

# GM SunRaycer Operations Guide

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## 1. Seat Belts

The seat belts have six separate webs: two lap belts, two shoulder harnesses, and two leg harnesses. The leg harnesses snap into clasps on each lap belt. The shoulder harnesses and lap belts attach together as shown in Figure 1. Tighten the lap belts first, then the shoulder belts. When leaving the vehicle, it helps to stow the leg belts through the bottom rim of the steering wheel.

## 2. Power System Block Diagram

A block diagram of the power system is shown in Figure 2. The arrows indicate the possible directions of power flow.

The solar array is partitioned into 20 separate substrings. Each adjacent pair of substrings feeds into a peak power tracker. The peak power tracker is a DC to DC converter which automatically optimizes the voltage on the solar panel, and feeds power into the battery buss at the buss voltage. The 10 peak power trackers are housed in a card cage with 12 slots. Slots 1-5 and 8-12 now have trackers.

## 3. Circuit Breaker Panel

Three circuit breakers to disconnect the motor, array, and batteries from the buss are housed in a panel to the driver's right. The functional locations of these breakers in the system block diagram are shown in Figure 2. Immediately to the left of the circuit breakers are the pre-charge pushbutton switches. These are needed to pre-charge capacitors in the motor-drive electronics.

To turn on any of the breakers, it is first necessary to hold down the corresponding pre-charge switch for 3 seconds (count one-one thousand, two-one thousand, etc). After 3 seconds, turn on the breaker before letting go of the pre-charge switch. The breakers can be turned off directly without pushing the precharge switch. The breaker box and a sample turn-on sequence are shown in Figure 3.

The SPEED and BATTERY CURRENT cruise controls are disabled when the driver pushes the brake pedal.

#### MIN VOLT LIMIT switch

This switch engages a mode in the motor drive electronics that prevents the buss voltage from dropping below 100 V. This limit should be engaged in order to operate the car with the battery disconnected from the buss.

#### Brakes (three kinds)

The brake pedal activates the hydraulic front disk brakes. Brake lights and cruise control interrupt are enabled by pushing this pedal.

The button on the steering wheel activates regenerative braking. Regenerative braking can only be used in the MANUAL operating mode with control by the accelerator pedal (POT/PEDAL set to PEDAL). When the button is pushed in, lifting off the accelerator pedal gives regenerative braking — the amount of braking depends on the position of the pedal. Zero braking occurs at 1/4 pedal travel, max when the pedal is fully released. The motor torque vs. accelerator pedal position is shown in Figure 5.

The emergency brake is a bicycle disk brake on the right rear wheel. It is activated by a bicycle-type brake lever. The lever also has a lock feature that can be used as a parking brake.

### 5. Instruments and Secondary Controls

#### **Right Panel:**

Meters for array current, battery current, motor current (into motor drive electronics), and buss voltage are on the right panel (Figure 4). The locations of these meters in the system block diagram and sign conventions are shown in Figure 2.

Also on the right panel is the battery amp-hour meter. The red LED next to it blinks at a rate proportional to battery current. The switch on the back of the amp hour meter reverses the direction of positive counting; the C+ position increases amp-hours as the battery charges, the D+ position increases amp-hours as the battery discharges. The battery has a maximum capacity of 30 Amp-hours.

### **Center Panel:**

Meters for speed, motor winding temperature, and motor torque are in the center panel above the steering wheel. There are also two red LED's: one lights up at motor torque above 50%, the other when there has been an over-current fault in the motor drive electronics. In the case of an over current fault, the car will be immobile and all circuit breakers should be shut off until the fault is located and corrected.

The maximum allowable motor winding temperature is 120 deg C.

### **Left Panel:**

The left panel (Figure 6) contains meters for temperatures, array string voltages and currents, and current for the 12V system. It also contains switches for turn signals, hazard lights, motor fan, battery fan, vent fan, and telemetry on/off.

The fans are controlled automatically by thermostats set to go on at 131 deg F (55 C), or can be manually overridden by the dash switches. The LED's above each switch light up whenever the fan is running. There are two thermostats controlling the motor fan -- one on the motor case and one on the encoder body. The fan turns on if either one reaches 55 C. The battery fan thermostat is in the battery duct just downstream of the fan. The vent fan thermostat is in the interior of the car near the vent fan.

Maximum temperatures are:

Encoder	80 C
Motor Driver	70 C
Tracker	70 C
Battery	60 C

The electronics (motor driver, tracker) should not be powered up if their temperatures are above 70 C (maybe because the car has been sitting in the sun). To check this, always power up the battery circuit breaker first. The battery supplies power to run the temperature sensing circuitry. If they are too hot, turn on the vent fan.

## 6. Startup Checklist

seat belts on  
Fwd/off/rev switch to off  
mode set to manual  
battery current set to zero  
charge mode  
pot/pedal to pedal  
torque pot to zero  
min volt limit off  
pre-charge 3 sec  
battery breaker ON  
    check buss voltage between 90 and 136  
    check motor drive and tracker temps  
pre-charge 3 sec  
array breaker ON  
pre-charge 3 sec  
motor breaker ON

## 7. General Notes

- There are no steering stops yet. Be careful not to turn the steering wheel too far. The normal range is 1/2 turn to either side of straight ahead
- The speed cruise control and speedometer operate from motor RPM. The electronics are now set up for the 20-inch Avocet Freestyle tires. The readings will be about 10% too fast with the smaller Moulton/Wolber tires.
- do not use reverse for regenerative braking.