

SERVICE MANUAL

¹⁹⁹⁸
~~1997~~ SOLECTRIA FORCE

Nominal System Voltage: 156V
Batteries: Lead Acid
Charger: BC3300 (3.3kW/240VAC)

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FORWARD

This manual has been prepared as a supplement to the service information contained in the Geo Metro 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 508-658-2231 or fax 508-658-3224, Monday-Friday 9 AM to 5 PM Eastern Time.

FORCE DESCRIPTION AND SERVICE GUIDELINES

This section contains a description of the 1997 Solectria Force and its major features. For operating information, refer to the 1997 Solectria Force Owner's Manual.

Please read the section entitled **Standard Practices For Working On or Near High Voltage Systems** before servicing any vehicle.

All major components are electrically connected to the battery pack and have high voltage labels. Use due caution when servicing.

For complete servicing description, see specific procedures in the text.

Basic Vehicle Layout

The 1997 Solectria Force operates on a 156V nominal DC system. The exact voltage level of the battery in any Force depends on the battery's state-of-charge, and whether power is being taken from, or put back into the batteries. The battery modules are divided between a front and a rear battery box, located under the hood in the motor compartment and under the floor of the trunk.

The Force drive system uses a 3-phase AC induction drive motor. The motor controller, located on top of the front battery box under the hood in the motor compartment, receives high current, high voltage (156V) direct current (DC) electricity from the battery and delivers variable frequency alternating current (AC) to the motor, located behind the front battery box.

***NOTE:** Each of the following three electronic components has high voltage cables which supply them with power.*

1. DC-DC Converter

The DC-DC converter (which supplies 12V DC to power the vehicle accessories), power brake system, and air conditioning components are also located under the hood. The electric heater is located under the dash board.

2. Battery Charger

The Battery Charger is located on the driver's side of the trunk and may be one of two models, the standard BC1600 or the optional BC3300.

Battery Charger - BC1600

The vehicle's battery pack is recharged from any 20A, 120VAC, 60Hz outlet (NEMA 5-20R). This outlet should be on a dedicated GFI-protected circuit.

Battery Charger - BC3300 Optional

If your car is equipped with an optional BC3300 charger, it is designed to be charged using a standard 20A, 240VAC, 60Hz outlet (NEMA 6-20R). This outlet

should be on a dedicated GFI-protected circuit. In an emergency or if 240VAC is not available, a BC3300 equipped car may also be charged with 120VAC using the custom adapter cord provided.

3. Amp-Hour Meter

The digital Amp-Hour meter display is located in the instrument cluster, while the Amp-Hour meter box is found under the dash near the steering column.

Safety

The Force contains various systems for operator and service personnel safety:

The car will not drive if it is plugged in.

The car will not drive if the Range-Power Selector is set to Forward or Reverse when the ignition key is turned on (for safety, Range-Power Selector must be set to OFF position when ignition key is turned on).

All high voltage DC components except the controller and the charger are fused at the main DC fuse box. Chargers are fused in-line in the trunk.

Battery thermal management and the optional cabin preheat system, which operate on AC, are fused at the AC junction box in the trunk (Note: Cars equipped with a BC1600 charger do not use an AC junction box as they are internally fused in the charger.)

Each battery box is independently fused to open and disable the high voltage circuit during overcurrent conditions. These high-amperage fuses are located inside each of the battery boxes.

The batteries in the Force are completely isolated from the car chassis to prevent the possibility of electrical shock or current leakage to the car. However, there is still a remote possibility that a closed circuit could be formed by a subset of battery modules as a result of short circuiting to the car chassis or other conductors during a severe accident.

Extreme care must be taken when handling any high voltage cables so as not to short circuit the battery to the vehicle chassis or other potentially live wires or terminals.

Unless two separate and isolated locations of the high voltage system at different electrical potentials are touched simultaneously, there is no hazard for shock. Nevertheless, exposed electrical cables should be treated with caution, and assumed to carry high voltage regardless of the gauge of wire.

Battery Information

The lead acid batteries used in Solectria vehicles are sealed, starved-electrolyte lead acid. The starved-electrolyte batteries will not spill significant amounts of electrolyte, even if the modules are broken in two. However, any clear fluid leaking from a Solectria vehicle should be treated as electrolyte with the potential for corrosion.

Avoid contact with the skin or inhaling fumes. Wear acid/base resistant rubber gloves, rubber boots, and protective clothing and stay up-wind. Dilute the spill with large amounts of water. Sodium bicarbonate (baking soda) may also be used cautiously to neutralize any electrolyte spills.

Disabling the Vehicle

The Force is virtually silent when turned on. The absence of noise or motor "running" sounds does not indicate that the vehicle is disabled.

Servicing the Car - Emergency Procedures

To secure the car, set the parking brake firmly by lifting the standard hand-operated brake lever between the front seats. Turn the Range-Power Selector, located on the floor console, to the OFF setting to prevent the vehicle from being driven.

Turn the key off, as you would in a conventional vehicle, to shut off the motor controller, thereby disconnecting the motor, and disabling 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).

To isolate accessories: To disconnect all high voltage electricity from all auxiliary systems (such as air conditioning, Amp-Hour Meter, heat, and the 12-volt DC-DC converter), disconnect the small, red one-pin Anderson Service Disconnect located between the large gray Anderson connector to the controller and the high voltage fuse box on the passenger side, front strut tower.

With this connector unplugged and the motor controller turned off (key off), the electrical power of the car is isolated to the battery boxes, the controller, the charger and the connector.

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. **The charger can be disabled by disconnecting the small black one-pin Anderson connector under the fuse box, or simply unplugging the charger output wires (2-pin red Anderson connector).**

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.

WARNING!

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.

To isolate batteries: Before removing any battery interconnect wires, the red one-pin Anderson Service Disconnect must be unplugged, the input to the controller must be unplugged, and the charger output wires must also be unplugged.

Once these operations are completed, all high voltage and low voltage power to the vehicle will be disabled. Note that each electronic box under the hood and bed may hold a charge for some time in capacitors even after being disconnected from the battery. Exposed conductors from these units should be treated with caution.

Following the procedure above for disabling the vehicle should make the vehicle "safe" while servicing it. For operator safety, battery boxes should be opened only by trained service personnel. Also, electrical cables should never be cut. Cutting cables presents additional safety problems, and is not recommended by Solectria. Failure to follow these guidelines could lead to serious injury.

Vehicle fires: Spray vehicle fires with dry chemical or carbon dioxide foam (ABC or BC extinguishers). In general, battery boxes should not be opened. However, if there are indications that a battery module is smoldering or heating up after an accident or fire, disconnecting the smoldering battery pack should eliminate the problem. **Follow the directions in the previous paragraph for isolating the battery pack.** To disconnect individual batteries, refer to the specific procedure in the text. As stated above, cutting cables and opening battery boxes create additional hazards that are best avoided if possible.

ADDITIONAL SERVICE INFORMATION

The 1997 Geo Metro Service Manual GMP/97-M (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, except for the following parts:

- Electric Drive System (motor, controller, transmission)
- Batteries
- Solectria Electronic Components
- Heating and Air Conditioning system
- Solectria - installed wiring

SERVICE NOTES

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

WARNING!

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 at reinforced sections of sub-frame and apply parking 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 vehicle. If you must tow with the front wheels (i.e., drive wheels) on the ground, never leave the key in the ON position and the regen disable switch in the DRY position. **Regenerative braking is enabled with the key ON and this could cause a high towing load and the batteries to be severely overcharged.** If you must tow in this manner, the regen disable switch must be set to the SLIPPERY position and the key turned OFF. **SEE "TOWING INSTRUCTIONS" IN APPENDIX C.**
7. **Washing:** Solectria does not recommend washing this vehicle in an automatic carwash.

STANDARD PRACTICES FOR WORKING ON OR NEAR HIGH VOLTAGE SYSTEMS

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 caddy, 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 Service Disconnect before removing a live device. (If the vehicle is not fully charged when you begin working on it, leave a note on the Amp-Hour counter with the reading before disconnecting it.) Always unplug vehicle from wall outlet while servicing.
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:
 - turn ignition key off
 - check the Amp-Hour counter and put a post-it note on the meter with the reading
 - disconnect 110VAC or 220VAC charging cord (gas cap) or other charger
 - disconnect the red 1-pin Anderson Service Disconnect
 - verify that the Amp-Hour counter has no power (no display should be visible)
 - install the controller or fuse
 - reattach the red connector and check that the Amp-Hour meter reads 00.00
 - plug charger cord into wall outlet
9. When servicing batteries, always isolate the battery pack from other components 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!**

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. The transmission oil level should be checked at every periodic maintenance.

Checking Transmission Oil Level

1. Turn ignition key off and set parking 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 12,000 miles thereafter, the transmission oil should be replaced.

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 parking 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 15ft.-lbs. **DO NOT OVERTIGHTEN.**
4. Allow sealer to set approximately 15 minutes before adding transmission oil.
5. 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 (Automatic Transmission Fluid).
6. Reinstall filler plug and check for leaks. Reinstall belly pan with new tie-wraps.

Replacement of Motor/Transmission Assembly

Note: Do NOT lower vehicle without drive axles installed. If you must move the vehicle, each of the front wheel bearings may be supported with a 9/16" bolt and nut and two 1 3/4" washers.

1. Turn ignition key off and apply parking 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 the front wheels and 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 12V wire harness connectors at the firewall from the motor cooling fan and the motor temperature sensor.
15. 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.
16. Remove the two Phillips screws attaching the motor cooling fan housing to the motor and carefully tilt it up and off the motor. The drivetrain will not clear the fuse box with the fan on.
17. 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.)
18. 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.

