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Solar Panel Output Testing and Verification Guide

Purpose

The purpose of this guide is to verify solar panel output and charging margin in Opti solar installations using voltage-based measurements. These tests help determine whether the solar array is performing as expected or if limited solar input may be contributing to incomplete battery recovery or recurring offline events.

This procedure does not evaluate battery health, controller configuration, or downstream loads and should be used as an initial diagnostic step.

When to measure

- Perform this measurement during **clear or mostly sunny conditions**
- Avoid testing during heavy overcast, rain, dawn, dusk, or rapidly changing cloud cover
- Testing under poor solar conditions will reduce measured voltage and may lead to incorrect conclusions

Quick Reference - Measurement Steps

These steps describe how to collect measurements only; interpretation and decision guidance are provided in the sections that follow

- Confirm the installed solar panel matches the panel referenced in this guide; verify using the manufacturer label on the back of the panel if needed
- Measure PV voltage at the charge controller with the panel connected (Step 2)
- Use the results from Step 2 to assess available charging margin
- Perform open-circuit voltage testing (Step 3) at the panel only if PV voltage under load is marginal or low as defined in Step 2

Step 1 – Confirm Installed Solar Panel

Purpose

Before performing output testing, confirm the installed solar panel model so measured voltage values can be compared accurately against expected performance.

Referenced Panel (Assumed Configuration)

This guide references the Sonali Solar SS-180 to SS-210 (24V) series, a 72-cell module commonly deployed in Opti solar installations. Key electrical characteristics for this panel family include:

- Nominal operating voltage (Vmp): approximately 36–38 V
- Open-circuit voltage (Voc): approximately 45–46 V
- Panel rating: 180–210 W
- Configuration: two panels feeding a 24V ProStar MPPT-25M charge controller

These values are used throughout this guide when interpreting test results.

Verification

1. Locate the manufacturer label (sticker) on the back (underside) of the solar panel.
   - The label is typically located near the lower edge or corner of the panel frame, as shown in the image below.
2. Verify that the manufacturer and model match the Sonali SS-180–210 (24V) series referenced in this guide.
3. If the installed panel differs from the panel referenced in this guide, please provide a clear photo of the label before proceeding with testing.

Why this matters

Solar panel voltage output varies by panel type and configuration. Confirming the installed

panel ensures that measured voltage values are interpreted correctly and prevents incorrect conclusions about system performance.

Tools Required

- Multimeter capable of measuring DC voltage
- Small screwdriver (Phillips #1 or #2) to remove the charge controller terminal cover (if applicable)
- Mobile phone or camera to capture a photo of the solar panel label and / or charge controller if verification is needed.

Notes

- A clamp-on current meter is not required for this procedure
- No solar panel disconnection is required for initial voltage testing
- All measurements should be performed during daylight hours

Step 2. Measure PV voltage at the charge controller (panel connected)

Purpose

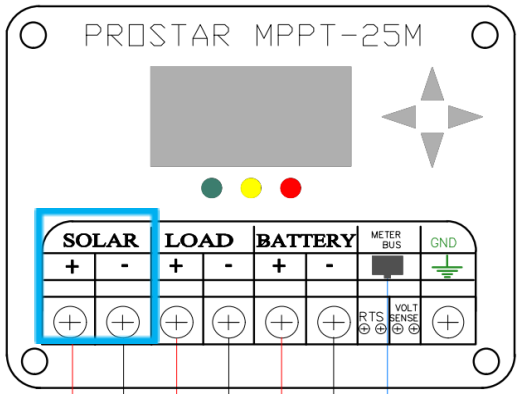
This step verifies that the solar panel is producing sufficient voltage under load under favorable solar conditions and that adequate charging margin is available to support battery recovery during periods of reduced sunlight.

Where to measure

- Measure directly at the PV+ and PV– terminals on the solar charge controller
- On the ProStar MPPT-25M controller, these are the leftmost large terminals labeled “Solar +” and “Solar –”
- The solar panel should remain connected to the charge controller for this test

How to measure

1. Set the meter to measure DC volts
2. Leave the solar panel connected and the system energized
3. Place the meter probes on the Solar + and Solar – terminals
4. Allow the reading to stabilize before recording the value



Expected results (clear or mostly sunny conditions)
Measured PV voltage will vary with panel temperature and charging state. Use the ranges below to assess available charging margin.

• 35–38 V Indicates strong solar input and healthy charging margin
System is well positioned to recover batteries even after several low-sun days
• 34–35 V Acceptable but reduced charging margin
System may struggle to fully recover batteries during extended periods of poor weather
• 30–33 V Marginal charging margin
Increased risk of incomplete battery recovery following multiple low-sun days
• Below approximately 30 V Insufficient solar input under load
High likelihood of recurring overnight outages during periods of reduced sunlight

Interpretation notes
• This measurement is intended to establish solar capacity under favorable conditions
• If PV voltage is marginal or low during clear conditions, system performance will be further reduced during overcast or winter weather
• ProStar MPPT-25M controllers may briefly adjust voltage during charging transitions; focus on sustained values rather than momentary dips

Next step
If PV voltage values are consistently marginal or low under clear conditions, proceed to Step 3 to measure open-circuit voltage (Voc) to further assess panel condition.

Step 3. Measure open-circuit voltage (Voc) at the solar panel

Purpose
This step checks the condition of the solar panel itself by measuring open-circuit voltage (Voc).

This test helps determine whether the panel is operating normally or if reduced performance may be caused by panel damage, failed internal cell strings, or wiring issues.

Where to measure

• Measure directly at the solar panel output wires after they have been disconnected from the charge controller
• Take this measurement as close to the panel as practical

How to measure

1. Turn off the solar input by opening the solar breaker or disconnecting the solar panel wires at the charge controller
2. Make sure the solar panel wires are completely disconnected and not touching the controller, each other, or any metal surfaces
3. Set the meter to measure DC volts
4. Place the meter probes on the positive and negative solar panel wires
5. Allow the reading to stabilize before recording the value

Safety notes

• A sunlit solar panel will continue producing voltage even when disconnected
• Do not allow the exposed panel wires to touch each other or grounded metal surfaces; this can cause brief arcing, inaccurate measurements, or damage to panel wiring and internal components

Expected results (clear or mostly sunny conditions)

Use the ranges below to assess panel condition.

• 42–46 V Indicates normal open-circuit voltage
Panel cell strings and bypass diodes appear to be functioning as expected
• 40–42 V Lower than ideal open-circuit voltage
May be acceptable depending on panel temperature, but indicates reduced margin
• Below approximately 40 V Indicates abnormal open-circuit voltage
Suggests possible panel damage, failed cell strings, degraded connections, or wiring issues

Interpretation notes

• Open-circuit voltage shows panel behavior without any system load applied
• A healthy panel should show normal open-circuit voltage even if PV voltage under load is reduced
• Low open-circuit voltage under clear conditions strongly points to a panel-side issue rather than a controller or battery limitation

Assessing Solar Panel Health Using Data from Steps 2 and 3 Above

These two steps answer different questions about the same solar panel.

Step 2 asks:
What does the panel do when the system is actually trying to use it?

Step 3 asks:
What is the panel capable of doing on its own?

Together, these steps compare PV voltage under load (Step 2) to open-circuit voltage with no load (Step 3). The relationship between these two measurements helps determine where a performance limitation or fault is occurring.

Interpreting combined results from Steps 2 and 3

- **Step 2 is low, Step 3 is normal**

This indicates the solar panel itself is healthy, but voltage drops once load is applied.
Likely causes include:
- Insufficient solar capacity for the site
- Shading or soiling that becomes limiting under load
- Wiring losses between the panel and charge controller
- Overall system design margin that is too tight for extended periods of poor weather

This is the most common scenario; all components may be functioning normally, but available solar energy is not sufficient under real operating conditions.

- **Step 2 is low, Step 3 is also low**

This points to a panel-side issue rather than a system limitation.
Likely causes include:
- Failed internal cell strings
- Degraded bypass diodes
- Internal panel damage or advanced aging
- Poor connections at the panel leads or junction box

In this case, panel repair or replacement is typically required.

- **Step 2 is normal, Step 3 is normal**

The solar panel is performing as expected under both load and no-load conditions.

If outages or instability persist, the issue is likely elsewhere in the system, such as:
- Battery capacity or condition
- Charge controller configuration
- Load profile or overnight energy demand

- **Step 2 is normal, Step 3 is slightly reduced**

This is often temperature-related and may be acceptable.
If the system still struggles during extended poor weather, this pattern typically indicates limited system margin rather than a discrete fault.