

HVAC Cheat Sheet · 1. Refrigerant PT chart (saturation pressure, psig)

°F	R-22	R-410A	R-32	R-454B bubble	R-454B dew	°F	R-22	R-410A	R-32	R-454B bubble	R-454B dew
-40	0.6	10.7	11.0	9.5	8.4	50	84.1	142.6	145.8	135.0	129.3
-35	2.6	14.0	14.4	12.7	11.4	52	87.4	148.4	151.2	140.0	134.1
-30	4.9	17.7	18.2	16.2	14.8	54	90.8	153.8	156.7	145.1	139.1
-25	7.4	21.8	22.3	20.1	18.5	56	94.4	159.3	162.4	150.3	144.1
-20	10.2	26.2	26.8	24.3	22.6	58	98.0	164.9	168.1	155.7	149.3
-18	11.4	28.1	28.7	26.1	24.3	60	101.6	170.7	174.0	161.1	154.6
-16	12.6	30.0	30.7	28.0	26.1	65	111.2	185.8	189.5	175.4	168.5
-14	13.9	32.0	32.8	29.9	27.9	70	121.4	201.8	205.8	190.5	183.1
-12	15.2	34.1	34.9	31.9	29.8	75	132.2	218.7	223.2	206.5	198.7
-10	16.5	36.3	37.1	33.9	31.8	80	143.6	236.5	241.5	223.4	215.2
-8	17.9	38.5	39.4	36.1	33.8	82	148.4	244.0	249.1	230.4	222.0
-6	19.4	40.8	41.7	38.2	35.9	84	153.2	251.6	256.9	237.6	229.0
-4	20.9	43.2	44.2	40.5	38.1	86	158.2	259.3	264.9	244.9	236.2
-2	22.4	45.7	46.7	42.9	40.4	88	163.2	267.3	273.0	252.4	243.5
0	24.0	48.2	49.3	45.3	42.7	90	168.4	275.4	281.3	260.1	251.0
2	25.7	50.8	51.9	47.8	45.1	92	173.7	283.6	289.8	267.9	258.6
4	27.4	53.5	54.7	50.3	47.6	94	179.1	292.1	298.5	275.8	266.4
6	29.2	56.3	57.5	53.0	50.1	96	184.6	300.7	307.4	284.0	274.4
8	31.0	59.2	60.5	55.7	52.7	98	190.2	309.5	316.4	292.3	282.5
10	32.8	62.2	63.5	58.5	55.4	100	195.9	318.5	325.7	300.8	290.9
12	34.8	65.2	66.6	61.4	58.2	102	201.8	327.7	335.1	309.4	299.4
14	36.8	68.4	69.8	64.4	61.1	104	207.7	337.1	344.8	318.3	308.0
16	38.8	71.6	73.1	67.5	64.1	106	213.8	346.7	354.6	327.3	316.9
18	40.9	74.9	76.5	70.7	67.1	108	220.0	356.5	364.6	336.5	326.0
20	43.1	78.4	80.0	73.9	70.3	110	226.4	366.4	374.9	345.9	335.2
22	45.3	81.9	83.6	77.3	73.5	112	232.8	376.6	385.3	355.5	344.6
24	47.6	85.5	87.3	80.7	76.8	114	239.4	387.0	396.0	365.2	354.3
26	50.0	89.2	91.1	84.3	80.3	116	246.1	397.6	406.9	375.2	364.1
28	52.4	93.1	95.1	87.9	83.8	118	253.0	408.4	418.0	385.3	374.1
30	55.0	97.0	99.1	91.7	87.4	120	260.0	419.4	429.3	395.7	384.3
32	57.5	101.1	103.2	95.5	91.1	122	267.1	430.7	440.9	406.2	394.8
34	60.2	105.2	107.5	99.5	94.9	124	274.3	442.1	452.7	417.0	405.4
36	62.9	109.5	111.9	103.5	98.8	126	281.7	453.8	464.7	427.9	416.3
38	65.7	113.9	116.3	107.7	102.9	128	289.2	465.8	477.0	439.1	427.4
40	68.6	118.4	121.0	112.0	107.0	130	296.9	477.9	489.5	450.5	438.7
42	71.5	123.0	125.7	116.4	111.2	135	316.7	509.4	521.8	479.9	468.0
44	74.5	127.7	130.5	120.9	115.6	140	337.4	542.5	555.8	510.7	498.8
46	77.6	132.6	135.5	125.5	120.0	150	381.7	613.9	628.8	576.8	565.4
48	80.8	137.5	140.6	130.2	124.6						

Which column: superheat uses the dew (vapor) temperature at suction pressure; subcooling uses the bubble (liquid) temperature at liquid pressure.

R-454B's dew point runs 2.1 to 2.4°F above its bubble point. R-410A's glide is about 0.2°F, so its column is dew through 50°F and bubble from 52°F, as Chemours prints it. Sources: Chemours OPTXLPTAC-2 (4/25) and C-XL41PT-ENG (7/23), checked against Arkema Forane (05-2025).

2. Superheat and subcooling

Reading	Formula	Where
Superheat	Suction line temp – dew (vapor) saturation temp at suction pressure	Suction port; line at the outdoor unit (Goodman: 4 to 6 in from the compressor)
Subcooling	Bubble (liquid) saturation temp at liquid pressure – liquid line temp	Liquid service valve; line near the outdoor coil (Carrier), within 6 in of the unit (Rheem)

Order: airflow first, then charge. ACCA 5 QI: airflow within the maker's tolerance before the charge is measured; superheat within $\pm 5^{\circ}\text{F}$ and subcooling within $\pm 3^{\circ}\text{F}$ of the maker's target, not added to the maker's own tolerance; superheat test typically at 55°F outdoor or above, subcooling at 60°F or above. TXV/EEV systems charge by subcooling; fixed orifice (piston) systems by superheat.

TXV and EEV: subcooling to the rating plate (examples from current manuals)

Unit	Target	Valid when	Otherwise
Carrier 26SCA5 AC, R-454B (06/24)	Rating plate value, $\pm 3^{\circ}\text{F}$	Outdoor $70\text{--}100^{\circ}\text{F}$, indoor $70\text{--}80^{\circ}\text{F}$, 15 min run	Adjust for line length only; check later
American Standard 5A7A4 AC, R-454B (10/24)	Design subcooling corrected for line length and lift	Above 55°F outdoor; indoor $70\text{--}80^{\circ}\text{F}$; 20 min between adjustments	Weigh in; return in spring or summer
Lennox ML17KC2 AC, R-454B (03/26)	2-ton 9.6°F · 3-ton 12.2°F · 4-ton 13.6°F · 5-ton 15.1°F , all $\pm 1^{\circ}\text{F}$	65°F outdoor and above	Below 64°F , weigh in
Goodman GLZS4BA HP, R-32 (12/23)	$8 \pm 1^{\circ}\text{F}$ at the liquid valve (compressor superheat $16\text{--}19 \pm 1^{\circ}\text{F}$)	60°F outdoor and above, cooling	Heating mode: by weight
Rheem (-)P14AY/(-)P15AY HP, R-454B	Charging chart inside the access panel	Cooling 55°F and up; heating $40\text{--}60^{\circ}\text{F}$; 15 min	Never below 40°F

No label? $10\text{--}12^{\circ}\text{F}$ is most common, up to 16°F on some systems; $10 \pm 3^{\circ}\text{F}$ rule of thumb (HVAC School). TXV superheat at the evaporator outlet: about $5\text{--}15^{\circ}\text{F}$. R-454B and other blends: charge as liquid only.

Fixed orifice (piston): target superheat, $^{\circ}\text{F}$

	Indoor (return) wet bulb, $^{\circ}\text{F}$														
OD $^{\circ}\text{F}$	50	52	54	56	58	60	62	64	66	68	70	72	74	76	78
55	7	10	12	15	18	21	24	27	30	—	—	—	—	—	—
60	5	8	10	13	16	19	22	25	28	31	—	—	—	—	—
65	—	4	8	11	14	17	19	22	25	28	31	—	—	—	—
70	—	—	5	8	11	14	17	19	22	25	28	31	—	—	—
75	—	—	—	5	7	10	14	18	21	24	28	31	—	—	—
80	—	—	—	—	4	7	10	12	16	19	23	26	29	33	—
85	—	—	—	—	—	4	7	10	14	18	21	24	28	30	32
90	—	—	—	—	—	—	4	8	11	14	18	22	25	28	31
95	—	—	—	—	—	—	—	4	8	13	16	20	23	26	29
100	—	—	—	—	—	—	—	—	6	10	13	18	21	25	29
105	—	—	—	—	—	—	—	—	4	7	11	15	20	24	28
110	—	—	—	—	—	—	—	—	—	4	9	13	18	23	28
115	—	—	—	—	—	—	—	—	—	—	6	12	16	21	26

American Standard 5A7A4 (R-454B) table, 11-AC49D1-1C-EN, every second wet-bulb column. Measure return wet bulb at the unit just before the coil and outdoor dry bulb. Add refrigerant to lower superheat, remove to raise it; wait 10 to 15 minutes after any change. Dash: no target, weigh the charge in. Carrier's R-410A piston table (24SCA4) gives the same 10°F at 95°F outdoor / 67°F wet bulb and runs about 2°F higher elsewhere, $\pm 3^{\circ}\text{F}$.

3. HVAC troubleshooting chart: refrigerant-side readings

Clean filter and coils, airflow verified, the metering device known. A TXV holds superheat roughly steady until it fails or loses its full column of liquid; a piston does not.

Fixed orifice (piston)

Fault	Suction	Head	Superheat	Subcool	Amps	Air split
Low charge	Low	Low	High	Low	Low	Low
Overcharge	High	High	Low	High	High	Norm/low
Low indoor airflow / low return temp	Low	Norm/low	Low	Norm/low	Norm/low	High
Dirty condenser	High	High	Norm/low	Norm/low	High	Low
Liquid line restriction	Low	Norm/low	High	High/norm	Low	Low
Oversized piston	High/norm	Norm/low	Low	Low	Low	Low
High return air temp	High	High	High	Norm/low	High	Low

HVAC School diagnostic quick sheet. Low charge vs restriction: subcooling low on the undercharge, high on the restriction (look for a temperature drop or frost at the drier). Low airflow vs low charge: superheat low on airflow, high on charge.

TXV / EEV (Rheem cooling-mode table)

Fault	Head	Suction	Superheat	Subcool	Amps	Notes
Overcharge	High	High	Low	High	High	Slight overcharge: suction and SH normal (HVAC School)
Undercharge	Low	Low	High	Low	Low	Slight undercharge: suction and SH normal
Liquid line restriction	Low	Low	High	High	Low	Looks like undercharge; subcooling normal to high (Goodman)
Low indoor airflow	Low	Low	Low	Low	Low	Air split high; fix airflow before charge
Dirty outdoor coil	High	High	Low	Low	High	Clean before judging charge
Low outdoor temp	Low	Low	High	High	Low	Below the maker's minimum, no charge check
Inefficient compressor	Low	High	High	High	Low	Goodman: low high side, high low side, low coil split, low amps, charge correct
TXV bulb charge lost (underfeed)	Low	Low	High	High	Low	Rule out a liquid line restriction first
Bulb loose or poorly insulated (overfeed)	High	High	Low	Low	High	HVAC School shows head and amps low; risk of floodback

Restriction and head pressure: the charts disagree (Rheem lists it under both high and low head; Goodman and Trane under both). HVAC School: "In general, restrictions are in the liquid line and will result in low head after sufficient run time." Subcooling high is the reading they agree on.

Non-condensables: high head, fluctuating pressures, gurgle at the metering device. Goodman's test: shut down, let pressures equalize at least 15 minutes, compare pressure with the coldest coil's temperature on the PT chart; a higher saturation temperature than the coil means non-condensables.

TXV check (Carrier): bulb in an ice bath for 1 minute, superheat should rise.

4. AC troubleshooting chart by symptom

Symptom	Likely causes	Check first
Nothing runs	Power, fuse or breaker, loose or broken wire, transformer, thermostat or wiring, control board, pressure-control lockout	Line voltage, then 24 V; board code; lockout resets by cycling power, then find the cause
Blower runs, outdoor unit dead	No 24 V at contactor coil (thermostat, LV wiring or fuse, safety open on loss of charge), contactor coil, no line voltage through contactor	24 V across the coil; contactor closed: line voltage on load side
Fan runs, compressor does not	Run or start capacitor, start relay, loose connection, internal overload open, stuck compressor, open or grounded winding, low voltage	Capacitor μ F; voltage at compressor; windings and ground. Hot overload: Rheem says wait at least 3 hours
Compressor hums, won't start	Run capacitor, stuck compressor; start capacitor, start relay, contacts	Run capacitor, then voltage at the terminals
Compressor runs, fan does not	Fan capacitor, fan overload, fan motor, loose lead, contacts; heat pump: defrost control or relay	Fan capacitor and windings; head climbs and compressor trips without the fan
Trips on overload or short cycles	Fan stopped, outdoor air blocked or recirculating, overcharge or non-condensables, low charge, voltage high or low, run capacitor, discharge restriction, high superheat, bearings	Running voltage within $\pm 10\%$ of nameplate (Rheem); coil and fan; charge
Runs, not enough cooling	Filter or indoor coil dirty, low airflow, low charge, restriction, inefficient compressor, wrong or failed valve, infiltration, undersized	Airflow (~ 400 CFM/ton), then the five refrigerant readings
Indoor coil or suction line ices	Low airflow, low charge, cooling below 65°F outdoor without low-ambient kit, moisture, restricted piston or strainer	Filter, blower, return; then charge. Below 32°F saturation the coil freezes
High head pressure	Dirty outdoor coil, fan off, recirculation, overcharge, non-condensables, high load	Coil, fan, clearances; non-condensables test; charge
Low head, high suction	Compressor valves or internal relief, TXV stuck open, heat pump reversing valve leaking	Goodman compressor test; reversing valve temperatures
Pressures and superheat swing	TXV hunting (superheat swings more than 10°F, Carrier), non-condensables	Bulb clamp and insulation; air distribution on the coil
Gurgle at expansion device	Non-condensables, undercharge	Subcooling at the condenser outlet and at the TXV inlet (Danfoss)
Compressor noisy	Overcharge, broken internals or valves, loose TXV bulb, hold-down bolts; 3-phase scroll reverse rotation	Superheat (floodback); bolts; phase rotation
Registers sweat	Low indoor airflow	Blower speed, filter, ducts
Too cool then too warm; uneven rooms	Thermostat faulty or badly placed, unbalanced airflow, infiltration	Thermostat location and wiring; dampers

Combined from Carrier's air conditioner troubleshooting chart (24-25-8SM), Goodman's service problem analysis guide (RS6200006), Rheem's general troubleshooting guide (92-105074-04-17) and Trane's 4TWR6 fault matrix. Disconnect power before opening the unit: "Contactor may break only one side" (Rheem).

5. Heat pump troubleshooting chart

In heat mode the indoor coil is the condenser and the outdoor coil the evaporator. Heating readings diagnose; they do not set the charge (weigh in below the maker's minimum outdoor temperature and verify in cooling season).

Fault, heating mode (Rheem)	Head	Suction	Superheat	Subcool	Amps
Overcharge	High	High	OK	High	High
Undercharge	Low	Low	OK or high	Low	Low
Liquid line restriction	Low	Low	High	High	Low
Low outdoor airflow	Low	Low	Low	Low	Low
Dirty indoor coil	High	High	Low	Low	High
Low indoor temperature	Low	Low	OK	High	Low
Inefficient compressor	Low	High	High	High	Low
Outdoor TXV bulb charge lost	Low	Low	High	High	Low
Outdoor bulb poorly insulated	High	High	Low	Low	High

Symptom	Likely causes	Check first
Outdoor coil ices and stays iced	Defrost control or its power, defrost thermostat or sensor failed or loose, reversing valve not shifting, defrost relay welded (fan keeps running), low charge, blocked outdoor air, low indoor airflow	Force a defrost (below): valve shifts, fan stops, aux on. Sensor tight on the tube; Rheem sensor ~30,000 ohms at 35°F; Carrier: 24 V at T1
Defrost runs long or leaves ice	Termination setting, sensor location, low charge, fan relay not stopping fan, thermostat satisfied mid-defrost, control or thermostat failed	Termination jumper, sensor, charge, fan relay
Runs, blows cool, low heat	Reversing valve, charge, non-condensables, inefficient or stuck compressor, outdoor fan stopped, coil dirty or frosted, restriction, open heat element or limit, defrost control	Supply temperature against normal (below); fan; valve; heating readings
Reversing valve stuck or leaking	No 24 V to solenoid, coil open, pilot or slide stuck, mid-position (high suction), internal leak (low head, high suction)	24 V at solenoid; pull coil and listen for the click; raise head and cycle modes. Leak: true suction vs suction after the valve no more than 4°F apart (Goodman)
Trips on overload in heat	Dirty filter or indoor coil, indoor fan off, charge, non-condensables, valve mid-position, voltage, capacitor	Indoor airflow first: restricted indoor airflow is a primary cause of high head in heat (Trane)
Aux heat on far more than usual	Outdoor fan motor, low charge, compressor, defrost board stuck in defrost, valve stuck in cooling	Lennox: aux on more than about 30 minutes means call a tech. Aux during defrost is normal

6. Heat pump defrost and what is normal

Maker	Starts defrost	Interval	Ends	Limit	Force a test
Carrier time-temp	Thermostat closed (32 ±3°F) for set run time	30/60/90 (120 some); factory 60 or 90	~65°F	10 min	Short speed-up pins (jumper DFT if coil warm); remove at shift
Goodman	Sensor closed (~31°F) + heat call	30/60/90	~75°F	10 min (12 upgraded)	Jumper DFT-R, jump test pins; defrost within 21 s; 24 V C-O, W2-C
Lennox ML14XP1	Thermostat closed, run time	30/60/90; factory 90	Thermostat opens	14 min	Short TEST pins 2 s; remove within 5 s
Rheem (-)P14/P15	Coil <35°F, 34 min run, ambient-coil calc	Demand	70°F (50/60/80)	14 min	Short and hold TEST pins with a heat call
Trane / Am. Std.	Change in air-to-coil ΔT	Demand	47°F (70°F, J2 cut, ≤30°F)	<6°F: 12 min or 35°F every 3 h	Short FRC_DFT to TEST_COMMON 2 s

Reversing valve terminal: O energized in cooling (Carrier, Goodman); B energized in heating (Rheem (-)P14/P15); on Trane's 4TWR6, B is the 24 V common. Match the thermostat's O/B setting to the outdoor unit's diagram. **Normal:** steam or fog in defrost; a whoosh at start and end; outdoor fan off and aux heat on in defrost; compressor pausing ~30 s in and out of defrost where the delay is enabled; light frost under 1/4 in that clears (Carrier); coil 10–20°F colder than outdoor air (Trane); defrost 5–15 min (Lennox), 3–5 min on demand defrost (Trane); supply air about 85–105°F, against 120–140°F from a gas furnace (Carrier, Trane).

7. Rules of thumb and formulas

Reading	Rule of thumb (manufacturer data wins)
Evaporator saturation, cooling	35°F below return air temperature $\pm 5^\circ\text{F}$ at 400 CFM/ton; 38–40°F below at 350 CFM/ton. Below 32°F saturation the coil will eventually freeze
Condensing saturation	15–20°F above outdoor $\pm 3^\circ\text{F}$ on most modern systems. By efficiency: 30°F (6–10 SEER), 25°F (10–12), 20°F (13–15), 15°F (16+)
TXV superheat, evaporator outlet	5–15°F (10 $\pm$ 5)
Subcooling, TXV/EEV	Rating plate. Without one: 8–14°F typical, 10 $\pm$ 3°F; 10–12°F most common, up to 16°F
Subcooling, fixed orifice	5–23°F with load, usually 10 $\pm$ 3°F; charge by superheat
Temperature split, cooling	16–22°F return to supply; lower in high humidity
Airflow	400 CFM/ton nominal; ACCA 5 QI: typically 350–450 CFM/ton
Total external static	0.3–0.7 in wc on most systems
Example, 95°F outdoor, 80°F return	Evaporator $\sim 45^\circ\text{F}$ (40–50): R-410A 118–143 psig, R-454B dew 107–129 psig. Condenser 110–115°F: R-410A 366–392 psig, R-454B bubble 346–370 psig

To find	Formula
Sensible capacity, Btu/h	$\text{CFM} \times \Delta T (^{\circ}\text{F}) \times 1.08$
Total capacity, Btu/h	$4.5 \times \text{CFM} \times (\text{return enthalpy} - \text{supply enthalpy})$, enthalpy from wet bulb
Airflow from electric heat, CFM	$(\text{volts} \times \text{amps} \times 3.413) \div (\text{temperature rise} \times 1.08)$
Airflow from a gas furnace, CFM	$(\text{gas input cu ft/h} \times \text{Btu per cu ft} \times \text{measured efficiency}) \div (\text{temperature rise} \times 1.08)$
Gas input from the meter, cu ft/h	$3,600 \times \text{smallest dial size (cu ft)} \div \text{seconds for one revolution}$
Run capacitor under load, μF	$2,652 \times \text{start-winding amps} \div \text{volts across the capacitor}$
Conversions	1 ton = 12,000 Btu/h · 1 W = 3.413 Btu/h · 1 kW = 3,413 Btu/h · 746 W = 1 hp · gas outlet pressure: natural gas 3.5 in wc, LP 11 in wc

Sources: HVAC School, "The 5 Pillars of Residential A/C Refrigerant Circuit Diagnosis," "What Should My Subcooling Be?" and the HVAC Air / Refrigerant Diagnostic Quick Sheet; ANSI/ACCA 5 QI-2015 §4.1. Pressures from the chart on page 1. Full citations at usedeepsel.com/hvac-cheat-sheet.