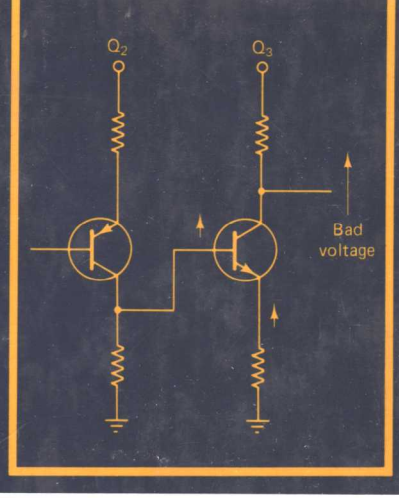
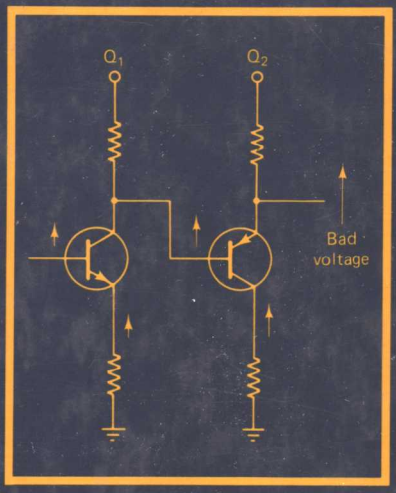
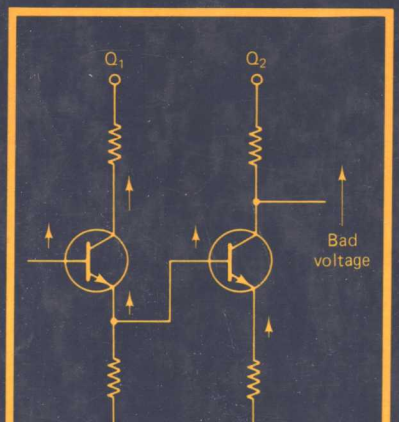


Electronic Troubleshooting





Don Matsuda

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DON MATSUDA

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Preface

In many years of teaching, writing, and troubleshooting, I have yet to come across a textbook devoted to troubleshooting a circuit down to the defective part. Most books will show you how the circuit works. They might show you how to find the defective circuit, but not the defective part in it. They assume that if you're smart enough to learn how it works, you're smart enough to fix it. Nothing could be further from the truth. Troubleshooting is a special field of work. It has its own rules. These rules are derived from everyday practice, and they must be taught from the point of view of everyday practice.

In tech school, you learn theory and design. They give you the right-value voltages and it is your job to find the right-value parts. This book does the opposite. From wrong-value voltages, you find wrong-value parts. Troubleshooting is different. This book is different. It has ideas that are used by every experienced technician. It shows how troubleshooters work their way into the circuits by starting from the outside. Once inside the circuits, they often make simple voltmeter checks. The mere fact that the voltages are too high or too low is usually enough for locating the bad part. Hence there is usually no need to get bogged down in a morass of mathematical calculations.

Don Matsuda

Contents

1

The Game Plan: The Troubleshooter's Approach

EXPERIENCE REQUIRED

If you want to learn to troubleshoot electronic circuits, this chapter will help you get started. You should at least have seen or heard about the following widely known electronic applications, devices, and words:

1. Radios, stereo systems, television sets, transmitters, satellite communications, radar, computers, industrial controls, medical equipment, and robotics, to mention a few.
2. Input and output devices such as microphones, speakers, phono pickups, cassette recorders, video cameras, video display tubes, switches, keyboards, and digital displays.
3. Wires, connections, circuits, lines, ac cords, plugs, switches, fuses, electric meters, transistors, and integrated-circuit chips (ICs).
4. Voltage and power as types of electrical measurements.
5. Dc as a type of electrical current that is different from ac.
6. Signals of various kinds, including AM, FM, TV, VHF, UHF, telephone, telegraph, and code.

It would be helpful if you understand games, riddles, percentages, odds, detective stories, or similar activities. A knowledge of basic electricity and electronics would be very helpful but is not absolutely necessary at this point.

1-1 STARTING FROM THE OUTSIDE AND WORKING YOUR WAY IN

All electronic systems, such as radios, transmitters, VCRs, and computers, are connected to input and output devices. We are all familiar with microphones, speakers, video cameras, display tubes, keyboards to printers, pushbuttons, and indicator lights. One of the first steps in troubleshooting is to check these devices. When something goes wrong with a system, these outer devices may exhibit symptoms that point to the circuit that is causing the trouble.

A second source of clues is the system power supply. Practically all electronic systems require electrical power from batteries or ac outlets that feed their power-supply sections. One of the first things you will learn to check when a system fails completely is the power supply. You will check it for partial failures, too.

Another source of clues is the set of knobs and pushbuttons on the system control panels. With experience you will be able to manipulate these controls to find out what might be wrong within the system.

> *Note:* One advantage of checking the clues from these outer sources is that you may not have to tear the system apart to fix it. It is easier to start from the outside.

To gain entry to the system circuits, you must know how it is divided up into sections. Figure 1-1 shows how the system might be divided. In this case we have only three sections. There may be many more. Each of these has a particular job or function. Each modifies the output in a specific way.

Inside each section you'll find electronic circuits. Often a section consists of a single board on which the circuits are mounted. This will make it easier to identify and locate a section.

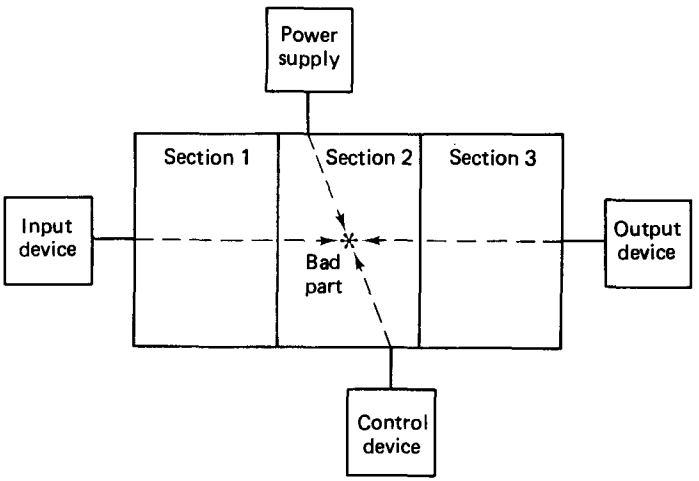

Figure 1-1 Dividing the electronic system into sections makes it easier to find the bad part. Note the four pathways to the target.

Inside the circuits you will find the individual parts. When any of these parts go bad, the entire system may fail. Figure 1-1 shows four possible pathways that lead you to the bad part. They start from an input device, an output device, a power source, and a control device.

Nearly all circuits are on the signal paths or bypaths between the input and output devices. Nearly all circuits have direct or indirect electrical lines from the power supply. Many circuits are connected to control devices.

1-1-1 The Game Plan

One of the main purposes of this chapter is to show you how to develop a game plan based on the way the system is set up. It will lead you down the pathway to the bad part. Along the way we preview some of the information found in the later chapters and sections. You can always come back here to see how they fit into the overall game plan.

To troubleshoot a problem, you will start from the outside and work your way in. This will be a step-by-step process. Each step will get you farther into the circuits. Each step will get you into the next step. This is your game plan. The major steps or phases of this plan will be as follows:

1. The outside: making the preliminary external checks, noting the symptoms, and deciding whether the trouble is in the equipment or in the user environment (including the user).
2. The gateways: checking the symptoms shown by the input, output and control devices, as well as the power supply; and making electrical checks on their lines and connections.
3. Working your way in: tracking down the bad electrical path from the gateways to the bad section or circuit with test instruments and common sense.
4. Nailing down the bad part: tracking down the circuit paths with test instruments to find and replace the bad part.
5. Cooking: operating the repaired equipment for 20 minutes or longer, sometimes for several days, depending on the type of fault.

We say that there are five major steps. More often than not, the first step or two can lead you directly to the defective circuit, sometimes right down to the bad part itself.

1-1-2 Divide and Conquer

At each step, the main idea is to divide your job into smaller segments. There are several advantages to this.

1. The smaller segments will be easier to work on because they have less things to contend with.
2. The smaller segments will give you more specific clues. This is where your knowledge, studies, and experience come in.

3. You can concentrate on one segment and not let the others bother you. If you pick the wrong segment, you can drop it and concentrate on another. Either way you will not have to follow up on all the imaginable possibilities.
4. Perhaps the most important advantage would be psychological. The dividing process fosters a "can do" attitude and a feeling of confidence. This is important for beginners.

1-2 PHASE 1: THE OUTSIDE

The worst thing a beginner or any technician can do is to start digging into the equipment without any preliminary investigation. Impatiently digging in like this can be a total waste of time. Unless something is burned out or visibly damaged, we have an iron-clad rule: Start from the outside.

1-2-1 The User Environment (The Preliminaries)

If possible, the preliminary checks should be made in the actual user environment. If this cannot be done, you will have to obtain as much secondhand information as you can over the phone or from the service ticket. You can also consult the field technician or whoever deals with the user.

Divide the user environment into:

1. The user
2. External wires, cables, and connections
3. Temperature, humidity, dust, and contamination
4. Interference (unwanted signals)
5. The controls (knobs, pushbuttons, and levers)
6. Input and output devices
7. The equipment itself

You must decide which of these seven possibilities to investigate first. With experience you will be able to look them over quickly and mentally eliminate most of them. Two major considerations will determine your choice: doing what is most likely to give you results, or doing what is easiest. Often, you can do both.

> TIP 1-1
>
> Never, never so much as lift a screwdriver without first going through the preliminary steps. Check the user environment if possible, and interrogate the user. Check all the external wires and connections, and check the controls, switches, back-panel fuses, and circuit breakers.

The detailed procedures for investigating most of the seven possibilities are given in the later chapters. Many are from Chapter 16, which deals with intermittent troubles. Here we preview a few things from the other chapters to illustrate the steps in the general game plan.

1-2-2 Interrogation

The first step in troubleshooting will involve the user. Remember, this person may not understand technical words. Use plain language. On the other hand, you must translate the user's language into your own. For example, when the user of a television set says "no picture," the actual condition can be any of the following: no raster (dark screen), no sync (broken or unstable picture), no vertical (horizontal line across the screen), no horizontal synchronization (many slanted lines), or no video (screen lights up with no picture). Each of these symptoms calls for a different line of action. Ask more questions to determine exactly what is meant by "no picture." Be tactful, and have confidence (in yourself and the user). Here are some important questions you can ask.

1. Can you turn the equipment on? The user may not know how to turn on and adjust the equipment.
2. How long does it take before it shows up?
   a. Parts and connections may go bad only after they warm up to a certain temperature. Once the equipment is on the bench, apply heat to the suspected parts to hasten the appearance of the symptoms. You cannot fix something that works okay. You will learn more about this in Chapter 16.
   b. When a fuse or circuit breaker blows out immediately, the power circuits are the prime suspects.
   c. Shorts in lower-power circuits blow the fuses and circuit breakers later.
3. When the trouble does occur, does it happen suddenly or gradually?
   a. Again, you can apply heat to the suspected parts to make the fault show up. You will also learn to monitor the electrical changes and learn about the symptoms that show up when a particular part or circuit fails.
   b. Sudden changes can occur when heat or vibrations break poor connections or cause unwanted connections to occur inside or outside a part. You will learn how to wiggle and tap the parts to locate the bad one.
   c. Sudden changes can also occur when part values reach a critical point that causes certain devices to switch on or off. You will learn to monitor voltages to see how far they are from the critical values.
4. What changes take place while it is acting badly?
   a. Each circuit changes the output in a certain way when a particular part in it changes value.
5. What time of the day does it show up, and under what circumstances?
   a. Power lines may have higher voltages at certain times of the day.
   b. Street traffic and spark-plug, as well as industrial machinery interference, may have peak periods.
   c. Nights and mornings may be cooler than afternoons.

d. Cranes at construction sites may change positions and deflect the signals at certain hours.

6. How long have you had this trouble—how many days, weeks?
   a. New industrial installations can cause interference.
   b. New high-rise construction can reflect signals and cause poor reception.
   c. Weather conditions, such as storm damage to cables and antennas, could cause troubles. Hot weather can cause trouble, too.

Here is another important reason why you should carefully question the user and obtain definite information. Sometimes you will spend hours on a problem of which the user may not even be aware. You will have trouble justifying your time. Before taking the job in, let the user know of any trouble you see or foresee. Note down clearly on the job ticket just exactly what the user wants you to work on.

One last reason why questioning is important. You may be wondering why we refer to Chapter 16 so much with regard to the user. The trouble may not even show up when the equipment is brought in for repairs. In these cases you must rely heavily on the user's comments.

1-2-3 What the Controls Tell Us

Besides the user, the control knobs and buttons can also tell us a few things. Not only can they tell us whether the equipment is really bad, they can also give us clues as to just where the trouble is internally.

Front- and back-panel controls, such as intensity or frequency controls, are connected to the circuits at strategic locations. Their actions give clues as to where the trouble is located. There are two types of controls. In Fig. 1-2(a) the control is an

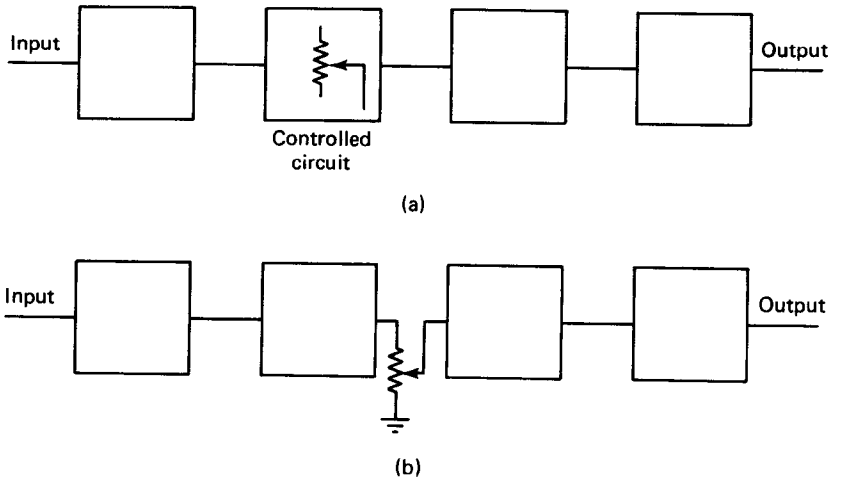

Figure 1-2 (a) Manipulating a circuit control may tell you whether or not the circuit is working. (b) A control in the signal path tells whether the trouble lies before it or after it.

integral part of the circuit. This type will give you clues by the changes that come about as you adjust it. A detailed knowledge of its role in the circuit will give you special clues. Also, the controlled circuit could lie in a signal path. This would give clues as to the location of the defect in the signal path.

The second type of control, shown in Fig. 1-2(b), is inserted in the path between circuits to modify the signal in some way, usually in strength. This control will also help you locate the origin of the defective signal.

In the following tips, "before" means toward the input device, and "after" means toward the output device.

TIP 1-2

If a control is in an extreme position to obtain a normal output, it may be compensating for a bad part.

TIP 1-3

If a signal symptom can be changed by adjusting a control that lies in a signal path, the trouble originates at the control or in the path before it. If the symptom cannot be changed, the trouble lies after it.

If the signal cannot be changed, and it is excessive, the ground terminal of the control could be open. (In Chapter 2 we tell you about "grounds" and "opens.")

TIP 1-4

Dirty controls in audio systems generate scratchy sounds at the speaker when manipulated. In video systems "noise" often appears as streaks on the display tube as you manipulate the control. On an oscilloscope it appears as jumpy or jagged waveforms. Any such "noise" pick up indicates that everything between the control and the output or pickup point is probably okay.

TIP 1-5

If the output changes suddenly or erratically as you slowly turn a control, the control could be dirty or broken. Before you replace the control, spray some control cleaner into it and rapidly turn the control back and forth to clean it.

1-3 PHASE 2: THE GATEWAYS INTO THE CIRCUITS

All electronics is nothing more than the interfacing of input devices to output devices. A simple example is the audio amplifier that interfaces a microphone to a speaker. Through one path or another, all electronic circuit parts are directly or indirectly connected to input and output devices.

A more complex example of an electronic system with all types of output and input devices is the video cassette recorder (see Fig. 1-3). It has a tape head, a cassette loader, an antenna connector, an audio input, a cassette loader, motor controls, various kinds of sensing devices, and more. (The dew sensor in the illustration detects

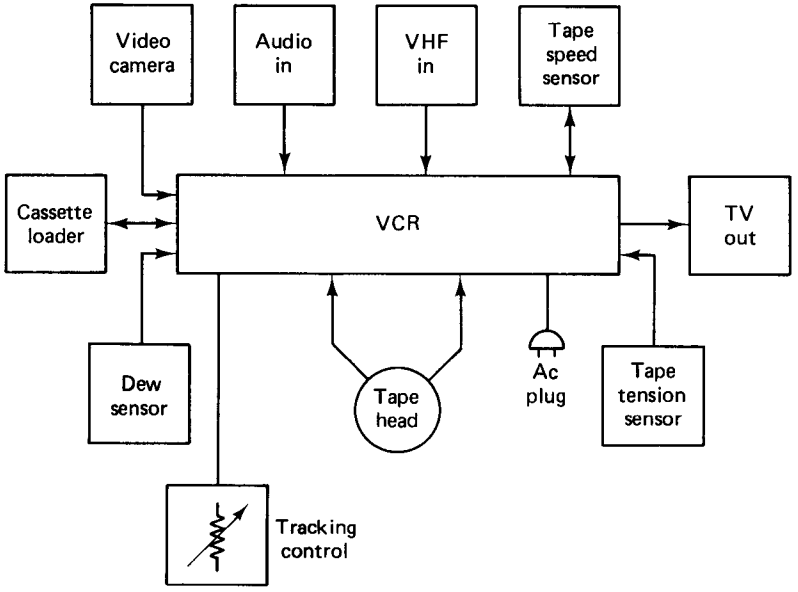

Figure 1-3 Electronic system with many input and output devices. Each can lead you to the defective circuit.

moisture on the tape.) Each one of the input and output devices in the illustration is a gateway into the circuits.

The power supply, as we noted before, is another gateway into the circuits. See the ac plug in the VCR diagram. We will learn in Chapter 6 that the power-distribution system reaches into just about every corner of the system.

The controls also constitute gateways into the circuits. Note the tracking control in the VCR system diagram.

1-3-1 The Input and Output Devices

There are two types of keys that open up the output gateways: clues that are picked up by your eyes, ears, nose, fingertips (symptoms), and clues that are picked up by your test instruments (electrical measurements). The symptoms will tell you which paths and circuits to check. The electrical clues at the output can be traced all the way back to the defective part.

Figure 1-4 is a simplified illustration of a defective color-monitor symptom and the dc signal path leading to the bad part. In this case the symptom is "no blue in the color display." We find a bad voltage on the blue output line. This line leads you to the blue color circuit. It leads you right to the troubled circuit and part. Note the break in the part that lowers the voltage below it. The up and down arrows indicate that the voltages have risen or fallen as a result of the break. In Chapter 7 you will learn why the arrow to the right of the amplifier points up instead of down.

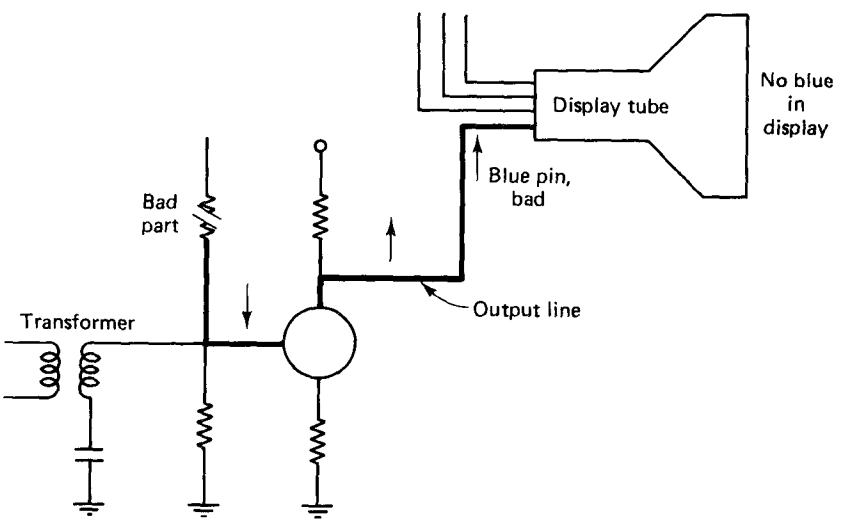

Figure 1-4 Voltage path leading from an output-device terminal to the bad part.