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HVAC Troubleshooting



Presented by Mark Cukro

www.serviceteamtraining.com

Objectives

- Troubleshoot more effectively
- Apply different search methods
- Reduce diagnostic time
- Test a circuit in seconds
- Tips for applying new methods in the field

Four comfort factors:

1. Temperature
2. Humidity
3. Air movement
4. Air quality

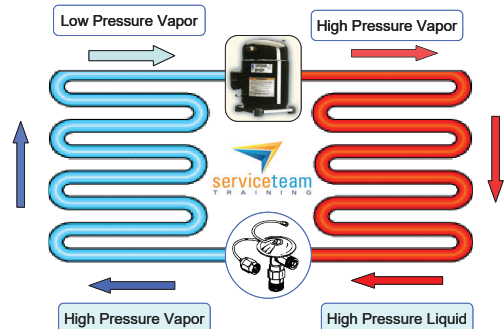


Fast Facts & Basic Rules

- 12,000 btu's in 1 ton of refrigeration
- 1 btu =
- SEER
- FLA
- LRA
- $\Delta T^{\circ}F$
- 800 btu's per person in moderate 850 in moderate dancing (nightclub)
- 550 sq ft of area gets 1 ton of refrigeration
- 400 CFM minimum for 1 ton of refrigeration



Summary of the Cycle



Troubleshooting

What are you troubleshooting?

Time	Fault – specific of non-specific
Temperature	Consistent or inconsistent
Airflow	Frequency of the fault
Water Flow	Point of origin
Energy	Point of termination
A Function	Electrical
Operator Error	Mechanical
Error Code	Other considerations for same fault
Overall Performance	Overall success rates

Types of Voltage

Control Voltage

is typically 24 Volts



Operating Voltage

is typically 240 Volts



Multimeters



Front Panel Symbols

Symbol	Meaning
v ---	v DC
v ~	v AC
mV	millivolts (.001V or 1/1,000V)
A	Amps
mA	milliamps (.001A or 1/1000A)
µA	microA (.000001A or 1/1,000,000A)
Ω	Resistance (Ohms)
k Ω , M Ω	kilo-Ohms, Megohms
)))	Continuity beeper



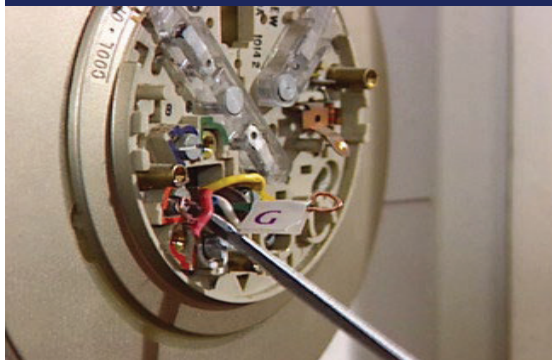
Symbols	Measurement Functions	Descriptions
V~	AC Voltage	Measures amount of AC Electrical Pressure
V=	DC Voltage	Measures amount of DC Electrical Pressure
mV	Milli Volts	.00V or 1/1000V
A	Amperes	Measures amount of electron flow
mA	Milli Amperes	.001 or 1/1000A
Ω	Ohms	Measurement of resistance to the flow of electron
⚡	Diode	Device used to control direction of electron flow
)))	Audible Continuity	Audible indication of continuity for low resistance
⚡	Capacitance	Device used to store electrical potential

Basic Rules and Starting Point

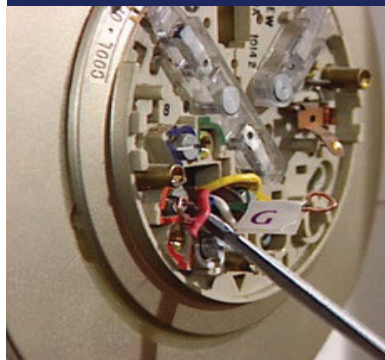
- Start at the Thermostat
- Auto/On
- Check Temp difference ▲
- Check Airflow
- Check electrical readings
- Check components
- Determine if you need to refrigerant access
- Make sure everything is clean
- Gauges/charge IF needed



Low Voltage Thermostats



Low Voltage Thermostats

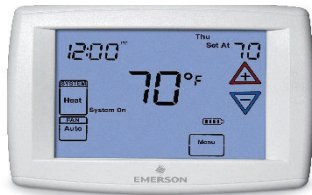


What does it do ?

How do I diagnose it?

How do I install one?

Thermostat



Troubleshooting

- Fan
 - Auto and then on/off – wait/timing
 - Check airflow
 - Call for Heat – wait/timing – on/off
 - Call for cool – wait/timing – on/off
- If you jump the terminals in the thermostat with a "jump wire" and the system works, most likely the thermostat is faulty.

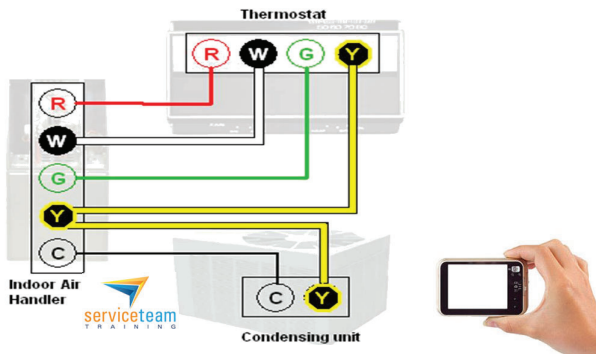
Common Thermostat Wiring



The simplest way to test a thermostat is to [use a Jumper](#)

- R to Y will energize the Cooling Cycle
- R to G will energize the Evaporator Fan Motor
- R to W will energize the Heat Cycle
- R to O will energize the Reversing Valve

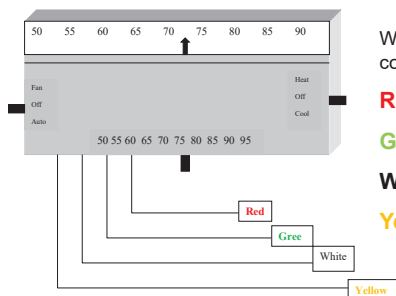
Low Voltage Wiring



Universal Wiring Color Codes

- ◇ R, or RH - for heat or RC for cool (red): "hot" side of transformer
- ◇ W - (white): heat control
- ◇ W2 - (pink or other color): heat, second stage
- ◇ Y2 - (blue or pink): cool, second compressor stage
- ◇ C or X - (black): common side of transformer (24 V)
- ◇ G - (green): fan
- ◇ O - (orange): Energize to cool (heat pumps)
- ◇ L - (tan, brown, grey or blue): service indicator lamp
- ◇ X2 - (blue, brown, grey or tan): heat, second stage (electric)
- ◇ B - (blue or orange): energize to heat
- ◇ B or X - (blue, brown or black): common side of transformer
- ◇ E - (blue, pink, gray or tan): emergency heat relay on a heat pump
- ◇ T - (tan or gray): outdoor anticipator

Wiring a Thermostat

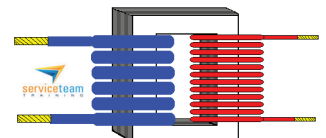
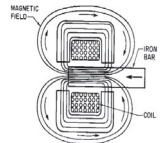


What does each color control?

- Red = 24 Volts
- Green = Indoor Fan
- White = Heat
- Yellow = Cooling

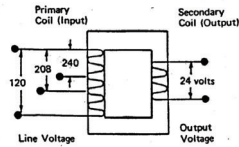
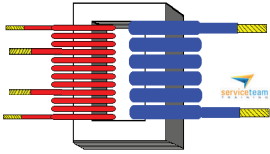
Transformers

- A transformer produces an electrical current through electromagnetic Induction
- A step-down transformer has more turns of wire on the Primary and less on the Secondary coil

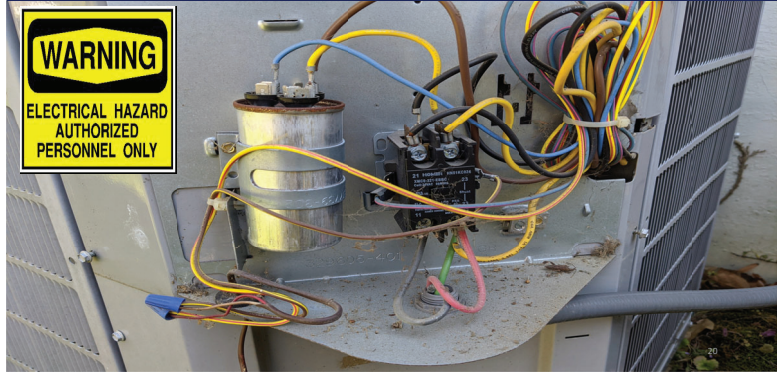


Transformers

- A transformer can be diagnosed by checking for Continuity and/or Voltage
- In a good transformer there should be continuity between All wires on each coil.
- There is No Continuity between the primary coil and the secondary coil.
- If there is no continuity between any wires on the same coil the transformer is Bad/faulty.



High Voltage



Capacitors



Single phase motors use capacitors to regulate the flow and phase of electricity to the motor by storing and discharging electrical energy. They increase efficiency reduce operating costs.

There are two types of capacitors, Start and Run.

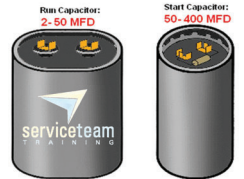
Many capacitors have a Bleed Resistor. This resistor allows the capacitor to completely discharge while the circuit is open to prevent the capacitor from becoming overcharged.

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Capacitor Ratings and Testing

- Volts of AC Current (VAC)
- Capacitance in Microfarads (μf or MFD)

- **Start** Capacitor Ratings: **21 to 1600 μf**
- **Run** Capacitor Ratings: **1.5 to 70 μf**

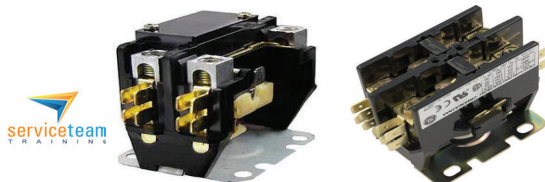


*Test with a Capacitor Tester
Or Multimeter*

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Contactors

- A contactor is a large version of a relay designed for a heavier duty.
- Since a motor in start mode draws up to 4 Times more current than while in run mode a contactor is used.



- Typically, a Single Pole or a Double Pole is used in residential HVAC systems.

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