The Complete Guide to Electronics Troubleshooting

James Perozzo

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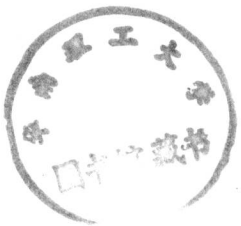

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Preface

This book is intended as a reference that new or experienced technicians will find valuable in the classroom and on the job. The material in this text can be covered with acceptable depth in as little as 8 weeks with advanced students, yet also serves well as a basic text for those just beginning a career in electronics repair. Together with suitable texts on basic theory, this volume is particularly valuable during the hands-on repair of actual equipment.

The basic difference in using this text as a supplement with either an 8-week or a full 2-year electronics program will be determined by the depth to which the students will be taken into real-world troubleshooting situations. It is strongly suggested that students be given the opportunity to actually try the methods presented herein, and that hands-on experience be interspersed with lectures covering the material in detail.

Unlike most texts, the instructor can choose to begin at the front, middle, or back without necessarily having to build on previous information to enhance other subjects besides troubleshooting that may be taught concurrently. The order of topics in this book begins with system troubleshooting and progresses to component removal and replacement. Each topic is covered at the point where it is most appropriate. The use of a bench power supply, for instance, is covered when it is most timely, after the equipment is opened and before the technician begins to troubleshoot with a voltmeter. Thus, *the flow of the book may appear to be somewhat scattered to those accustomed to topics being covered in a less chronological, modular form.* However, the topics are ranged, as closely as possible, in a logical, connected order.

Side-barred text identifies basic concepts and material pertinent to the troubleshooting topic of the moment, information that will prove beneficial for the entry-level technician. More advanced students may chose to review, scan, or skip these subjects entirely.

Prerequisites for the use of this book are training in basic electronics, including bipolar transistors, and in digital circuits. Other subjects and special components are explained in this text as they directly apply to practical troubleshooting.

There are three general types of jobs involving electronic problem detection and repair. The first is the one that most commonly comes to mind when one describes an electronic technician, that of returning "veteran" equipment to service. "Veteran" equipment has worked at one time, but because of a normal failure or abuse, it no longer functions properly or has failed altogether. The majority of electronic technicians find employment in this kind of job. There are two subdivisions of this kind of work: that of the field technician who goes to the customer's site to repair equipment and the bench technician who repairs incoming equipment at a fixed location. Some jobs require both field and bench work.

The second kind of job is the production-line technician, who detects problems in brand-new circuits that have just come off the end of the assembly line at a factory. This job is explored in Chapter 24. A detailed knowledge of troubleshooting is not usually required to be an assembly-line technician. The defective unit is simply detected and put aside in order to keep the assembly line moving. Defective circuits may then go to a bench technician if the assembly-line technician does not have the troubleshooting skills or the time necessary to pursue the problems further.

The third kind of job is the engineering assistant. This technician must be very familiar with the troubleshooting procedures within this book, plus a great deal more. This is the highest level that a technician can achieve. Advancement beyond this position will usually require an engineering degree.

An electronic technician can be thought of as an electronic "doctor." Just as the medical profession consists of general practitioners and specialists, so does the electronic technician profession. Within the overall job classification of electronic technician can be found many specialties, including analog, radio-frequency, digital, and microprocessor technicians, and field and bench technicians. This book is intended to serve as the basic troubleshooting reference for all technicians, regardless of specialty.

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CONTENTS

Some Necessary Basics

1

CHAPTER OBJECTIVES

This chapter provides a review of important, fundamental facts that must be clearly understood before beginning a study of electronic troubleshooting. At the conclusion of this chapter, the student will have a clearer understanding of terms and concepts, including:

- The need to first understand basic component operation: resistors, capacitors, inductors, and bipolar transistors.
- Basic safety and cautions to protect you and your equipment.
- Conversion between metric units.
- The definitions of ground, common, neutral, and chassis.
- The concepts of circuit impedance and internal resistance.
- Real-world definitions of shorts and opens.
- The methods used to number and identify component and integrated circuit leads.
- Memorizing a few simple, typical circuits.
- The importance and use of color codes.
- The importance of thoroughly understanding logic functions for basic gates.

- The understanding of classes of analog amplifier operation: A, B, and C.
- Number and type of hand tools for a minimal toolbox.
- Test equipment requirements, as determined by the type of equipment to be repaired.

1.1 ELECTRONIC KNOWLEDGE REQUIRED

Troubleshooting of electronic equipment only to the equipment or the card level can be done easily and requires little electronic knowledge. A simple substitution of suspected equipment or cards is generally sufficient to find and replace a malfunctioning unit and get the system back into operation quickly. However, repair to the component level demands knowledge far above a simple replacement of equipment or a card.

KNOW HOW COMMON ELECTRONIC COMPONENTS WORK

A really competent electronics technician must be able to troubleshoot to the component level if necessary. For that, the technician must have a thorough knowledge of how individual electronic components function. Resistors, capacitors, inductors, diodes, transistors, bipolar transistors, insulated-gate transistors, and silicon-controlled rectifiers are only a few of the basic components that must be understood before troubleshooting to the component level can be done competently. Most electronic schools offer these subjects.

The actual repair of equipment entails much more than a knowledge of components. Understanding the operation of electronic systems and the functions of equipment within those systems is necessary before component-level troubleshooting can be done productively.

1.2 SOME BASIC DOS AND DON'TS

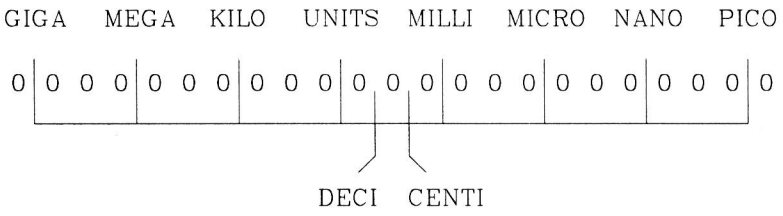
The following tips are not a complete list of what should or should not be done to prevent damage to you and your equipment. However, they are items that should be kept in mind and applied when appropriate.

1. Always turn off all power before removing or inserting circuit boards into equipment.

2. Remove rings or metal watchbands when working near high-voltage or high-current equipment because of the danger of shocks or burns.
3. Always connect the negative or ground lead of test equipment before contacting high voltage with the "hot" lead.
4. Always connect a suitable dummy load to a radio transmitter. This prevents damage to the final amplifier and interference to normal on-air signals.
5. When interconnecting equipment to a computer system, never connect a parallel device to a serial port or a serial device to a parallel port.
6. Discharge static electricity to ground before touching modern solid-state devices or boards. Use static-prevention products when available.
7. When turning on audio equipment, be sure the volume controls are turned down. Speakers can be damaged by excessive power settings.
8. Apply power to CMOS circuits before applying input signals.

1.3 CONVERTING ELECTRONIC TERMS

It is important to be able to convert both ways without error, from one metric multiple to another, when dealing with electronic quantities. The following figure may help in visualizing these conversions; the method an experienced technician carries out mentally. See Figure 1–1.



Place the value you have with the decimal point on the end of the line beneath the proper current multiple.

Now move the decimal point alone to under the new multiple and place it on the end of that line.

Example: Convert 0.5 milliwatts to watts.

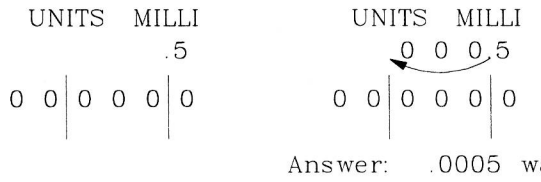


Figure 1–1 A graphic means of converting between metric multiples.

Practice converting terms up and down the metric scale until you are confident in your ability to do them free of errors. In particular, practice converting between the multiples as shown, for they are the most common in electronics:

Converting between hertz (Hz), kilohertz (kHz), megahertz (MHz), and gigahertz (gHz).

Converting between ohms (Ω), kilohms (kΩ), and megohms (MΩ).

Converting between microfarads (MFd) and picofarads (pFd).

Converting between seconds (s), milliseconds (ms), microseconds (μs and nanoseconds (ηs).

1.4 COMMON SCHEMATIC SYMBOLS

It will be necessary to be able to recognize the common schematic symbols that you will see on schematics. See Appendix II for a complete listing of these symbols.

1.5 THE VOCABULARY OF ELECTRONICS

The field of electronics, as with any profession, has its own vocabulary. New electronic terms are defined in most electronics dictionaries, which are often available at local specialty electronics stores. Some terms used are very important to troubleshooting, as explained in the following paragraphs.

To clarify any possible misunderstanding, study the following terms and definitions, which will be used in this text.

BASIC INFORMATION

LIVE AND DEAD CIRCUITS

For the remainder of this book, the term *live* will simply mean that all operating voltages are present to operate the circuits under test. A *dead* circuit is one that has no external operating voltages connected to it at all.

IN-CIRCUIT AND OUT-OF-CIRCUIT

If you can hold a single component in your hand, separate from any other equipment, it is *out-of-circuit*. If one lead of the component remains connected to the circuit but all other leads are disconnected, the component is still out-of-circuit. This is a common situation when testing components with an ohmmeter. Disconnect all component leads or leave no more than one lead connected to the circuit. The component is then effectively out of the circuits for further individual testing. An in-circuit component is fully