Most new techs, just like any other professional, can sometimes feel a little overwhelmed by all of the various electrical aspects of an HVAC service call. Just take it step-by-step, and be safe. Your sight can be saved by a pair of safety glasses. You had your safety glasses on, right? Arcing of electrical components throws off hot, burning, bits of metal. We call them sparks, but your eyes can call them “blinding.”

NOTE: it would not be possible to cover all permutations you would find in every situation. You will think of a situation you had on a call, and say to yourself, “he left that out.” Sure I did. This is a basic guide. We are doing this without pictures or graphic examples, so use your imagination a little. In fact, the better your imagination, the better you will begin to see the possibilities.

The first step, and the mindset on almost every call, is this:

IS THERE POWER?

You would be amazed at how many mechanical and engineering disciplines rely on this approach.

Let’s go over how some of the electrical theory can be applied in a service call situation. Obviously, if you arrive and you hear a fan running, there is some power. Often, you hear nothing.

SERVICE PANEL: is there a breaker tripped?


If a commercial service call, is it a three phase breaker? That would make sense for most rooftop units.
AT THE UNIT(S): is power present at the disconnect? Test this with your meter. Phase to phase, AND phase to ground.

Are there fuses in the disconnect? Make you readings on the load end of the fuse with the disconnect closed. This requires you to manipulate the disconnect interlock, so as soon as you can finish with your diagnostics, open the disconnect once more to restore this vital safety feature. For a pull-type residential disconnect, measure for power in the condensing unit. If you find a fuse open, your task will be to find out why. You will also find many pull-type disconnects with burned tines. Those must be a part of your repair plan, so don’t hesitate to write up your ticket for a new “pull” disconnect. See further along in this article.

NOTE: you can occasionally find a lever-type disconnect where the knives and tines no longer mate together with good contact. Looking for a voltage drop between the line lug wire connection and the line cap of the fuse (or the load lug wire connection) should show no more than a tenth (0.1) of a volt or so. Finding the applied voltage across these two points with the disconnect closed means the disconnect is no longer serviceable. Depending on the type of work (residential or commercial) or your local building trades requirements, replacing a disconnect may or may not be “your” work.

If you are at a furnace or air handler, check now for 24 volt power. Be certain of where the common side or the transformer is connected. In many units, one side of the 24 volt transformer secondary is grounded. That makes it handy, but in an unfamiliar unit, make certain you know “what” is wired to “where.” And, you may not have a stand-alone common wire at a condensing unit. In that case, your common is on one side of the contactor. If you have a functioning source of 24 volts AC, then where does it go, and how does it get to the point of commanding something to operate? Often, this is a simple as sending the 24 volts to a thermostat, and the stat connects that 24 volt feed to a wire that controls a fan, or a compressor, or a reversing valve.
DON’T turn off the power, if the breakers were all good (not tripped) and the fuses were not open. There may be valuable fault codes present, and you can wipe them out by a power reset on many units.

POWER ON? Look inside the furnace, air handler, or RTU. Is there a control board with a flashing LED, or a more complex board with stored codes that are displayed numerically? Write the codes down. If you have a list with definitions of the codes, write them down as well. Your service manager will want this info if you need to call them.

Is there any scorching or burning, or melted wires? You have some fish to fry here, and you have to decide how and why that happened. Is it a short? Was a wire overheated because of a poor connection that became a heating element, or was it simply a case of too much current through a conductor (that means wire here) or a device, like a contactor or motor? When you go looking for the cause of burning, you should have the power turned off. The damage is done, and now you are the HVAC CSI who has to find the evidence and construct the cause.

Is there an oil leak from a run capacitor? Did one pop, or is it distended? (That means it no longer has its normal shape). Capacitors should appear to have a normal shape, no oil leaking out, and be within 10% of the marked value of microfarads.

CALLS for heat or cooling. Are you finding power on the W1 or Y1 wires, and if a heat pump, is the reversing valve wire energized? This means the stat is trying to send a command to the unit(s). If the unit(s) are not responding, you are now “on the trail.”

If there are no calls, why not? Investigate. Maybe someone set the system to “off.” I have had calls where all I had to do was to set the system back to “auto.” No kidding. And, in a retail environment, you will need to reprogram the thermostat often, as people like to “adjust” them.
Can you simulate a call? Sure. Use jumpers at the terminal strip where the stat wires connect. Generally, you are applying R power to the terminals to command heat (W1 and W2), cooling (Y1 and Y2) fan (G) and reversing (O or B) as needed. Your jumpers are acting like the contacts in the micro relays on the PC board in the stat. Learn the sequence of operation so you know what to expect.

This is where you decide if you have a possible stat problem. If you see on the display that there is a call for cooling or heating (often, a picture icon of a snowflake or flame) and the wire connected to the stat for that function is not reflecting that choice by showing you a control voltage on that wire (and any timeouts are complete) you may have just found the problem, and the rare event of a customer being correct about “that bad thermostat” will have come to be reality.

Without burned wires or open fuses (or tripped breakers) you can simulate a call and see how the system responds. Do you have a motor or compressor with open windings? You won’t have “too much current.” In fact, with open windings you will probably have NO current. Aren’t you glad you bought a clamp meter to measure current? Some motors and compressors will look like they have open windings if they are hot, due to an internal protection device. If the unit is cool, you can check for open windings with your ohmmeter.

If you had open fuses or tripped breakers, disconnect any power controls (pull out, or throw the lever disconnect, if you have one) and start looking for the reason the equipment drew too much current. First, double check to make sure the disconnect really did open, and that power is OFF. Do this visually, by opening the disconnect and seeing the open tines, and then check for power to make sure the circuit is dead.
Remember, current flows MORE when resistance is LESS. So, an overcurrent situation is a function of reduced resistance. In a compressor, this can mean a winding to winding short in three phase, or a simple short to ground inside the compressor that creates a low resistance path for current to flow, ands lots of current WILL flow in that situation. So, with the power off as mentioned above, you can measure for a short to ground using the OHMS function of your meter. Disconnect the wires to make this test.

In a 24 volt circuit, a breaker or fuse tripping problem could be caused by a rub-through of a stat wire (a common problem) or a short in a contactor or relay coil (almost as common). Frequently, when you have a shorted coil in a contactor, you can no longer push the armature in manually to close the contacts, as the plastic spool that holds the coil of magnet wire has distorted due to heat produced by the high current of the shorted windings.

More complex units need to have a planned, methodical approach to electrical troubleshooting. Break things down into sections by separating wiring (either mentally or physically) where it makes sense to do so.

Basic ideas:

Voltage at a component and no response often means an open load, such as an open winding in a contactor, motor, or compressor.

An overcurrent device (fuse, breaker) being tripped often means a short somewhere, in a contactor, motor, or compressor, allowing too much current to flow, due to the decreased resistance of a short circuit. Your will sometimes find a simple short to ground by a cut or rub-through in wire insulation. Sometimes, an animal has gone on to the great beyond while chewing on a wire.

Think, and LOOK, and be safe. And happy hunting.