

## Troubleshooting / start-up checklist

Safety – voltage, eye protection, moving parts, remove jewelry

Keep disconnect key in pocket

Test without motors connected use test lamp or VOM. (The lamp makes a better visual display)

Visual inspection – control board wiring

Test potentiometer adjustment

- o Connect VOM to leads from potentiometer.
- o Verify that the potentiometer reads between 0 and 20 ohms with the pedal in the “off” position.
- o Slowly depress the pedal while watching the resistance reading. The resistance should smoothly increase to a maximum of 5000 ohms with the pedal fully depressed.

Test F/R switch operation

- o Connect one lead of the VOM to the “red” wire to the switch. Connect the other lead to the “yellow” wire. With the switch in the center off position, the VOM should show no connection (high resistance). With the switch in both the forward and reverse positions, the VOM should show no resistance.
- o Leaving one lead connected to the “red” wire, connect the other lead to the “green” wire. You should see no resistance with the switch in reverse but high resistance when the switch is in forward.
- o Connect the VOM to the yellow and green wires. You should see no connection between these wires with the switch in the “off” or “forward” positions.

Connect accelerator, F/R switch, instrument wiring to the control board terminal strip.

Connect batteries to battery terminal strip

Connect jumpers – vehicle is now “hot” Review electrical safety procedures.

Test battery voltage at terminal strip – each pair (1&2, 3&4) and full pack (1&4)

Note voltage scale of VOM

### Circuit and Relay Test

- o Put one lead on most negative (1)
- o Follow positive wiring from #4, to disconnect, turn disconnect on, to main relay (R1) turn F/R Switch to F – should hear click, verify by feeling relay by hand that it vibrates when switch is turned on. Make sure Reverse relays (R2 & R3 do not operate in Forward.
- o Turn F/R switch to R – should hear louder click – verify that all three relays click
- o With F/R switch in F, check voltage between battery terminal 1 and B+ on controller.
- o Repeat test with switch in R
- o With F/R switch in F, check voltage between B+ and B-
- o Repeat test with switch in R
- o Turn off disconnect switch.

### Controller Test

- o Connect VOM (or test light) to B+ and M-
- o Turn disconnect switch on
- o Verify that voltage is 0 with F/R switch in both forward and in reverse
- o With switch in Forward, slowly depress accelerator – voltage should increase (If you are using a test light, the light will get brighter – the controller works just like a light dimmer)
- o Repeat the test with the F/R switch in reverse.
- o Turn the disconnect switch off

Note: the controller retains an electrical charge after the switch is turned off. Energy is stored in capacitors inside the controller. It is possible to receive a shock or cause arcing if the positive and negative leads are shorted. The VOM can be used to measure this stored energy. A test light can be used to bleed the energy off. Once a motor is connected, you will note that after turning the disconnect off, you will see the motor “jump when the F/R switch is pressed.

### Motor test

- o Connect the motor(s) to the control board as shown on the schematics
- o Support the rear wheels of the vehicle off the ground so that the wheels can spin freely
- o Turn the disconnect switch on
- o Make sure that everyone is clear of the rear wheels.
- o Place the F/R switch in Forward, slowly depress the accelerator. Note the direction of wheel rotation. If the wheels spin backwards, the motor leads must be reversed.

- o Verify that the wheels spin in the proper direction when the F/R switch is placed in reverse.
- o Remove the governor plug. Test the operation again. The motors should not operate with the plug removed.
- o Turn the disconnect off
- o Reinstall the governor plug

#### Test drive

- o Set the vehicle on the ground.
- o Roll it outdoors or to a large open area
- o Test the brakes while rolling the vehicle to verify that they work
- o Have your test driver wear safety glasses – tires can kick up small objects from the road. Protective clothing including long pants, long-sleeve shirt or jacket, gloves and shoe are recommended. A helmet is a good idea.
- o Make sure drivers use the seat belt. Establishing good safety procedures is essential. Be sure that the test area is clear – free of traffic and spectators are not in the path.
- o Drive slowly, test steering, brakes, and fittings before building speed.
- o As with any vehicle, careful testing and inspection are needed. This is a hand-built vehicle. Vibration can cause fittings and hardware to loosen.