

Circuit Boards: The Inputs/Outputs Method (Never Condemn Blind)

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 6 • Electrical for HVAC II • Appendix A Comp 20 (continues) — the most mis-replaced part in the trade gets its trial rules **Class time:** ~4 hrs (1 video + 3 bench)

1. What you'll be able to do

- Treat any board as a **box with inputs and outputs** and run the universal trial: all inputs present and sane? → command conditions met? → outputs delivered? — only a board that FAILS to deliver outputs with all inputs proven gets condemned.
- Map a furnace IFC / air-handler board cold: power in (120 V + 24 V from its own transformer secondary), inputs (stat terminals, safety string, pressure switch, flame sense), outputs (igniter, gas valve, inducer, blower taps/data, humidifier/EAC taps).
- Read **diagnostic LEDs/fault codes** (the legend is ON the door — 3.7) and use stored-code memory before pulling anything.
- Catch the board-frame errors: condemning boards for dead inputs (a safety string open), for dead outputs' LOADS (a dead igniter ≠ dead board), or for blown onboard fuses (the 6.5 short came FIRST).
- Replace a board to standard: photo + label every spade, dip-switch/jumper settings copied, static precautions, THEN re-trial the new board (prove your fix).

2. Tools & materials

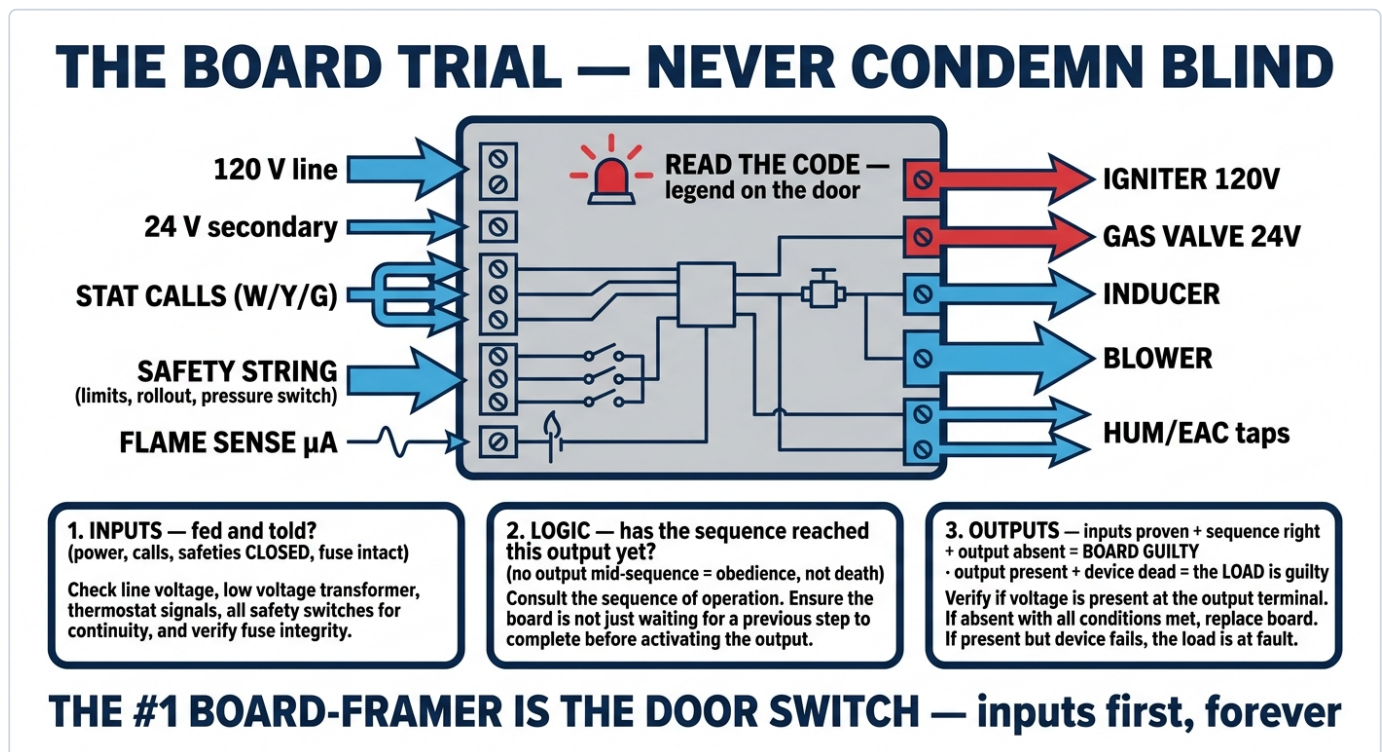
- Board wall: furnace IFC (working donor), air-handler board, a genuinely dead board (outputs dead w/ inputs proven — our courtroom exhibit), a falsely-accused board (perfect, from a "bad board" callback)
- Meters; the donor furnace (live trials); manufacturers' legends; anti-static kit

3. Watch first

Order	Video	Channel	Length	Why
1	Troubleshooting ALL HVAC Circuit Boards — Field Methodology	AC Service Tech	17:26	THE method
2	Control Board Operation for Troubleshooting	AC Service Tech	13:18	The box, mapped
3	Testing the Furnace IFC — Is It Bad?	AC Service Tech	13:45	The trial, run on camera
4	Board Troubleshooting: Voltages, Error Codes, Failures	HVAC School	5:27	Codes + common deaths
5	Air Handler Board Operation	AC Service Tech	5:01	The simpler cousin

4. The idea

The trial (three questions, board edition)



3.6 gave contactors three questions; boards get the same justice scaled up:

- 1. INPUTS — is the board being fed and told?** - Power: 120 V at the board's line plug; 24 V across its transformer secondary terminals (3.4); onboard fuse intact (and if not — 6.5 happened, hunt it first). - Commands: stat calls arriving at the terminals (W has 24 V on a heat call?). - Permissions: the safety string CLOSED (limits, rollouts, pressure switch, float —

measure the string's far end; an open safety is the board lawfully refusing, not failing).
Flame-sense μ A in spec (7.4) on furnaces.

2. **LOGIC — did conditions for the output exist?** Sequence position matters (7.2's sequence: the board won't fire the igniter before the pressure switch proves — "no output" mid-sequence is obedience, not death). The status LED tells you where it thinks it is — READ IT.
3. **OUTPUTS — with 1 and 2 proven, does the commanded output appear?** Voltage at the output terminal at the right moment (120 V to the igniter spades at ignition step; 24 V to the gas valve when flame's proven). **Inputs proven + sequence right + output absent = board guilty.** Output PRESENT but the device dead = the LOAD is guilty (igniter, motor, valve — their own lessons).

Codes, LEDs, and the memory

Modern boards confess: flash codes (legend on the door), stored last-faults (read BEFORE killing power — many clear on power loss), communicating systems put it on the stat screen. The code points at a NEIGHBORHOOD (— "pressure switch open" means the switch's whole rung: hose, port, drain, inducer... 7.5) — the trial convicts the resident.

Why good boards get executed

The falsely-accused board on our wall came from a real callback: "replaced board, still dead" — because the door switch was the open (3.1's first lesson!). The board-frame errors, named: **input-blindness** (didn't prove feeds), **sequence-blindness** (expected an output the logic hadn't reached), **fuse-blindness** (re-boarded into the same short — 6.5), **load-blindness** (output voltage was there; the igniter was dead). The trial exists because boards are expensive, backordered, and INNOCENT most of the time.

Replacement standard (when guilty)

Photo everything → label spades as they pull (terminal names, not wire colors — the 6.3 religion) → copy dip-switch/jumper settings to the new board BEFORE install (blower speeds! — 7.9's temp rise lives on those switches) → anti-static handling (carry by edges, ground yourself) → land, verify settings → **re-run the trial on the new board** (inputs, sequence, outputs — prove the fix, not just "it runs") → old board in the anti-static bag with the fault written on it (our parts shelf is a teaching library).

5. Bench procedure

1. **Board mapping:** the donor IFC — students build the inputs/outputs map by hand from the board + door diagram (3.7): every plug named, every safety in the string located.
2. **Trial reps (4 rounds, the live furnace):** instructor rigs: open rollout (input!), no stat call (command!), dead igniter with live output (load!), and the genuinely dead board (guilty!) — full three-question trial each round; verdicts must name the question that decided it.

3. **Code work:** force three faults, read the flash codes against the legend, check stored memory; then kill power and observe what the memory does (brand-dependent — the lesson is "read first").
4. **The courtroom exhibits:** the falsely-accused board's story told over its corpse (it still works — we prove it live); the guilty board autopsy (burnt trace, swollen cap — failure forensics).
5. **Full replacement:** the guilty board swapped to standard: labels, dip switches copied, static discipline, re-trial. Timed second pass.

Checkout: one rigged unknown — full trial, correct verdict naming the deciding question, and if guilty: replacement to standard with re-trial. **Comp 20 advances** (compressors complete it in 6.7).

6. Field gotchas

- **The door switch remains the #1 board-framer.** Inputs first. Forever.
- **Onboard fuse blown = the short predates you.** Re-fuse-and-hope re-kills boards (6.5's sermon, board-priced now).
- **Output relays click ≠ output delivered** — a clicking relay with burnt contacts drops the voltage AT the terminal: measure the OUTPUT, not the sound.
- **Dip switches left default** on a replacement = wrong blower speeds = 7.9 comfort callbacks. Copy, then verify.
- **Lightning-area boards** (Alabama): surge events kill boards in clusters — check the strip heat relays/transformer too; sell the SPD (3.8/6.1's economics).
- **Static kills silently:** a winter-carpet handling of a \$400 communicating board can wound it for a warranty-claim later. Edges + grounding strap; it's not theater.
- **Communicating systems** (Infinity-class): board trials go brand-procedure (the 6.2 Carrier video's world) — the three questions still frame it, the meter points just multiply.

7. Competency link

- **Comp 20 advances** (boards). 6.7 (compressor electrical) completes the competency.
- The trial structure IS 7.x's furnace diagnosis backbone (sequence + safeties + outputs), 8.2's defrost board method, and 9.8's inverter-board framing.

8. Check yourself

1. The three questions, board edition, in order.
2. Name the four board-frame errors and the lesson each one ignores.
3. 24 V missing at the board's secondary terminals. Is the board on trial yet? Where do you look (3.4)?
4. The safety string reads open. What is the board doing, and what's your next move?

5. Igniter never glows: the two-measurement split that decides board vs igniter.
 6. Why read stored codes before cycling power?
 7. The output relay clicks; the gas valve never gets 24 V. Verdict?
 8. Four items in the replacement standard that prevent callbacks.
 9. What gets copied off the old board before it leaves, and which lesson cares most (7.9)?
 10. The new board fixed it. What do you run anyway, and why?
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