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TecNote 2003 - Solar Power Assembly Troubleshooting

Primary Information

Foreground

The following information is applicable to any solar power system whether or not it is operating with a time switch or pager system. However, the procedures are described assuming this equipment exists. If your installation does not have such equipment, then simply disregard the reference.

Necessary Precautions and Steps

1. Read this following document carefully.
2. Make several copies and distribute it.
3. Incorrectly connecting the battery or solar panel wires can destroy the equipment.
4. DISCONNECT ALL ASSEMBLIES THAT HAVE ANY SYMPTOMS OF PROBLEMS.
5. DISCONNECT THE PAGER VIA THE WHITE PLUG DURING ALL CHECKOUT

Warnings

INCORRECTLY CONDUCTING TEST CAN DAMAGE EQUIPMENT AND CAUSE INJURY. TAKE EXTREME PRECAUTIONS WHEN MEASURING CURRENTS AS TO PREVENT SHORTING THE BATTERIES TOGETHER. SHORTED BATTERIES CAN EXPLODE.

Solar Panel

Verification Check List

1. Put ALL switches in the OFF position
2. Measure the voltage across the Solar Panels
3. Verify that the voltage is greater than 18 VDC, if not then go to SP-1 on troubleshooting list
4. With all switches in the OFF position, measure the current by placing the meter across the array. It should read at least 1.5 Amps per solar panel on a moderately sunny day, if not, then go to SP-2 on troubleshooting list.

Trouble Shooting List (SP)

1. The voltage needs to be checked at the solar panels themselves. It is important to verify that the diodes have been placed in the correct direction. However, to measure the voltage across the individual solar panel, temporarily remove one of the jumpers that place the panels in parallel. Measure the voltage on the terminal block. The voltage on each panel should exceed 18 VDC on a relatively sunny day. If the panels do meet the required voltage then closely inspect the diode jumpers for damage or incorrect placement. If everything checks out, then the problem must be in the wiring from the solar panel to the terminal blocks inside the cabinet. Check closely for corrosion between the lugs and the wiring. After checking for all potential faults, re-do the verification list.

Each solar panel on a very sunny day can supply around 3A. This is relatively consistent from panel to panel. If the panels are not providing the rated current, then there is possibly a bad connection or faulty wiring between the panels and the terminal block. If a bucket truck is available, then the current is best measured at each panel. A comparison of the current at each panel, and the current at the terminal block will indicate if the problem is with the wiring or the panel. If while measuring at the panel, the current does not meet the 1.5A per panel, then the panels are probably damaged, and in need of replacing.

Batteries

Verification Check List

1. Put ALL switches in the OFF position
2. Measure the voltage across the each of Batteries on the batteries themselves
3. Verify that the voltage is greater than 11 VDC, if not then go to B-1 on troubleshooting list
4. Put BATTERY #1 switches in the ON position
5. Measure the voltage across the Batteries
6. Verify that the voltage is greater than 11 VDC, if not then go to B-2 on troubleshooting list
7. Put ALL switches in the OFF position
8. Put BATTERY #2 switches in the ON position
9. Measure the voltage across the Batteries
10. Verify that the voltage is greater than 11 VDC, if not then go to B-2 on troubleshooting list
11. Put BATTERY #1 switches in the ON position
12. Put BATTERY #2 switches in the ON position
13. Measure the voltage across the Batteries
14. Verify that the voltage is greater than 11 VDC, if not then go to B-3 on troubleshooting list

Trouble Shooting List (B)

1. Low voltage does not necessarily indicate a bad battery - it can also be caused by lack of sunlight or a faulty charger. During long duration of cloud cover it is possible that it may not be receiving the necessary amount of re-charging. However, if sufficient sunlight has been available, then the charger and the battery become suspect. If the charger appears to be working intermittently, it may not be possible to isolate the charger as the cause by taking measurements on the charger (see Solar Charging for verification checklist). The best method is to replace the suspect battery/batteries with fully charged unit(s). If after an extended period of time the batteries drain down again, the suspect the charger system; otherwise the problem was fixed when the test batteries were placed in the cabinet.

2. If the battery shows the proper voltage on the battery posts, but not at the terminal block, then there is a fault in the wiring. Check for shorts, and check for continuity from the battery posts to the terminal block.

If each battery checks out fine at the battery posts and individually at the terminal block, but not when both battery switches are in the ON position, then you have a potentially dangerous situation. If this occurs, then IMMEDIATELY turn off all switches and disconnect all batteries. Very carefully check the battery wiring to insure that the polarity of the units have not been crossed.

Solar Charger (Method 1)

Method 1 verifies that there are no unexpected voltage drops in the system. This method helps trouble shoot faulty wiring, but does not check the current delivered by the charger.

Verification Check List

1. Put ALL switches in the OFF position
2. Put the ARRAY switch in the ON position
3. Measure the voltage across the Charger solar inputs
4. Verify that the voltage is greater than 18 VDC, if not then go to SC-1 on troubleshooting list
5. Measure the voltage across the Charger battery outputs
6. Verify that the voltage is greater than 11 VDC, if not then go to SC-2 on the troubleshooting list
7. Measure the voltage across the Charger load output
8. Verify that the voltage is greater than 11 VDC, if not then go to SC-3 on the troubleshooting list
9. Put the BATTERY switch in the ON position
10. Measure the voltage across the Charger battery outputs
11. Verify that the voltage is greater than 11 VDC, if not then go to SC-4 on the troubleshooting list
12. Put the TIMER switch in the ON position
13. Measure the voltage across the Charger load output
14. Verify that the voltage is greater than 11 VDC, if not then go to SC-5 on the troubleshooting list

Trouble Shooting List (SC)

1. If the input voltage of the solar panels in not at an adequate level, then the charger is unable to acquire enough power to charge the batteries. If the solar panels have already been verified (see the Solar Panel Verification List), then the problem exists in the wiring from the panels to the charger unit. Check for continuity from the solar panels to the charger solar input. Also inspect for shorts.

2. The charger must be providing power to the batteries in order for them to charge. The charger must be replaced if this is not properly functioning.

3. Similar to charging the batteries, the charger must also provide sufficient power to the load for it to operate properly. If this is not functioning, then the charger needs to be replaced.

4. If the batteries have been properly checked out (see the Battery Verification List), then the voltage should not be lower than the voltage on the batteries. This means that engaging the switch introduced a load on the output. Check continuity from the batteries to the charger, and look for shorts.

5. If the output of the charger provides the proper voltage level, but when the load is engaged it is unable to, then there is a potential problem with the power requirements of the load. It is possible that one of the loads has a fault, or that the load wiring has short. Disconnect the harness from the Chronomax, if the voltage level does not return to normal, then it is a definite wiring problem. If the voltage level does return to normal, then remove the beacon fuses and reconnect the harness. Check the voltage level with just the clock, if the voltage level falls below acceptable, then problem is in the clock or the harness. If the levels are sustained, then install each beacon fuse individual to identify which beacon wiring has the problem.

Solar Charger (Method 2)

Method 2 verifies that the charger is delivering the proper current to the batteries, but does not verify it is at the proper voltage levels. Measuring current does not indicate voltage drops due to corroded wiring or poor connections.

Verification Check List

1. Put ALL switches in the OFF position

2. Put Amp meter in the current path of the batteries. Disconnect the battery ground wire from the terminal block. Use the Amp meter to connect the battery ground wire to the terminal panel. This will allow the charge current to flow through the meter.

3. Disconnect the any equipment besides the clock

4. Turn on ONLY the battery switch, and the timer switch

5. Verify that the current measurement reads less than 100mA, if not, the see SC2-1.

6. Turn on the solar arrays

7. Verify that the current measurement jumps to at least 1.5A per panel, and the polarity sign changes. (If the other measurement was "-100 mA", then this should show "+3A").

8. Observe this for a few minutes to insure that the charger is not dropping out.

9. If the 3A does not hold the entire time, assuming batteries are not fully charged, then see SC2-2

Trouble Shooting List (SC2)

1. When the solar panel is disengaged, and the clock is turned on, the only current draw in the system should be from the clock. The clock typically draws less than 100mA. If this is not the case, then either the clock is damaged and drawing too much current, or there is a fault in the wiring. The measurement should definitely be above 50mA, and the clock should be operating.

2. As long as the batteries are not fully charged, then the charger will direct the full current load from the panels to batteries. Therefore, if the beacons are not active, then you should see almost the entire amount of current measured during the solar panels test being delivered into the batteries. If this is not the case, as long as the connectivity is fine, the charger is likely bad.

Chronomax Timer & Beacons

Verification Check List

1. Put ALL switches in the ON position
2. Verify that the Chronomax powers up, if not then go to CT-1 on the troubleshooting list
3. Press 'MAIN/DISP' to view the status of the clock
4. When the clock stops counting down, press 'ESC' to escape to the main menu
5. From the main menu, set the following parameters:

   SCHEDULE
   00 EDY 00:00 OFF
   COMM SETUP
   ID:0000 Baud:9600 Comm Tmr:3.0 Zone:0001 Fail Time:9999
   SET DUTY CYCLE
   Cycle- 40%

6. From the main menu, set the following parameters:

   MANUAL FLASH
   Flash - On

7. Verify that the LEDs on the clock panel are flashing, if not then go to CT-2 on the troubleshooting list
8. Verify that the BEACONS are flashing, if not then go to CT-3 in the troubleshooting list
9. From the main menu, set the following parameters:

   MANUAL FLASH
   Flash - Off

Trouble Shooting List (CT)

1. If the Chronomax does not power up, then there is either a problem with the clock itself, or the wiring. Remove the Chronomax from the harness and verify the DC input voltage on the harness. If the voltage is present, then the problem is inside the Chronomax, else carefully check continuity of the wiring, and check for shorts.
2. If the clock turns on for less then one minute, then automatically turns off, then check each of the EXCEPTIONS from the main menu. Verify that NO EXCEPTIONS were set in the clock. If the clock LEDS do not turn on at all, then there is a problem with the time switch.

3. If the beacons are not flashing, then two problems may exist. The first problem is that the DC flasher inside of the clock may have failed. To determine this, temporarily replace the clock. If the beacons flash after a temporary clock is installed, then the problem is with the DC flasher inside the clock. If the temporary clock does not solve the problem, the problem is in the wiring. Check the beacon fuses, and the continuity from the beacons to the time clock. It is best if the wiring is checked from the harness itself, this will provide a check of the harness.

Symptom Lists

This is a brief list compiled from user feedback in the field. THIS IS NOT A SUBSTITUTE FOR THE CHECKOUT. This is just a brief to make you aware of what might be wrong, and how things should and shouldn't be.

Feedback:

The Charger is showing a battery voltage higher than 14.5VDC.

Response:

The batteries are essentially connected in parallel. The charger has a regulator inside that charges the batteries up to about 14VDC, and then stops charging. There are only two conditions that could cause such a high voltage. One, the batteries are incorrectly connected. Two, the charger is bad. We have NEVER seen this occur in the field. CAREFULLY check the readings to insure that the charger reading and the actual voltage of the batteries at the terminal match. Sometimes chargers that are equipped with voltmeters do not always indicate the proper voltage. Never take checkout reading from the onboard meter, always use a standalone voltmeter.

Feedback:

The load current without the beacons on is greater than 00.2.

Response:

The load current without the beacons should show up as 00.1 or 00.0. The Chronomax is always drawing power, and it is less than 100mA. With the beacons active, the load current may surge as high as 1.5. Therefore, any load current displayed by the charger as greater than 02.0 clearly indicates either a piece of failed hardware, or a short in the load/battery wiring. A number greater than 10.0 indicates a severe short, or failed piece of hardware.

Feedback:

The time switch operates until I turn on the manual flash, at which time the unit turns off and experiences a power up reset.

Response:

The time switch has a low voltage sensing circuit. If the battery voltage is low, then turning on the beacons can surge current and cause the battery voltage to dip below the necessary level to sustain time switch operation. However, I HAVE SEEN THIS OCCUR, and it was caused because the batteries were not properly connected. The unit was trying to power itself and the beacons from the solar array, which can not handle the demand of the beacons. Essentially, the batteries were not connected in this situation.

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