

Practical Handbook of Low-Cost Electronic Test Equipment

Robert C. Genn, Jr.

illustrated by E. L. Genn

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The Many Ways This Book Will Help You Accomplish More with Low-Cost Test Equipment

Have you ever wished for a mini-computer programmed to give you fast answers to questions on troubleshooting? Do you hesitate to purchase more expensive test equipment because you're not certain you're getting the most from the equipment you already have? Do you agree that of all the facilities available to the technician-experimenter, test equipment is the most important? Would you like an extraordinarily helpful "assistant" that you can rely on for practical solutions to problems with test equipment? If your answer to these questions is yes, this book has been written for you.

Every chapter is brimming with realistic, simplified techniques that show you how to make inexpensive test equipment do double or triple duty. Packed with special techniques, all based on solid experience, this book will help you get far more out of multimeters, basic oscilloscopes, color TV alignment generators, and a wide range of low-cost test equipment. For example, I don't own an oscilloscope and would like to check the ripple of a DC power supply. No problem. Simply turn to Chapter 1, and you'll find a way to do so with nothing but a volt-ohmmeter (VOM). You'll also discover many new tricks to use with common shop equipment such as transformers, DC power supplies, and soldering guns. Moreover, all of the tests and modifications described in this book will be

detailed in the simplest possible way, with procedures that spell out *exactly* what to do, step-by-step.

Chapter 2 will show you how to re-use burned out tubes by using them to construct octal plugs and hook-up cables. In fact, every chapter shows you how to increase the versatility and range of your test gear, providing ideas that will save you time, energy, and money. For example, there is a unique section in this handbook that deals with automotive electrical problems that you can solve quickly and easily with nothing but your VOM.

As another example, did you know that with a few spare parts you can transform a basic, inexpensive scope into one of the most informative, most versatile, and most reliable test instruments you have ever used? The practical know-how is in Chapter 8, and you can probably find the few parts needed in your junk box of odds and ends.

A problem that can be especially tough is measuring decibels of attenuation at a multitude of points on a waveform if you don't have special equipment. Chapter 9 shows you how to make a simple scale that will reduce the time needed to do the job to seconds, and it can be done with any oscilloscope.

All chapters will cover test equipment and troubleshooting procedures that will help you get more out of every piece of test gear in your shop. The last two chapters are comprehensive *practical* guides to modern low-cost TV test equipment and how to use this gear when troubleshooting. Both include detailed guidelines on applications and general test techniques for all the TV test instruments found in the average shop.

It isn't necessary to wade through endless theory or background data to get the *usable* information you need. All you have to do to answer any question is check the index and turn to the page indicated and you'll find realistic advice and simplified techniques for making your test gear do double duty. You will find that we have eliminated all unnecessary, time-consuming material pertaining to electronic theory and have concentrated on subjects that are essential to helping you do your work *skillfully, quickly, and inexpensively*.

The Bureau of Labor Statistics predicts that close to a half-million electronics engineers and technicians will be employed by industry in the next five to eight years. The number of experimenters and electronics hobbyists will amount to a far greater number. Because of the impressive growth in this field, many authorities are predicting that consumer electronics may become the source of more jobs than any other single industry in the world. Every chapter in this book is full of practical ideas and techniques that are essential for the person who wants to work more successfully with electronic test instruments and equipment in this leading growth industry.

Robert C. Genn, Jr.

Also by the author

Workbench Guide to Electronic Troubleshooting

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Tested Techniques That Make Your Multimeter Do Double Duty

1

This chapter contains tested techniques that will enable you, in effect, to double the value of your multimeter. It will show you how to use your volt-ohmmeter (VOM) as a power monitor, capacitance checker, and induction measuring instrument. It will also enable you to perform a host of other checks and measurements that you may have thought were impossible without purchasing new and expensive equipment.

One area of electronic troubleshooting that many electronic technicians have considerable trouble with is automotive electrical systems. As a bonus, this chapter shows how to use an ordinary VOM to test distributors and ballast resistors, and how to quickly locate blown fuses that you may encounter while working with CB equipment, tape decks, and other electronic gear found in vehicles.

EFFECTIVE VOLTAGE-RIPPLE CHECKS WITH A VOM

There are many uses for the VOM that most of us do not always apply to our advantage. For example, if I suspect a DC

power supply filter system isn't working properly (you'll hear hum in radios or see weaving in TV pictures if there is excessive ripple), I usually grab a scope even when I have a good VOM in my hand—which only proves that it's hard to break bad habits.

If you want to check for excessive ripple voltage with your VOM, all you have to do is set the function switch to AC and measure the power supply's output. When you are making this check, it's better to read the peak-to-peak voltage scale if there is one on your meter. What you'll see on the output depends on the type of filter system you're checking. For example, if you're working on a two-section choke input filter system and the input capacitor opens, you'll see a considerable increase in ripple voltage but very little change in the DC output voltage. But if the output capacitor of the same system opens, you'll see the DC output voltage decrease by a substantial amount and an increase in ripple voltage.

As another example, when you're checking a simple AC-DC power supply like the ones found in many older radio receivers using series string tube filaments—typically, they use half-wave rectifiers and a resistor in place of the filter choke—you'll see a large DC output voltage drop if the input capacitor opens and, of course, a large increase in ripple level. However, if the output capacitor develops an open circuit, you'll see very little change in the output voltage but you will have a large increase in ripple voltage amplitude. As you can see, with just a little experience you can tell a lot about power supply filter circuits from a couple of measurements with your VOM.

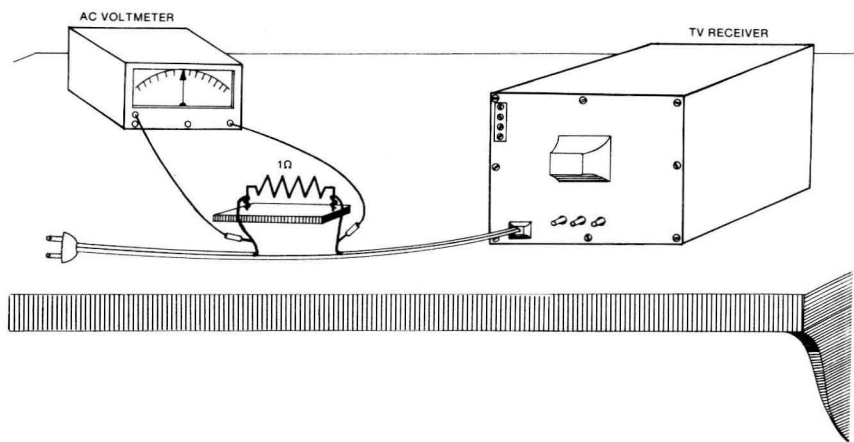
To ease the pain of troubleshooting, here are several other possible causes of hum in the output of a power supply.

1. A defective diode in a full-wave rectifier circuit.
2. A defective filter choke.
3. Trouble in the voltage regulator circuit. You'll probably find above-normal load current in this case.
4. Improper soldering (cold soldered joint), broken connections, or incorrect values of component parts can also cause increased ripple. Be sure to check these possibilities.

Sound simple? It is. In fact, these checks are so simple that they are frequently overlooked. Furthermore, they can be real life-savers if you don't have a scope handy. However, if you are working with a regulated supply, it's better to use the procedure given in Chapter 9.

HOW TO USE A VOM AS A POWER MONITOR

Frequently, a technician needs a wattmeter and one isn't available. Naturally, if a wattmeter is handy it's the best instrument to use. On the other hand, if you don't have one, you can make a simple wattmeter that will determine the power of resistive loads—such as radio and TV receivers—by using a 1 ohm resistor and your voltmeter. To make the measurement, place the 1 ohm resistor in series with the equipment under test and connect your voltmeter as shown in Figure 1-1.



**Figure 1-1: Connections for
measuring power with an
AC voltmeter**

After you have the circuit set up, first measure its line voltage and then measure the voltage drop across the resistor. Now, here's the secret. You'll read 1.0 volt on the meter for each 1.0 ampere of

current flowing in the circuit. Therefore, all you have to do is multiply the meter reading by the line voltage reading. For example, if you read 110 volts on the line and 1 volt across the resistor, the power is 110 watts. Incidentally, if you don't have a 1 ohm resistor with the desired wattage rating, you can make one using the heating elements from old electric heaters, electric irons, or discarded toasters.

Let's stop right here and emphasize a few warnings. There are electronics techs who rely on their sixth sense to tell them when they are getting into trouble when working with AC power lines. For the rest of us, there are rules to follow.

1. Remember, ordinary 120 volt household power can kill. *You should not work on energized electrical circuits alone.*
2. When you're servicing power circuits, turn the power off. Place the switch to the off position, pull the plug, or pull a fuse.
3. Never connect any instrument across an AC power line unless you're sure there are no test leads at ground potential. Pay particular attention to VTVMs and TVMs and other meters that have one test lead connected to ground. If you don't, you're sure to see sparks fly and you, plus your equipment, may be ruined!
4. You should use a variable voltage source and increase the power line voltage slowly. This allows you to monitor the current flow and avoid any excessive current.

After you have made the measurement, your next step is to check the manufacturer's plate or instruction manual for the equipment under test. Let's say your power measurement is fairly close to the manufacturer's recommended value. In this case, leave the equipment on for four or five minutes and monitor the voltmeter reading. The reason for doing this is that you want to be sure the piece of heating element doesn't change value when heated.

As soon as you're sure it doesn't change value when heated, you're ready to start making equipment checks. For example, if you're checking a piece of gear and find your reading below the