Commissioning Test Checklist

Print this sheet and fill it in on commissioning day. Test every circuit before it carries power, write down what you measured, and then energize one piece at a time in an order that the manuals agree with. See Chapter 27.

A first power-up done in the wrong order, or with one string wired backward, can destroy an inverter in a second, and the warranty may not cover it. Plan a full day, in good weather, with clear sky around midday for the PV tests. Have a helper.

The order below is common for all-in-ones: battery first, then inverter, then PV, then loads. Some makers want a different order. **Follow your manual** where it differs from this chapter. Verify against your manuals, your local code, and the NEC.

Your site. Date: _____ Time: _____ Weather: _____

Prepared by: _____ Helper: _____

Before you start (See Chapter 27)

- [ ] Everything off. PV disconnects open, MC4s at the inverter unplugged or the string fuses pulled, battery breaker off, inverter off, AC breakers off, generator off with auto-start disabled.
- [ ] Lock out what you can (See Chapter 3), and tell everyone in the house.
- [ ] PPE: safety glasses, insulated gloves rated for the voltage, and no rings or watch (See Chapter 4).
- [ ] Tools: a CAT III or CAT IV meter rated for at least 600 V DC, a DC clamp meter, an insulation tester if you will do that test yourself, a torque wrench and screwdrivers, a thermometer for module temperature, and an irradiance meter if you have one.
- [ ] This blank sheet and a pen.

Step 1. Torque and visual check (See Chapter 27)

- [ ] Every lug, breaker, busbar, and terminal is torqued to the value in its manual or on its label. Battery terminals especially: a loose battery lug can melt.
- [ ] Each one is torque-marked with a paint pen line across the nut and the part.
- [ ] Visual: no bare copper sticking out of a lug, no nicked insulation, no crossed colors, correct wire size on each breaker, bushings in every box, cable ties UV-rated outside, no tools left in an enclosure.
- [ ] Battery cables are routed away from sharp edges, the fuse is installed, and polarity at the battery is marked and checked by eye.

Step 2. Continuity and the EGC (See Chapters 22, 24, and 27)

With a meter on the ohms or continuity setting, and **everything de-energized:**

EGC continuity, module frames, rails, and the ground-mount frame back to the EGC bar at the inverter:

_____ ohms

A few tenths of an ohm, mostly the meter leads, is normal.

☐ The EGC connects to the grounding electrode conductor at the bond point.

☐ There is **one** neutral-ground bond (See Chapter 22).

Look first. This is the main check. With every source off and locked out, and the panels tested dead (hot to neutral, hot to ground, and neutral to ground, all near zero volts), open each panel. The bonding screw or strap should be installed only where your Chapter 22 case puts it, and removed everywhere else. Downstream, the neutral bar should sit on its insulators, with no grounds landed on it.

Your Chapter 22 case (1, 2, or 3): _____ Bond location: _____

Measure, only if your bond is a screw or strap you installed (Chapter 22, Case 3). With everything still off and tested dead, remove that bonding screw or strap. Resistance, neutral bar to ground bar, subpanel: _____ House panel: _____ Both should read open or very high. A low reading means a second bond, or a neutral touching ground somewhere downstream: find it before you go on. Then put the bond back, torque it to the panel's label, and measure again: neutral to ground should now read near zero. After the bond is back: _____ ohms

Never energize anything with the bond removed. Without the bond, a fault to a metal box has no path to trip a breaker, and the box can sit at full voltage. The bond goes back in before any source is turned on.

If the bond is inside the inverter (Cases 1 and 2), do not open the inverter to lift it. Do the visual check of both panels, confirm the generator matches your plan (See Chapter 23), and use the manual's own method for checking the bond, or have an electrician check it.

Ground-rod resistance: if you drove one rod and are relying on the 25 ohm rule (See Chapter 24), you need a real earth resistance test, done with a fall-of-potential tester. A regular multimeter cannot do it. Most people drive two rods instead, or hire the test. Result, if tested: _____ ohms

Step 3. Insulation resistance test (See Chapter 27)

This test can damage equipment, and it uses high voltage. Do it only if you have the right tester and have read its manual, or have an electrician or solar tech do it.

☐ The inverter, SPDs, and anything else electronic are disconnected from the circuit under test.

Test each PV string's conductors to ground, positive and negative separately, using the test voltage and method in the module maker's guidance or IEC 62446-1. For a system between 120 V and 500 V, like the house at about 378 V cold, that is a **500 V** test and at least **1 megohm** in the current edition. Over 500 V, the test voltage is 1,000 V, still with a 1 megohm minimum. Check your tester's settings and the module maker's guidance.

Do not short a live string to do the combined method unless you have a listed shorting device made for it.

Circuit	Test voltage	+ to ground	- to ground	At or above the minimum?
String 1 (ground)	_____ V			☐
String 2 (roof)	_____ V			☐
Other: _____	_____ V			☐

Readings that are low, or that change a lot between dry and damp mornings, mean a problem. Find it before going on.

Step 4. String polarity and Voc (See Chapter 27)

Polarity first, always. A reversed string on many inverters can destroy the MPPT input the moment you close the disconnect.

For each string, at the inverter end, with the disconnect still open: set the meter to DC volts, a range above your expected Voc. Red lead on the conductor you marked positive, black on negative. **A positive reading means polarity is right.** A negative reading means it is reversed. Stop and fix it at the source. Also check each conductor to ground. A solid full reading to ground on one conductor can mean a ground fault.

Expected Voc at test temperature (See Chapter 27). Sample: module back surface at **10 °C**, nameplate Voc **40 V** at 25 °C, coefficient **minus 0.28% per °C**. Temperature difference: 25 minus 10 = 15 °C colder. Voc gain: 15 x 0.28% = 4.2%. Per module: 40 x 1.042 = 41.68 V. String of 8: 41.68 x 8 = **333.4 V**.

Your module temperature: _____ °C Your expected string Voc: _____ V

Your reading should be close. Within a few percent is normal. Readings that are one module's worth low suggest a module bypassed or a connector open somewhere. Compare strings. The roof array often runs hotter, so a slightly lower roof Voc is not a problem.

String	Polarity (positive?)	Expected Voc	Measured Voc	To-ground reading	OK?
1, ground	☐	_____ V (sample 333.4 V at 10 °C)	_____ V		☐
2, roof	☐	_____ V (sample 333.4 V at 10 °C)	_____ V		☐

Step 5. Battery on, BMS wakes (See Chapters 18, 19, and 27)

- ☐ Battery voltage at the battery terminals is close to the nominal 51.2 V for the sample house, and the same polarity you marked. Measured: _____ V State of charge: _____
  BMS temp: _____
- ☐ At the inverter's battery terminals, with the battery breaker still off, there is nothing, or only a small leftover voltage. Measured: _____ V
- ☐ Each module is on and the BMS is awake, with addresses or DIP switches set as the manual says.
- ☐ Pre-charge step done if the manual requires it. **Follow the manual.**
- ☐ Battery breaker closed. Inverter on, per its manual.

- [ ] Closed-loop communication with the BMS is up: the inverter shows the battery's state of charge, temperature, and charge limits from the BMS, not just a voltage.

Step 6. Inverter settings (See Chapters 19, 21, 23, and 27)

Enter every setting before any PV or load is connected. Use the settings sheet you prepared in Chapter 21. Photograph every settings screen.

- [ ] Battery type: lithium, with the BMS protocol selected. Use the maker's preset if there is one.
- [ ] Charge limits within the battery maker's limits.
- [ ] Low-temperature charge cutoff (See Chapter 19), if the BMS does not handle it or as a backup.
- [ ] Low battery cutoff and restart levels.
- [ ] Output: 120/240 V split-phase, 60 Hz.
- [ ] Generator input: maximum input current, maximum charge current from the generator, and auto-start settings. Auto-start is **disabled** for now.
- [ ] **No grid profile, no export settings.** This is an off-grid house. If the inverter asks for a grid code, use the off-grid or stand-alone mode in the manual. Never enable grid sell or export.
- [ ] Clock and date set, for logs and quiet hours.
- [ ] Settings screens photographed.

Step 7. PV on, one input at a time (See Chapter 27)

- [ ] Polarity rechecked on input 1 (the ground string).
- [ ] PV disconnect 1 closed. Screen shows PV voltage close to measured Voc, then tracking toward Vmp. Charging or supplying the inverter's own draw: [ ]
- [ ] Repeated for input 2 (the roof string).

If anything smells, sounds wrong, or shows an error, open the disconnect and stop.

Step 8. Operating current (See Chapter 27)

Most homeowners should skip a true Isc measurement and measure **operating current** instead. Measuring Isc means shorting the string, and that is only safe with a PV analyzer or a meter and shorting device built for it.

With the battery low enough to take full charge (or loads on), and the sun high and clear, clamp a DC clamp meter around one conductor of each string.

Expected current (See Chapter 27). Sample: irradiance **800 W/m²**, about 80% of the 1,000 W/m² test condition. Expected Isc: 15.6 A x 0.8 = about 12.5 A. Expected operating current, near Imp: 14.7 A x 0.8 = **about 11.8 A**. Temperature changes current only slightly, so ignore it for this check. Two strings of the same modules at the same tilt and sun should read within a few percent of each other.

Your irradiance: _____ W/m² Module temp: _____ °C

Your expected operating current: _____ A

String	Measured operating current	Close to expected?	OK?
1, ground	_____ A	☐	☐
2, roof	_____ A	☐	☐

A string reading well below the other, under the same sun, is shaded, dirty, has a bad connector, or a failed module. Find it.

Step 9. Rapid shutdown test (See Chapters 11, 15, and 27)

Test with the system producing.

☐ Roof string voltage noted at the inverter: _____ V
At a point outside the array, if you can: _____ V

☐ Initiator pressed. Time to drop: _____ seconds
Voltage after initiation: _____ V

☐ Within **30 seconds,** conductors outside the array boundary dropped to **30 V or less,** per 690.12. Inside the array, the limit depends on the method; check your rapid shutdown equipment's listing.

☐ Initiator released or reset per its manual, and the array came back.

Step 10. AC output and load tests (See Chapters 6, 7, and 27)

☐ All house branch breakers off, then inverter output breaker closed, then the subpanel feeder breaker, then the house panel main.

☐ At the house panel: L1 to N _____ V (about 120) L2 to N _____ V (about 120)
L1 to L2 _____ V (about 240) N to G _____ V (near 0)

☐ Branch circuits on one at a time. A few receptacles checked with a plug-in tester. Every GFCI and AFCI tested with its test button.

☐ **Load test:** ran the busy moment from Chapter 7, up to about 1,900 W on the sample house. Your busy-moment watts: _____
Battery current and inverter temperature watched: ☐

☐ Well pump started cleanly (sample surge 4,000 W). Your surge: _____ W
Errors: _____

☐ System ran on inverter power for at least an hour with normal loads. Terminals and the inverter checked for unusual heat (with care, or with an infrared thermometer).

Step 11. Generator and bond test (See Chapters 22, 23, and 27)

Follow the Chapter 27 sequence: start the generator, connect it through the listed inlet, confirm transfer, read the charge current and confirm it stays at your limit, then check the bond with the generator running **without opening any panel**.

Neutral to ground at the house panel should still be near 0 V if the system is bonded. In Case 2 (Chapter 22), the inverter opens its bonding relay and the generator's bond takes over. In Case 1, the inverter keeps the bond and the generator is floating. In Case 3, the bond stays at the first disconnect. In all three, a reading near 0 V only shows that a bond is present. Two bonds also read near 0 V, so the voltage alone can't prove there is only one. Instead, turn on a few house loads and put a **clamp meter around the equipment grounding conductor** where you can reach it outside a panel, such as the generator cord's ground or the grounding electrode conductor. With one bond, it should read near zero amps. Steady current there means neutral current is flowing on the ground path, usually from a second bond: shut down and fix it per Chapters 22 and 23. If you can't reach a ground conductor without opening a live panel, have an electrician do this check.

- ☐ Transfer confirmed. Charge current: _____ A At your limit: ☐
  Generator holds voltage and frequency: ☐
- ☐ Clamp on the EGC, generator running, house loads on: _____ A (near zero)
- ☐ N-G voltage with generator running: _____ V (near 0 V; this alone does not prove one bond)
- ☐ Generator input breaker opened; inverter went back to battery power without dropping the loads.
- ☐ Auto-start enabled only after the steps above. Test: starts, loads after warm-up, and stops. Settings returned to normal.

Step 12. Sign-off (See Chapter 27)

When every step passes, fill in and sign the sheet below, attach photos of settings screens and labels, and file it with the manuals, the plans, and the inspection card. Keep a copy off-site.

Stop and call a pro (See Chapter 27) if you have any reading you cannot explain, especially a voltage to ground, a reversed string, or a low insulation reading; if the inverter shows a ground fault or isolation fault and you cannot find it; if you do not have the right tester for insulation or earth resistance; or if the BMS and inverter will not communicate after you follow both manuals.

Commissioning sheet

Sample layout from Chapter 27. Numbers in brackets are the house sample figures, for reference only.

Item	Expected	Measured	OK
Date, time, weather			
Module temp		_____ °C	
Irradiance		_____ W/m²	
Torque and marks, all terminations	done		☐
EGC continuity, frames to EGC bar	low ohms	_____ ohms	☐
One N-G bond confirmed	yes		☐
Insulation, string 1 +/ground, -/ground	[at least 1 megohm at 500 V, for a 120 to 500 V system, current edition of IEC 62446-1]	_____ / _____	☐
Insulation, string 2 +/ground, -/ground	[same]	_____ / _____	☐
Polarity string 1 / string 2	positive		☐
Voc string 1 (ground)	[333.4 V at 10 °C]	_____ V	☐
Voc string 2 (roof)	[333.4 V at 10 °C]	_____ V	☐
Battery voltage, SOC, BMS temp	[about 51.2 V]		☐
BMS comms on inverter	yes		☐
Settings entered and photographed	yes		☐
Operating current string 1 / 2	[about 11.8 A at 800 W/m²]	_____ / _____ A	☐
Rapid shutdown: volts and seconds	[30 V or less in 30 s or less, outside the array boundary]	_____ V, _____ s	☐
AC L1-N, L2-N, L1-L2, N-G	[120, 120, 240, near 0]		☐
GFCI and AFCI tests	pass		☐
Load test 1,900 W and pump start	no faults		☐
Generator transfer and charge limit		_____ A	☐
N-G at the house panel with generator running	near 0 V (bond present; this alone does not prove one bond)	_____ V	☐
EGC clamp current with generator running (See Step 11)	near 0 A	_____ A	☐
Auto-start test	starts, loads, stops		☐
Serial numbers: modules, inverter, battery, RSD			
Signed			

Signed: _____ Date: _____ Copy filed off-site: ☐