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FREE GUIDE FOR HVAC TECHS

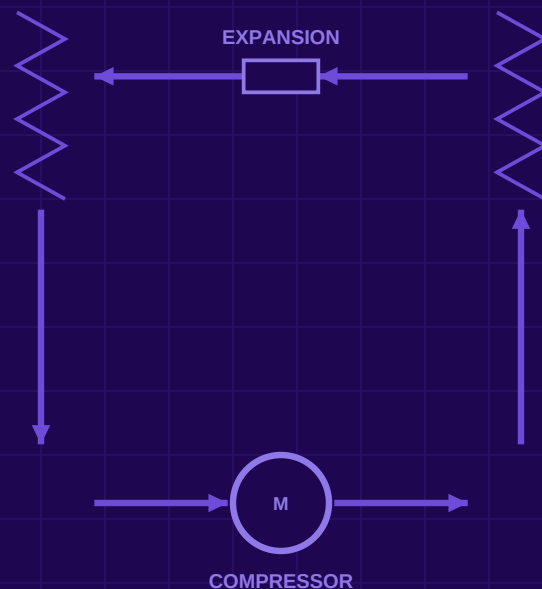
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FAULTS
SOLVED

Troubleshooting map for mini-split systems

Symptom, cause and fix + P/T chart for R-410A, R-32, R-22 and R-134a

- The 20 most common problems, step by step
- Pressure-temperature chart (°F and °C)
- Superheat, subcooling and pressure matrix
- Evacuation, refrigerant charging and electrical tests
- Preventive maintenance checklist



Before you start

This map covers the problems that show up most on mini-split service calls, from standard (on/off) units to inverters. For each problem you get the most likely causes, what to measure and how to fix it.

Use it as a quick reference on your phone: start with the symptom the customer reports, go through the causes in order and confirm each one with a measurement before replacing parts.

Pressure and temperature values are for reference. Each manufacturer has its own charts, and on inverters the values change with compressor speed.

! SAFETY FIRST

- Turn off the breaker and verify zero voltage before opening the units.
- Discharge capacitors before measuring: they hold a charge even with the unit off.
- Inverter boards have high-voltage capacitors: wait the time stated in the manual (usually 3 to 10 minutes).
- Wear gloves and safety glasses when handling refrigerant: it can cause frostbite.
- R-32 is A2L (mildly flammable): no open flame nearby, good ventilation and A2L-rated tools.
- Never vent refrigerant: recover it with a recovery machine and cylinder, as EPA rules require.

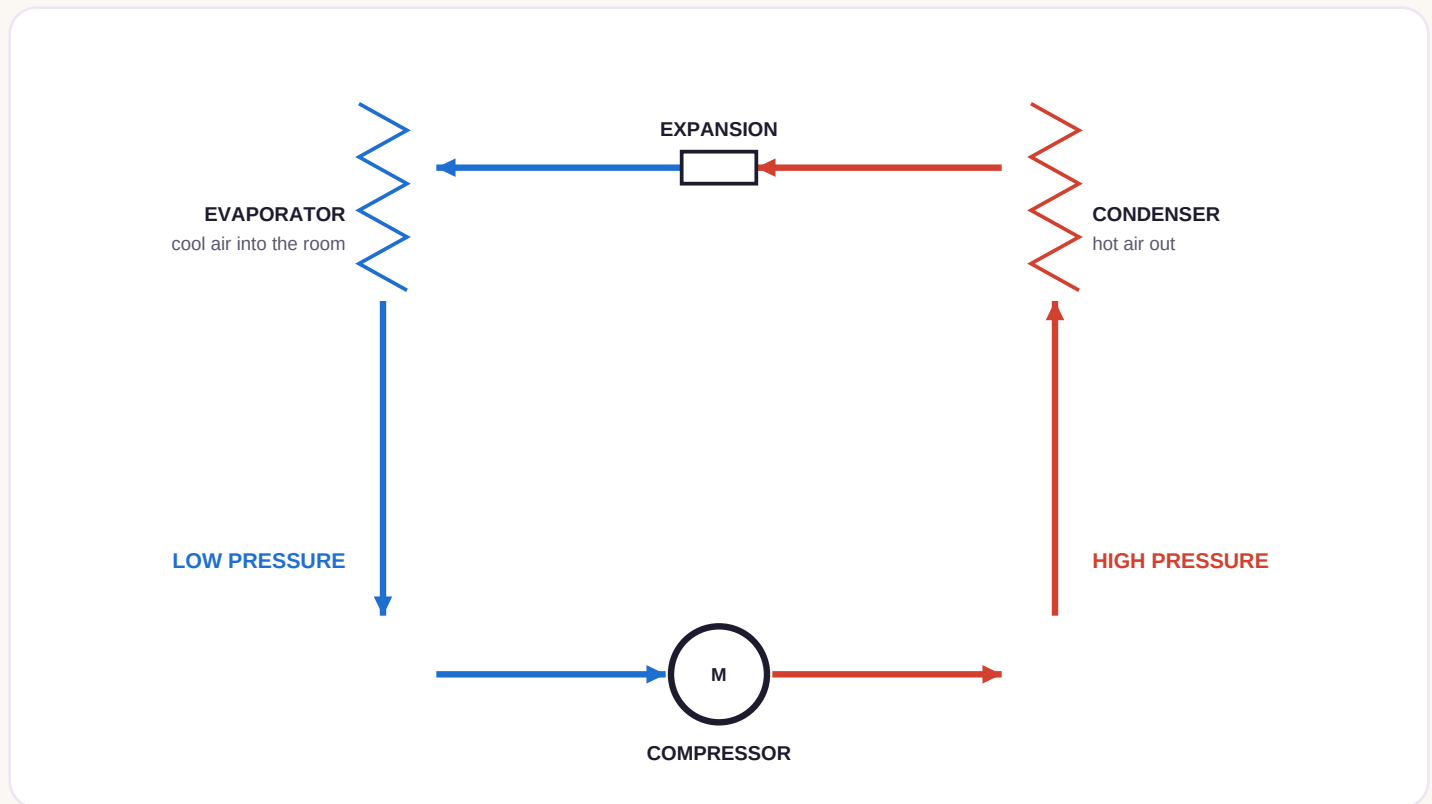
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Everyday tools

Gauge manifold (analog or digital)	reads high-side and low-side pressure; digital models also calculate superheat and subcooling
Vacuum pump	removes air and moisture from the system before charging
Micron gauge	confirms a real vacuum; the manifold gauge cannot read a deep vacuum
Clamp meter	compressor and fan motor amps, voltage and continuity
Capacitance meter	tests capacitors (many clamp meters already have it)
Pipe clamp and air thermometer	line temperature (superheat) and supply and return air temperature
Charging scale	charge by weight, the safest method
Dry nitrogen + regulator	pressure testing and brazing without oxidation
Leak detector	electronic, bubbles or UV dye

The refrigeration cycle in 1 minute



- 1 COMPRESSOR: draws in cool, low-pressure vapor and compresses it to high pressure and high temperature.
- 2 CONDENSER (outdoor unit): the hot vapor rejects heat to the air and turns into liquid.
- 3 EXPANSION (cap tube or TXV/EEV): pressure drops suddenly and the liquid gets very cold.
- 4 EVAPORATOR (indoor unit): the cold liquid absorbs heat from the room and evaporates. The vapor returns to the compressor.

Pressure-temperature (saturation) chart

Gauge pressure (psig) at which the refrigerant boils or condenses at each temperature. Use it to find evaporating and condensing temperatures from your manifold readings. R-410A at bubble point. Data calculated with the CoolProp property library.

°C	°F	R-22 (psig)	R-410A (psig)	R-32 (psig)	R-134a (psig)
-20	-4	20.9	43.4	44.2	4.6
-17.5	0	24.4	49.1	49.9	6.7
-15	5	28.3	55.2	56.1	9.1
-12.5	10	32.4	61.7	62.7	11.6
-10	14	36.8	68.6	69.8	14.4
-7.5	18	41.5	76.1	77.4	17.4
-5	23	46.5	84.0	85.5	20.6
-2.5	28	51.8	92.5	94.1	24.1
0	32	57.5	101	103	27.8
2.5	36	63.6	111	113	31.8
5	41	70.0	121	123	36.0
7.5	46	76.8	132	134	40.6
10	50	84.1	143	146	45.4
12.5	54	91.7	155	158	50.6
15	59	99.8	168	171	56.1
17.5	64	108	181	185	62.0
20	68	117	195	199	68.2
22.5	72	127	210	214	74.8
25	77	137	226	230	81.8
27.5	82	147	242	247	89.2
30	86	158	259	265	97.0
32.5	90	170	277	283	105
35	95	182	296	303	114
37.5	100	194	316	323	123
40	104	208	337	345	133
42.5	108	222	359	367	143
45	113	236	382	391	154
47.5	118	251	406	415	165
50	122	267	431	441	176
52.5	126	284	457	468	189
55	131	301	484	496	202
57.5	136	319	513	525	215
60	140	337	543	556	229

Superheat and subcooling

Pressure alone can fool you. To know if the charge is right, compare the actual line temperature with the saturation temperature from the chart.

SUPERHEAT (suction line, near the outdoor unit): how much hotter the vapor is than the temperature at which it evaporated. High = evaporator is starved of refrigerant. Low = risk of liquid floodback to the compressor.

SUBCOOLING (liquid line, at the condenser outlet): how much colder the liquid is than the temperature at which it condensed. Low = undercharge. High = overcharge or restriction.

SUPERHEAT

= suction line temp. - low-side saturation temp.

SUBCOOLING

= high-side saturation temp. - liquid line temp.

Superheat (TXV/EEV)	10 to 15 °F (5 to 8 °C)
Superheat (cap tube)	use the manufacturer's chart: it varies with outdoor heat
Subcooling	8 to 12 °F (4 to 7 °C)
Return vs. supply air split	15 to 22 °F (8 to 12 °C)

Pressure diagnosis matrix

Read the low-side and high-side pressures together with superheat (SH) and subcooling (SC). The combination points to the cause.

Low side	High side	SH	SC	Most likely cause
low	low	high	low	undercharge (leak)
low	normal/low	high	high	restriction: filter drier, cap tube or TXV/EEV
low	low	low	normal	low airflow over the evaporator: dirty filter, coil or blower wheel
high	high	low	high	overcharge
normal/high	high	normal	normal/high	poor condensing: dirty condenser, weak fan, non-condensables
high	low	low	low	compressor not pumping or reversing valve leaking through

Problems, causes and fixes

PROBLEM 01 Won't turn on (display dark, no beep)

LIKELY CAUSES (MOST COMMON TO LEAST COMMON)

- Breaker off or tripped
- Blown fuse on the control board
- Dead batteries or faulty remote
- Loose terminal or power wire
- Faulty power supply on the control board

WHAT TO MEASURE

- Voltage at the power terminal block (120 V or 240 V)
- Continuity of the board fuse
- Remote's IR LED through a phone camera (should flash)

HOW TO FIX IT

- Reset the breaker and find out why it tripped
- Replace the fuse with the same rating and find the cause
- Tighten the terminals; repair or replace the board

PROBLEM 02 Indoor unit runs, but the outdoor unit won't start

LIKELY CAUSES (MOST COMMON TO LEAST COMMON)

- Interconnect wire loose, swapped or spliced
- Bad compressor or fan capacitor
- Contactor with an open coil (on/off units)
- Compressor thermal overload open
- Communication error (inverter)

WHAT TO MEASURE

- Voltage at the outdoor terminal block with a call for cooling
- Capacitor on the capacitance meter
- Contactor coil (continuity)
- Error code on the display

HOW TO FIX IT

- Rewire the interconnect per the wiring diagram on the label
- Replace the capacitor: same μF , equal or higher voltage
- Replace the contactor
- Let the overload cool down and find out why it overheated

Problems, causes and fixes

PROBLEM 03 Runs, but doesn't cool (blows room-temperature air)

LIKELY CAUSES (MOST COMMON TO LEAST COMMON)

- Compressor won't start (capacitor, overload, contactor)
- Low charge due to a leak
- Wrong mode (fan or dry)
- Service valve left closed after installation
- Compressor not pumping

WHAT TO MEASURE

- Compressor amps vs. nameplate
- Low-side pressure and superheat
- Air temperature split (return vs. supply)

HOW TO FIX IT

- Fix the compressor starting problem
- Find and repair the leak, evacuate and charge by weight
- Open the service valves all the way
- Compressor not pumping: replace

PROBLEM 04 Not cooling enough

LIKELY CAUSES (MOST COMMON TO LEAST COMMON)

- Dirty air filters
- Dirty indoor coil or blower wheel
- Outdoor unit dirty, in strong sun or without room to discharge air
- Low refrigerant charge
- Unit undersized for the room

WHAT TO MEASURE

- Air temperature split: 15 to 22 °F (8 to 12 °C)
- Pressures, superheat and subcooling
- Clearance around the outdoor unit (manual)

HOW TO FIX IT

- Clean the filters and do a full coil cleaning
- Clear the outdoor unit; avoid hot air recirculation
- Correct the charge after finding the leak
- Check the sizing (BTU page)

Problems, causes and fixes

PROBLEM 05 Compressor turns on and off by itself (short cycling)

LIKELY CAUSES (MOST COMMON TO LEAST COMMON)

- High head pressure: dirty condenser, fan not running or overcharge
- Weak capacitor
- Low voltage at startup
- Faulty or poorly placed room sensor
- Unit oversized for the room

WHAT TO MEASURE

- High-side pressure while running
- Capacitor and voltage at startup
- Sensor resistance vs. manufacturer's chart

HOW TO FIX IT

- Clean the condenser and check the fan
- Replace the capacitor
- Correct the wire gauge and breaker size
- Replace or relocate the sensor

PROBLEM 06 Outdoor fan won't spin

LIKELY CAUSES (MOST COMMON TO LEAST COMMON)

- Fan capacitor
- Motor seized (bearing) or burned out
- Loose connection
- Board not sending voltage (inverter)

WHAT TO MEASURE

- With power off, spin the fan blade by hand: it should turn freely
- Capacitor on the capacitance meter
- Voltage reaching the motor
- Motor winding resistance

HOW TO FIX IT

- Replace the capacitor
- Lubricate or replace the motor
- Redo the connection
- Diagnose the board using the error code

Problems, causes and fixes

PROBLEM 07 Water dripping from the indoor unit

LIKELY CAUSES (MOST COMMON TO LEAST COMMON)

- Clogged drain (slime, dirt, insects)
- Drain hose kinked or without slope
- Indoor unit not level
- Cracked drain pan
- Ice melting on the coil (see problem 8)

WHAT TO MEASURE

- Pour water into the drain pan and see if it drains
- Level of the indoor unit
- Hose slope along the entire run

HOW TO FIX IT

- Clear with a blower or water and clean the drain pan
- Keep a continuous slope (about 1 to 2 %)
- Level the unit
- Replace the drain pan

PROBLEM 08 Ice on the indoor unit or the lines

LIKELY CAUSES (MOST COMMON TO LEAST COMMON)

- Dirty filter or low airflow
- Indoor blower wheel slow or dirty
- Low refrigerant charge
- Room or outdoor temperature too cold
- Faulty coil sensor

WHAT TO MEASURE

- Turn cooling off and let it defrost before measuring
- Superheat and low-side pressure
- Blower speed

HOW TO FIX IT

- Clean the filter, coil and blower wheel
- Find the leak and correct the charge
- Replace the sensor if its resistance is off the chart

Problems, causes and fixes

PROBLEM 09 High head pressure / outdoor unit running very hot

LIKELY CAUSES (MOST COMMON TO LEAST COMMON)

- Dirty condenser or crushed fins
- Weak fan or wrong fan blade
- Overcharge
- Air or moisture in the system (non-condensables)
- Hot air recirculating (enclosed location)

WHAT TO MEASURE

- Condensing temp. vs. outdoor air temp. (typical split 18 to 30 °F / 10 to 17 °C)
- Subcooling
- Compressor amps

HOW TO FIX IT

- Wash the condenser and comb the fins
- Correct the airflow around the installation
- Recover the refrigerant, evacuate and charge by weight

PROBLEM 10 Very low suction pressure

LIKELY CAUSES (MOST COMMON TO LEAST COMMON)

- Low refrigerant charge
- Restriction in the filter drier, cap tube or TXV/EEV
- Low airflow over the evaporator

WHAT TO MEASURE

- Superheat and subcooling (see the matrix)
- Temperature drop across the filter drier (more than 4 °F (2 °C) = restriction)

HOW TO FIX IT

- Low charge: find the leak before topping off
- Restriction: replace the drier or the component and evacuate
- Low airflow: full cleaning of the indoor unit

Problems, causes and fixes

PROBLEM 11 Noise from the indoor unit

LIKELY CAUSES (MOST COMMON TO LEAST COMMON)

- Blower wheel dirty or out of balance
- Loose screw or cover
- Refrigerant expansion hiss (normal)
- Plastic creaking as it heats and cools (normal)

WHAT TO MEASURE

- Listen with the blower running, then with only the compressor
- Blower shaft play

HOW TO FIX IT

- Wash and balance the blower wheel
- Tighten the parts
- Explain to the customer which noises are normal

PROBLEM 12 Noise or vibration at the outdoor unit

LIKELY CAUSES (MOST COMMON TO LEAST COMMON)

- Worn rubber isolators
- Fan blade hitting or bent
- Tubing touching the cabinet
- Loose mounting bracket
- Internal compressor noise

WHAT TO MEASURE

- Touch the lines with the unit running to find the vibration
- Play in the bracket and bolts

HOW TO FIX IT

- Replace the isolators and tighten the bracket
- Separate and secure the lines
- Compressor knocking internally: replace

Problems, causes and fixes

PROBLEM 13 Bad smell at startup

LIKELY CAUSES (MOST COMMON TO LEAST COMMON)

- Mold and bacteria on the coil and drain pan
- Standing water in the drain
- Very dirty filter

WHAT TO MEASURE

- Visual inspection of the coil, drain pan and blower wheel

HOW TO FIX IT

- Clean with a coil cleaner made for AC systems
- Clean the blower wheel and the drain
- Tell the customer to clean the filters every 15 to 30 days

PROBLEM 14 Remote control not responding

LIKELY CAUSES (MOST COMMON TO LEAST COMMON)

- Weak batteries
- Remote's infrared LED
- Indoor unit receiver
- Fluorescent or LED lighting interference
- Remote locked (lock function)

WHAT TO MEASURE

- Point a phone camera at the remote's LED: it should flash when you press a button
- Test with another compatible remote

HOW TO FIX IT

- Replace the batteries or the remote
- Replace the receiver
- Unlock it (see the manual)

Problems, causes and fixes

PROBLEM 15 Breaker trips at startup

LIKELY CAUSES (MOST COMMON TO LEAST COMMON)

- Breaker smaller than specified
- Shorted wire
- Compressor shorted to ground
- Locked compressor (locked rotor amps)
- Moisture on the board

WHAT TO MEASURE

- Compressor insulation: terminals to case should read infinite
- Wire gauge and breaker size (manual)
- Starting amps

HOW TO FIX IT

- Correct the breaker and wiring
- Grounded compressor: replace
- Locked compressor: test the capacitor and starting before condemning it

PROBLEM 16 Compressor running too hot or tripping on overload

LIKELY CAUSES (MOST COMMON TO LEAST COMMON)

- High superheat (low charge)
- Low or high voltage
- Weak capacitor
- Poor condensing
- Worn compressor

WHAT TO MEASURE

- Voltage with the compressor running (acceptable variation is usually up to 10 %)
- Superheat
- Amps vs. nameplate

HOW TO FIX IT

- Correct the charge and the airflow
- Replace the capacitor
- Fix the voltage issue with the utility or in the wiring

Problems, causes and fixes

PROBLEM 17 Communication error (inverter)

LIKELY CAUSES (MOST COMMON TO LEAST COMMON)

- Wrong, spliced or undersized interconnect cable
- Line and neutral swapped where the manufacturer requires polarity
- Communication wire run with power wires (interference)
- Indoor or outdoor control board

WHAT TO MEASURE

- Continuity of each conductor in the cable
- Communication voltage at the terminal block (per the manual)
- Error code

HOW TO FIX IT

- Run a new, unspliced cable of the gauge in the manual
- Follow the terminal order
- Separate communication from power
- Replace the board the diagnosis points to

PROBLEM 18 Leaks: where and how to look

LIKELY CAUSES (MOST COMMON TO LEAST COMMON)

- Flare nuts and flares (most common)
- Brazed joints
- Indoor coil (corrosion)
- Service valve Schrader cores
- Tubing or cap tube rubbing on the cabinet

WHAT TO MEASURE

- Bubble solution on suspect spots
- Electronic leak detector
- Pressurize with nitrogen and watch for a pressure drop

HOW TO FIX IT

- Redo the flare with a proper tool and the correct torque
- Braze while flowing nitrogen
- After the repair: evacuate and charge by weight

Problems, causes and fixes

PROBLEM 19 Won't heat in heat mode (heat pump)

LIKELY CAUSES (MOST COMMON TO LEAST COMMON)

- Reversing valve coil without voltage or burned out
- Reversing valve stuck
- Faulty outdoor sensor
- Cooling-only unit (no heat function)

WHAT TO MEASURE

- Voltage at the reversing valve coil in heat mode
- Coil resistance
- Line temperatures when switching modes

HOW TO FIX IT

- Replace the coil
- Try to free it with light taps and mode changes; if it won't shift, replace the valve
- Replace the sensor

PROBLEM 20 Blinking LED or error code

LIKELY CAUSES (MOST COMMON TO LEAST COMMON)

- Sensor (thermistor) open or shorted
- Loose or corroded connector
- High-pressure, low-pressure or current protection
- Board failure

WHAT TO MEASURE

- Write down the code and check the manufacturer's manual
- Thermistor resistance vs. chart (many are 5 kohm or 10 kohm at 77 °F (25 °C))
- Connectors and harnesses

HOW TO FIX IT

- Replace a sensor that is off the chart
- Clean and reseal the connectors
- Fix the cause of the protection before resetting

Evacuation and charging, step by step

- 1 Pressure test with dry nitrogen at the pressure specified by the manufacturer. Wait and make sure the pressure does not drop.
- 2 Release the nitrogen and start the vacuum pump with the micron gauge installed at the point farthest from the pump.
- 3 Pull down to 500 microns or lower.
- 4 Close the valves and wait 10 minutes: if it rises above about 1,000 microns, there is still moisture or a leak.
- 5 Open the valves to release the factory charge; if the line set exceeds the standard length, add charge by weight per the label (per foot or meter).
- 6 R-410A and other blends: always charge as a liquid.

A good evacuation prevents the most expensive problem in refrigeration: moisture in the system, which forms acid and burns out the compressor.



Quick electrical tests

Capacitor

- Discharge it before measuring
- Measure with a capacitance meter and compare with the label (tolerance printed on the part, usually $\pm 5\%$)
- Bulging, leaking or out of tolerance: replace
- Dual run capacitor: C = common, HERM = compressor, FAN = fan motor

Single-phase compressor (on/off)

- Measure C-R, C-S and R-S
- R-S is the highest and equals the sum of the other two
- C-S is higher than C-R: that is how you find common, start (S) and run (R)
- Any terminal to the case: should read infinite

Inverter compressor (3-phase U-V-W)

- All three phase-to-phase resistances should be equal
- Terminal to case: infinite
- Never connect an inverter compressor directly to line voltage

Sensors (NTC thermistors)

- Resistance drops as temperature rises
- Compare with the manufacturer's chart at the current temperature

Preventive maintenance checklist

- | | |
|--|--|
| ☐ Clean or wash the air filters | ☐ Tighten terminals and electrical connections |
| ☐ Clean the indoor coil, drain pan and blower wheel | ☐ Measure voltage and amps and compare with the nameplate |
| ☐ Clear and test the condensate drain | ☐ Test the capacitors |
| ☐ Wash the condenser and comb the fins | ☐ Check pressures and the air temperature split |
| ☐ Check the line set insulation | ☐ Check the brackets, isolators and outdoor unit mounting |

QUICK SIZING (BTU/H)

US rule of thumb: about 20 BTU/h per square foot; add about 10 % for rooms with strong afternoon sun.

Add about 600 BTU/h per person beyond 2; for a kitchen, add about 4,000 BTU/h.

It is only an estimate: rooms with lots of glass and top floors call for a proper load calculation (Manual J).

Area (sq ft)	Normal sun	Strong afternoon sun
up to 300	6,000 to 9,000	9,000
300 to 450	9,000	12,000
450 to 600	12,000	15,000
600 to 900	18,000	24,000
900 to 1,200	24,000	30,000
1,200 to 1,500	30,000	36,000 or more

Good work!

- 1 Always start with the simple stuff: power, filters and cleaning.
- 2 Measure before replacing parts: each measurement rules out a cause.
- 3 Record pressures, amps and temperatures on the customer's service report.
- 4 Save this map on your phone to check it on service calls.

Did this map help you? Send it to a fellow tech.

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