



# Trane Communicating Systems

MODULE A32

ADVANCED SYSTEMS

PREREQ D23

**The scene:** A tech gets dispatched to a no-cool on a two year old Trane XV18 system. He pops the thermostat off the wall expecting R, Y, G, C and finds three wires landed on terminals marked R, B, and D. No Y to jumper. No contactor call to hopscotch. The thermostat screen says "Err 91.02" and the customer says the last company told her the whole control board was bad, eight hundred dollars, and they could come Tuesday. Our tech puts a meter set to DC volts across D and B at the air handler and reads 12 volts. He does the same at the outdoor unit and reads 0. Ten minutes later he finds a landscaper's wire staple through the bus cable behind a bougainvillea, repairs the run with a proper splice, watches the system rediscover the outdoor unit, and closes the call. The board was never bad. The conversation between the boards had been cut, and he was the only tech on that job who knew how to listen to it.

In D23 you learned to diagnose 24V control circuits with the hopscotch method: closed switches read zero volts, the one open device reads full control voltage, and the meter walks you to the fault. That whole method assumes the control circuit is a set of switches passing 24VAC to loads. A communicating system throws that assumption out. The thermostat, the indoor unit, and the outdoor unit are computers having a digital conversation over a data bus, and your job shifts from tracing switch legs to verifying that the conversation is happening, that every device is participating, and that the messages are getting through clean. This module teaches you that skill on the platform you will see most at Island Breeze: Trane and American Standard ComfortLink II.

## Short Version

A conventional system signals with 24VAC on dedicated wires: Y means cool, W means heat, G means fan. A communicating system replaces all of that with serial data on a shared bus. Trane ComfortLink II (American Standard calls the same platform AccuLink) runs the bus on three terminals: R carries 24VAC power, B is common and the data reference, and D is the data line. Field practice is to pull four conductor 18 gauge thermostat cable and keep one as a spare. On first power-up the comfort control runs discovery, finds every device on the bus, learns each one's type and size, and auto-configures the system; the installer then walks the Installation Wizard and setup groups for airflow, staging, dehumidification, and accessories. The bus health check is one DC voltage reading from D to B: about 12 VDC means active communication, about 16 VDC means the bus is idle with nobody talking, and 0 VDC means the bus is dead, shorted, or a device is dragging it down. Faults report as alert codes (Err numbers on the control, text on the outdoor display) in three severities, and the single most important sorting skill is telling a communication fault (the message is not arriving) from an equipment fault (the message arrived and reported a real problem). Boards on these systems carry configuration memory, so board replacement has its own discipline: move the personality module, re-run discovery, verify firmware, and clear offline devices. Always pull the service facts for the exact model, because details move between generations.

## Key Values

| ITEM                               | VALUE  | NOTES  |
|------------------------------------|--|--|
| Bus terminals (ComfortLink II)     | R, B, D  | R is 24VAC power, B is common and data reference, D is data  |
| Field cable                        | 18 AWG color coded thermostat cable, typically 4 conductor   | Bus uses three terminals; the fourth conductor is a spare. Solid wire larger than 18 gauge will not fit the connectors   |
| Bus voltage, D to B, communicating | About 12 VDC   | Active data traffic on the bus   |
| Bus voltage, D to B, idle          | About 16 VDC   | Bus powered but no communication happening   |
| Bus voltage, D to B, dead          | 0 VDC  | Broken D line, grounded D line, or a device with D and B reversed pulling the bus down                                   |
| Thermostat input power             | 24VAC, acceptable range 18 to 30 VAC   | Powered from the indoor unit on R and B  |
| Separation from inductive loads    | Minimum 1 foot   | Motors, ballasts, line starters, electronic air cleaners, distribution panels  |
| Shielded cable rule                | Not typically required; use it when the separation rule cannot be met, ground the shield at ONE end only | Two grounded ends create a current loop that adds noise instead of removing it   |
| Unused conductors                  | Ground at the indoor unit chassis only   | Floating spare wires act as antennas   |
| Control power-up time              | 90 to 120 seconds  | Do not start diagnosing a blank screen before boot finishes  |
| Comm fault trigger                 | Demand message sent every 1 minute; fault declared after 3 missed messages                               | This is why a comm fault takes a few minutes to appear after a wiring disturbance  |
| Alert severities                   | Normal, Major, Critical  | Critical alerts shut down or lock out operation  |
| Communication code families        | 89 equipment missing, 90 CRC and bus busy, 91 loss of communication                                      | Code 91.02 is the classic broken data line; 90.02 often means R and B reversed   |
| Personality module codes           | Err 114.xx   | 114.06 with no local copy shuts the compressor down until a good module is installed                                     |
| Charging Mode window               | Outdoor 55 to 120F, indoor 70 to 80F   | Charging Mode-Cooling in the Technician menu is the only approved way to set charge on TruComfort variable speed systems |

| ITEM                            | VALUE                    | NOTES   |
|---------------------------------|--------------------------|---|
| COMM LED on the outdoor control | Flashes the device count | Counts how many communicating devices the outdoor board sees on the bus |

A note on names before the numbers settle in. ComfortLink II is Trane's residential communicating platform. AccuLink is the identical American Standard label. TruComfort (Trane spells it without the second e) is the variable speed compressor technology in the XV18 and XV20i family, and those units require a communicating control. The values above come from current Trane literature; the verification habit this module drills is that you confirm them against the installer guide and service facts for the exact model in front of you, every time, because terminal layouts and menu paths shift between generations.

## Field Checklist

### Commissioning a ComfortLink II system

1. Pull the installer guides for the thermostat, indoor unit, and outdoor unit for the exact models on the job. Menus and dip switch duties change between generations.
2. Wire the bus: 18 gauge color coded cable, R, B, D matched terminal to terminal at every device. Keep one consistent color per terminal across the whole job.
3. Walk the wire run: at least 1 foot from motors, ballasts, and panels, no splices you cannot see and tug test, no staples through the jacket.
4. Ground unused conductors at the indoor unit chassis only. If you had to run near interference, use shielded cable grounded at one end.
5. Power up indoor first, then outdoor, then watch the control boot (90 to 120 seconds).
6. Let discovery run: the control finds each device and announces it. Confirm every installed device appears. A fully communicating system auto-fills the basic equipment settings.
7. Run the Installation Wizard: date and time, installer setup, service reminders, dealer code.
8. Walk the installer setup groups and verify, not just accept, the auto-configuration: equipment type and stages, sensors, accessories (humidifier, air cleaner, dehumidifier), comfort settings including dehumidification, airflow settings.
9. On a TruComfort variable speed system, set blower delays and airflow at the outdoor unit's communicating display assembly (CDA); the thermostat airflow group is disabled for those systems.
10. Verify charge with Charging Mode-Cooling from the Technician Access menu (hold 5 seconds), outdoor between 55 and 120F, indoor between 70 and 80F, with the subcooling corrections for line length and lift.
11. Run a full test cycle in each mode. Read the bus voltage D to B at the thermostat, indoor, and outdoor: about 12 VDC everywhere.
12. Save the configuration record: photograph the summary screen, the model and serial of each device, and the bus voltage readings.

### Diagnosing a communication fault

1. Read the alert before touching anything: the code number, the text, and the alert history. Photograph it.
2. Sort it: communication fault (89, 90, 91 family) or equipment fault (everything else). An equipment fault that arrived over a working bus does not need bus diagnosis.
3. Meter D to B, DC volts, at the thermostat: 12 VDC says the bus is alive here, 16 VDC says powered but silent, 0 VDC says dead bus.
4. Repeat at the indoor unit and the outdoor unit. The reading changes where the fault lives.
5. Dead bus everywhere: look for a grounded or shorted D line, or one device pulling the bus down. Disconnect bus legs one at a time; if the voltage comes back when a leg is lifted, the fault is down that leg.
6. One silent device with a healthy bus: check that device's power first (line voltage, fuse), then its bus terminals for reversed D and B, then its connectors.
7. Check the COMM LED device count on the outdoor control against the number of devices actually installed.
8. After any board replacement: move the personality module if the platform uses one, re-run discovery, verify firmware versions match, and remove stale offline devices from the summary table.
9. Fix the cause, then watch the system rediscover and clear. A comm fault that returns within minutes was never fixed.

#### IB STANDARD

RunTru by Trane is an Island Breeze install brand, which makes ComfortLink and AccuLink literacy mandatory for senior techs: you will commission these systems, not just service them. Every communicating commissioning and every comm fault diagnosis gets documented in ServiceTitan inside the standard 8-photo close-out: the discovery summary screen showing every device online, the alert history as found, and the D to B bus voltage readings at thermostat, indoor, and outdoor. A communicating system whose configuration is not photographed will cost the next tech an hour of reverse engineering.

## Full Breakdown

### What changes when the boards start talking

Recall the conventional control scheme from D23: the thermostat is a panel of switches. Close R to Y and the condenser contactor pulls in. Close R to G and the blower runs. Every function gets its own wire, every wire carries 24VAC or nothing, and your meter can read the whole story as voltage across switches.

A communicating system replaces that switch panel with a network. The thermostat (Trane calls it a comfort control), the indoor unit board, and the outdoor unit board each carry a microprocessor, and they exchange serial data over a shared pair of conductors called a bus. Serial data means information sent as a rapid stream of voltage pulses encoding digital messages, the same idea as the data line in an ECM blower from D23, now extended to the whole system. Instead of "Y is energized," the comfort control sends a message that says, in effect, "I need 70 percent cooling capacity." The outdoor board answers with compressor speed, the indoor board matches blower CFM to the capacity actually being delivered, and every device reports its status, its faults, and even its identity back up the bus.

That last part is the piece with no 24V equivalent: the devices introduce themselves. When a ComfortLink II system is first powered, the comfort control runs a discovery process, finds every device on the bus, and learns each one's type, nominal tonnage, and capabilities, then configures itself to match. The outdoor unit literally tells the system "I am a variable speed heat pump, four tons." Airflow targets get set from that report. This is why the basic equipment settings auto-fill on a fully communicating system, and it is also why a device that stops reporting is a named, specific event the system notices and alarms on.

What you gain: precise staging and modulation, automatic airflow matching, system-wide fault reporting at the wall, and commissioning menus instead of dip switch archaeology. What you lose: the ability to diagnose by voltage on function wires. There is no Y to jumper. Your D23 hopscotch still matters, because 24VAC power wiring, transformers, fuses, and safeties still exist on these systems, but the control conversation itself needs a different test set, and that is the rest of this module.

### The bus: R, B, D, and why the labels matter

The module title and a lot of field folklore say "four wire bus," so let us get the truth on the table, verified against the current installer literature. ComfortLink II runs on three terminals:

- **R** carries 24VAC from the indoor unit's transformer. It powers the comfort control and any bus device that does not have its own power supply.
- **B** is the 24VAC common, and it pulls double duty as the reference for the data signal. On the comfort control it may be labeled B/C.
- **D** is the data line. Every message between every device travels on D, measured against B.

So where does "four wire" come from? Two places. First, field practice: you pull four conductor 18 gauge thermostat cable so you have a spare conductor for the day one of the three fails inside a wall, and that habit is worth keeping. Second, other brands: Carrier's Infinity platform genuinely uses four labeled conductors (A, B, C, D), and techs blur the brands together. On a Trane or American Standard communicating job, you land three. Devices that have their own line voltage power supply, like the outdoor unit, may need only D and B at their bus connector, because they do not draw 24VAC power from the bus. Check the unit's installer guide for which terminals it actually lands; that is the verification habit again.

One device on the bus holds a special role. The indoor unit board (or the 24V relay panel in mixed systems) acts as the Bit Master: it generates the data clock that paces the whole conversation. Lose the Bit Master and the entire bus goes silent, which the system reports as its own distinct alert (no system clock, Err 91.03). Keep that in your mental model: the bus is not a democracy, and a dead indoor board can silence devices that are perfectly healthy.

Now the part D23 trained you to respect: what the wiring does to the signal. Data on D is a low voltage digital signal, and three wiring sins corrupt it.

**Crossed terminals.** The bus cares which wire lands where, and the system is specific about how each mistake presents. Reverse R and B at the comfort control or indoor unit and the bus reads busy with no idle, alert 90.02. Reverse R and D and you get a bus mis-wire alert, 91.05. Reverse D and B at one device and that device drags the data line down, bus stuck low, 91.06, and at a communicating outdoor unit the same swap can flatten the whole bus to 0 VDC and kill the system clock conversation. This is why you keep one consistent wire color per

terminal across the entire job: pick a convention, write it on the inside of the panel if you have to, and never improvise color mid-run.

**Bad conductor quality.** Splices, corrosion, undersized wire, and staple-nicked jackets add resistance and intermittency. A 24VAC switch leg tolerates a mediocre splice; a data line does not. Every splice is a reflection point and a future open. The standard is 18 gauge color coded thermostat cable, continuous runs wherever possible, and any unavoidable splice made mechanically sound, weather protected, and accessible.

**Electrical noise.** The data signal can be corrupted by electromagnetic interference, called EMI: voltage induced into the bus wires by nearby magnetic fields, the same induction that makes a transformer work. The installer guide's rule is at least 1 foot of separation from large inductive loads: motors, line starters, lighting ballasts, electronic air cleaners, distribution panels. Where you cannot get the separation, use shielded cable, and ground the shield at one end only; grounding both ends turns the shield into a loop that carries current and makes its own noise. Unused conductors in the cable get grounded at the indoor unit chassis only, because a floating spare wire running alongside the data line is an antenna feeding noise straight into the bus.

#### PHOENIX FIELD NOTE

Phoenix monsoon season is an EMI and surge factory. Lightning within a mile induces transients on every long wire run, and July through September produces clusters of communicating system calls the morning after a storm: scrambled boards, corrupted bus traffic, and alert histories full of CRC errors timestamped to the storm hour. Two habits pay for themselves here. First, read the alert history with timestamps before clearing anything, because a pile of comm errors all logged at 2 a.m. during a storm tells a different story than the same errors spread over three weeks. Second, recommend whole-system surge protection on every communicating install; these systems put a computer in three places, and Phoenix tries to cook all three every summer.

### Commissioning: where the dip switches went

On a conventional system, configuration lives in hardware: dip switches for blower taps, jumpers for heat pump versus AC. On ComfortLink II, almost all of it moves to the comfort control's menus, and commissioning becomes a structured software walk. Here is the sequence, using the current XL series control as the reference; the practical exam follows this same arc.

**Power-up and discovery.** Energize the indoor unit first so the Bit Master and 24VAC source are alive, then the outdoor unit, then watch the control boot, which takes 90 to 120 seconds. On first power-up the control runs discovery automatically: it polls the bus, finds each communicating device, and records what each one is. Your job during discovery is to verify the roster. Every device you installed must show up: indoor unit, outdoor unit, any communicating zone panel or air cleaner. A device missing from discovery is a wiring or power problem to fix now, not after the trim goes back on.

**The Installation Wizard.** On first boot (or after a factory default restore) the control launches a guided wizard: date and time, installer setup, service reminders, and the dealer code. The wizard is re-runnable from the service menu through Technician Access, which on current controls you hold for five seconds to open. Learn that path; it is also the gate to test modes and charging mode.

**Installer setup groups.** Behind the wizard sit grouped settings screens. The grouping shifts slightly between control generations, which is why you verify against the installer guide, but the structure is stable:

- **Equipment basics:** outdoor unit type (cooling only or heat pump), stages (single, two stage, variable), indoor unit type (gas, electric, hydronic), heat stages, blower type. On a fully communicating system these auto-configure from discovery. Verify them anyway: thirty seconds of reading catches the mismatch that becomes a winter no-heat.
- **Sensors:** the control's onboard temperature and humidity sensors, optional wired remote and outdoor sensors. Wiring a remote indoor sensor disables the onboard sensors, so know what is supposed to be reporting.
- **Accessories:** humidifier type and control mode, air cleaner, dehumidifier, ventilation.
- **Comfort settings, including dehumidification.** Two methods live here. Airflow reduction drops blower CFM about 30 percent when indoor humidity runs above the cooling target, variable speed blowers only. Overcooling lets the system cool past setpoint to wring out humidity, a tenth of a degree per percent of humidity error, capped at a configurable 1, 2, or 3 degrees. In a dry Phoenix June you will leave these conservative; during monsoon humidity they earn their keep.
- **Airflow and staging behavior:** blower on and off delays, stage thresholds. Here is the variable speed exception that catches techs: on a communicating TruComfort variable speed system, the thermostat's airflow settings group is disabled, and fan delays and airflow get set at the outdoor unit's CDA, the communicating display assembly plugged into the outdoor control board. The outdoor board runs the modulation logic on those systems, so the airflow authority lives there. If you are hunting a setting and the menu is grayed out, you are probably standing at the wrong end of the system.

**TruComfort pairing and charge verification.** The XV18 and XV20i variable speed units pair with the communicating air handler and comfort control as a matched set, and the system will not run them from a conventional thermostat. Once paired and discovered, charge verification has exactly one approved path: Charging Mode-Cooling, reached through Menu, Service, Technician Access (hold five seconds), Test Mode, Variable Speed. The mode drives the system to a known steady state so subcooling readings mean something; a modulating compressor left to its own logic never holds still long enough to charge against. The window is outdoor temperature 55 to 120F and indoor 70 to 80F, and the subcooling target gets corrected for line set length and vertical lift from the table in the service facts. Charging a variable speed system outside charging mode is guessing, and the IB evacuation and weigh-in standards from the install track still apply underneath all of this.

**Close-out.** Run a full cycle in every mode and watch the system report itself: capacity demand, compressor speed, CFM. The control's service menu gives you a system report screen, a history of cycles and runtimes, and on current controls a USB port to save logs. Photograph the discovery summary and bus voltages, register the warranty, done.

## **Fault codes: the system tells you, if you can read it**

A communicating system is its own first diagnostic tool. Every device reports faults up the bus, the comfort control displays them as alert codes, and the outdoor control board adds its own LEDs and display text. Learn the reporting machinery once and every Trane communicating call starts with free information.

**Where faults appear.** On the comfort control, alerts show as Err codes with a number family and sub-number, for example Err 91.02, plus an alert history with timestamps. On the outdoor unit, the variable speed control board carries a STATUS LED whose flash rate shows the operating state (idle, running demand, test mode, or lockout), a COMM LED that flashes a count of the communicating devices it sees on the bus, and a plug-in CDA screen that spells out alert text and live data. The CDA device count is an underrated tool: a system with three communicating devices whose COMM LED flashes two has just told you exactly what kind of problem you have, and which kind of device is missing.

**Severity classes.** Alerts carry one of three severities. Normal alerts are informational, the system keeps running and logs the event. Major alerts mean degraded operation. Critical alerts shut down the function or lock it out. The severity tells you how the system responded; it does not rank how urgent the root cause is. A Normal severity CRC error logged two hundred times is a screaming EMI or wiring problem even though no single event hurt anything.

**The families.** You will never memorize every code, and you should not try. You learn the families, and you look the specific code up in the service facts or the alert code reference for the unit on the job. The map:

- **Communication families: 89, 90, 91.** Family 89 is equipment missing: a device that discovery recorded has stopped reporting. Family 90 is corrupted traffic: CRC errors (a checksum test that failed, meaning a message arrived damaged) and bus busy conditions, including the R and B reversal signature. Family 91 is loss of communication: blower comm, inducer comm, system comm (91.02, the broken or shorted data line), no system clock (91.03, the Bit Master is gone), bus mis-wire (91.05), bus stuck low (91.06).
- **Equipment families: most other numbers.** Control board internal failures (18), temperature sensor faults (67 covers ambient, coil, dome, and suction sensors), pressure faults (80), ground fault detection (88), personality module faults (114), EEV faults (155), suction pressure sensor (174), limp mode operation (175), and on variable speed units a long run of inverter drive families covering current, DC bus voltage, drive temperature, and motor starting. The inverter drive theory behind those codes, what a drive actually does to make a compressor modulate and why it monitors its own rectifier temperature, is A33's territory; here you need to recognize them as equipment faults that arrived over a healthy bus.

**The sorting question.** Every alert gets one question first: is this a communication fault or an equipment fault? An equipment fault means the bus works; the outdoor board measured something wrong and successfully told you about it. Diagnose the equipment, with D23 and D24 skills, guided by the code's possible-cause list. A communication fault means the message path itself is broken, and nothing the system tells you about equipment can be fully trusted until the bus is fixed, because half the witnesses are unreachable. Bus first, equipment second. The system even helps with timing: the comfort control sends its heat and cool demand message every minute and declares a comm fault after three missed messages, so a comm fault appearing a few minutes after someone disturbed wiring is cause and effect, not coincidence.

## Bus diagnosis: one DC reading does most of the work

Here is the communicating equivalent of the D23 hopscotch, and like the hopscotch it turns one meter skill into a whole method. Set the meter to DC volts, not AC. Put the probes on D and B.

- **About 12 VDC: the bus is alive and devices are talking.** Data traffic pulls the average voltage down to roughly 12. If you have 12 volts and an alert, you are most likely looking at an equipment fault or a single

silent device, not a dead bus.

- **About 16 VDC: the bus is powered but silent.** The bias voltage is present and nobody is transmitting. Think dead Bit Master, a system that has not finished booting, or every device but the one you are probing disconnected.
- **0 VDC: the bus is dead at this point.** Broken D conductor, D shorted to ground, or a device wired D-to-B backwards clamping the line down.

The power of the reading is that you take it at multiple points and compare, exactly like parking a probe on common and walking a 24V circuit. Read D to B at the comfort control, at the indoor unit, and at the outdoor unit. 12 volts at the air handler and 0 at the condenser puts the fault in the wire run between them: the stapled cable, the chewed splice, the flooded junction. 0 volts everywhere says the whole bus is loaded down or the source end is broken.

When the whole bus reads dead, isolate by disconnection. Lift the bus leg to one device at a time and watch the meter. The literature gives you the signature pair for a reversed outdoor connection: with D and B swapped at the outdoor unit, you read 0 VDC with the field wires connected, and roughly 12 VDC on the field wires the moment you disconnect them at the outdoor unit, because the rest of the bus springs back to life without the clamping device. If the field wires read 0 even disconnected from the outdoor unit, the D line itself is grounded somewhere in the run. That one comparison, connected versus disconnected, sorts a miswired device from a damaged cable in under a minute.

For a single silent device on a healthy bus, the sequence is the ECM discipline from D23 wearing new clothes. Prove the device has power: line voltage present, its fuse intact. Prove its bus landing: D to D, B to B, terminals tight, no corrosion. Then check the device count on the outdoor COMM LED or the control's summary table to confirm who the system actually hears. Only when power and wiring are proven does the device's own board become the suspect. The board is still last, even when the board is a computer.

And EMI earns one more mention as the intermittent that fools meters. A bus that measures perfectly but logs CRC errors by the dozen is being shouted over, not cut. Walk the cable route looking for the new air cleaner mounted against the bus run, the cable draped across a blower motor, the run sharing a hole with line voltage. The alert history is your witness list: note what was running when the errors logged.

## Board replacement discipline

On a conventional system, a control board swap is wiring transfer and done. On a communicating system the board carries identity and memory, and sloppy swaps create the industry's least favorite callback: the system that "was fine until the new board went in."

Four rules:

**1. Move the personality module.** Trane variable speed outdoor boards store the unit's configuration data on a removable memory device called the personality module, the PM. The replacement board ships generic; the PM tells it what unit it lives in. The Err 114 family enforces this: a missing or corrupt PM with no good local copy is a critical alert and the compressor will not run until a good PM is installed. When you swap the board, the PM moves from the old board to the new one. Leaving it on the dead board in the recycling pile is a self-inflicted lockout.

**2. Re-run discovery.** The comfort control remembers the roster from original discovery. A new board is a new device on the bus, and stale entries linger. After a swap, re-run setup so the system rediscovers, and use the control's summary table to remove devices showing offline. A roster that does not match reality generates equipment-missing alerts forever.

**3. Verify firmware compatibility.** The boards in a communicating system run software, and software has versions. A replacement board fresh from the supply house can carry firmware newer or older than the rest of the system, and mismatches show up as devices that discover but misbehave, features that gray out, or comm errors with no wiring cause. Current comfort controls take software updates (USB on the wall control); check versions after a swap and update per the service literature. When a system goes strange right after a board replacement and the wiring checks clean, firmware is a first-class suspect, not a last resort.

**4. Document the proof set.** Same D23 standard, new evidence: photograph the alert as found, the old board's PM moved to the new board, the rediscovery summary showing every device online, and the closing bus voltage. Board condemnations on communicating systems need the same input-proof discipline as always: bus voltage healthy, power present, alert pointing at the board, and the code's own troubleshooting steps followed, before the part goes on the truck.

## When the system can and cannot fall back to 24V

A question you will get from customers and rookie techs alike: if the fancy bus dies in July, can we make it run like a normal AC until the part comes? The honest answer is equipment-specific, and it is a commissioning-time question, not an emergency-time question.

Some Trane communicating components are dual-mode by design. The current communicating air handlers are built for ComfortLink II or conventional 24V operation, with a terminal strip and configuration path for each; their service facts literally carry both control schemes. Mixed systems are also supported deliberately: a communicating indoor unit can run a non-communicating outdoor unit through a 24V relay panel that translates bus demands into contactor closures, and that relay panel architecture appears in the official wiring diagrams.

Variable speed TruComfort outdoor units are not dual-mode. An XV compressor's speed command exists only as bus data; there is no 24VAC signal that means "run at 47 percent." No communicating control, no cooling. That is a sales-floor fact too: a fully variable system commits the homeowner to the communicating ecosystem, thermostat included.

So the field rule has three parts. First, learn the fallback capability of what you install at commissioning time and write it in the job record. Second, never improvise a fallback on a system that does not document one; jumping 24V onto bus terminals is how boards die. Third, when a documented fallback exists, treat it as a bridge, not a destination: the system runs degraded, single-stage-dumb, until the communicating repair is made.

## Thinking that transfers, and where the track goes next

Every major brand built one of these: Carrier and Bryant call it Infinity and Evolution, Lennox calls it iComfort, Rheem and Ruud call it EcoNet, York's is part of the Affinity line. The protocols differ, the terminal labels differ (Infinity's four-wire ABCD being the famous contrast to Trane's three-terminal bus), and the menus differ everywhere. What transfers is the method you just learned: identify the bus, learn its healthy voltage signature from the service literature, verify discovery against the installed roster, sort communication faults from

equipment faults before trusting any code, respect polarity and wire quality, and treat boards as computers with identity and firmware. Brand-specific depth on those other ecosystems is A34. The inverter drives that make variable speed compressors possible, and the drive-side fault families you saw flash past in the Err code list, are A33. Walk in with this module solid and both of those become vocabulary lessons instead of new worlds.

## Common Mistakes

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1. **Diagnosing a communicating system like a 24V system.** Jumping R to a bus terminal hoping to force a call, or condemning a board because no terminal shows 24VAC on a call. There is no Y. The bus carries data, the meter goes to DC volts across D and B, and the 12, 16, 0 readings replace the hopscotch. Cost: dead boards from improvised jumpers, plus the misdiagnosis.
2. **Skipping the alert history and clearing codes on arrival.** The history with timestamps is the witness statement: a storm-hour cluster of CRC errors versus weeks of scattered ones are different diagnoses. Clear it before reading it and the evidence is gone. Photograph first, always.
3. **Treating a communication fault like an equipment fault.** Chasing a "blower error" through the motor and capacitor playbook when the 91 family code meant the message path to the blower is broken. Bus first, equipment second; nothing a silent device reports can be trusted.
4. **Sloppy bus wiring habits: improvised splices, inconsistent colors, staples, cable lashed to the blower housing.** A 24V circuit forgives all of these; a data line punishes each one with intermittents that test fine while you stand there. Cost: the callback nobody can reproduce until someone walks the whole cable route.
5. **Grounding a cable shield at both ends, or leaving spare conductors floating.** Both turn noise protection into a noise source. Shield grounded one end only; unused conductors grounded at the indoor chassis only.
6. **Replacing a board without moving the personality module or re-running discovery.** The new board either locks out on the Err 114 family or joins a roster that still lists its dead predecessor, generating equipment-missing alerts. Cost: a correct part turned into a callback by procedure failure.
7. **Setting charge on a variable speed system without Charging Mode.** A modulating compressor never holds a steady state on its own, so gauge readings taken in normal operation are noise. Technician Access, Test Mode, Charging Mode-Cooling, inside the temperature window, with line-length corrections. Anything else is guessing with a manifold.
8. **Trusting memory instead of the installer guide.** Menu paths, terminal labels, and settings groups shift between control generations, and AccuLink badging hides identical Trane hardware. The habit that defines a communicating-literate tech is pulling the service facts and installer guide for the exact model before commissioning or condemning anything.

*Next module: A33, Inverter and Variable Speed Drive Theory, where the drive-side fault families you glimpsed in the Err code list (current, DC bus, drive temperature, motor start) get their full story.*

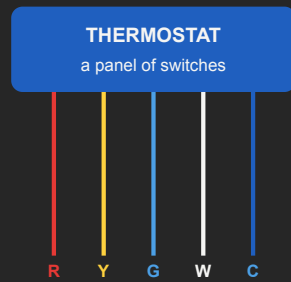
# Module Visuals

## COMFORTLINK ARCHITECTURE

### COMFORTLINK II ARCHITECTURE: SWITCHES VS MESSAGES

#### CONVENTIONAL 24V

one wire per function, 24VAC or nothing



Y energized = run cooling. G = run fan.

#### AIR HANDLER

relays, dip switches

#### CONDENSER

contactor, on or off

#### DIAGNOSE WITH:

AC volts across switches (D23 hopscotch)  
jumper Y to test, read 24V at the coil

#### COMFORTLINK II (ACCULINK)

serial data on a shared bus, three computers talking

#### COMFORT CONTROL

a computer with a screen

"I need 70% capacity"

"4 ton VS heat pump here"

"matching CFM to capacity"

#### THE BUS: R, B, D

R = 24VAC power  
B = common + data reference  
D = data, every message

#### INDOOR BOARD

Bit Master: data clock  
24VAC source for bus

#### OUTDOOR BOARD

runs modulation, CDA,  
personality module

#### DIAGNOSE WITH:

DC volts across D and B (12 / 16 / 0)  
alert codes, discovery roster, no Y to jumper

Discovery: every device introduces itself on first power-up. The roster must match what you installed.

## FAULT CODE FAMILIES

# ALERT CODE FAMILIES: SORT BEFORE YOU DIAGNOSE

EVERY ALERT, ONE QUESTION FIRST:  
COMMUNICATION OR EQUIPMENT?

### COMMUNICATION: THE BUS IS BROKEN

the message path failed, witnesses unreachable

#### FAMILY 89: EQUIPMENT MISSING

a device discovery recorded has stopped reporting

#### FAMILY 90: CORRUPTED TRAFFIC

CRC errors (damaged messages), bus busy. 90.02 = R and B reversed

#### FAMILY 91: LOSS OF COMMUNICATION

91.02 broken or shorted data line  
91.03 no system clock (Bit Master gone)  
91.05 bus mis-wire, 91.06 bus stuck low

### EQUIPMENT: THE BUS WORKS

the message arrived and reported a real problem

18: control board internal failure

67: temperature sensors (ambient, coil, dome, suction)

80: pressure faults

88: ground fault detection

**114: personality module (PM missing or corrupt;  
no good copy = compressor locked out)**

155: EEV faults

174: suction pressure sensor, 175: limp mode

Inverter drive families: current, DC bus, drive temp,  
motor start (drive theory is module A33)

Diagnose the equipment with D23/D24 skills.

### THREE SEVERITIES: HOW THE SYSTEM RESPONDED, NOT HOW URGENT THE ROOT CAUSE IS

**NORMAL:** informational, keeps running

**MAJOR:** degraded operation

**CRITICAL:** shutdown or lockout

### BUS FIRST, EQUIPMENT SECOND.

Read and photograph the alert history with timestamps before clearing anything. 200 Normal CRC errors is a screaming wiring or EMI problem.

## FOUR WIRE BUS WIRING

# THE BUS: THREE TERMINALS, AND THE FOUR-WIRE TRUTH

### COMFORTLINK II TERMINALS

- R** 24VAC power from the indoor transformer powers the comfort control and bus-powered devices
- B** common, AND the data reference may be labeled B/C at the comfort control
- D** data: every message, measured against B self-powered devices may land only D and B

### SO WHY "FOUR WIRE"?



18 AWG, 4 conductor

1. Field practice: pull 4 conductor cable, land 3, keep 1 spare for the day a conductor dies inside a wall
2. Brand confusion: Carrier Infinity really uses four (A, B, C, D). Trane lands three.

**ONE COLOR PER TERMINAL,  
THE WHOLE JOB. NO EXCEPTIONS.**

### THREE WIRING SINS THE DATA LINE PUNISHES

#### CROSSED TERMINALS

- R and B swapped: bus busy, **alert 90.02**
- R and D swapped: bus mis-wire, **alert 91.05**
- D and B swapped: bus stuck low, **alert 91.06, can flatten the bus to 0V**

#### BAD CONDUCTOR QUALITY

- Splices, corrosion, staple nicks: a 24V switch leg forgives them, a data line does not.
- Continuous runs where possible.
- Any splice: mechanical, protected, accessible, tug tested.

#### ELECTRICAL NOISE (EMI)

- Keep the bus at least 1 FOOT from motors, ballasts, line starters, air cleaners, distribution panels.
- Shielded cable when you cannot: shield grounded at ONE end only. Spares grounded at indoor chassis.

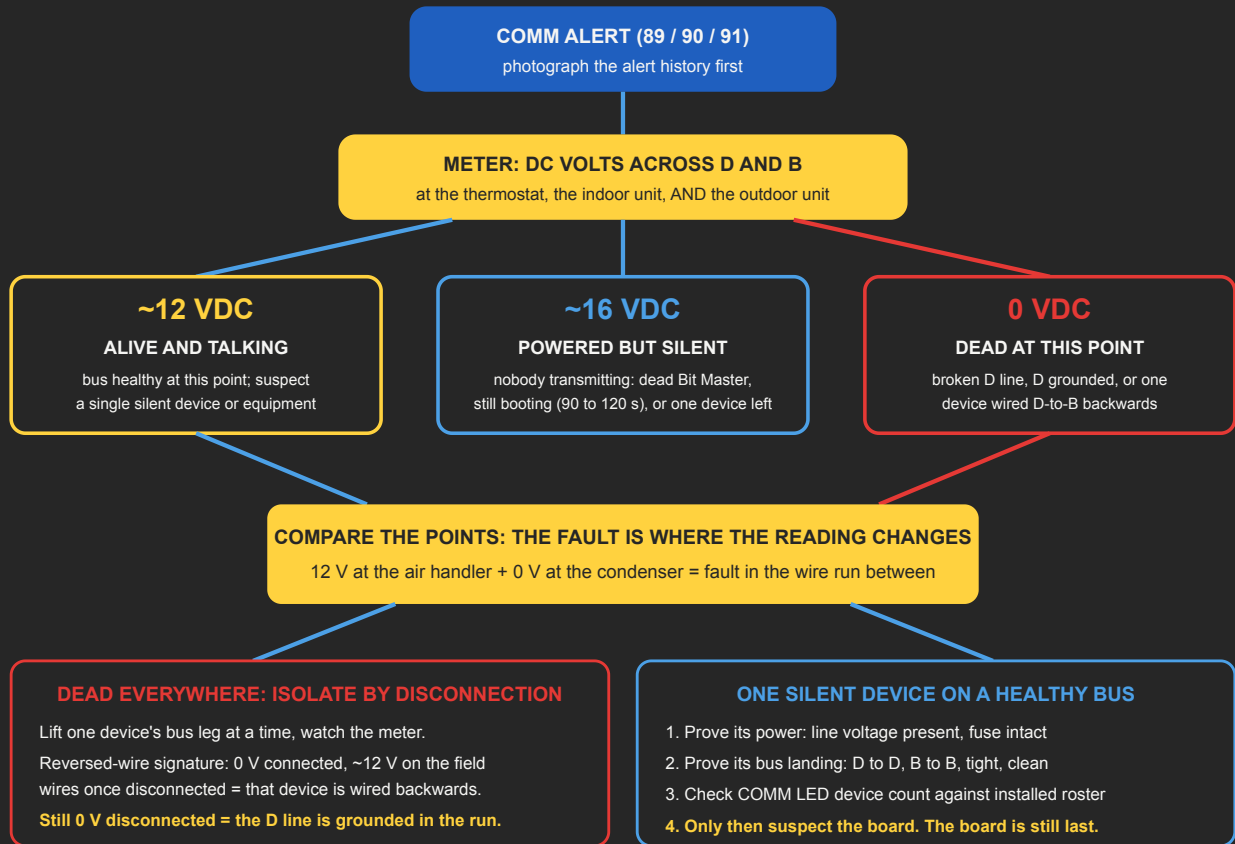
**The indoor board is the Bit Master: it paces the whole conversation.**

Lose it and the entire bus goes silent: no system clock, alert 91.03.

Verify terminal layout against the installer guide for the exact model. Labels move between generations.

## PAIRING FAILURE TREE

# COMM FAULT HUNT: ONE DC READING DOES THE WORK



## SETUP CONFIG FLOW

# COMMISSIONING FLOW: WHERE THE DIP SWITCHES WENT

### 1. WIRE AND WALK THE BUS

R, B, D terminal to terminal, one color per terminal,  
1 ft from inductive loads, spares grounded at indoor chassis

### 2. POWER UP: INDOOR FIRST, THEN OUTDOOR

Indoor carries the transformer and the Bit Master clock.  
Boot takes 90 to 120 seconds. Wait it out.

### 3. DISCOVERY: VERIFY THE ROSTER

Control polls the bus, each device reports type and tonnage.  
Every installed device must appear. Fix holes NOW.

### 4. INSTALLATION WIZARD

Date, time, installer setup, service reminders, dealer code.  
Re-run any time: Menu, Service, Technician Access (hold 5 s)

### 5. SETUP GROUPS: VERIFY, NOT JUST ACCEPT

Equipment, sensors, accessories, comfort and dehumidification,  
airflow and staging. Auto-config fills it; you read it anyway.

### 6. CHARGE, TEST, DOCUMENT

Charging Mode-Cooling, full cycle each mode, bus voltage check,  
photos: roster, report screen, D to B readings

### TRAP 1: VARIABLE SPEED AIRFLOW

On a TruComfort variable speed system the thermostat's  
airflow group is DISABLED, not broken.

**Airflow and blower delays are set at the  
outdoor unit's CDA display.**

The outdoor board runs the modulation, so the  
airflow authority lives outside.

### TRAP 2: CHARGING A MODULATING SYSTEM

A variable speed compressor never holds steady state  
on its own. Gauge readings in normal operation are noise.

**One approved path: CHARGING MODE-COOLING**

Menu, Service, Technician Access (hold 5 s),  
Test Mode, Variable Speed, Charging Mode-Cooling

Window: outdoor 55 to 120 F, indoor 70 to 80 F.  
Correct subcooling target for line length and lift.

### DEHUMIDIFICATION SETTINGS

Airflow reduction: about 30% CFM cut over humidity target  
(variable speed blowers only)

Overcooling: 0.1 F per 1% humidity error, capped 1, 2, or 3 F

Pull the installer guide for the exact model first. Menus and groups shift between control generations.