |   1.71  |
+-----------+-----------+---------+----------+--------+--------+--------+---------+---------| press
|UB max. [V]| 221.59  |  222.24 | 221.43   | 222.84 | 222.19 | 222.84 |  222.84 |  <F1>
+-------------+---------+---------+---------+--------+--------+--------+---------+---------|for help
|TB min.[°C]|  17.97  |  27.96  |  29.80   |  27.68 |  26.61 |  17.97 |  175.00 |
+-------------+---------+---------+---------+-------+--------+--------+---------+---------| press
|TB max.[°C]|  28.03  |  31.32  |  34.96   |  33.35 |  27.75 |  34.96 |  48.31  |<F10>
+-------------------------------------------------------------------------------------+to quit
```

The parameter the you need the most to pin-point a problem with a BC3300 is Status displayed on the top left of the screen. Common values and their meaning are listed below:

3- Overvoltage from AC (220 VAC)
5- Overvoltage (fuse blown or missing connection)
9- Fault on temp sensor #1 (white & black wires on box), FRONT BATTERY BOX
17- Fault on temp sensor #2 (gray & black wires on box), REAR BATTERY BOX
33- Battery over temperature
65- Maximum DC Kw-h limit exceeded
129- Maximum Amp-limit exceeded
257- Maximum time limit exceeded