ProStar Bench Test Instructions

Morningstar Corporation

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Tools:

Phillips screwdriver
Flat-blade screwdriver
DMM(digital multimeter)
Power supply, 20V 2A or similar
Small Ah 12V battery (~10Ah)
Small 12VDC load (eg. Small 1/3A bulb)

NOTE: All equipment ratings and testing values are for 12/24V ProStars. Multiply all voltage ratings and values by 4 for 48V controllers

1. Getting Started

A few things to do before we begin.

Disconnect unit from system wiring

- Open disconnects, switch off breakers
- Be careful not to short or damage the controller when removing

Inspect for physical damage to case, heatsink, or protruding components

Remove cover (keep handy to reference terminal positions when wiring during testing)

- Flip the unit over (face down)
- Remove the 4 screws that secure the black heat sink to the plastic enclosure
- Carefully remove the plastic case

Not necessary to remove external temperature probe if installed

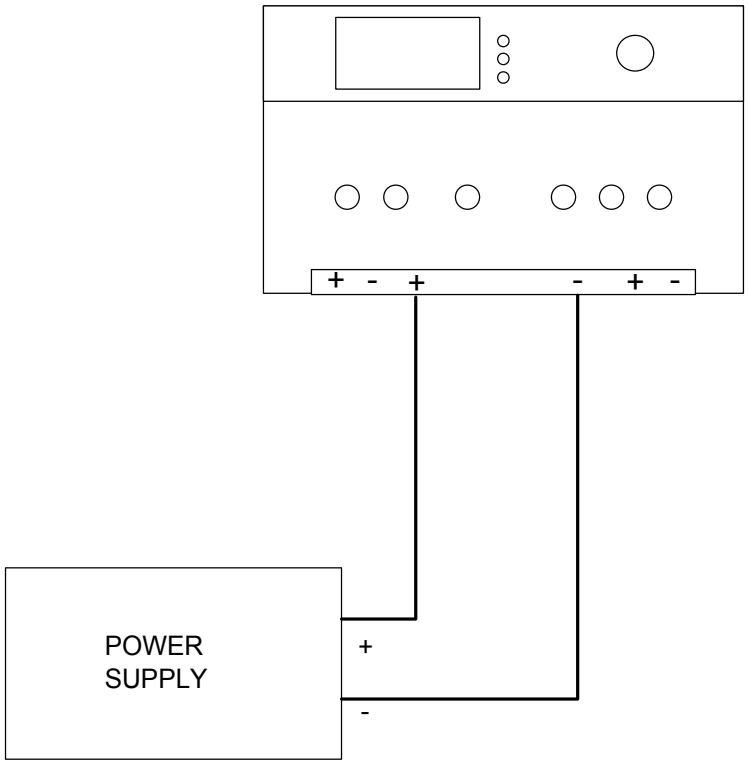
2. Power Up Unit

The controller's power up routine indicates that the processor is operating and that the controller has not had a catastrophic failure.

Procedure

Attach a small power supply as battery:

- Power supply positive to “Battery +” on the controller
- Power supply negative to “Battery –“ on the controller



Wiring Diagram

Correct operation

- The unit performs a power up sequence:
- illuminates “Battery Status” LEDS Green→Yellow→Red
- illuminates only one “Battery Status” LED corresponding to the batteries state of charge
- If the unit has a meter, the meter should begin displaying each of the 3 values(Vbatt,Iarray,Iload)
- The “Charging” LED does NOT come on

Failure

- The unit showed no signs of life
    - Damaged processor,
    - Damaged power supply
    - other failure
- Some/All LEDs illuminated, but no sequence
    - damaged processor
- An LED in the start up sequence did not illuminate
    - Bad or incorrectly mounted LED
    - damaged processor pin

- An LED on the Meter did not illuminate during a reading
  - Bad or incorrectly mounted LED
  - Bad meter connection
  - Damaged LCD driver

3. Self-Test Routine (Meter Option Only)

The self-test routine is special software run by the processor to check internal circuits for correct operation. This step is for units with the digital meter only. Go to step 4 if your unit does not have a meter.

Procedure

Same wiring as step 2
Press and hold the disconnect button for approximately 4-5 seconds.

Correct Operation

The unit begins the self-test routine:

Item Displayed	Notes
8.8.8	**Should display on the meter after 4-5sec and remain until the button is release**
12u / 24u / 48u	**System voltage**
15A / 30A	**Controller current rating**
r1.X	**Code revision number where "X" is a number**
- - -	**Indicates that no errors were detected**
25c	**Ambient temperature at the controller**
rP	**Remote temperature probe is detected**
25c	**Measured temperature of remote probe(if probe detected)**
Sen	**Battery sense lines detected**
S-X	**Battery select switch position (X=1,2,or 3)**
J-1	**Telecom noise jumper cut**
End	**Self test is complete**
End - - - End	**Sequences until disconnect button is pushed**

Notes:
1. Items in gray may not be displayed if probe or sense lines not connected
2. You may perform the test several times until you are certain you view all the information. To hasten the process, pushing the disconnect button during the self-test will immediately advance to the next displayed value

Failure

- It gets about halfway through the test, then the controller resets!
  - check if there is something shorting the load +/- terminals of the controller.

- During the self-test routine, it displays an error code(s) “EXX” where XX is a number.
    - Refer to *table 1* below to troubleshoot any errors found.

Table 1. Error Summary of Self-Test

Error	Description	Possible Causes	Solutions	Notes
E01	Battery Switch	Battery switch in empty 4th position, in between positons, or switch damaged	Use a screwdriver to ensure that one of the 3 battery types is selected. The switch should click into place	
E03	Reference or Regulator	Reference diode or 5V regulator damaged/out of calibaration	Not a user serviceable failure	May cause a variety of other errors and failures
E04	Array Side	Damaged Input MOSFETS Processor A/D channel damaged Array shunt circuit damaged	Refer to step 4 to confirm failure Not a user serviceable failure Not a user serviceable failure	
E07	Load MOSFETs	Load MOSFETs shorted Load Gate drive damaged Load +/- jumpered together	Replace Load MOSFETS Not a user serviceable failure Check for debris or other objects shorting the load terminals	No LVD functionality No load over-current protection
E08	Load Current Zerot	Load current amplifier damaged Load MOSFETs damaged Load current circuit damaged	Not a user serviceable failure Replace Load MOSFETs Not a user serviceable failure	
E09	Load MOSFET Open	Load MOSFETS open Load gate drive damaged	Replace Load MOSFETS Not a user serviceable failure	May reset the processor if short exists on load terminals
E10	Internal temp probe open	Temp sensor damaged Temp sensor cut/open	Replace temp sensor with a 2N3904 BJT transistor Repair / Replace temp sensor with a 2N3904 BJT transistor Not a user serviceable	No over-temperature protection

		Reference voltage too low	failure	
E11	Internal temp probe shorted	Temp sensor damaged Temp sensor shorted	Replace temp sensor with a 2N3904 BJT transistor Inspect for debris, find and fix short	
E12	Remote temp probe out of range	Temp sensor leads shorted Temp sensor leads damaged Reference voltage too low	Remove remote temperature probe, inspect for pinched cable, re-test without probe connected Replace probe Not a user serviceable failure	Defaults to on-board temperature sensor. Can not detect open remote temp probe, but “rP” will not be listed in self-test if probe not found. If you do not have a probe attached and still get this error, check the connection point on the board where the probe would be soldered for a short. Else, the reference is probably bad.
E13	Sense detect	Long battery leads cause excessive drop The “Sense – “ terminal is not connected	Minimize length of cables from battery to controller, Maximize cable gauge Be sure both battery sense lines are securely attached and that they are not damaged	

4. Check PV / Battery MOSFETs

The input MOSFET power transistors allow the controller to switch the power from the array to the battery/load.

Procedure

Attach a small Ah battery:

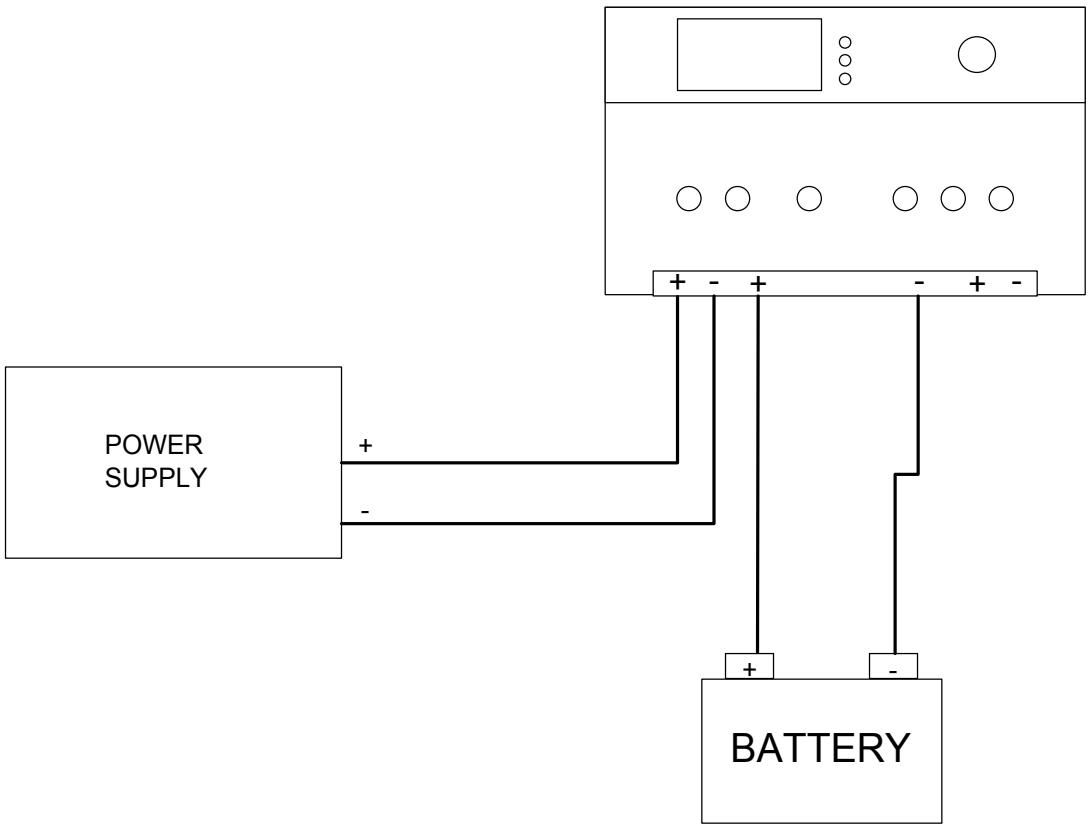
- Battery positive terminal to “Battery +” on the controller

- Battery negative terminal to “Battery –“ on the controller

Note the status of the “Charging” LED
Adjust power supply to ~16V, set current limit to ~1A
Turn off power supply
Attach the power supply

- Power supply positive lead to “Solar +” on the controller
- Power supply negative lead to “Solar –“ on the controller

Turn on power supply
Measure the “Array +/-“ voltage
Measure the “Battery +/-“ voltage



Wiring Diagram

Correct Operation

- Before the power supply is attached, the “Charging” LED should be off
- After the power supply is attached and turned on, the “Charging” LED should be illuminated
- If the battery is not fully charged(i.e. below the regulation voltage), the measured Array and Battery voltages should be the same value (+/- 0.2V)

Failure

- The “Charging” LED illuminates as soon as the battery is attached, without a power supply attached
    - MOSFETS may be damaged in a “shorted” state
- The “Charging” LED never illuminates after the power supply is attached
    - MOSFETS may be damaged in an “open” state
    - Damaged gate drive
- The measured array voltage is greater than the measured battery voltage
    - MOSFETS may be damaged in an “open” state or running linear
    - Damaged gate drive

5. Battery Removal Protection

Battery removal protection will shut down the controller in the event that the battery is removed while the Array is still connected. This protects any loads connected to the controller from the high voltage of the PV array.

Procedure

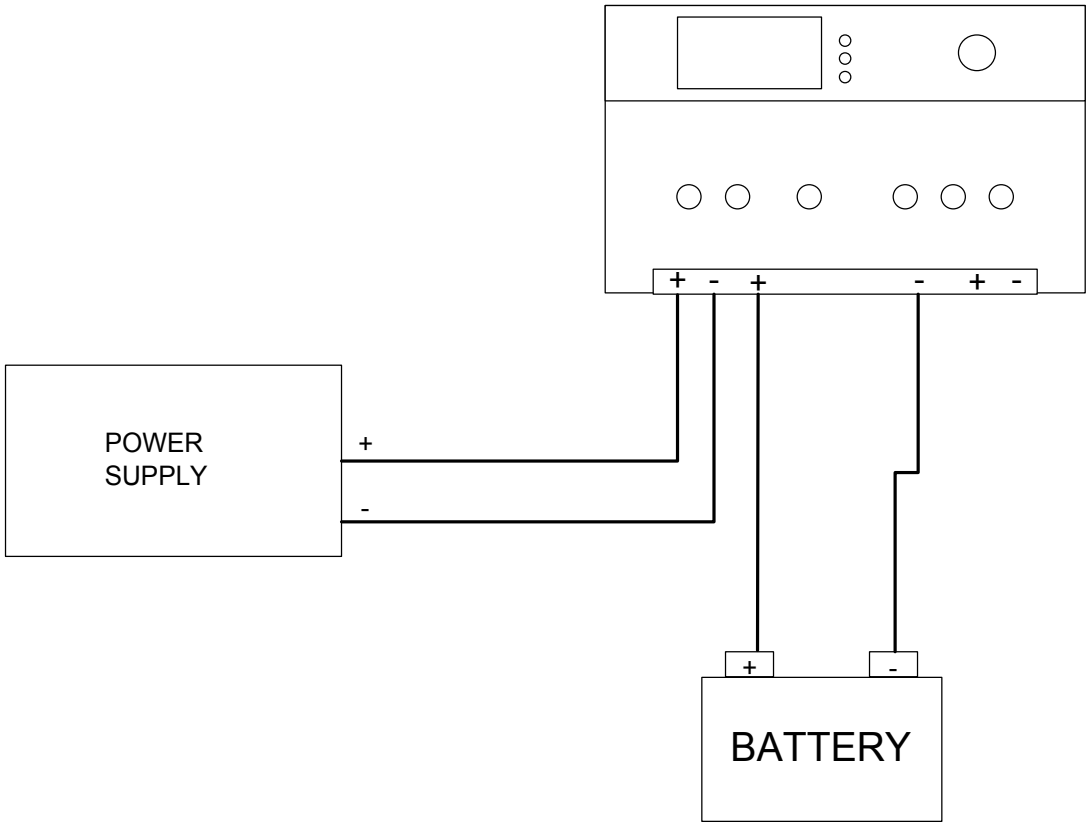
Attach a small Ah battery:

- Battery positive terminal to “Battery +” on the controller
- Battery negative terminal to “Battery –“ on the controller

Adjust power supply to ~16V, set current limit to ~1A
Turn off power supply
Attach the power supply or PV panel:

- Power supply positive lead to “Solar +” on the controller
- Power supply negative lead to “Solar –“ on the controller

Turn on power supply
Remove one of the battery leads (positive or negative)



Wiring Diagram

Correct Operation

- When the battery lead is disconnected, the controller shuts down immediately.(All LEDS turn off)

Failure

- When the battery lead is disconnected, the controller still operates (LEDS still illuminated)

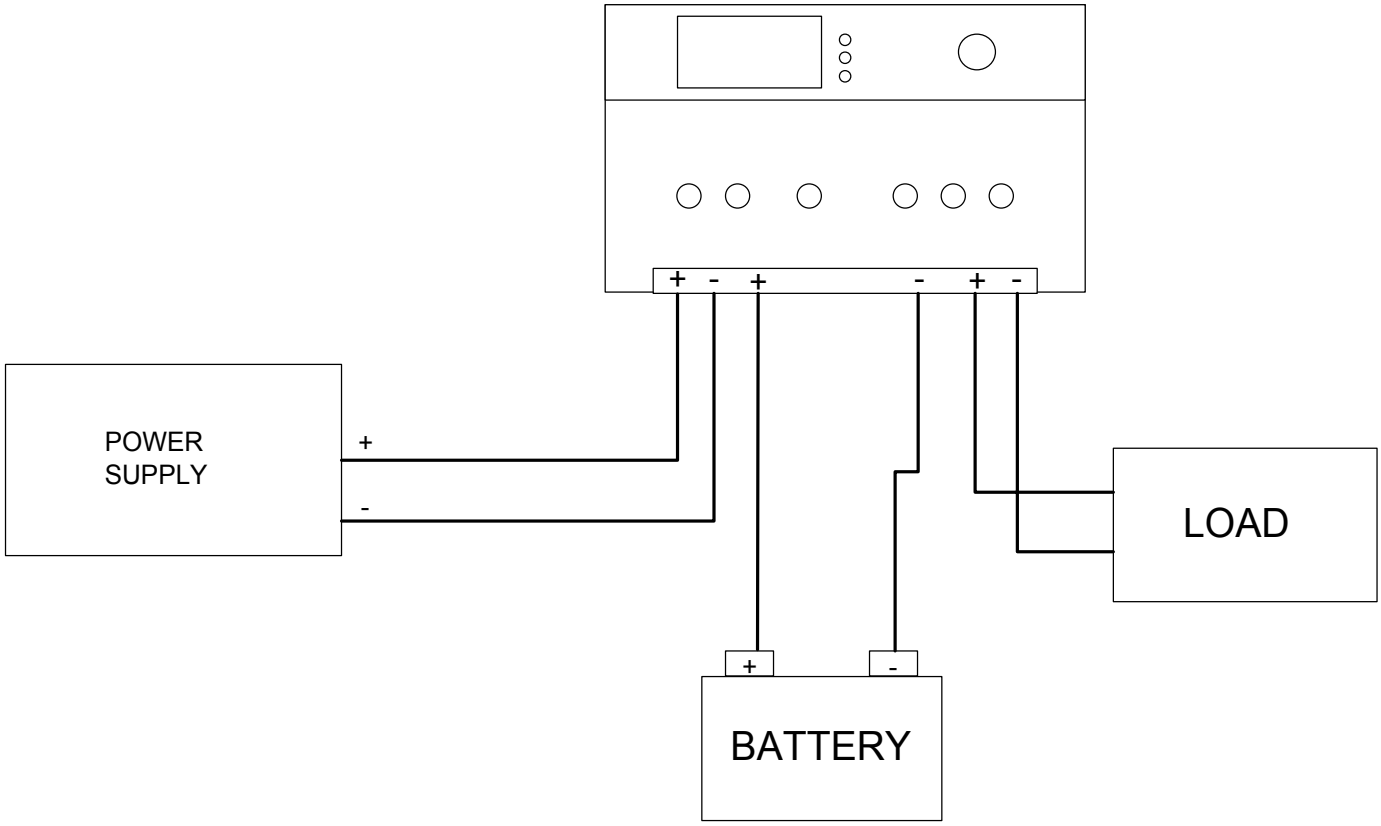
6. Putting It All Together

This last step will check the overall function of the controller, and provides one final check that everything is working properly

Procedure

1. Wire a small load to the load terminals of the controller
2. Attach a small Ah battery:
   - Battery positive terminal to “Battery +” on the controller
   - Battery negative terminal to “Battery –“ on the controller

3. Watch start-up sequence and observe when the load turns on.
4. Adjust power supply to ~16V, set current limit to ~1A
5. Turn off power supply
6. Attach the power supply
7. Power supply positive lead to “Solar +” on the controller
8. Power supply negative lead to “Solar –“ on the controller
9. Wire a small load to the load terminals of the controller
10. Turn on the powersupply



Wiring Diagram

Testing Operation

- The load turns on AFTER the controller finishes the start-up sequence. If the load turns on before the start-up sequence, the load MOSFETs may be damaged.
- The “Charging” LED is illuminated.
- The Load turns off when the disconnect button is pressed once. (meter units will display “OFF” for load current reading)
- The Load turns on again when the button is pressed a second time.
- When the disconnect button is pressed and held for 3 seconds, then released, the load turns off and the “Charging” LED turns off – disconnecting both Load and Array. (meter units will display “OFF” for both Load and Array current)

- Press the button and release once more and both the PV and Load are reconnected.