APPENDIX B

Troubleshooting Guide

1996/7 Solectria Force NiMH

Nominal System Voltage: 180V, 185V, or 198V

Batteries: Nickel Metal Hydride

Battery Charger: Solectria BC3300
208-240V AC input, 3.3kW DC output

Section I: Problem Solving

Section II: Systems Diagnosis

Section I: Problem Solving

SYMPTOM	CHECK FOR	PROCEDURE
Vehicle does not drive.	Vehicle is plugged in.	Unplug it.
	Range-Power selector is set to one of the forward or reverse settings when the ignition key is turned on.	Set the Range-Power selector to the "OFF" setting and turn the ignition key off then on again (2 clicks). Now set the Range-Power selector to one of the forward settings, or to the reverse setting, and try driving the vehicle again. Be sure to push accelerator pedal down at least half way before car will start to move. (When the ignition key is turned on, the vehicle will power up only if the Range-Power selector is at the OFF setting.)
	13.2V system is not working. Are lights out? Horn not working?	*See "13.2V accessories don't work" below.*
	DAQ has disabled the vehicle due to excessive battery temperatures or voltage problems, etc.	Refer to "Troubleshooting with DAQ" to check for temperature and voltage conditions..
If the vehicle does not move or stops abruptly while driving	Main fuse in front or rear battery box may have blown or one or more battery modules are open.	Leaving the key on, check main battery voltage at the gray Anderson connector to the motor controller. If lower than 154V, refer to "Troubleshooting with DAQ" to check for open fuses or modules. This will be possible only if the DC-DC converter is still operational.
	Ignition circuit. Does ignition circuit under dash	*See "Checking ignition circuit" in Section II.*

	"click" when key is turned? (Click sound is normal.)	
	Motor Controller. Does motor controller "clunk" on? (Clunk sound is normal.)	*See "Checking Motor and Controller" in Section II.*
	Motor speed sensor out of adjustment or failed.	*See "Checking Motor and Controller" in Section II first, then see "Motor Speed Sensor Adjustment" in text.*

SYMPTOM	CHECK FOR	PROCEDURE
Vehicle is sluggish, or Alarms are on	Is Amp-hour meter reading over 70-80 Ah? If so, batteries are running low on energy and need to be recharged.	The car may not drive if amp-hour meter reads over 70-80 Ah. The battery pack should be fully recharged at this time (until the "Charge Complete" LED on the dash comes on). If necessary, the vehicle may be driven following a partial recharge, but it should be fully recharged at the earliest opportunity for maximum battery performance and life.
	Is Range-Power selector is set to ECON?	Select to NORMAL or POWER setting for more power (and less range).
	Motor overheated? Controller will limit speed to 45 mph until the motor cools down.	Drive in ECON or NORMAL.
	Is vehicle in "limp home" mode due to low, weak, or damaged battery pack, or faulty battery interconnects?	Set the Range-Power selector to "NORMAL" and push the accelerator pedal all the way down. Using the optional dash mounted voltmeter (or a separate voltmeter – *See "How to Measure Voltage" section in text*), check to see that the voltage does not drop under 154V at any time when the amp-hour meter is between 00.00 and 60.00 amp-hours. If it does, see "Troubleshooting with DAQ"
Vehicle is jerking on acceleration	Faulty controller or faulty 25-pin cable.	*See "Checking Motor and Controller" in Section II.*
	Motor speed sensor out of adjustment.	See *"Motor Speed Sensor" in text.*
	Faulty accelerator pot-box signal.	If hesitation occurs at a particular point in the accelerator pedal travel, or seems to be affected by bumps, then the problem may be in the pot-box. Call Solectria for details on checking pot box resistance.

SYMPTOM	CHECK FOR	PROCEDURE
12-volt accessories don't work	Ignition key is not in "ON" position.	Turn ignition key on (2 clicks).
	DC-DC Converter is in brown-out mode.	Turn off ignition key and disconnect input wires to the DC-DC Converter (small gray Deutsch connector with green and white wires), then reconnect input wires to DC-DC; check output on 2-pin gray Anderson connector for 13.2V (red and black wires), or turn key on and turn on the headlights.
	Blown fuse at DC fuse box or at DC-DC converter.	Check fuses at DC fuse box and at the DC-DC converter as follows. 1. Turn ignition key to off position. 2. Disconnect the small gray Deutsch connector with green and white wires. 3. Take out the fuse from on top of the DC-DC Converter, and test it with a continuity meter. 4. Replace the fuse if it is blown with the same value and type of fuse, or re-install the original if it is not blown. 5. Take out the DC-DC Converter fuse from the High-Voltage DC fuse box and test it with a continuity meter. 6. Same as step 4. 7. Re-connect the small gray Deutsch connector. 8. Try turning headlights on. 9. See "*Checking DC -DC Converter*" *in Section II.*
	Main fuse in front or rear battery box is blown or battery module is open.	Check for approximately 180V at controller. See "*Vehicle does not drive*" *in Section I of this Troubleshooting Guide.*

SYMPTOM	CHECK FOR	PROCEDURE
Air Conditioning (A/C) not working	No 13.2V signal to A/C controller.	**WARNING! STAY CLEAR OF AIR CONDITIONING MOTOR WHEN DIAGNOSING.** 1. Unplug single red wire from A/C controller. Turn on ignition, fan, and A/C, and check for +13.2V between harness wire and chassis ground. 2. If no +13.2V is present, reconnect the wire and unplug the molded connector at the pressure switch mounted on the receiver/drier. Connect the wires with a jumper or pliers to temporarily bypass the switch and if the A/C motor starts, then the system refrigerant is low. Have it tested, evacuated and recharged with 24 oz. R134a refrigerant. 3. If the compressor does not run with the pressure switch bypassed, then check the relays at the 13.2V fuse box, located under the hood behind the glovebox on the evaporator.
	Blown fuses and/or blown A/C controller	1. Turn ignition key off and unplug high voltage input to A/C controller. Check for approximately 185V (between the white and green wires). If no 185V, check A/C fuse at main DC fuse box. 2. If ~185V is found, turn ignition key off, re-connect high voltage input, and undo the connector between the A/C motor controller and the A/C motor. Turn ignition key on and check controller output to A/C motor for minimum of 40-50V DC. 3. If there is no voltage present at the controller output, unplug the high voltage input wire again and check the fuse in the controller. If this fuse is fine, the A/C controller must be replaced.

		Note: Do not plug in the high voltage supply or the motor unless the red +13.2V wire is disconnected or the ignition key is off. Doing so will cause sparks that will damage the connectors.
	Burnt brushes and/or A/C motor.	Turn ignition key off and disconnect A/C motor to controller wires. Turn ignition key back on and check for minimum 48V DC at output of A/C controller to motor. If voltage is present, turn key off. Remove motor brushes and inspect commutator for wear and discoloration. Clean commutator with cotton swab and alcohol, and replace. Replace brush if carbon section is less than ¼" in length. Otherwise, replace motor.

SYMPTOM	CHECK FOR	PROCEDURE
Brakes not working adequately	Vacuum pump not working or vacuum switch not working.	To check if pump is working, turn key on and listen for pump after applying brakes several times. If pump doesn't run, check if +13.2V DC is present at pump terminal. If +13.2V is present, check for +13.2V at switch (at reservoir). Also, check switch ground.
	Vacuum leak or vacuum low.	Let the pump stop running, apply brakes three times and note the feel of the pedal. If you get less than three pumps on the brake pedal before it feels stiff or if the vacuum pump doesn't stop running within 60 seconds, you may have a vacuum leak. Check for leak or low vacuum with vacuum gauge. Vacuum switch should shut off at 19" of Hg.
Vehicle trips GFI (Ground Fault Interrupt) Circuit	Water and salt in AC plug or extension cord	**With charging cord unplugged** at both ends, wash the two ends in hot soapy water. Rinse and dry. Wash off AC plug at charge port (gas cap) on vehicle with distilled water and an old tooth brush.
	Charger faulty.	Bypass the charge port by plugging the extension cord directly into the charger. If the GFI still trips, then call Solectria for a replacement charger.
	GFI Circuit faulty.	Have GFI circuit checked by licensed electrician. Alternate models or makes may work more reliably with Solectria chargers. Call Solectria for more details.

SYMPTOM	CHECK FOR	PROCEDURE
BC3300-equipped vehicle is not charging - Green LED at amp-hour meter is not flashing and numbers are not counting down	No power from wall outlet.	Check that extension cord has 110/220V at the vehicle end. Reset circuit breaker or GFI.
	No LED light come on at trunk-mounted charger interface box. No AC voltage input to charger.	With vehicle plugged in: check for the AC voltage at the end of the charger input extension cord inside the trunk. If no voltage present: check for voltage at the AC junction box. If voltage is present to the charger and the charger doesn't operate, contact Solectria Corporation. The charger may have to be replaced.
BC3300 equipped vehicle is not charging - yellow LED is lit on trunk-mounted charger interface box	Charger is in fault mode.	With a laptop PC, follow "Instructions to Monitor a BC3300"
	Charger is in fault mode. DAQ may have disabled charger	Contact Solectria for assistance.
	Charger is in fault mode: Problem with battery pack voltage to charger.	With vehicle unplugged, disconnect two-pin red Anderson charger output connector and check for DC voltage at vehicle harness. If no voltage or very low voltage is present, check the inline fuse between the Anderson connector and the positive terminal of #14 or #15 battery. (This fuse is located outside of the battery box near the left rear strut tower.) Sometimes the fuse can be blown in such a way that full pack voltage can be measured at the output. In this case, leave the charger output hooked up to the car harness. Carefully back probe the connector. Make sure the car is unplugged from the wall. If no or low voltage is present, then disconnect the 2-pin red Anderson connector and replace the fuse.
	Charger is in fault mode: Bad signal from temperature sensor.	Unplug vehicle. Disconnect temperature sensors from charger interface box and

		measure the resistance at the vehicle side of the harness (black Packard 3-pin, 2-wire connectors with clear and black wires). Resistance should measure anywhere from 15k to 45k depending on battery temperature. If no resistance is measured or if out of specification, call Solectria for a chart which shows correct resistance values at various temperatures. (It's possible the batteries may be too hot or too cold.) Otherwise, call Solectria for a replacement sensor.

Section II: Systems Diagnosis

PROCEDURE	STEPS
Checking DC-DC Converter	With key off and car unplugged from wall, use a voltmeter to back probe the low voltage side of the DC-DC converter (gray Anderson connector with red and black wires). • **If full 13.2V is present**, then the DC-DC is working. Check the vehicle 13.2V fuses to see if there are circuits without power. • **If voltage is considerably lower than 13.2V**, check car harness for a short. • **If no voltage is present**, unplug the high voltage input to the DC-DC converter (gray Deutsch connector with green and white wires) and check the fuse in the DC-DC converter. If the fuse is blown try replacing it with the same current rating (5A). Re-install good fuse, re-connect the high voltage input (be certain the key is off or 13.2V output is disconnected) and check for 13.2V at gray Anderson connector. If there still is no 13.2V, unplug the high voltage input and check the car harness for ~180V to 200V input to the DC-DC Converter. If full voltage is present and the fuse in the DC-DC is good and there still is no 13.2V output, then the DC-DC converter must be replaced. If there is no voltage or very low voltage present at the DC-DC input, check the DC-DC fuse in the main DC fuse box with the DC-DC input still unplugged. If the DC-DC fuse in the main fuse box has continuity, check the main battery pack voltage at the gray Anderson connector to the controller. See "Vehicle does not drive" section.

PROCEDURE	STEPS
Checking Ignition Circuit	Sit in the vehicle with the windows rolled up (it must be quiet to hear the ignition relay). Set the Range-Power selector to any forward setting. Make sure the car is unplugged from wall outlet and the Parking Brake is set. Turn the ignition key ON. Wait until the reminder chime stops. Put seat belt on. Slowly turn the Range-Power selector back towards the OFF setting. (Don't let the spring detent in the Range-Power selector affect turning the handle). Listen for the relay in the ignition box to 'click' (the relay is located under the steering column) being careful not to confuse the ignition relay click with the mechanical detent in the Range-Power selector that 'clicks' first. The ignition click indicates that the ignition circuit, the Range-Power selector, and the neutral interlock circuit are all working properly. If no 'click' is heard, check for keyed +13.2V DC to the ignition box (white wire). *See "Ignition Box" section in text to access.* Unplug the single pin white wire to the ignition box and plug it back in with key on to check if the relay inside 'clicks'. Make sure it is also grounded (gray wire). If 13.2V is present and ground is in good condition, check the Range-Power selector for continuity in Forward or Reverse (call Solectria at 508-658-2231 for details). If okay, replace the ignition box.

PROCEDURE	STEPS
Checking Motor and Controller	Make sure the vehicle is unplugged and the parking brake is securely set. Make sure that the ignition circuit is working by listening for ignition relay 'click' under dash. *Refer to "Checking Ignition Circuit" in previous section.* Turn the ignition switch off and on with the Range-Power selector in the "OFF" setting. Listen and/or feel for the controller to 'clunk' when the key is turned on. If the controller does not clunk, check battery pack voltage at gray Anderson connector. If approximately 185V is present, check the integrity of the 25-pin cable both at the controller and at the ignition box. If it appears okay, then call Solectria for further testing of the 25 pin cable or a replacement controller. If the controller 'clunks', but the motor does not turn, check the 9-pin cable from the motor speed sensor. It may also be necessary to perform a pot-box resistance test (call Solectria for details), or a motor speed sensor adjustment/replacement. IF INSTALLING A NEW CONTROLLER: Sometimes the new controller is out of phase with the motor. Swap the red and white cables coming from the motor at the red, white, and blue connector.

Appendix C

Lists:

Tools & Test Equipment

Scheduled Maintenance

Tools & Test Equipment

Essential Tools available only from Solectria	Price
Solectria Diagnostic Test Box (ignition/potbox bypass)	$380.00
Probe set for Deutsch connectors	$40.00
Probe set for Packard connectors	$40.00
TOTAL	**$460.00**

Other Essential Tools	Price (approximate)	Available from	Recommended Model
Deutsch Connector Crimping Tool	$160.00	Ladd Industries (800) 223-1236	Deutsch HDT48-00
Molex Standard Pin Crimper	$125.00	Sterling Electronics (800) 745-5500, Richey Electronics (973) 575-7960, Hamilton Electronics (800) 354-1616	Molex 11-01-0008
Molex pin removal tool	$12.00	Sterling Electronics (800) 745-5500, Richey Electronics (973) 575-7960, Hamilton Electronics (800) 354-1616	Molex 11-03-0044
Packard Weatherpack Crimping Tool	$128.00	Waytek (800) 328-2724	Waytek 402
Regular crimper & wire stripping tool (10 AWG to 22 AWG)	$14.00	Waytek (800) 328-2724	Waytek 403
Soldering iron with pin-point tip, 60 Watts	$69.00	Contact East (978) 682-2000	Weller W60P-3
Digital multi-meter (volt-ohm meter)	$99.00	Contact East (978) 682-2000	Fluke Model 70
Standard automotive tools	$500.00 (estimated)	Automotive tool supplier	n/a

Optional (available only from Solectria)	Price
Battery Discharger	$3,500.00

Revised May 1998. All prices subject to change without notice.

Solectria Electric Vehicle

Scheduled Maintenance

	Odometer (miles)															
Item	6,000	12,000	18,000	24,000	30,000	36,000	42,000	48,000	54,000	60,000	66,000	72,000	78,000	84,000	90,000	96,000
Rotate/inspect tires	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Change gearbox oil	x	x		x		x		x		x		x		x		x
Inspect gearbox oil level			x		x		x		x		x		x		x	
Inspect steering & suspension		x		x		x		x		x		x		x		x
Inspect brake system		x		x		x		x		x		x		x		x
Change brake fluid										x						

Owner/Operator Inspections

Weekly
Check windshield washer fluid level
Check hood latch operation

Monthly
Check tire pressure

Every 6 months
Check restraint system
Check wiper blades

Once a year
Lubricate key lock
Lubricate body
Check steering column Lock
Check parking brake performance

Appendix D

Diagrams:

Layout and Wiring

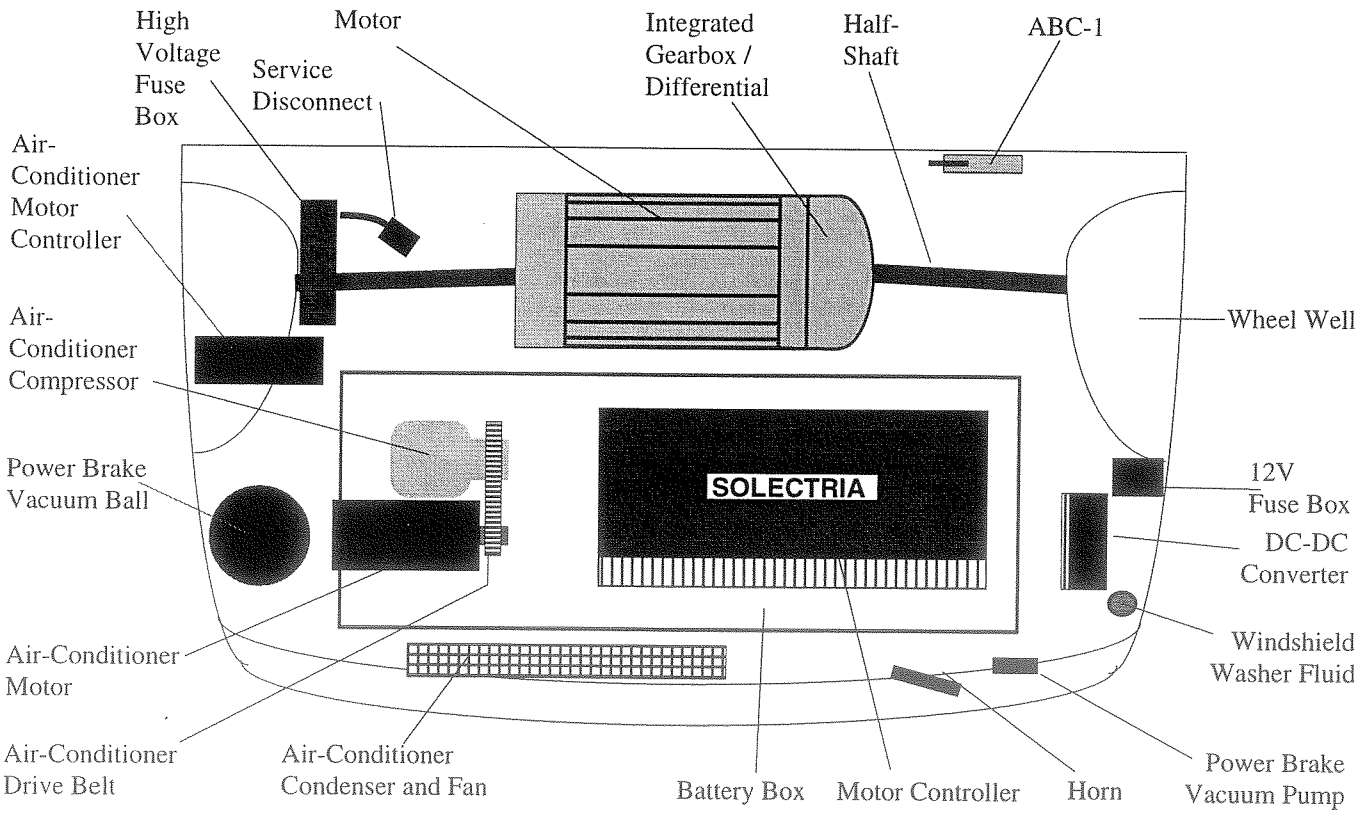
Connectors

DAQ

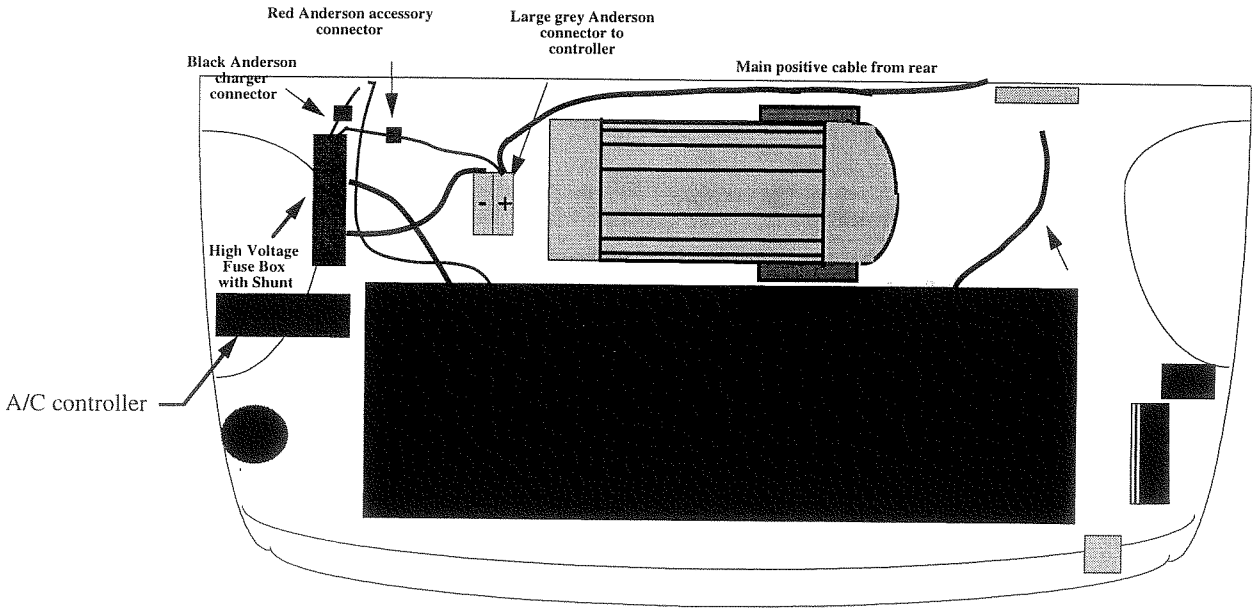
Towing

1996/7 NiMH SOLECTRIA FORCE

DIAGRAM OF EQUIPMENT UNDER THE HOOD

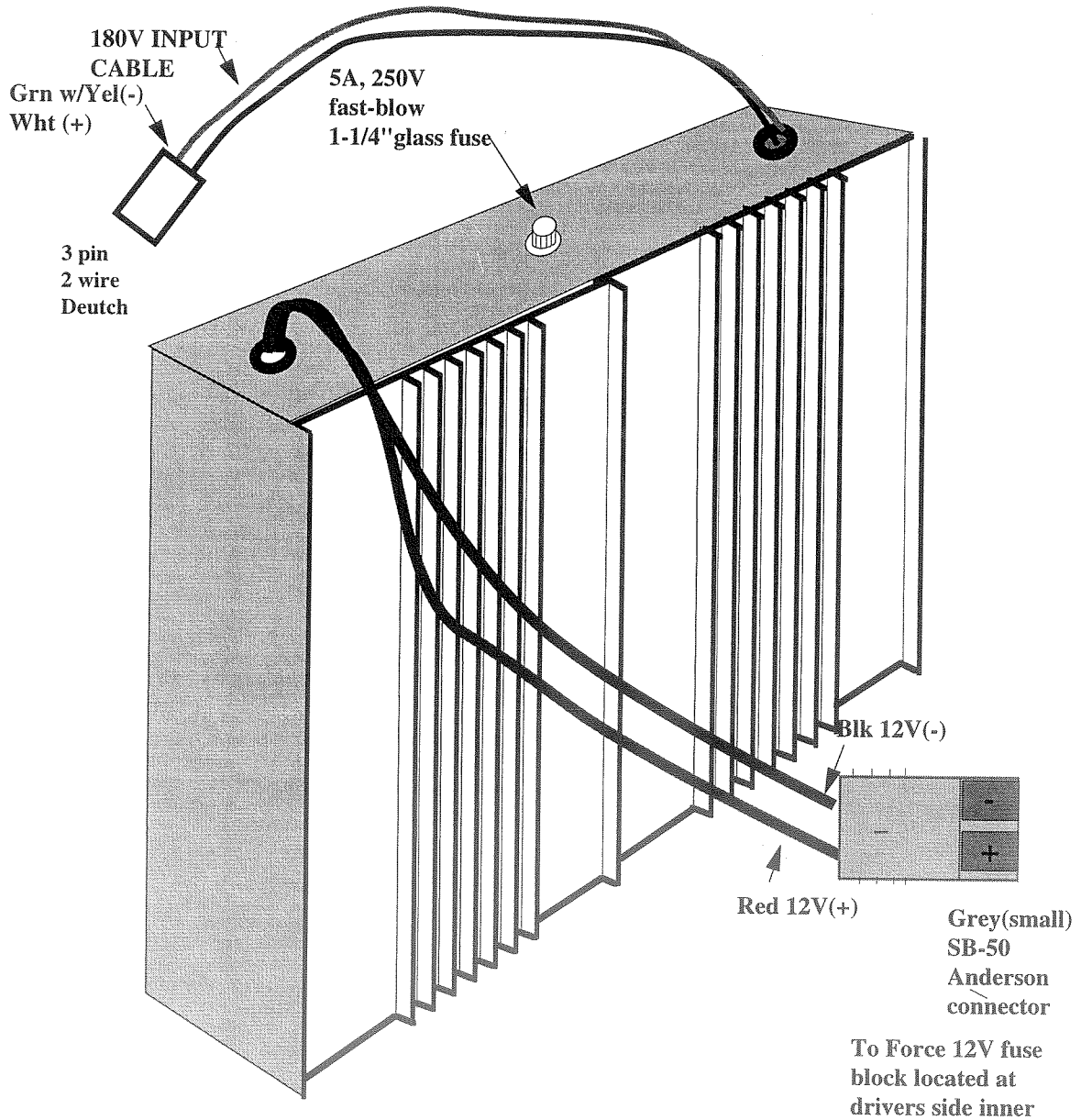


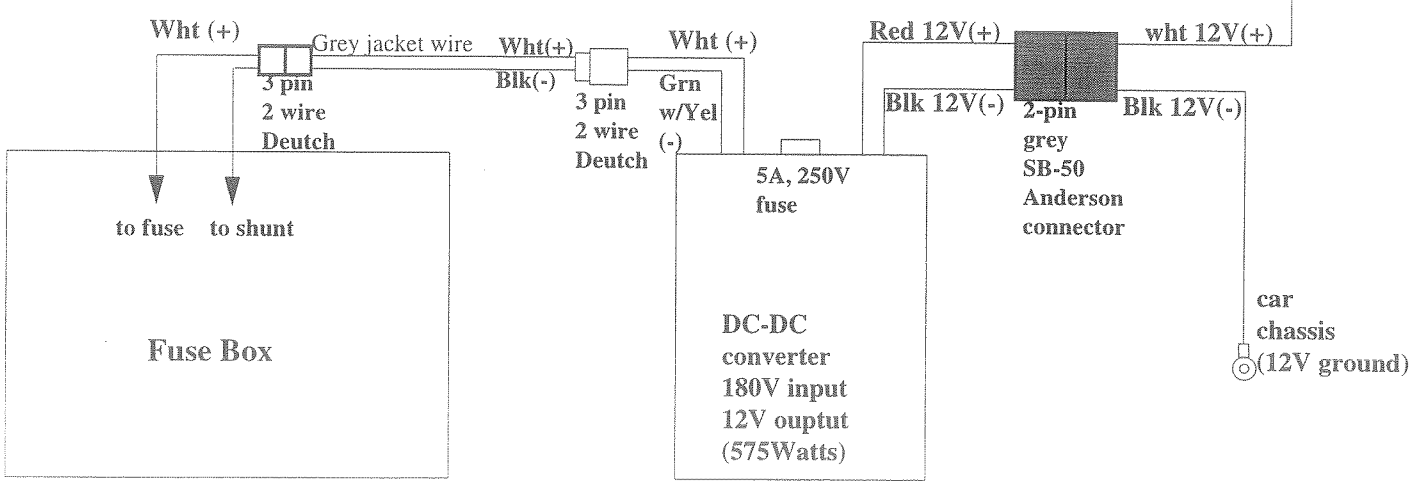
1998 NiMH FORCE FRONT BATTERY BOX



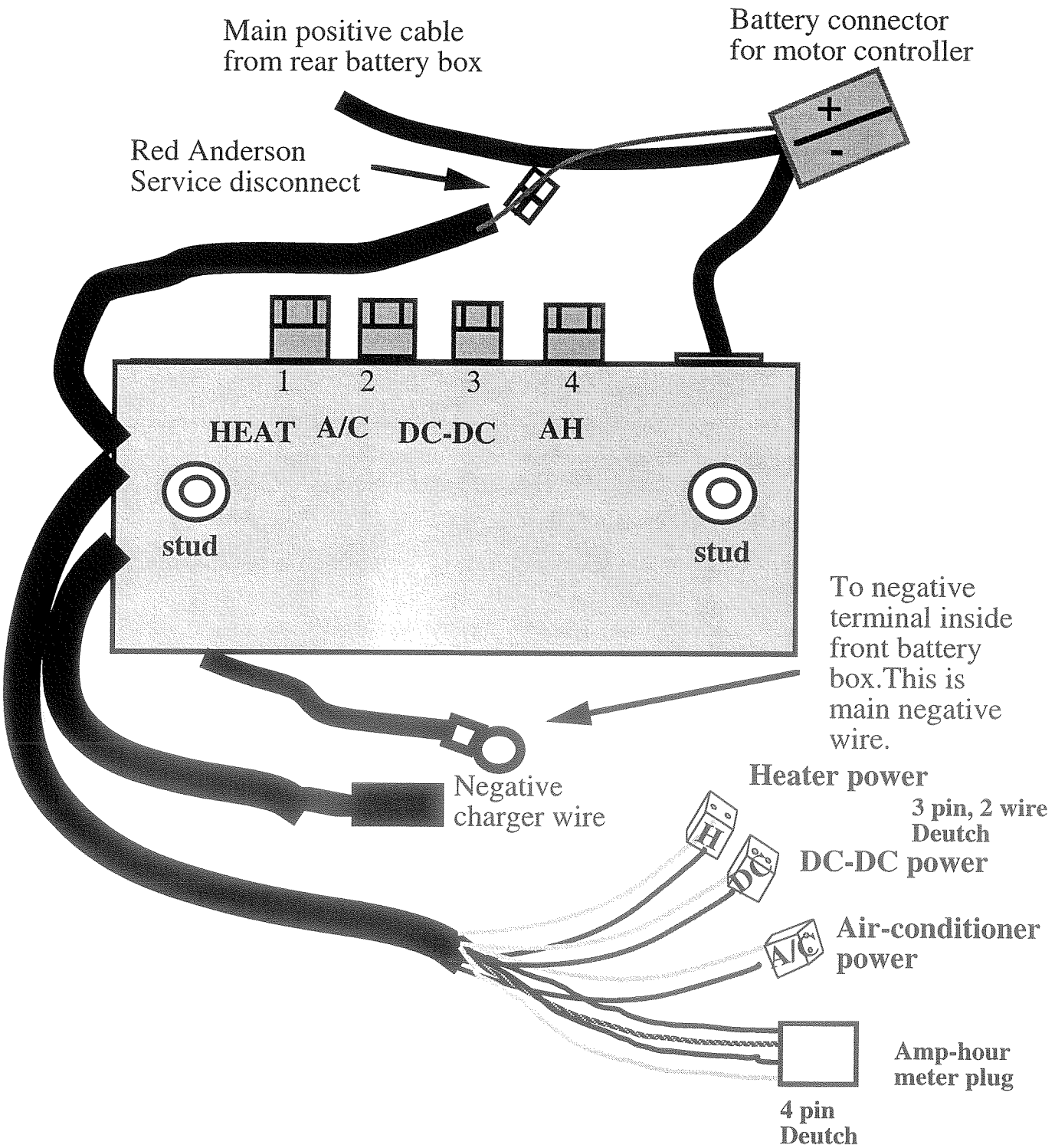
WARNING: DO NOT open the battery box under any circumstances. Call Solectria with questions.

1996/7 NiMH FORCE DC-DC WIRING



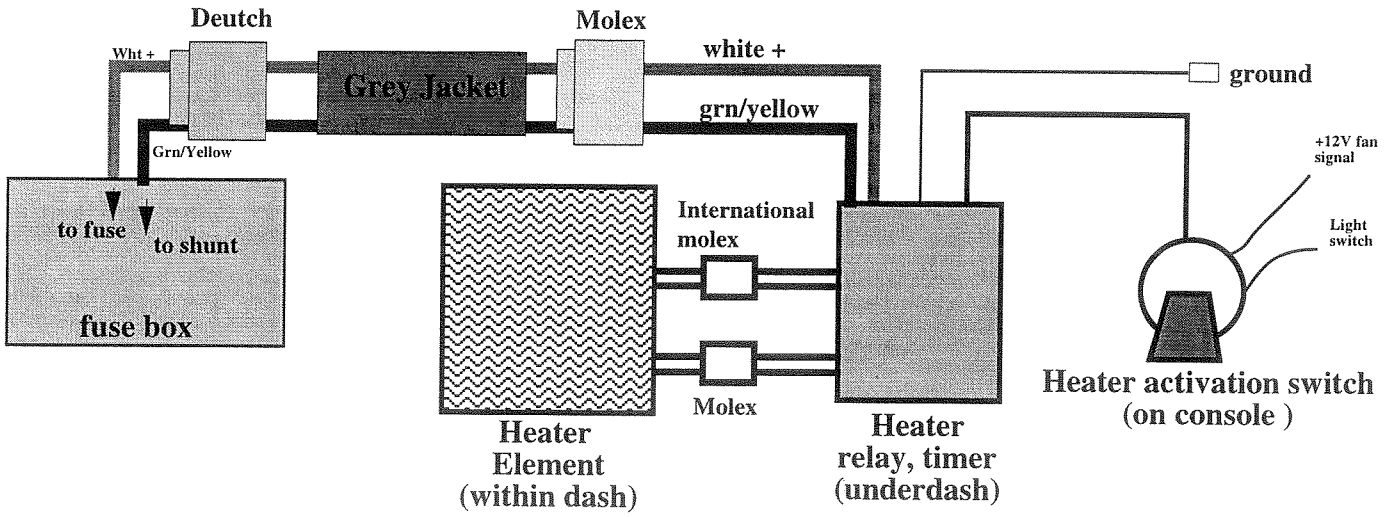


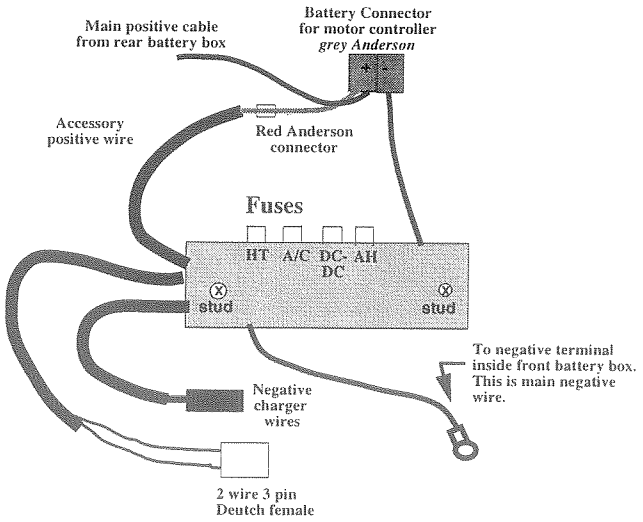
1996/7 NiMH FORCE FUSE BOX



1.) DC-DC converter fuse (6A, 250V)
2.) Heater fuse (20A slow blow, 250V)
3.) Air conditioning fuse (20A, 250V)
4.) Amp hour counter fuse (2A, 250V)

1996/7 NiMH FORCE HEATER WIRING





1996/7 NiMH FORCE AUTOMATIC IGNITION WIRING

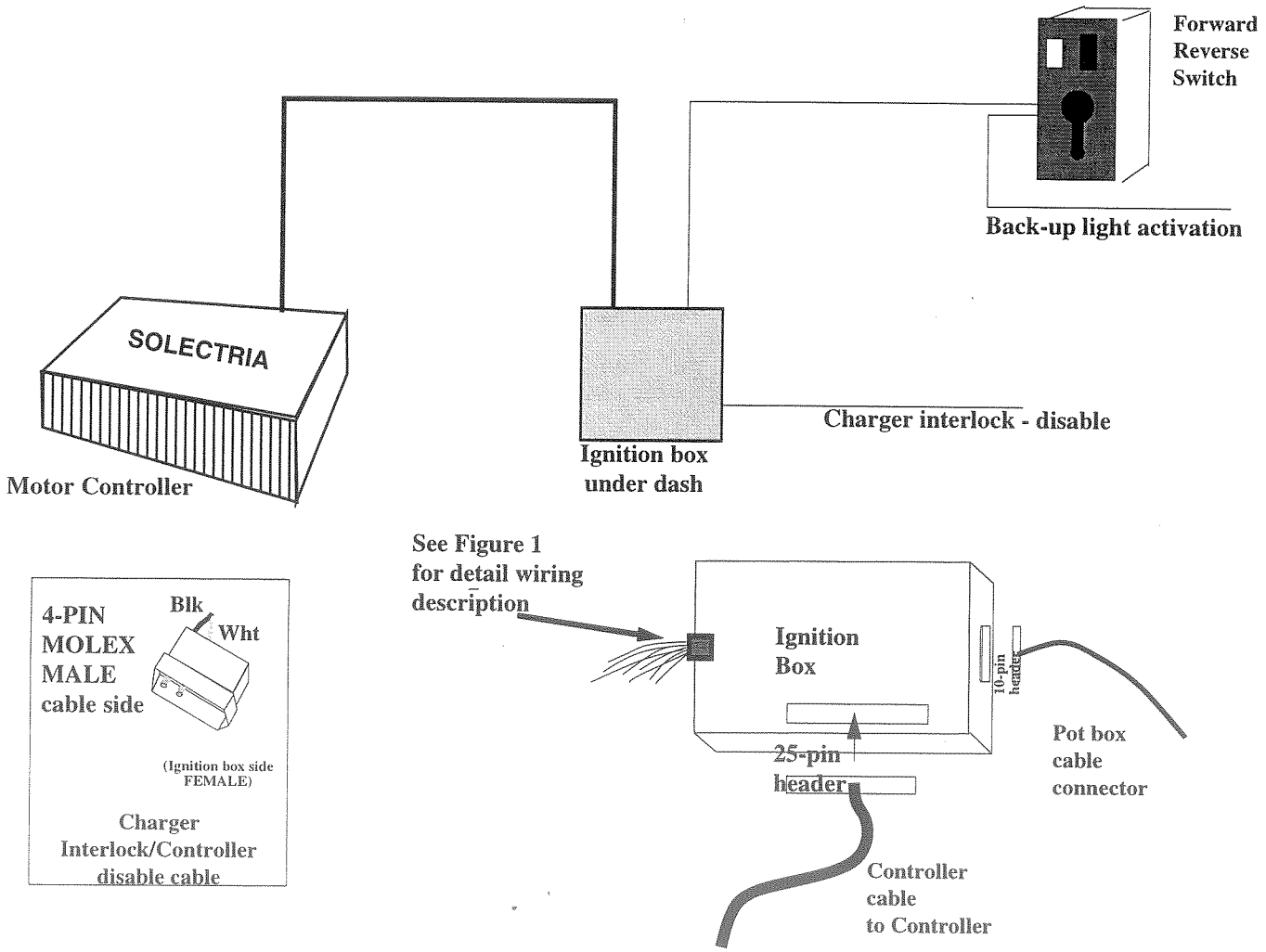
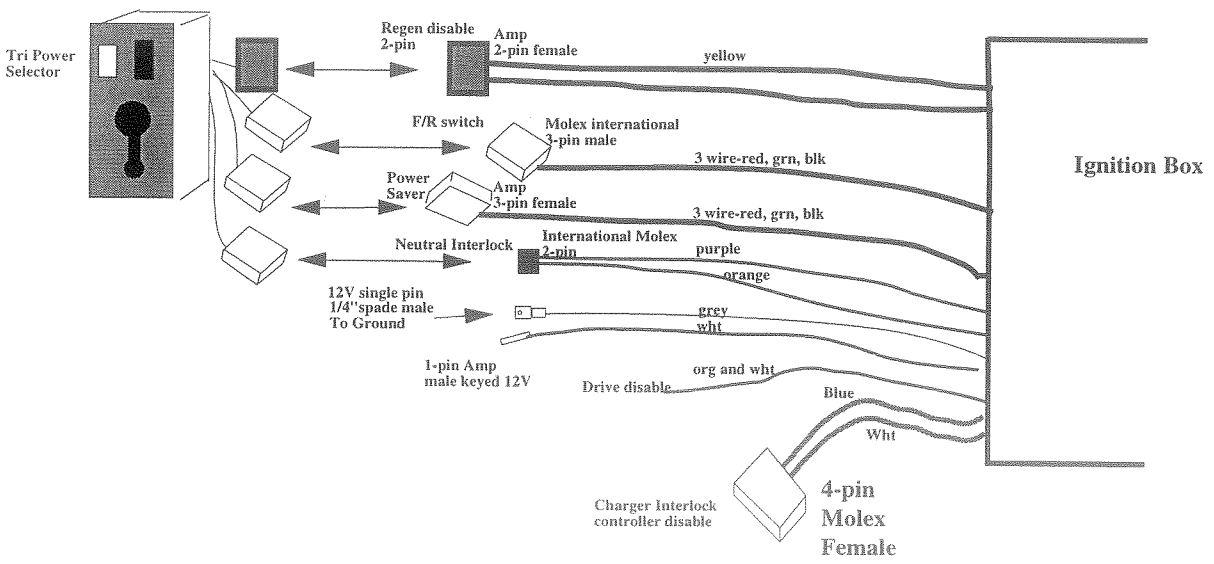
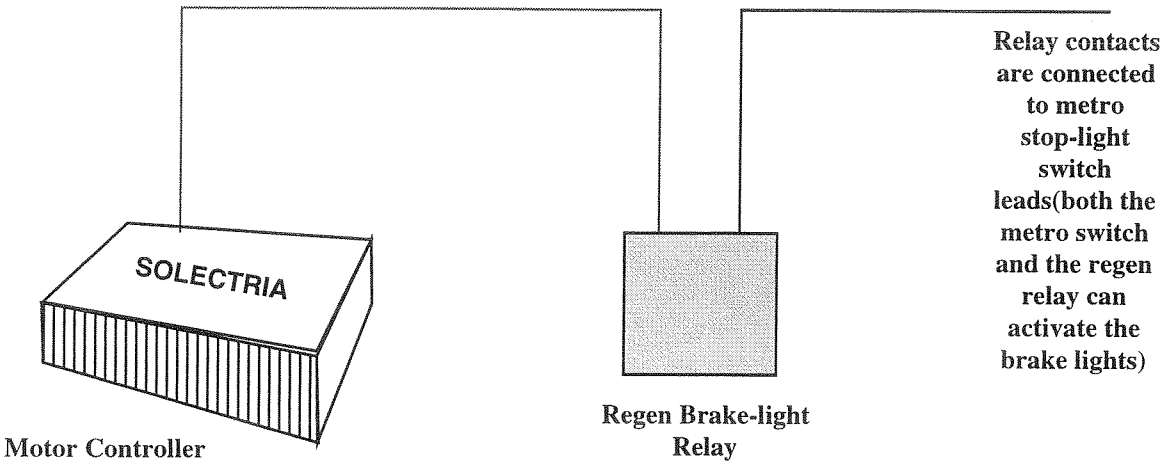
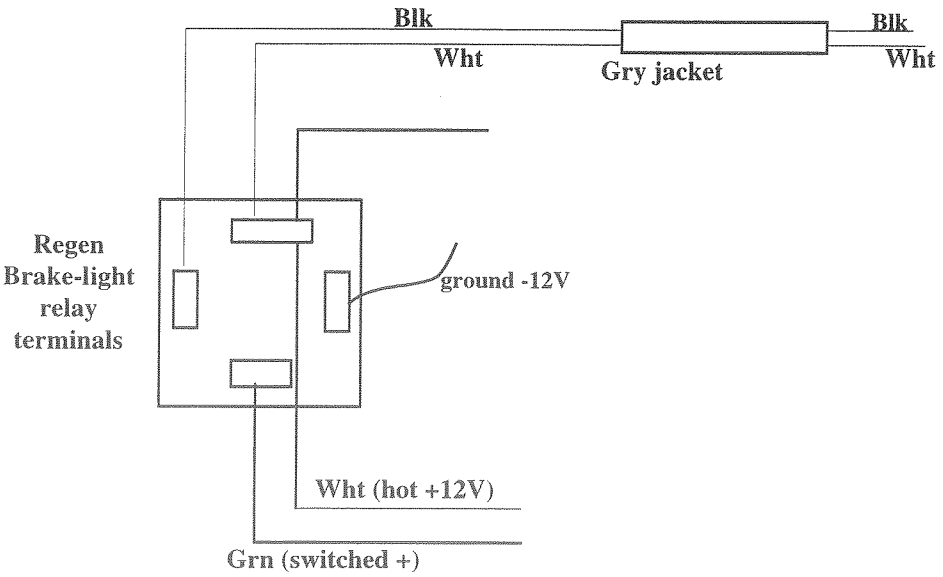


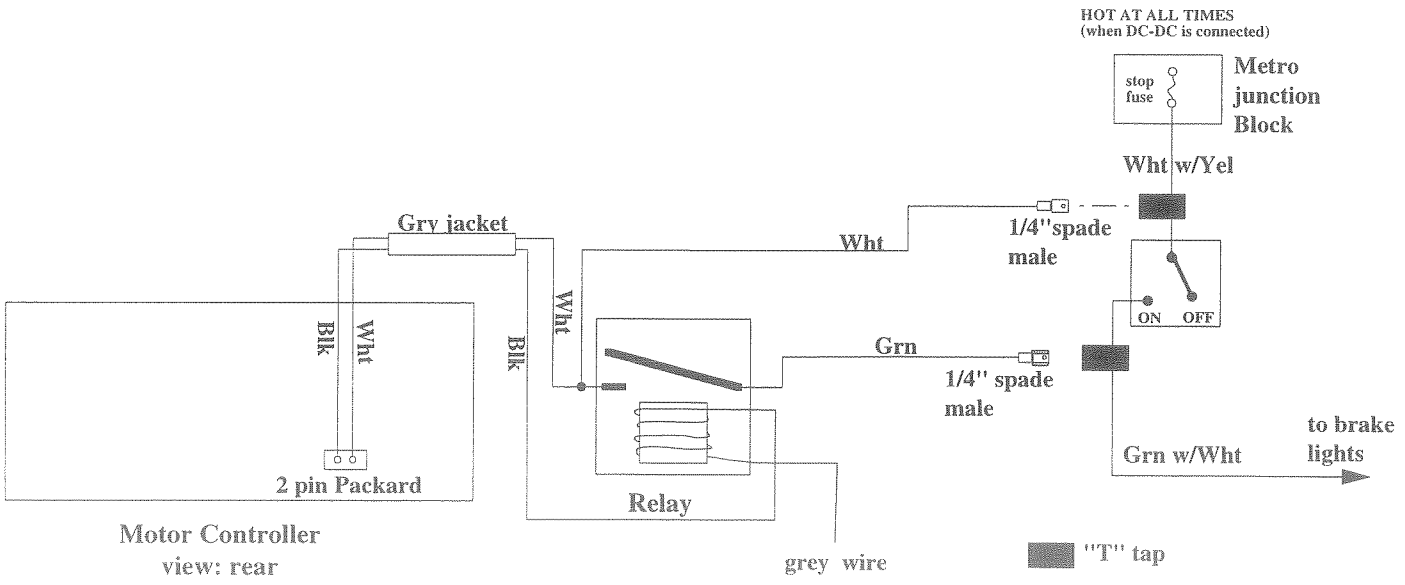
Figure 1



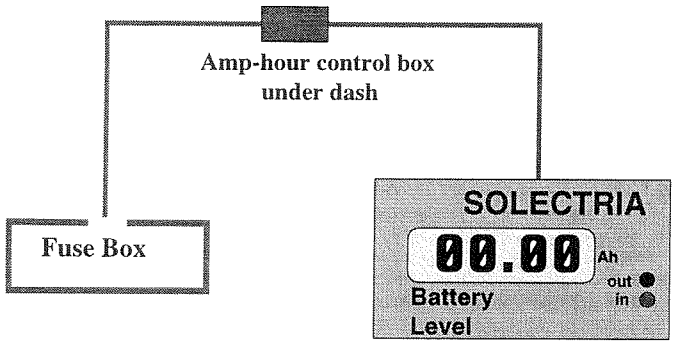
1996/7 FORCE REGEN BRAKE LIGHT WIRING



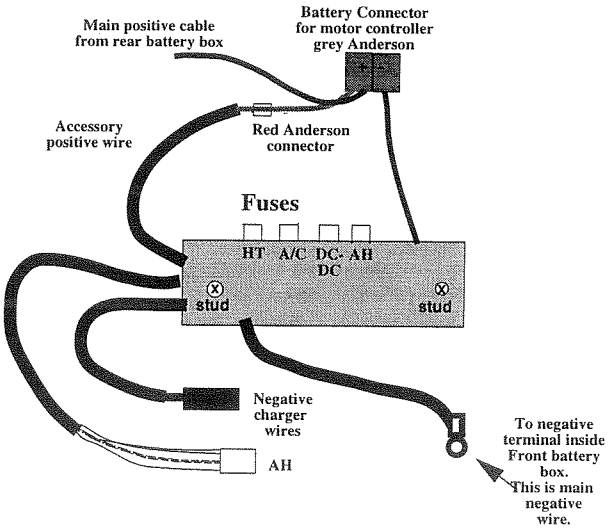


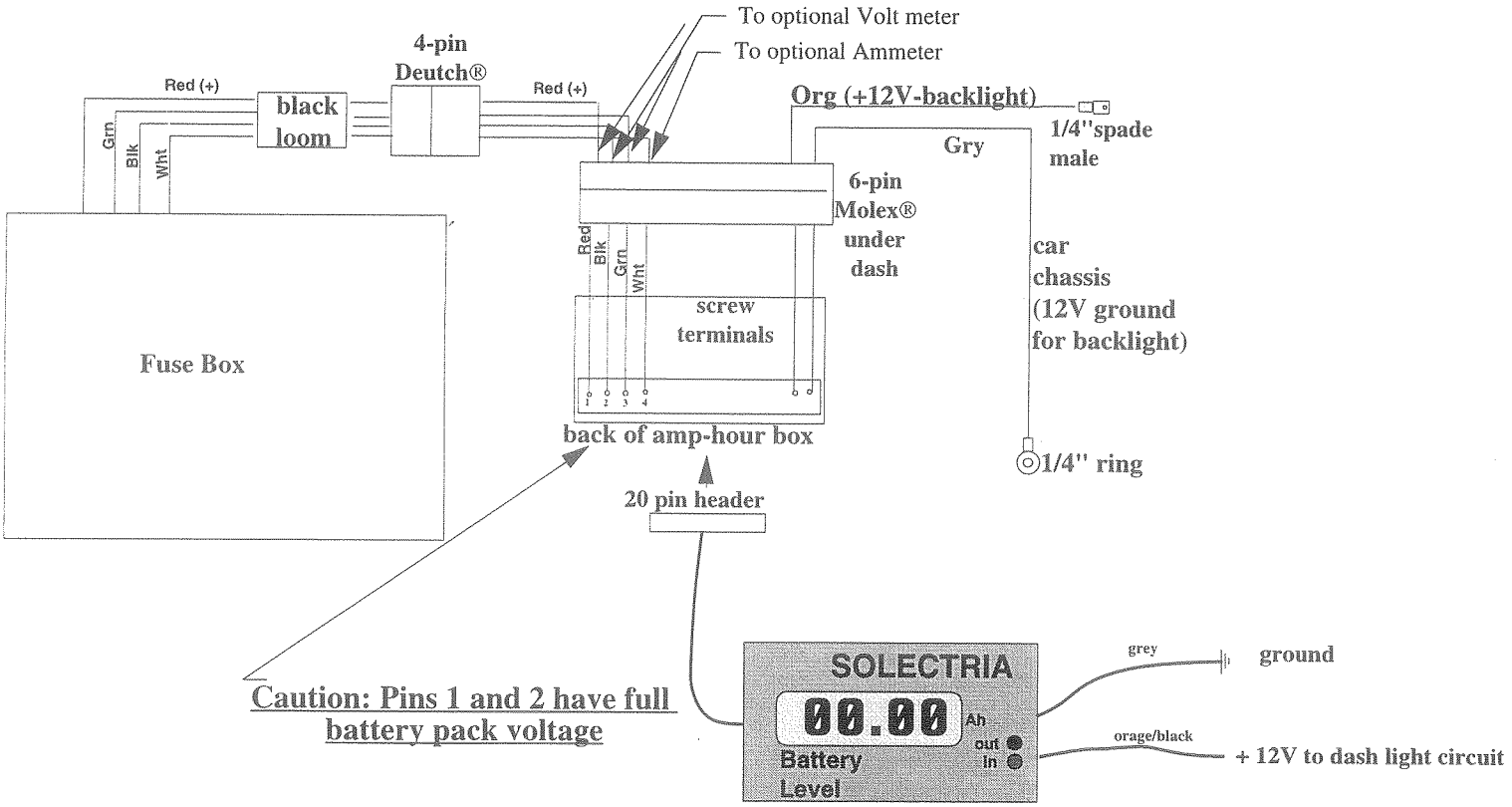


1996/7 NiMH FORCE AMP-HOUR METER WIRING

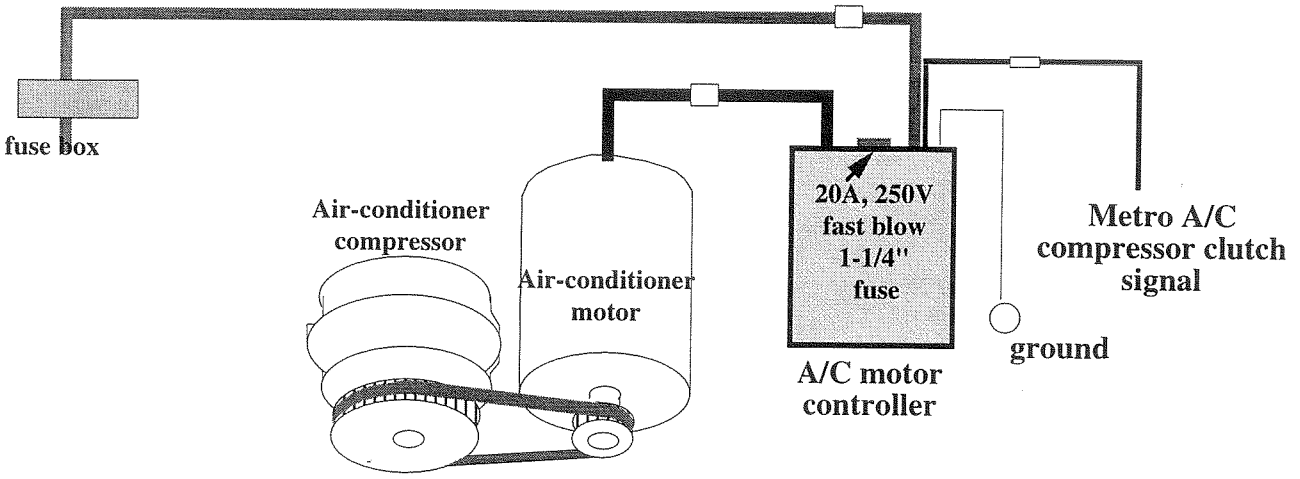


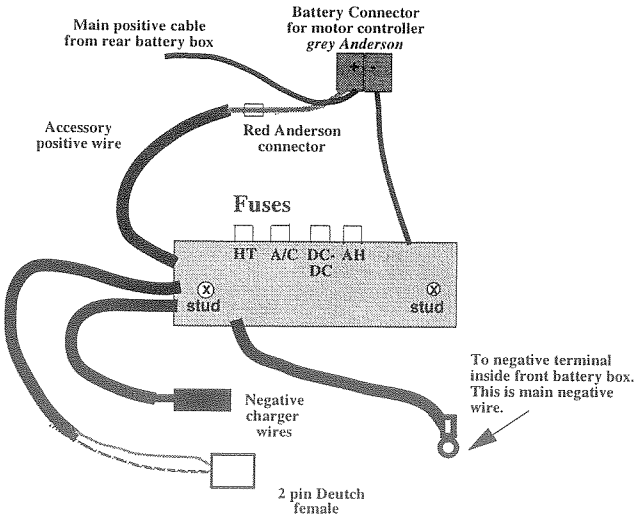
Amp-hour
display
on dashboard

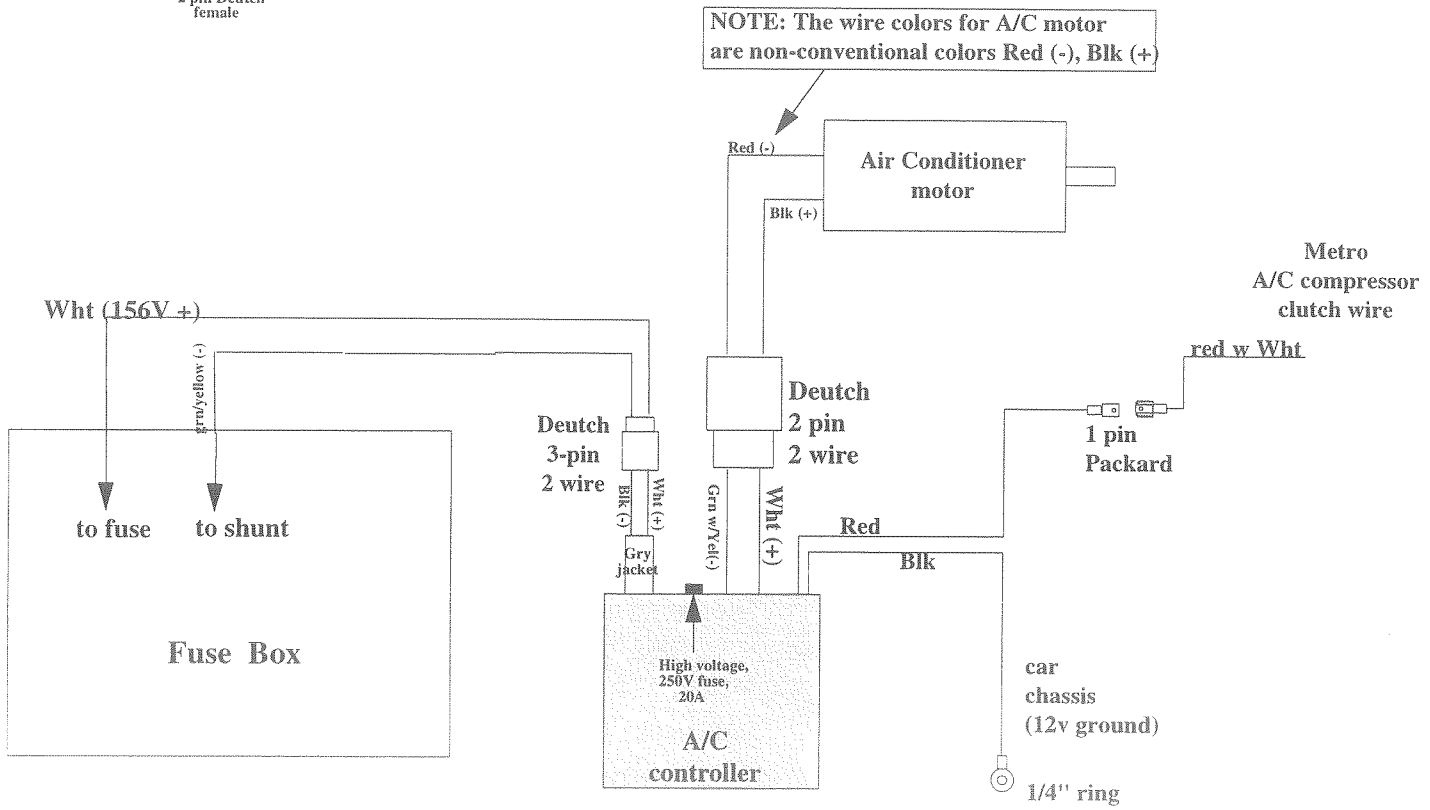




1996/7 NiMH FORCE AIR-CONDITIONING WIRING

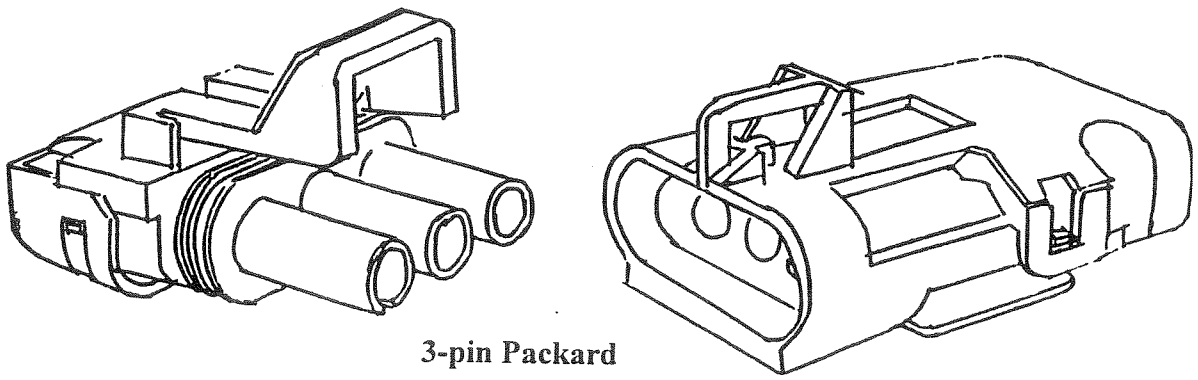






Solectria Connectors

(3-pin model depicted)



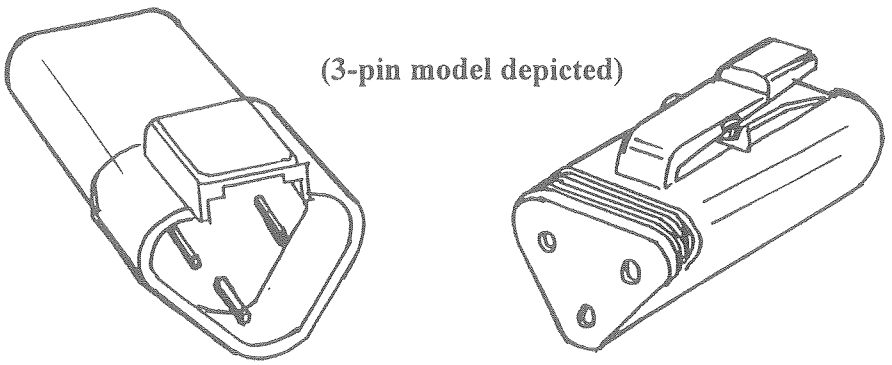
3-pin Packard

- *Battery Temperature Sensors*

4-pin Packard

- *Regen Brake Light Activation*

(3-pin model depicted)



2-pin Deutsch

- *A/C Controller to A/C motor*

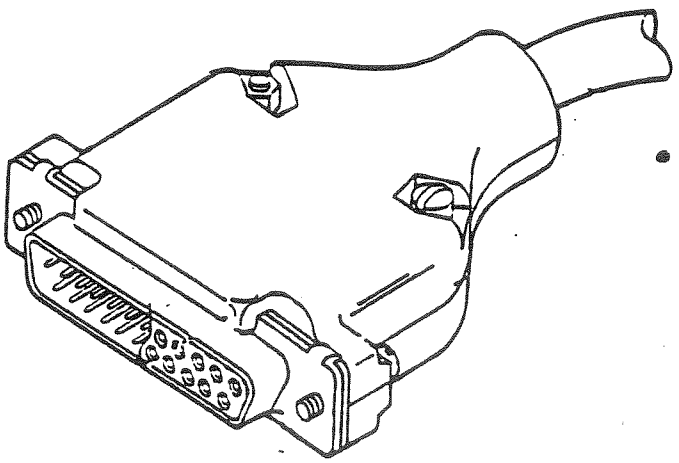
3-pin Deutsch

- *DC-DC, Heat and A/C out of fuse box*

4-pin Deutsch

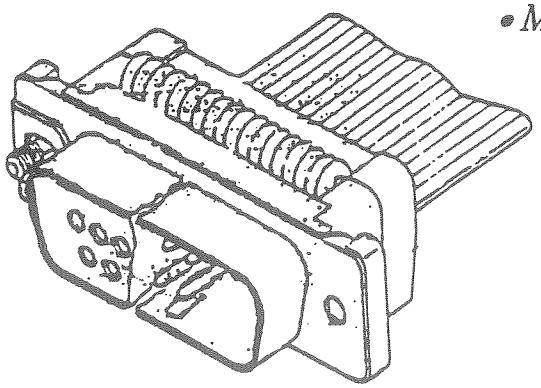
- *Amp-hour meter harness under hood*

Solectria Connectors



25-pin D sub

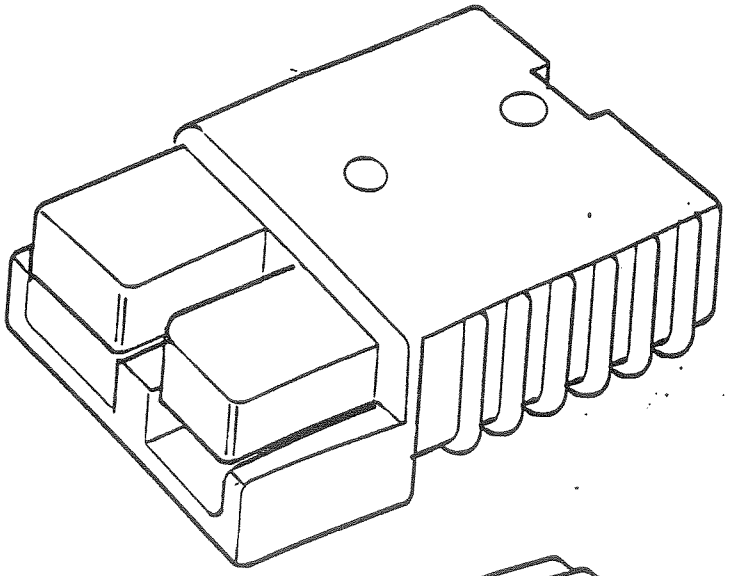
- *Ignition Box to Motor Controller*



9-pin D sub

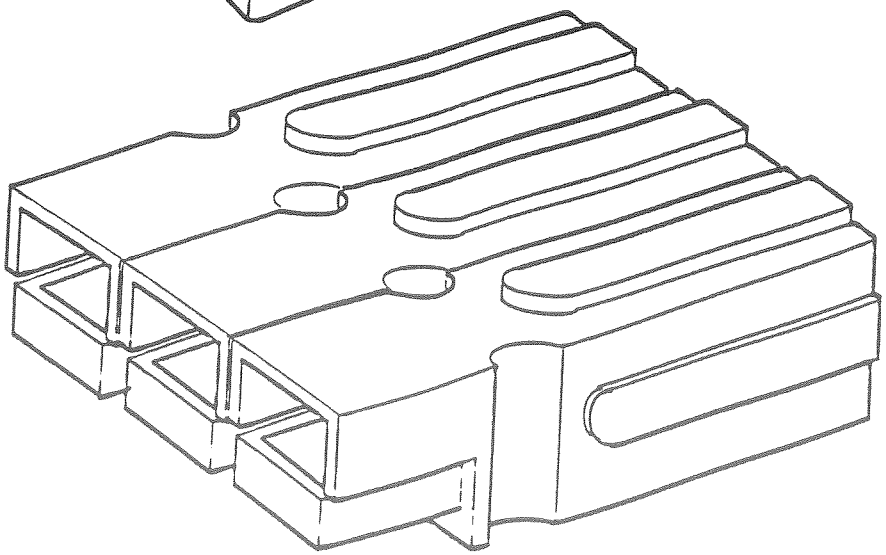
- *Motor Speed Sensor to Motor Controller*

Solectria Connectors



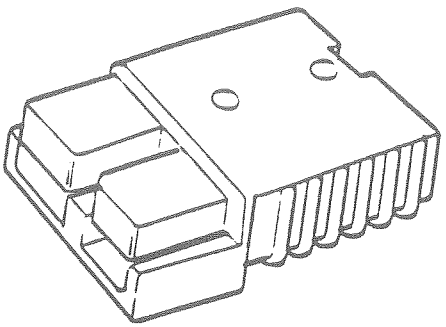
SB175 Large Grey Anderson

- *Battery to Motor Controller*



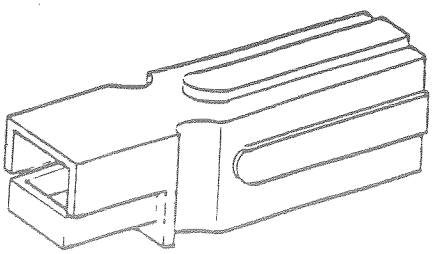
Power Pole 120

- *Red, White and Blue Motor Power Leads*



SB50 Anderson

- *Red-BC3300 Charger output to Batteries*
- *Grey- DC-DC 12V Output*

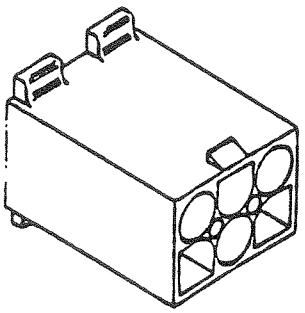


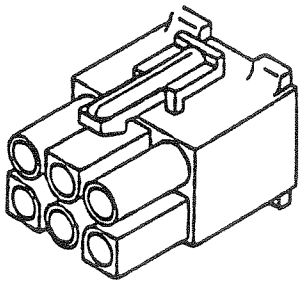
Power Pole 50

- *Red- Accessory Positive-Service Disconnect*
- *Black - Charger Negative Disconnect*

Solectria Connectors

Male **Female**



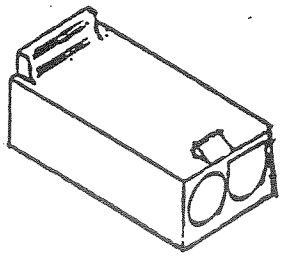


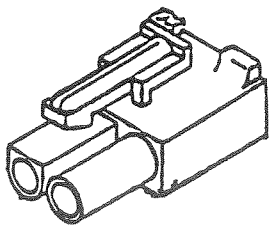
6-pin International Molex

- *Amp-Hour Counter Harness under dash*

3-pin International Molex

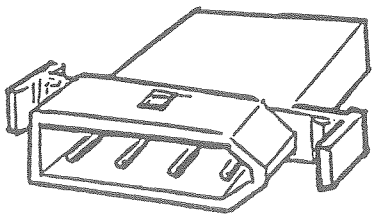
- *Range-Power (Forward-Reverse) Selector*

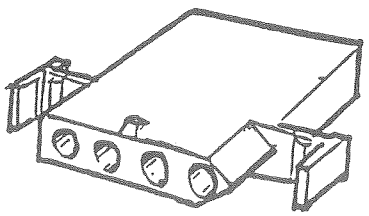




2-pin International Molex

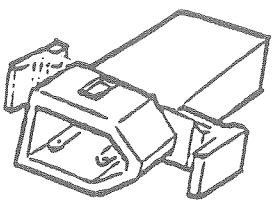
- *Neutral Interlock*
- *110VAC or 220VAC to Battery Thermal Management*

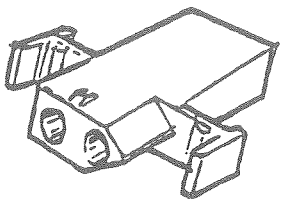




4-pin Molex

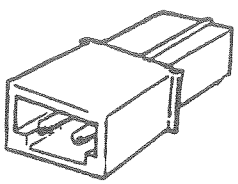
- *Charger Interlock*

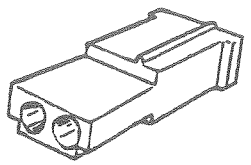




2-pin Molex

- *High-Voltage Heater under dash*





2-pin Amp

- *Regen Disable*

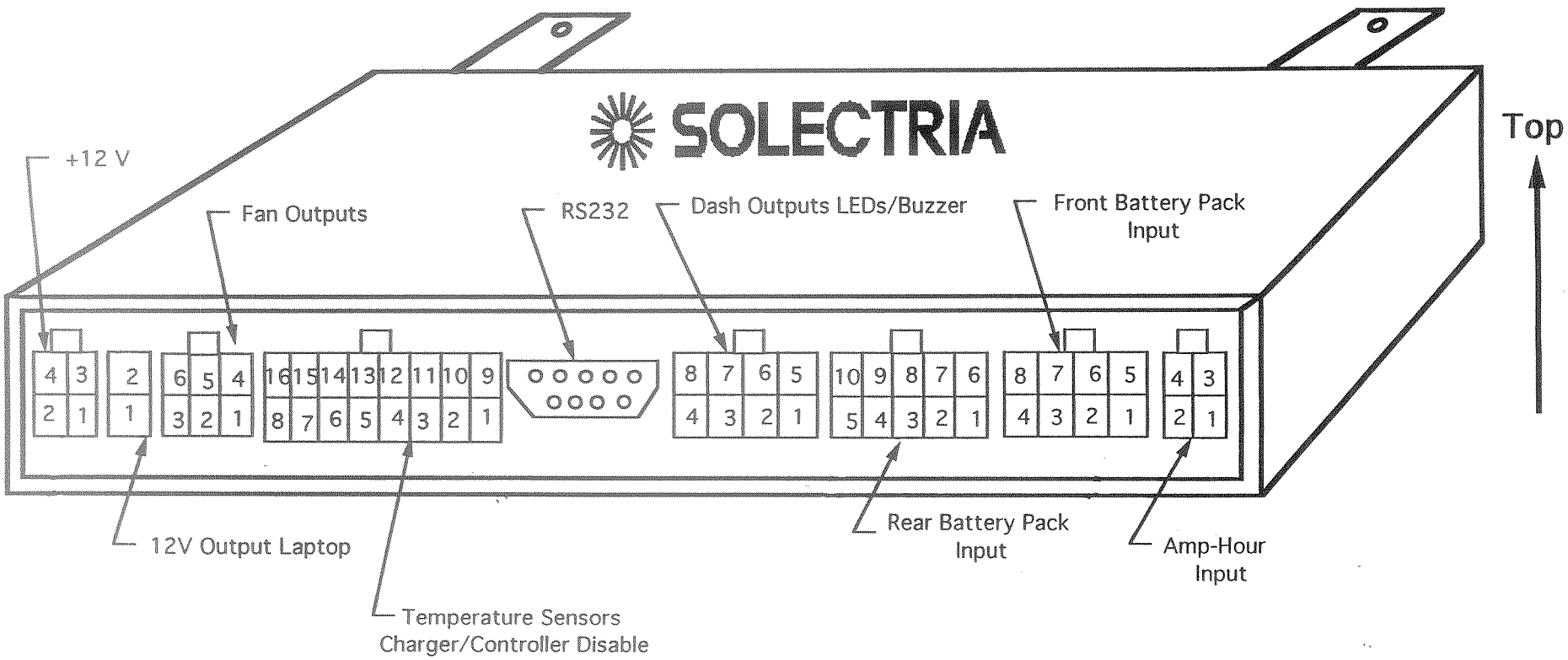
4-pin Amp

- *Charge Complete LED*

*Note: Connector nomenclature is defined by Solectria. Connector gender may not be consistent with other industries. Please note whether the pins are exposed or set into the connector.

SOLECTRIA

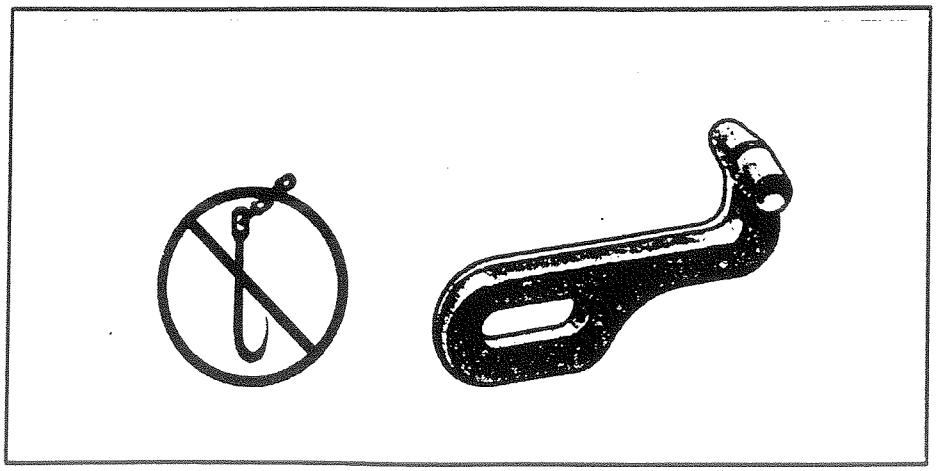
DAQ Connector Description Diagram



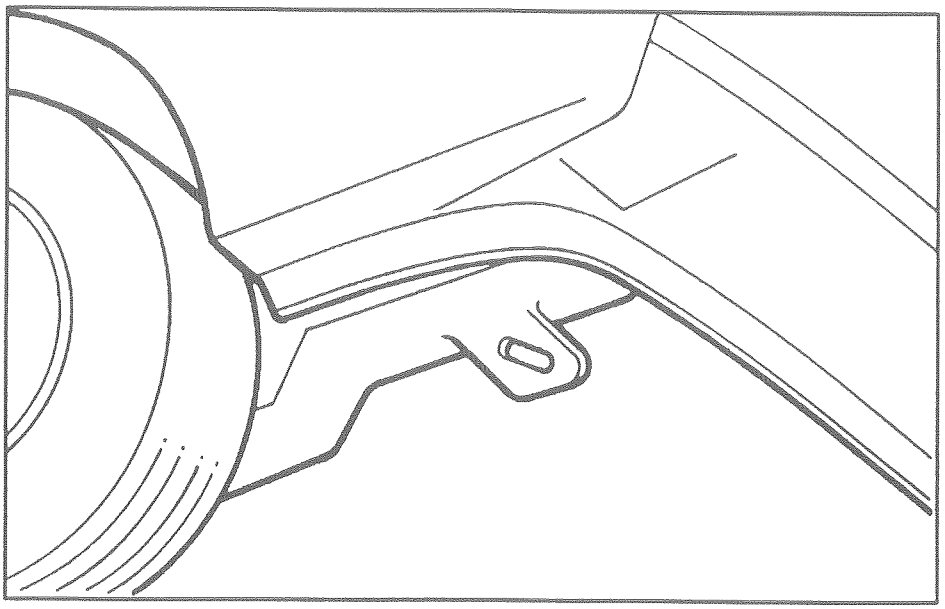
rev 5/97
K.Y.

Towing Instructions for 1997 Solectria Force

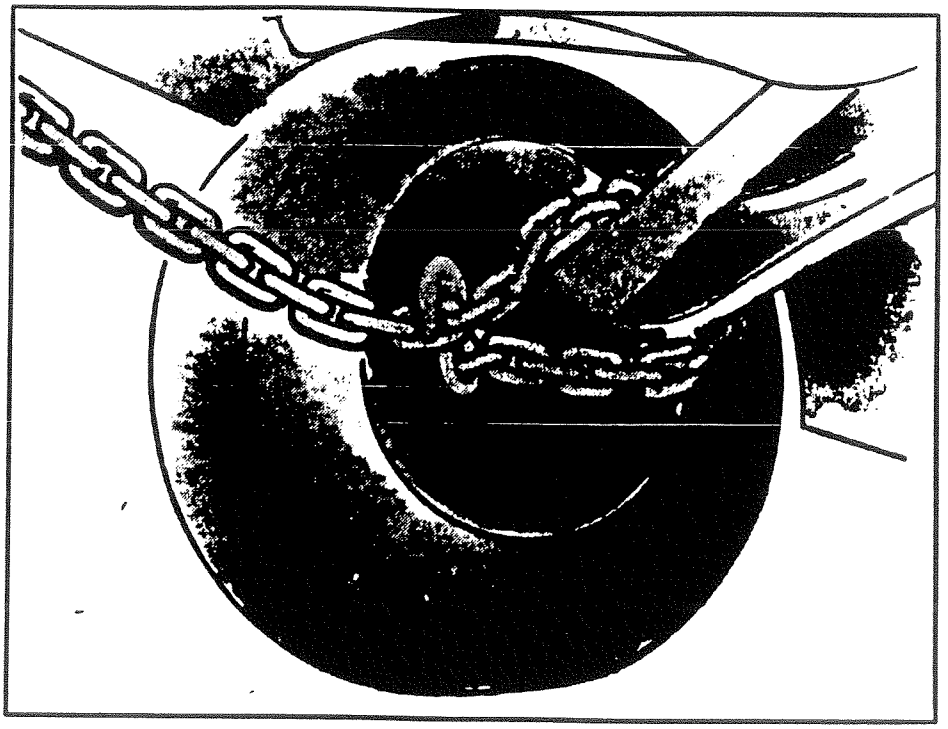
Do not attach winch cables or "J"-hooks to suspension components when towing.



Always use "T"-hooks inserted into the "T"-hook slots. See diagrams.

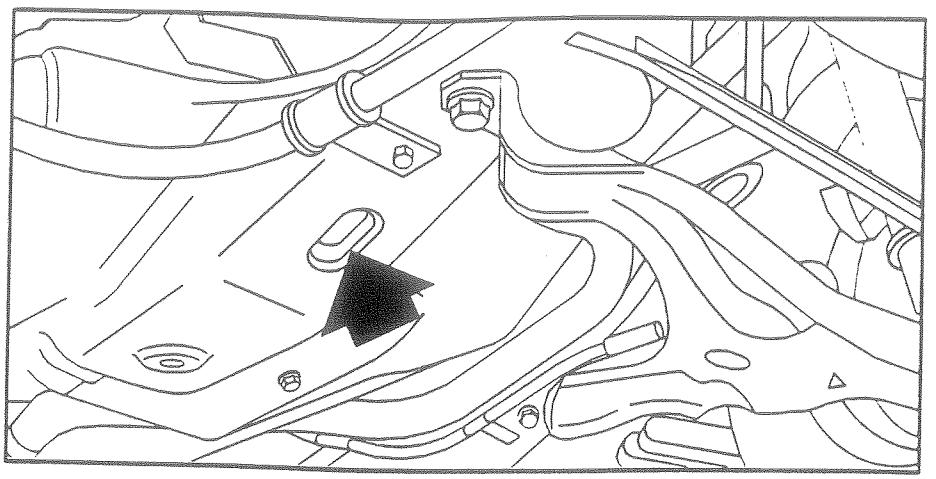


Attach T-hook chains on both sides, in the slotted holes in the brackets, just ahead of the front wheels.



Attach a separate safety chain around the outboard end of each lower control arm.

Do not wrap chain around track rods, sway bars, tie rods, or brake lines.



Attach T-hook chains to the T-hook slots in the bottom of the floor pan just ahead of the rear wheels on both sides.