ProStar Trouble Shooting Guide

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This troubleshooting guide assumes basic knowledge of circuits and the necessary safety precautions to be used when working with live circuits present in solar energy systems. The following equipment is necessary to troubleshoot and repair the ProStar controllers:

- Multimeter
- Adjustable Power Supply capable of supplying 2A at 15V
- Small lead acid battery (7aHr)
- Load, approximately 2A (automotive brake lamps Type 1156 work well)
- Screwdrivers, Large Phillips, small Phillips and flathead
- Soldering iron, solder and solder wick
- Wire cutters
- Needle nose pliers (for bending MOSFET leads)

The testing instructions assume the ProStar has been removed from the PV system and the cover has been removed from the ProStar.

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1. ProStar Overcharges Battery, ProStar Does not Charge battery Green LED stays on All night:

ProStar out of calibration or PWM/Input MOSFETs are damaged

a. Set the power supply voltage to approximately 13.5Vdc and connect to the battery terminals.
b. Measure voltage at TP12
   - Voltage should be greater than 20V.
   - If voltage is less than 20V, the MOSFET driver may bad
   - Check voltages at other test points as described below.
c. Measure the voltage at the PV input terminals. It should be zero volts.
   - If the battery voltage (about 13.5V) is measured at the PV input terminals, measure the voltage at TP10. If the voltage at TP10 is greater than 10V, the input MOSFETs are damaged and need to be replaced
d. Measure the voltage at TP10
   - Should be less than 0.5V
   - If higher than 5V Input when the green charging LED is off, MOSFETs are bad
   - If the green charging LED is on, the voltage at TP10 should be greater than 20V.
   - If the green charging LED is on and there is no power supply or PV array connected to the solar input terminals, the Input MOSFETs are bad.
e. Measure voltage at TP11
   - Should be less than 0.5V
   - If higher than 5V when the Green charging LED is off, the PWM MOSFETs are bad.
f. Connect a jumper wire between the PV(+) terminal and the Batt(+) terminal. Wait for the green charging LED to turn on.
g. Measure the voltages at TP10 and TP11 again.
   - The voltages should both be greater than 20V.
   - If the voltage at TP10 is less than 20V the Input MOSFETs are most likely damaged.
   - If the voltage at TP11 is less than 20V, the PWM MOSFETs are most likely damaged.
   - If the voltage at TP10, TP11 and TP12 is less than 20V, the MOSFET driver chip (IC2) or the capacitors C2 or C3 may be damaged.
   - See the MOSFET replacement section for instructions on replacing the MOSFETs.

2. LVD Does not work
Load Does Not Turn On

a. Connect a small load to the load terminals
b. Set the power supply voltage to approximately 13.5Vdc and connect to the battery terminals.
c. The load should not turn on until the start up sequence is complete. If the load turns on before the start up sequence is complete, the load MOSFETs are damaged and should be replaced. See Appendix A: ProStar MOSFET Replacement Procedures for instructions.
d. Measure voltage at TP12
   - Voltage should be greater than 20V.
   - If voltage is less than 20V, the MOSFET driver may bad
   - Check voltages at other test points as described below.
3. If the ProStar is equipped with a meter, press the red disconnect button to turn the controller off. If the load was on, the load should now be off
4. Measure the voltage at TP12. The voltage should be less than 2V. If not, the Load MOSFETs are damaged and should be replaced. See Appendix A: ProStar MOSFET Replacement Procedures for instructions.

3. Battery Type select does not change:

a. Start up controller with 13.5V power supply
b. Measure Voltage on Battery Select Pin (or TP7). The voltage should be greater than 4.3V.
c. Measure voltage on Pin 11 (middle pin on Right side of the chip) of IC6. The voltage should be greater than 4.5V
d. Measure voltage on Pin 10 of IC6 (just below pin 11 on the right side of the chip), it should be less than 0.5V
e. Measure voltage on Pin 9 of IC5 it should be < 0.5V
f. If the voltage at TP7 is less than 4.3V and the voltage at Pin 11 of IC6 is greater than 4.5V then replace diode D2 and resistor R41 and retest the controller. Be careful to observe the correct polarity when replacing the diode. The black band on the diode should be next to R41.
g. If the voltage at TP7 is less than 4.3V and the voltage at pin 11 of IC6 is less than 4.5V then replace capacitor C5 and retest the controller.
h. If the voltages at Pin 10 and Pin 11 of IC6 are the same then replace IC6 and retest the controller.
i. Measure and record voltage on Pin 8 and Pin 9 of IC5, they should be different. Pin 8 of IC5 is in the upper left-hand corner of the chip. Pin 9 is just below Pin 8. If they are the same, replace IC5.
j. Toggle battery select pin (briefly touch a wire from the pin to the PV(-) terminal). Measure and record voltage on Pin 8 and Pin 9 of IC5 again, the voltages should have changed if not, replace IC5 and retest the controller.
k. If the voltage on Pin 9 is low (less than 0.5V) then the LED is bad, replace LED1 and re-test the controller

Re-Testing the controller:
Connect a small (7aHr) battery to the battery terminals of the ProStar. Connect a power supply set to output 2A at 15V to the PV input terminals of the ProStar being careful to observe correct polarity. After two minutes, the green charging LED should have turned on and the ProStar should be charging the battery. Monitor the battery voltage, once the ProStar has gone into regulation mode, the power supply voltage will be higher than the battery voltage. Record the battery voltage then toggle the battery type select pin. Measure the battery voltage again, with the Green battery type LED off, the battery voltage should be about 0.3V higher than with the Green Battery Type LED on.

4. ProStar goes into LVD when battery voltage is greater than 11.6V

a. Connect a 13.5V power supply to the battery input terminals of the ProStar
b. Connect a jumper wire between the Battery Positive terminal and the battery sense positive terminal.
c. Measure the voltage at TP1 (the silver dot on the left below the chip that has MORNINGSTAR printed on it) the voltage here should be 1.85V (approx. 13.7% of the input voltage)
d. Measure the voltage at TP4 (to the right of TP1). The voltage here should also be 1.85V.
e. Disconnect the Power supply and reconnect the power supply to restart the ProStar
f. With the jumper wire in place, the ProStar should not go into LVD. If the ProStar does not go into LVD and the voltage at TP1 is less than 1V, replace C9 and C10 and re-test.
g. If the voltage at TP4 is less than 1V, replace C7 and C8 and re-test the controller.
h. If the voltage at TP1 is approximately 1.85V or if the voltages at both TP1 and TP4 are less than 1V and all four capacitors (C7, C8, C9 and C10) have been replaced then replace the microcontroller (IC3) and re-test.

5. Meter does not work
Bad values on meter display
Voltage and/or current readings are not accurate
Red button does not function

Currently Morningstar has not developed repair procedures for the ProStar meter boards. The current procedure is to remove the nonfunctioning meter board, replace it with a new meter board and recalibrate the ProStar with the new meter board.

The meter operates independently of the ProStar. If the meter is malfunctioning and no replacement meter is immediately available, the meter can be removed from the ProStar and the controller will function as a non-metered controller.

Meter failures fall into three main categories.

1) Meters are not calibrated. To re-calibrate the meter, refer to "ProStar Meter Adjustment" for calibration instructions.
2) Meter driver chip is bad – meter shows garbage or erratic readings (for example a battery voltage of 50V for a 12V system). This requires the meter to be replaced with a working meter board.
3) The load and/or PV currents are reading zero amps when the system is functioning. The main cause of this problem is multiple system grounds (i.e. the PV negative leg grounded, the battery negative leg grounded and the load negative grounded). Refer to "ProStar Meter Verification" for testing information.

ProStar Meter Verification:

Valid only for ProStar charge controllers with the battery select pin.

Materials required:

- Power Supply, 2A @ 13.5V (or a well charged battery)
- 1-2A (approx.) load – measure the load current before the test
- Volt meter
- Phillips and Flathead screwdriver

Test Steps:

1. Remove cover from the ProStar
2. Connect the power supply negative lead to the ProStar's PV(-) terminal
3. Connect the power supply positive lead to the ProStar's Battery (+) terminal
4. Connect the load to the ProStar load (+) and load (-) terminals
5. Turn the Power supply on
6. The ProStar meter will cycle between the Battery voltage, the PV input current and the Load output current.
7. Measure the voltage at the ProStar battery terminals. The measured voltage should agree (+/- 0.1Vdc) with the value displayed on the ProStar meter.
8. If the PV input current and the load output current are equal (+/- 0.1Adc) and agree with the actual load current (+/- 0.1A) then the meter is functioning correctly.

6. Controller does not start

a. Meter functions but controller does not start.
   - In some cases, the meter will fail and cause the controller not to start. If a metered controller fails to start (only the green battery type LED lights up), remove the meter and retest the controller.

b. Controller has no meter and does not start
   - Measure the voltage at TP2. The voltage here should be +5V, if it is significantly less than +5V, there is either a short circuit on the PC board or one of the following components has gone bad:
     - IC1 – REF02, +5V supply
     - IC3 – the microcontroller
     - IC5 – 74HC74M flip flop
     - IC6 – 74HC14 Hex Schmidt Trigger
     - C13 - 10µF, 25V electrolytic capacitor

c. Controller stays in the start up sequence (LED's continuously sequence from left to right)
   - Check for a short circuit between the load(+) and load(-) terminals
     - Check for foreign material around the load terminals and between the PSB and the heat sink.
     - If a short circuit exists, replace the transorb TS2
   - Check the voltage at TP12
     - If the voltage at TP12 is close to the battery voltage, replace the load MOSFETs
     - If the voltage is less than 2V, the load MOSFETs are good.
   - Measure the voltage at Pin 2 and Pin19 if IC2
     - If the voltage at Pin 19 is close to the battery voltage and if the voltage at Pin 2 is less than 1.5V, replace IC2
     - If the voltage at Pin 2 of IC2 is above 3V, IC2 is most likely good
   - Measure the voltage at Pin 2 of IC6.
     - The voltage at Pin 2 should be greater than 4.6V and the voltage at Pin 1 should be less than 1V.
     - If the voltages at Pin 1 and Pin 2 are the same, replace IC6.

Appendices:

A. ProStar MOSFET Replacement Instructions
B. ProStar Test Point Summary
C. ProStar Microcontroller Pin Out Summary
D. ProStar PCB Silk Screen
E. ProStar V4.0 Schematics

Appendix A: ProStar MOSFET Replacement Procedures

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(Assumes bad FET's have been located)*

Required tools:

- Solder iron
- Solder wick
- Solder sucker
- Solder
- Philips screwdriver
- Wire clippers

Caution:

Exercise caution when soldering. Protective eyewear is recommended.

Procedure:

1) Remove the four screws holding the plastic cover.

2) Remove Screws holding MOSFET's to heat sink.

3) Separate Printed Circuit Board (PCB) from heat sink. Keep the five plastic spacers in a safe place. Do not wipe white thermal compound off the heat sink.

4) From bottom of ProStar PCB, cut MOSFET leads to remove package from board.

5) Use soldering iron & solder sucker and/or solder wick to remove solder from FET leads and remove FET leads from the PC board.

6) Clear solder from holes with solder sucker and/or wick.

7) Using existing MOSFET's as a guide, carefully bend the replacement MOSFET leads to match the MOSFET hole pattern.

8) Insert MOSFET leads into holes but do not solder yet.

9) Reinsert the five plastic spacers in the heat sink.

10) While holding loose FETs in position, place PCB back on top of heat sink

11) Carefully re-attach MOSFET's to heat sink with short screws, starting with MOSFET's currently soldered to board and finishing up with the new MOSFET's. Do not tighten screws until all MOSFET's have been attached to the heat sink.

12) Insure the new MOSFET leads are in the proper holes and the replacement MOSFET's are sitting flat on the heatsink. Gently tighten all screws being careful not to over-tighten the screws so as not to crack the MOSFET cases.

13) After all the screws have been tightened, solder the MOSFET leads to the PCB being careful not to bridge solder between the leads. Note that it is only necessary to apply solder to the top side of the board. When the MOSFET leads and PCB are properly heated, the solder will fill the entire mounting hole.

14) Once the solder has cooled, desired trim the MOSFET leads if desired.

15) Inspect the installation for solder bridging between MOSFET leads and to make sure the solder has flowed into the mounting holes.

16) Check the PV input terminals with an ohmmeter to insure there are no short circuits.

17) Test the controller for correct operation using the Field or Bench testing instructions.

* Bad FETs can be determined via the ProStar field or bench testing instructions

Appendix B: ProStar Test Point Summary

The test point values are valid when a +12.0Vdc supply is connected to the PV(+), Battery (+) and Sense(+) terminals.

NAME	TEST POINT #	HIGH	NOMINAL	LOW
Battery Input	1	1.700	1.671	1.640
Power Supply	2	5.015	5.000	4.985
Temp @25°C *	3	644mV	628mV	612mV
Sense Input	4	1.700	1.671	1.640
Array Input	5	65mV	60.9mV	55mV
EEPROM (none)	6	5.015	4.98	4.7
Battery Select	7	5.0	4.56	4.0
Spare	8	----	----	----
Isolation Voltage	9	11.75	11.6	9.0
Isolation Gate Drive – OFF	10	100mV	40mV	10mV
Isolation Gate Drive – ON	10	24	20	18
PWM Gate Drive – OFF	11	1.6	1.0	600mV
PWM Gate Drive – ON	11	24	20	18
Load Gate Drive – OFF	12	100mV	40mV	10mV
Load Gate Drive – ON	12	24	20	18

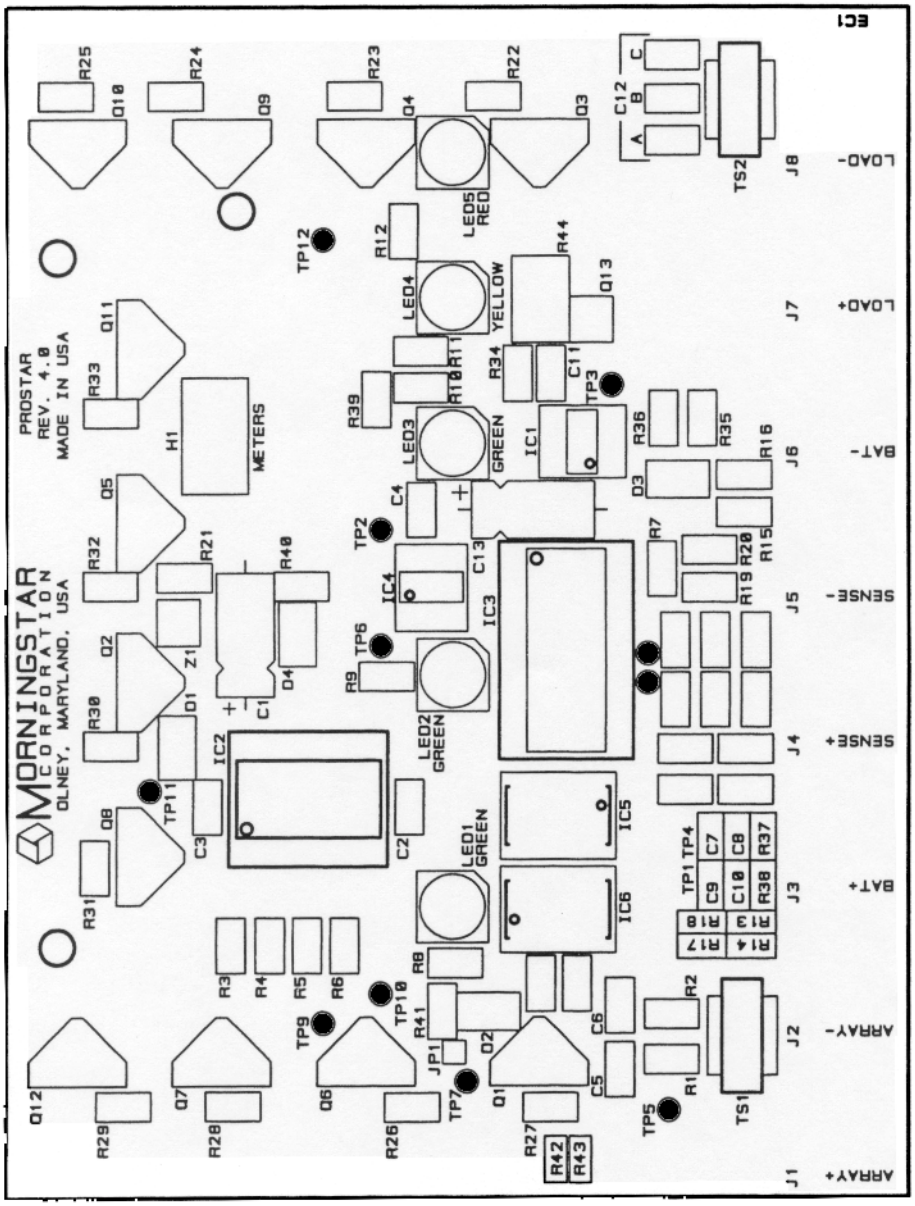
* These values are approximate and depend on the temperature of the controller. If the regulation voltage is correct for the ambient temperature this value is correct by default.

Appendix C: ProStar Microcontroller Pin Out Summary

Pin Number	ProStar Function
1	Digital +5V Supply
2	Not Used
3	Not Used
4	Not Used
5	Battery Type Selection
6	Shorted Load Detection
7	Battery Type LED
8	Battery Full LED
9	Battery 50% LED
10	Charging LED
11	Night Isolation FET
12	Load FET
13	Not Used
14	Not Used
15	PWM FET
16	Battery Low LED
17	Analog Ground
18	Array Voltage
19	Not Used
20	Battery Voltage
21	Battery Sense Voltage
22	Load Current
23	REF02 Temperature
24	Analog +5V Supply
25	External Reset
26	Oscillator In 1
27	Oscillator In 2
28	Digital Ground

* Pin 1 is located on the upper right corner of the chip.

Appendix D: ProStar PCB Silk Screen



PROSTAR 4.0 TOP SILK SCREEN
SCALE 3:2 VIEWED FROM TOP