

Inverter Component Testing: Thermistors, EEV, Boards, BLDC Fans

YES Electric • Arc Workforce Academy HVAC Apprenticeship

Draft 1 (October 2026). This lesson is under review. Videos are made by other companies, not YES Electric; follow this lesson and your journeyman where they differ. Boxes marked "Shop photo coming" will get real photos from our shop in a later version.

Unit 9 • Ductless Mini-Splits • Job Function 18 • Appendix A Competency 49 —

"Commission, test, and troubleshoot mini-split systems using manufacturer diagnostic procedures and error codes" **Class time:** ~6 hrs (1.5 video/discussion + 4.5 bench, under direct supervision for all board-level work)

1. What you'll be able to do

By the end of this lesson you will be able to:

- **Safely verify a DC bus is discharged** before touching any board component — the skill Lesson 9.1 told you that you were NOT allowed to do until today.
- Test a thermistor's resistance against its temperature chart and recognize when a "drifted" sensor is causing symptoms with no fault code at all.
- Test an EEV (electronic expansion valve) / LEV stepper motor's coil resistance and recognize the signs of a stuck valve.
- Perform a basic IPM (inverter power module) diode-mode test pattern and understand what a consistent vs inconsistent leg-to-leg reading tells you.
- Test an inverter compressor's windings correctly (low and EQUAL across all three legs) and explain why that's different from the single-phase compressor testing you learned in Unit 6.
- Test a 5-wire BLDC fan motor and explain how it differs from the PSC/ECM motors in Lesson 6.2.

This lesson is where Lesson 9.1's theory becomes hands-on component work. Every part discussed here is one that doesn't exist on the fixed-speed equipment you studied in Units 1–8 — this is genuinely new territory, not a variation on something you already know.

2. Tools & materials

- Digital multimeter with DC voltage, resistance (ohms), and diode-test functions
- Manufacturer thermistor resistance/temperature charts for the shop unit's brand/model

- A bench-mounted or de-energized outdoor unit with an accessible IPM board, DC bus, EEV, and compressor terminals
- EEV/LEV coil test reference data (resistance spec per manufacturer)
- BLDC fan motor resistance table for the shop unit's brand
- Insulated tools, safety glasses, voltage-rated gloves per shop policy for board-level work
- Anti-static precautions (wrist strap or grounding mat) for board handling — inverter boards are ESD-sensitive

3. Watch first

Order	Video	Channel	Length	Why
1	THERMISTOR Operation and Testing! Inverter and Mini Split Training!	AC Service Tech	5:41	The thermistor test procedure, short and exact
2	EEVMate Tool: Testing Electronic Expansion Valves (EEVs) in Mini Splits & VRF Systems	HVAC School	10:55	Dedicated EEV diagnostic tooling and method
3	Inverter Mini Split FAN MOTOR Operation and Testing! 5-Wire BLDC	AC Service Tech	12:24	The BLDC fan motor test procedure
4	How to Test a Mini Split Compressor? (Troubleshooting)	Taddy Digest	5:01	Quick compressor winding test reference
5	Samsung DVM Compressor Inverter Board Repair! E361, E461 and E277	Taddy Digest	34:54	Full board-level repair case study — watch after the shorter videos above, as the "how it all comes together" session
Reference	Samsung HVAC Ducted Testing BLDC Fan Motor with Resistance Tables	Taddy Digest	9:15	Second worked BLDC example with resistance-table method

4. The idea

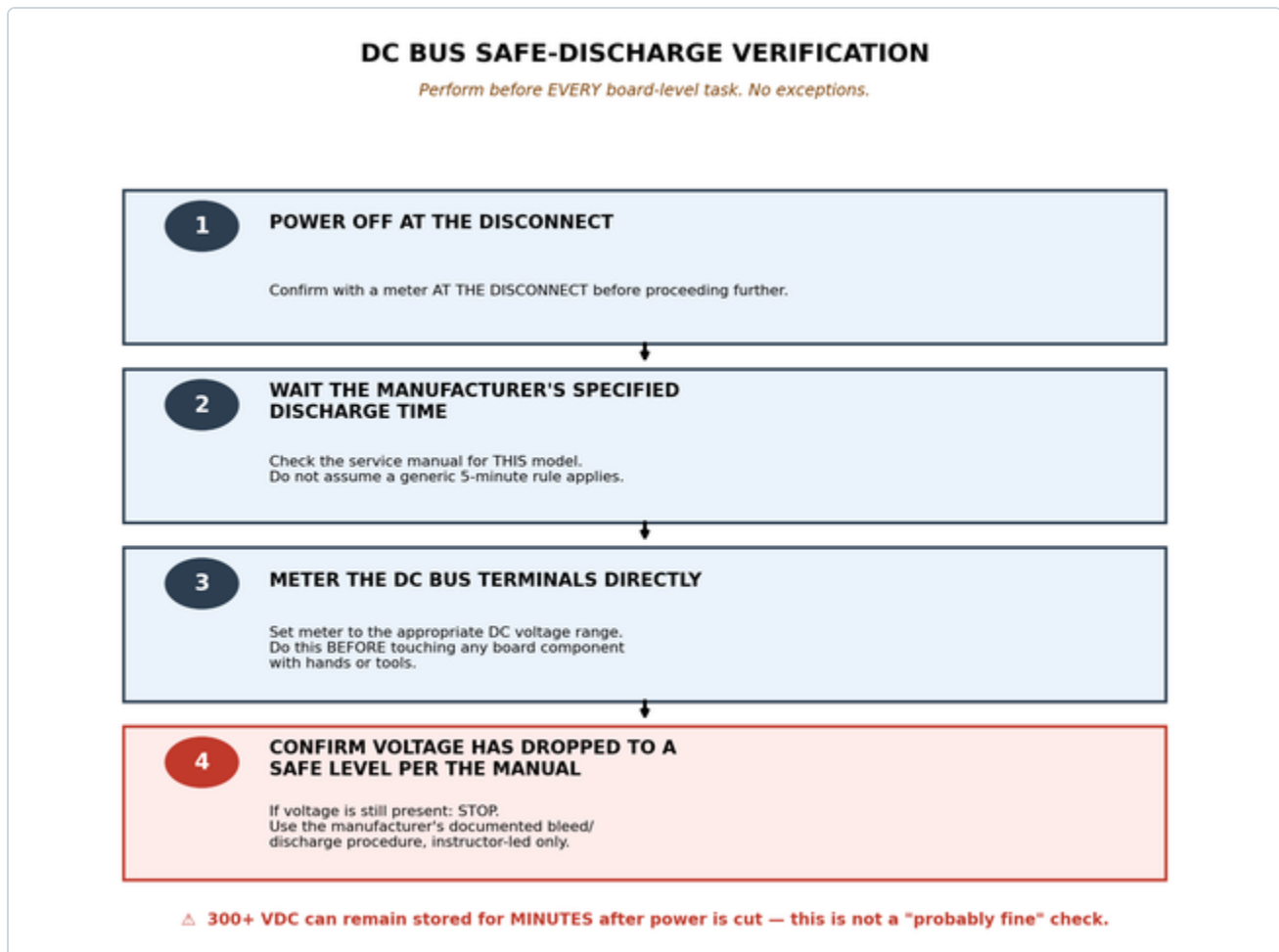
First: the DC bus safe-discharge check (mandatory before anything else today)

Lesson 9.1 told you the DC bus capacitor(s) can hold 300+ volts DC for minutes after power is cut, and that nobody touches a board with a meter before this lesson. Here's the procedure, always performed under direct instructor supervision:

1. **Power OFF at the disconnect**, confirm with a meter at the disconnect itself before proceeding further.
2. **Wait the manufacturer's specified discharge time** (varies by model — check the service manual; do not assume "5 minutes like a run capacitor" applies universally).

3. **Meter the DC bus terminals directly**, set to an appropriate DC voltage range, BEFORE touching any board component with your hands or a tool. Confirm the reading has dropped to a safe level per the manufacturer's guidance.
4. **If voltage is still present** after the specified wait time, do not proceed — some units have a manual bleed/discharge procedure (a resistor or a documented discharge point) that must be used; this is an instructor-led step, not a guess.

This check happens EVERY time, before EVERY board-level task in this lesson, no exceptions for "I just checked it five minutes ago."



Thermistors — the invisible failure

A thermistor is a resistor whose resistance changes predictably with temperature — the outdoor board reads several of these (indoor coil, outdoor coil, sometimes discharge line, sometimes ambient) as part of the constant sensing loop from Lesson 9.1. **Testing method:** disconnect the thermistor, measure its resistance, measure its actual temperature (IR thermometer or a known reference), and compare against the manufacturer's resistance/temperature chart.

The dangerous failure mode isn't total failure (open or shorted, which usually throws a clean fault code per Lesson 9.7) — it's **drift**: a thermistor reading a few degrees off from reality with NO fault code at all, because it hasn't crossed the board's fault threshold. A drifted sensor causes the

board to make slightly wrong modulation decisions — short cycling, wrong capacity, subtly "off" comfort — with nothing on the display pointing at the cause. This is why, when a system "just doesn't feel right" and no code is present, thermistor accuracy belongs on your checklist even without a fault prompting it.

EEV / LEV — testing the valve that replaced your TXV knowledge

Recall Lesson 1.1's metering device and Unit 5's TXV content — the mini-split's electronic expansion valve does the same JOB (control refrigerant flow into the evaporator) but is driven by a **stepper motor** commanded by the board, not a mechanical bulb-and-spring. Two test approaches:

- **Coil resistance test:** disconnect the EEV, measure resistance across its stepper coil pairs, compare against the manufacturer's spec. Wildly out-of-spec or open/shorted readings condemn the valve coil.
- **Cycling test:** at power-up, many EEVs perform an audible/tactile "homing" cycle (a light ticking or clicking as the stepper finds its reference position) — listening or feeling for this at startup is a quick field check that the valve is responding at all.
- **Dedicated tools** (like the EEVMate referenced in §3) can actively drive and monitor an EEV's response for a more thorough diagnostic than resistance alone.

Field symptom pattern (most relevant on multi-zone, previewed here for 9.9): one zone won't heat or cool properly while others on the same system work fine — that's a classic stuck-LEV signature on that specific indoor unit's valve, not a system-wide charge or compressor problem.

IPM board testing — the diode-mode pattern

Full board-level repair is specialist territory, but a basic **diode-mode test** on the IPM (the module from Lesson 9.1's drive-chain diagram) is within a well-trained tech's reach: with the DC bus CONFIRMED discharged (see above), a diode-mode continuity check leg-to-leg on the IPM's output should show a **consistent pattern of readings** per the manufacturer's test procedure. Inconsistent, wildly different, or dead-short readings between legs point to a failed IPM. This is a "confirm before you order the expensive part" check, not a full repair procedure — most shops replace rather than repair a failed IPM.

Compressor testing — why "ohm it and go" doesn't fully apply anymore

Unit 6/8 taught you to ohm a single-phase compressor's windings and compare against expected values. An inverter compressor is internally a **3-phase motor** (even though it's fed by single-phase utility power upstream — recall Lesson 9.1's drive chain, which builds its own multi-phase output). Testing it correctly:

- **All three winding legs should read LOW resistance and EQUAL to each other** (within the manufacturer's tolerance). Significant imbalance between legs points to the compressor itself.

- **Balanced windings but the compressor won't start** points away from the compressor and toward the drive board / IPM instead — the motor is electrically fine, but it isn't being told to run correctly.
- **Many brands provide a compressor-isolated test mode** in service software/tools that runs the compressor directly from a test driver, bypassing the normal control logic — use it when available instead of guessing between "compressor" and "board" from resistance readings alone.

BLDC fan motors — five wires, not a run capacitor in sight

Lesson 9.1 already told you inverter fans are BLDC (brushless DC), commanded by the board rather than running on a capacitor-assisted single phase like the PSC motors from Lesson 6.2 or the module-driven ECM/X13 motors from that same lesson. A 5-wire BLDC motor typically has power, ground, a speed-command signal, and a feedback line — **do not attempt to power it directly off line voltage the way you might bench-test a PSC motor.** Testing follows the manufacturer's specific procedure: resistance checks on the winding pairs per a resistance table (brand-specific), and command/feedback signal checks with the motor connected to its board under supervision.

5. Bench procedure

All steps under direct instructor supervision. DC bus discharge check (§4) performed and confirmed before Step 1 and re-confirmed before returning to the unit after any break.

1. **DC bus discharge verification**, performed and narrated by each student individually before proceeding.
2. **Thermistor test**: remove and test one indoor coil and one outdoor coil thermistor from the shop unit, compare readings against the resistance/temperature chart, and calculate whether either shows drift beyond acceptable tolerance.
3. **EEV coil resistance test**: disconnect and test the shop unit's EEV coil pairs, compare against spec.
4. **EEV cycling observation**: with the valve reconnected and the unit powered up under supervision, listen/feel for the homing cycle at startup.
5. **IPM diode-mode test**: with the bus confirmed discharged, perform the manufacturer's diode-mode leg-to-leg test pattern and record the readings.
6. **Compressor winding test**: ohm all three legs, confirm they're low and equal, and calculate/state the imbalance tolerance from the spec sheet.
7. **BLDC fan motor test**: ohm the winding pairs per the resistance table; observe command/feedback behavior with the motor connected and running under supervision.
8. **Case study review**: watch the Samsung board-repair case study (§3, video 5) as a class and identify, at each stage of that video, which of today's seven component tests the tech is effectively performing.

Checkout (graded, pass/redo): Student independently performs and correctly narrates the DC bus discharge verification, thermistor test with chart comparison, EEV coil test, and compressor winding test on the shop unit, under instructor observation. This completes the hands-on component-testing layer of Competency 49.

6. Field gotchas

- **Skipping the DC bus discharge check "because it's probably fine" is how techs get hurt** — this isn't a capacitor-shock inconvenience like a run capacitor, it's a genuinely dangerous voltage that doesn't announce itself.
- **A thermistor that's drifted but not failed outright causes symptoms with zero fault code** — if a system "just feels off" with nothing on the display, this is on your checklist.
- **Chasing a "compressor problem" when the windings are actually balanced** wastes a compressor replacement on what was really a drive-board fault — test both properly before you commit to a part.
- **Powering a BLDC fan motor directly off line voltage** (old habits from PSC motor bench testing) can destroy it — these motors expect a specific low-voltage DC command signal, not raw line power.
- **ESD (static discharge) damage to a board** is invisible until the board mysteriously misbehaves later — use anti-static precautions on every board-level task, not just when it's convenient.
- **A failed IPM diode-mode test still generally means "order the board"** — repair-vs-replace economics almost always favor replacement at this level; the test's value is confirming the diagnosis before you spend the money, not attempting a component-level board repair.

7. Competency link

- **Competency 49** — component-level testing is the deepest layer of "troubleshoot mini-split systems using manufacturer diagnostic procedures," building on the fault-code workflow from Lesson 9.7.
- Direct payoff of Lesson 9.1's safety deferral ("nobody touches a board until Lesson 9.8") — the theory from that lesson is now applied hands-on.
- Cross-references Lesson 6.1/6.2 (motor types) and Unit 5 (TXV/metering devices) by contrast — understanding how BLDC and EEV differ from what you already know is what makes this lesson land.

8. Check yourself

1. State the DC bus safe-discharge verification procedure in order. What must you confirm before touching any board component?

2. What test method confirms a thermistor's accuracy, and what reference do you compare it against?
 3. Why is thermistor "drift" more dangerous, diagnostically, than a thermistor that fails completely open or shorted?
 4. What are the two ways this lesson describes to check an EEV's condition?
 5. What field symptom pattern (mentioned here, expanded in 9.9) points specifically at a stuck EEV on one zone of a multi-zone system?
 6. What does a consistent vs inconsistent IPM diode-mode reading tell you?
 7. How should the three winding legs of an inverter compressor read relative to each other, and what does an imbalance point to versus a "balanced but won't start" symptom?
 8. Why can't you bench-test a BLDC fan motor the same way you'd bench-test a PSC motor from Lesson 6.2?
 9. Why does this program treat ESD precautions as mandatory for board-level work?
 10. In the Samsung board-repair case study video, name at least three of today's seven component tests you observed being performed.
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