

Communication Wiring & Electrical (S1/S2/S3, MCA/MOP, Surge)

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 48 — "Install single-zone ductless mini-split systems (indoor head, outdoor unit, lineset, and electrical)" **Class time:** ~5 hrs (1.5 video/discussion + 3.5 bench)

1. What you'll be able to do

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

- Explain why a mini-split has **no conventional 24V thermostat wiring** and instead uses a proprietary DC communication signal riding on the interconnect cable between indoor and outdoor units.
- Correctly land the interconnect cable at **matching terminal order on both ends** — the single most common "it never worked right" install mistake in the whole trade.
- Size and install a **dedicated circuit for the outdoor unit from nameplate MCA/MOP** — not a rule-of-thumb based on tonnage.
- Install a disconnect within sight of the outdoor unit and explain why surge protection is cheap insurance for an expensive board.
- Verify a healthy communication signal with a meter, and know the ONE thing you never do to a comm line with boards connected.

2. Tools & materials

- Interconnect cable of the correct gauge/conductor count for the model (varies by brand/model — commonly a stranded 4-conductor cable in the 16–14 AWG range, but ALWAYS verify against the install manual; never substitute stat wire)
- Digital multimeter with DC voltage function
- Wire strippers, ferrules/connectors rated for the terminal block, torque driver for terminal screws (many boards specify a screw torque — check the manual)
- Whip/cable, disconnect box, breaker, and surge protective device (SPD) sized per the unit's electrical data plate

- The Lesson 9.2 mock install (indoor head + outdoor unit already mounted)
- Copy of the manufacturer's wiring diagram for the shop unit's exact model

3. Watch first

Order	Video	Channel	Length	Why
1	Wiring a Mini Split System, Step by Step!	AC Service Tech	11:29	The core field procedure this lesson is built around
2	How To Install Electrical Circuit For A Mini Split	Quality HVACR	18:12	Full electrical rough-in from the panel to the disconnect
3	Mini Split Failure from Electrical Surges, High and Low Voltage! HOW TO SOLVE IT!	AC Service Tech	13:09	Why the surge protector line item earns its keep
4	Commercial HVAC Split install wiring charging basics #twinning #furnace #commercialhvac	Taddy Digest	15:29	A second brand's terminal layout, for pattern comparison
Reference	How to use 24 V thermostat with Samsung HVAC and secondary float switch install part 2	Taddy Digest	5:17	Preview of third-party thermostat integration, discussed below

4. The idea

There is no R/W/Y/G/C here — and that's the point

Every thermostat wiring lesson in this program up to now (Lessons 6.3, 6.4) has been built on the universal 24V letter code: R, C, Y, G, W, O/B. A mini-split throws that whole system out. **Control happens digitally** — through the wireless remote, a wired controller, or an app — and the indoor and outdoor units talk to each other over a **DC communication signal riding on the interconnect cable**, not a 24V call-for-cooling relay circuit. Recall Lesson 9.1: the outdoor board is constantly reading sensor data and deciding compressor speed in real time. That decision-making requires constant two-way digital conversation between indoor and outdoor units — a simple on/off 24V signal couldn't carry it.

The interconnect cable — one cable, four jobs

Power for the OUTDOOR unit comes from its own dedicated circuit. The INDOOR unit, unlike every air handler you've wired in Units 6–8, **does not get its own separate power circuit** in most single-zone residential installs — it's powered through the interconnect cable running from the outdoor unit. That one cable typically carries:

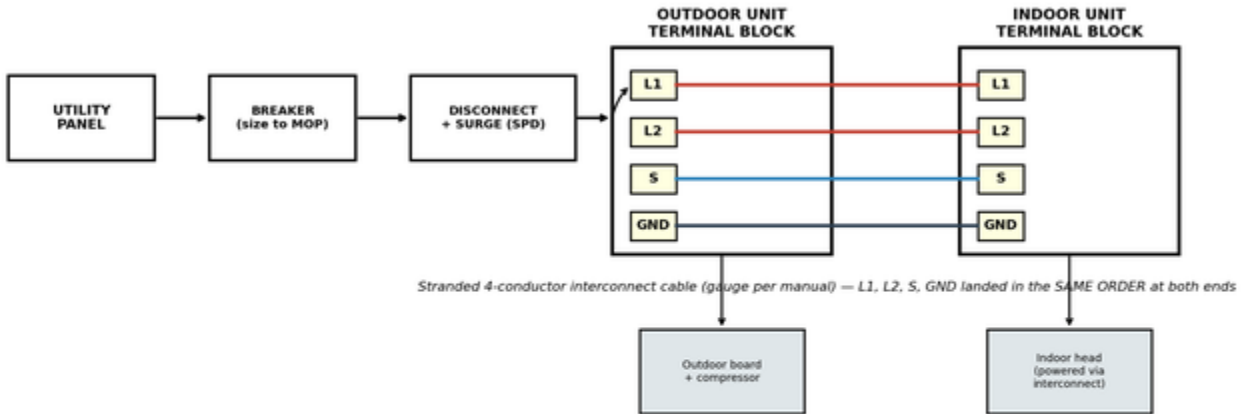
Conductor (common field naming — verify against YOUR unit's manual, brand naming varies)	Job
L1	Power leg 1
L2 (or N)	Power leg 2 / neutral, depending on brand/voltage scheme
S (signal/communication)	The DC data conversation between boards
Ground	Equipment ground, always

Field techs commonly call these terminals **S1/S2/S3** regardless of brand (a naming convention that originated with Mitsubishi but gets used generically) — but **the actual terminal count, letter/number labels, and wire colors are brand- and model-specific**. The one rule that never changes: **whatever order you land the conductors at the outdoor unit, you must land them in that SAME order at the indoor unit**. Swap two wires and the units either won't communicate at all, or worse, communicate incorrectly and misbehave in ways that don't throw an obvious fault code — the classic "installer swore it was fine, customer says it's never worked right" service call.

This isn't program-invented caution — it's straight out of a real manufacturer's install manual, printed in bold and repeated: **"Control wiring from the outdoor unit must be a point to point; i.e. the terminal that the wire is attached to on the outdoor unit must be the same terminal it is wired to on the Indoor unit. *** DO NOT CROSS WIRES BETWEEN TERMINALS. *** THIS IS EXTREMELY IMPORTANT!"** The same manual warns that miswiring "will cause the unit to fail to operate at a minimum and can seriously damage the unit in the worst case." When a manufacturer uses that much emphasis in a printed manual, believe them.

Cable specifications also vary by brand and model more than techs coming from conventional 24V wiring expect — one real manufacturer manual specifies a minimum 16 AWG control cable, not the 14/4 assumed elsewhere; another calls for heavier gauge on longer runs or higher-capacity units. **Always confirm minimum wire gauge and conductor count from the specific unit's manual** — undersizing this cable on a long run causes voltage drop problems that mimic a communication fault.

INTERCONNECT WIRING — SAME TERMINAL ORDER AT BOTH ENDS

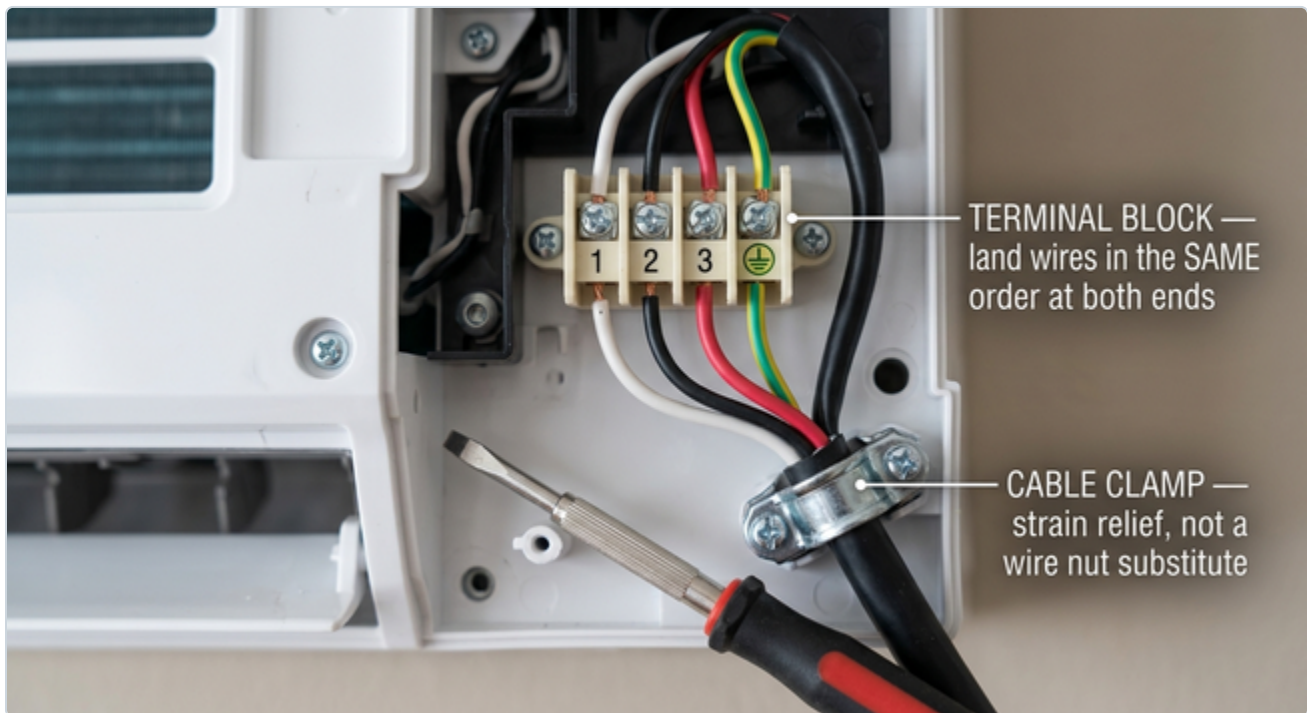


⚠ Terminal labels (L1/L2/S/GND, sometimes called S1/S2/S3) are COMMON FIELD NAMING —

always verify against the SPECIFIC unit's manual. Whatever order you land at the outdoor unit,

land that SAME order at the indoor unit. Mismatched order = the #1 "never worked right" callback.

And this is what that terminal block actually looks like with real wires landed — numbered terminals, a ground symbol, and a cable clamp doing strain relief, not holding the connection itself:



Sizing the circuit — nameplate, not a rule of thumb

Every mini-split's electrical data plate lists **MCA (Minimum Circuit Ampacity)** and **MOP (Maximum Overcurrent Protection)** — these are the numbers that size the wire and the breaker, exactly like the MCA/MOP discipline you learned in Lesson 3.8. **A common mistake is sizing off "it's a 1-ton unit so it needs a 20-amp breaker"** — inverter equipment's actual draw doesn't map to tonnage the way old fixed-speed equipment did. Read the plate, size to the plate, every time.

- **Dedicated circuit** to the outdoor unit — never shared with another load.
- **Disconnect within sight** of the outdoor unit (same code logic as Lesson 3.8's disconnect rules for any outdoor condensing unit).
- **Surge protective device (SPD)** — not code-required everywhere, but program standard on every install. A \$60–100 SPD is cheap insurance against a \$700–900 inverter board fried by a lightning-adjacent utility surge, which Alabama's storm season delivers regularly. The video in §3 (row 3) shows exactly what that failure looks like and costs.

How the SPD actually gets wired — a detail installers get wrong: the surge protector connects in **parallel**, not in series, on the **LOAD side wires only** (the conductors feeding the outdoor unit) — power never routes through the device itself, it just sits alongside the circuit and clamps a spike when one occurs. Never tap it into the line/power-feed side ahead of the disconnect. Landing it is typically a wire-nut (or listed splice connector) tap onto the load conductors, not a dedicated terminal. **Watch your grounds while you do this:** adding an SPD often means a second ground conductor needs to land at the same point as the existing one — never stuff two wires under a single lug screw to make that fit. Use a listed splice/pigtail ("wire bug") to join both grounds into one conductor, then land that single conductor under the lug. A double-lugged ground is a loose-connection failure waiting to happen, and it's an inspection fail in most jurisdictions.

Communication signal — what a meter can and can't tell you

The comm line carries a **DC signal**, often superimposed in a way that a basic meter reads as a fluctuating or steady DC voltage when the units are powered and talking. A rough field check:

- **Fluctuating or present DC voltage across the signal terminals** (with the manufacturer's expected range — check the service manual) generally means the boards are talking.
- **Flat zero or a voltage that never changes** can mean a dead board on either end, a broken wire, or a wiring order mistake.

Never megohm/megger the communication line with either board connected. A megger applies a high test voltage that will destroy the low-voltage DC communication circuitry on the board almost instantly. If you need to megger a run (rare, and only for suspected insulation failure on the conductor itself), disconnect BOTH boards from that conductor first.

Third-party thermostat integration — know when to talk a customer out of it

Some customers want to run a mini-split off a smart thermostat they already own (Nest, ecobee) instead of the proprietary remote/app. This requires a **manufacturer interface adapter** (each major brand makes one) that translates a conventional 24V call into the proprietary digital protocol. Know two things before you say yes to this request:

1. It only works with the specific adapter model rated for that mini-split model — there's no universal version.
2. **It reduces the unit to simple on/off control — you lose all inverter modulation.** You're paying for and selling an inverter system's efficiency and comfort story (Lesson 9.1), and a third-party stat integration quietly throws most of that away. Explain this trade-off to the customer plainly before installing one.

5. Bench procedure

1. **Read the nameplate.** On the shop unit's outdoor data plate, find and record MCA and MOP. Size the wire gauge and breaker from those numbers — show the work, don't guess.
2. **Rough in the electrical:** dedicated circuit run to a disconnect mounted within sight of the outdoor unit, SPD installed per its instructions (commonly at the disconnect or panel).
3. **Land the interconnect cable at the outdoor unit** per the manual's exact terminal diagram — call out each conductor and terminal label out loud as you land it.
4. **Land the SAME conductors in the SAME order at the indoor unit.** Before powering anything, have your partner independently trace and verify both ends match — this is a two-person check, not a solo one, because this exact mistake is invisible to the person who made it.
5. **Power up and check for communication.** Meter the DC signal terminals per the manual's expected reading; confirm the indoor head responds to the remote/wall controller.
6. **Deliberate fault drill:** instructor swaps two conductors at one end on a second practice board (power OFF for the swap). Student powers up, observes the failure symptom (no communication, fault code, or misbehavior — brand dependent), then correctly diagnoses and fixes it by re-checking terminal order — NOT by replacing a board.
7. **Third-party stat scenario:** instructor poses a customer request for Nest/ecobee integration. Student explains, out loud, the adapter requirement and the modulation trade-off, in words a homeowner would understand.

Checkout (graded, pass/redo): Student independently sizes and lands a complete electrical + interconnect installation on the mock unit, passes the two-person terminal-order verification, and correctly diagnoses the deliberate-fault drill without replacing a part.

6. Field gotchas

- **Mismatched terminal order is THE classic mini-split callback** — worse than a flare leak in some markets, because it doesn't show up as an obvious leak; it shows up as "it's never worked right" weeks later. Verify with a second set of eyes, every install.
- **Stat wire (18/5 or similar low-voltage cable) is NOT a substitute for the interconnect cable** — the manual specifies conductor gauge and insulation rating for a reason (it carries real current on the power legs, not just a signal). Using leftover thermostat wire here is a fire-risk mistake, not a shortcut.
- **Skipping the SPD to save \$80 on a job** looks fine until the first close lightning strike fries a board that costs 10x that to replace — plus the truck roll, plus the customer relationship.
- **Sizing the breaker off tonnage instead of the nameplate** either starves an inverter unit of the inrush current it occasionally needs or leaves it under-protected — read the plate.
- **Meggering a comm line with boards attached** destroys the board. If you don't remember anything else from this lesson's electrical safety content, remember this one.
- **A customer's DIY-adjacent request for a smart-stat conversion is a conversation, not just an install** — set the modulation-loss expectation before you touch a wire, not after they notice the unit "feels different."
- **Double-lugging two ground wires under one screw to make room for the SPD's ground** is a shortcut that fails inspection and fails safety — use a splice, not a squeeze.

7. Competency link

- **Competency 48** — electrical is explicitly named in the competency text ("...outdoor unit, lineset, **and electrical**"); this lesson completes that portion alongside Lessons 9.2 and 9.3.
- Builds directly on Lesson 3.8 (electrical safety, disconnects, MCA/MOP) and contrasts with Lesson 6.3/6.4 (conventional thermostat wiring) — knowing both systems well enough to explain WHY they differ is the mark of a tech who understands the equipment, not just the terminals.
- Feeds Lesson 9.7 (communication fault diagnosis) directly — everything you verify here is what you'll be troubleshooting there when it fails in the field.

8. Check yourself

1. Why doesn't a mini-split use the R/W/Y/G/C thermostat wiring code from Units 6–8?
2. In a typical single-zone residential install, does the indoor head get its own dedicated power circuit? Explain.
3. What is the ONE rule that must never be violated when landing the interconnect cable at both ends?
4. What do MCA and MOP tell you, and why is sizing a mini-split circuit off tonnage alone a mistake?

5. Why does this program treat a surge protective device as standard, not optional, on every mini-split install?
 6. What does a fluctuating DC voltage across the signal terminals generally tell you about the system?
 7. What must you NEVER do to a communication line, and what happens if you do it anyway?
 8. What extra hardware does a third-party smart thermostat (Nest/ecobee) integration require, and what does the customer give up by choosing it?
 9. A newly installed mini-split powers on, the indoor head display lights up, but the remote does nothing and there's no fault code. What's your first suspicion, and how do you check it?
 10. Why is the terminal-order verification step in this lesson's bench procedure done by a SECOND person, not just the installer?
 11. Is the SPD wired in series or parallel, and on which side of the disconnect — line or load? Why does that matter?
 12. Why is double-lugging two ground wires under one screw a problem, and what's the correct fix?
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