Circuit diagnosis

• Plan of attack
• Testing techniques and analysis
• Verification
• Failures – causes and patterns
Circuit Diagnosis - Plan of attack

• In general the process of diagnosis is about keeping facts and assumptions organized.
• Never mistake the two.
Circuit Diagnosis - Plan of attack

- Always use a plan.
- Always record results.
- Intermittent failures often a long take time to identify.
- Always verify and re-verify.
Circuit Diagnosis - Plan of attack

• A plan should start with verifying the problem, if possible.
• In general the plan should isolate through process of elimination.
• The plan should prioritize based upon ease of testing and likelihood of failure.
• Always find out what was done most recently.
Circuit Diagnosis - Plan of attack

- Often times known good data is hard to acquire.
- This can come from schematics, troubleshooting charts, other maintenance manuals, or other known good systems.
Circuit Diagnosis - Plan of attack

• This data can be various readings like voltages, resistances, or it can be O-Scope patterns, or data codes.
• But, effective diagnosis will not happen without good data.
Circuit Diagnosis - Plan of attack

• Use various connectors, switches, or circuit breakers to isolate circuits or portions of circuits.
Circuit Diagnosis - Plan of attack

• If a part proves bad, determine why if failed if possible.

• Parts that smelled burnt often fail due to too much load for some other reason.

• Avoid parts swapping unless its a last resort, this can get very expensive.
Circuit Diagnosis - Plan of attack

• Always assume multiple problems, particularly if you are not the first one looking at it.
• Be particularly alert if you see evidence of new parts currently installed.
• If there are multiple symptoms look to see what is common between symptom areas.
Circuit Diagnosis - Plan of attack

• Don’t always trust manufacturer’s data.
• Things like wire color or numbers sometimes get changed without being documented.
• Is very uncommon, so don’t readily assume this, but if it happens, it’ll drive you nuts.
Circuit Diagnosis - Testing techniques and analysis

- Testing technique is also critical.
- Make sure you are testing what you think you are.
- Trying to read power source voltage from a ground won’t tell you much.
- Or reading resistance with an unseen parallel path will nullify any results.
Circuit Diagnosis - Testing techniques and analysis

• Be careful how you hook up test equipment.
• A current test applied incorrectly can fry a lot of pricy stuff.
• Make sure the circuit status is correct prior to hook up, circuit off/circuit on/circuit devices running.
  – Don’t use an Ohm or Amp meter for voltage tests.
Circuit Diagnosis - Testing techniques and analysis

- Try to test at connectors without compromising their sealing capacity.
- Penetrating insulation is bad at best, but if you must, reseal with a dab of electrician’s silicone sealant. (Non-corrosive)
Circuit Diagnosis – Verification

- Always verify testing repeatability under differing conditions.
- Low voltage coupled with a voltage drop check can ensure accuracy.
- Heated vs cooled testing is often done.
- Once repaired re-verify circuit operation completely.
Circuit Diagnosis – Verification

• Check to be sure other circuits are also working.

• In fixing one thing you may have loosened a poor connection somewhere else.

• Be thorough, customer confidence is what pays the bills.
Circuit Diagnosis – Verification

• Always be in hyper-alert if other attempts have been made to rectify this problem.
• Many are challenged electrically and will repair symptoms leaving the cause unrepaired.
• They may also add new complications to your diagnosis/repair efforts.
Circuit Diagnosis - Failures – causes and patterns

• There are only three types of failures within any circuit.
  – An Open
  – A Short
  – A failed electromotive source
  – or a partial/combination of the above.
Circuit Diagnosis - Failures – causes and patterns

• An open is when there is a break in portion of the circuit cause the electrons to stop flowing.

• A short is when the electrons are allowed to flow anywhere other than designed.
Circuit Diagnosis - Failures – causes and patterns

• A failed source will depend upon the type of source.

• In a chemical source either the source is internally shorted/open, or its chemically depleted.
Circuit Diagnosis - Failures – causes and patterns

- In a magnetic source either there is an internal short/open, a loss of magnetism, a failed current converter/regulator, or the unit has mechanically failed.
Circuit Diagnosis - Failures – causes and patterns

• Circuit boards
• Typically fail at solder joints.
• Traces get fried.
• If smoky there is a high current user that needs fixing.
• Onboard component repair is rare but doable if you know the circuit.
Circuit Diagnosis - Failures – causes and patterns

- Connectors
- Most common cause of electrical failures.
- Pin misalignment, or pin push-back
- Bad pin crimping
- Full of H₂O or corrosion
Circuit Diagnosis - Failures – causes and patterns

- Idiots
- If you are replacing a new part look for the idiot who didn’t diagnose the original problem, and don’t join them.
- Black vinyl electrical tape is a good sign of needing idiot intervention.
- The stupid list is infinite!!!
Circuit repair

- Component replacement
- Soldering
Circuit repair – Component replacement

• If at all possible know why a component failed before you replace it.
• In general internal component repair should be done at the depot level.
• Field level repair is usually component or inter-connection replacements.
Circuit repair - Soldering

- The correct, and good quality tools are mandatory, do not use cheap unregulated irons.
- Solder surfaces must be clean and kept that way.
- Use flux minimally, and remove thoroughly.
Circuit repair - Soldering

• Delicate components should have heat sink between heat source and part.
• Heat source is wetted with solder to conduct heat quickly.
• Parts are heated then solder is added.
• Prefluxing is helpful with un-tinned parts.
Circuit repair - Soldering

• Adequate heat is critical to avoid cold joints that crack after time.
  – Solder cools too fast and pre-cracks due to shrinkage.

• Plan for insulation prior to soldering (pre-install heat shrink or other mounting devices as needed)
Circuit repair - Soldering

- Do not compromise heat sinks, reattach with proper hardware and bonding agents.
- Do not overheat trace (delaminate it from board)
- Do not create conductive bridges (joints should be concave but filled)