# Trouble-Shooting

**What Is It**

Simply put, trouble-shooting is the art and science of getting something to work. If you work in electronics then, at some level, you will be involved in trouble-shooting. If you are a repair-tech, trouble-shooting is the name of the game. If you are a designer, then you will have to "debug" your designs which means trouble-shooting of another sort. Trouble-shooting can be divided into two kinds of situations: repair and development.

In repair, you know that the equipment you are trouble-shooting did, at one time, work. Then something happened that made it stop working. Maybe a component failed. Your job is to find out what went wrong and then to fix it.

In development you are working on prototypes. Either new designs or modifications of existing designs. In such a case, when it doesn't work properly there are three possibilities. First, as in repair, there may be a faulty component. Second, the breadboard or prototype wasn't built according to design. Third, there may be a fault in the design. Usually, there is a combination of all three in an early prototype.

We'll discuss some basic ideas of trouble-shooting that will apply to all situations. One principle should be stated right here: SAFETY FIRST. Don't do anything that may harm you, others, or the equipment you are working on. Remember that high voltage can cause burns, and a shock across your chest can stop your heart.

What You Will Need

Before starting to trouble-shoot, there are a few things you should have:

A good set of tools (see our catalog).
Appropriate test equipment (see our catalog).
Schematics, source-code, and other documentation.
A knowledge of what the equipment is supposed to do.
If possible, a working unit for comparison.
A knowledge of basic electronics theory and devices.
A clean, well-lit place to work.

**Check The Obvious**

Some things that can go wrong are so obvious that sometimes people forget to look for them. Here is a partial list of things to check before you start ripping the equipment apart:

Is it plugged in?
Is it turned on?
If the "ON" light is not lit, is the light burned out?
Is the fuse blown? NOTE: If the fuse is blown, replace it once and try again. If it blows again, then there is a major problem somewhere; do not keep replacing the fuse.
Are all the cables connected? To the right places?

**Think Logically**

In their frustration, novice trouble-shooters have been heard to say: "There's nothing wrong with this thing, it just refuses to work!". Equipment is inanimate. If it doesn't work, then there is something wrong with it. It's not being stubborn. So just keep cool and use some basic logic on it. It has to follow the laws of science.

One basic thing you should know about logic is the idea of Logical Induction. It says that if "A" causes "X" and "A" is true, then "X" must be true. But be careful! If "A" causes "X" and "X" is true it does not necessarily follow that "A" is true. Look at the circuit in **Figure 1**. If switch "A" is closed (true) then light bulb "X" must be on (true). But if light bulb "X" is on, it is not necessary that switch "A" is closed since switch "B" might be closed instead. In other words, use common sense but don't leap to conclusions.

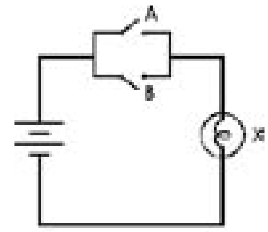

Figure 1

**Circuit**

Here is an example of the above. In trouble-shooting, you often trace a signal from stage to stage to find out where it goes wrong. **Figure 2** shows a block diagram of a two-stage amplifier. Suppose the signal going into stage_1 is good but the signal coming out of stage_1 is bad. Does that mean that stage_1 must be defective? Not necessarily. Stage_2 could be defective in such a way that any signal on its input is shorted to ground. That will make the output of stage_1 look bad. If you disconnect the stages then the output of stage_1 might look good. But before separating stages, be careful! Does stage_1 need a certain load on its output to work? Find out first.

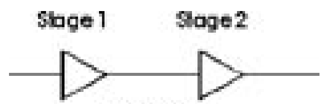

Figure 2

**Block Diagram of Two-Stage Amplifier**

**Where to Start**

You check the obvious and decide that the equipment is actually broken. Where do you start? The answer is: where there is the most stress on the components. Stress kills. In electronic equipment stress takes the form of heat, vibration, moisture, corrosion, high voltages across components, and high current through components.

**Places where you are likely to find high stress are:**

**Power supplies.**
**Power amplifiers.**
**Output stages.**
**Cable connectors, especially if subject to vibration or frequent coupling/uncoupling.**
**Sockets.**

If you are a field-service technician, then remember that to the customer in front of you with the broken equipment you are your company. You may have to "fix the customer" before you fix the equipment. People skills are important, especially if you're not going to be able to fix it that day.

**What To Do Next**

If you've looked at the usual suspects and they're not to blame, then the fun begins. Two useful things to do are "differential diagnosis" together with "what if". Differential diagnosis means you look at the problem and try to figure out all the things that could cause the observed symptoms. Then you try to figure out ways of telling one cause from another. For example, you see 5 Volts at a point where you should see 8 Volts. Possible causes may be:

**problem in power supply**
**heavy load on 8 Volt bus**
**bad solder joint in 8 Volt bus**

Then you go to those areas one by one looking for problems.

The what if technique is similar. You say to yourself something like: "OK, the 8 Volt bus is low. What if I disconnect the circuit from the bus and use an external 8 Volt supply? Can I damage something doing that? If that cures the symptom, then what have I learned? If it doesn't, then what have I learned?"

**Time Is Money, Maybe Yours**
Depending on how complicated the equipment is that you are trouble-shooting, you can divide it up into various levels as shown in Figure 3: Click Here For ASCII Version of Figure 3.

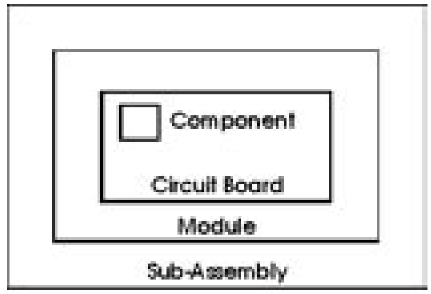


*Figure 3*

**Three Levels of Troubleshooting**

**sub-assembly**
**module**
**circuit-board**
**component**

How far down you go in finding the fault depends on the economics of the situation. If you are being paid $50 per hour and a module costs $20, then once you identify the faulty module it is cheaper to replace it than to repair it. On the other hand, if the module costs $500 but the circuit boards are $25, then it is cost-effective to continue trouble-shooting until you identify the bad board. But at that point it would be cheaper to replace the board than to trouble-shoot down to the bad component.

**Buttoning Up**
In summary, to be an effective electronics trouble-shooter you need to know how the circuits works, you need documentation, you need the right tools, and you need to be able to think logically. It also helps to have self-confidence, which will only increase with experience. So roll up your sleeves, turn on your test-equipment, get the schematic and a cup of coffee, and make that thing work!